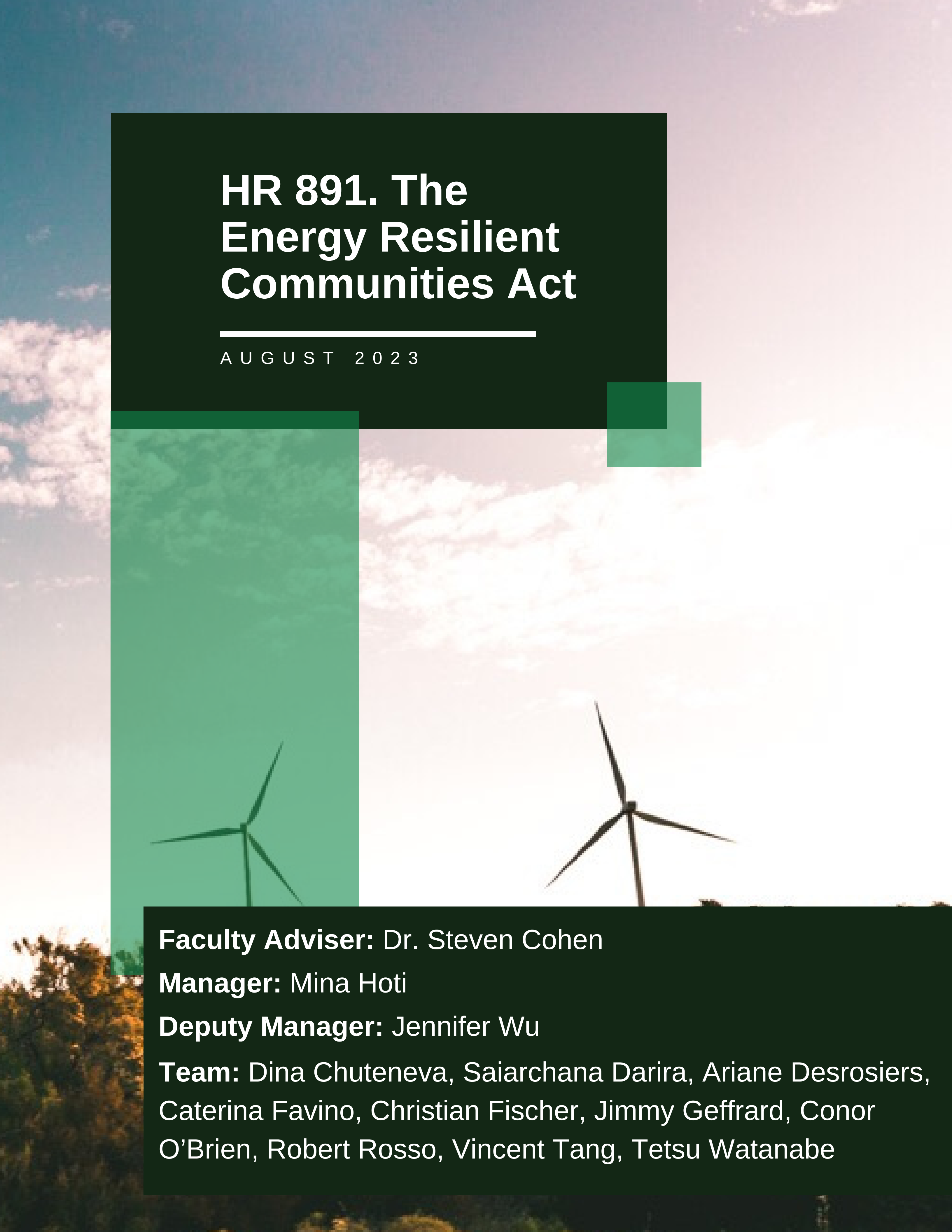

# HR 891. The Energy Resilient Communities Act

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**Faculty Adviser:** Dr. Steven Cohen

**Manager:** Mina Hoti

**Deputy Manager:** Jennifer Wu

**Team:** Dina Chuteneva, Saiarchana Darira, Ariane Desrosiers, Caterina Favino, Christian Fischer, Jimmy Geffrard, Conor O’Brien, Robert Rosso, Vincent Tang, Tetsu Watanabe

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# EXECUTIVE SUMMARY

As we write this, in August 2023, Texas is facing yet another extreme heat wave, with record-breaking temperatures and a whopping 800% increase in energy bills, meaning citizens are paying $2,500 per megawatt-hour (Malik, 2023). Demand for energy, and the electricity bill that comes with it, has never been this high. Disasters such as these are becoming increasingly more frequent with climate change.

This report will delve deeper into the science of climate change and its implications for extreme weather. We will outline the inefficiencies in the current US grid system, and address the proposed solution: clean energy microgrids. We will explore the technology, feasibility, and issues associated with microgrids as the proposed solution, as well as examining the metrics employed for gauging the success of microgrids.

The US Department of Energy estimated that there were more than 450 operational microgrids in the United States in 2022. However, a senior research analyst at Wood Mackenzie, a consultancy for renewable energy, estimates the number to be closer to 3,500 (Laterman, 2023).

H.R. 891 - The Energy Resilient Communities Act (H.R. 891) allocates billions of dollars in clean energy microgrids, technical assistance, and community-owned energy systems. This bill signifies a promising era in the clean energy transition and in the modernization of the existing power grid, with a particular focus on environmental justice communities. The success of this bill hinges upon the evaluation of the grant program's success in effectively reducing greenhouse gas emissions associated with electric power generation in the United States. Additionally, the grant program must showcase achievements in promoting clean energy production and constructing energy systems that benefit communities (US Congress).

At Heron's Nest, the 62-kilowatt community solar system and 255-kilowatt-hour battery unit ensure that residents always have backup power. Credit: Bobby Altman for The New York Times

# INTRODUCTION TO H.R.891

The Energy Resilient Communities Act (H.R. 891) provides funding for energy solutions that improve communities' energy resilience, energy democracy, and overall community energy security. These energy solutions include technical assistance for clean energy infrastructure (such as clean energy buildings standards), community outreach programs, clean energy microgrid projects, and educational programming on clean energy. The mechanism by which these energy solutions are intended to happen is through a grant program overseen by the Secretary of Energy.

WHO

**Sponsors:** Congresswoman Nanette Diaz Barragán, Democratic Congress Member for California's 44th Congressional District since 2017, and 46 Democratic Co-Sponsors

**Department of Energy:** Responsible for providing grants to climate resilient infrastructure, giving the Secretary of Energy responsibility to direct the grant program and its associated educational outreach programs

**Prioritization:** Given to applications from environmental justice communities

WHEN

This bill is being introduced to the 118th Congress, between 2023-2024.
It was introduced to the House of Representatives on February 9, 2023.

HOW

The bill will give the Secretary of Energy and the Department of Energy authority to oversee and disseminate grants. This includes $1.5 billion in annual grants for clean energy microgrids to support critical community infrastructure, such as hospitals and schools, in the case of extreme weather events; an additional $50 million in annual grants for technical assistance, such as upgrading building codes and standards; and finally, $150m in grants for community owned energy systems. Priority is given to applications from environmental justice communities, meaning communities with significant representation of communities of color, indigenous communities, and low-income communities that are at risk of experiencing negative health or environmental impacts.

# DEFINITIONS

## Excessive GHG Emissions:

Greenhouse gasses (GHGs) are gasses that trap heat within the atmosphere ($CO_2$, $CH_4$, $NO_2$, and various fluoridated gasses) (EPA, 2023). The Environmental and Energy Study Institute (EESI) states that 75% of current GHG emissions are derived from fossil fuel consumption (Bertrand, 2021). Criteria air pollutant emissions are any gaseous emissions for which known human exposure thresholds exist and for which ambient air quality levels have been set (State of California, 2023).

## Energy Resilience:

The US Code defines energy resilience as the “ability to prevent, plan for, minimize, adapt to, and recover from anticipated and unanticipated energy disruptions in order to ensure energy availability and reliability sufficient to provide for mission assurance and readiness, including mission essential operations related to readiness, and to execute or rapidly reestablish mission essential requirements” (Legal Information Institute, 2023).

## Community Security:

Community security is defined as the denial of active citizenship and public engagement on issues related to security and justice (US Legal, 2023). As an end-state, community security means that people feel protected and valued as members of society (Bennett, 2014).

## Energy Democracy:

Energy Democracy involves social ownership of energy infrastructure in a decentralized energy grid that allows for citizen participation in energy-related decisions; in this system citizens are both the stakeholders and customers of the energy grid (Szulecki, 2017).


# THE ENVIRONMENTAL PROBLEM

## GREENHOUSE GAS EMISSIONS & EXTREME WEATHER EVENTS

Greenhouse gas emissions, primarily driven by human activities such as the burning of fossil fuels and deforestation, are significantly contributing to the intensification of extreme weather events. The accumulation of gases like carbon dioxide ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$) in the earth's atmosphere creates a blanket over the earth and enhances the natural greenhouse effect, leading to a warmer climate. This warming, in turn, disrupts established atmospheric patterns, causing shifts in weather patterns and an increased frequency of extreme events.

Climate change then leads to more intense El Niño and La Niña events, meaning the amplified energy in the atmosphere fuels more intense heatwaves and therefore prolonged droughts in some areas, and heavier rainfall and flooding in others. These events arise from complex interactions between atmospheric, oceanic, and environmental systems, but the overarching influence of elevated greenhouse gas levels is undeniable.

## CASE STUDY: TEXAS

### 2021: DEEP FREEZE

The Texas energy crisis in 2021 is a stark example of how increased frequency of extreme weather events can severely impact the outdated US grid system. In February 2021, an unprecedented winter storm hit the state, causing temperatures to plummet far below average. This led to a surge in electricity demand as people attempted to heat their homes, while simultaneously, the cold weather hampered the generation of electricity from both renewable and non-renewable sources. Texas largely operates an isolated grid system that is not designed for such extreme weather, resulting in a massive power failure. An estimated 4.5 million customers were left without power, and, tragically, there were at least 246 recorded deaths (GAO, 2021; Stivek, 2022).

### 2022: HEATWAVE

In 2022, Texas experienced the opposite problem—a heatwave that once again strained the state's energy grid. The grid was not prepared for such high electricity demand caused by increased air conditioning use. This led to the Electric Reliability Council of Texas issuing conservation alerts and warnings of potential blackouts (Malik, 2023). While Texas managed to avoid widespread blackouts during the heatwave, the situation highlighted the state's vulnerability to extreme weather events and the urgent need for grid resilience and modernization. These back-to-back crises underscore the growing threats of climate change and the need for a radical rethinking of the current grid system to ensure it can withstand the challenges of the future.

## THE CURRENT GRID SYSTEM IN THE UNITED STATES

We need to start by understanding the strengths and the weaknesses of the current grid system in the United States. 16% of the world's fossil fuel consumption is consumed in the US, and fossil fuels are used to produce 60.2% of energy in the US (Center for Sustainable Systems, University of Michigan, 2022). The centralized model, while efficient in managing high volumes of electricity, has inherent vulnerabilities due to its size and interdependence (EIA, 2023). The grid system in the United States is divided into three major interconnected networks: the Eastern Interconnection, the Western Interconnection, and the Texas Interconnection (EIA, 2022a). Each interconnection operates independently, balancing electricity supply and demand within its region. This means that during a very hot summer when NYC experiences more energy usage than its grid can handle, it can borrow electricity from nearby regions. However, it also means that when the system fails, there are widespread outages, which affects the stability of the entire grid. The centralized grid system is therefore susceptibile to natural disasters and extreme weather events (McLaughlin, 2022).

As electricity is transmitted through grid lines and distribution networks, a large amount of it is lost due to line congestion, transformer losses, and resistive heating. The farther away the energy is transmitted, the more energy is lost because the resistance of lines increases with distance. The conversion of electrical energy into heat in conductors, such as copper or aluminum, known as resistive heating, occurs due to the inherent resistance of these materials (Chint, 2021). Centralized systems, therefore, experience a high degree of energy loss given the potentially long energy transport distances from the generation site.

Additionally, line congestion and transformer losses further contribute to the decreased amount of energy transported, ultimately resulting in less efficient energy distribution in centralized systems (Costa-Campi et al., 2018). This inefficiency not only leads to increased costs but also exacerbates GHG emissions. To compensate for energy loss and the costs associated with it, we increase our reliance on fossil fuels.

Furthermore, the grid's design and operation are based on principles and assumptions that were established several decades ago (Blunt, 2022). This includes assumptions about the types and locations of generation resources, the demand patterns, and the level of reliability required. However, these assumptions are increasingly challenged by the changing electricity landscape. This includes the growth of reliable and affordable renewable energy sources, the increasing frequency and intensity of extreme weather events due to climate change, and the growing electricity demand patterns due to the electrification of various sectors (Zakeri, 2021). This necessitates a rethinking and redesigning of the grid system to ensure its resilience, reliability, and efficiency in the face of these emerging challenges.

## Household Energy Security by Demographic Characteristics (percent of households)

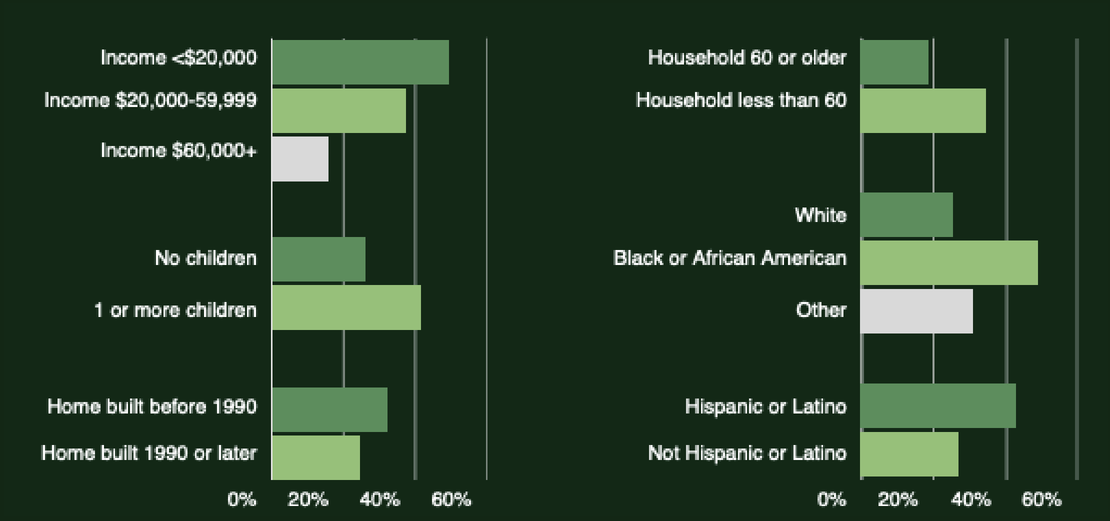


**Figure 1.** Source: U.S. Energy Information Administration, Residential Energy Consumption Survey 2015

## WHO IS IMPACTED THE MOST?

As climate change leads to more extreme weather events, the current grid system cannot manage them. Every customer of the US grid system is impacted when a disaster strikes, as energy prices go up and communities are left without warming or heating in extreme weather. However, Environmental justice communities are impacted disproportionately. This group usually includes low-income groups, people of color, or those receiving critical care in medical facilities. Low-income groups and communities of color already spend a greater portion of their income on energy expenses; they do not have the ability to meet higher energy costs and invest in adaptation infrastructure, such as backup generators. Thus, when a power failure occurs, it impacts these groups more than others (GAO, 2021). **Figure 1** highlights how, in the US, lower-income households and households of color are significantly more energy-insecure, which is defined by the Energy Information & Administration as those who self-report a challenge in paying energy bills or sustaining adequate heating and cooling (Berry et al, 2018).

Similarly, air pollution from fossil fuels tends to be concentrated in these communities, leading to increased health problems (Thompson, 2019). A 2022 study by Jbaily et al. found that the average PM2.5 concentration for Black people in America was on average 3.7% higher than that of white people (Harvard School of Public Health, 2022).

The bill terms these communities as 'environmental justice communities,' which are defined as communities with "significant representation of communities of color, low-income communities, or Tribal and indigenous communities, that experiences, or is at risk of experiencing, higher or more adverse human health or environmental effects" (H.R. 891, 2023). Lastly, certain communities—such as people in medical facilities—rely on stable electricity sources and are extremely vulnerable to power outages (GAO, 2021).

# THE SOLUTION: CLEAN ENERGY MICROGRIDS

## THE PROPOSED SOLUTION IN THE BILL

To combat climate change, grid inefficiency, and energy insecurity, we need to go back to the solution proposed by HR 891. This bill proposes a grant program to be established under the governance of the Secretary of Energy. The funding provided should be used to improve energy resilience and is dedicated to three key uses:

1. Technical assistance for clean energy infrastructure and clean energy microgrids
2. Strengthening of community outreach and partnership for clean energy microgrid programs
3. Building of clean energy microgrids that support Environmental Justice communities, and residences of medical customers and critical community infrastructure

| | |
|---|---|
| **$1.5 Billion** | **Annual grants for clean energy microgrids** |
| **$150 Million** | **Annual grants for community owned energy systems** |
| **Additional $50 Million** | **Annual grants for technical assistance** |

**Priority given to applications from environmental justice communities**

## DEFINING CLEAN ENERGY MICROGRIDS

Clean energy microgrids are microgrids fueled by renewable energy sources. Microgrids themselves are comparatively small, controllable power systems composed of one or more generation units connected to nearby users that can operate with, or independently from, the local bulk transmission system, sometimes referred to as the "macrogrid" (C2ES, n.d.) Microgrids are a form of distributed generation since the energy is created close to where it is used.

The basic principle behind the introduction of networks of microgrids, in lieu of currently centralized large-scale grids, is one of risk mitigation and economizing our power generation system in the long term. Centralized power generation sources suffer from the vulnerabilities inherent in many users relying on a single resource—if something happens to these power generation hubs, society is left with no backup power generation sources. Microgrids, by contrast, necessarily limit the potential for blackouts through an abundance of generation sources that service fewer users. Intuitively, a more even geographic distribution of power generation sources limits the risk of all of the power users experiencing blackouts at once (Hossain, 2021). Microgrids are less vulnerable to natural disasters owing to their capacity to work in isolation or in unison to make up for outages across connected microgrids.

Given the hyperlocality of microgrids, energy distribution to local users will experience increased efficiency owing to the minimization of energy lost in long distance transmission, which occurs due to line congestion, transformer losses, and resistive heating in centralized grid systems. Transmission and distribution losses in centralized grid systems are generally around 22.5% of the energy generated and are principally influenced by line length (given that much of the country is not near a centralized grid hub) and by distribution transformers, which change the voltages of supplied energy, not being located near users (EEP, 2013). This loss of energy through distance biases the move to more local distribution sources that can implement power distribution controls across shorter distances and achieve greater efficiency in utilizing generated power.

Microgrids can run on several fuel sources such as renewables (solar, wind, hydro, and biomass), fossil fuels (natural gas and diesel generators), and small nuclear reactors. Historically, microgrids generated power using mainly fossil fuel-fired combined heat and power (CHP). When a microgrid consists of 100% renewable energy, it is referred to as a clean energy microgrid (C2ES, n.d.).

At the end of 2022, there were approximately 175 solar—and solar-plus—storage microgrids in the US, although, their percentage of the overall production capacity is still lower compared to fossil-fuel powered microgrids. Nevertheless, clean microgrids are on an accelerating path with a 47% increase in solar and storage capacity in 2022 compared to 2017 levels. Analysts predict that by 2025, wind, solar, hydropower, and energy storage will represent 35% of annual microgrid capacity, although they accounted only for 10% in 2022 (**Figure 2**) (Department of Energy, 2021a+b; Wood Mackenzie, 2023).

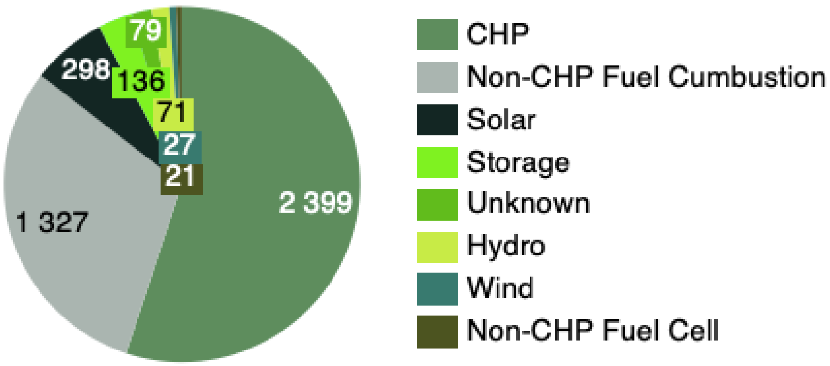


**Figure 2.** Source: Walton/Microgrid Knowledge, 2023
**Total installed microgrid capacity in the US in MW, December 2022**

## CASE STUDY: **BROOKLYN**

The Brooklyn Microgrid is an example of a community-driven energy resilience project that began in 2015 with an aim to supply 10 MW. The project aimed to create a localized energy system that promotes renewable energy generation, energy sharing, and community engagement. The Brooklyn microgrid project was initiated by LO3 Energy, a Brooklyn-based energy technology company, in collaboration with local residents, businesses, and organizations (Brooklyn Microgrid Project, 2023).

https://www.brooklyn.energy/press

The Brooklyn Microgrid, set in a five-square block area of Gowanus and Park Slope, is a network of solar panel owners whose energy sources are linked together, and while still connected to the main grid operated by ConEd, are able to operate independently as a single entity if power is lost. The network had 50 participants as of March 2016, and by 2020, the number reached 40 prosumers (an individual who both consumes and produces), or solar panel owners, and 200 consumers (Ibid).

**Average time to repair a fault in a traditional grid system compared to a smart grid system:**

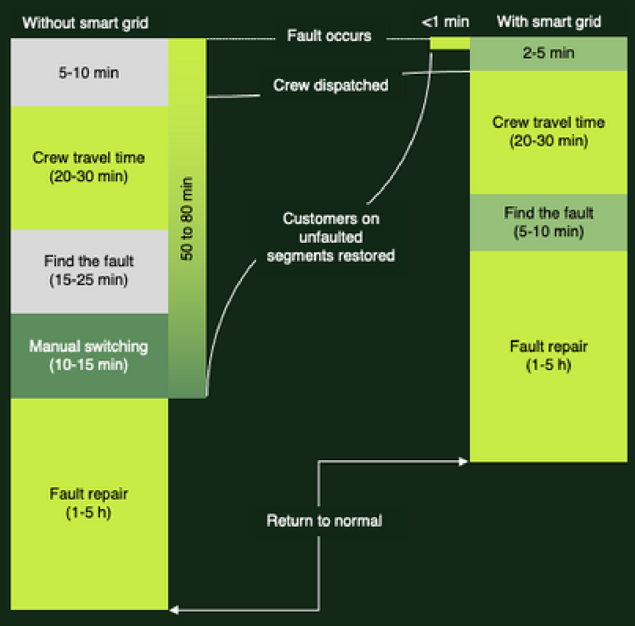


**Figure 3**. Source: Hossain, 2021

## THE TECHNOLOGY OF SMART MICROGRIDS

In order to understand if this is the best solution, we need to understand the technology behind smart microgrids. Smart grid technology leverages data analytics on energy consumption patterns so that supplied energy is optimized to meet the energy needs of users. Traditional centralized energy generation distributes energy in a stream and has little capacity to redirect the flow of energy other than increasing or lessening the magnitude of the distributed power which is sent across the entirety of the grid (Marnay, 2006). Smart grids, by contrast, are able to employ machine learning techniques to the issue of inconsistent energy consumption patterns through harnessing the data from smart meters and are able to quickly react to natural disasters and their effects on blackouts. Smart meters are devices that are installed for energy users that report data on electricity consumption, voltages, and other relevant usage data which are reported back to the local utility/other grid system in order to train the machine learning used by a smart grid. These smart meters create, by virtue of the number of data points, a good model of power usage by training the AI on consumption patterns. This model enables smart grids to adapt the flow of energy such that outages are remedied and power cost and distribution are optimized.

These smart grid systems, as seen above in **Figure 3**, allow for speedy analyses of faults in the system, which prevents long-lasting blackouts for the consumers. Smart grid systems also engender a more informed consumer base and allow for lower energy prices for users given their capacity to benefit from real time energy pricing to ensure the lowest energy price. In an ideal society, we can also use the variable distribution of energy load across different time periods to better inform public education in energy consumption patterns such that energy consumption is done efficiently (Shahidehpour, 2023).

A key part of the science behind creating energy resilient communities is leveraging both the distributed and resource efficient microgrids with the machine learning techniques of smart grids to create networks of smart microgrids that supply energy locally when operating in isolation and more broadly to make up for deficits in energy generation elsewhere (**Figure 4**). Such a network of microgrids is less susceptible to anomalous weather conditions and distributes power more efficiently through local control systems to small numbers of users.

The creation of clusters of smart microgrids requires a number of things before being enacted. For each microgrid, a load study must be carried out to determine the energy usage needs of the community being served by each grid. Microgrids are not one size fits all and are highly location specific and so the size and distribution of energy for each grid is site dependent. Once the load is understood, in order to create a clean energy microgrid, we must survey the available resources for each locality. We can easily imagine that solar power would be effective in hotter climates, wind, and water in coastal areas, and geothermal energy in others—a thorough analysis of the availability of each renewable energy source and the cost required to harvest them is therefore needed for each generation site. Lastly, once the need and generative capacity are understood, we must distribute the energy to the users and allow for users and microgrids to send surplus energy back to the main distribution lines. This distribution, both to and from the main transmission lines, needs not only to meet the generation and storage needs of the areas serviced by each microgrid, but also have the capacity to redirect energy to other areas as they need it.

**Decentralized Energy Management System**

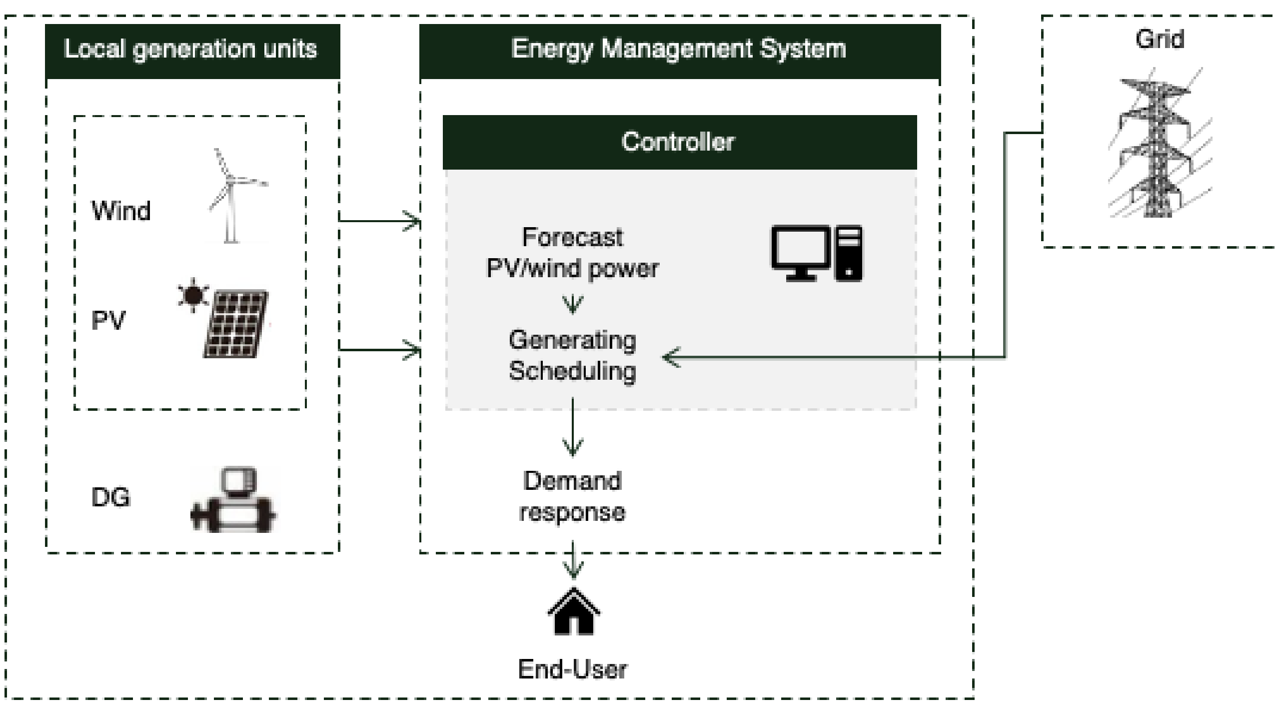


**Figure 4.** Source: Wynn, 2023

Given a system of clustered microgrids, the energy distribution system needs to be able to accept surplus energy from domestic and microgrid sources. Utilizing a smart grid methodology to determine when surpluses exist based on the user demand and the projected schedule of generation, as seen below in **Figure 5**, enables smaller scale energy producers to add to the macrogrid through automated switches and controlled distribution generation storage (KPMG, 2023). Such redistribution of surplus energy functions through bi-directional interchange meters which incorporate the point of change of equipment ownership that delineates the equipment owned by the macrogrid and by the smaller generator. The installation of these bidirectional interchange meters and any breaker panels is accomplished through cooperation with energy providers, who ensure safety standards are met and the installation is carried out effectively. An example of this prosumerism (selling energy back to the grid) using such equipment is the program in California protected under Rule 21, which establishes the standards for installing the interchange meters, testing domestic equipment usage, and setting the applicable fees (Hirsch, 2018).

**Integration of a solar energy generation system with an existing power distribution system**

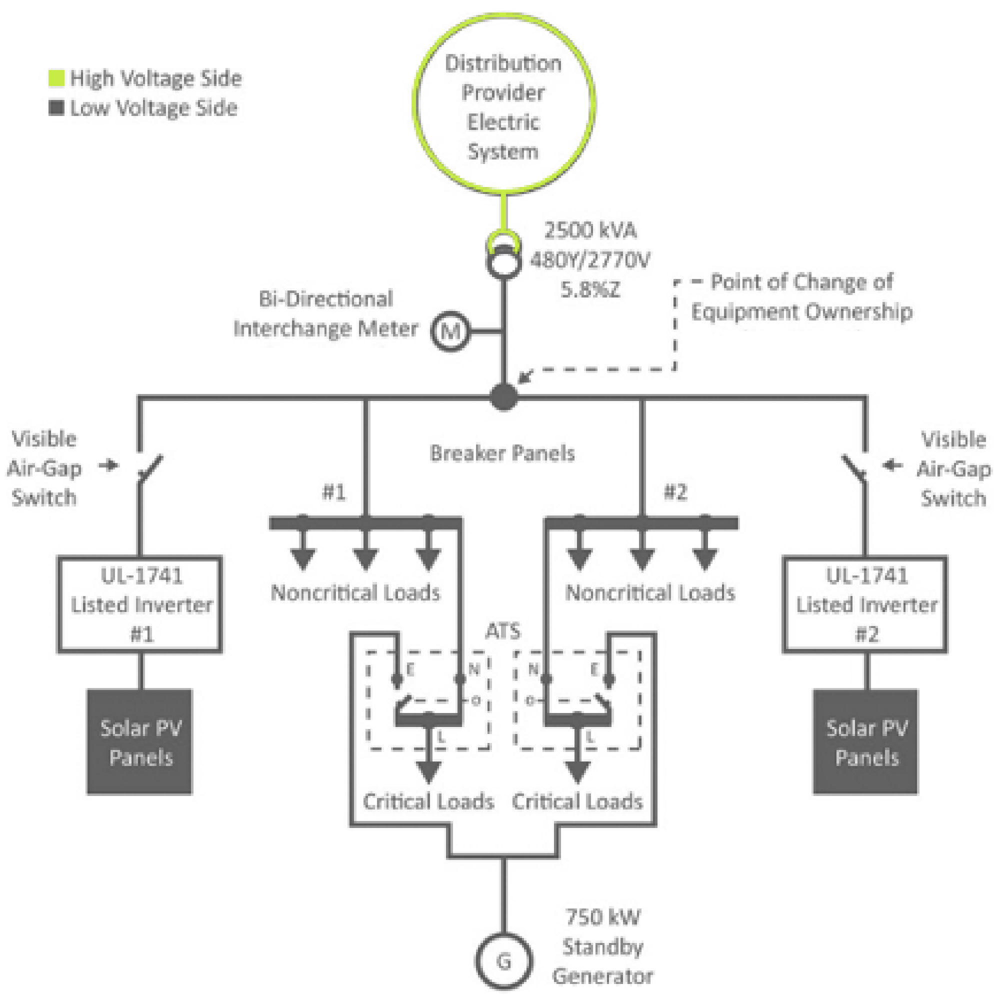


**Figure 5.** Source: NERC, 2017

## FEASIBILITY OF MICROGRIDS AS A SOLUTION

While microgrids offer several potential benefits, including increased resilience, reduced energy costs, and integration of renewable energy sources, assessing the feasibility of microgrids almost always shows a dichotomy of benefitting and blocking factors:

**Scale vs. efficient distribution:** Microgrids are designed to serve a localized area, which can limit their capacity and scalability. Interconnecting with the larger grid can pose technical and regulatory challenges. However, the biggest benefit of microgrids is that they can both be connected to the larger grid and be islanded in the case of a disaster. Additionally, the energy gets produced locally, close to where the energy will be consumed in the end. This solves a lot of the inefficiencies of the macrogrid, which derive from the large distribution network.

**Availability of energy resources vs. clean energy:** The availability of renewable energy resources like solar, wind, or hydropower plays a crucial role in the feasibility of microgrids. The cost-effectiveness and reliability of these resources influence the overall economic viability of the microgrid. A site specific analysis is necessary; some locations will benefit from wind energy while others from solar panels. On the other hand, clean energy microgrids will supply communities with the needed green energy for the net-zero transition (Walton, 2023).

**Technological complexity vs. technological advantage:** The deployment of microgrids requires an advanced technological infrastructure, including smart meters, energy management systems, and communication networks. The availability and affordability of these technologies are essential considerations for the feasibility of microgrids. Microgrids require careful planning, design, and integration of various components, such as renewable energy sources, energy storage, and grid control mechanisms that might not be available for some environmental justice communities. Ensuring proper system operation and addressing technical issues can be challenging. However, all these challenging technologies also provide the inherent benefits of clean energy microgrids. Microgrids are data driven and can be controlled by a smart system which allows for more efficiency and reliability (C2ES, n.d., VECKTA, 2021; NREL 2018).

**Economic viability now vs. in the future:** The financial aspects of microgrids, including upfront costs, ongoing maintenance, and revenue streams, need to be carefully evaluated. Factors like energy prices, potential revenue from energy trading, and payback periods affect the economic feasibility of microgrid projects. These costs may pose financial barriers, particularly for smaller communities or projects with limited resources. Although, the cost in the short term can be higher than supplying energy from the macrogrid, projections are that the cost will be significantly lower in the future (NREL, 2018; VECTKA, 2021).

**Community concerns vs. community engagement:** Successful microgrids often require active community participation and support. Building awareness, fostering collaboration, and addressing any potential barriers or concerns within the community can contribute to the feasibility of microgrids. However, this can also lead to potential roadblocks in cases where the community's concerns aren't well addressed and considered.

## FEASIBILITY OF MICROGRIDS AS A SOLUTION

Given a wide array of technologies to convert renewable energy sources to the electricity needed to power our homes, the clean energy microgrid is well-positioned to make use of hybrid approaches to energy generation to ensure minimal depletion of natural resources. Taking the dual usage of solar and wind energy as an example, when combined with modern energy storage technologies like fuel cells and pumped hydrogen storage, we can create a system that meets the energy consumption needs of smaller distribution networks using naturally occurring energy sources (Al-Ghussain, 2020).

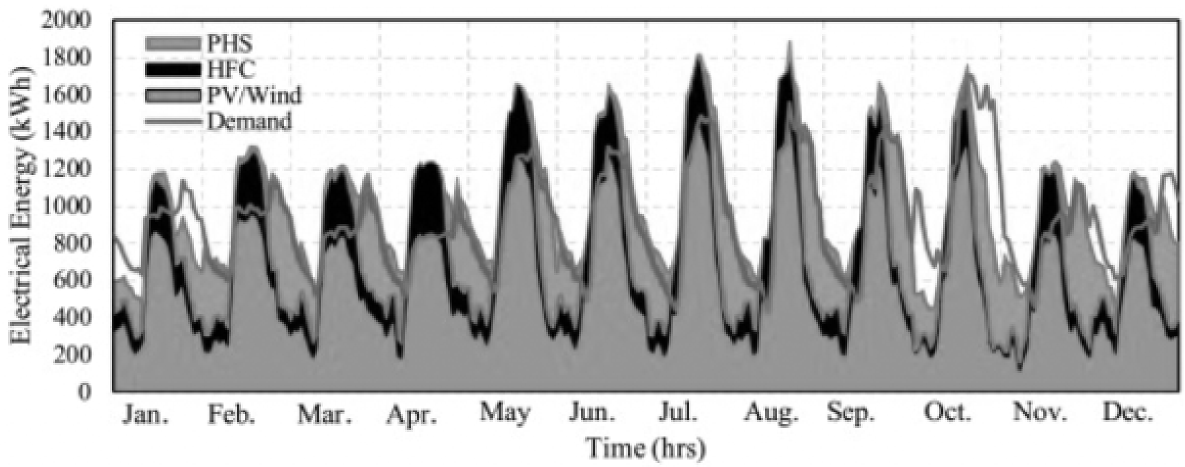


**Figure 6.** Source: Al-Ghussain, 2020

**The average hourly energy consumption needs met by an optimized construction of hybrid solar (PV)/wind generation sources using hydrogen fuel cells (HFC)/pumped hydrogen storage (PHS) to make up for nighttime deficits in energy generation**

From the Cypriot study pictured above in **Figure 6**, we can see that, through an annual load analysis and solar/wind availability model, electricity demands were met by entirely renewable sources working in tandem with energy storage. According to this study, it is possible to effectively engineer renewable energy source-generated grid systems through leveraging the maximum available output of renewable energy sources and new energy storage technologies to meet energy consumption needs. Such a model suggests that, following the investment required to create such hybrid energy generation structures, we can revolutionize the currently antiquated centralized, fossil fuel-dependent energy generation system with clean, low-cost energy generation sources that are optimized for the renewable energy resources available in each geographic region.

## SKEPTICISM TOWARDS MICROGRIDS

As with any innovation, the integration of multiple decentralized energy sources into the current power generation infrastructure has received some skepticism. There have not yet been any widespread implementations of integrated microgrids into the current system, meaning we don't yet have all the answers. Some have argued that decentralization will threaten the safety and reliability of the power generation system (Wu, 2022). However, examples of successful case studies such at the microgrid in Brooklyn, show this is possible. As we continue to fund and increase the demand for green technology, we will see improvements in technology, recycling, and infrastructure. This will mean clean energy microgrids become more green and more reliable over time.

Additionally, there are critics who assert that the use of smart grid technologies that rely on data fed by smart meters from across the nation pose privacy issues for energy consumers (Cornell, 2020). However, the decentralized nature of microgrids and the ability to island them means microgrids are far more resilient to cybersecurity attacks than the regular grid. Lastly, there is the issue of enabling the distribution of energy generated by microgrids, clustered or otherwise. Given that most of the nation’s energy transmission lines are owned by private companies, individuals cannot sell or share the energy generated by their microgrids (Shahidehpour, 2023). We therefore need policy to incentivize private infrastructure owners to allow the community to use these lines.

# MEASURING SUCCESS

## 1) GHG EMISSIONS FROM MICROGRIDS

The first metric we can use to measure the success of this bill is to measure a reduction in GHG emissions and other pollutants as a result of clean energy microgrid usage. In a given microgrid location, we will first need to measure GHG emissions without the microgrid. Then, we will need to measure GHG emissions after the microgrid is installed. Based on **Figure 7**, for companies in the Electric Utilities sector, GHG emissions from fossil fuel power generation (49.7% of the total), use of sold goods (19.9% of the total), and fuel-and-energy-related activities (18.9%) are the three most significant sources, accounting for 88.6% of total sectoral emissions according to Carbon Disclosure Project estimates (2023). Among them, we identified that GHG emissions from fossil fuel power generation and fuel-and-energy-related activities are the two key sources of emissions for microgrids.

To measure GHG emissions from microgrids, grid operators can follow established global standards, such as the Carbon Disclosure Project and the Greenhouse Gas Protocol. In addition, microgrid operators can also set GHG emission reduction targets by referring to global standards such as Science-Based Initiatives.

**Emission Categories as % of Total Emissions – Electric Utilities Sector**

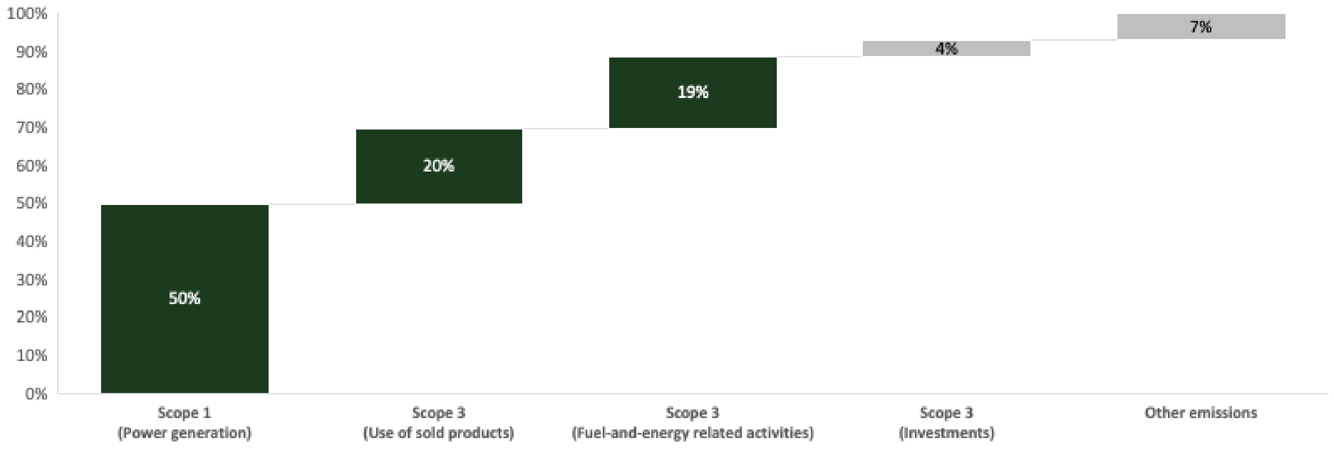


**Figure 7.** Source: CDP, 2023



## 2) THE EFFICIENCY OF MICROGRIDS

Second, in order for a microgrid project to be successful, it must be efficient. Efficient microgrids can integrate renewable energy sources, store excess energy for later, and generate electricity locally to increase energy efficiency and cost savings. We can measure the efficiency of microgrids by measuring heat rate and/or affordability:

- **Heat rate:** The amount of energy used by an electrical generator/power plant to generate one kilowatt-hour (kWh) of electricity. The US Energy Information Administration (EIA) expresses heat rates in British thermal units (Btu) per net kWh generated.
- **Affordability:** Another way to measure efficiency is the electricity price per unit for end users. This can measure cost reduction from microgrids and helps to determine if electricity is less expensive than before the implementation of microgrids.

## 3) THE RESILIENCE OF MICROGRIDS

Finally, we need to measure for resilience. Resilient microgrids can prevent, plan for, minimize, adapt to, and recover from anticipated and unanticipated energy disruptions to ensure energy availability and reliability sufficient to provide for mission assurance and readiness, including mission essential operations related to readiness, and to execute or rapidly establish mission essential requirements. We can measure the reliability and resilience of microgrids through:

- **Availability**: The availability factor of a power plant is the amount of time that it is able to produce electricity over a certain period, divided by the amount of time in the period. This parameter helps analyze the demand vs. supply gap.
- **Quality**: The quality of a microgrid is determined by its ability to meet the established regulatory standards for the electricity it generates. These standards can differ based on the specific regulations of each state and locality. Commonly considered factors encompass voltage levels, frequency consistency, harmonics, and the overall stability of the system.
- **Reliability**: This is intended to measure the number of interruptions, and its duration, as well as the total number of end users affected. Specific metrics include System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI), and Customer Average Interruption Duration Index (CAIDI).
- **Flexibility**: This metric often measures time to respond and cater to sudden changes in power requirements which are set by regulators.

# CONCLUSION

Extreme weather events are becoming more frequent and more severe. The current outdated and inefficient grid system cannot handle increased loads when there is excessive demand for heating or cooling, leaving communities without power when they need it the most. This is leading to soaring utility bills, and in extreme cases, deaths amongst the most vulnerable communities.

Locally located clean energy smart microgrids could be the perfect solution. With the ability to connect to the centralized grid, and disconnect when there is a disaster, these grids are highly resilient and efficient. H.R. 891 provides funding to make this idea a widespread reality across the United States with priority given to environmental justice communities.

We have seen that there are questions around the cost, technological capabilities, and scalability of microgrids. However, as the demand for this solution grows, its technology will improve and become more affordable. Additionally installation and maintenance costs will go down. We also raised questions on the GHG emissions of green energy compared to fossil fuels. It is true that green energy is not yet completely sustainable, however it has been found to produce only 5% the emissions of coal (Tierney & Bird, 2020).

H.R. 891 is a necessary step in tackling climate change and protecting the communities that are most vulnerable to it. In order to achieve success, the microgrid projects implemented as part of this fund must reduce GHG emissions and increase efficiency and resilience of the grid. Additionally, microgrids must work in unison with the centralized grid in order to achieve maximum efficiency.

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