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Linking the Past and the Future**

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## **Ethics and Appropriate Technology: An Integrative Model\***

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**Abstract:** *What role should philosophy as ethics play in appropriate technology? Stephen Hawking announces that “philosophy is dead.” E.O. Wilson argues that philosophy and a fortiori ethics should ground themselves in science. Against this STEM tide, the German philosophy Friedrich Nietzsche over one hundred years ago saw philosophy as a guarantor of life’s future. As an exercise in ethics, philosophy must demolish old life-destroying values and replace them with new life-enhancing values. A more recent United States philosopher, Richard Rorty, claims that a single person or discipline cannot execute philosophy’s mission. Rorty argues that the philosopher is dead. However, philosophy itself is reborn as a gathering together of all the intellectual disciplines—including science and technology. The paper’s methodology is to propose a model for the relationship between ethics and appropriate technology. Appropriate technology is here defined as macro- or micro-scale technologies that serve to guarantee the future of life. Judgments concerning the ethics of any proposed appropriate technology must be the collective work of humanists, philosophers, physical and social scientists, engineers and technologists in close cooperation with community members, both local and global, whose survival and flourishing will depend on the quality of those judgments.*

**Keywords:** Nietzsche; Rorty; philosophy; ethics; methodology; appropriate technology

**Paper category:** Policy, standards and ethics

### **INTRODUCTION:**

Prominent scientists like the physicist Stephen Hawking (2015, 5) have proclaimed the death of philosophy. In a Howard University lecture, the biologist Richard Dawkins and the astronomer Neil deGrasse Tyson (2010) announced that philosophy has outlived its usefulness with respect to science. The biologist E.O. Wilson (2014) argues that philosophy and the humanities should ground themselves in science. The psychologist Stephen Pinker (2011, 2013, and 2018) insists that religion can no longer shed light on the meaning and direction of life because science has falsified the claims of virtually all religions. For Pinker, the future of life must take its direction from science.

Bolstered in part by the pronouncements of these distinguished scientists, universities are cutting back funding for philosophy, religion and the other humanities to bolster the STEM disciplines. The German philosopher Friedrich Nietzsche foresaw the catastrophic results of this policy far before our 21<sup>st</sup> century. In the late 19<sup>th</sup> century, Nietzsche prophesied that the coming century would replace religion with science and unleash wars of unimaginable scope and destruction. New technologies like the airplane would foster a globalization dominated by unguided control of the earth’s resources.

The essay’s first methodology section focuses on Nietzsche’s (2014/1887, III [14], 91) extraordinary claim that philosophy must serve as the “guarantor of the future” of life. Philosophy’s method is to destroy foundational values that no longer promote the preservation and growth of life. Philosophy as ethics must propose new values that have experimental promise for saving life.

The second methodology section revises Nietzsche's method with the United States philosopher Richard Rorty's (2016) claim that philosophy can no longer be practiced by individual philosophers. Philosophy's scope, particularly in the field of ethics, requires the synoptic vision of teams of researchers in the full spectrum of intellectual disciplines, ranging from philosophy through science and history to the arts including both the fine arts and technology.

The paper's results and discussion section proposes a demarcation line between appropriate and inappropriate technology. Stephen Pinker's (2011, 2018) controversial volumes attribute the decline of human violence to a fusion of technology and the humanities. He speculates that powerful literature like *Uncle Tom's Cabin* helped develop empathy for enslaved Africans. However, that literature could only exert its widespread force because of the printing press's invention. Current information communication technology (ICT) makes the printing press a halting first step toward the universal dissemination of information. Renewable energy and infinite recycling of other resources promise a reduction of our 300,000 years of struggle over resource scarcity, whether real or merely perceived. Automatization of labor that does not require creative human consciousness promises less rigid economic restrictions across classes.

The conclusion considers whether philosophy and the humanities have the power to move humanity toward Nietzsche's goal: the preservation of life through growth. Given predictions by prominent scientists like Hawking on the end of life through global climate change between 100 and 1,000 years from the present, the marriage of ethics, appropriate technology and humanities oriented toward the preservation of life is humanity's best hope.

## **METHODOLOGY**

The paper's methodology examines two prospective models for ethics. The first is based on Nietzsche's claim that philosophy as ethics has a paramount goal: to guarantee the future of life. His model is to propose new values to replace old values that can no longer accomplish this task. The second is grounded in Rorty's claim that philosophers alone cannot accomplish this goal. Rorty envisions philosophy's method as a form of synoptic vision that secures input from all intellectual disciplines to make judgments about policy, standards and ethics.

### **Part I: Nietzsche's Model**

Nietzsche was driven by fear of science and technology overwhelming European culture. He (2014/1887) predicted that science would subsume the roles religion had played in European culture. Science and technology (2001/1887) unmoored from the guiding lines of the humanities would let loose the dogs of war. Nietzsche (1996/1880) predicted wars of unimaginable breadth and devastation, driven by technological innovations such as airplanes.

Philosophy and philosophy alone has the power to accomplish the world's most critical mission: to guarantee the future of life on earth. Philosophy (2001/1887, V [343], 199) accomplishes this task by reason of its method: synoptic vision. Greatly influenced by Greek culture, Nietzsche believed in the literal sense of the Greek word, *philo-sophia*, a love of wisdom defined as total knowledge. A philosopher's knowledge must include both the sciences and the humanities.

Nietzsche believed that philosophy's task is to revalue all values, by analyzing correlations between values and their ability to execute philosophy's mission—guaranteeing life's future. He states: "*All sciences must, from now on, prepare the way for the future work of the philosopher: this work being understood to mean that the philosopher has to solve the problem of values and that he has to decide on the rank order of values*" (2014/1887, I [17],

34). Philosophy is an experimental “science” in the sense that its pronouncements about value must be tested against experience.

For Nietzsche, philosophy must be the engine that directs growth. Philosophy must rely on the imaginative power of the arts and the controlling power of the sciences. Philosophy is effectively the gate-keeper between imagination and control. A perfect philosophy would be a science capable of guaranteeing the future of life. It is not something possible now. Nietzsche (2001/1887, I [7], 34-35) imagines experiments taking centuries to complete to turn philosophy into science. Such experimentation would “eclipse all the great projects and sacrifices of history to date. So far science has not yet built its cyclops-buildings; but the time for that will come too.”

## **Part Two: Rorty’s Model**

Richard Rorty (2009a&b), late 20<sup>th</sup> century American pragmatist and acute disciple of Nietzsche, envisions a distinct evolutionary trend in human thought. Unable to comprehend or control the forces of nature, humans made up mythological tales to explain what they could not understand. As the human capacity for reasoning became more acute, humanity turned to philosophy for more rational accounts of our experience. Socrates was martyred because he used reason against mythology. With the advent of modern science, philosophy in turn was shown to be an irrational attempt to explain the unexplainable.

Like Nietzsche, Rorty feared that unchecked science and technology would destroy humanity’s prospects. Only the humanities, by imagining new ways to carve out the future, have the power to save humanity from the STEM disciplines. Tracking his own abandonment of philosophy for literature departments at the University of Virginia and Stanford, Rorty in two of his last essays stated that Shakespeare and Cervantes have done more for the advancement of life than the collective works of all the philosophers.

Rorty’s (2016) last published volume expresses his ambivalence about philosophy’s future. He titled the book, *Philosophy as Poetry*, as if philosophy might still have the power of literature and poetry to save life from the STEM disciplines. However, in the early part of the work he reaffirms his conviction from his last two essays that only the emotional power of the humanities has the potential to sway humans away from self-destruction.

In the last few pages of the volume, Rorty (2016, 59-61) proposes a new role for philosophy, one that takes philosophy away from the philosophers and reassigns its tasks to teams of researchers. Rorty assumes that what has bound philosophers together from the time of Plato and Aristotle to the present moment is synoptic vision, the effort to comprehend all possible experience with single visions of reality. The dramatic successes of science in the work of Darwin and Hertz in the 19<sup>th</sup> century and Einstein and Bohr in the 20<sup>th</sup> century made it impossible for a single person to comprehend science at a depth that would permit a philosophical generalization over both the sciences and humanities. Earlier philosophers like Descartes and Kant had such a firm grasp of both science and philosophy that they could make contributions to the fields of gravitation and cosmology. Nietzsche was perhaps the last philosopher who could imagine that his value judgments could be grounded in both the sciences and humanities.

Rorty makes a provisional suggestion that historians should take over the philosopher’s task of synoptic vision. In the end, however, he concludes that only teams of researchers from all intellectual disciplines can command both the empirical and emotional power to carve out humanity’s viable paths to the future.

Ironically, Rorty announces the death of the philosopher in the re-birth of philosophy. Rorty (2016, 61) affirms that “philosophy always buries its undertakers,” but he postulates a quite new vision of philosophy’s method. No single mind is capable of grasping the whole of human experience and knowledge in order to make competent judgments about the

reevaluation of values that will guarantee the future. Only teams of thinkers with a sound base in the history of their disciplines' engagement with life can master that competence. The next section explores the possibility that ethics teams from a wide range of disciplines may integrate the humanities and sciences with engineering and technology to promote the fusion of ethics and *appropriate* technology. The recommendations of these teams must include deliberative feedback from the communities whose futures depend on their merits.

## RESULTS AND DISCUSSION

To this point, the paper has emphasized the dangers to life threatened by science and technology unchecked by ethics and the humanities more generally. The key question is whether technology can be the very instrument with the capacity to fulfil Nietzsche's charge: guaranteeing the future of life. The claim may seem preposterous in the face of chemical, biological and nuclear weapons of mass destruction—to say nothing of the technologies that threaten the sixth mass extinction through global climate change, the instrument of the five previous mass extinctions (Schell 2000, Gardner 2011, Kolbert 2014).

Technology is a double-edged sword. Science, oddly enough, is not the danger. Science is simply the generalized description of experience. The danger arises from the uses to which science is put: namely, *inappropriate* technologies. *Appropriate* technologies are here defined as those which have the promise to guarantee the future of life. *Inappropriate* technologies are those which promise the opposite.

Influenced by Schumacher's (1989) *Small is Beautiful*, appropriate technology has been seen as small scale technology. Nothing could be further from the truth. From *Homo erectus*' first use of fire some millions of years ago to today's concentrated solar power towers in the world's deserts, scale yields to utility. Without fire, humans could not have defended themselves against other top predators who did not discriminate on their preferences for flesh. Without those present-day towers and photo-voltaic "farms" in areas of high solar energy, humans cannot defend themselves against the scarcity of energy that necessarily leads to the deployment of weapons of mass destruction and global greenhouse gas production.

Harvard anthropologist Richard Wrangham (2004) claims that human intra-species kill rates have declined precipitously over the past 10,000 years. Our rates matched those of the two other top predators, wolves and chimpanzees, in hunting and gathering and proto-agricultural periods. Wrangham is careful to note that his research covers kill rates rather than absolute numbers killed.

The world wars and genocides of the 20<sup>th</sup> century saw far more humans killed than perhaps any previous century. However, humans numbered in the billions in that century. During the *Homo erectus* extinction period, the human population may have been reduced to mere thousands due to global climate change. Not many humans would have to have been killed to achieve very high kill rates.

Darwin (Darwin, *Descent of Man*, cited in Wilson 2016, 210) announced the two principles that drive kill rates. First, groups must increase their numbers to the point where other groups cannot compete. Second, group members must bond themselves so tightly together that they are willing to die for the sake of the group. Over the past 10,000 years, the *territorial imperative* for all mammals has become the *capital imperative* for humans.

Animals like wolves and chimpanzees increase the size of their groups by taking territory from neighboring groups. They must constantly patrol their territorial limits to prevent incursions unless environmental niches are sufficient to ward off conflict. Historically, humans through technology have transformed the territorial imperative into the capital imperative. Where circumstances permit, humans advance on their neighbors, sometimes assimilating or displacing them, sometimes enslaving or killing them.

As agricultural and weapons technologies advance, human groups evolve from small tribes to tribal nations to nation states to empires. Group expansion decreases the intra-species kill rates of humans. Currently five empires—China, India, Russia, Western Europe and North America—effectively control the earth. Technologies of mass destruction have for the past three-quarters of a century served to prevent the overthrow of one empire by another.

Far-sighted religious thinkers and philosophers like the Buddha, Christ, Kant, Marx and Hegel envisioned a time when all humans will define themselves as part of a single group. The three philosophers imagined this event could only take place through global warfare when one group emerges victorious. Nietzsche prophesied that the group would be the collective nations of Europe (2003/1885-1888, 2 [57], 71).

None of these thinkers could have imagined that technology is now so advanced that it has the power to stop nearly all life on earth. Current weapons of mass destruction do not have that force, but the potential to exterminate human life through biological weapons increases by reason of advanced gene-sequencing techniques like CRISPR. The 19<sup>th</sup> century German philosophers who imagined that a final Armageddon yielding a single super-power that would dominate the earth suffered from a failure of imagination.

Can there be any hope that humans could begin to think of themselves as comprising a single group? Could *appropriate* technology be the grounds for this hope? My hypothesis is that a perception of scarcity rather than an acute genetic need for dominance has been the engine of group conquest. Groups under conditions of scarcity, whether real or perceived, define themselves restrictively through genetic, linguistic and cultural markers. As those conditions abate, genetic, linguistic and cultural diversity become desirable for powerful groups. Until the recent advent of its catastrophic economic bankruptcy (some 20 trillion dollars in debt) and presidency, the world's most powerful new empire, the United States, at least in some quarters prided itself on those three kinds of diversity.

Does the world now have the capacity to forge *appropriate* technologies that have the power to eliminate the perception of scarcity? Three principal forms of scarcity have driven inter-group contestation: energy and other material resources; labor; and information creation and dissemination. The United States entered into unwinnable wars in Korea, Vietnam, Afghanistan, Iraq and now Syria in its efforts to control global energy and other resources. U.S. rhetoric has always involved “making the world safe for democracy,” but its practice has been commanding resources to insure its quality of technology-based life. By losing the recent election by more than 3 million votes, the current president has demonstrated that the U.S. is far from being properly defined as a *democracy*. That same president heightens the perception of energy scarcity by imposing unworkable tariffs on solar energy technology.

Machine technologies have reduced the scarcity of labor to the point where chattel slavery could be abolished—to be replaced, to be sure, by wage and debt slavery and human trafficking. The work week in technology-based nations like Germany has been reduced to three or four days a week for highly skilled workers.

The internet has made the global dissemination of information possible. Under our present conditions of perceived scarcity, only some two billion of the earth's seven plus billions have internet access. Information access now carries a high cost, in terms of both economy and time. Full access to the world's global information store now requires some 16 years of schooling. (The word *school* comes from the Greek word, *schole*, meaning leisure time.) The ability to add to the world's store of information may require many more years in pursuit of technical degrees like JDs, MDs or PhDs. Gatekeepers of information like publishers of journals and books demand revenues for their products far beyond their costs and ethical profits.



Access to information has always been the dividing line between upper and lower classes. The former have the leisure and the means to acquire information at their will. The latter have access to information sufficient to allow them to perform unskilled labor. Knowledge continues to be the dividing line between those with and without power.

Appropriate technologies will reduce energy scarcity through solar renewables and introduce infinite recycling of other material resources. Through automatization, appropriate technologies will eliminate the need for human labor that does not require creative human consciousness, and increase human command of leisure time. Through increased leisure and advanced Information Communication Technologies, virtually all humans will have access to what now counts as a university education (Bowen 2013). Humans driven by the desire to create new knowledge will hold the virtual equivalent of a PhD by solving unsolved problems. Those driven by the desire to create new art forms will astound the world with their prowess.

## CONCLUSIONS

The primary unsolved problem is whether humanity has the will to execute these three primary appropriate technologies in order to avert catastrophic global warfare and climate change. President Trump, the Koch brothers and their followers speed our path to the sixth mass extinction through global climate change. The global North/South divide insures that 2.5 billion do not have access to sanitation that can preserve the lives of their newborn.

The Harvard psychologist Stephen Pinker (2011, 2018) has written two controversial volumes on the decline of human violence over the past 10,000 years. The first is an historical account and the second is a statistical record defending the claims of the first volume. His research's importance for the essay's concluding remarks is his insistence that violence only declines with the fusion of technology and the humanities.

Pinker believes that humans have a deep capacity for empathy that includes not only humans but animals and other life-forms. However, the expression of empathy depends on technology. Vegetarianism becomes an ethical issue only when agricultural technology advances to the point where protein consumption no longer depends on killing relatively complex life-forms. Capital punishment becomes an ethical issue when penal technology renders it unnecessary in advanced economies. Abortion and infanticide become moral issues only when contraceptive technologies advance to the point of making them unnecessary. Vengeance becomes unethical when advanced political technologies make personal vengeance illegal and severely punished. Chattel slavery becomes unethical in machine-based economies.

Nonetheless, Pinker (2011) holds that technologies independent of the steering mechanisms of the humanities are incapable of moving humanity toward empathy. Literature like *Uncle Tom's Cabin*, Pinker believes, moved humans to identify with Africans as fellow humans. The paper's section on Rorty affirmed his sense that great literature like that of Cervantes and Shakespeare has done more to change humanity's ethical sensibilities than all the works of philosophers. Unlike Rorty, however, Pinker insists that without the technology of printing presses, literature could have no effect whatsoever, since only a few would have access to hand-copied books.

One of Pinker's most forceful examples of the fusion of technology and the humanities is the Vietnam War. Resistance to the war was fueled by photographs, documentary films, literary accounts, and the ever-pervasive nightly news on TV. Pinker singles out the photos of the Vietnamese girl running from napalm bombs and the point-blank pistol execution as having great emotional force to turn the U.S. electorate against the war.

The conclusion proposes a new fusion of technology and the humanities: an online global map of human misery. Empathy that has practical consequences cannot arise without

a direct experience of another self. The map would color-code all the earth's areas with an index of misery. The global South would bear the greatest burden, with a concentration in equatorial Africa. *New York Times'* estimates of human deaths in the Eastern Congo since 1998 approach 5 million, nearly the numbers of the European World War II holocaust. The Eastern Congo is the site of scarce resources like coltan and tantalum, minerals critical to the production of cell phones and jet turbine fan blades. Destabilization of the area by neighboring governments leads to the high death toll. At present, few in the global North are aware of the catastrophic loss of life in Africa.

The point of the map of misery is to make that loss real to the two billion humans who may have the will and the means to stop this new holocaust if they are made intimately aware of what is happening. The map would not restrict itself to the global South. The impoverished in the global North do not have access to the technologies that guarantee the quality of life. Clicking on the map's areas would bring up historic and real-time images of what is happening on the ground in both the North and South. The map's on-the-ground content would rely on the power of the humanities to draw forth the empathy that Pinker believes fuels the decline in violence.

E.O. Wilson (2012, 2014, 2017) lends hope to Pinker's optimism about the human milk of kindness with his recent research suggesting that humans are *eusocial* or *good in groups*. Rejecting earlier hypotheses that humans are genetically condemned to sacrifice self-interest only for the sake of their close kin, Wilson now believes that humans are genetically inclined to sacrifice self-interest for the sake of their groups. The past 10,000 years have shown that humans have the capacity to go far beyond genes, language and culture as defining elements of their groups. Through their unbounded imagination at play in the fusion of ethics, appropriate technology and the humanities, humans now have the potential to define their *group* as the *whole earth* including all its inhabitants (Singer 2011).

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\*NOTE: Citations for Nietzsche's texts include in sequence publication date of translation, original date of publication, book or part number, section number, and page number in the translated edition.

## Leveraging Corporate Social Responsibility for Ethical Appropriate Technology Innovation, Incubation and Development

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### Abstract

*Corporate Social Responsibility (CSR) has been enshrined and articulated in the Companies Act of 2013 in India. Under this Act, corporations operating in India and realizing a profit larger than 5 crore (50 million) rupees are required to invest a minimum of 2% of their profits in clearly defined activities that, in general, contribute to social development. Examples of such activities include eradicating hunger and poverty, promoting gender equality and empowering women, ensuring environmental sustainability, rural development projects and contributions, including financial and technological support, to incubators located within academic institutions. Within the Indian Institute of Technology, Madras (IIT-M), several CSR supported projects have been initiated, developed and some have been implemented. In this paper, we describe the CSR framework and how it relates to the mission of IIT-M, the projects that CSR funding supports, and focus on the assessment of the various projects that have reached beyond the laboratory bench research and development phase to result in actual technology production, either through direct implementation or through the incubation and establishment of commercially viable entities engaged in the technology production. Further, we examine this in the context of sustainable development, millennium development goals and various other benchmarks and interrogate whether this model of engaging corporates in social development is viable, documenting results that have been realized through various CSR funded appropriate technology and sustainable development projects. We review the outcomes of these projects and examine the tangible and measurable impacts on the ground and in the communities, from social, environmental and economic perspectives, and providing a sustainability assessment. A particular focus will be the ethical foundation for CSR legislation. The conclusion examines the relationship between CSR initiatives and ethics-based engagement of corporations with under-resourced communities.*

**Keywords:** Corporate Social Responsibility, Ethics, Appropriate Technology, Sustainable Development, Incubation, Innovation

### Introduction

The role of academia in society has been evolving to create better linkages for solving societal problems. The United States, United Kingdom and Europe have created ecosystems that link government, industry and older technology institutions for just such a purpose. This ecosystem manoeuvres technology solutions to the market place to solve problems of industry in particular and those faced by society in general.

In India, academic institutions serve the primary purpose of teaching; research is largely a secondary activity. The government of India however supports much of the basic research work and encourages taking the research output to the market place through agencies like Technology Development Board (TDB) and National Science and Technology

Entrepreneurship Development Board (NSTEDB), among others (see <http://www.nstedb.com/institutional/tbi.htm>). A further fillip was provided to funding opportunities through the introduction of the new Companies Act 2013, which mandates Corporate Social Responsibility (CSR) funding on leading companies across industry verticals, allowing them to play an important and significant role in innovation of technologies that can address quality of life issues across the nation. Specifically, Companies fulfilling any one of the following criteria must spend 2% of their profits averaged over the 3 previous financial years in the current year on CSR funding: i) Turnover of Rs 1000 crore or more ii) Net worth of Rs. 500 crore or more iii) Profit after tax of Rs 5 crore or more. (1 crore = 10 million)

This encouraging move has opened up several possibilities for industry institute partnerships in socially relevant research and manufacturing. There are four distinct ways for academia to interact with Industry and benefit from their CSR funds.

First, contributions or funds provided to technology incubators located within academic institutions that are approved by the Central Government. The creation of Technology Business Incubators is supported initially by NSTEDB with the expectation that industry will subsequently support the established incubators through their CSR budget. At the Indian Institute of Technology, Madras (IITM) industry has aided the central government recognised incubators IITM Incubation Cell (IITMIC) and Rural Technology and Business Incubator (RTBI).

Second, industry can avail of tax exemptions when supporting research in an Institution like IITM and can later take the output to the field. IITM is committed to the mission of developing strong and sustainable partnerships with academia, industry and entrepreneurs. There is socially relevant and innovative Research and Development (R&D) underway at IITM in the areas of water purification, sanitation (household and larger scale), rural electrification using solar/DC (Direct Current) supply, new generation DC motors, indoor air purification, various low-cost and high-tech health technologies, cost-effective housing, new pedagogies among many others. All are at various stages of development and implementation.

Third, academia can also design a CSR program for a company based on its CSR policy – an effective way that academia and industry can collaborate is to pool expertise and interests to address the country's societal development issues. The fourth way is to support students at IITM, engaged in social entrepreneurship and innovation and incubation of innovative and appropriate technology projects with scholarships and endowments.

The Act further permits companies to pool funds to implement projects, giving scope for corporate houses to support very large projects proposed by academia. The guidelines further state that the mode of engagement with an implementing agency should involve projects and programs with a long duration, removing the need for companies to look for new CSR projects every year, and building sustainability and long-term viability to projects.

IITM has envisaged many socially relevant and beneficial projects that require very large funding for implementation. For instance, the ambitious plan to use inverter-less solar power to run Direct Current (DC) appliances in 100,000 homes. This implementation has been initiated and currently more than 20,000 homes have been provided with solar panels that are used to power light emitting diode (LED) bulbs, tube lights, and brushless DC motor fans, all with provisions to charge cellular phones and even run DC televisions or laptop computers. The conventional way of using solar power involves conversion of the DC generated by the photovoltaics to Alternating Current (AC), which incurs losses on conversion. Many appliances, however, like LEDs, television sets, laptops and cell phones are essentially DC devices and therefore powering them up with DC considerably increases efficiency and allows the use of smaller sized solar panels, which can reduce costs. By

pooling CSR funding from multiple companies, it is possible to achieve the goals of the project covering the target of 100,000 homes on inverter-less solar-generated DC directly.

The newly instituted Development Office at IIT Madras has raised over Rs. 70 crore (700 million) in 2017 from corporate houses and other organisations to support socially relevant work being done on campus. IITM has been ranked the # 1 Engineering Institute in the country for the 3rd time in 2018, an enviable status that showcases its capability and strength, while underscoring its credibility and trustworthiness for CSR-based project partnerships. Corporates do not have to look any further for a partner who can innovate technology solutions to solve the many problems facing the nation. Such industry–institute partnership to solve social problems can foist India on par with ecosystems of the developed world.

### **Successful Appropriate Technology Development and Implementation**

The success of “appropriate technologies” (ATs) in addressing issues of development and sustainability has not always been clear. The on-going debate centers around whether AT’s are relevant in the 21<sup>st</sup> century, whether they can adequately and effectively address the myriad needs of developing communities that seek to improve their quality of life (Rybzynski, 1991; Lissenden et al, 2014; Tharakan, 2004, 2006; Patel et al, 2014; Ravesteijn, 1989). There is no general consensus or clear rubric in terms of AT development and implementation and their potential for success. It is apparent that multiple factors impact outcomes, including but not limited to, technical, social, environmental, cultural and economic ones. This diversity of conditionality always informs the process of socio-technological intervention in developing communities, beginning with whether the community actually needs or desires the intervention at the outset. The entire process, from technology identification, selection and development, to deployment and scaling must be informed by concerns raised from technical, environmental, economical, cultural and social perspectives.

Technical factors can include the nature of the technology itself, and always depends on context. For instance, success of a megawatt-scale solar installation or a hand pump depend on entirely different drivers and factors, albeit both are AT’s: the former an example of Macro AT while the latter is exemplary of MicroAT (Verharen et al, 2015). In the former, technology availability, conversion efficiency, spare-parts and maintenance service availability, national grid connectivity, and storage capability for excess energy produced are all important technical factors determining success. Related factors include availability of skilled personnel, while the most critical component determining appropriateness is who benefits from generated renewable energy and who pays the costs of the installation and whether the power generated is consumed locally, or if exported to a grid, whether local communities are first adequately supplied and resourced in terms of electricity, and second whether the community receives revenue from the exported power. A technology deemed appropriate in one context can be rendered “inappropriate” in another (Agarwal et al, 2001).

Social factors that bear on success include whether the workers and/or users are adequately trained in the technology, from installation and operation to maintenance and upkeep. Another important social factor is whether technology users are willing to pay for access, and how much they are willing to pay or whether the community can afford the technology. Social factors can also include cultural ones such as whether the technology’s use is acceptable in the cultural context and given the social and cultural practices of the using community (Tharakan, 2004).

Environmental factors influencing AT success cover a host of issues ranging from the impact of the technology’s deployment on global climate change to the quality of the

immediate environment in terms of wastes produced and needing treatment and disposal, as well as the overall analysis of resources being used and depleted. Other environmental factors include the technology's impact on air and water pollution, both in terms of levels of contaminants and presence of hazardous components that could render the environment uninhabitable: various media in the environment may become carcinogenic, teratogenic or causative of some other adverse health problem in humans or animals.

Economic factors also impact success of AT adoption, implementation and expansion. The ability of a community to pay for the AT is critical, especially to the sustainability, including maintenance and dispersion of the AT. Initially itself, financial support for the AT is critical, whether from private or governmental sources. Funding focus must be on supporting the AT through the entire technology development and implementation process: the implemented technology should be net positive, either in revenue generation or cost savings.

Closely tied to economic concerns are regulatory ones. AT technology developers and installer's need to partner with relevant government ministries, institutions, and agencies, ensuring that requisite policy-level work is being put in place. Legislation, policies and regulations governing the AT deployment may be needed: AT developer's can work with relevant units to facilitate the process (Tharakan, 2006).

All of the above factors notwithstanding, what appears most critical to successful scaling of AT's and achieving positive measures of success and sustainability is whether the AT is commercially viable. However, commercial viability cannot be a simple cost, revenue model, as certain technologies may need support from the state in order to be viable, perhaps requiring subsidies or one-time grants to ensure that the initial implementation is successful.

### **Successful Appropriate Technology Development through CSR**

Commercial viability is what connects the success of AT's to corporate social responsibility issues. Business houses from different parts of India have come forward as partners to support socially relevant projects at IIT Madras using their CSR budget. IIT Madras has, through CSR funding, received support for its student innovators and incubators that have yielded a rich tableau of successful appropriate technology projects that are yielding real benefits to the concerned and impacted communities. In this section, we provide summaries of exemplary CSR-supported innovation and incubation project that have resulted in tremendous positive social impact and outcomes for the concerned communities.

Bangalore based Titan Company Limited, AMEX, Goldman Sachs, Chennai headquartered Cholamandalam Investments and Finance Company Limited and others have all provided support to the IIT Madras incubators that are recognised by the Central Government of India (CGOI).

Indian Additives Limited, Chennai have supported water and waste management work in a village named Vichoor a few kilometres away from their base of operation (Figure 1 below). This 3 year project was carried out by a team of faculty and students from IIT Madras.





Figure 1: Vichoor village before (above left) CSR-supported water and waste management activities were initiated and conducted (right).

Pune (Maharashtra, India) based Aricent have partnered with the IIT Madras National Programme on Technology Enhanced Learning (NPTEL). The CSR support has been given to create free online course material, transcription into regional vernacular languages of certain courses and also supports examination fees for deserving candidates. Around 70,000 students have benefited from the scholarship. Other companies are now coming forward to support NPTEL.

The TTK Group, having its Corporate Office in Bangalore, has supported the "TTK Center for Rehabilitation Research and Device Development (R2D2)". Here, researchers from IIT Madras are involved in research related to human movement, the influence of orthotic and prosthetic devices on human movement, and the design and development of mechanisms, products and assistive devices for people with impairments. Additional support for this group has been provided by the Wellcome Trust for the specific development of a standing wheelchair (shown in Figure 2 below).



Figure 2: A “standing” wheel chair, developed through CSR support provided by the TTK Group and the Wellcome Trust.

Technip, an oil exploration company with the Indian Head office in Chennai, have through their CSR program supported two projects at IIT Madras. The first project is an innovative way by which an 8<sup>th</sup> standard student is trained to teach a 4<sup>th</sup> standard student. The pilot had very good results. This is being expanded to 20 more schools. The second project is about waste management at a village in Singa Perumal Koil panchayat named



Vilangaddupakkam. Both these projects are being implemented by IIT Madras faculty and students.

In another example that cuts across various fields and disciplines, Tamil Nadu Newsprint and Papers Limited (TNNPL) have used their CSR funds to support four very diverse projects:

- a) Development of Prototypes of footwear device for gait analysis and rehabilitation;
- b) Language development project on bringing proficiency in English to slum and rural school children
- c) Capacity building for farmer producer companies for better management practices and sustainable growth
- d) Empowering and developing women entrepreneurs: exploring various avenues across fields that support women in their innovation efforts while providing support.

In all these instances, the support is provided through a long-term partnership, which spreads the support over a period of four years, albeit along different timelines for the different projects as these various projects will not all follow the same time course for research, development, implementation and scaling.

Verizon, Sasken and a few more companies have supported implementation of solar panel and direct current appliances in rural homes in different parts of the country.

In summary, well over 150 companies have established relationships with IIT Madras through their corporate social responsibility arms, working to fulfill their corporate requirements and ensuring that these are in alignment with regulatory CSR requirements (Thomas, 2016).



Figure 3: Solar panel installations (top left and middle) and direct current appliances supported through Verizon and Sasken corporations as part of their CSR obligations.

## Ethical Rationale for CSR

The Indian government's legislation mandating CSR marks a dramatic evolution in global ethics. Historically, governments, religious institutions and other non-profit organizations assume responsibility for the survival and flourishing of their groups. They have assumed that responsibility only for narrowly defined concepts of group membership. The defining parameters in tribes, tribal nations and early nation states are restricted to genes, languages and cultures. Nations with limited resources base their group definitions on practical considerations of self-interest.

The CSR goals stated in this paper's introduction, such as eradicating hunger and poverty, promoting gender equality and empowering women, ensuring environmental sustainability, and inaugurating rural development projects and contributions fall under the umbrella of universal human rights, including both the rights of women, children and indigenous peoples. The concept of universal human rights was enunciated only after the catastrophic wars of the 20<sup>th</sup> century through the United Nations (1948) Universal Declarations of Human Rights and the 2000 Millennium Development Goals.

The Universal Declaration of Human Rights, Article 25, Section 1 (United Nations, 1948) specifies the foundational values that governments or corporations must ensure are in place: 'Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control.' Article 26, Section 1 states the right to a basic education: 'Everyone has the right to education. Education shall be free, at least in the elementary and fundamental stage.'

Article 26, Section 2 expresses the right to an education that promotes flourishing of the entire human community: 'Education shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms. It shall promote understanding, tolerance and friendship among all nations, racial or religious groups, and shall further the activities of the United Nations for the maintenance of peace.' Principles fostering survival and flourishing define the basic philosophy of the UN Millennium Development Goals (United Nations, 2000). What is especially important is the right of communities to maintain their own culture and identity (Silversmith and Ruggles, 2004; Singer and Stavenhagen, 2004; Sen, 2000).

Globally, those rights have been honored in theory rather than in practice. That the Indian government has recognized its own incapacity to ensure the survival and flourishing of all of its citizens in their extraordinary diversity of genes, language and culture is truly exceptional in contemporary global polity. Mandating corporations to assist the government in discharging its ethical obligations to those most in need of assistance marks a revolution in ethics. What makes CSR critical not only for India but for virtually all other nations is the growing failure of governments to address the most important problems of both their citizens and recent immigrants, whether legal or not. If governments will not discharge their social responsibilities, then corporations must begin to fill the gap.

The Harvard psychologist Stephen Pinker (2011, 2018) attempts to explain evolutions in ethics through two volumes that argue that human violence has declined because of the co-evolution of technology and humanistic devices for promoting empathy for non-group members. The novel, *Uncle Tom's Cabin*, for example was a powerful force in helping U.S. citizens recognize the humanity of Africans as a motive for abolition of slavery. However, the novel could not have had its requisite force without the invention of the printing press. Abortion, infanticide, capital punishment, and eating animals, among others, have all become ethical issues because of the technologies that make them no longer necessary.

Supplementing Pinker's claim that humans become more ethical over time, the Harvard biologist E.O. Wilson (2012) now claims that humans, like 19 other species including insects, shrimp and African mole rats, are genetically predisposed to sacrifice self-interest for the sake of group interest. His current position replaces his old view based on the Hamiltonian idea that humans are genetically inclined to sacrifice self-interest only for the sake of close kin. If Wilson's new hypothesis is correct, the open question is still how humans are inclined to define their sense of *group*. As stated above, under conditions of scarcity, humans have always used genetic, linguistic and cultural markers to define the limits of their groups.

The very idea that corporations under the influence of government-mandated CSR principles are beginning to re-define their senses of groups for whom they are responsible suggests that historical considerations of scarcity are no longer operative. Appropriate technology innovations such as renewable energy, cradle to cradle recycling of resources, automatization of labor that does not require creative human consciousness, and the potential for universal dissemination of information through information communication technology have the potential to reduce historic apprehensions of scarcity.

Without these technological advances, it is not likely that the Indian government would have the power to implement its stringent regulations for CSR. Corporations have practical incentives to ensure the ethical rights of their employees and consumers. That they are now committed by Indian government mandate to include those outside their circle of immediate concern indicates that a much-needed revolution in ethics is taking place.

To be sure, other motives are driving the adaptation of CSR principles. The principal religions of India such as Hinduism, Buddhism and Islam are grounded in a sense of ethical responsibility to those who are incapable of sustaining or transforming their lives. This culturally and religiously driven impulse cannot be disregarded.

In addition, the power of contemporary technology forces both governments and corporations to re-consider the effects of their policies on disadvantaged populations. 9/11 impelled the United States into unwinnable wars in Afghanistan, Iraq, and now Syria. The expense of these wars has led to the U.S. national debt of over twenty trillion dollars. Historically, powerful governments could exercise their policies independently of their consequences. Now, however, contemporary technology, such as using passenger airplanes as primitive cruise missiles, has forced the U.S. into virtual bankruptcy. Governments that anger individuals who are excluded from group inclusion invite unprecedented reprisals from those most effected by their policies.

The recent decision by the U.S. Agency for International Development (USAID) illustrates the sensitivity of the U.S. to this new threat horizon. The Agency has recently added co-operation with the U.S. Department of Defense as one of its primary strategies. The rationale behind this change in goals is the conviction that underserved populations are those most likely to revert to "terrorist" tactics to express their revulsion to their situations. (USAID 2018: <https://www.usaid.gov/policy/dod-cooperation>).

The Indian government's legislation mandating CSR is a halting first step toward actuation of the United Nations Declarations of Human Rights. However, that step is accelerated by already-existing Indian government legislation mandating national service for students who have received sufficient education to be competent in solving the problems of underserved communities. The Indian National Service Scheme was founded in Gandhi's Centenary Year, 1969. In its current practice, NSS is a voluntary association aimed at motivating college and university students to engage in community service. (<https://nss.gov.in/#>). Perhaps the next step to extending the principle of CSR in India is to make participation in the National Service Scheme mandatory, supported by CSR funds.

India has passed dramatic legislation (MNREGA – Mahatma Gandhi National Rural Employment Guarantee Act) which guarantee the rights of the rural poor to jobs if they are not able to find them by reason of their own resources (<https://carnegieendowment.org/2013/02/11/employing-india-guaranteeing-jobs-for-rural-poor-pub-50856>). The program has suffered from underfunding and structural problems under the current Bharatya Janata Party (BJP) government, but it is a first step toward recognition of the rights of the poor. Legislation also guarantees the Indian rural poor the right to transparency in federal distribution of funds to their neighborhoods ([http://siteresources.worldbank.org/PUBLICSECTORANDGOVERNANCE/Resources/285741-1343934891414/8787489-1344020463266/8788935-1399321576201/Requests\\_and\\_Appeals\\_RTI\\_Working\\_Paper.pdf](http://siteresources.worldbank.org/PUBLICSECTORANDGOVERNANCE/Resources/285741-1343934891414/8787489-1344020463266/8788935-1399321576201/Requests_and_Appeals_RTI_Working_Paper.pdf)). The legislation was aimed at stopping corruption in federal fund distribution. Efforts to enforce transparency are hindered by government inertia.

Finally, The National Food Security Act 2013 was another important foundational legislation ([https://en.wikipedia.org/wiki/National\\_Food\\_Security\\_Act,\\_2013](https://en.wikipedia.org/wiki/National_Food_Security_Act,_2013)) that would be part of the legislative actions in India that have underpinned some remarkable technological developments with significant positive social impact.

## Conclusion

With these four remarkable legislative advances, India now serves as a model for transforming theories of universal rights to practical action. The miracle of Indian CSR legislation is the ethical sense that governments alone cannot address the needs of their citizens. By federal mandate, corporations must now address the needs of citizens who would never be considered as part of corporate self-definition. The message for the future is that private citizens, under the aegis of national service, will step up to the task that corporations have now begun to address: the survival and flourishing of all citizens in the Indian polity.

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## COUPLING ETHICAL STEM RESEARCH TO COMMUNITY ENGAGEMENT AT AFRICANA UNIVERSITIES

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### Abstract:

*The essay investigates the ethical principles of the responsible conduct of STEM research at Africana universities to engage those principles in discharging the ethical responsibilities of universities to their supporting communities. The model's ethical platform for ethical STEM studies follows W.E.B Du Bois' community-based vision of historically Black college and university (HBCU) and by extension African university missions. The underlying hypothesis is that a constellation of seven program activities will (1) increase the ethical STEM research output of Africana universities and (2) insure the broad ethical impact of that research on the under-resourced communities that justify in part Africana universities' raison d'être. The first program activity will define the very concept of responsible, ethical conduct of research in the context of Africana universities through dedicated orientation programs and freshmen seminars for selected incoming STEM students. The second establishes the ethical responsibility of Africana universities for student retention and reduced times for graduation through peer-tutoring programs developed by the University of Maryland/Baltimore Campus. The third builds on the ethical cultures of service learning grounded in Engineers without Borders principles. The fourth enhances Africana universities' ethical cultures of undergraduate research through mentoring toward senior theses and projects. The fifth enhances an ethical culture of life-long learning for STEM alumni. The sixth establishes STEM alumni cultures of learning that can help overcome the disadvantages of MOOCs and other Information Communication Technologies (ICT) for life-long learning. The final program activity encourages STEM alumni communities of learning to expand their ethical conduct of research by engaging with external community members most urgently in need of their problem-solving skills. The essay concludes with uses of appropriate ICT for the model's last three activities with emphasis on technologies for universal broadband access in under-resourced communities, computation-capable cell phones, Massive Open Online Course technologies, and computer-based tutorial programs.*

**Keywords:** ethical stem research, community engagement, Africana universities W.E.B. Du Bois, peer tutoring, service learning, lifelong learning, alumni communities of learning, information communication technology, computer-based tutorial programs

**Paper category:** Policy, standards and ethics

### INTRODUCTION

What are the STEM researcher's ethical obligations—to the research institution, to fellow faculty, to students, but much more broadly to the external community members that justify the existence of the research institution (Appiah 2008, 2011; Askland 2009; Bouville 2008)? The essay's principal research question is whether a group of seven activities can embody a comprehensive ethical platform for the responsible conduct of research in STEM studies at Africana universities. The term *Africana* here means both African universities and

historically black colleges and universities in the United States. The first task for universities following the essay's model will be to establish baselines for their current undergraduate research performance. Such research will measure research output in the form of senior STEM theses or projects, STEM student papers published in undergraduate journals, and research papers co-published in professional refereed journals with Africana university faculty.

In addition, because an ethical culture includes not only measurable outcomes but the conditions that make those outcomes possible, preliminary research will examine student retention and times to graduation in select STEM disciplines.

The essay's model focuses not simply on undergraduate research production, but also on the broader impact of that research. STEM students as researchers are learning critical problem-solving skills as they progress through their majors. In ethical STEM cultures, students acquire problem-solving skills not simply for their own personal advancement, but also to impart those skills to those who do not share their privileges.

The results are two-fold. First, students will work to transfer their problem-solving skills to their peers who require additional assistance that professors may not be able to provide. The clearest examples of this ethical transfer of skills are the near-peer tutoring models at Xavier University in New Orleans and the University of Maryland Baltimore Campus (UMBC). The pre-med program at Xavier and the STEM programs at UMBC achieve nearly one hundred percent graduation rates. Faculty observing students having difficulty in their STEM classes assign those students to near-peer tutors and carefully monitor student performance throughout the semester through near-peer tutor feedback.

Second, select STEM students will engage in service learning. In these activities, students motivated by their commitment to ethical principles will work to transfer their problem-solving skills to outside community members most in need of their assistance.

The ethical model for both these targets of the model is "Each One Teach One." W.E.B. Du Bois (2001; Lewis 2001) argued that a primary justification for HBCUs is their ethical commitment to solving the problems of the communities whose needs justified the founding of HBCUs. Beyond that baseline, Du Bois believed that HBCUs should be responsible for helping those community members learn to solve their own problems (Verharen 2001a, 2001b). Adult university-level education has always been an ethical mission for prominent HBCUs such as Howard University faculty (Logan 2004).

Africana universities should examine the ethical principles grounding their mission and goal statements. For example, Howard University's mission statement promises a first-rate education to those who would not otherwise have the opportunity. Its STEM programs graduate the highest number of black students in the U.S. Its mission emphasizes research undertaken to solve national and global problems. Howard is a prime example of an "ethical culture in STEM research."

Howard's mission statement describes it as a black comprehensive research university dedicated to solving national and international problems. Howard is an institution grounded in "ethical culture." Even Howard's shuttle buses trumpet her founding commitment: "SOCIAL JUSTICE IS IN OUR DNA." George Washington Williams (1883) and W.E.B. Du Bois' (2001) visions for HBCUs underpin Howard's ethical culture. Both thinkers wanted HBCU students to see that their ethical responsibilities extended far past their own preparations for careers.

To pay back all those who have suffered and died to make a first-rate university or college education possible, Africana universities must orient their education toward the solutions of problems of the underserved communities that justify the continuing existence of universities that are born of the struggle for freedom from slavery and colonialism.



Williams, an African American Civil War veteran, felt that Howard students in particular owed a debt to the African Americans who gave their lives in the Civil War. He wanted a monument to those heroes, sited across the street from General Howard's house and the main campus, to remind Howard students of their debt (Franklin 1998).

The ethical foundation for the program is based on W.E.B. Du Bois' (2001) research. The ethical responsibilities of Africana university alumni include solving problems for those who cannot afford to pay professionals for their services. In addition, Du Bois insisted that Africana university alumni use their skills to empower community members to solve their own problems.

Du Bois' hope was that Africana universities would serve as a spearhead for continuing education for members of underserved communities. Aligning with Du Bois, Howard university faculty, for example, like Alain Locke and Kelly Miller joined Anna Julia Cooper and others associated with Howard to promote adult education for those most in need (Harris 1991, Logan 2004).

A university grounded in ethical culture will not imagine that its ethical responsibilities to its students stop with graduation. Professional codes in some STEM disciplines require life-long learning as a condition for membership in a profession. An ethical university will take all steps within its power to assist its STEM alumni with life-long learning.

And those same alumni, grounded in the ethical culture of their *alma mater*, will dedicate some important part of their professional lives to community members most in need of their problem-solving skills. Du Bois (2001) believed that the longest-range mission of HBCUs would be to make it possible for virtually every human being to have a university education. Contemporary STEM disciplines have produced the technologies that now make it possible in principle to realize Du Bois's dream. A university grounded in a comprehensive ethical culture will work toward that goal.

The faculty of an ethical university have roles in identifying and preparing promising "early-participants" for peer leadership in STEM learning communities. Faculty have an additional role in conditioning alumni to universally recognize and eagerly accept the responsibility of life-long learning as part of community involvement. And, finally, faculty have a role as catalysts and consultants; working with students, alumni, and the community to identify and build appropriate groups and processes to deliver effective solutions to community problems.

That dream was impossible in Du Bois's time. However, three revolutions in contemporary appropriate technology can make Du Bois's dream come true: renewable energy and other resources; increasing leisure through AI, robotics and automation; and information communication technology (ICT) that can promote the global distribution of higher education (Verharen et al 2012a, 2013a, 2013b, 2014).

## **METHODOLOGY**

The essay's model for cultivating ethical cultures for the STEM disciplines addresses two primary research questions:

Research Question 1: The near-term measurable outcome is whether students grounded in universities' ethical principles and selected for the model's activities will contribute to the university community's wellbeing through near-peer tutoring, service learning and successful completion of publishable senior theses or projects.

Research Question 2: The long-range measureable outcome is whether engaging the universities' ethical principles to orient the university toward life-long learning will inspire alumni to carry on the university's ethical commitment to solving problems in underserved communities.

The essay proposes a model for a universities' comprehensive ethical commitment to their own members and the community members that justify their continuing existence—as truly Africana universities. The model's broader impact will enhance the university's explicit and measurable commitment to the solution of community problems, particularly in areas where the need is greatest: health, education, economy and criminal justice.

The essay poses the fundamental research question of whether a combination of pedagogical approaches including ethics-based matriculating STEM student orientation, freshmen seminars, near-peer tutoring, service learning, senior theses, university responsibility for STEM alumni life-long learning and community service will result in enhanced STEM research output in Africana universities and broad impact in solving the problems of underserved communities that justify the continuing existence of those universities.

Following the model, universities will establish baselines of STEM student retention rates, times to graduation, production of undergraduate research, and faculty participation in undergraduate research mentoring. Initial research will also examine STEM student participation in near-peer tutoring programs, service learning, successful completion of senior theses/projects, and university responsibility for life-long learning of its STEM alumni. Finally initial research will examine STEM alumni efforts to assist external community members in solving problems.

These collective research initiatives will develop a baseline used to assess the model's practicality. The near-term measurable outcome is whether the students selected for the model's activities will participate in near-peer tutoring, service learning and successfully complete senior theses or projects. The long-range measurable outcome is the model's success in orienting the university toward life-long learning for alumni who carry on the university's ethical commitment to solving problems in their respective communities.

The essay proposes a model structured through seven program activities. The program activities will generate a more general model for universities' discharge of their ethical responsibilities to external communities and other stakeholders. The model will serve not only STEM disciplines but virtually all disciplines centered in contemporary universities.

The essay's model can be initially implemented over a five year period. Its first exercise is the selection of a cohort of entering students who have chosen a STEM major. A small number of incoming students will be selected in the program's first year on the basis of their demonstrated academic skills and community engagement. In the program's second through fifth years, those selected students will be awarded stipends that permit them to engage in peer-tutoring and service learning. In the fourth year, the cohort in collaboration with the program's senior personnel will commence research on models for lifelong learning. In the fifth year, the cohort and senior personnel will develop MOOCs and other ICT instruments to enable the cohort to set up alumni communities of learning. The program's ultimate measurable outcome is whether those alumni communities commit their problem-solving resources to community engagement. The pedagogical model will be actualized through seven different activities in which each cohort of students will participate.

#### ACTIVITY I: STEM STUDENT ORIENTATION TO ETHICAL RESEARCH CONDUCT

The pilot orientation program for matriculating STEM student cohort is designed to foster an ethical sense of responsibility to be problem-solvers in the Africana university tradition. A primary consideration is the respective roles of philosophy and science in addressing ethical questions (Davis 2003, Emison 2004, Fleischmann 2004, Haws 2004, Vogel 2004, Davis 2006, Graber & Pionke 2006; Lozano et al. 2006, Martin 2006, Miller 2008, Zandvoort 2008, Kabo & Baillie 2009, Lekka-Kowalik 2010; Harris 2010, Burgh & Nichols 2012). Of particular interest is a focus on universities' responsibilities for human

rights (Dhillon 2011; Dworkin 2002, 2013). The model will link the pilot orientation activity to freshmen seminars grounded in the ethical foundations of the university’s history of problem-solving in the STEM disciplines. It will also foster student focus on ethics across the curriculum and changes in the ethical cultures of professional societies (Bullock & Panicker 2003, Harris 2004). The program will introduce students to reflect on defining responsible conduct for research (RCR) by examining Africana universities’ cultural and institutional history of promoting ethical conduct of research. The orientation program will also target professional codes of ethics in the respective STEM disciplines with a focus on changes in those codes over time and the rationales behind those changes (Comstock 2012, Israel 2015, Komić et al. 2015, Koepsell 2017, Stieb 2011). At Howard University, the authors propose to highlight the orientation program by means of a collaborative project with the African American Civil War Museum. The director, Dr. Frank Smith, has agreed to develop an exhibition that focuses on George Washington Williams’s vision of Howard University’s mission with emphasis on the General Oliver Otis Howard’s role in the university’s founding.

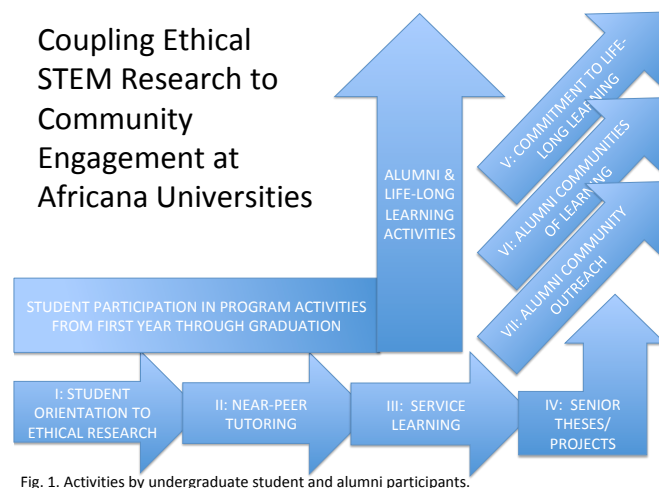


Fig. 1. Activities by undergraduate student and alumni participants.

## ACTIVITY II: NEAR-PEER TUTORING IN STEM SUBJECTS

The model’s research question examines the hypothesis that a dedicated peer tutoring program coupled to faculty mentoring will enable nearly 100% student retention and 4 year graduation rates among STEM majors at Africana universities. The model is based on prior Howard University experimentation with peer tutoring. One Howard faculty member collaborated with a computer science major as a peer tutor for a full academic year. The Dean of the College of Engineering and Architecture funded a dedicated assistantship for that purpose. The philosophy department funded a senior philosophy major as a peer tutor for an academic year. That student went on for a PhD at Harvard and today serves as a university professor. The model also targets peer tutoring models deployed at the University of Maryland/Baltimore Campus for STEM majors and Xavier University/New Orleans for pre-med majors. Xavier University admits a certain percentage of “at risk” students, yet in part because of its peer tutoring system, its retention rate of first-time freshmen has approached 75%. Before the director of the Xavier pre-med program, Professor J.W. Carmichael, implemented his system of peer tutoring, Xavier was sending only about five to eight students to medical school each year. 2018 saw 54 Xavier students accepted into a broad range of professional medical training programs. Xavier pre-med students have achieved 93% success rates in receiving their MDs. UMBC President Freeman Hrabowski has co-authored three volumes on the theory and implementation of peer tutoring in STEM disciplines at his institution: *Beating the Odds: Raising Academically Successful African American Males* (1998), *Overcoming the Odds: Raising Academically Successful African American Young Women* (2001), and *Holding Fast to Dreams: Empowering Youth from the Civil Rights Crusade to STEM* (2015). The model includes the appointment of a peer tutoring faculty committee targeted with oversight of the program. The committee has the

responsibility to select advanced STEM majors of outstanding promise as peer tutors. The committee also solicits dedicated faculty members in STEM disciplines who will accept the responsibility for assigning peer tutors to STEM students experiencing difficulties in STEM gateway courses. The committee also bears responsibility for advising STEM tutees on preparing for U.S. standardized exams such as the MCAT, DCAT and GRE exams and their African equivalents, securing summer internships and seminars, and writing successful applications for professional and graduate schools throughout the three year course of the grant. The model includes a graduate student program administrator and a panel of five external evaluators. The intellectual merit of the program is the research required to devise a peer tutoring model for the STEM disciplines that will serve to increase Africana university STEM student retention rates and decrease graduation times. The model's research component is to test the model's effectiveness over a five year trial period. The broader impact of the program will be the dissemination of the successful model throughout Africana university undergraduate education.

### ACTIVITY III: SERVICE LEARNING FOR STEM STUDENTS

The service learning activities' measurable effects will be student participation in community outreach defined as a transfer of student problem-solving skills in their respective STEM disciplines to external community members most in need of those skills (Field & Leicester 2000, Bringle et al. 2004, Aspin 2007, Aspin & Chapman, 2007, Fejes & Nicoll 2008, Jarvis 2009, London 2011, Dolgon et al. 2017). An excellent test of whether students have learned a skill or body of information is whether they can teach those skills. In case of Africana universities, community members may urgently require university assistance in solving problems. Those problems may include basic literacy, numeracy, and elementary instruction in solving economic, healthcare, education or criminal justice issues. Howard University faculty, for example, developed examples of service learning. The first was Howard University's Community Technology Center, funded by a \$1M U.S. Department of education grant to bridge the digital gap for communities near the University. The second was the Howard University Mini Medical School, funded by a \$10K grant from the NIH Science Education Department, to teach surrounding community members basic skills in understanding and assessing medical diagnoses. The third was the Howard University Annual High School Philosophy Conference which awarded prizes to the best student essays presented at the conferences. Another Howard faculty member has supervised Howard University Engineers without Borders programs in East Africa and Central America over the past decade, where student teams have engaged with communities in developing and implementing sustainable technological solutions to critical community problems, while some of those students have leveraged their service activities with independent study courses, effectively transforming their EWB implementation site visits into service learning activities (Tharakan 2011, 2012, 2013a, 2013b, 2014, 2017; Tharakan et al. 2016).

### ACTIVITY IV: STEM SENIOR THESES/PROJECTS

The senior thesis/project activity of the model measures the increase in students completing their research programs with emphasis on results publishable in undergraduate journals or co-publishable with research professors in peer-reviewed professional journals (Catalano 2004). The Howard University model for undergraduate student research, for example, is embodied in the Capstone Course and senior project required for graduation in the College of Engineering, as well as the senior thesis required for graduation in the Honors Program of the College of Arts and Sciences. The model proposes that orientation toward undergraduate student research will commence with selected STEM students at matriculation orientation, and continue through the freshmen seminar for select STEM students grounded

in ethical culture. The model will incorporate committees of research faculty deeply engaged in mentoring undergraduate STEM research and STEM discipline seniors who have shown the most promise in their research projects. These committees will be tasked with mentoring participating students throughout their university experience. The principal aim is to assist students with choosing research projects grounded in ethical principles and oriented toward publication in select undergraduate journals and in peer—reviewed professional journals as co-authors where appropriate.

#### ACTIVITY V: UNIVERSITY COMMITMENT TO LIFE-LONG LEARNING IN STEM DISCIPLINES

The success of the activity for Africana universities' commitment to life-long learning for their alumni will be measured by on-line research content targeted by discipline and transmitted to alumni. The model will be constructed over the fourth and fifth years of the grant, as it will engage the university with a commitment to life-long learning for STEM alumni. The model will be based on existing Information Communication Technology (ICT) using modifications of already existing alumni magazines and Massive Open Online Courses (MOOCs) (Field & Leicester 2000, Aspin 2007, Aspin & Chapman 2007, Fejes & Nicoll 2008, Jarvis 2009, London 2011, Bowen 2013).

#### ACTIVITY VI: STEM ALUMNI COMMUNITIES OF LEARNING

The point of the alumni communities of learning activity is to overcome the well-established failures of MOOCs and other ICT devices. An alternative model called "flipped-classrooms" shows promise for successful implementation of MOOCs. However, these classrooms require face-to-face contact. Hence an activity of alumni communities of learning is required to test the effectiveness of Howard's commitment to life-long learning. The sixth model will use ICT to enable alumni to set up alumni communities of learning in their respective communities to offset the defects of MOOC technology as examined by Bowen (2013).

#### ACTIVITY VII: STEM ALUMNI IN COMMUNITY OUTREACH

The last activity will engage alumni communities of learning in reactivating their former ethical commitments to community outreach through their undergraduate service learning activities. The program will measure the duration, intensity and effectiveness of alumni interaction with community members most in need of alumni problem-solving skills. The seventh activity will enable select STEM pilot alumni to impart their problem-solving skills to members of external communities most in need of those skills. The expectation is that their grounding in ethical cultures through their near-peer tutoring and service learning at their Africana *alma mater* will inspire them to transfer their professional skills to external community members whose problems constitute the *raison d'être* of universities that, like Howard University, have "Social Justice in their DNA."

The model places an immense burden on Africana university faculty and students. Faculty will contribute time to establishing STEM orientation programs, service learning projects, undergraduate research mentoring with a concentration on senior theses. Faculty will also be obliged to stimulate new initiatives by interaction with students, alumni, and communities to iteratively create and engage problem-solving foci. Students will be asked to volunteer for near-peer tutoring programs. And the University will attempt to link its on-line courses and dedicated MOOCs to life-long learning programs for STEM alumni. Africana universities, already engaged in faculty and student participation in community development, will encourage alumni to join these community development programs.

The long-range goal of the model's dissemination and outreach is to establish a

network of institutional partnerships between HBCUs and African universities housed in a virtual Center for Creating Cultures for Ethical STEM. Creating virtual networks of indigenous and international experts, the Center will collaboratively address development challenges identified by communities partnering with the universities (Higgs 2012; Verharen 2012a, 2012b, 2015).

The uniqueness of the model is the establishment of ethical, community-inclusive partnerships that are data-driven, evidence-based, and tied to the use of *appropriate technologies*, defined as technologies that empower communities to address self-prioritized needs and thus improve their quality of life and standard of living. A long-range goal of the Center is to partner communities, NGO's, small and medium enterprises (SME's) with students from HBCUs and African universities. The goal is to leverage the enthusiasm of students under the guidance of faculty and professionals in STEM disciplines to design, develop and implement innovative sustainable solutions to community-identified problems.

Based on past and ongoing experience with partner-identified challenges, the model emphasizes the use of multidisciplinary and research-driven approaches to identify and address community-delineated issues within an ethical, social and culturally aware decision making framework that will involve all affected and effective groups (albeit with particular sensitivity to gender inequity), be fully participatory, and include assessment and evaluation at all phases.

The novelty of this approach lies in the coupling of ethics, community empowerment initiatives and entrepreneurship with partnership with educational institutions committed to integrating social and ethical engineering education into their program offerings, with faculty who are engaged in taking the teaching and learning experience outside the university's walls and into impoverished communities.

The Center's network will serve to expand the ethical culture mode. The successful execution of the model will provide a clear ethics framework for the solution of the problems facing the world's most impoverished communities, whether local, national or international.

Target communities will be identified by their poverty indicators, community input, and student, faculty and alumni engagement from HBCUs and African universities.

## **RESULTS AND DISCUSSION:**

### **The Model's Intellectual Merit: Frontiers of Knowledge**

The model's principal objective is to increase the ethical research output of Africana university undergraduates, faculty and alumni in STEM disciplines. Specially tailored undergraduate orientation programs, freshmen seminars and faculty mentoring programs will stimulate selected students to commit themselves to senior theses and projects publishable in undergraduate journals. Select faculty mentors will co-publish student research in professional peer-reviewed journals. And STEM faculty commitment to life-long learning will enable alumni to continue research that may be published and/or patented throughout their careers.

The model proposes that Africana universities make senior theses and projects mandatory for graduation. The model also mandates that universities track the research and publication records of its alumni. Through the stimulus for life-long learning and responsibility for alumni communities of learning, Africana universities will be enabled to execute their ethical commitment to underserved communities that require the problem-solving skills of their STEM alumni.

### **The Model's Broader Impacts**

The broader impacts are seven-fold. First, the freshmen orientation programs and seminars will introduce students to self-reflection on their comprehensive ethical obligations

as Africana university students. The measured outcome will be their participation in the model's seven program activities.

Second, students will work to transfer their problem-solving skills to their peers who require additional assistance that professors may not be able to provide. Students in the STEM near-peer tutoring programs will be motivated to take ethical responsibility for the success of their peers in STEM programs where peers are experiencing difficulty. The clearest examples of this ethical transfer of skills are the near-peer tutoring models at Xavier University in New Orleans and the University of Maryland Baltimore Campus (UMBC). The pre-med program at Xavier and the STEM programs at UMBC achieve nearly one hundred percent graduation rates. The measured outcome will be the number of students served in the tutoring program together with their pass rates.

The third broader impact is to engage select STEM students in service learning. In these ethics-based activities, students work to transfer their problem-solving skills to outside community members most in need of their assistance. The skills will range from elementary reading, writing and computation delivered by first and second year students to more advanced skills like basic literacy in the natural and social sciences as well as mathematics. The measured outcome will be the number of students engaged in service learning together with the quality of their community engagement assessed through surveys.

The fourth is the model for alumni life-long learning in STEM disciplines. A university's ethical obligations extend beyond its current students to alumni who are required to sharpen their problem-solving skills—sometime by professional societies and codes—throughout their careers. MOOCs and other Information Communication Technology will enable alumni to strengthen and update their professional problem-solving skills. Assessment will focus on alumni professional publications, patents and client/patient satisfaction.

The fifth is to enhance the alumni's ethical obligation to engage in community outreach as envisioned by W.E.B. Du Bois. He believed that a primary functions of Africana universities is to produce alumni who dedicate themselves not only to solve problems of community members most in need, but also to teach them to solve their own problems. Alumni centered in alumni communities of learning will take their advanced problem-solving skills to community members who do not understand the professional services that will help them solve their problems, who are unable to pay professionals for their services, and who are capable of learning to solve their own problems with the help of professional assistance. The measured outcome will follow the model of assessing student service learning.

The sixth is that through dissemination and outreach the model will serve as a template for universities' discharge of their ethical responsibilities to the external communities and other stakeholders that justify the existence of universities insofar as they are publically funded. Assessment will analyze the extent of the program's dissemination of its products and the numbers of universities adapting the program's activities.

The seventh broader impact and long-range goal is of course Du Bois' dream of "each one teach one": Africana universities' alumni will be in the vanguard of taking the first steps to insure that virtually every human being has access to those aspects of a university education that can guarantee their survival and flourishing.

## **CONCLUSIONS**

### **The Model's Assessment and Evaluation**

The model's assessment plan schedules semester and annual evaluations. The plan is targeted to each of the seven activities. The success of the orientation program can be assessed both by questionnaires and student participation in the subsequent six activities.

Near-peer tutoring can be assessed by the numbers of students who sign on to the

near-peer tutoring programs in the STEM disciplines and most importantly by student retention and time to graduation of the students who are tutored in the program.

The numbers of students participating in service learning can be the first indicator of the project's success in this activity. A record should be kept of the numbers of students and community members participating in service learning programs. More important will be the pre- and post-intervention questionnaires submitted both by community members and students engaged in STEM service learning programs.

A critical test of the model's performance will be the numbers and quality of the senior theses and projects completed by the STEM students in the activities. Key indices will be the numbers of student theses published in undergraduate journals and co-publications with faculty mentors in professional refereed journals.

A primary long-range evaluation of the project's success will be the numbers of university instruments brought to bear on the life-long learning of its alumni. A critical assessment of that university's commitment to that goal will be the numbers and quality of alumni communities of learning. The definitive evaluation of that program will be the research products produced by those communities. These products may range from publications in refereed journals or presses to patents and community-oriented business start-ups.

The final assessment of alumni communities of learning will be their commitment to continuing their service to the communities most in need of their problem-solving skills. The baseline evaluation items will be identical to the instruments for service learning assessment on the undergraduate level. More sophisticated items will be based on Africana universities' historic commitment to adult education and the transfer of professional problem-solving skills to community members most in need.

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# The Longest Power Blackout in History and Energy Poverty

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## Abstract

*Hurricane María crossed Puerto Rico on September 20 of 2018 and caused a devastation that resulted in a power blackout that lasted 329 days and accumulated an estimate of Customer Hours of Lost Electricity Service (CHoLES) of more than 2.9 billion. While the length of the blackout is outstanding, more than 600 million people in the African Continent live without access to electricity. The analysis on the blackout has implications for the design on energy access solutions for remote rural communities in many African countries. One of the main results of this analysis is that almost a third of the total CHoLES was due to the last 200,000 customers that were reconnected to the grid from day 156 to day 329 after the Hurricane. With the lower cost of Solar PV + Battery Systems (PV+B), small solar rooftop systems provide a cost effective alternative to increase the resiliency from the bottom-up. An estimated capital investment of \$1,400 million to install small PV+B systems in the last 200,000 homes reconnected would have reduced the blackout size by one third and the length of the blackout by 57%. Similarly, an investment of \$3,500 million for the last 500,000 homes that were reconnected would have reduced the blackout size by two thirds and the length of the blackout by 78%. The decentralized nature of solar rooftop systems combined with the native generating power provides a strong case for the incorporation of the Appropriate Technology Framework in the transformation of the electric power system in Puerto Rico with the bottom-up grid concept. The main results provide important insights to deliver the required resilience at the lowest possible cost with a focus on decentralized resilience while also enabling a radically distributed power generation and energy storage system.*

**Keywords:** Appropriate technology, customer hours of lost electric service, energy access, María, solar home systems

**Paper category:** Energy

## INTRODUCTION

On September 20 Hurricane María crossed Puerto Rico and left a devastation that no other hurricane has done for the last 90 years. María was recorded as the strongest hurricane in the Atlantic during the last 60 years and the resulting impact is still being studied. For example, while the official deaths related to María was still 64, different studies suggested that the total number is much higher, 822 during September and October (Rivera and Rolke, 2018), 1,085 during September and October (Santos-Lozada and Howard, 2018) almost 3,000 between September and February (Santos-Burgoa et al. 2018) and even more than 4,000 from September 20 to December 31 2017 (Kishore, Marqués, Mahmud, et al. 2018).

The economic impact of María in Puerto Rico during 2017 has been studied with early estimates ranging from \$16 to \$20 billion (Estudios Técnicos, 2017). The total estimate of damages determined by the National Hurricane Center of the NOAA is \$90 billion (NHC, 2018), which places María as the costliest hurricane on record to strike Puerto Rico and the US Virgin Islands, and the third costliest for all United States

including its colonial territories. Different aspects of recovery plans have been developed with the most recent one proposing a strategy that would take years to implement and an uncertain approach that focus on a disaster capitalism framework such as the highly centralized proposed recovery plan (COR3, 2018).

A recent report estimates that during the first year of emergency management and initial restorative efforts, more than 90% of the \$5,000 million in federal aid that was spent was channeled through contractors outside of Puerto Rico limiting the multiplying effect that recovery efforts could have in the local economy (Lamba-Nieves and Santiago-Bartolomei, 2018). Furthermore, only 4% of the restoration funds is being proposed to improve health services. On the positive side, this includes a healthy amount of funds to enable most households to obtain a solar home system with batteries that could improve their resiliency. Household resiliency and the potential to build a grid from the bottom-up are two of the most important ramifications of this work and it has important energy policy implications.

The lack of power for an extended period of time in most communities has been a central factor in the large death toll, interruption to other services such as water and telecommunications, decreased safety in the roads, depressed economic activity, and higher cost of living in general. This paper explores the blackout in Puerto Rico starting with the total amount of Customer Hours of Lost Electricity Service (CHoLES) and an initial distribution of them among customers that: 1) recovered the service first, 2) those that did during after the first 10 weeks and 22 weeks, and 3) the customers that recovered service last. Access to good and reliable electricity is important to enable a good quality of life and the people of Puerto Rico experienced for 329 days, the longest blackout in history. These results place the María's Blackout as the longest in history and one of the largest blackouts ever recorded only second to the Hayan and Bopha typhoons (Houser & Marsters, 2018). Both typhoons produced massive power outages in a great portion of the Philippines, with a population of 100 million people, approximately 30 times the population of Puerto Rico.

The paper also takes a quick look at the potential impact that the blackout had in the number of deaths due to the hurricane. Another section provides short-term recommendations on how to better prevent such a massive blackout with a large toll on the lives of many people. A preliminary comparison is made between communities in Puerto Rico without power for an extended period of time, and communities that live without power in Africa. The last section focused on potential appropriate technology niche areas that could become increasingly important for communities in Puerto Rico and regions with high levels of energy poverty.

## **METHODOLOGY**

This work is mainly based on publicly available data related to the blackout in Puerto Rico after Hurricane María. The main data used was collected from the U.S. Department of Energy Situation Reports from September 20 2017 to April 2018 (DOE, 2018). Additional data was collected from social media through official accounts of the Puerto Rico Electric Power Authority and the U.S. Army Corp of Engineers. The results presented here are the most comprehensive that have been made publicly available. To study the full extent of the impact that the longest blackout in history had in the people of Puerto Rico is outside of the scope of this work. However, the social impact of this power blackout, the inequities that it brought to light, and the search for ways forward to prevent such disasters are the main motivations of the study.

The electric power restoration data was used to estimate the total Customer Hours of Lost Electricity Service (CHoLES). A conservative estimate was determined as a lower bound for the total CHoLES substituting the percentage of customers without service with the information reported during the first 3 months after the Hurricane such as the percentage of normal peak load, percentage of historic average load, percentage of instant maximum load, and percentage of instant maximum production. The conservative estimate resulted in a total of 2,931 million CHoLES. A worst case scenario was also explored to establish an upper bound for the CHoLES even though the conservative estimate was used for the analysis. Other studies have placed the estimated CHoLES in 3,900 million by March 2018 (Román, 2018), 3,394 million by April 2018 (Houser & Marsters, 2018) and 3,316 million by May 2018 (Kwasinsky, Andrade, Castro-Sitiriche et al. 2018).

Table 1 shows that the total number of customers reported for September 2017 was 1,466,627 including 614 industrial customers, 123,702 commercial customers and 1,338,958 residential customers (PREPA, 2018). A worst case scenario was used to estimate the percentage of customers without power during the first 3 months. It is assumed that the industrial customers, with an average consumption of almost one thousand times more than residential, were reconnected to the power network first, followed by all the commercial customers. The industrial customers consumed between 12% and 14% of the total monthly energy from January to August in 2017, while it consumed between 9% and 18% from January to August in 2018. If 13% of usual generation is needed for industrial customers and assuming the worst case scenario in which all the industrial customers are served first, the first 26 days would be dedicated to the restoration of the 614 industrial customers. That would increase the total number of CHoLES in 6% for that period from 862 million to 915 million.

Table 1: Consumption PREPA Customers by Type

Customer Type	Number of Customers <sup>1</sup>	Customer Percentage	Energy Consumption Percentage <sup>2</sup>
Industrial	614	0.04%	13%
Commercial	123,702	8%	47%
Residential	1,338,958	91%	37%

The commercial customers consumed between 46% and 49% of the total monthly energy from January to August in 2017, while it consumed between 42% and 50% from January to August in 2018<sup>3</sup>. If 47% of usual generation is needed for commercial customers and assuming the worst case scenario in which all the commercial customers are served before the residential customers, the period from day 28 to day 70, November 29, would be dedicated to the restoration of the 123,702 commercial customers. That would increase the total number of CHoLES in 61% for that period, from 933 million to 1,504 million.

The residential customers consumed between 35% and 40% of the total monthly energy from January to August in 2017. If 37% of usual generation is needed for

<sup>1</sup> As of September 1, 2017.

<sup>2</sup> Using PREPA Data from January to August of 2017 and January to August of 2018.

<sup>3</sup> February was not included because it would represent only 6% of the consumption and it is most likely an error in the data.

residential customers and assuming the worst case scenario in which all the residential customers are served last, the period from day 71 to day 105 would be dedicated to the restoration of the 1,338,958 residential customers. That would increase the total number of CHoLES in 121% for that period from 398 million to 881 million. After Day 105, on January 3, 2018, the specific number of customers without service started to appear in DOE reports. In total, the worst case scenario resulted in 4,038 million CHoLES, or 1,107 million CHoLES more than the conservative estimate.

## RESULTS AND DISCUSSION

The main work presented is based on the total customer hours of power outage, CHoLES. This type of index integrates the importance to prioritize blackouts for many customers, even if these are relatively short, and also considers the imperative to provide a viable alternative for remote rural communities that usually wait much more to recover access to electric power services. The results do not indicate that the last ones to be served should be the highly populated urban areas and it is probable that the restoration efforts will not drastically change. However, the results highlight the need to provide alternative energy options for those living in rural areas. Considering the transition phase the electric power industry in Puerto Rico is going through, it is crucial that the interests of those last customers in remote communities are put first when considering resilient distributed power systems.

One of the main results of this analysis is that almost a third of the total CHoLES (900 million) was due to the last 200,000 customers that were reconnected to the grid from day 156 to day 329 after the Hurricane. The estimates also indicate that slightly more than a third of the total CHoLES (1,041 million) were due to the 300,000 customers that were reconnected to the grid from day 71 to day 156 after the Hurricane. An estimate of 900 million CHoLES were due to the 967,000 customers that were reconnected to the grid from day 1 to day 71 after the Hurricane. Figure 1 shows how the total CHoLES were accumulated and the contribution that each of the three groups made to such a massive power outage.

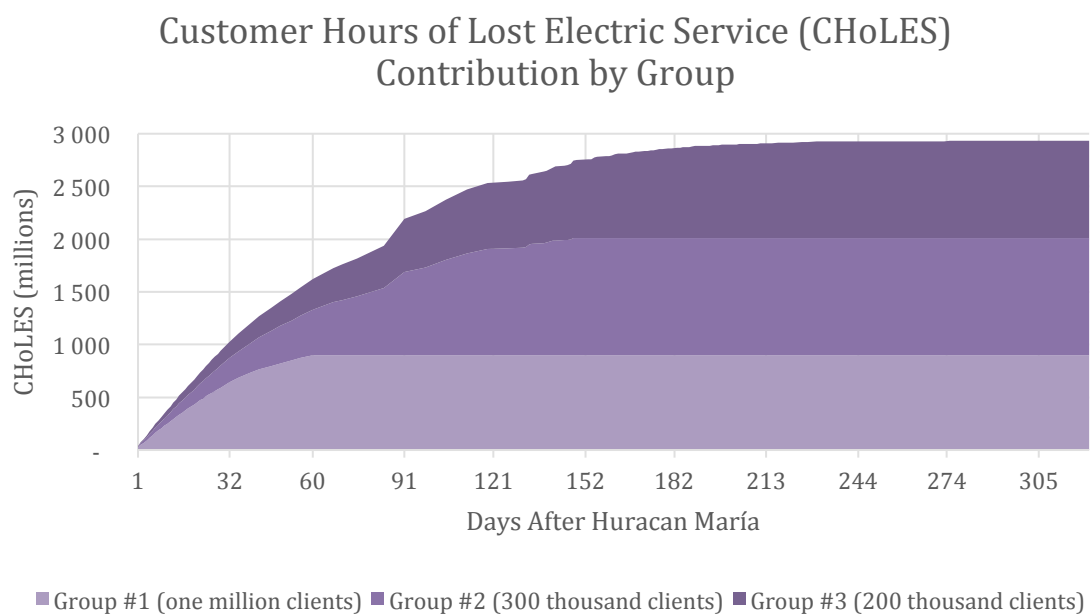


Figure 1: Customer Hours of Lost Electricity Service (CHoLES) by Group

**Snapshot: Two months after Hurricane María**

1. About one fourth of the seventy-eight municipalities had absolutely no electric power from PREPA. See municipalities in grey on Figure 2 by Status PR.
2. A fault on a 230 kV transmission line caused a decrease from 50% to 22% of the load that had been restored five days earlier, but it was back to 46% while 58.4% of the 1,146 transmission lines were functioning and 74.9% of the 344 substations were functioning (DOE, 2018).



Figure 2: Municipalities in Grey have 0% Electric Power on November 20 2017

**Snapshot: Five months after Hurricane María,**

1. Close to two hundred thousand households did not have power representing 13.4% of the total number of PREPA clients.
2. All Regions were electrified to a level of 80% or above except for the Caguas Region, which includes remote municipalities from the central mountain range such as Orocovis, but also those on the southwest coast that was hit hardest such as Yabucoa, Humacao and Naguabo as seen in Figure 3 from USACE.

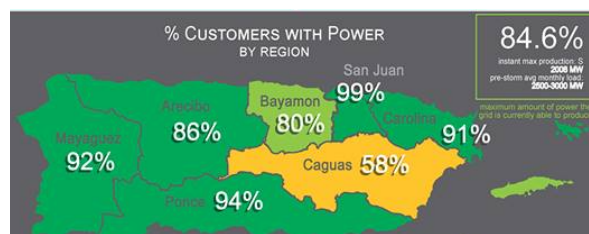


Figure 3: Power Restoration by Region on February 26 2018

**Snapshot: Nine months after Hurricane María,**

1. Fifteen thousand households did not have power representing 1% of the total number of PREPA clients.
2. The last 1% group contributed 83.6 million CHoLES in nine months without power. This is almost 3% of total 3 billion CHoLES and the equivalent of a national blackout more than 2 days (58 hours long) in Puerto Rico.
3. The last 1% to be electrified needs to become a priority for public policy in the recovery of Puerto Rico and the investments to make Puerto Rico more resilient.

**Snapshot: Ten months after Hurricane María,**

1. Five hundred households did not have power that accounted for 3.6 million CHoLES, which is the equivalent of a national blackout more than 2 hours long in Puerto Rico.
2. Nine municipalities were not energized 100%. Six of them, Utuado, Jayuya, Morovis, Adjuntas, Orocovis and Cayey, are in the central mountain region while the other three, Naguabo, Guayama and Guayanilla, are coastal municipalities that also have a large mountain rural area.



- Two municipalities were less than 99% energized and they were both in the most remote central mountain region: Utuado and Jayuya.

Figure 4 and Figure 5 show the total restoration process of the electric power network in Puerto Rico and the recovery process by region, respectively. The regional data was only publicly available during the period that USACE reported it. The regional data shows that the Caguas region had a restoration curve much slower than the rest of the regions. The region of Arcibo was second in slower recovery for the first 145 days, then had a steep ascent to move closer to the other regions. The slow recovery of Caguas and Arcibo is due to the fact that they contain most of the towns in the Central Mountain Range.

### Percent of Generation (Day 1 - 119) Percent of Clients with Power (Day 121 - 329)

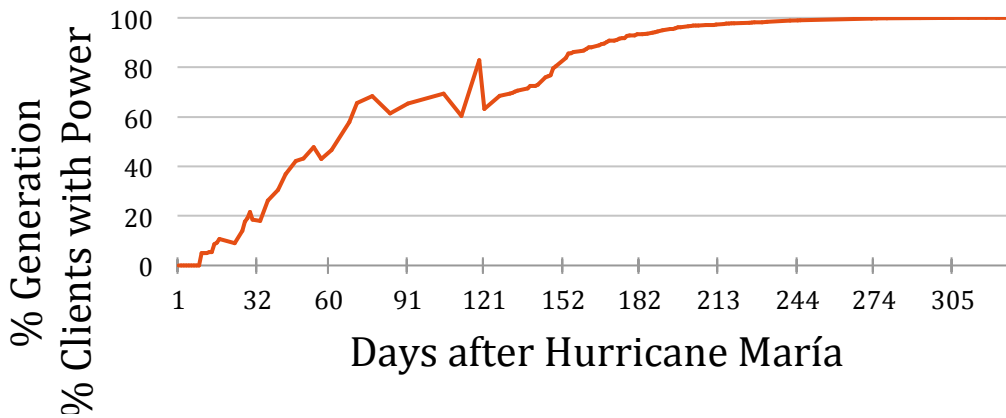


Figure 4. Snapshot to the Overall Power Recovery in Puerto Rico after Hurricane María

### Recovery of the Electric Power System by Region

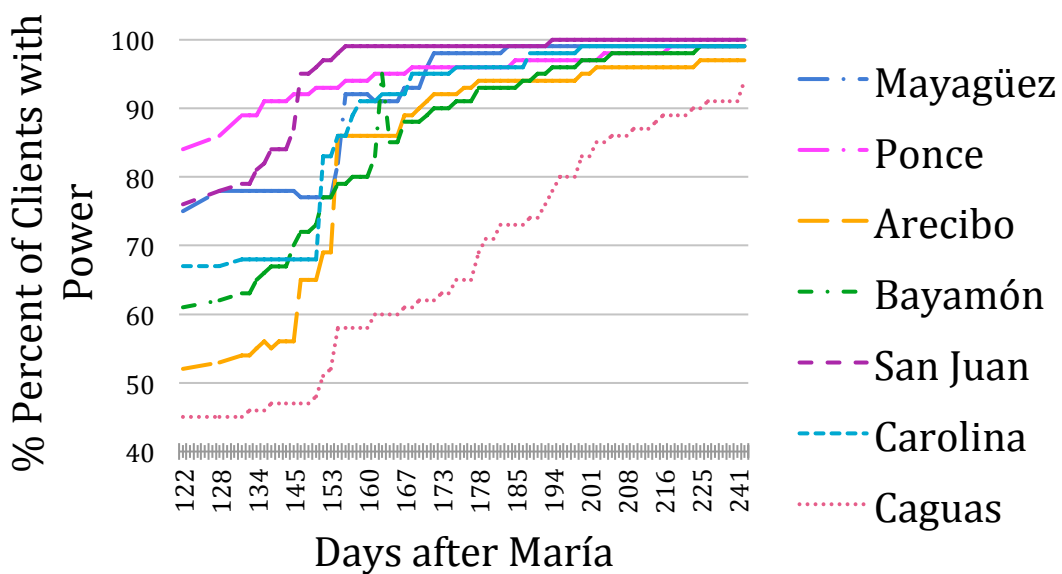


Figure 5. Regional Power Recovery in Puerto Rico after Hurricane María

## **Impact of Power Outage**

While a comprehensive work to study the impact of the longest power outage in the people of Puerto Rico is needed, such study is outside of the scope of this effort. However, the studies focused on the deaths related to hurricane María provide a good idea of how critical is electric power to achieve a sustained quality of life. The Puerto Rico Center for Investigative Journalism (CPIPR) published their work that covers 487 cases from September 2017 to March 2018 (Sosa-Pascual, Campoy and Weissenstein, 2018), which are perhaps close to 25% of the total number of deaths related to Hurricane María. The larger group of causes of deaths reported by CPIPR was the one labelled due to “lack of electricity with 158 deaths which accounts for 32% of the cases. These 158 deaths include cases of in which there was no power for machines related to respiratory conditions, no refrigeration for insulin, bed sores due to electric bed not functioning, and accidents due to lack of appropriate lighting. It was also reported that “kidney-disease-related deaths rose nearly 43%, to 211” (Sosa-Pascual, Campoy and Weissenstein, 2018) because of the lack of appropriate power and enough water in dialysis centers.

A previous study based on a survey to 3,299 randomly chosen households across Puerto Rico reported that 83% of the households were without electricity in the most remote areas from September 20 to December 31 2017 (Kishore, Marqués, Mahmud, et al. 2018). The same study reported that, overall, households spent an average of 84 days without electricity, 68 days without water, and 41 days without mobile phone coverage for that period. However, considering that the power outage lasted a total of 314 days and that less than 60% of the households were connected to the grid by day 101 on December 31, the total average of days without electricity should now be much higher. A deeper look into the Appendix files with a focus on the proportional distribution of days without services ordered by remoteness and the tables with information of lack of access to medical care could be useful (Kishore, Marqués, Mahmud, et al. 2018b).

The study that estimated the number of deaths related to Hurricane María in 2,975 also determined that the estimated relative excess mortality was drastically higher for the lowest socioeconomic level with a relative excess ratio above 1.6 for January 2018 compared to values between 1.1 and 1.2 for the other two socioeconomic levels (Santos-Burgoa, et al. 2018). This is crucial information to appropriately setup a coherent energy policy that provides Puerto Ricans in the most vulnerable communities with the most resilient power sources and to improve their chances of survival. Even though Puerto Ricans went through the longest blackout in history, it needs to be put in context with other communities that lack universal access to electricity.

## **Long Term Power Outage and Energy Access**

Perhaps the only communities that have experienced power outage longer than in Puerto Rico are the 1,000 million people that live without access to electricity every day, of which more than 500 million are in the African Continent, according to data from 2016 (IEA, 2017). Figure 6 shows the relationship between the approximate restoration service in Puerto Rico the first 40 days after Hurricane María and the electrification rate of different countries in Africa. Figure 7 shows the relationship between the approximate restoration service in Puerto Rico during the period consisting from day 40 to day 241 after Hurricane María and the electrification rate of different countries in Africa. Follow up studies need to analyse the impact of a power outage in life expectancy, life satisfaction and other dimensions that define the quality of life

compared to the effect that continued lack of access to power has on many communities in the African Continent. Available results provides evidence that decentralized solar PV plus battery systems could be the most appropriate solution to both, greatly improve the resilience of the Puerto Rican people and also enable universal electric energy access to the most remote communities in the African continent.

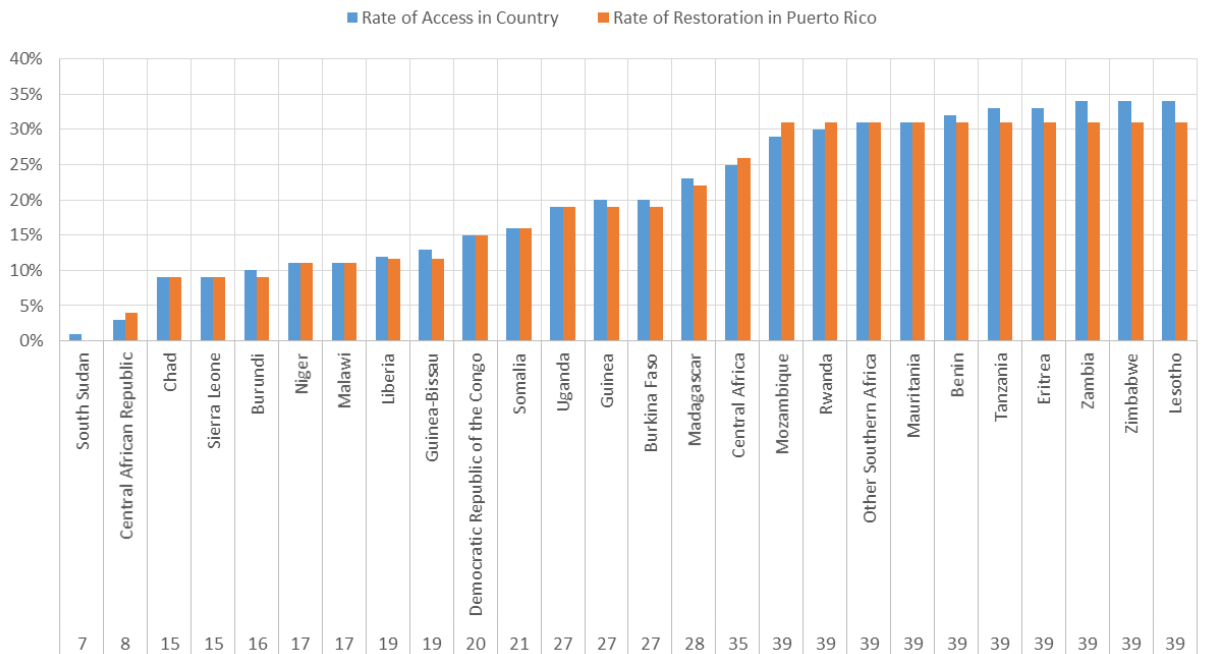


Figure 6: Comparison of Power Restoration in Puerto Rico during the First 40 Days and Electrification Rates in African Regions and Countries

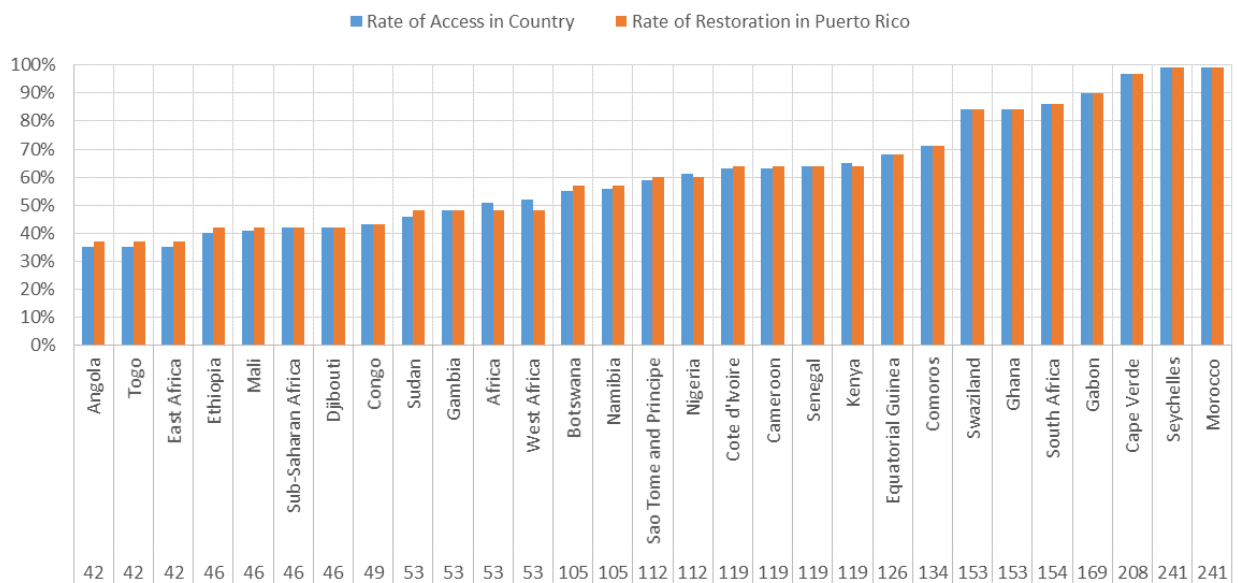


Figure 7: Comparison of Power Restoration in Puerto Rico from Day 40 to Day 241 after Hurricane María and Electrification Rates in African Regions and Countries

## **Revitalization Energy Policy for Puerto Rico**

The status of the power recovery ten months after María tells us that the remote rural areas are the ones that need to be addressed first. The remote context calls for decentralized power solutions, which are mainly driven by solar PV plus battery systems (PV+B) at the household level. Other technologies will also play an important role to add levels of resiliency at community level and even at municipality and regional level. However, the radically distributed energy systems at household level should remain as the key building block for the resiliency at higher levels. For example, a community microgrid would benefit from a high level of penetration of rooftop solar home systems at household level, particularly if they also have energy storage capacity. The flexibility that a large amount of PV+B systems provide can enable a variety of smart grid capabilities in the future such as peer-to-peer energy transactions, variable electricity rate, demand side management, and virtual power plant.

One scenario is explored assuming 20% penetration of PV+B home systems in Puerto Rico before the peak of the 2020 hurricane season. Assume two hundred thousand houses with a minimum power generation capacity of 2 kW peak solar power and minimum energy storage of 10 kWh with an estimated installed system cost of \$7,000 USD. In the medium and long term it is an underestimate because this cost is projected to decrease every year, mainly due to fast declining cost of energy storage and moderate decrease in solar PV cost. Further immediate savings could be achieved if communities get organized and purchase such systems in bloc.

The level of energy consumption that a small PV+B system can provide is aligned with the Responsible Wellbeing Framework with an approximate energy production close to 3,000 kWh annually. The recommended range of annual energy consumption per capita is between 400 kWh and 2,000 kWh, which could translate into 1,600 kWh to 8,000 kWh per household (Castro-Sitiriche and Jiménez-Rodríguez, 2014). If 200,000 PV+B minimum systems were installed by 2020, it would represent a total of 400 MW of PV generation capacity and 2 GWh of energy storage capacity radically distributed across the Puerto Rican archipelago at an estimated cost of \$1,400 million.

In the 20% for 2020 scenario, special attention should be given to the communities that recovered electric power services last. If those 200,000 houses with the PV+B minimum systems belonged to those that recovered power last, the total CHoLES would have been 32% less, from 2,931 million CHoLES to 2,003 million CHoLES. Also, the total length of the longest blackout in history would have been about half long with a total of 156 days instead of 329. Also, this would imply an impressive 400 MW of PV generation capacity and an unprecedented 2 GWh of radically distributed energy storage capacity. To put this in context, the total residential energy storage capacity installed in 2017 was 29 MWh (SEPA, 2018) and it is projected to reach 774 MWh for 2018 (Maloney, 2018). The increase of residential energy storage installation capacity from 2017 to 2018 was 27 times more in only one year, which demonstrates that the market has the capacity to accommodate the drastic increase in demand that the proposed path for Puerto Rico would represent.

The families that spent more than five months without power should be given priority in the reconstruction phase that Puerto Rico is slowly starting. However, medium and long term recommendations are also relevant at this point in which PREPA is in a privatization process, the Fiscal Oversight and Management Board is controlling the process, and the long term planning for PREPA is taking place. A medium term energy policy goal of 500,000 households by 2025 with PV+B minimum systems is also included in the analysis. If those 500,000 houses with the PV+B minimum systems

belonged those that recovered power last, the total CHoLES would have been 69% less, from 2,931 million CHoLES to 912 million CHoLES. Also, the total length of the longest blackout in history would have been 71 days instead of 329.

A one million households with the PV+B minimum systems by 2035 is also included to support the vision of 50% energy consumption coming from renewable sources. One million of household PV+B minimum systems installed could contribute one-third of the 2035 goal of 50% energy from renewable energy sources. The cost estimate for one million households would be less than \$7,000 million USD which is a reasonable investment level considering that the range from \$4,200 to \$6,200 USD earmarked for residential PV+B systems and an additional \$26,000 million in energy investments in the Reconstruction Plan (COR3, 2018). When combined with the potential for business to also install solar rooftop PV+B systems and industrial customers to coordinate with utility scale PV+B systems the energy outlook for Puerto Rico emerges as a potential model for sustainable energy future worldwide. Table 2 provides the main numbers for the different future scenarios

Table 2. Minimum PV+B Projections for Puerto Rico Future Scenarios

year	2020	2025	2035
Percent of houses with minimum PV+B system	20%	50%	100%
Number of houses	200,000	500,000	1,000,000
PV Power Capacity (MW)	400	1,000	2,000
Percent of TOTAL Generation Capacity	8%	20%	40%
Energy Storage Capacity (GWh)	2	5	10
Estimate Annual PV Energy Generation (GWh)	584	1460	2920
Percent of Residential Annual Energy Consumption	8.98%	22.45%	44.89%
Percent of Total Annual Energy Consumption	3.37%	8.43%	16.87%

### Appropriate Technology for Radical Decentralization of Power

A Solar PV + Battery Systems (PV+B), small solar rooftop systems, for example 2 kWp of PV and 10 kWh of storage at an estimate cost of \$7,000 USD each, provide a cost effective alternative to increase the resiliency from the bottom-up. In the previous section the outlook for decentralized power in Puerto Rico demonstrated the feasibility for such a drastic change in direction. This kind of distributed approach has the potential to spark economic growth for many small solar businesses that can benefit from the installations of thousands of small solar PV+B systems. The prospects in remote rural African communities are very different because of the level of consumption, access to capital investments and household purchase power. However, the bottom-up resiliency concept and the bottom-up grid for Puerto Rico does provide a useful framework to build the energy future of remote rural communities in Africa with a completely decentralized structure.

Starting with modular PV+B at the household level with the potential to be expanded and the flexibility to be interconnected in nanogrids and microgrids in the near future, the following step would be to interconnect different networks at higher levels as it becomes economically feasible. Grid flexibility and flexible power converters will be central to future power networks. The potential for power aggregation and implementation of small smart systems will drive those remote communities to the forefront of power technology innovation. Enabling technologies such as smart meters,

flexible power converters, and novel concepts such as transactive energy and the internet of things, could become commonplace in the most remote places first. However, major investments in this technology and resources for pilot projects are needed before these technologies are effectively deployed in rural Africa. Puerto Rico could provide the bridge to connect the current innovations in decentralized power technologies and the market potential of more than 500 million people in the African continent living in energy poverty. The fact that small solar PV+B systems are needed in Puerto Rico and also in many African countries provides revitalization opportunities for remote rural communities and serve as a reminder that “small is beautiful”.

## **CONCLUSIONS**

The impact that the longest blackout in history had in the people of Puerto Rico was established from the people’s perspective using the Customer hours of Lost Electricity Service (CHoLES). It was found that a small percentage of customers accounting for 14% of the PREPA customers contributed one third of the total CHoLES. A minimum PV+B system is proposed to provide Puerto Rican households with a much needed local resilience that can be built from the bottom-up. The level of energy consumption that a small PV+B system can provide is aligned with the Responsible Wellbeing Framework. Furthermore, the decentralized nature of solar rooftop systems combined with the native generating power provides a strong case for the incorporation of the Appropriate Technology Framework in the transformation of the electric power system in Puerto Rico with the bottom-up grid concept.

The bottom-up grid framework has the potential to transform the energy landscape of Puerto Rico and also the most remote communities in rural Africa. The main results provide important insights to deliver the required resilience at the lowest possible cost with a focus on decentralized resilience while also enabling a radically distributed power generation and energy storage. Future work is needed to further analyze the feasibility to transfer such a massive amounts of generation and storage capacity for energy access and their potential contribution to improve the quality of life of more than 500 million people. Similarly, much work needs to be done in the areas of flexible power converters and flexible grid capabilities, which are already positioned to play a major global role in the grid of the future.

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# DECOLONISING AFRICAN UNIVERSITIES THROUGH TRANSFORMATION INTO KNOWLEDGE PRODUCERS

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## Abstract

The growing consensus is that the legacy of colonialism greatly influenced and currently shapes the process of knowledge production in Africa. This viewpoint holds that while colonialism ushered African societies into modernity, according to the European model, it had also been responsible for suppressing local knowledge traditions and altering their development path. On the other hand, endogenous knowledge has become an important component of bottom-up approaches to strengthening sustainable development processes. The debates on sustainability and rural development in late 1990s brought about the realisation that a different type of knowledge production is required to link scientific and other forms of knowledge. In this paper<sup>1</sup>, ideas generated in the long history of decolonisation debates as well as the shorter one on endogenous knowledge are used to explore the central question of whether the concept of endogenous knowledge can contribute to decolonising higher education. Three countries feature prominently in this exploration--Tanzania, South Africa, and Sudan. While the paper skims the surface of what exists in and around the two areas of study, decolonisation and endogenous knowledge, it contributes to thinking about a decolonising and development approach to education. With a legacy like Rodney's, and new social movements like that led by students in South Africa, it is possible to imagine a better future for the African university.

**Keywords:** higher education, decolonisation, African university, knowledge production

**Paper category:** Policy, Standards and Ethics

## INTRODUCTION

During my undergraduate years while studying computer science at the University of Khartoum, I often wondered if we Sudanese will ever be able to build a whole computer (not assemble parts and set up the machine, but manufacture and program its components), especially one that can take the heat, dust, and limited/unstable electricity. Now, after many years teaching computer science, we are a long way from that possibility where we still have one image in mind when we think of a computer. Whereas the intellectual and technical effort have been following a similar path of knowledge transfer that brought the computer, it is worth noting that more recent developments such as solar-powered computers, power storage technologies, temperature alarms, and Third World laptops, as well as concepts from the field of appropriate technology, may solve some of the problems. In this context, an important question to ponder is what factors persist in our education system that hinder the imagination of the African student and our knowledge production processes?

The legacy of colonialism is seen by some as a major influence and a current shaper of the process of knowledge production in Africa. This viewpoint holds that while colonialism ushered African societies into modernity according to the European model, it had also been responsible for suppressing local knowledge traditions and altering their development path. Walter Rodney, in his economic analysis of *How Europe Underdeveloped Africa* (1973) argued that colonialism, by transferring elements of capitalism and not the ecosystem that holds it together, Africa's chances to hold onto its past or to develop a modern

society outside the metropolis were constrained and ultimately failed. These ecosystems are what Hidalgo refers to as the knowhow that exists in “unpacked form”, “embodied in networks”, and can only be transported in object form, that is, in its practical uses like a law, policy, procedure, technology, etc. (2015:168-9). He argued that the inability to unpack this knowhow is primarily responsible for why parts of the world are underdeveloped. For Rodney, the solution to Africa’s underdevelopment was to, radically, shift away from the international capitalist system because it restricts human social development. Whether the shift is, doable or even desirable is still open for debate there is probably more agreement today about the need to look at meaningfully packing local knowhow that exists in unpacked and embodied forms, into our modernised elements like the university.

Interestingly, endogenous knowledge has become an important component of bottom-up approaches to strengthening sustainable development processes. The debates on sustainability and rural development in late 1990s brought about the realisation that a different type of knowledge production is required to link scientific and other forms of knowledge. In this context, ideas generated in the long history of decolonisation debates as well as the shorter one on endogenous knowledge, are important to consider because they provide the theoretical foundation for exploring the potentials and impediments for endogenous knowledge to become a decolonisation tool. In the paper, I recall Tanzania’s decolonisation legacy and explore the debates in South Africa, but focus on some of the Sudanese decolonisation experiments that involved the blending of scientific and endogenous knowledge systems. In particular, I consider the integration of “Al-Khalwa<sup>ii</sup>” with the modern school by Alshiekh Babikir Badri, of “Al-Maseed<sup>iii</sup>” with the mental health hospital by Dr. Altigani Almahi, and of the “street school” with elementary school teaching by Educationalist/Poet Mahgoub Sharif, in addition to the more recent introduction of “Sudaniat” (Sudanese Studies) into the university curriculum. I argue in this paper that while these experiments offer us a learning opportunity from local models, they are yet to open the way for a new epistemic culture that sees their notions as the norm not the exception. The paper aims to contribute to the body of anticolonial criticisms and discussions on processes of epistemic decolonization that could slowly, and cumulatively, liberate spaces and intersections of learning and social progress.

## **THE CONCEPTS: DECOLONISATION AND ENDOGENOUS KNOWLEDGE**

Originally, after WWII, the meaning of decolonisation was more about the process of moving from the political and military power of colonisers to creating independent nations. However, for liberation movements and native scholars, the term extended to include intellectual decolonisation. That is, dismantling the dominance of the Eurocentric knowledge production model giving way to local epistemic cultures. Linda Tuhiwai Smith analysed dominant research methodologies where she highlighted their role in devaluing Maori ways of knowing and limiting indigenous researchers. She described Kaupapa<sup>iv</sup> Maori, as a new way of thinking about Maori indigenous research and called for “*decolonising methodologies*” arguing “*we have a different epistemological tradition which frames the way we see the world, the way we organize ourselves in it, the questions we ask and the solutions we seek.*” (Tuhiwai Smith 2006:188). Comparably, Hountondji (2009) regards scientific activity in Africa as “*extraverted, i.e. externally oriented, intended to meet the theoretical needs of our Western counterparts and answer the questions they pose.*”

In their discussion of South Africa, Hendricks and Leibowitz (2016) note that calls for the decolonisation of countries, institutions, the mind and of knowledge are not new nor went uncontested. They found expression in the Pan Africanist, Black Consciousness and African Renaissance movements, and that universities, too, have long been at the centre of decolonisation debates. Mbembe recalls that in the 1960s and 70s, to decolonise meant to

Africanize, and that the meaning of “Africanization” was also contested (2016). Mbembe notes that for Fanon, who was critical of the African middle class, the Africanization paradigm meant opportunism, retrogression, and chauvinism, i.e., more of a rhetoric. Whereas for Ngugi, Africanization was about the “politics of language,” and decolonisation was a process (rather than an event) of “seeing ourselves clearly” and placing Africa at the centre of our teaching and writing. Le Grange (2016) reviews decolonisation models (e.g. Chilisa’s five phased process of: rediscovery and recovery; mourning; dreaming; commitment and action), and the different generations of colonisations (First and Second) and new forms of colonialisms (such as neo-colonialism, neo-liberalism), that he argues all would need addressing in decolonisation efforts.

Several theories and areas of study have originated from, or influenced by, decolonisation debates such as critical race theory, post-colonial studies, subaltern studies and feminist theories from the global south; and there are fields that can contribute to the decolonisation process like appropriate technology and knowledge management. While the intersections of decolonisation with these study fields are important to discuss in the pursuit of approaches and understanding impacts, they are not the focus of this paper on endogenous knowledge. Decades after the early debates in South Africa (Hendricks and Leibowitz 2016), renewed calls by contemporary South African students for Africanization and decolonisation of the university enliven the old debates that also the prospects of yielding new theories and fields as well as the discovery of possibilities within existing areas of study. At the heart of the current decolonisation question for African academia however, is what Mamdani (2017) sees as the divisions between the universal and the public intellectual, and those between the models of university excellence versus relevance. Discussions went on for decades about the space for African indigenous knowledge systems and the role of African philosophy in the decolonisation process. Some of the examples of this process in practice, focusing on education, are discussed in the following two sections of this paper. The link, however, between indigenous knowledge and, more recently, endogenous knowledge to development is important for the decolonisation debate. This is simply because if education is to serve development then endogenous knowledge must be “seen”, which in turn, requires decolonising education.

The distinction of endogenous development from other models is that it specifically incorporates the worldviews of local people about development beyond the limits of the participatory paradigm that does not engage the spiritual paradigm (Millar et al, 2008). The model is part of new economic growth theories that still requires intellectual effort to deal with the difficulties in testing its performance and defining causal relationships (Capolupo 2009). In a special volume on “Development in Practice”, Malunga and Holcombe (2014) explore in detail the meaning of endogenous development from different perspectives and the difference between endogenous and exogenous development. For Asian success stories, Lee et al (2009) studied biotechnology knowledge clusters in South Korea and Singapore to compare the endogenous and exogenous development models. The authors concluded that it is counterproductive to use a single lens to develop a regional development policy because each has its limitations. For South Korea, their endogenous model failed to develop global players, while Singapore’s exogenous model failed to develop local skills and entrepreneurship. The authors instead suggest approaching the development of knowledge clusters in this era of globalization through a global production network perspective. The question for the South Koreans and Singaporeans was more about where investment comes from. For Africa, the questions have been about aid, or “Dead Aid” as Moyo (2010) declared.

Sometimes, the terms indigenous and endogenous are used interchangeably. For Oppong (2013), they both refer to “*knowledge about the people, by the people and for the people.*” According to Rist et al (2011), the two terms are almost conceptually identical if not

for the “difficulties” the term “indigenous” faces in academic and politics realms. The use of “endogenous”, for Rist, clears the ethnocentricity and historicity implied in “indigenous” and leaves the door open for all forms of knowledge that are outside the dominant Eurocentric worldview. Jackson (2013) explains the difference from the social science perspective. To him, the term indigenous “conveys a relationship between the local and global” where the local is probably marginalised, whereas endogenous “conveys a meaning of arising from within”. The author suggests the use of the term ‘endogenous’ if one wishes “to steer clear of such a global relationship”. This perhaps could be a blessing or a curse for the term as a decolonisation approach. For the approach to work in today’s African university, seeking to improve its international ranking where its scholars compete for peer-reviewed journals and top publishers, a global relationship is required. To be on equal level with the global, barriers (like those discussed in the following subsections) need to fall.

## **A BRIEF HISTORY OF THE DECOLONISATION OF THE AFRICAN UNIVERSITY**

Almost half a century passed between the famous Dar es Salaam and Makerere debates in post-independence Africa and the current demands for decolonizing the university by the Student movement in South Africa. While the earlier debates emerged primarily from anti-colonial liberation movements, the latter debates in South Africa are occurring because of multiple issues. Chetty and Knaus (2016) argue that the student protests are a manifestation of a class struggle in South African universities. While this view manifests in the #FeesMustFall, Dismelo (2015) adds more dimensions to the class struggle argument that the movement “*is also about laying bare the failures of the heterosexual, patriarchal, neoliberal capitalist values which have become so characteristic of the country’s universities*”. These added dimensions are visible in the #RhodesMustFall, which Mbembe (2016) links the protest to “the question of the de-racialization of this country’s [South Africa] institutions and public culture”. The call for the statue to fall is by no means “frivolous,” according to Mbembe highlighting the influence of architecture on the intellectual life in the university, which resembles many images of university buildings across Africa. The multiple dimensions are also apparent in the more recent #TotalShutdown women protest in South Africa.

Decolonisation attempts at the University of Dar es Salaam, which was involved in the debates on the Ujamaa philosophy and socialist development in Africa in Nyerere’s post-independence Tanzania, particularly focused on developing alternative epistemologies that later became known as the Dar es Salaam School (Campbell 1986). The scholarly debates at Dar es Salaam were about making the university relevant to the masses by re-examining the purpose and content of the curriculum. This involved attempts to develop historical narratives from local knowledge, transform social sciences from disciplinary to career-based structure, and develop or utilise alternative analytical frameworks for understanding the relationships among colonialism, dependence, and “underdevelopment” in Africa. In highlighting Rodney’s impact on Dar es Salaam and social sciences, Campbell notes the elitist context that faced progressive scholars as they challenged “modernisation theories” and produced knowledge from African lives and narratives. He concludes that Rodney’s legacy laid “*a foundation for an intellectual culture which raises social questions from the point of view of those who want to escape being ‘The Wretched of the Earth’*”.

The history of decolonisation debates and efforts of the university in South Africa go back to the days of the national struggle but more pointedly to the 1990s as the country looked towards dismantling the Apartheid system. Specific policies and plans were devised to address education, e.g. the Higher Education Act 101 in 1997 and the National Plan for Higher Education in 2001 (Wikipedia). The University of Cape Town engaged in its own

decolonisation debate for many decades before devising specific transformation policies in 2015 to address the issue of representation in jobs, student population, and the curriculum. However, the effectiveness of policies are vehemently contested by university staff and by members of parliament (UCT Website; Mortlock 2017). Other efforts particularly focus on the curriculum. For example, in 2017, North West University graduated its first batch in Indigenous Knowledge Systems (Pitamber 2017). Many efforts are pointedly targeting the integration of local knowledge systems, for example the debates on the relevance of Ubuntu philosophy to promote inclusiveness and social justice in higher education that has surged in South Africa in curriculum policy documents since 2002 (Lefa 2015) and in other southern African countries, e.g. Namibia (Shanyanana 2016).

Decolonisation ideas and work exceed by far this short narrative; however, we can still observe different and changing trends. For example, approaches vary from dealing with democratisation and accessibility issues to others tackling philosophical and epistemological questions. While for many years, the concentration on decolonisation experiments was primarily in the social sciences, it began to shift to the medical sciences and more recently to engineering. Taking the University of Cape Town as an example, there is a thread that links the time of the refusal of promotion to Archie Mafeje to professorship in the late 1960s, and the “Mamdani Affair” in the late 1990s, to the 2015 student protests. The decolonisation debate is far from over; the unease or opposition inside the African academy is entrenched in university structures (Heleta 2016) as well as the strength of neoliberal forces that altered the scene (Mbembe 2016), for example from state-funded national projects to privatised internationalised realms.

## **DECOLONISATION EXAMPLES FROM THE SUDANESE LANDSCAPE**

The first decolonisation project in Sudan can be traced back to the “Sudanisation” process, which involved replacing colonial public service administrators and most university faculty with Sudanese. The process also involved a dual Arabisation/Islamisation process that represents the vision of the independence generation (dominated by Muslim northern/central Sudanese) who also inherited colonial institutions and power in the country. Although this dual process is significant for any decolonisation debate on Sudan, it is outside the scope of this short paper to address its consequences. For example, virtually all of the ethnic groups that reside outside of what is commonly referred to as the “central riverain culture” (the so-called “Arab-Nubian core” of the Sudan) have been variously marginalized by the socioeconomic, cultural, and religious policies of colonial administrations, and by successive Sudanese multi-party and military governments. These different forms of marginalisation culminated in 1989 with the most extreme policies of the National Islamic Front government (now National Congress Party, “NCP”). Amidst the triple impact from the Ottomans, Egyptians, and British, as well as today’s Islamist, patriarchal, and militarised Sudan, its decolonisation processes are indeed of a complex multi-layered nature. The work of notable Sudanese scholars like Abdullahi Ali Ibrahim who is critical of a much-cherished educational institution, Bakht Alrudha<sup>v</sup>—that was set-up by the British to design the curriculum and train teachers (Ibrahim 2010). Ibrahim saw Bakht Alrudha as dismissive of local culture. His views on colonial education structures and his analysis of the Arabisation process, which he described as a “Manichean Delirium” is interconnected to the problem of Sudanese identity (Ibrahim 2016) and demonstrate the two major layers of influence on the education of the contemporary Sudanese, Arab and British.

The work of other scholars who explored the influence of Arabic on Sudanese intellectual trends (Ibrahim, 1976; Tongun, 1998; Ahmed, 1998), adds to our understanding of the complexity of decolonisation. Furthermore, there are still class and power struggles and the particulars in Sudan’s colonial legacy and history (see, for instance, Fadl 1971, 1979,

2008; Niblock 1987; Deng 1995; Grawert 2010) that correspond to the writings of Rodney and Mamdani on Africa. In contrast to the relative availability of literature on the colonial experience and its impact, there is less written on decolonisation approaches. Perhaps, the best documented project is that of “Ahlia education” that saw the mobilisation of efforts and resources to build schools and technical training centres. This people’s act resisted the British’s education policies, and responded to the popular demand for modern education (Basher 1980). For this paper, I give a brief overview of decolonisation history in Sudan with focus on projects in education to explore the differences between approaches and their relationships to those of Tanzania and South Africa. It is worth noting that the authors of the projects discussed did not explicitly define their projects through the decolonisation lens. In my analysis, decolonisation was implicit in the integration of endogenous knowledge where I argue that these experiences showed how decolonisation might look on the ground. In other words, they represent decolonisation praxis.

### **The Early Years**

Early post-independence years saw flourishing art and literary circles. Decolonisation came in the form of movements such as the Khartoum School and Abadamak who emerged in the early 1960s, both ought to develop a Sudanese identity in their expressions. The Khartoum School of modernist art is considered to have blended the African, Arab, and Western styles (Tate Website; Gronlund 2018). Hale (2018), who witnessed the rise of this movement, interviewed the artists who are considered its founders and wrote about their work. For her, the movement is/was a “Sudanisation” of modernist art. In her interviews, the artists argued that the difference of the “subject matter” and their aesthetic notions create the distinctive features – a Sudanese identity in their version of modern art<sup>vi</sup>. The Abadamak theatre group, writers and poets, used performance art and literary expressions to get closer to the people (or at least a segment of the people) and explored the question of identity. The legacy of Abadamak’s intellectual debates and different schools of thought that emerged like “The Forest and the Desert”, occupy an important place in Sudan’s cultural history and debates among today’s art and culture circles.

### **The Middle Years**

The 1970s and 80s, saw the second longest military government and a brief parliamentary democracy. Whereas the cycle of military/democracy is a pattern since independence, the generals who ruled between 1958 – 1964 and 1969 – 1985 followed more benign policies of Arabisation/Islamisation (the second General even toyed with Marxist Socialism for a brief time in his early years) compared to policies enacted by the Islamist military coup in 1989. The two projects that are prominent, for the middle years (the third and fourth decades after Sudan’s independence in 1956), were carried out by individuals who blended cultural knowledge with the “modern health system” in different ways. Altigani Almahi, the first psychiatrist in Sudan, integrated “Al-Maseed” in his practice as well as in the referral system of the first psychiatry hospital he helped establish in the early 1970s. Al-Maseed, a local body that plays a religious and educational role in Sudanese society, is also a refuge to people in need. For example, families would take their “insane” members to the Sheikh who would use various “cures,” some of which involved beating. Dr. Almahi linked the two systems that allowed Al-Maseed to refer patients to the hospital, in a similar way that Babikir Badri (the pioneer of girl’s education in early twentieth century) linked “Al-Khalwa” with the school. As a scholar, Almahi who was the first dean of the Psychiatry department at the University of Khartoum, studied cultural practices like the “Women’s Zar” (a spirit possession ritual) and argued for its therapeutic value and worth for scientific inquiry.

Professor Ahmed Alsafi, who was Almahi's student, wrote a book about him and followed up on the work of engaging with cultural knowledge to improve medical education and practice. Alsafi's work on establishing a medicinal plants unit within the health system and his effort to preserve Sudanese medical heritage expanded on that of his teacher. A successful anesthetist, he is author of numerous books on the history and the cultural side of medicine. One of his most recent publications is a dictionary offered to medical students and early career doctors to learn the different Sudanese dialects for describing symptoms and illnesses the students learned at school. While both teacher and student sought to blend their cultural and scientific knowledge, they differed in approach. Both developed frames that can integrate local and scientific knowledge, Almahi in health service and Alsafi in health training. Alsafi's efforts extended to creating a medical heritage museum (the only one) and the largest collection of bibliographic data of health publications about Sudan. This preservation of heritage is vital for new decolonisation projects.

### **After 1989**

The start of this era saw drastic and rapid changes to the entire educational system, its structure and curriculum, and even included changes to the school dress code. Although Arabisation and Islamisation have been in the cards since Sudan's independence, the Islamist military regime that gained power in 1989 implemented abrupt transformations and followed strict interpretations. There is a myriad of studies on these changes and their impact, more notably by Al-Tom (2006) and Ombadda (2015) among many scholars critical of educational policies in this era. Ali (2002) sees that the government "reforms" failed to address the old problem of "indigenisation versus modernisation" of education. Ali contributed an interesting example of how human rights concepts such as solidarity and tolerance are replaced by Islamic faith and piety in the elementary school curriculum, demonstrating how ideology and education play out for the "transformation" sought after by the government. In my opinion, the consequences of educational policies implemented over the past three decades further complicates future decolonisation efforts that will not only confront the question of religious versus secular curriculum. There is also the sharp rise of tribalism, significant demographic changes, not to mention salient issues like conflict, identity, and governance of a still diverse country, even after the secession/independence of South Sudan.

The two examples of decolonisation projects selected from this era can be regarded as representing the extremes in a spectrum of individual and institutional efforts. They are also distinct in the way by which they engaged with endogenous knowledge. The first project was the way by which an elementary school teacher, Mahjoub Sharif, the "People's Poet", as he was fondly remembered in Sudan, exposed his students to an unlimited curriculum--the street. He expressed this image in his famous poem "Personal Card". At the time, the early 1990s, Sharif joined Alhfad School after losing his job like thousands others during the government lay-offs in all sectors for "public good" of those who are not allied with the Islamists. Ibrahim (2010), the unforgiving critic of Bakht Alrudha, sees in one of its graduates, Mahjoub Sharif, a counter-revolution and a response to the flaw Ibrahim saw in the institution's obliviousness to the abundant culture around it. On the one hand, Ibrahim thinks that Sharif, being the firm believer that he was in the idea that the environment surrounding the school is full of culture, took his students on walks and used what they experienced to describe a concept in grammar or mathematics. One example of particular significance for this paper found in Sharif's extracurricular activities that Ibrahim discussed was his use of "Alhabobba" (the grandmother) as a teaching process. As Ibrahim noted, Alhabobba, who is typically the reservoir of local knowledge, a storyteller, and possibly the first teacher a child meets, demonstrates Sharif's regard for the child's environment, and also

shows a secular approach (as opposed to Al-Khalwa for Babikir Badri) to blending cultural and modern systems.

The second example comes from the mandatory curricula in higher education, which also saw drastic changes after 1989, one of which was the introduction of a Sudanese studies course for university students. The course mainly contains modules about the history, geography, and culture of the Sudan. It is classroom-based, with credit hours, written examination, and sometimes a research project. With lack of analytical studies about this university-wide compulsory course, I can only speculate about how effective it is as a decolonisation tool or how meaningful it is to students from informal conversations<sup>vii</sup> with students and teachers. Their views indicate that the course is neither effective nor meaningful but part of patriotic rhetoric and moulding of minds towards State ideology. Despite the impression I got from students about how they feel about this course, which they think of as a chore or that it repeats what they already know, there are teachers who are exploring creative ways to make it more relevant to the discipline the student is pursuing as well as more enjoyable. In discussions with Abdelgadir Ismail (2017), who teaches Sudanese Studies at Omdurman Ahlia University, he explained how the course could include outdoor activities. One of the example he gave of these activities is for medical students to visit “Ghadeer Mountain” where Mohamed Ahmed (known as Almahdi) died. The students can explore the different theories that explain his death. Ismail explained that the context can be brought alive by the students when they recall the historical, the social, environmental, etc. that can introduce them to malaria, typhoid, but also the different narratives that are told. Even with creative scholars like Ismail, the main challenges to using the course as a consciousness raising and contextualisation exercise stem from the absence of academic freedom in an authoritarian and “full-fat<sup>viii</sup>” Islamist state.

## **ENDOGENOUS KNOWLEDGE FOR DECOLONISATION: CONCLUDING REMARKS**

Several observations can be drawn from the few examples taken from the decolonisation contexts of Tanzania, South Africa, and Sudan. First, the post-independence liberation aspirations gave the decolonisation debate its first surge in the different countries, with the Arts and Humanities taking centre stage. Second, decolonisation approaches have varied from state policy to people’s efforts, with politics and ideology playing significant roles. Third, while the link between “underdevelopment” and the need for decolonisation is clear, the forging of a development path through decolonisation is less vivid. Nyerere perhaps came the closest in his vision of a different educational and development trajectory for his country and Africa. There is no equivalent in Tanzania or Sudan to the student movement in South Africa and their reanimation of the decolonisation debate. From what I read (e.g. Campell 1986, Vaught 2015, Burrowes 2017), the spirit of Walter Rodney still lives on in the students of the University of Dar es Salaam and other parts of Africa and African Diaspora. From what I see in Sudan, the student movement is fragmented and oppressed, but nonetheless concerned with the declining state of the education system.

The meaning of “Endogenous Knowledge” of what comes from within a society does not preclude the interactions of this society with the outside. After all, indigenous knowledge does not exist in a vacuum. Scholars and practitioners working on indigenous knowledge, or the larger set of endogenous knowledge, for development, lay a foundation for an intellectual culture rooted in African definitions of science and development. They share characteristics of decolonisation scholars with their focus on “knowledge within” and “people-centred” approach to science and development. For this reason, their engagement in the decolonisation debate can bring new arguments for both epistemic cultures and new interdisciplinary spaces in the African university. For example, would the controversy around “indigenous”



knowledge lessen if replaced by “endogenous”? Would “development” bridge the divide between the universal and public scholar? Would either camp see the interactions between their fields as de-politicisation or radicalisation of their ways of thinking? Would a university, established in the colonial image like the University of Khartoum, be able or even want to transform itself into one that thrives on knowledge within, rather than global rankings?

With the current drive for market economies and educational development, everyone has to consider exploring the links between decolonisation and endogenous knowledge and the role they can play in “real<sup>ix</sup>” development, the underlying theme of this paper. This, I argue, is critical in a new world system that is characterised by globalisation, information and communication technologies, and a knowledge society. The era is upon us in a similar fashion to how the industrial revolution and the rise of capitalism setting in at the time of colonialism. Whose theories will take us through the 21<sup>st</sup> century and beyond?

One way forward may have to start with understanding the impacts of post-independence education reform movements and decolonisation approaches, perhaps drawing on Walter Rodney’s notion of human social development. The knowledge gained (inherently endogenous) can inform critical and continuous appraisals of theories we teach, technologies we buy, and policies we enact. Recalling Archie Mafeje’s socio-historical analysis (1998), these learning processes can only happen within democratic states and through open minds because of the multiple layers of contradictions that face decolonisation: such as between disciplinarity and multi-disciplinarity as well as among new forms of colonisations, globalisations, education spaces, and intellectuals. A crucial step towards a decolonised future lies in responding to what Mamdani has called the tensions between the public intellectual and the universal scholar in the African university that profoundly relate to resolving the “inside-outside” contradiction that Kwame Nkrumah (1965) saw as a prerequisite for the liberation of African intellectuals. In futures thinking, the student movement in South Africa can be regarded as a signal of change that maybe, is ushering in new intellectual trends and creating communities of learning and unlearning. For Edward Said (1985), these trends and communities are opening up spaces of “intellectual resistance”, and as they grow, they will be shaping and producing bodies of endogenous knowledge.

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## Notes

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<sup>i</sup> The paper builds on a presentation by the author entitled “Intellectual Access to Local Knowledge Systems: Sudanese Possibilities” at the Conference on the Cultural Side of Health, 18 – 19 March 2017, Khartoum.

<sup>ii</sup> Al-Khalwa for Sufi is a religious retreat. In Sudan, the term is also used to denote a religious school that is a prominent feature in the history of education.

<sup>iii</sup> Al-Maseed in the Sufi tradition is like a sanctuary where Sufis take refuge from the material world.

<sup>iv</sup> Principles and ideas, which act as a base or foundation for action (Maori Dictionary). Find at <http://maoridictionary.co.nz/>.

<sup>v</sup> Bakht Alruda, now that National Institute of Education, was a training college for elementary teachers established in 1934 in Bakht Alruda in White Nile region.

<sup>vi</sup> In her opinion, Hale reckons that the Khartoum School “was a kind of elite movement because Sudanese, at that time and even now, had no relationship to painting. So, even though the artists tried to Sudanise through subject matter, etc., most Sudanese did not appreciate their work.”

<sup>vii</sup> This course is mandated by the Ministry of Higher Education and is delivered at all higher education institutions for students in any discipline. The number of teachers or students I conversed with is by no means representative of this large population even if we consider one institution like the University of Khartoum with its five campuses and over 16,000 undergraduate students in 23 faculties. Therefore, the author’s comments should be taken as speculative and subjective, but also raise questions for relevant bodies to evaluate.

<sup>viii</sup> This phrase was used by the president of Sudan recently (11 August 2018) at the closing of the National Congress conference to describe the ideology of their movement.

<sup>ix</sup> Using Edward Said “Real Intellectual” in *Representations of the Intellectual*.