Converging Approaches to a Resilient, Sustainable Puerto Rico

A Coordinated, Synchronized, and Integrated Approach

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Executive Summary

The Commonwealth of Puerto Rico is well positioned for sustainable development, growth, and a better future. There are challenges, to be sure, but the archipelago can achieve these goals with synchronized, coordinated, and integrated approaches for recovery, rebuilding, and posturing for the way ahead. This paper provides independent observations and recommendations to consider in achieving these objectives. If done well, Puerto Rico could return to the prosperity it once enjoyed and serve as a model for other cities, regions, and states.

The many challenges range from climate and coastal change to the lack of resilient and assured energy infrastructure, existing debt, poverty levels, low labor force participation, and the ongoing exodus of residents, mainly to the mainland, which contributes both to human capital shortages and the aging of the population. Going forward, plans must integrate modernization with technology enablers and then "maintenance" and "resiliency," and these need to be resourced. Energy solutions and infrastructure should be built "resilient against hurricanes, earthquakes, floods and fire,"[1] recognizing the many inter-dependencies among infrastructures, new technologies and governance.

Success will depend on being able to maintain continuity of effort over time and execute strategic plans, regardless of political transition. Technological acceleration and strategic plans must include civil society and include a "governance ecosystem" of government, business, and civil society experts. They could benefit from an independent, non-partisan, entity to coordinate federal and local governments, non-governmental organizations, business and civil sectors, and funding agencies to demonstrate returns on investment (ROI) and achieve a resilient, smart, connected Commonwealth.[2]

This paper outlines solutions to achieve early momentum and lasting consequences, especially in three areas: (1) setting the foundation for a diverse, resilient, and sustainable energy supply and transmission system, (2) integrating these with key enablers of a "smart and connected Puerto Rico," and (3) building a workforce to meet these challenges and innovate to anticipate new ones. Sustainable solutions are, first and foremost, human solutions. They include the responsible balancing of population and resources to attack both economic and energy poverty in ways that let people meet their needs without compromising the ability of future generations to meet theirs.

Recommendations: There is no one solution and no one has all the answers. Effective solutions will have to be "co-created" with Puerto Rico's stakeholders, not developed in isolation. The authors have researched the progress of the recovery efforts to date, identified challenges the island faces, and recommend a foundation for a sustainable, resilient, and adaptable solution with an emphasis on assured infrastructure and energy solutions. It also recommends key enablers which, if used correctly, can help posture the Commonwealth for the future and suggests way to enable the workforce. Based on this research and these observations, the team recommends that Puerto Rico:

- Focus first on human capital, including education, health, and security to improve quality of life.
- Recognize that solutions involve people, organizations, and processes, as well as technology.
- Build a stable "governance ecosystem" of government, business, and civil society with that includes an enduring, nonpartisan entity.
- Pursue coordinated, synchronized, and integrated approaches that cut across silos.

I. Impacts of an "Age of Accelerations"

Technology and information are revolutionizing the way we work, think, and live. Information and its movement help determine economic winners and losers, have an impact on international relations and shape the way we communicate and interact. These changes are accelerating. The distinguished author and New York Times columnist Thomas L. Friedman points to three trends that underpin what he calls the "Age of Accelerations:" **technology, globalization,** and **climate change**. Whatever the formulation, these changes are occurring simultaneously and rapidly, with impacts that are becoming "fast, fused, deep, and open," in Mr. Friedman's words, which highlight today's complex, global interactions. We should expect them to continue, with important future consequences. Many challenges are being aggressively addressed, but solutions too often are presented in isolation rather than approached holistically.[3]

Similarly, Dr. Klaus Schwab, Founder and Chairman of the World Economic Forum, postulates a Fourth Industrial Revolution, where converging, accelerating forces are blurring the lines between the **physical, digital,** and **biological spheres**.[4] Dr. Schwab expects that these changes will be massively disruptive, transforming management, as well as production and distribution. They can provide very important collective benefits to society, but also can negatively affect many individuals through changes in employment and the pace of social change.

These accelerating changes are not confined to information and communications technology (ICT). They extend to biotechnology (synthetic biology, genetic engineering, accelerated vaccine production), robotics (driverless cars, drones, production robots), nanotechnology (chips and processors, batteries, medicine, energetic explosives) and the energy and energy storage that underpin everything. These are the interdependent elements of what might be termed **BRINE (bio-robo-info-nano-energy)**. **Artificial intelligence** (AI), **advanced manufacturing** and **augmented/virtual reality** (AR/VR) also provide excellent opportunities. Not all technologies have the same impact, of course. Bridging technologies bring marginal improvements without a significant impact on how we do business. Leap-ahead technologies bring us to the next level but not significant enough to change our way of life. Disruptive technologies are capabilities so significant that they change the way we live, work, do business, and even think.[5]

A key premise of this analysis is that exceptional increases in science and technology (S&T) capabilities will have **social impacts as well as operational ones**. The *rate* of technological change is important. Accelerating and converging technologies interact with political, economic, and social forces, challenging out-of-date management and governance structures, and even people's ability to adapt. Governments can't control many of these trends, but government leaders need to be aware of them and be prepared to address their consequences.

Some worry that there will be significant net job loss to machine learning and AI, leading to a workforce that is split into a few high-technology, high-skilled jobs; and many more low-technology, low-skilled ones.[6] Others think these fears are overdrawn. In any case, these concerns ultimately involve people, not just technology, and responses have to engage public-private, whole-of-society, and trans-national stakeholders in comprehensive, integrated ways.

II. Challenges Facing Puerto Rico

2.1 The Environment and Climate. The 2018 U.S. National Climate Assessment[7] noted that global climate model predictions, though imprecise, suggest an increased frequency of strong hurricanes (Categories 4 and 5) in the Atlantic Basin, including the Caribbean. It also includes a range of sea level rise predictions with significant impacts, especially together with high tide flooding in urban areas. Other estimates include more frequent and intense droughts. Besides the recommendations in this paper, Puerto Rico can increase its resilience by collecting better data on extreme events, creating an observatory for all coastal threats and promoting coastal building alternatives, cost analysis and collaboration with domestic and foreign organizations.

2.2 Lack of Resilient and Assured Energy. Puerto Rico lacks a sustainable and resilient energy foundation. According to some analyses[8] Puerto Rican energy infrastructure is nearly three decades older than that of the rest of the United States and relies on 98% fossil fuels for power generation. The grid is especially weak in the Central Cordillera and remote areas. Even though hurricanes damaged just 25% of the power lines, 100% of the grid was made inoperable. Intermittent outages continue,[9] and some remain without power today.

Furthermore, the Puerto Rico Electric Power Authority (PREPA) has a monopoly on power generation and owns nearly all the electric transmission infrastructure. Deeply in debt, and with over $9 billion (B) in bonds coming due, the company filed for bankruptcy in 2017. A debt restructuring plan was reached for PREPA to repay creditors, but Puerto Ricans, who already pay higher electricity rates than residents of the lower 48 states,[10] will end up paying even more.[11] I

A way ahead is provided by Law 17, passed in March 2019. It calls for 40% of the power to come from renewable energy by 2025, and 100% by 2050.[12] The law also set up a process for energy decision-making. Some progress is being made, such as the recommendation in August 2020 by the Puerto Rico Energy Board (PEB) on the Integrated Resource Plan (IRP) for:

> …procurement of 3,500 megawatt (MW) to 3,900 MW of new solar and 1,360 megawatt hours (MWh) to 1,480 MWh of grid scale battery storage by 2025… About $2 billion in improvements to the transmission system is also contemplated. [13]

2.3 The Debt Crisis. The Puerto Rican government's debt crisis affects all elements of the Commonwealth. In 2014 three major credit agencies downgraded several Puerto Rican bonds to "junk status," which prevented the government from selling more bonds in the open market. Unable to obtain the funding to cover its budget imbalance, the government began using its savings to pay its debt while warning that those savings would eventually be exhausted.

To prevent this, the US Congress enacted a law known as PROMESA, which appointed an oversight board with ultimate control over the Commonwealth's budget. Resulting steps included tax increases while curtailing public services and reducing government pensions, which provoked social distrust and unrest. In August 2018, a debt investigation report of the Financial Oversight and Management Board for Puerto Rico (FOMB) reported the Commonwealth had $74 billion in bond debt and $49 billion in unfunded pension liabilities as of May 2017.[14]

2.4 Disparities in Federal Social Funding. More than 60% of Puerto Rico's population receives Medicare or Medicaid services, with about 40% enrolled in Medicaid. Puerto Rico receives significantly less federal funding for these programs than the 50 states, stemming from a 1968

U.S. Congressional cap on Medicaid for U.S. territories. As a result, Puerto Rico might typically receive $373 million in federal funding a year, while, for instance, Mississippi, with a population similar to Puerto Rico's, receives $3.6 billion. Not only does this lead to an exodus of underpaid health care workers, but the disparity has had a major impact on Puerto Rico's finances.[15]

2.5 Workforce conditions. Currently, 43% of Puerto Ricans live in poverty, double the rate of Mississippi, which has the highest poverty rate in the continental U.S.[16] Ending poverty in all forms needs to be a goal. Only 75% of citizens graduate from high school while 25% have a bachelor's degree or higher. Very importantly, only 44% of Puerto Ricans are active in the labor force,[17] the lowest labor participation rate in all the states and territories, although many probably participate to some extent in the informal economy. Though more than half the island's residents report having a computer, just over 50% have monthly internet subscriptions.

2.6 The Brain Drain. With high levels of poverty and dim job prospects, Puerto Rico has faced a "brain drain" for years. This began with the phase-out of the Section 936 tax incentives between 1996 and 2006,[18] which pushed the economy into a downturn in 2006 that continued through 2018, exacerbating the exodus. Puerto Rico's population peaked in the early 2000s at a little under 3.7 million and has declined since.[19] By some estimates it is now below 3 million.

III. Foundations of a Resilient, Sustainable Puerto Rico

3.1 Sustainability and Maintenance. Puerto Rico needs systems that can endure, with lower maintenance costs, even though such systems may be more expensive initially. These include smart management systems for utilities to reduce personnel costs and systems that can withstand violent weather, natural wear over time, and potential cybersecurity threats. Buried power lines are an example. As Former Resident Commissioner Antonio Colorado, has noted:

> "It is clear with respect to our physical infrastructure that both maintenance and resiliency are of the utmost importance. Housing, buildings, roads and bridges, utilities, among many other things, should not be constructed nor permitted unless we can be assured they have been designed to withstand hurricanes, earthquakes, floods, and fire. At the same time, we must be certain, especially in relation to public infrastructure, that we have the resources required for maintenance and upkeep. Our engineers and architects should become the best in these areas of professional knowledge." [20]

Natural infrastructural systems (such as mangroves to reduce coastal erosion), are a cost-effective, sustainable, potentially regenerative way to protect existing infrastructure against violent weather and make coastal building resilient to rising seas. Sustainability is not static. Sustainable solutions need to be as dynamic as the world that surrounds them.

3.2 Resilience and Adaptability. Resilience can be defined as "coping capacity plus adaptability,"[21] in which coping capacity includes the phases of anticipate, withstand, and recover from disruptions. Adding "adapt" aligns this concept exactly with the four resiliency phases of the National Institute of Standards (NIST).[22] There are 3 types of resilience: (a) Cultural—is an individual, community or organization willing to fight back when under attack? (b) Operational—can key internal and external messages be delivered and acted on? and (c) Infrastructural—are interdependencies among critical infrastructures understood and the risks mitigated? Cyber resilience needs to be built into any "smart and connected" initiative. Adaptability is critical. As Thomas Freidman points out, it's not the strongest, fastest, or smartest

that survives, but rather the most adaptable.[23] Adaptable people and organizations prepare, withstand and recover, and learn to operate in the new post-disruption normal.

3.3 Energy Infrastructure Modernization. The modernization of Puerto Rico depends on its energy infrastructure which underpins the integrated power, communications and transportation approaches that form the basis of a "Smart Puerto Rico."

3.3.1 *Generation and Storage*. The August 2020 recommendations on the IRP,[24] noted earlier, represented a significant victory for renewable energy, moving toward Law 17's renewable goals,[25] plus "billions of dollars for transmission and distribution hardening." Regulations are being developed for "demand response and energy efficiency," and PREPA has been charged with "looking into the potential for offshore wind, and refurbishing the island's hydro resources."[26] The recent PROTech Ocean Thermal power initiative offers high priority development opportunities as part of a "Blue Ocean Economy."

The next IRP will extend beyond 2025, and PREPA has been asked to "explicitly account' for the potential for virtual power plants… as more residents install solar and storage." The new plan "emphasizes 'the central role that customers can play through provision of energy supply and [demand response]'…[considering] an electricity grid focused on distributed generation and 'prosumers.'[27]

3.3.2 *Distribution and Transmission.* Resilience of the transmission and distribution system includes elements like hardening, divisions into mini- or micro-grids, making the grids smarter, and building in physical (and increasingly cyber) security. Recently, the White House said that $9.6 billion in federal funding will go to repair and replace transmission and distribution lines, electrical substations and power generation systems.[28]

a. *Hardening.* Much of Puerto Rico's power transmission system now uses vulnerable, above-ground wires. Since the Aug 24 IRP decision expanded transmission and distribution hardening, there should be some progress. Integration with transportation is important since trenches can be dug as roads are built to bury both power lines and fiber.

b. *Mini- and Micro-Grids.* PREPA has been working to install mini- and micro-grids to add to more renewable power generation and increase battery storage capacity[29] but some of the mini-grid proposals were rejected on Aug 24. Rural electric cooperatives are being certified by the Puerto Rico Energy Board (PEB), enabled by post-Maria Legislation, Law 258-2018.[30]

c. *Smart Grids* give consumers the ability to control electricity usage and make resource-conscience decisions about consumption. Especially when combined with micro-grids they ensure that damages to one part of the grid do not render the entire grid powerless. Adaptable to emerging technologies, and more efficient and resilient than the status quo, smart grids can help communities combat the climate crisis by reducing energy waste and preparing for a digitized future.[31] Smart meters improve real-time understanding about the time and costs of electricity. For all their advantages, smart grids also increase the need for cyber resilience.

3.3.3. *End User Components.* PREPA and the Government of Puerto Rico have emphasized delivering essential power resources to those who need them most, including more energy-dependent households and emergency service centers like hospitals, but change has been slow.[32]

The ability of smart grids to distribute energy collected from homes and buildings, including in urban areas, supports the "virtual power plants" and "prosumer" concepts in the next IRP.[33]

a. *Consumption.* The first step in the design of any energy system is to reduce demand. Amory Lovins of the Rocky Mountain Institute (RMI) has called these "negawatts." Sources of energy demand include transportation (29% of U.S. demand),[34] commercial (18%) and residential buildings (20%), and industry (32%). Demand will be changing in many ways, including electric transportation, smart communities, and more efficient structures.

b. *Buildings and Facilities.* Buildings are the largest contributor to global greenhouse gas (GHG) emissions. They use about 40% of global energy, 25% of global water, 40% of global resources and emit approximately 30% of GHG emissions.[35] In Puerto Rico, the commercial sector consumes nearly half of the island's electricity, and the residential sector consumes just above one-third.[36] The World Resource Institute estimates that an 80%-90% reduction in building emissions is needed to keep climate change below 1.5 degrees Celsius.[37] Updating buildings to be smarter and more energy efficient can preclude the need for even costlier repairs when infrastructure breaks or becomes outdated. Steps include LED lighting and lighting controls, plus passive heating and cooling designs in new buildings.[38]

   Smart buildings can process data, predict occupant behavior and preferences, and forecast energy demands and peak hours,[39] all of which increase the importance of the Internet of Things (IoT).[40] They also can create jobs. Projected increases in energy efficiency may create as many as 2 million jobs in Europe[41] and, while specific Puerto Rican estimates aren't available, updating building infrastructure here could have similar impacts in many fields.

c. *Transportation.* Transportation demand is likely to shift from petroleum-based fuels to electricity as plug-in electric vehicles and energy-efficient public transport come online. The advent of smart, and eventually autonomous, vehicles will dramatically increase demand for communications through more vehicle-to-vehicle (V2V) and vehicle-to-other (V2X) links, like communications with roadside infrastructures.[42] This also will increase electricity demand throughout the sector. Funding for interdependent road repair projects to enable cable trenching and smart infrastructure upgrades has been hard to pin to one specific agency, reinforcing the need for cross-cutting approaches. With careful planning, Puerto Rico could position itself as a model for green transportation systems.

d. *Clean Water and Sanitation.* Given the environmental forecasts, Puerto Rico must strengthen existing water and sanitation systems, devise sustainable management practices, and develop additional resources. Production can be increased through desalination, purification of wastewater, development of wells, and capture of rainfall and watershed runoff.

IV. Key Enablers of a Smart and Connected Puerto Rico

4.1. A Smart and Connected Puerto Rico, Defined. Cities, communities, and regions are the drivers of sustained and inclusive growth. The White House defines smart cities as "communities that are building an infrastructure to continuously improve the collection, aggregation, and use of data to improve the life of their residents – by harnessing the growing data revolution, low-cost sensors, and research collaborations, and doing so securely to protect safety and privacy."

4.2 Urban and Regional Innovations. Smart and connected communities are innovative, adaptive frameworks within which cities, regions, and countries can forge a stronger and more prosperous world. A smart city framework can contribute to faster economic recovery, improve government's ability to manage resources effectively, promote stability and security, improve quality of life, and adapt to the future, leading to greater sustainability. A smart and connected community works smarter not harder by bridging the gap between good government and big data. Technology integration encourages faster recovery from natural disasters, promotes better organization of buildings and residences, and fosters resiliency in the face of pending disruptions from climate change. Intelligent, cloud-connected technologies, managed with public-private partnerships, can prepare citizens for pending developments within the "Age of Accelerations."

4.3 The Importance of Coordinated, Synchronized, and Integrated Approaches. These approaches will be much more effective if they are coordinated between the public and private sectors, synchronized and interdependent, and link technology to changes in people, processes, and organizations. Concurrent, interoperable, and people-centered developments in energy, infrastructure, transportation, and communication sectors can lead to improvements in agriculture, manufacturing, public health, governance, hospitality, and nearly every other sector.

Ecosystems of government, business, and the civil sector can yield impressive results in implementing new connective and harmonized technologies that improve the quality of life and ensure more equitable access to resources. Developing these capabilities in Puerto Rico, indeed anywhere, is thus a collaborative process, involving designers, architects, engineers, government authorities, and various other professions, not to mention the end-user stakeholders. Re-emphasizing Mr. Colorado's point, maintenance of the community and its systems requires a similar level of collaboration, as any smart city or region is constantly evolving and developing. The technologies at play should be adaptable and interactive across various sectors.

Sustainable solutions are, first and foremost, human solutions. Technological solutions cannot succeed without community acceptance, trained work forces and agreed-upon laws, regulations, and insurance procedures. Such integration is the basis of this analysis for Puerto Rico.

4.3.1 "Puerto Rico 2045:" Development of a Long-Term Strategy. Puerto Rico needs a strategic plan, or roadmap—one that is co-developed and implemented with Commonwealth stakeholders, rather than being done externally. Continuity of efforts over the long term is essential, which can leverage the "governance ecosystem" to extend beyond political turnovers. This strategy should establish lines of effort with specific goals and objectives like infrastructure, energy, transportation,[43] education, healthcare, and economy are examples. These lines of effort also could be more generic like Recover, Rebuild, or Prepare, where infrastructure, energy, transportation align to the three main pillars. The plan should list near, mid- and long-term goals, metrics, objectives, and ROI, along with responsibilities for coordination and synchronization.

The Puerto Rico Innovation & Technology Service (PRITS)[44]. was created by Law 75 of 2019. Its mission is "to set in motion and enable the transformation of Puerto Rico that will result in new knowledge and real impact through innovation, technology and a collaborative hands-on approach to their challenges." The vision is "to be a smart island where citizens experience and engage with a world-class innovation ecosystem that optimizes the development of human capital and results in economic growth." PRITS has developed a guide for evaluating projects.[45]

4.4 Networks and Telecommunications. Telecommunications play a key role in all aspects of modern life: education, jobs, power generation and distribution, transportation, agriculture, and overall quality of life. A strong telecommunications system can link individuals with the systems meant to support them. Emergency and disaster response also depend on effective comms, as do public health and safety. In the next few years, the faster throughput and lower latency of 5G wireless networks will dramatically increase the amount of information available, with AI being key to making sense of this deluge of data, reducing response times and improving outcomes. This depends on stable power, as well as governmental and private sector coordination to integrate and maintain the necessary infrastructures.

4.4.1 *The Internet of Things.* Smart communities, cities and regions are being built on the backbone of the IoT. In one description this refers to:[46]

> the billions of physical devices around the world that are now connected to the internet, all collecting and sharing data….[It's now] possible to turn anything, from something as small as a pill to something as big as an airplane, into a part of the IoT. Connecting all these different objects and adding sensors to them adds a level of digital intelligence to devices that would be otherwise dumb, enabling them to communicate real-time data without involving a human being. The IoT is making the fabric of the world around us smarter and more responsive, merging the digital and physical universes.

The IoT's impacts—on computing, spectrum, data strategies, software update plans, equipment maintenance, and especially cyber vulnerabilities are core elements of any smart community.

4.4.2 *Cyber Resilience.* Cyber resilience must be integrated into the design of intelligent and connected systems.[47] The cyber "attack surface" increases dramatically as more devices are connected, as do the impacts of successful attacks. Cyber security strategies are not enough--smart systems must be designed from the beginning not only to include effective protection, but also to be able to anticipate disruptions, withstand them, recover from them, and then adapt or reposition to the post-disruption "new normal." Such resilience requires public-private collaboration, built on effective regulation/legislation and a strong technological backbone.

4.5 Technology Integration Enablers. AI, machine learning, data management, and data-driven decisions all are powerful tools in Puerto Rico's future. As organizations increasingly rely on intangible assets to create value, the ability to data mine, analyze, learn, problem solve, and assist in automated decision-making processes becomes more valuable. Robust data management systems and practices are essential for every organization, regardless of size or type.

4.6 ***Transportation.*** Reliable and sustainable development of air, marine, and land transportation is crucial to Puerto Rico's economy, and cross-sector interoperability is key to transportation development.[48] Whether the vehicles are powered by electricity or fossil fuel, diverse power sources will be needed along all transport links, coordinated by communications. Smart public transport in rural areas will need extended connectivity. Power line and comms fiber installations should align with road construction and repair planning. Intelligent governance processes will analyze transportation data and use it to make data-driven decisions and coordinate planning.

4.7 Banking and Finance Institutions. Financial Technology (Fintech) is transforming the financial sector by disrupting the traditional means of financial transactions. Software, data and

algorithms improve and automate financial services, such as online banking, trading, and financial advice from the average consumer to hedge fund managers and retail traders. This enables novel business models like robot-advisors and new actors, such as Apple.[49] Distributed ledger technology, like blockchain and Ethereum, can improve transparency and accountability. [50]

V. Building the Workforce

5.1 Quality of Life: Investments in the Human Cloud. All efforts to build a more resilient and sustainable future need to include people in ways that promote their interests, build more effective governance, and improve quality of life—the Human Cloud. This means significant changes in education, entrepreneurship, energy, agriculture, transportation, internet and connectivity, employment, governance, and approaches to climate and coastal change.

The "Smart, Connected Puerto Rico" framework can extend quality of life benefits in many ways. Safer and more reliable energy, communication and transportation infrastructures can deliver necessary services faster and more efficiently. If integrated and resilient they can enhance disaster preparedness and response. Increasing network speed and connectivity can improve distance learning, telework and telemedicine. Connecting to cloud computing and distributed software will be necessary for an evolving job market. A prerequisite is getting people computers connectivity, and an understanding of how to use it, but this often involves one-on-one personal interactions with trusted parties to show people on the wrong side of the digital divide why opting into these technology is in their interest. Integrating "high tech-high touch" to make Puerto Rico a hub for resilience and innovation could help restore lost jobs, increase the net income of the population, prevent the loss of young workers, and perhaps induce others to return,

A key component in this should be science, technology, engineering, and mathematics (STEM) education for youth, leavened with Art and Design whenever possible (STEAM). Prioritizing skills in areas like cyber, advanced manufacturing, micro-electronics, AI and biotech to compete in the "convergence of the digital, physical, and biological worlds," will enrich Puerto Rico's economy and job market. A center for resilience and innovation education and research could attract funds and people and energize the economy but bringing people back into the labor force probably will be harder and can't be done with tech alone.

***5.2 Leadership*.** Leadership development needs to be an integral part of building Puerto Rico's workforce and investing in its quality of life. Puerto Rico has a unique opportunity to leverage today's challenges and build strong, effective, and forward-looking leadership that could resonate through both Latin America and the Caribbean, especially if focused on resilience.

5.3 Governance and Government Services. Effective governance is crucial in cross-sector implementation. Puerto Rico has struggled in this area, but there are measures that can both empower citizens and stakeholders and improve their oversight ability. One such group has been put together by former Resident Commissioner Colorado and others. It includes:

> "former Secretaries of Economic Development and former Executive Directors of the Puerto Rico Industrial Development Company, who collectively over the five past decades, have been responsible for the island's efforts to bring meaningful employment opportunities for our people….We will continue to meet with both sectors representatives on issues related to the economy of Puerto Rico and its interaction with that of the U. S. Mainland. Our main

> objective is to contribute to Puerto Rico's economic development with our experience of many years in this area. Our members belong to both principal parties in Puerto Rico and to both parties on the Mainland. Our opinions are and will be by consensus in a bipartisan way.[51]

This is the basis of a "governance ecosystem," including government, business, and civil society.

5.3.1 *E-Governance* also can provide cost effective and efficient government services while enhancing oversight, transparency, and accountability. Estonia is well-known example,[52] and is one of the best performers in the EU in ensuring a transparent and effective public procurement system," which is broadly trusted.[53] Governance extends beyond government to involve business and civil society stakeholders. Georgia, a country that struggles with accountability, has a website where citizens can anonymously report bribery or misuse of funds. This has been an important tool in providing political cover to tackle deeper, more entrenched financial issues.[54] Integrating partners into an ecosystem of governance typically has long-term positive effects in building sustainability and resilience.

5.4 Cross-Cutting Coordination and Implementation. Puerto Rico already has lots of external oversight, from the FOMB, to various outside agencies, to White House coordinators, etc. Outside observers have expressed concern "…about the ability of the government of Puerto Rico to effectively manage a level of money that so vastly exceeds their normal annual operating budgets." Still, these entities have little experience with the kind of synchronized, coordinated, integrated approaches proposed here. A question is what is the most effective, and acceptable mechanism. The "governance ecosystem" of Section 5.3 does much to improve continuity and inclusiveness. Yet, it could benefit from an independent, non-partisan, entity to integrate, represent, and advise on synchronized, coordinated and integrated approaches across the federal and local governments, non-governmental organizations, business and civil sectors, and funding agencies to achieve a resilient, smart, connected archipelago.

Below this, an organization comprised of functional, technical, and operational experts from all sectors, and from business, civil society, and academia, with the appropriate checks and balances, could ensure an unbiased approach to acquire and sustain leading edge capabilities. This entity should apply synchronizing, coordinating, and integrating approaches mainly in four areas: (1) preparing for and recovering from disasters, (2) building capacity for reconstruction and a longer future, (3) promoting resilient and sustainable thinking, and (4) pursuing innovation for future sustainable living. This entity helps implement the strategic plan and the lines of effort to ensure synchronization and continuity for Puerto Rico's long-term sustainable future.

These functions are different from Puerto Rico's many Ombudsman Offices created to advocate for women, senior citizens, and on many other social issues. The original "Law of the Citizen's Attorney (Ombudsman)," as amended,[55] created the position of Small Business Attorney. They help improve administrative procedures and guarantee citizens fair, prompt, adequate, and harm-free treatment by the government agencies of the Commonwealth of Puerto Rico.

VI. Conclusions

Puerto Rico's way ahead needs to integrate people, processes (including governance), and organizations (government, business, civil society, and academia), as well as technology. Actions need to address low labor force participation, persistent debt, recurring natural disasters and

execution of stable, long-term plans. Designing and building physical infrastructures to be resilient will pay long term dividends. Resources must be set aside for maintenance and upkeep, recognizing the many inter-dependencies among infrastructures, policies, and technologies. Siloed funding cannot resolve the archipelago's enduring, cross-cutting problems.

This poses profound challenges for governance. Technology develops in ways that can both enable and threaten social well-being. Many forces, like technological acceleration and climate change, cannot be dealt with on a local basis. Strategic plans have to be executable across political transitions. Civil society must be part of a stable governance and program stewardship ecosystem that integrates it with government and business. This could benefit from an independent, non-partisan, entity to integrate, represent, and advise on synchronized, coordinated and integrated approaches across the federal and local governments, non-governmental organizations, business and civil sectors, and funding agencies to achieve a resilient, smart, connected archipelago.

Executing integrating approaches for a more sustainable future would make Puerto Rico an exemplar for other communities looking to revitalize. If done well, the Commonwealth could market itself as a hub for intelligent technologies, processes and organizations. Setting such an example also might help reduce brain-drain issues, if cross-sector communications and cutting-edge technologies show Puerto Rico to be at the center of innovation, and a model for the future.

This approach, with the appropriate level of governance, will enable a sustainable future that responsibly includes population and resources, effective actions to protect the environment, and measures to eliminate inequality. It balances current and future social and economic demands with the availability of the earth's resources, helping people meet their needs without compromising the ability of future generations to meet theirs. Ensuring social protections, eradicating both economic and energy poverty, and mitigating climate and coastal change are key elements of any sustainable future, yet they also will pose profound challenges to governance, challenges that can't be addressed effectively without coordination.

VI. Recommendations

There is no one solution and no one has all the answers. Effective solutions will have to be "co-created" with Puerto Rico's stakeholders, not developed in a vacuum. This paper recommends four steps to build a sustainable, resilient, smart, and connected Puerto Rico, well positioned for the future and able to serve as a model for others to emulate:

- Focus first on human capital, including education, health, and security, to improve quality of life in the face of challenges from the "Age of Accelerations."
- Recognize that solutions involve people, organizations, and processes, as well as technology.
- Build a stable governance ecosystem of government, business, and civil society. Establish a nonpartisan, independent, entity to advise, promote cross-cutting solutions, and interface as needed on behalf of a sustainable, resilient, smart, and connected Puerto Rico.
- Pursue coordinated, synchronized, and integrated approaches that cut across silos, beginning with resilient, sustainable energy solutions compliant with Law 17, and coordinated with the telecommunications and transportation sectors. Build in security and systematic maintenance.

APPENDIX A – ENDNOTES –

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