
EE/CprE/SE 491 WEEKLY REPORT 7

3/26/23 - 4/2/23

Group Number: 16

Project title: Feasibility of Solar PV Energy for Puerto Rico

Client &/Advisor: Vikram Dalal

Team Members/Role: Adam Curtis, Hannah Nelson, Isaac Buettner, Larry Trinh, Manuel Perez-Colon

o Weekly Summary

This week we gave a presentation to the class about our project plan. We also had to complete multiple assignments for class, but they helped us pinpoint the specifics of our project. We had a meeting on Monday to determine research goals for the week. We decided to practice a “waterfall” style for the week— all researching the three possible solutions for Puerto Rico PV: community, farm, and rooftop. We divided into groups and focused our research on the advantages and disadvantages of each in order to determine what we want to “implement” by the start of May to stay on track with our schedule. This research should provide guidance into the specific direction we want to take the project.

o Past Week's Accomplishments

Hannah: Researched community-based PV systems. Surprisingly, there is an extensive amount of research and initiative (in certain states) to propel the idea forward. In the mainland US, there are community solar projects in 39 states. 22 of these states have incentives to support those who invest. Community PV systems allow low-middle income (LMI) and those without adequate resources (roof size, shading, etc.) access to solar energy. Most often, participants will either buy a portion of the off-side system or “lease” on a monthly basis. This decreases the burden of large upfront costs associated with rooftop systems.

Major advantages include electricity rate stability and savings for LMI households, the grid can benefit depending on the location of panels, utilities can benefit from government incentives, improves customer engagement, and the payoff is not years away. Some disadvantages: not enough well-developed state policies to incentivize participants. There is a lot of grey area for issues like whether people should get tax credits from these programs and may need large subsidies, challenging to start first program in the area.

Manuel: Contacted Prof. Villegas Pico to discuss the possibility of him helping us gain NREL contacts or studies performed by him. Researched the pros and cons of large scale solar farms based of current examples in the world.

Adam: Researched the benefits and drawbacks of large scale solar farms to compare to the rest of the groups research of community solar farms and rooftop solar. A few drawbacks of large scale solar farms include the necessity of large, relatively flat, unshaded plots of land near transmission lines and ideally near the load as well. This is not a huge problem in the U.S. as flat land is abundant in the midwest but in Puerto Rico, which is a relatively small island with mountains and jungle taking up much of the center of the island, it would be difficult to find a place to install larger solar farms. I believe the community based solar farms will be much better suited to Puerto Rico than a large, say 300 MW solar farm.

Data for how much energy PR consumes per year [1]:

This can be broken down into commercial, residential, and industrial.

Year	State	Data Status	TOTAL				MW Consumed
			Revenue Thousand Dollars	Sales Megawatthours	Customers Count	Price Cents/kWh	
2022	PR	Preliminary	4,351,075	14,518,941	1,498,774	29.97	1657.413356
2021	PR	Final	3,686,454	16,457,112	1,485,263	22.40	1878.665753
2020	PR	Final	3,258,225	16,137,816	1,477,169	20.19	1842.216438
2019	PR	Final	3,560,495	16,158,428	1,466,923	22.03	1844.569406
2018	PR	Final	3,563,682	16,434,227	1,473,231	21.68	1876.053311
2017	PR	Final	3,016,376	13,611,491	1,465,438	22.16	1553.823174
2016	PR	Final	3,203,005	17,342,857	1,459,963	18.47	1979.778196
2015	PR	Final	3,549,268	17,266,160	1,454,643	20.56	1971.022831
2014	PR	Final	2,695,995	10,445,635	1,461,781	25.81	1192.424087

[1] <https://www.eia.gov/state/data.php?sid=RQ#Prices>

Reached out to Anne Kimber and got some information back about which standards we should be looking at when creating our design. The standards in question are:

IEEE 1547 (Inverters)

Rule 21 (Control System of Inverters)

NFPA 70 (National Electrical Code)

NFPA 85 (Battery Standards)

Larry: Worked on the pros and cons of microgrid solar energy. There are a couple pros of microgrids such as Microgrid offer many financial benefits such as solar panels can be more economically stable than energy produced from fossil fuels. Moreover, they are more reliable, and that makes them become more popular. The reason behind their

stability is when electricity has to travel long distances before arriving in populated areas, it is under possibility of storm, fire, and flood. Local generated energy can help to prevent those. Microgrid also has a benefit of faster construction. On the other hand, the cons of Microgrid is resistance from utilities, that means when the grid is expended, the microgrid becomes more complicated, also microgrid is hard for maintenance.

<https://www.pacificdataintegrators.com/insights/microgrid-pros-and-cons>

<https://www.techzim.co.zw/2020/06/a-look-at-microgrids-the-pros-and-cons-of-localised-power-generation/#:~:text=Drawbacks%20of%20microgrids&text=Energy%20may%20need%20to%20be,infrastructure%20is%20also%20a%20hurdle>.

<https://www.techzim.co.zw/2020/06/a-look-at-microgrids-the-pros-and-cons-of-localised-power-generation/>

Isaac: This week, I started researching rooftop solar and the pros and cons it carries especially in the context of Puerto Rico. It was interesting learning how LMI households could produce half of the total solar potential of PR rooftop solar alone, with the total solar potential of rooftops being 4x the annual energy consumption. For all residential buildings, they would be able to produce 4.25x the energy they need, for LMI this statistic is 5.7x more energy than they need, and even assuming half of LMI household rooftops were unsuitable for solar panels, more than 2.5x the energy they needed would be produced. Overall, it was a pretty good week and I think our presentation went smoothly and we are able to coordinate nicely during our meetings and have great communication laying out what we want to tackle next.

<https://www.nrel.gov/docs/fy21osti/78756.pdf>

Individual contributions

<u>NAME</u>	<u>Individual Contributions</u> <i>(Quick list of contributions. This should be short.)</i>	<u>Hours this week</u>	<u>HOURS cumulative</u>
Adam Curtis		6	33
Hannah Nelson	Research, assignments, PPT for Dalal	6	33
Isaac Buettner	Assignments, Research	5	31
Larry Trinh		4.5	30
Manuel Perez	Research, assignment, outreach to Dr. Villegas Pico	4	18

- o **Plans for the upcoming week** *(Please describe duties for the upcoming week for each member. What is(are) the task(s)?, Who will contribute to it? Be as concise as possible.)*

Hannah - I started briefly looking into Puerto Rico-specific community solar projects. They finished their first one (!!) in March! It is a mountain town in the middle of the island. This could be really important to look into, especially if we decide to adopt different plans for different geographical regions. Continue research of the organization, Casa Pueblo, and how

they developed a plan. There is also an NREL study about the challenges of implementing community-based systems that I would like to reference.

Manuel - Contact NREL researchers and meet with Dr. Villegas Pico. Dive deeper into other countries with similar climates and topological conditions to Puerto Rico and any renewable energy efforts they've carried out.

Adam - Begin looking through standards found this week for important things we will have to make sure our final design abides by, compile a list.

Larry - I will continue to research the advantages and disadvantages of microgrids compared to other solutions. At the same time, I will self-educate myself with grid integration and prepare for the meeting with Dr Dalal on Monday by preparing a powerpoint file and some questions to ask.

Isaac - I think for this upcoming week, when I finish with looking at rooftop solar viability for Puerto Rico, I would like to start looking into existing distribution and transmission grids in Puerto Rico, and what an optimal grid would look like for this case.