

# The Co-Created Guatemalan Field School: Carbon Reduction with Appropriate Technology

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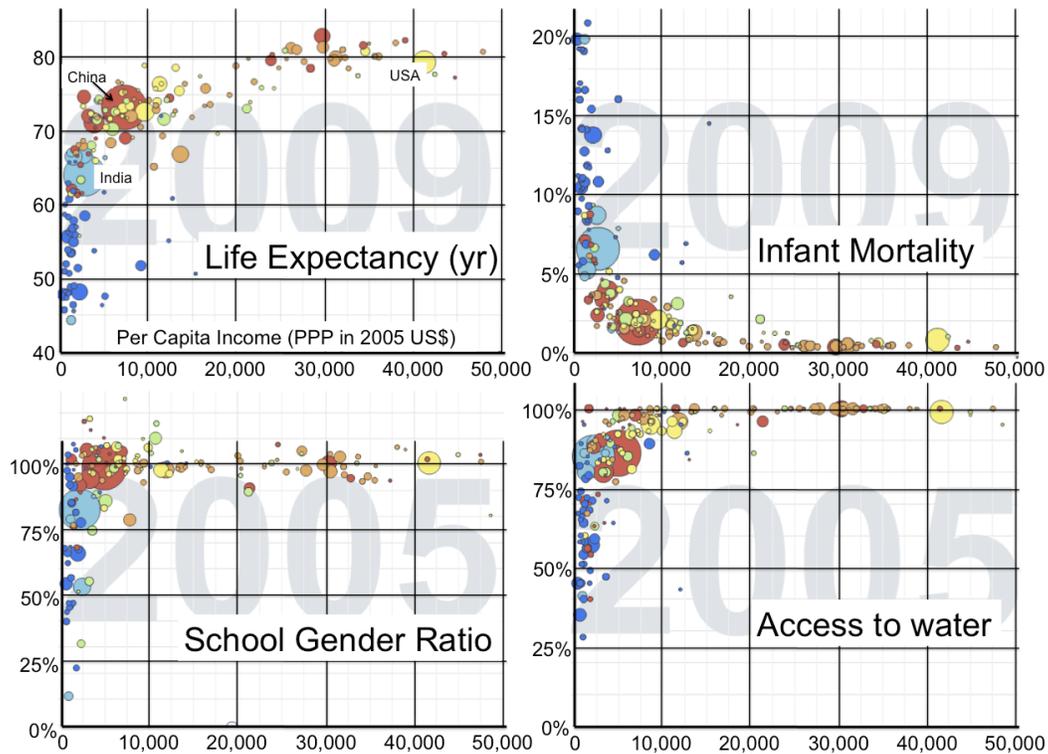
**Abstract.** We are exploring a collaborative development model where US students study in a developing country with local students, in this case in San Pablo, Guatemala – a village of 800 at elevation 3000 m near the Mexican Boarder. The Cal Poly summer study abroad program “Guateca”, to commence July 1, 2011, was jointly conceived with San Pablo leadership on August, 2010, and has since grown through input from both Cal Poly and San Pablo communities. The program aims to build cross-cultural community and explore choices both societies have in the context of the rapidly changing energy landscape to develop in a way that preserves the environment and builds independence from increasingly expensive conventional energy sources.

## DEVELOPMENT IN INDUSTRIALIZED AND IN DEVELOPING COUNTRIES

I will define “development” as the establishment of technological and societal infrastructure intended to meet the needs of the people. The present industrialized countries developed in an era of inexpensive fossil fuels with little accountability for the “external costs” of energy use including pollution and climate change. Most of the world is not industrialized and does not have the option to develop in the same way that the United States (for instance) did, as resources are now scarcer. Additionally, increased concern about the local and global impacts of unrestrained growth is propagating attention to sustainability in both industrialized and developing countries. While the economic context is different, the same strategies may successfully answer the same needs in both societies. Our intention is to work together with communities in developing countries to jointly educate ourselves, promoting novel technologies and community practices.

There is a near universal human drive to increase wealth, energy consumption, and the resulting emission of pollutants, including greenhouse gases, well past the point that this increased “development” improves any measure of human well-being. For instance, take child mortality: while 20% of the children in the poorest African nations die before the age of 5 years, there is no correlation between child mortality and income once per capita income exceeds \$20,000 US per year – less than half the per capita income of the United States. Psychological studies also indicate that once human needs are met, well-being does not increase with increased wealth [1]. Yet, most societies, people, and governments strive to maximize income regardless of

present economic prosperity. With this seemingly without-benefit excess prosperity comes a near proportional increase in CO<sub>2</sub> emissions, as seen in Fig. 4 of the paper submitted by Ashok Gadgil. If happiness is our societal goal, then we *should* be able to achieve it within the carrying capacity of the planet partially by decreasing our collective economic goals. While I recognize the societal challenge in this goal, I am compelled nonetheless to recognize it as the obvious conclusion from the data at hand.



**FIGURE 1.** Four Happiness (and Unhappiness) Indicators as a function of per capita income in 2005 United States Dollars corrected for Purchasing Power Parity. Each dot represents a country, and the area is proportional to the population. These statistics and many more are available at [www.gapminder.org](http://www.gapminder.org). [2]

Many past development efforts have used industrialized development as a model for developing countries and imposed solutions with minimal input from those “to be developed”. The results are often that technologies do not work as planned, or have adverse unintended consequences. Usually it is the very poor rural people who bear the brunt of the unintended consequences, as their viewpoints are left out of development planning processes most consistently. For example, building hydroelectric dams in developing countries usually means destroying the livelihood of up to millions of people who live on the riverbanks;[3] whereas in the United States these poor rural, indigenous communities have already been nearly destroyed or moved to cities, so the immediate threat to livelihoods is not a necessary

consideration. We have as one of our goals to be working with the rural poor so that none of our actions will affect them negatively. Our group is only beginning to build collaborative knowledge through our joint program, with the intention of making us a more effective agent of empowerment, as well as provide insight to us on how to make better choices for our own lives.

The past decade has seen an increased respect for people in developing communities recognizing what is best for themselves and being the most appropriate consultant for their own empowerment.[4] This has led to a more collaborative outreach and development process. We embrace this direction, recognizing that while we have access to significant mechanical, electrical, and agricultural technologies, this knowledge is applicable where we learned it, in American Universities. In the culture, land, and infrastructure of a developing country, our technological solutions may not work, as they are not “appropriate” for the setting. Thus, we begin a study together without well-established technological goals, but with a commitment to an educational process including inventory of the community’s needs as well as the collective physical and academic resources that each side has.

### **Vision Statement**

Guateca will become a model for cross-cultural collaborative education, emphasizing sustainable enterprises and fostering international community and local well-being.

### **Mission Statement**

Guateca is a collaborative education program between Cal Poly and San Pablo students, faculty, and citizens in San Pablo, a village of 800 in the Guatemalan mountains. This co-developed education program has the following goals:

1. Builds cross-cultural community with the needs and interests of both communities in mind.
2. Fosters technological and social development by encouraging curiosity and empowering innovation.
3. Advances language and cultural fluency, while studying energy and innovation of sustainable enterprises.
4. Develops sustainable technologies to meet the needs of San Pablo as well as generate income locally.
5. Our intention is to work openly together, sharing resources and ideas, embracing new challenges, goals, and resources.

### **The Guateca Summer Study Abroad Program**

Beginning what is a five-year program commitment, the first group of Cal Poly students will go to Guatemala for collaborative study this summer. After a week-long orientation, 15 Cal Poly students from a broad distribution of majors will travel to San Pablo to be joined by 15-20 San Pablo college students for two months of culture, language, sustainable technology, and service learning. We will stay with local

families, study, and work on projects with the community. Supported by summer tuition from the Cal Poly students, three classes will be taught by instructors from Cal Poly, and supported by various US and Guatemalan institutions:

- 1) Energy, Society, and Environment.
- 2) Language. With a 1-to-1 student-teacher ratio, between the equal number of US and Guatemalan students, Cal Poly students will study Spanish while San Pablo students study English. Spanish curriculum and assessment will be conducted by Cal Poly for US students. We seek a Guatemalan university to recognize the English curriculum.
- 3) Development of Sustainable Enterprises – Instruction will be supported by local experts in appropriate engineering fields, business, and agriculture.

### **Program History**

In Cal Poly's project-based classes, an interdisciplinary team of faculty and guest instructors mentors 30 – 40 students across all majors. For four years, students have explored the causes of poverty (UNIV-391) and innovated prototypes to address technical needs (UNIV-392). Additionally, this year, we are exploring appropriate business models in Agriculture Business (AGB-450). While the classes have disseminated important global information and fostered creativity, there has lacked a connection to a real community partner to give the projects meaning.

San Pablo, Tacana (population ~800) has a history of community and social well-being that make it particularly well suited for the Guateca endeavor. Jesuit influence since 1960 is seen in the terraced landscape, litter-free countryside, and strong community organization. The community successfully combats alcoholism, and prioritizes education. They have developed a K-12 school system offering hands-on experiences through weekend workshops and plan to enlarge their high school program with small business development and pre-university courses. San Pablo has organized Guateca program participants (15-20 university students and 5-7 community leaders), who have begun collaborating with their Cal Poly counterparts, additional instructors, and local universities, as we develop a plan for the coming program this summer.

Last summer (2010), we visited San Pablo for four days and met with community leaders. Together we started designing a collaboration model and also identified technologies that would have the greatest probability of success and best fulfill local needs. During December 2010, 12 Cal Poly students from UNIV-391 spent 10 days in San Pablo refining ideas for their projects. In winter of 2011, a new group of Cal Poly students in UNIV-392 did more work on technology development for the program while we identified and hired two English teachers to both teach English to San Pablo students and to facilitate communication between San Pablo and Cal Poly. A group of 4 Cal Poly students forming the Guateca advisory board has worked with Schwartz,

Cal Poly's Continuing Education, and the interested parties in San Pablo and Cal Poly administration to shape this summer's program and recruit students.

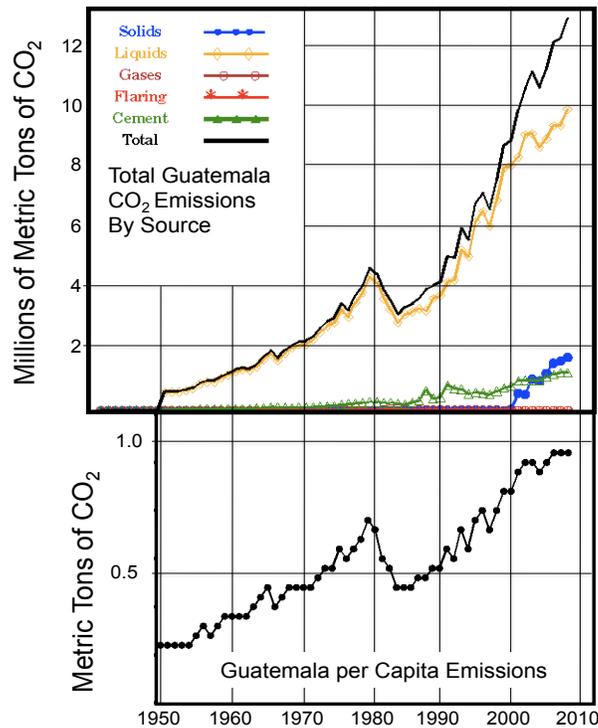
## **CARBON REDUCTION MECHANISMS**

### **Guatemala's Carbon Footprint**

Guatemala's 15 million citizens presently average slightly less than one metric ton of greenhouse gases per year (see Fig. 2). While this figure is more than 4 times what it was 60 years ago, it is still only 5% of the near constant 20 tons per person that the U.S. has maintained during the last 60 years. The economic intention of developing countries is to emulate the US economy, which would greatly increase global emissions as developing countries represent the bulk of the world's population. Our intention is to foster an alternate means to human prosperity (as indicated by a happiness index of needs met, rather than per capita income) to emulating the high carbon practices in the U.S. Besides serving global interests, a low-carbon development alternative may also serve the adopting poor countries because today, a society that develops will do so without the benefit (or handicap as the case may have been) of inexpensive energy. In any case, we recognize the autonomy of each Guatemalan to make these choices for themselves. To empower these choices, we recognize education as the most effective way out of poverty [5] as we ourselves explore and model what we (US and Guatemalan participants) find to be compelling energy practices. The summer school, funded by US students, is a model that provides education that is presently out of reach of most Guatemalans.

### **Guatemala's Carbon Footprint**

We have begun an ongoing emissions assessment for the Guatemala summer school itself and for the technologies that we are exploring. Given the distance to Guatemala and the mileage of a 747, we estimate about 500 kg of CO<sub>2</sub> emitted from the round trip flight to Guatemala, and another 100 kg from bus and automobile travel, and about 0.2 metric tons for living as a Guatemalan for two months. At the same time, 2 months of US emissions will be displaced: about 3 metric tons. With this rough estimate, the carbon footprint of the program should be about *negative* 2.2 metric tons per student. The calculation has several uncertainties. An average college student likely has less than average US American emissions, San Pablo emissions are certainly well below the Guatemalan average, and we may have considerable travel on the road in Guatemala. In the coming summer, we will monitor activities to improve this estimate.



**FIGURE 2.** Guatemalan CO<sub>2</sub> emissions by source (above), and per capita (below). [6] In comparison, US per capita emissions during the same period have remained relatively stable at about 20 tons/person.

## Introduction of Low Carbon Practices and Consumer Goods

The sustainable technologies and enterprises Guatemala will explore will also have an impact on carbon emissions – both in the developing and industrialized world. During the summer school, students will estimate the lifecycle emissions of the introduced enterprise and compare it with that which the new enterprise will displace. For a rough example, a family uses 40 gallons (150 kg) of hot water a day. If the water needs to be heated by 40°C, about 7 kWh are consumed. Thirteen percent of Guatemala’s electricity is produced from coal [6]. We presume that all the available hydro electricity is used, and that any additional load to the grid will be met with (the marginal generation of) coal-fired electricity with an efficiency of roughly 1/3. The Guatemalan grid has a loss of 14%, resulting in a carbon intensity of the consumed electricity of about 1.1 kg of CO<sub>2</sub> per kWh. Heating this water with grid-supplied, coal-generated electricity would result in about 8 kg of CO<sub>2</sub> emissions, or about three metric tons of CO<sub>2</sub> per year. Seven kWh of heat could be extracted on a sunny day with 2 m<sup>2</sup> of solar thermal panels, but we might play it safer by installing a 4 m<sup>2</sup> section of a roof with a clear plastic panel over the preexisting roof, connecting it to a 100 liter tank and requiring 20 m of plastic tubing for thermal transfer. Such a device might entail about 300 kg of embedded carbon dioxide emissions, indicating a carbon payback time of less than two months. At

present, we do not know if the proposed technology will work on site, what the required materials will ultimately be, and how the technologies will be used. These calculations are part of the course work for the present classes taught at Cal Poly [7] and will be part of the Guateca projects during the summer.

### **Supporting and Showcasing a Community that Already Prioritizes Sustainability**

San Pablo is already a model sustainable community, by having developed a very high standard of living through education and community responsibility. Our program is already receiving significant attention in Guatemala. Other communities are interested in learning how they can become involved. Our response is an observation of the building of a successful community that San Pablo achieved before we arrived. Thus the mere presence of our program elevates San Pablo to be a model for other poor rural communities in implementing practices that prioritize healthy, sustainable living.

### **Providing an Alternative to “Becoming US-Americans”**

As stated above, the US presently has a per capita carbon footprint that is 20 times that of Guatemala and other developing countries. Ten percent of Guatemala’s GDP is remittance payments from mostly young men working in the US to their families in Guatemala [8]. In the process, they often leave their children for many years, and often do not return at all. The pursuit of an American lifestyle is very apparent. The numbers beckon the question, “can we prevent them from becoming like us?” Certainly, we are collectively embarrassed by the arrogance and hypocrisy in such a statement. We fully recognize the need for the US to reduce our carbon footprint and the right of each person in a developing country to achieve their desired lives. We reframe the idea into the statement, “while we at home in the US endorse carbon reduction strategies, can we foster more compelling solutions for Guatemalans to choose from besides emigration to the US and/or becoming an extension of the US economy through remittance employment.” We have already found a community (San Pablo) where most of the young people wish to remain. They have expressed an interest to develop a more effervescent professional community in San Pablo in connection with the interest to retain educated youth. We will explore if the presence of Guateca fosters the creation of such an atmosphere and if the technologies introduced and the associated technological challenges has an effect on retaining educated youth in the village where they benefit from both the economic and social support of their community.

### **Providing a Test Site and Model of Alternative and Sustainable Energy Practices for Industrialized Nations**

Consumer acceptance is a major obstacle for any technology, especially for one that can be perceived as compromising, or requiring a change in lifestyle. While industrial countries have indicated a commitment to adopt sustainable technologies and

practices, our everyday needs are met by our present carbon-intense practices. For example, while people universally express approval of my outdoor solar shower in the 7 years I've had it, none pursued building one. These people already receive the services of conventional fossil fuel heated showers. In contrast, we did a "willingness to pay" survey for various technologies in San Pablo. We asked the question, "How much do you presently pay for hot water?" A common answer was, "nothing, we don't have hot water." In developing countries the carbon-intense technologies are often not an option because they are also more expensive. Because an experimental technology here may provide the difference of meeting a need, the barrier to adoption may be much lower. We anticipate that large-scale adoption of some successful appropriate technologies will provide a means to test and learn about the technologies and how people implement them. Additionally, San Pablo can also provide a non-industrial model of development for communities in both developing countries as well as in industrialized countries.

## **CONCLUSION**

We recognize that this contribution lacks substantial data. We have presented an idea and plan:

- 1) Given that development efforts have often failed due to lack of input from the people being targeted, Cal Poly and San Pablo will begin with a co-development model based on equal input and participation from both sides.
- 2) Given the strength of education as a means to walk out of poverty and promote social change, our program will be centered around education.
- 3) Given the importance of economic and environmental sustainability, we will focus on sustainable technologies and practices.

Our school begins this month. Data to follow.

## **ACKNOWLEDGMENTS**

Many thanks to the community of San Pablo for the insight and hard work they have demonstrated in the creation of a progressive modern community providing an inspiration to exit poverty by leveraging education and community organization; and for including us in their program. I thank Luz Marina Delgado for bringing me to San Pablo. I thank the many students – both Guatemalan and American, especially Jamie Cignetti and Kristian Velásquez Pérez for their insight and honesty and Julio Velásquez Roblero, a San Pablo community leader. I thank the many instructors that have taught the appropriate technology classes with me especially Kevin Williams, Sema Alptekin, Patrice Engle, and Andy Kreamer, an activist for social progress living in Berkeley, California.

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