

(CEER-X-107: CONTRIBUTION OF PUERTO RICANS TOWARDS THE SOLUTION OF ENERGY PROBLEMS by Dr. Juan A. Bonnet, Jr., Director, CEER-UPR. Presented at U.S. Department of Energy, 14 September 1981, Hispanic Heritage Week. CENTER FOR ENERGY AND ENVIRONMENT RESEARCH, UNIVERSITY OF PUERTO RICO, U.S. DEPARTMENT OF ENERGY.

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On behalf of the Puerto Ricans who form a vital part of the Hispanic heritage of this nation, I would like to thank you for inviting me here today. I am sure that everyone in this room knows that Puerto Rico is an island, 100 miles long by 35 miles wide, located about halfway down the Caribbean between North and South America. Puerto Rico is a self-governing commonwealth of the United States, where our elections for everyone, from governor down to municipal assembly persons, coincide with national elections here on the mainland. We have an elected Resident Commissioner here in the Congress, and we have the world's best rum, best beaches, tastiest food, liveliest music, and prettiest women.

At last count, there were three million two hundred thousand of us on the island. That comes to about a thousand people per square mile. Thankfully, we are gregarious. Our birth rate has been declining in recent years, coinciding with higher education levels, urban growth, and the desire of many of our young women to have a career outside the home. Puerto Rico in the 1980s is a vastly different place from the Puerto Rico of the 1930s and 40s.

Then, most of our people lived in rural areas and the economy depended principally on a few crops such as sugar and tobacco.

To put it bluntly, we were very poor. Today, Puerto Rico probably has the highest standard of living of any Latin people outside the U.S. mainland in this hemisphere, with the exception of Venezuela. Our per capita income is over \$3500. We are an urban, middle-class, industrial and commercial society today. We also enjoy a longer average life expectancy than our fellow continental citizens. We are very much a part of national life, although most of us speak Spanish most of the time. We travel frequently between the island and the mainland, some of us looking for work and others visiting family and relatives. During the 1950s, many of our people migrated north to the mainland, hoping to find work and escape rural poverty. Now, the trend has reversed. Every year, more Puerto Ricans who migrated north, found jobs, saved money, and raised families are returning to the island to work or enjoy retirement.

As you might suppose, our transformation from a poor agrarian society to a middle-class urban

community with an economy based on increasingly advanced industry and commerce has greatly increased our energy consumption. Although we started by generating power from hydroelectric sources, we don't have long, large rivers. Very soon, we began developing what is now an almost total dependence on imported petroleum. Currently, our electric power authority is gearing up to adapt some of our plants, or build new ones, so they may burn coal, with, of course, proper environmental safeguards. At the same time, we're looking beyond coal to a day when our energy will come from renewable sources.

For those of you new to the Department of Energy (DOE), or who may not know about your agency's involvement with Puerto Rico, I should add that our search for renewable energy sources in Puerto Rico today is the current phase of a quarter-century of joint effort between the DOE, its predecessors, and the scientific community of Puerto Rico.

Puerto Rico. I want you to know that everyone involved in energy in Puerto Rico is aware of our tradition of mutual cooperation, and we appreciate the stimulus and support given by the Department of Energy. Currently, Puerto Rico faces severe energy problems. We are at the mercy of the oil cartel, as 99 percent of our energy is derived from foreign, imported oil. Last year, more than \$1.5 billion left our island to purchase petroleum. We rank 26th globally in per capita petroleum consumption.

Apart from the high cost of energy affecting both our homes and businesses, we also face the unique problem of being an island. If anything goes wrong with our system, as happened in lower Manhattan last week, we are stuck. This happens despite Puerto Rico having the second-largest publicly-owned power utility, second only to Los Angeles Light and Power, under the U.S. flag.

In the Continental U.S., when one system undergoes a severe breakdown, there are methods of connecting to surrounding grids. However, in Puerto Rico, our grid stops at our shoreline.

The Center for Energy and Environment Research of the University of Puerto Rico has dedicated nearly 25 years to developing alternate energy sources for our trade winds-blessed, ocean-surrounded, and sun-kissed island in the Caribbean. These descriptions likely give you a sense of what we are working on at the Center, which is known in Puerto Rico and at the DOE as CER. Some of you may be surprised to hear about our 25-year history. Although Puerto Rico's development from an underdeveloped to a developed country has been relatively recent, we have been among the frontrunners in the field of energy and environmental research.

Consider this: Puerto Rico, which had one of the first offices of energy in the U.S., was also one of the first among the States to have an Energy-Conservation initiative.

Plan and its own Energy Policy Document. Puerto Rico was also one of the first sites in the U.S. where demonstrations of nuclear power were carried out at the Bonus Nuclear Power Plant. Our government-owned Electric Authority, back in 1960, was one of the first places in the U.S. to consider the possibility of Ocean Thermal Energy Conversion, or OTEC as it is known today. Other interesting facts include that on our small off-shore island of Culebra, which is halfway between Puerto Rico and the Virgin Islands, we have a windmill to generate energy for the island's nearly 800 inhabitants. The 200-kilowatt windmill is part of the NASA/U.S. Department of Energy

demonstration projects. Puerto Rico today is almost completely electrified in our rural areas, thanks to the U.S. Rural Electrical Administration, a feat that is not true practically anywhere else in the world. We in Puerto Rico had one of the first nuclear research and training centers in 1957. But this is all existing and part of history. What I would like to tell you about today is what we are doing at CEER in efforts to meet the energy needs of the future head-on. Our scientists, a mix of Americans and Puerto Ricans, are dedicating their time in the 1980s to find the answers to a better energy system for our island; a system that will take advantage of the natural resources that we have and that are there -- free -- for the asking. A system that will both be reliable and less costly for our children and our children's children. Our areas of study and investigation at CEER can be broken down into the various natural resources that we enjoy. Thanks to being surrounded by the ocean and having almost a full year of sun, we are able to experiment year-round in Ocean Thermal Energy Conversion on the only fixed platform laboratory in the U.S. Our laboratory platform, which is a converted Landing Craft Utility, is anchored only a bare 2.5 kilometers offshore where our insular shelf falls off abruptly to some 1,800 meters.

It's interesting to note that it's the deepest moored ship in the world, situated in 3,400 feet of water. OTEC, as you may know, is a form of solar energy that is based on the temperature difference in water drawn from the ocean's depths. In this case, the water is drawn from about 1,000 meters deep where the temperature is approximately 5°C, compared to the surface water that ranges from about 26°C in winter to 29°C in late autumn.

Experimental OTEC plants were constructed as far back as 1861, which is more than 100 years ago. The basis of the current understanding is that in a closed-cycle system, warm seawater evaporates a high-pressure working fluid similar to that used in refrigerators. Meanwhile, the cold water from the ocean floor recondenses the fluid. This process of evaporation and condensation within a closed cycle then turns a turbine, creating electrical energy that can be transmitted to shore for distribution.

Regions such as Puerto Rico, the Gulf Coast, and the entire Caribbean basin have great interest in OTEC because of its potential to solve the energy problems of this part of the world. In Puerto Rico, we hope to utilize our natural resources to produce electricity through tropical grasses, mainly sugarcane. We believe this will become a source of solar-dried fuel in the future and enable us to reduce our dependence on petroleum by about 15 percent.

In our initial field harvest, a leading short-rotation grass produced energy equivalent to one million BTUs at a cost of only around \$1.60. In the second year of production, sugarcane yields amounted to \$1.70 per million BTUs as compared to the \$4 per million BTUs that Puerto Rico pays today for imported bunker C residual fuel.

But that's not all. Not only would the production of biomass lower our imported oil bill, but it would also make a significant contribution to our economy. We Puerto Ricans are famous for many things—from West Side Story to being considered the best diamond polishers in the world. And there's one other thing everyone...

The text can be fixed as follows:

What we are known for is our rum, most notably Don Q and Bacardi. However, as our sugar cane lands have declined during recent decades, the amount of molasses we have been able to produce

has also decreased. Currently, nearly all of it is imported, which takes away needed jobs and increases our balance of payments. Biomass, in addition to producing low-cost energy, also produces molasses. We believe we could produce enough to serve our billion-dollar rum industry domestically.

A third area where we are actively engaged in contributing to energy research at CEER is solar energy. As any of you who have vacationed in Puerto Rico know, we are blessed with having sunshine practically every day of the year. As a result, our scientists have spent the last two years working on solar industrial process heat for industrial applications. They have been testing the weatherability of various solar device materials, constructing a solar data network, doing comparison testing of commercial solar water heating units, and exploring solar space cooling, air conditioning, solar agricultural applications, and photovoltaics.

We are designing an energy-integrated poultry farm and also developing a mathematical model of a demonstration solar pond. All these projects are currently funded by the U.S. Department of Energy. It's important to mention here that there are more than 15,000 solar water heaters installed in Puerto Rico.

And then there's the ocean. Our Marine Ecology Division spends long days and nights trying to uncover its secrets. Among the things we are attempting to determine is how Puerto Rico's marine, oceanic, estuarine, and brackish ecosystems function. Most importantly, we are studying the effects of man-made contaminants on the ocean itself and the fish that inhabit it.

While this type of investigation is not directly involved with energy, it is crucial to determining how far humans can go in using natural resources both for energy and for the production of needed materials. This is yet another area that we at CEER are concerned about.

The subject we concern ourselves with is Terrestrial Ecology. We believe our main function is to gain a fuller understanding of tropical ecosystems, energy management, pest and pollution control, and the ability of different ecosystems to assimilate disturbing elements and forces. To do this, we have our own beautiful natural laboratory - our rainforest at El Verde in the mountainous area of eastern Puerto Rico, which, pride aside, is indeed gorgeous. We have six different climatic regions on our island.

We also spend our time trying to help others in environmental health through studies we have conducted. One, in collaboration with the World Health Organization, resulted in ways of eliminating the schistosomiasis host. We have also worked with the government of the Dominican Republic on several occasions, and recently concluded an energy study for the government of Panama. At present, we are conducting studies for the Caribbean Development Bank.

We are also organizing a series of seminars: one on Nuclear Energy in November 1981, a Wind Seminar in Barbados in December 1981, and a Biomass Seminar planned for April 1982. From August 1 to 7, 1982, the Second National Conference on Renewable Energy Technologies will be held in San Juan, as part of the XVII Conference of the Pan American Union of Engineering Societies. More than 2,000 participants are expected. The II Meeting of the Pan American Conference on Ocean Engineering will be held concurrently.

Here at CEER, we have our own Training and Education Division. Each year, we mentor several groups of students in the sciences, with the goal of encouraging them to choose this career path. I'm proud to say, we seem to be succeeding. Of the group of high school juniors we trained two summers ago who entered college last fall, 100% of them chose to begin a career in some branch of science. The Summer Science Student Program held at CEER in the last three years has been a success.

Complete success. Also, the Summer Research Apprenticeship Program and Oak Ridge Associate Students have been outstanding. All of this is directly or indirectly funded by DOE.

If this brief summary of our activities at CEER seems like a lot, I need only say that we Hispanics are indeed an energetic people. Termed the poorhouse of the Caribbean just a scant few decades ago, Puerto Ricans have raised themselves by the bootstraps to where today, many of our leaders in business, politics, and academia are the offspring of people who perhaps did not even have a grade school education. Our universities are jammed full of young people, actually more than 150,000, who are on their way to becoming the next generation's leaders, many of them in science and energy research. More and more top-level jobs in our banking, manufacturing, and science fields are being held by young, well-trained Puerto Ricans, and it has all happened in just a few, brief decades. I hope this has given you a quick overview of who we are and what we are up to in Puerto Rico both in general and specifically in terms of energy and environmental research. Unlike our fellow Hispanics on the mainland, we are not a minority on our island but a majority, and our aim is to work together to turn Puerto Rico into a showcase of scientific research that can be admired and looked to with pride by our fellow Hispanics and all Americans. Before finishing, I would like to give special thanks to the U.S. Department of Energy for its continued support of CEER.

I'd especially like to thank DOE officials of the Offices of Energy Research, Health and Environmental Research, Conservation and Renewable Energy, Industrial Relations, Minority Economic Impact, and the Oak Ridge Operations Office. I also want to thank other collaborators from NSF, EPA, DOA, AID, NASA, etc., who have helped us through the years. We have a good start on our journey, and hopefully with the continued moral and financial support of you people here at the

In future Hispanic Heritage weeks, the Department of Energy will be recognized as the group that has helped solve all people's energy problems. Muchas gracias, saludos and thank you.