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Viable transformation of an electric utility? The case of the Puerto Rico electric power authority

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ABSTRACT

There are similarities that Puerto Rico's electric grid transformation has with other jurisdictions in terms of integration of distributed energy resources (DERs), net energy metering (NEM) and a diversified energy mix. However, it is important to first evaluate the impacts of Puerto Rico's debt restructuring in view of federal emergency funds to be deployed. This paper aims to analyze expected impacts of the restructuring agreement and related plans on Puerto Rico's economy and on its electric utility, PREPA. A restructuring agreement, and related plans, that considers a charge that starts at 2.768 cents per Kwh; that its length is 47 years; that comprises a nonbypassable and unavoidable charge, including on energy generated by consumers; and that excludes the regulator from the evaluation and implementation of debt restructuring charges, it is worth to analyze.

1. Introduction

Many electric utilities are struggling with their finances and operations. Problems that the industry faces arise from various sources: technological innovations, changes in their economic environment, natural disasters and new environmental conditions and attitudes.[3] The case of the Puerto Rico Electric Energy Authority (PREPA) is an interesting particular case because of the multiplicity of causes for its present bankruptcy and the institutional conditions and constrains it faces to straighten its operation and finances.

PREPA was created in 1941, as a vertically integrated public power utility, owned by the Commonwealth of Puerto Rico. Initially, it was known as the Water Resources Authority (Tugwell, 2010), since its original purpose was to provide irrigation to the south part of the island for agricultural purpose, having hydroelectric generation as a byproduct.[4] As the needs of electricity grew, and Puerto Rico moved towards an industrial economy, thermoelectrical plants were built throughout the island, hand to hand with the construction of an island wide transmission system. The model of a self-regulated monopoly, based on a vertically integrated structure, was successfully used as part of socio-economic transformation of Puerto Rico during the 1950s, 1960s and 1970s. Problems began to arise from the 1980s, when increasing oil prices wiped away the petrochemical industry in Puerto Rico, resulting in a sharp, and almost instantaneous reduction in the demand for electricity. Lack of investment and deferred equipment maintenance, as well as political interferences with the operation of the utility, caused that its performance metrics, even prior to the hurricanes that hit the island during 2017, showed that a change was urgently needed.

In May 2014, the organic law of the Puerto Rico Energy Commission (now Puerto Rico Energy Bureau), Act 57 of 2014, was approved, providing the electric utility its first regulatory framework since its creation. The proceedings held by the Energy Commission during its first years brought light to the critical condition of PREPA, with a System Average Interruption Frequency Index (SAIFI) of 11.61 per year, a System Average Interruption Duration Index (SAIDI) raging between 10 and 16 h per year, and a Customer Interruption Duration Index (CAIDI) of 180 min (Puerto Rico Energy Bureau, 2017). Further, its level of indebtedness, including obligations with creditors and pension fund, is

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[3] For example, see Kury (2019).
[4] See PREPA. Brushstrokes of Our History https://aeepr.com/en-us/QuienesSomos/Pages/History.aspx.

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two and a half times the value of capital assets, and debt to total asset ratio is nearly two. For PREPA's transformation to succeed, drastic changes need to be done on the utility to break long patterns of indebtedness, underperforming and lack of regulation, oversight and expert management.

2. Expected consequences of proposed PREPA transformation

There are many similarities that Puerto Rico's transformation has with many other jurisdictions such as California and Hawaii, especially in regards, integration of distributed energy resources, net energy metering and a diversified energy mix. The discussion presented on this paper is the base for further analysis on those topics. Discussing such important topics is necessary, however it is important to first have a discussion on the impact of Puerto Rico's debt restructuring in view of the massive amount of federal emergency funds to be deployed.

During 2020 it was announced the deployment of $10 billion in the Puerto Rico's electrical grid[5]. This amount is in accordance with the analysis done on this paper and previous analysis done by one the of the authors of this paper (Cao Garcia, 2020) where 45% and 90% of the amounts included on the 2018–2019 Puerto Rico Electric Power Authority Integrated Resource Plan[6] ($14,746,000) and on the Grid Modernization Plan[7] ($20,310,000) were used to determine the sustainability of the proposed restructuring plans (Torres Placa and Cao García, 2021).

PREPA filed bankruptcy in 2017 in federal court as part of PROMESA Title III[8]. Its financial restructuring is in progress. In March 2022 the Government of Puerto Rico terminated its current agreement with long term debt creditors or Restructuring Support Agreement (2019 RSA)[9]. Nonetheless, through PREPA's insolvency and bankruptcy process the cancellation of previous long term debt restructuring support agreements has resulted similar subsequent agreements. Therefore, to evaluate the 2019 RSA, and related plans that address additional PREPA debt, which considers the implementation of a charge that starts at 2.768 cents per Kwh on its first year, that increases to and remains on 4.55 cents per Kwh on year 24th of the agreement, and could be supplemented by another charge that starts in 1.2 cent per Kwh for PREPA's pension plan reform; which its length is for 47 years; that includes a nonbypassable and unavoidable charge on all electricity generated in Puerto Rico independent of the source, including energy generated by consumers; that excludes the regulator, the Puerto Rico Energy Bureau from the evaluation and implementation of debt restructuring charges; and requires exemption from local laws and regulations is something that it is worth to analyze.[10]

The success of PREPA's restructuring and subsequent transformation depends on the execution of the current legal and regulatory framework. Unfortunately, key documents, such as PREPA's 2020 and 2019 Fiscal Plans,[11] do not detail how these transformations are going to be financed, and no analysis is provided for expected economic impacts that should arise from increasing electricity rates to PREPA consumers. This paper aims to consider expected economic and financial consequences on the Puerto Rican economy, and PREPA's financial outlook, of the implementation of the measures proposed in the 2019 RSA, and related plans that address additional PREPA debt.

2.1. Expected economic impacts

After the 2019 RSA[12] and the PREPA (2019) Fiscal Plan were published, and because neither of them provided an assessment of their expected economic consequences, an independent assessment was performed, by one of the authors of this paper, to evaluate the impact of the proposed electricity rates increases on local economy and society.[13,14] The assessment was made public in August 2019. It starts by describing the proposed rate increases in the 2019 RSA and Fiscal Plan, as shown on Table 1 below. In addition to the scenarios on both documents, the assessment considers a rate scenario called Alternative Transition Charge (ATC)[15] that is defined as the maximum rate that the local economy could absorb, and allows for servicing a restructured debt.[16]

The economic consequences of the projected increases are evaluated over a five year period.[17] Key impacts include:

1. The effects on production costs of major industrial sectors.
2. Expected impact on the inflation rate.
3. Expected effects on production and employment.

Table 1
Required electricity tariff rates under different scenarios.

All Customers Average: c/kwh				
Fiscal Year	Alternative TC (ATC)	RSA TC	RSA TC + Fiscal Plan: No Risks	RSA TC + Fiscal Plan w/Risks
FY20	22.99	22.99	22.99	24.94
FY21	23.98	25.45	27.05	29.81
FY22	23.98	25.45	27.05	30.49
FY23	23.98	25.45	27.15	31.39
FY24	23.98	25.69	27.39	32.26

[5] American Public Power Association (2020). Puerto Rico is to receive nearly $10 billion from FEMA to rebuild its grid https://www.publicpower.org/periodical/article/puerto-rico-receive-nearly-10-billion-fema-rebuild-its-grid.

[6] See Siemens Industry (2019), The Puerto Rico Integrated Resource Plan 2018–2019.

[7] See Puerto Rico Central Office for Recovery, Reconstruction and Resiliency (2019a, 2019b), Grid Modernization Plan for Puerto Rico.

[8] See Puerto Rico Oversight, Management, and Economic Stability Act (PROMESA). Title III of the Act refers to Adjustment of Debts. https://www.congress.gov/bill/114th-congress/senate-bill/2328.

[9] See Definitive Restructuring Support Agreement (2019).

[10] On March 8, 2022, the Puerto Rico Fiscal Agency and Financial Advisory Authority ("AAFAF"), submitted a motion to the federal court conducting the PREPA Title III proceedings terminating the Definitive Restructuring Support Agreement, dated as of May 3, 2019.

[11] See PREPA (2019) Fiscal Plan for the Puerto Electric Power Rico Electric Power Authority, as certified by the Financial Oversight and Management Board for Puerto Rico; and PREPA (2020) Fiscal Plan for the Puerto Electric Power Rico Electric Power Authority, as certified by the Financial Oversight and Management Board for Puerto Rico.

[12] See Definitive Restructuring Support Agreement (2019).

[13] See Cao García (2019).

[14] The study was commissioned by Tomás J. Torres Placa, Consumer Representative on the PREPA Governing Board.

[15] The Alternative Transition Charge (ATC) is evaluated on the different scenarios considered as part of the study.

[16] Since the study was issued in august 2019, it does not consider the effects of COVID-19, nor the impacts on electricity rates as consequences of increases on oil costs. Nevertheless, when considering the overall weakening effect that the pandemic and high oil costs has had on the economy, it is expected that the capacity of the local economy to absorb electricity rates increases has decreased.

[17] The RSA is expected to occur over a 47year period. It considers periodic increases in the RSA surcharge (defined as Transition Charge) over the years. Given the state of the sciences, it is unreasonable and unrealistic to attempt to predict consequences over a two generations period of time. In consequence the analysis in the report was limited to a 5 years span.

Table 2
Percent change in cost of intermediate inputs by industrial categories under considered scenarios.

Industrial Sectors	Alternative TC (ATC)		RSA TC		RSA TC + Fiscal Plan (No Risks)		RSA TC + Fiscal Plan (Risks Included)	
	FY 2022	FY 2024	FY 2022	FY 2024	FY 2022	FY 2024	FY 2022	FY 2024
Agriculture	0.05%	0.05%	0.09%	0.09%	0.13%	0.09%	0.43%	0.26%
Mining & Construction	0.09%	0.09%	0.17%	0.18%	0.25%	0.28%	0.42%	0.51%
Manufacturing	0.19%	0.19%	0.35%	0.37%	0.51%	0.54%	0.85%	1.03%
Wholesale & Retail Trade	0.22%	0.22%	0.91%	0.98%	1.34%	1.48%	2.25%	2.71%
Hospitals & Health Serv.	0.04%	0.04%	0.17%	0.18%	0.25%	0.28%	0.42%	0.51%
Electricity & Irrigation Serv.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Other Services	0.06%	0.06%	0.26%	0.28%	0.38%	0.42%	0.64%	0.78%
Government	0.15%	0.15%	0.62%	0.66%	0.90%	1.00%	1.51%	1.83%
Overall Average	0.13%	0.13%	0.35%	0.38%	0.52%	0.56%	0.87%	1.05%

4. Expected effects on electricity consumption.

2.1.1. Economic impacts by major industrial sector

After expected rate increases were estimated for four possible scenarios, the analysis moves to compute the consequences of such increases on the cost of intermediate inputs. For that purpose, it was used the 2013 Input-Output Matrix (I/O Matrix) for Puerto Rico,[18] which was aggregated into eight major sectors. Electricity rate increases were computed in the vector of electricity and irrigation services for all sectors, except PREPA's vector, under the assumption that PREPA does not actually pay for the electricity it consumes. The estimates are made for fiscal years 2022 and 2024 in the four scenarios that are considered in the report. Table 2 summarizes the results:

As can be seen, when considering all the increases, on column on the far right, the most affected sectors are:

1. Wholesale and retail trade with a 2.71% cost increase by year 2024
2. Government with a 1.83% cost increase by year 2024
3. Manufacturing with a 1.03% cost increase by year 2024

It should be noted that these sectors are particularly critical in terms of their impact on the local economy:

1. Increases in operating costs in the wholesale and retail trade sector are usually translated to customers, reducing their purchasing power, and increasing incentives for emigration.
2. In the case of the government sector, it should be remembered that the Commonwealth faces a serious fiscal crisis that constrains its spending capacity. An increase in operation costs is going to aggravate its present fiscal crisis.
3. Manufacturing is critical for local economic performance. The Puerto Rican economy depends on exporting manufactured goods. Increases in operation costs reduce its (already diminished) capacity to compete in world markets. It should be remembered that in Puerto Rico employment in manufacturing has been declining for more than a decade and any cost increase would worsen the situation.

Construction is another sector that has been stagnant in Puerto Rico for over a decade, with declining employment. Expected increases in input costs are going to promote further adverse effects over the real estate sector of the economy, with the aggravation that electricity rates increase also adversely affects everyday home maintenance and use.

2.1.2. Impact on the consumers price index (inflation)

The next topic analyzed was the impact of possible electricity rate increases on local inflation. For this analysis, the expenditure weights computed by the Puerto Rico Department of Labor and Human Resources to estimate the Consumer Price Index (CPI)[19] were used (Commonwealth of PR and Departamento del Trabajo y Reursos Humanos de Puerto Rico, 2008). Expected price increases range from a minimum of 0.36% in the case of the ATC scenario[20] for years 2022 and 2024, to a maximum of 2.47% in 2024 in the case of the rates for the RSA TC[21] coupled with the additional rates increases in the Fiscal Plan, which includes highly probable operational risks. These increases in CPI are additional to normal inflation (Table 3).

It is to be noted that, except in the ATC scenario, in all other scenarios expected increases in CPI are higher in FY2024, than in FY2022; i.e., they tend to induce cost push inflation. According to published statistics, the Puerto Rican economy has shown fair price stability over the past 10 years, exhibiting an average inflation rate of 1.11% from fiscal years 2009–2018.[22] This situation could change if proposed electricity rate increases are implemented.

2.1.3. Expected impacts on production and income

The next topic examined is the expected impact of proposed electricity rate increases on Puerto Rico's Gross National Product (GNP).[23] Any increase in electricity rates can be expected to have negative impacts on production and income. All production processes use electricity, so any increase in electricity rates increases the costs of Puerto Rican producers and weakens their ability to compete with foreign producers. This impairs the ability of the local economy to export, as well as the ability of Puerto Rican businesses to produce for the domestic market in competition with imported products. To evaluate the expected

[18] PR Planning Board, *2013 Puerto Rico Input-Output Matrix*. San Juan, PR, no date.

[19] These weights refer to consumers expenses by consumptions categories in year 2006, the latest available information. The weights were computed by the Puerto Rico Department of Labor and Human Resources, with the assistance of the US Bureau of Labor Statistics.

[20] The Alternative Transition Charge is defined as the maximum rate increase economically allowable under this analysis, including any other surcharge, fee or rate increase of any kind.

[21] Transition Charge included on the 2019 Definitive Restructuring Support Agreement.

[22] PR Planning Board, *Statistical Appendix to the Economic Report to the Governor 2018*, Table 1.

[23] Gross National Product analysis was done at constant prices (i.e., without inflation).

Table 3
Expected change in the consumer price index.

EXPENDITURE CATEGORIES	Alternative TC (ATC)		RSA TC		RSA TC + Fiscal Plan (No Risks)		RSA TC + Fiscal Plan (Risks Included)	
	FY 2022	FY 2024	FY 2022	FY 2024	FY 2022	FY 2024	FY 2022	FY 2024
Apparel	0.01%	0.01%	0.04%	0.04%	0.06%	0.06%	0.10%	0.11%
Education & communications	0.00%	0.00%	0.01%	0.01%	0.02%	0.02%	0.03%	0.04%
Foods & beverages	0.05%	0.05%	0.21%	0.22%	0.30%	0.34%	0.51%	0.62%
Other goods and services	0.02%	0.02%	0.03%	0.03%	0.04%	0.04%	0.06%	0.08%
Residential electricity	0.26%	0.26%	0.47%	0.50%	0.68%	0.73%	1.14%	1.38%
Health services	0.00%	0.00%	0.01%	0.01%	0.01%	0.02%	0.02%	0.03%
Entertainment	0.00%	0.00%	0.01%	0.01%	0.01%	0.01%	0.02%	0.03%
Transportation	0.02%	0.02%	0.06%	0.07%	0.09%	0.10%	0.16%	0.19%
Total	0.36%	0.36%	0.83%	0.89%	1.22%	1.32%	2.05%	2.47%

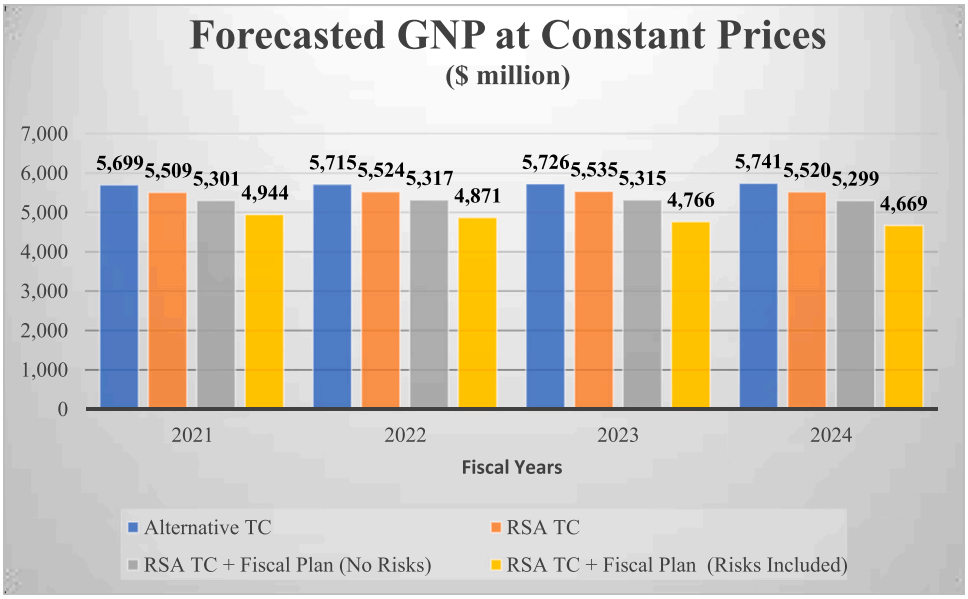

Fig. 1. Forecasted GNP at constant prices under different scenarios considered on the Cao-García study from year 2021 to 2024 (Cao-Garcia, 2019).

effects of the increases in electricity rates, an equation was estimated for projecting the GNP at constant prices. (Fig. 1).[24]

The result obtained, when viewed in context of the 2017 Real GNP value of $6006.8 million, shows the expected real impact of the proposed electricity rate increases on the Puerto Rico economy. The following Diagram and Table[25] show that the scenario with the lower negative impact on economic performance is the Alternative Transition Charge (ATC) proposed in the report. Moreover, it is the only scenario where, all other things constant, some economic growth is forecasted. On the other hand, GNP is estimated to decrease in 22.8% by 2024 if the Transition Charge plus the Risk Adjustment Rates on the Fiscal Plan are applied (Table 4).

2.1.4. Employment effects

Once the economic impacts of alternative rate increases have been forecasted, it is possible to estimate expected effects on employment. This is of outmost relevance, given the negative trend in employment registered in Puerto Rico over more than a decade. This situation is illustrated in the following diagram (Fig. 2).

The first step is to estimate the direct impact on employment per million dollars of GNP at constant prices. It was estimated that, on average, between fiscal 2009–2018, 161.4 jobs were needed to produce each million-dollar worth of actual real production. Direct employment requirement per million dollars in GNP at constant prices was applied to the expected changes in GNP forecasted for each scenario under consideration, to estimate expected effects on the level of employment in the island (Table 5).

The table shows that, in the case of the ATC, the economy seems to absorb the increase in electricity rates, and by FY 2024 it is able to

[24] The forecasting equation was specified as;
$GNP_t^{PR} = \beta_0 + \beta_1 PKWH_t + \beta_2 GDP_t^{US} + \beta_3 N_t + \beta_4 r_t \quad u_t$
Where:

GNP_t^{PR} Gross National Product at constant prices of Puerto Rico in year t, t = 2008–2017. Variable Name: GNPR_PR.
β_i Estimated coefficient for the i-th independent variable.
$PKWH_t$ Unit price of electricity for all PREPA consumers in $/kwh in year t.
DPI_t National Income in Commerce and Services in millions of dollars in year t. t = 2008–2017. Variable Name: YN_COM_SERV.
N_t Total population in thousands of persons. t = 2000–2017. Variable Name: POP.
GDP^{US} Gross Domestic Product of the US, at constant prices, in year t. t = 2000–2017. Variable Name: GDPR_US.
r_t Prime interest rate in year t, t = 2000–2017. Variable Name: R.
The equation was estimated using the Robust Least Squares procedure (Yohai method). It is noted that the equation does not take into account the effects of the coronavirus pandemics on the local economy, because, at the time of the report, it had not begun.

[25] It should be noted that forecasted values in each scenario for all fiscal years are lower than those assumed on page 59 of the 2019 Fiscal Plan.

Table 4
Percent difference between forecasted GNP and historic FY2017 GNP at constant prices.

Fiscal Year	Alt. TC (ATC)	RSA TC	RSA TC + Fiscal Plan (No Risks)	RSA TC + Fiscal Plan (Risks Included)
2021	***-5.12%***	***-8.29%***	***-11.74%***	***-17.70%***
2022	***-4.86%***	***-8.03%***	***-11.48%***	***-18.90%***
2023	***-4.68%***	***-7.85%***	***-11.51%***	***-20.66%***
2024	***-4.43%***	***-8.11%***	***-11.78%***	***-22.28%***

Source: Fig. 1

generate 2294 additional jobs, over the employment level of FY 2018. In the case of the RSA TC, the economy begins to slowly absorb the effects of the initial rate increase, but, since the RSA TC includes an additional rate increase for FY 2024, total employment again declines in FY 2024, with a total loss of 33,382 jobs in FY 2024, which is equivalent to 3.4% of total employment in FY 2018. If the electricity rate increases proposed by the 2019 RSA are compounded with the rate increases proposed in the 2019 Fiscal Plan with optimistic assumptions, by FY 2024 the economy is expected to have a net loss of 68,928 jobs, a number equal to 7.1% of total employment in FY 2018. In the last scenario, where electricity rate increases in the RSA TC are added to those proposed in the 2019 Fiscal Plan, including more realistic risk assumptions, the losses in employment are really significative, by fiscal year 2024 is expected that total employment of the economy is going to be reduced by 170,756 jobs, or 17.6% of total jobs in FY 2018.

2.1.5. Demand for electricity

Finally, the demand for electricity is forecasted under each rate increase scenario. Such forecasts are relevant because PREPA's electricity sales depend on its customers consumption; also, because increases in the RSA TC are predicated on declining demand for electricity. PREPA is in the process of privatizing energy generation, and how much private production is needed should be based on accurate demand estimates.

To forecast electricity consumption in Puerto Rico, equations were estimated for the three most relevant customer classes: (1) residential, (2) commercial, and (3) industrial.[26] These three classes account for 98% of total electricity consumption on the island.[27] To forecast total electricity consumption for each fiscal year over the forecasting period, consumption for each category was aggregated, and 2% was added to the total obtained to include the consumption of customers categories left out. This procedure implicitly assumes that the main customer classes will continue to be responsible for 98% of total electricity consumption. The results are presented in the next diagram. (Fig. 3).

The 2019 RSA considers a Transition Charge that starts at 2.768 cents/kWh from years 1–3, then increases to 2.957 cents/kWh from years 4–8 and continues to rise in increments until it reaches 4.552 cents/kWh in year 24. These predetermined increases represent an increment of 64.5%, during the first half of the RSA. Since the Transition Charge is collected from all customer classes, the 64.5% increase entails an assumed decrease in electricity consumption in the same proportion.[28]

The forecast tends to indicate that future electricity consumption could be underestimated by the 2019 RSA and the 2019 Fiscal Plan. The consequences, that arise from the underestimating of expected future consumption of electricity, are important. Two serious probable consequences are:

1. The Transition Charge schedule in the 2019 RSA depends upon expected future consumption of electricity over a very long period of time. As stated before, it is unreasonable to forecast electricity consumption over such an extended period of time – as well as a Transition Charge schedule. But if there is a tendency to underestimate future consumption, then the Transition Charge rates in the 2019 RSA schedule will be overestimated. For these reasons, it is of outmost importance that, instead of defining a 47 years schedule of Transition Charges, the charge should be reviewed periodically. The Puerto Rico Energy Bureau is the competent institution to undergo the task of these periodic Transition Charge reviews.
2. PREPA still generates most of its electricity with its own plants. However, since many of these plants were built in the ninety sixties and seventies, PREPA is in the process of privatizing electricity generation, through power purchase or plant administration agreements. If consumption of electricity is not properly forecasted, it might be difficult for PREPA and private companies to negotiate reasonable agreements. If projections for electricity consumption are underestimated, private companies may not be interested to negotiate power purchase agreements or may want to guarantee their sales through capacity payments, leading to possible scenarios of insufficient generation or excessive costs due to lack of adequate forecasts.

3. PREPA's financial sustainability

In May 2020, a second assessment was made public analyzing PREPA's financial position after Hurricanes Irma and Maria.[29,30] Not surprisingly, the report finds that PREPA's financial position is dire, requiring additional and more severe measures than the proposed on the 2019 RSA to bring PREPA to solvency and a sustainable financial position, which is urgently needed within actual conditions.

[26] Each demand equation was estimated using the following methods;

1. OLS
2. Stepwise regression
3. If the Durbin-Watson statistic in the OLS showed autoregressive errors, or indetermination, the equation was also estimated through the Durbin-Watson method.
4. Robust Least Squares (Yohai method)
5. Robust Least Squares, adjusted for autoregressive errors through the Cochran-Orcutt method.
6. 2SLS

Results obtained from the six estimation methods were compared, and, the equation with the best statistical fit was selected to be used for the analysis.

[27] 2019 *Fiscal Plan, op. cit.,* p. 63.

[28] No explanation was provided in the 2019 RSA for such a significant decrease in electricity consumption.

[29] Cao García (2020), *op cit.*

[30] This report was also commissioned by Tomás J. Torres Placa, Consumers Representative at PREPA Governing Board.

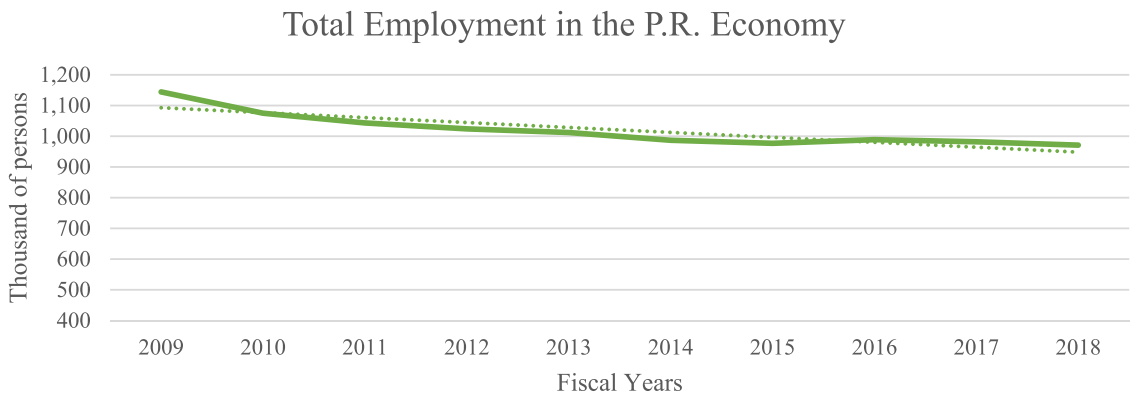

Fig. 2. Total Employment in the Puerto Rico economy from year 2009–2018 (Puerto Rico Planning Board, 2018).

Table 5
Expected employment consequences for each rate increase scenario (number of persons).

Fiscal Year	Alt. TC (ATC)	RSA TC	RSA TC + Fiscal Plan (No Risks)	RSA TC + Fiscal Plan (Risks Included)
2021	-4414	-35,151	-68,606	-126,315
2022	-1914	-32,650	-66,105	-138,033
2023	-106	-30,843	-66,388	-155,043
2024	2294	-33,382	-68,928	-170,756

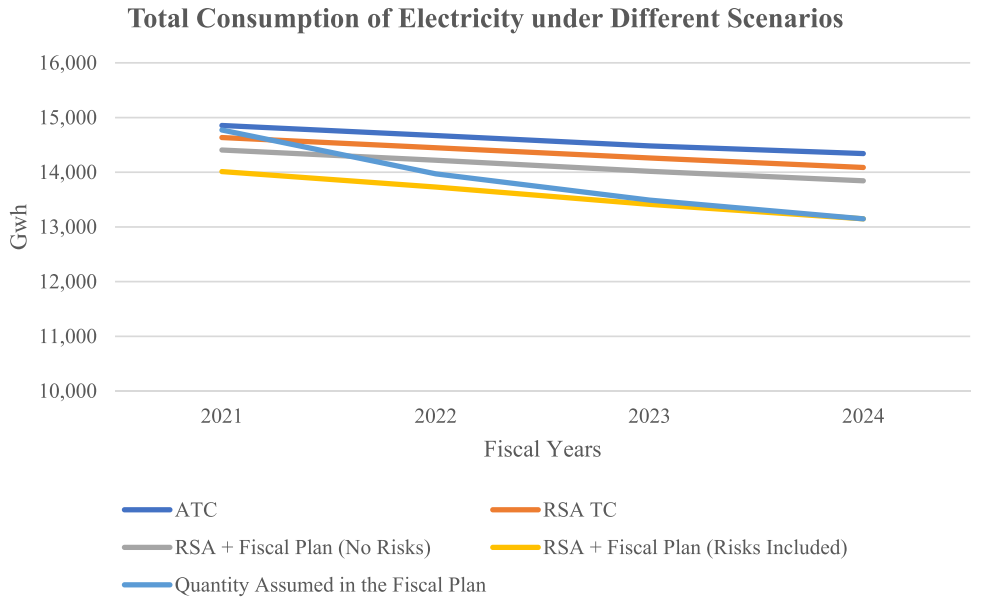

Fig. 3. Total Consumption of Electricity under different scenarios considered on the Cao-García study from 2021 to 2024 (Cao- Garcia, 2019).

Available data do not allow for a detailed analysis of the financial impacts of the January 2020 tremors and the COVID-19 pandemic.[31]. However, those events bring additional pressure on PREPA, with expected consequences for all customer classes. Electricity demand is being directly affected by the closing of businesses, and the ability of many residential consumers to pay their electricity bill is questionable. Defaults and late payment certainly are among the ways COVID-19 will impact PREPA. The pandemic will reduce PREPA's ability to repay its debt.

PREPA is operating an old and unstable system that urgently needs to be modernized. To upgrade the electric power grid, substantial investment is required. These required investments are expected to be financed, in part, by the federal government through FEMA and other federal entities. The rest will need to be financed by PREPA issuing new debt.

[31] Financial data used in the analysis is taken from interim reports published by PREPA on its web page (Monthly Reports to the Governing Board). These reports are not audited financial statements, but they are more up to date and reliable sources of information available. The last report used on that evaluation is the one for December 2019. https://aeepr.com/es-pr/investors/FinancialInformation/Monthly%20Reports/2019/December%202019.pdf.

To gain access to the bond market, PREPA has to solve its accumulated debt, partly through PROMESA Title III[32]; and very importantly, by generating operational surpluses sufficient to service new debt. The problem is that PREPA has been consistently showing annual operational deficits at least since 2006.[33] Unfortunately, PREPA has not produced any report nor explained how it will resolve its structural operational deficit, except through the assumption that privatization will make operations more efficient.

3.1. Insolvency of PREPA after the RSA

Given the depth of PREPA's debt, the 2019 RSA is unsustainable. PREPA has total liabilities for $17.69 billion and total assets for the amount of 9.88 billion[34] The 2019 RSA provides a reduction of approximately 22.5% only in the $8.30 billion power revenue bond long term debt. This reduction is a small fraction of PREPA's total debt. Clearly, this does not solve PREPA's insolvency problem. To provide an enduring and sustainable solvency, PREPA's debt need to be restructured beyond the2019 RSA.

It's important to note that since the securitization bonds are issued by a special purpose vehicle (SPV), which is a separate entity from PREPA, the restructured debt is assumed by that entity. Through this kind of instrument, PREPA's restructured long term bonds debt might not be reflected on the utility's accounts. Nevertheless, the restructured bonds debt will still be paid by PREPA customers, through a special charge in energy bills, the Transition Charge.

PREPA's debt is of such magnitude that even if the existing power revenue bonds debt is completely eliminated from its accounts, PREPA would continue to show a debt-to-asset (D/A) ratio of 0.95.[35] This implies that PREPA, even if the power revenue bond debt is wiped out as part of the current bankruptcy proceedings, after restructuring it would be on the very verge of insolvency.

3.2. Debt sustainability analysis

The analysis on the May 2020 assessment[36] evaluated sixteen scenarios in which US federal funds are used to finance some of PREPA's needed capital improvements. Eight scenarios were designed based on investments included in the Integrated Resource Plan (IRP),[37] as proposed by PREPA, and another eight scenarios were based on the "Grid Modernization Plan".[38] The 16 scenarios were specified and analyzed over a 10-year period to assess the financial sustainability of PREPA. The analysis considered the savings resulting from the 2019 RSA, the amount of expected federal reconstruction funds as a function of the investment described in the IRP and the "Grid Modernization Plan",[39] and the resulting debt to asset ratio per year for each scenario. The analysis also considers an alternate scenario where the restructured debt is not considered a liability of PREPA.

As previously mentioned, the Puerto Rico Energy Bureau on August 24, 2020 issued a Final Resolution and Order that approved a Modified IPR and Modified Action Plan. The Bureau rejected major elements of the proposed natural gas infrastructure and, on the other hand, increased the amount for renewable energy. Nevertheless, the load forecast was accepted by the Bureau and, as part of the transmission and distribution analysis, the MiniGrid concept - with further optimization requirements by the Bureau - was accepted. Accordingly, for analysis purposes, it is reasonable to assume that the estimated cost of the IRP and the Grid Modernization Plan can be used as a reference for the amount of funds required for the reconstruction of the Puerto Rico electrical system.

Therefore, as shown on the Debt to Asset Ratio Tables for the IRP and the "Grid Modernization Plan", whether considering either of the cost estimates the following is observed:

1. Even with large amounts of federal funds, in all scenarios that considered the restructured debt, after the implementation of the RSA, PREPA remains insolvent or with parameters much higher than the U.S. national average for comparable electricity companies and near insolvency.
2. PREPA only showed solvency on scenarios when:
   a. the restructured revenue bonds debt is presumed not a liability for PREPA[40]; and
   b. FEMA and other federal government agencies finance 90% of needed capital improvements.
3. Under the scenario where the restructured debt is not considered a liability of PREPA, if federal agencies only finance 45% of the total investment, the financial position after the 2019 RSA would reflect a debt-to-asset (D/A) ratio, much higher than the U.S. national average for comparable electricity companies and close to insolvency parameters.
4. The scenarios that fulfill the two solvency conditions are feasible if, and only if, PREPA is able to generate annual net operation income sufficient to service the new debt PREPA will have to issue to finance its share of required capital investments, not covered by federal reconstruction funds. It is uncertain how PREPA will be able to achieve such operational transformation, particularly when the only strategy stated for this required goal is the expectation that privatization, coupled with rate increases, will somehow produce operational income surpluses[41]. (Table 6 and 7).

It is interesting to note that Exhibit 30 of PREPA, 2020 Fiscal Plan shows the projected expenses for PREPA's generation plants and power purchase agreements, and its transmission and distribution system. GenCo and GridCo are identified as the new entities that will manage these assets.[42] The Fiscal Plan indicates that the recently selected transmission and distribution system operator[43] will begin operating in Fiscal Year 2022. Exhibit 30 shows that the projected expenses for GridCo increase from $897 million in FY2022 to $909 million in FY2025, this represents an increase of $12 million, or 1.3%. In

[32] See Puerto Rico Oversight, Management, and Economic Stability Act (PROMESA) *op. cit.* Title III of the Act refers to Adjustment of Debts.

[33] Cao García (2020), *op, cit.,* pp. 11–14. Also see Monthly Report to the Governing Board for December 2019. https://aeepr.com/es-pr/investors/FinancialInformation/Monthly%20Reports/2019/December%202019.pdf

[34] See Monthly Report to the Governing Board for December 2019. https://aeepr.com/es-pr/investors/FinancialInformation/Monthly%20Reports/2019/December%202019.pdf.

[35] Cao García (2020), *op, cit.,* p. 7.

[36] *Ibid.* pp. 14–22. Also see Appendices 4, 5 and 6.

[37] Siemens Industry (2019). The estimated cost for reconstruction works, as part of the IRP, was $14.7 million.

[38] Puerto Rico Central Office for Recovery, Reconstruction and Resiliency (2019a, 2019b). The estimated cost for reconstruction works, as part of the Grid Modernization Plan, was $20.3 million.

[39] On the study the amount of federal reconstruction funds was set on 45% and 90% of the required funds, in accordance with the 2019 PREPA Fiscal Plan.

[40] This is under the assumption that Restructured Revenue Bond debt will be assumed by a new legal entity through the issue of securitized bonds, and not to be regarded as a PREPA's liability; or, for analysis purposes, PREPA's Restructured Revenue Bonds debt would be discarded.

[41] It is well known that undiscriminated increases in electricity rates could reduce the demand, and, if they exceed some threshold, the reduction in demand would result in financial insolvency for the electric company.

[42] Defining GenCo as the PREPA subsidiary that will own generation assets and GridCo as the PREPA subsidiary that will own transmission and distribution assets.

[43] LUMA Energy was selected the transmission and distribution system operator in a process managed through the Puerto Rico Public-Private Partnerships Authority, in accordance to P.R. Act 120 of 2018.

Table 6
Debt to Assets Ratios (D/A) under Different Scenarios based on.

	PREPA Retains Ownership of New Generation Plants				PREPA Privatizes All New Generation Plants			
	Federal Gov't Pays 90% of Investment		Federal Gov't Pays 45% of Investment		Federal Gov't Pays 90% of Investment		Federal Gov't Pays 45% of Investment	
Fiscal Year	Scenario I	Scenario I-A (ND) Restructured Debt Not Considered as a PREPA Liability	Scenario II	Scenario II-A (ND) Restructured Debt Not Considered as a PREPA Liability	Scenario III	Scenario III-A (ND) Restructured Debt Not Considered as a PREPA Liability	Scenario IV	Scenario IV-A (ND) Restructured Debt Not Considered as a PREPA Liability
1	1.53	0.89	1.53	0.89	1.54	0.89	1.54	0.89
2	1.39	0.81	1.42	0.84	1.49	0.86	1.49	0.86
3	1.18	0.69	1.29	0.80	1.43	0.83	1.45	0.85
4	0.87	0.53	1.08	0.73	1.04	0.62	1.19	0.77
5	0.85	0.51	1.08	0.74	1.03	0.61	1.19	0.77
6	0.82	0.50	1.07	0.75	0.98	0.58	1.16	0.77
7	0.75	0.46	1.03	0.74	0.97	0.58	1.16	0.78
8	0.75	0.46	1.04	0.75	0.95	0.57	1.16	0.78
9	0.75	0.46	1.05	0.77	0.93	0.56	1.16	0.79
10	0.76	0.47	1.07	0.78	0.93	0.56	1.17	0.80

Source: Appendix 4,-Cao García, (2020).

Table 7
Debt to Assets Ratios (D/A) under Different Scenarios based on the Grid Modernization Plan.

	PREPA Retains Ownership of New Generation Plants				PREPA Privatizes All New Generation Plants			
	Federal Gov't Pays 90% of Investment		Federal Gov't Pays 45% of Investment		Federal Gov't Pays 90% of Investment		Federal Gov't Pays 45% of Investment	
Fiscal Year	Scenario V	Scenario V-A (ND) Restructured Debt Not Considered as a PREPA Liability	Scenario VI	Scenario VI-A (ND) Restructured Debt Not Considered as a PREPA Liability	Scenario VII	Scenario VII-A (ND) Restructured Debt Not Considered as a PREPA Liability	Scenario VIII	Scenario VIII-A (ND) Restructured Debt Not Considered as a PREPA Liability
1	1.53	0.89	1.53	0.89	1.54	0.89	1.54	0.89
2	1.39	0.81	1.42	0.84	1.54	0.86	1.49	0.86
3	1.18	0.69	1.29	0.80	1.48	0.83	1.45	0.85
4	0.77	0.47	1.01	0.71	0.92	0.54	1.09	0.73
5	0.76	0.46	1.02	0.72	0.92	0.54	1.10	0.75
6	0.70	0.43	0.99	0.72	0.82	0.48	1.05	0.73
7	0.63	0.40	0.95	0.72	0.80	0.47	1.04	0.74
8	0.63	0.40	0.97	0.73	0.79	0.47	1.04	0.75
9	0.64	0.40	0.99	0.75	0.78	0.47	1.05	0.76
10	0.65	0.41	1.01	0.77	0.79	0.47	1.07	0.78

Source: Appendix 5 Cao García, (2020).

consequence, the entrance of the transmission and distribution system operator seems not to have a significant impact on PREPA operational deficits.

4. Conclusion and a proposed strategy

The analysis developed in the previous pages shows that the 2019 RSA is not a solution to PREPA's financial situation. We have shown that, if the 2019 RSA is implemented as proposed, PREPA will continue to be insolvent, or near to insolvency parameters, and will not be able to access the bond market to finance its share of needed capital improvements. The result will be in significantly higher electricity rates, that will cause serious hardship to the local economy, which has been in a structural contraction since fiscal year 2007.[44] In lieu of the RSA, Puerto Rico needs a restructuring strategy that meets the following objectives:

1. Achieve financial sustainability for present and future operations of the electric utility, including:
   a. Debt levels in line with national parameters of similar utilities with a Debt to Asset Ratio of 0.56,[45] reducing PREPA's debt in accordance with the value of its depreciated assets currently valued in $9.88 billion. That would result in a debt of approximately $5.5 billion. This entails a more comprehensive restructuring than the one being considered since as previously mentioned as of December 2019 PREPA has total liabilities for $17.69 billion.
   b. Access to federal funds as the primary source for reconstruction financing.
   a. Access to the bond market, in order to finance the share of needed capital improvements not covered by federal agencies
2. Avoid extreme measures, included on the proposed RSA, that could adversely affect demand for electricity and the credibility of the debt restructuring process, such as:

[44] See Puerto Rico Planning Board (2020). Table 1 of the Statistical Appendix shows a Gross Product decline, at constant prices, for the last 10 years of over 12%.

[45] See Cao García (2019); and American Public Power Association, (2018) Financial and Operating Ratios of Public Utilities, Arlington, VA, December 2018.

a. Nonbypassable and unavoidable charges on all electricity generated in Puerto Rico independent of the source (PREPA or non-PREPA), including for energy generated by consumers.[46]
b. Excluding the Puerto Rico Energy Bureau from the evaluation and implementation of debt restructuring charges.[47]
c. Non-compliance with local laws and regulations.[48]

3. Pursue electricity rates, including debt restructuring and reconstruction cost, that can be absorbed by the economy without further constraining its capacity to generate investment, income and employment. This means that electricity rates in Puerto Rico should not become an obstacle to economic development.
   a. The charges on the 2019 RSA result in electricity rates increases. Those increases have a negative impact in consumption. Lower consumption would induce additional rate increases resulting in additional financial restructuring of the utility on the near future.
   b. The 2019 RSA, on the other hand, seems to significantly underestimate the demand to assure collection from customer classes.[49] A lower demand implies higher charges to consumers. This assumption should be reconsidered, especially in the verge of technologies such as electrical vehicles (EVs) that could have an impact on demand.[50]
4. Implementation of legal and regulatory framework
   a. Fulfill current policy, legislative goals and plans approved by the regulator (Puerto Rico Energy Bureau, 2020)[51] to promote other sources of electricity, including distributed generation of renewable resources, micro-grids[52] and energy wheeling.[53] This can produce market pressure on PREPA.
   b. Adding market pressure to PREPA would encourage more efficient operation in compliance with policy goals. This is achieved by means of providing the capabilities to consumer to self-generate or acquire energy from a third party.
5. Improve PREPA's performance and operation, to assure:

a. Annual operational surpluses (to cover servicing of debt to be issued to finance required capital investments).
b. Capital improvement plans and maintenance programs, beyond federal reconstruction funds.
c. Increased reliability of service.

Additionally, comprehensive, coherent, and transparent capital improvement plans, and maintenance programs needs to be developed hand to hand with the allocation of federal reconstruction funds. The deployment of $10 billion in the Puerto Rico's electrical grid[54] comprising underground and aerial electrical infrastructure, new substations and related infrastructure works will have a direct impact on urban, commercial and industrial centers as well and the overall landscape of Puerto Rico. Therefore, plans need to be, not only comprehensive and coherent, but transparent and inclusive, with a participatory approach, involving the end-user, including consumers, community leaders, local organizations and administrators.

PREPA not only needs to achieve debt levels within national parameters through the implementation of a more comprehensive restructuring process, but also to reform its administration and operation. This reform, beyond any privatization effort, must be accompanied by a strong regulatory oversight with broad public participation. Further, within the new options that consumers have as part of the new energy policy (Puerto Rico Act 17, 2019), PREPA is now forced evolve into a utility of reliable service and competitive costs.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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[46] See Schedule I-A, page I-A- 2 and I-A- 4 of Definitive Restructuring Support Agreement (2019). The Financial Oversight and Management Board for Puerto Rico.

[47] See Schedule I-B, page I-B- 3 of Definitive Restructuring Support Agreement (2019). The Financial Oversight and Management Board for Puerto Rico *op cit.*

[48] See Schedule I-B, page I-B- 6 of Definitive Restructuring Support Agreement (2019). The Financial Oversight and Management Board for Puerto Rico *op cit.* This includes non-compliance with over 15 laws, regulations, and plans.

[49] As previously discussed on this paper, the predetermined increases on the 2019 RSA represent an increment of 64.5%. Since charges on the 2019 RSA are collected from all customer classes, the 64.5% increase entails an assumed decrease in electricity consumption in the same proportion.

[50] On November 18, 2021, the Puerto Rico Energy Bureau issued the Principles for Initiating EV Infrastructure Deployment, NEPR-MI-2021–0013. Puerto Rico Energy Bureau (2021). https://energia.pr.gov/wp-content/uploads/sites/7/2021/11/20211118-MI20210013-Resolution-and-Order.pdf

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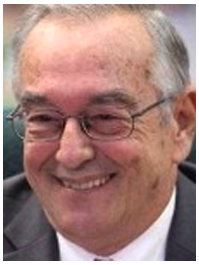

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