Future Energy, Water, Industry and Education Park (FEWIEP): A Secure and Permanent US-Mexico Border Solution

Luciano Castillo (Consortium Lead), Jay Gore, William K. George, Ronald Adrian, Carlos Castillo-Chavez, Leonardo P. Chamorro, Richard Tapia, Carlos F. M. Coimbra and Colleagues[1]

[1]Higher Education Institutions in Arizona, California, Florida, Indiana, Illinois, Puerto Rico, New Hampshire, New Mexico, New York and Texas.

$1.1 B addition to the DHS appropriations is requested for establishing FEWIEP

SUMMARY: There is bipartisan recognition that the border between the US and Mexico must be secure and that trafficking of goods and contraband at any point across the 1,989 miles of this border must stop. We applaud the steps being taken to adequately fund the Department of Homeland Security for ensuring border security. However, the need for a long-term solution presents an opportunity to **build a secure, large-scale economic development zone at strategic locations along the US-Mexico border**. We propose that a team of academic institutions helps the DHS build a **Future Energy, Water, Industry, and Education Park (FEWIEP).** Proposed activities will benefit both the United States of America and Mexico. Presidents Trump and López both support economic and technological growth and great income opportunities (jobs will be created for many educational levels, and training opportunities will be available by means of the FEWIEP institutes located along the border as shown in figure 1) that result from Science, Technology, Engineering and Math (STEM) education. This novel initiative has the potential to mitigate illegal immigration into the US, due to the vast employment opportunities that would be created on both sides of the border.

Future Energy, Water, Industry, and Education Park: Given that most of the southern border lies in arid or semi-arid regions having high solar irradiation and wind, an energy park along the border is both feasible and desirable. It would bring substantial business opportunities for both countries. The idea is to build an economic development and education zone (FEWIEP) along the border between the US and Mexico.

According to a study carried out by Romero-Hernandez et al. (2012), **the Mexican/US border is one of the best sites in the world for energy production, including substantial access to natural gas, solar, and wind resources**. This offers potential for short- and long-term economic development, including higher paying job creation. According to this study*, the state of Chihuahua (south of New Mexico) has one of the highest solar irradiation potentials in the world*, which is also abundant in the US Southwest, North of the border.

George and Wosnik (2019) estimated that a solar park of only five solar panels of 1-meter width (5.0 m/16 ft) along the entire border (3,200 km or 1,989 miles) can produce approximately 15.8 GWh/day.[1] This energy production is on the same order of magnitude as the hydropower production along the US/Canada border, and approximately the same as that from a nuclear power plant. The estimated cost is $4.5 B installed (assuming a cost of $1.50/Watt); however, selling all energy produced with a return of investment of less than 10 years, while providing the means for instant feedback and surveillance capability throughout the entire region for both security and environmental purposes. The estimated eight million solar panels that would be required are well within the current US capacity (the Tesla Solar City in Buffalo plant can alone produce 10,000 per day). The proposed energy infrastructure can be incorporated into and be an integral part of a border security installation, such as a wall or a fence. This technological buffer

[1] Cleary, the proposal is not to build a solar farm along the entire US-Mexico border, due to terrain, supply, demand, alternate sources etc. However, the simple calculation shows that significant generation is feasible without land acquisition.

can in turn also help to protect the energy infrastructure and prevent illegal immigration across the border. The economic stimulus of North American solar panel manufacturers would be large enough to present a significant challenge to current Chinese dominance of the PV market. The benefits of making the US and Mexico the solar energy leaders of the world are incalculable.

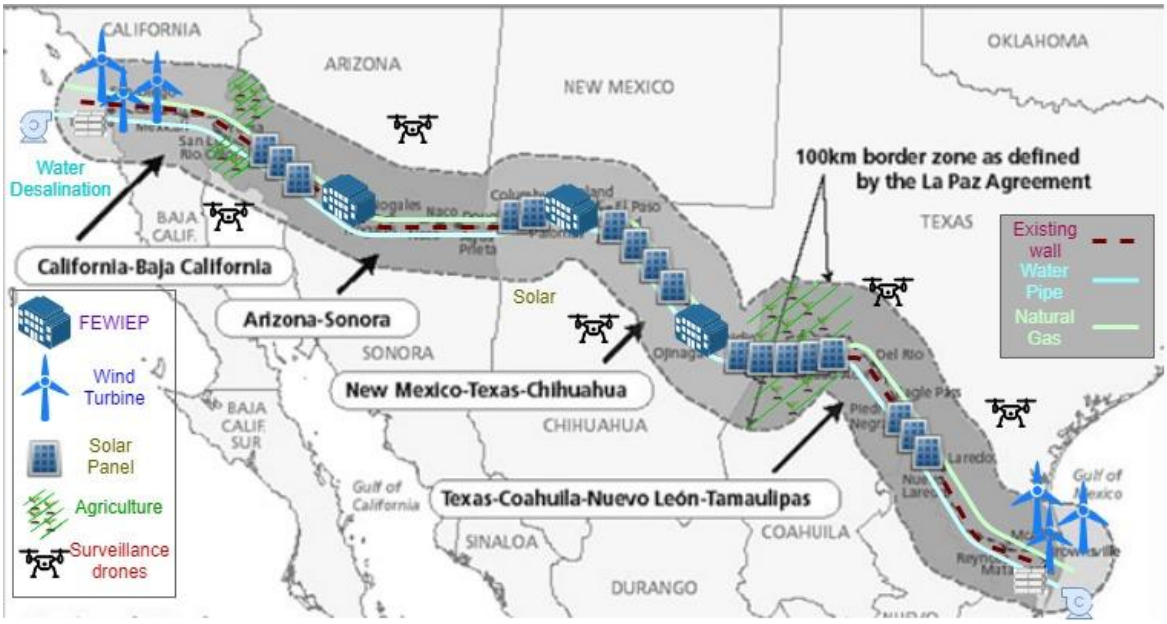

Figure 1: Conceptual schematic of FEWIEP along the US/Mexico corridor.

The modularity of solar provides an ideal opportunity for contracting individual sections separately, and for private/public partnerships for construction and operation. The expanded infrastructure needed for power transport (i.e., smart grid) is already critically needed in order to handle existing power, particularly in California. The FEWIEP will also present many other **opportunities for establishing industries, in addition to complementary natural gas, solar and wind parks.** The East-West solar corridor also provides a unique ability to address power load shifting for the entire region; energy from the West can be used to alleviate load in the evening in the East, while power from the East can provide pre-dawn generation to the West. Through a series of DOE-funded projects, US universities and businesses have unique capabilities to provide solar and wind forecasting for balancing the grid over continental regions.

Figure 1 shows the 100 km (62 mile) border zone defined by the La Paz agreement. There are already many cities in this zone that would benefit directly from FEWIEP, much as the cities and industries of New York and Ontario have benefited from the Niagara River project, and the Southeastern US has benefitted from the Tennessee Valley Authority (TVA). Examples of cities in this zone (see figure 1) include San Diego, Tucson, El Paso, Ciudad Juarez, Laredo, and Tijuana, among others.

WIND-WATER: California, Texas, New Mexico, and Arizona are in the grip of severe to exceptional drought conditions. These border states are living beyond their means when it comes to groundwater (Ferguson et al. 2018). Current state water plans focus on conservation and sustainability. These are laudable objectives, but do not represent a blueprint for growth and prosperity (England & Warsinger, 2019). *Without a long-term, sustainable water supply, border communities will run out of water, triggering mass migration to areas with water availability.*

Part of the problem can be addressed by redistributing the water of the Rio Grande using the generated energy. In addition to the energy park, we propose a series of wind turbines with a hydraulic drive-train combination for reverse osmosis[2] within this zone to desalinate the water from the Pacific and the Gulf of Mexico (see figure 1). By dedicating a substantial portion of the energy generated to desalinization and pumping, this project can also bring fresh water and energy to the region, plus an economic growth that benefits everyone in these diverse semi-arid regions. **Water and energy availability along the border will create new market demand and prosperity, thereby reducing illegal immigration**. Thus, ***this unique opportunity offers to Mexico the option to be an equal partner and invest proper resources on the project.***

As pointed out in the report by Wood et al. (2012), areas of strong winds exist in the Gulf and Baja California regions, which are ideal for wind farms. **The water may feed major agricultural regions for both countries along the border**. It requires the construction of a transcontinental, interconnected super-pipe system along the 1,989-mile border. This would be constructed by a skilled-labor force from both the US and Mexico. The desalinated seawater can be pumped from California and Texas to other southern states along the border. Such massive project could indeed be appealing for Mexico since it will offer unique economic and social opportunities for them also—access to clean energy and fresh water.

Warsinger (2019) estimated that 600 MW wind power in the Gulf Coast and Baja California to operate reverse osmosis plants may provide 2.3 million acre-feet of water per year. This is enough to satisfy the water needs for all of Texas' manufacturing, mining, livestock, and other power needs.

FEWIEP INSTITUTES ALONG THE CORRIDOR (Border): FEWIEP will bring a broad spectrum of workforce from the US and Mexico related to manufacturing, construction, installation, engineering, management, agriculture, education, and research & development (R&D). In addition, portion of the funds requested ($1.1B) will be employed for the creation of specialized institutes along the border that will provide workforce development and mentoring, development of needed innovations for the regions (cybersecurity, microgrid, energy, precision irrigation and agriculture, etc.). Our consortium of universities with states, national laboratories and industries will be part of these institutes and the steering committee (as listed in cover page) will provide the vision, design (of the energy-water corridor), innovations and strategies for future development of the new vibrant border including new technologies to enhance security.

The proposed FEWIEP has the potential to become a legacy for the US and Mexico and have a significant, long-lasting impact on energy, water, industry and education. It also has the potential to make the desert bloom—an almost 2,000 miles long oasis that would **become host to enormous agricultural production, relieving foreseen food shortages, creating wealth for Mexico/US** and reducing CO2 from the atmosphere. Leaders on both sides will receive accolades across the world for their contributions to the environment and economic growth of the region. *The late Rice University Professor and Nobel Laureate Rick Smalley stated that a solution to the energy grand challenge can be a solution to all of humanity's top grand challenges*. At the 2010 Conference of Parties (COP16) in Cancun, Mexico, the United States presented promotion of renewable energy as a solution to the world's economic, energy, and environmental problems (J. P. Gore, 2016). According to the study by the United Nations

[2] New desalination technologies (Warsinger 2019) will lower the cost of capital infrastructure, use less energy and will be powered by renewable energy, and generate less toxic waste water compared to traditional desalination technologies. The US could position itself as a global desalination market leader and develop arid regions of the country.

Environment Program, renewable energy sources generate more jobs per unit capacity than any other type of energy source, (UNEP 2008, Castillo et al. Scientific American, 2018).

ECONOMIC FREE TRADE ZONE: As shown in Figure 1, this zone is 100 km wide. Reduced-tax zone incentives to accelerate energy conversion and business development may enhance the success of the industrial park. The cost of such park could be paid from the energy sold or taxes collected from industries along the technology park. Thus, such a region can become a major accelerator for new manufacturing plants and technological industries, making it the biggest industrial park of its kind in the world. It will promote new jobs and unique opportunities for both countries (Castillo et al. Scientific American, 2018), while saving water typically used for cooling of water plants in the generation of electricity. This will be critical in a zone lacking water. Thus, it is expected that *this extensive, sustainable program will enhance the quality of life (including high-salary job opportunities) of people in both the US and Mexico*.

CAPITALIZATION: Both countries involved will capitalize on the project. Investment from the government will lead to private sector investments and bring in major US solar manufacturers (like Tesla Solar City and Solar World) and entrepreneurs in the field of batteries, as well as existing power companies, both during construction and later for operation.

PARTNERSHIPS: We will build a consortium of universities (including Purdue University, University of Arizona, University of Illinois at Urbana-Champaign, SUNY, and other Universities in Arizona, California, Florida, Indiana, Illinois, Louisiana, Puerto Rico, New Mexico, New York and Texas as well as Mexican institutions), industries and laboratories in the US (National Renewable Energy Lab, Sandia National Lab, etc.), Mexico and Latin America may provide technical expertise and new innovations for its development. Our eminent team will provide unique leadership to push forward such an ambitious project. For example, Prof. Jay Gore (personal communication, 2017) worked with energy Directors of all fifty states including Texas, New Mexico, Indiana, Illinois and New York to organize a panel at COP16 that addressed the State and Local Governments interest in economic development while mitigating the effects of Climate Change.

Our initial approach is to engage Senators from New York, California, New Mexico, Arizona, Indiana, Illinois, and Texas. On the Mexican side, we will work with key people to approach the administration of President López.

ACKNOWLEDGMENT: We drew liberally from the previous work of others in preparing this document, and in addition to including them in the reference we gratefully acknowledge their contributions.

FEWIEP Consortium:
[1] Luciano Castillo, **PhD.** Kenninger Professor of Renewable Energy and Power Systems, Purdue University.
[2] Jay P. Gore, **PhD.** Reilly University Chair Professor and Associate Head of Graduate Programs within Mechanical Engineering at Purdue University.
[3] Leonardo P Chamorro, **PhD.** Assistant Professor in the Department of Mechanical Science and Engineering in the University of Illinois at Urbana-Champaign
[4] Carlos Castillo-Chavez, **PhD.** Regents Professor, and Joaquín Bustoz, Jr. Professor of Mathematical Biology at Arizona State University
[5] Ronald Adrian, **PhD.** *United States National Academy of Engineering*, Regents Professor at Arizona State University.

[6] William K. George PhD. Visiting Professor Department of Aeronautics, Imperial College; Professor of Turbulence Emeritus, Chalmers University of Technology; former SUNY/Buffalo Professor
[7] Richard Tapia, PhD. *United States National Academy of Engineering*, *Medal of Science,* Maxfield-Oshman University Professor at Rice University.
[8] David Warsinger, **PhD** MIT, Assistant Professor at Purdue University.
[9] Fazle Hussain, PhD. *United States National Academy of Engineering*, Texas Tech University.
[10] Sharath Girimaji, **PhD.** Department Head Ocean Engineering, Texas A&M.
[11] John Dabiri, PhD. MacArthur Fellow, Senior Fellow at Precourt Institute for Energy, Stanford University.
[12] Arquimides Ruiz, **PhD.** Wind Energy, National Wind Institute, Texas Tech University.
[13] Dev Niyogi, Atmospheric Science, Purdue University.
[14] Raul B. Cal, **PhD.** Professor, Renewable Energy, Portland State University.
[15] Harindra Joe Fernando, **PhD.** The Wayne and Diana Murdy Endowed Professor, University of Notre Dame.
[16] Carlos F.M. Coimbra, **PhD.** MAE Department Head, Center for Energy Research. University of California at San Diego.
[17] Mark Glauser, PhD, Fellow: AIAA, ASME, APS. Syracuse University.
[18] John W. Sutherland, **PhD,** The Fehsenfeld Family Head of Environmental & Ecology Engineering, Purdue University.
[19] James Riley, PhD. *United States National Academy of Engineering. The PACCAR Professor of Engineering. University of Washington.*
[20] Sara C. Pryor, PhD, Professor of Earth & Atmospheric Sciences. Cornell University.
[21] Rebecca J. Barthelmie, PhD. Wind Energy Expert. Professor of Mechanical & Aerospace Engineering. Cornell University.
[22] Kenneth T. Christensen, **PhD.** Viola D. Hank Professor & Department Chair. University of Notre Dame.
[23] Elaine S. Oran, PhD. *United States National Academy of Engineering. Glenn L. Martin Professor of Fire Protection Engineering, Aerospace & Mechanical Engineering. University of Maryland.*
[24] Thomas England, PhD. H20 Systems, Inc.
[25] David Suleiman, PhD. Professor & Center Director. Department of Chemical Engineering. University of Puerto Rico-Mayaguez.
[26] Martin Wosnik, PhD. Professor of Engineering, Director, Center for Ocean Renewable Energy. University of New Hampshire.
[27] Amit Goyal, PhD. (NAE). *United States National Academy of Engineering, United States National Academy of Innovation. SUNY Buffalo.*
[28] Beverley J. McKeon, PhD. Theodore von Karman Professor of Aeronautics. California Institute of Technology.
[29] Zenon Medina-Cetina, Zachry Career Development Professor II, Ocean Engineering. Texas A&M.