



NC SUSTAINABLE  
ENERGY ASSOCIATION

1978-2023 |

**45 Years**

# Perceptions, Experience, and Adoption of Residential Clean Energy in North Carolina

A Report by the NC Sustainable Energy Association

**Winter 2023/2024**

Authors: Malcolm Gregory, Jerry Carey, Hannah Budds, Daniel Pate, Laura Langham, John Argentati



# CONTENTS

---

|                               |    |
|-------------------------------|----|
| <b>Introduction</b>           | 3  |
| Overview                      | 3  |
| Background                    | 4  |
| High-Level Findings           | 5  |
| <b>Methodology</b>            | 5  |
| Survey Population             | 5  |
| Survey Design                 | 6  |
| Survey Facilitation           | 6  |
| Limitations                   | 6  |
| <b>Results</b>                | 7  |
| Economics of Adoption         | 7  |
| Solar Photovoltaics           | 7  |
| Energy Storage                | 11 |
| Electric Vehicles             | 11 |
| Solar Thermal                 | 14 |
| Geothermal                    | 15 |
| Solar PV Adopter Demographics | 17 |
| <b>Conclusion</b>             | 20 |
| Areas for Further Research    | 20 |
| <b>Appendix</b>               | 22 |
| <b>Resources</b>              | 45 |

## Introduction

### *Overview*

The North Carolina Sustainable Energy Association (NCSEA) is a 501(c)(3) non-profit organization driving public policy and market development for clean energy in the state of North Carolina (NC). This work enables the expansion of clean energy jobs, economic opportunities, and affordable energy options for all North Carolinians. NCSEA approaches these efforts with comprehensive, evidence-based research and analysis.

In 2022, the organization administered the third iteration of its Sustainable Energy Survey. This survey aimed to capture in detail the motivations and dynamics of clean energy adoption across the state. In particular, the survey asked residents about solar, energy storage, electric vehicles, solar thermal, and geothermal ground source heat pumps. Additionally, a new set of demographic questions was included in the 2022 survey to gain a better understanding of the current population of clean energy adopters and identify barriers to clean energy adoption that impede low-income communities and communities of color from purchasing clean energy technologies at similar rates to other NC residents.

The data presented in this report will provide NCSEA and other key stakeholders with valuable insights into issues of accessibility. The findings and analysis housed in this report are essential to understanding the status, trajectory, and implications of residential clean energy adoption in NC. NCSEA thanks our partner Generation180 for its assistance in reviewing this report.

Examples of use cases for the analysis provided in this report include, but are not limited to:

- **Identify Barriers:** Pinpoint key obstacles to clean energy adoption for low-income communities and communities of color, enabling targeted solutions.
- **Guide Policy Formulation:** Inform policymakers to create effective policies and regulations for clean energy expansion in NC.
- **Advocacy and Mobilization:** Mobilize public support for clean energy initiatives using evidence-based insights from the report.
- **Inform Business Strategies:** Help companies tailor products and services to meet clean energy adopters' preferences.
- **Support Research and Funding Applications:** Strengthen funding proposals and research initiatives with the report's evidence-based findings.
- **Benchmark Progress:** Track clean energy adoption trends as a benchmark for assessing progress and targeting improvement areas.



## *Background: North Carolina's Clean Energy Landscape*

The growth of the clean energy industry has yielded a robust effect on the state's economy. According to the [\*Economic Analysis of Clean Energy Development in North Carolina: 2023 Update\*](#) report carried out by RTI International in partnership with NCSEA, NC has experienced:

- A cumulative economic impact of renewable energy and energy efficiency projects in the state of over \$59 billion from 2007 to 2022
- A total of 303,726 cumulative full-time job years (cumulative job years refer to the number of jobs added up over a given set of years) since 2007
- Over \$100 million in clean energy investment in more than 50 North Carolina counties

These numbers illustrate the efforts that have gone into making NC the fourth-largest state in terms of installed solar photovoltaic (PV) capacity.<sup>1</sup> Specifically, the state now has over 8,000 megawatts (MW) of installed solar, which is the equivalent of powering over 900,000 homes.<sup>2</sup>

Although utility-scale solar systems account for the greatest share of solar power generation in the state, there has been a rapid increase in the rate of residential solar adoption during the past several years. Utility-scale solar refers to large solar power installations, typically 1MW or greater, designed to generate electricity for the grid and serve multiple types of consumers. This is in contrast to smaller solar systems that are more commonly used for residential or commercial purposes. In 2021, a total of 7,195 residential solar systems, with a combined installed capacity of 56.3MW, were installed in NC. During this same period, 41 utility-scale projects with a total installed capacity of 647MW were brought online. Accelerated rates of adoption at the residential level signify distinct bipartisan support for solar energy. Recent polling data confirms that clean energy maintains widespread acceptance across NC's political spectrum, with liberals, moderates, and conservatives all voicing majority support for clean energy.<sup>3</sup> Widespread consumer-level interest and investment in clean energy presents a pivotal opportunity to continue scaling up residential solar generation.

Other clean energy technologies including energy storage, electric vehicles, and geothermal ground source heat pumps are also experiencing notable rates of adoption. These consumer dynamics make understanding the perceptions and experiences of clean energy adopters vital to planning and shaping NC's energy future.

Despite the robust market penetration of these key clean energy technologies, there are significant disparities among the state's population in terms of clean energy adoption rates. In this context, the report outlines the 2022 survey's demographic findings and analyzes the different social and economic characteristics that currently define clean energy adoption patterns within NC. This demographic analysis offers granular insight into the inequity of the current energy system and strategic pathways for future education, policies, and programs that aim to advance energy equity and expand market access to clean energy for all North

Carolínians. Ultimately, the goal of this analysis is to inform and empower all North Carolínians to adopt clean energy.

## High-Level Survey Findings

- *Across all clean energy system types, the majority of respondents reported reductions in their monthly utility bills.*
- *Since 2015, estimated payback periods for clean energy technologies have not significantly changed.*
- *Tax credits and other rebates or incentives are the most important financial options for consumers.*
- *Concern over utility bills and the environment are leading motivations for clean energy adoption.*
- *Solar adopter incomes are still generally higher than the median NC household income. However, the groups experiencing the greatest increases in adoption rates since 2015 are on the lower end of the income distribution.*
- *The square footage of residential solar homes has been moderately declining.*
- *North Carolina's urban counties comprise a majority share of solar adoption.*

## Methodology

### Survey Population

The target population for the 2022 Sustainable Energy Survey was NC residents who have installed any type of clean energy system, including solar, energy storage, electric vehicles, solar thermal, and geothermal ground source heat pumps. Respondents were identified through NCSEA's Renewable Energy Database (REDB) which contains extracted data from North Carolina Utility Commission (NCUC) project registrations. For over a decade, NCSEA has been diligently collecting data on proposed and installed renewable energy systems, encompassing a wide range of project types including solar PV, biomass, wind, and hydroelectric systems. Currently, the REDB houses a comprehensive repository of approximately 40,000 such systems, providing valuable insights about project type, status, system specifications, and general operations. Specifically, the team sent the survey to all North Carolina clean energy customers with email information (33,021 customers) that had been extracted from project registrations within our database over time.

## *Survey Design*

A universal survey design was utilized for all participants (see the Appendix for the full set of survey questions). The survey questionnaire consisted of both closed- and open-ended questions, with the initial inquiry requesting the respondent to identify which clean energy technology/ies they have adopted. Using skip logic, the survey then directed each participant to answer follow-up questions for each technology they have adopted. The five types of clean energy systems included in the questionnaire were:

| Type of Clean Energy Technology Adopted    | Number of Respondents |
|--------------------------------------------|-----------------------|
| Solar photovoltaics (PV)                   | 3,899                 |
| Electric vehicles (EVs)                    | 764                   |
| Energy storage                             | 539                   |
| Solar thermal                              | 94                    |
| Geothermal ground source heat pumps (GSHP) | 85                    |

Following these conditional sections, all respondents were asked to answer questions regarding COVID-19 pandemic impacts, demographic characteristics, and a final comments section. In total, the 2022 survey consisted of 85 questions. Past iterations of the survey conducted in 2012 and 2017 served as useful testing mechanisms which enabled NCSEA to refine and improve the 2022 survey validity.

## *Survey Facilitation*

The survey was distributed via email invitations using Microsoft Dynamics 365 Customer Voice. The inaugural mailing was sent on 10/21/2022, with three follow-up email waves delivered on 11/1/2022, 11/9/2022, and 11/15/2023. An email verification platform was utilized to validate all email addresses extracted from the REDB and the aggregate mailing list was divided into randomized clusters which allowed NCSEA staff to monitor the survey's progress. To incentivize survey completion, NCSEA randomly selected 20 survey respondents to receive \$50 Amazon gift cards. In total, the survey was electronically delivered to 33,021 clean energy customers, and on average it took respondents nine minutes to complete. After 14 weeks, 4,196 responses were received with a response rate of approximately 12.7% and representation from 90 of NC's 100 counties.

## *Limitations*

While efforts were made to select the broadest possible sample using the REDB, there may still be some sampling bias due to self-selection and the online nature of the survey. Additionally, participants' subjectivity, attitudes towards social and environmental desirability, or other factors may have produced instances of response bias. In the context of this survey, respondents may have overstated their satisfaction and support for their clean energy systems

to align with social expectations or appear more environmentally conscious. However, as in all projects dealing with clean energy consumer data, NCSEA took systematic care in ensuring resident anonymity and confidentiality of responses. These steps may have reduced the magnitude of bias embedded within the survey's results.

## Results

### *Economics of Adoption*

#### *Solar Photovoltaics (PV)*

Over 70% of all survey respondents chose to adopt solar photovoltaic systems, establishing it as the predominant clean energy technology adopted by NC residents who took the survey. Over 80% of those surveyed reported a decrease in their monthly utility bills, with almost two-thirds of those seeing a decline of over 30% in their electricity costs (see Figure 1). These findings indicate that solar is regularly a cost-effective energy source for NC residents, offering potential savings when compared to conventional utility-sourced electricity.

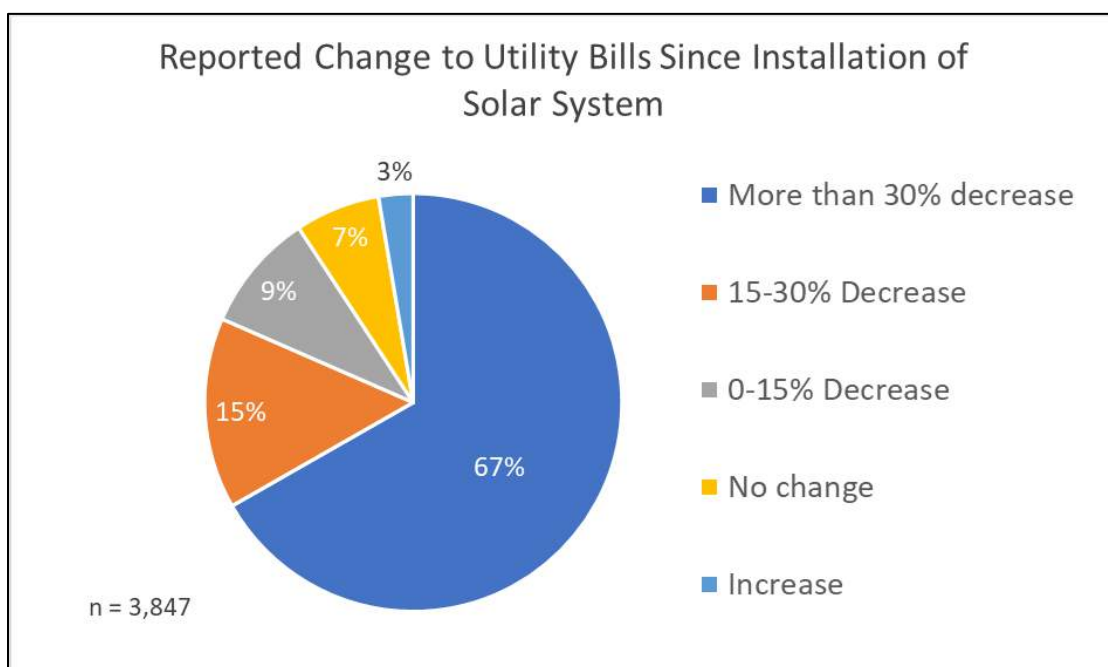


Figure 1: Reported Change to Utility Bills Since Installation of Solar System

Another important consideration for clean energy purchases is the payback period, or the time it takes for a clean energy system to recoup its initial investment. According to survey results, solar adopters have experienced a general trend towards longer payback periods, despite reporting lower monthly utility bills (see Figure 2). This could be partially attributable to the expiration of the state's renewable energy tax credit in 2015.

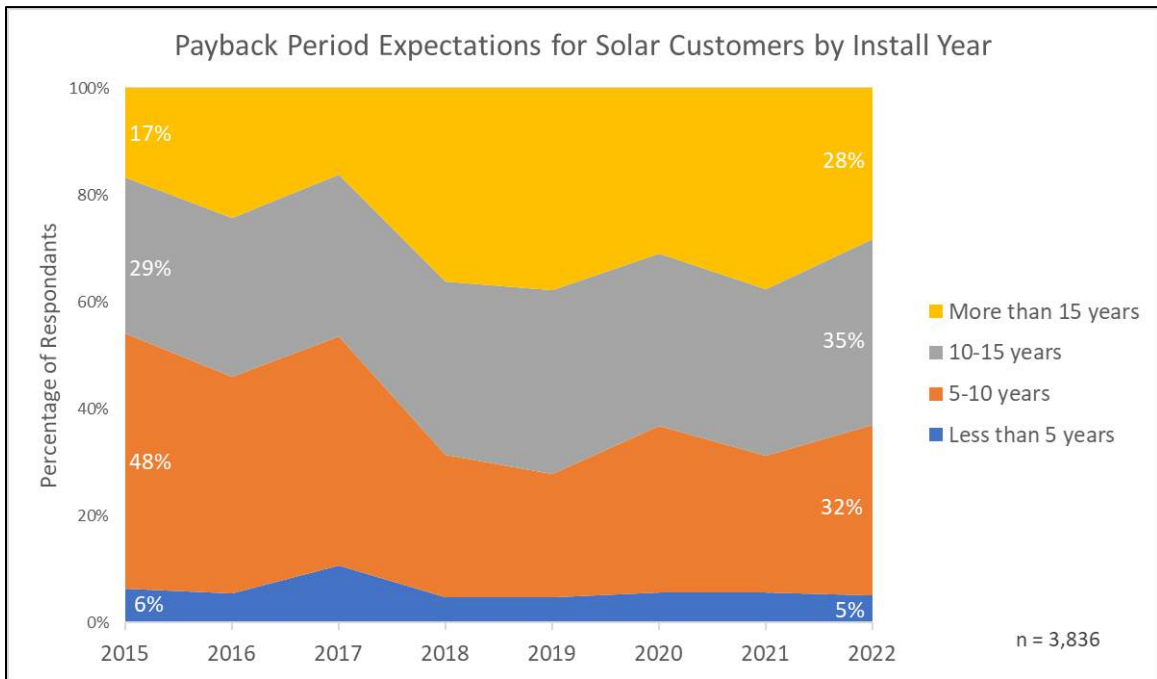


Figure 2: Payback Period Expectations for Solar Customers by System Install Year

Although anticipated payback periods have grown since 2015, over 66% of survey respondents do expect to recover their full investment within 15 years of installation. For many, a crucial element to realizing long-term savings is the availability of financing options that reduce the upfront cost of their solar systems. Figure 3 depicts seven such options, with the federal tax credit, rebates or incentives from utility providers, and loan or lease programs having the highest number of residents stating these factors were important.

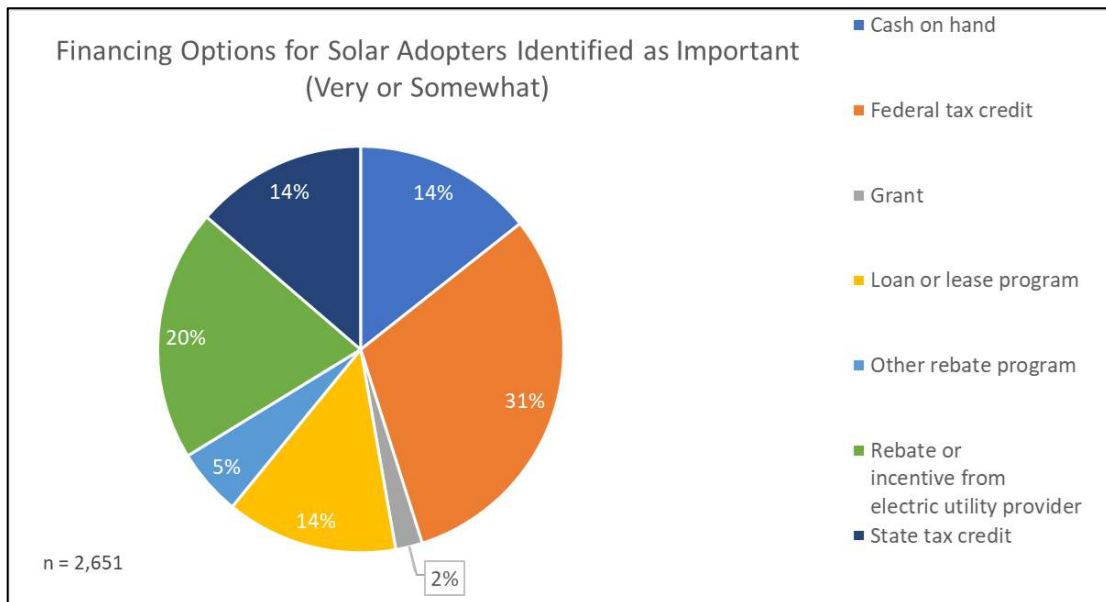


Figure 3: Importance of Financing Options for Solar Adopters



Before and during the process of solar system installation, many homeowners elect to consider energy efficiency upgrades. The installation of these related measures typically maximizes a solar system's efficiency and enhances the overall return on investment. Many survey respondents reported that they had taken this practical approach and implemented energy efficiency measures along with their solar systems. Figure 4 illustrates the distribution of specific measures, with smart thermostats, energy efficient lighting, and insulation being among the most popular.

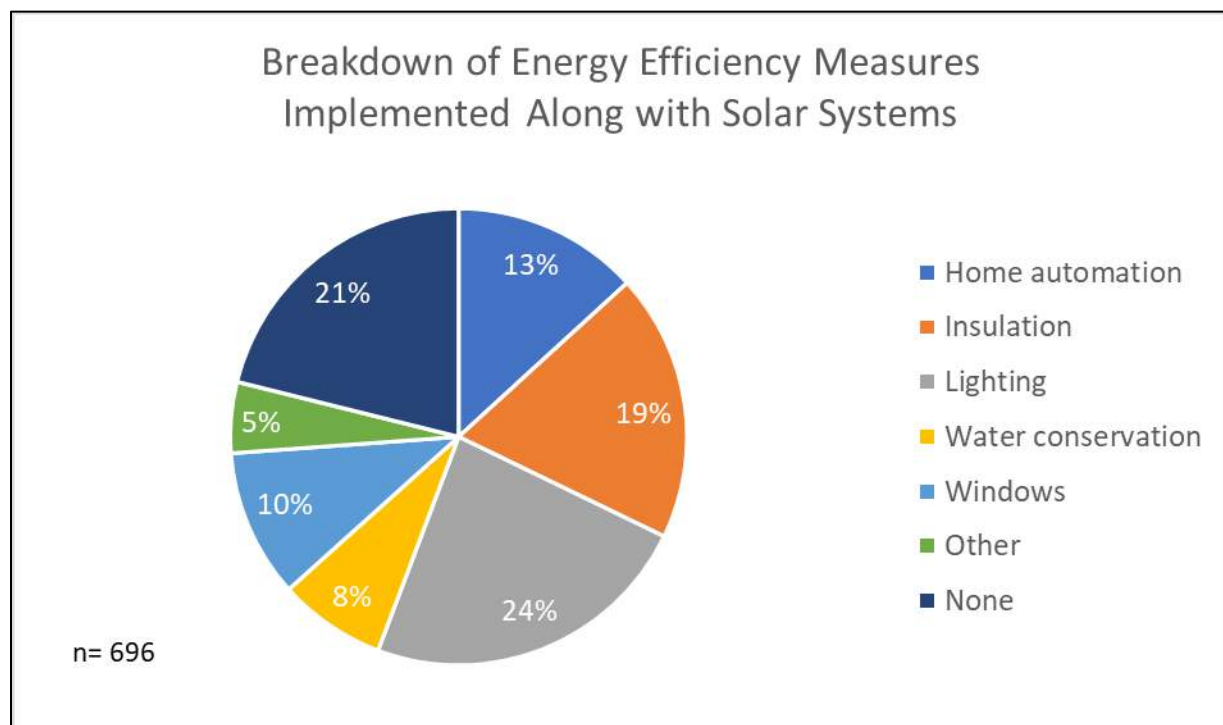


Figure 4: Breakdown of Energy Efficiency Measures Implemented Along with Solar Systems

Clean energy adoption can be motivated by an array of factors. Figure 5 demonstrates that current and future cost of electric bills, environmental concerns, and financial incentives were all top of mind for solar adopters who took the survey.

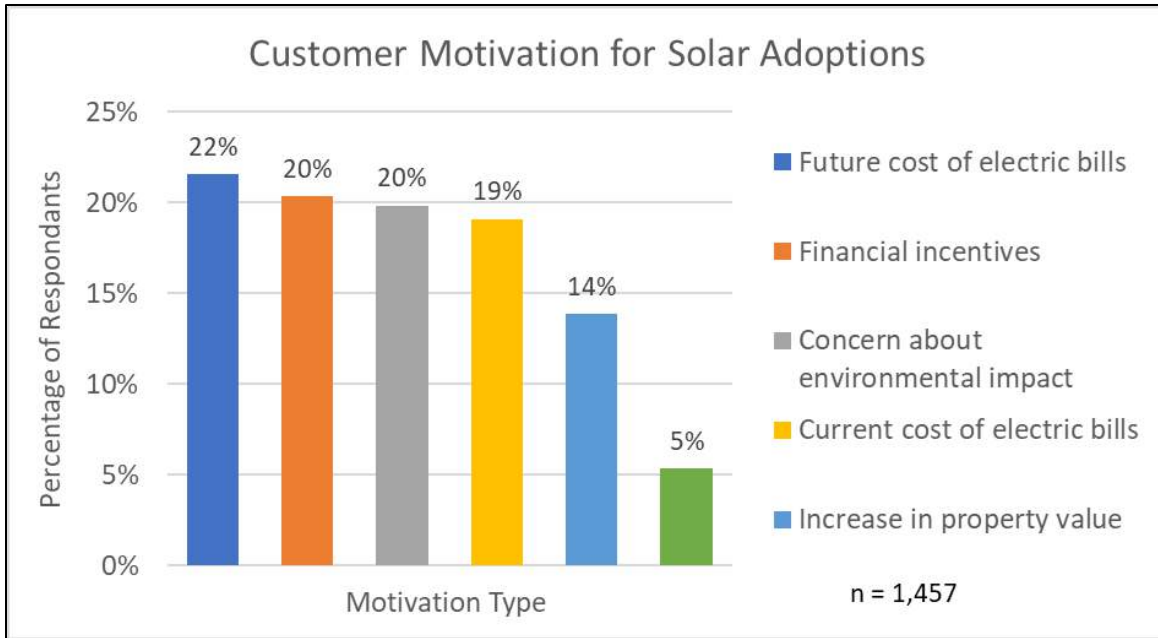


Figure 5: Customer Motivation for Solar Adoption

Gauging satisfaction across different aspects of the installation process is integral to understanding the health of the clean energy industry. This type of customer feedback provides valuable insights into technological reliability, efficiency, and overall performance. Survey results indicate that NC residents are generally satisfied with the process and performance of their clean energy systems (see Figure 6). System performance, installer company, and utility bill savings received the highest levels of satisfaction, while rebate or incentive programs, access to state tax credits, and installer support, monitoring, and maintenance received the lowest levels.

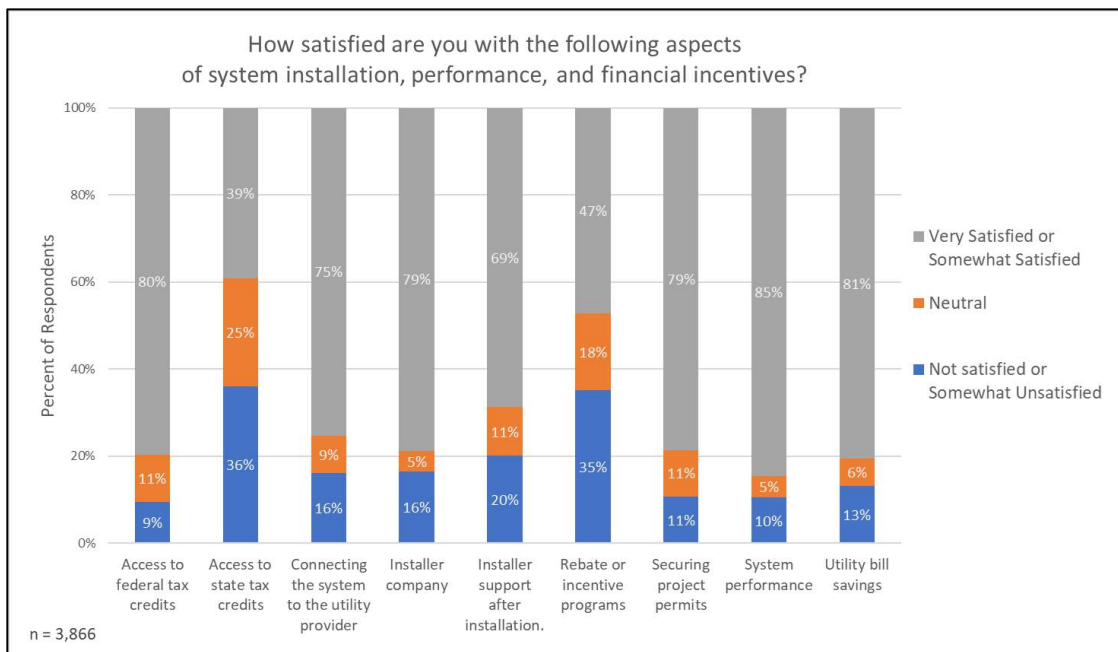


Figure 6: Satisfaction with Installation, Performance, and Financial Incentives

## Energy Storage

Home battery systems are experiencing widening popularity among homeowners. Nearly 10% of survey respondents reported owning an energy storage system, which is commonly installed alongside solar PV systems. Energy storage units permit their owners to further reduce their electric grid dependency and protect households from power outages. Figure 7 demonstrates that emergency backup electricity and peak energy load reduction are the predominant uses for energy storage technologies among survey respondents.

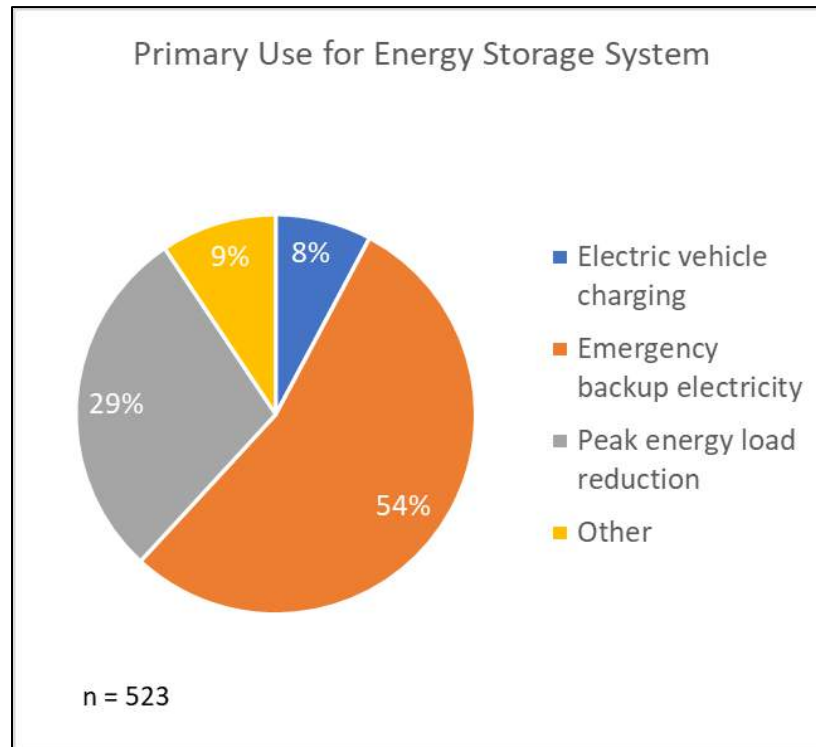


Figure 7: Primary Use for Energy Storage System

## Electric Vehicles

Electric vehicle (EV) adopters represented 18% of survey respondents, or 764 individuals. Respondents indicated that they owned or leased a wide variety of vehicle models, with popular options including the Tesla Model 3, Chevrolet Bolt, and Nissan Leaf. Figure 8 illustrates that urban areas have experienced the greatest market penetration of EVs, while rural areas have experienced the least.

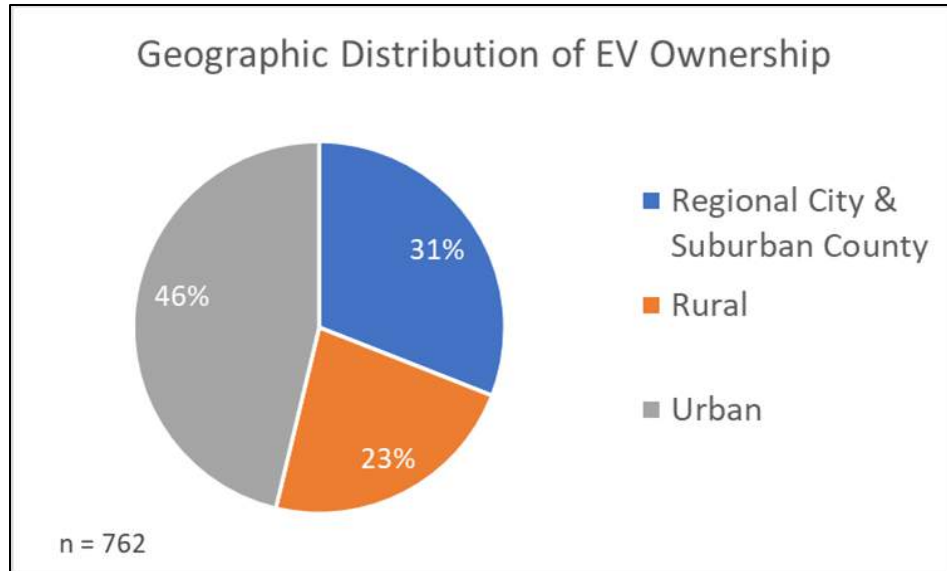


Figure 8: Geographic Distribution of Electric Vehicle Ownership

A near majority (46%) of EV adopters spent \$50,000 or less on their electric vehicle, and 39% of EV adopters spent between \$50,001-\$70,000.

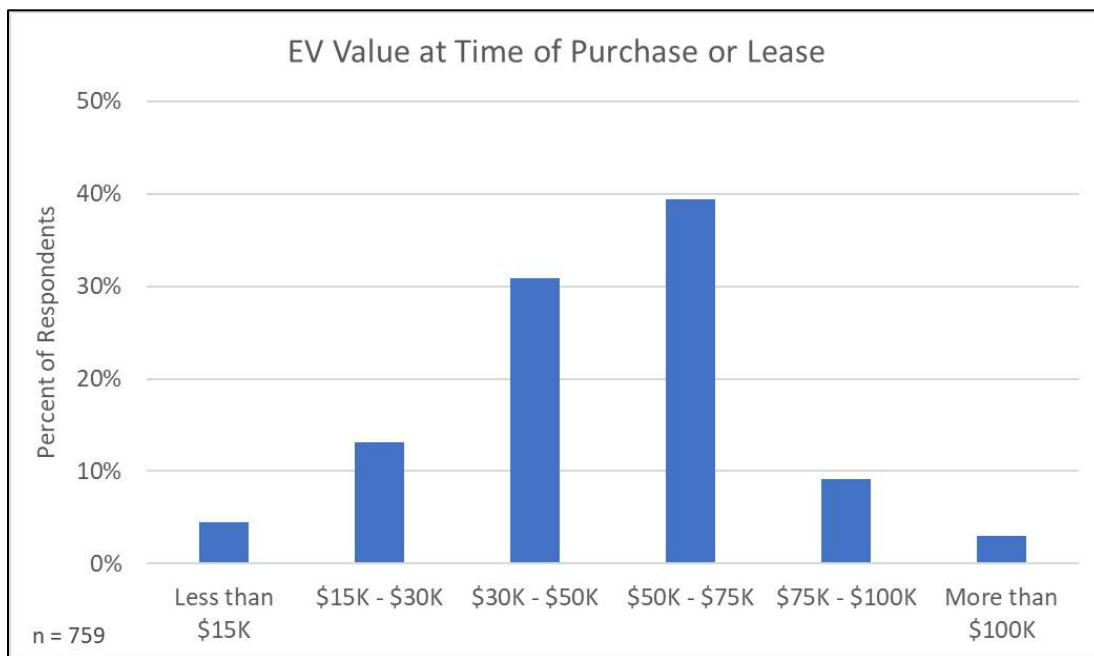


Figure 9: Electric Vehicle Value at Time of Purchase or Lease

Among the clean energy technologies surveyed, EV adoption was most concentrated among those reporting higher incomes. Figure 10 illustrates that over half of respondents claimed an annual household income of over \$120,000. This may be partly explained by the cost of EVs, which on average are more expensive than conventional internal combustion vehicles.<sup>4</sup> As depicted in Figure 8, nearly half of EV adopters reside in NC's urban areas, which are generally



outpacing the state's rural areas in terms of economic development and vehicle charging infrastructure.<sup>5</sup>

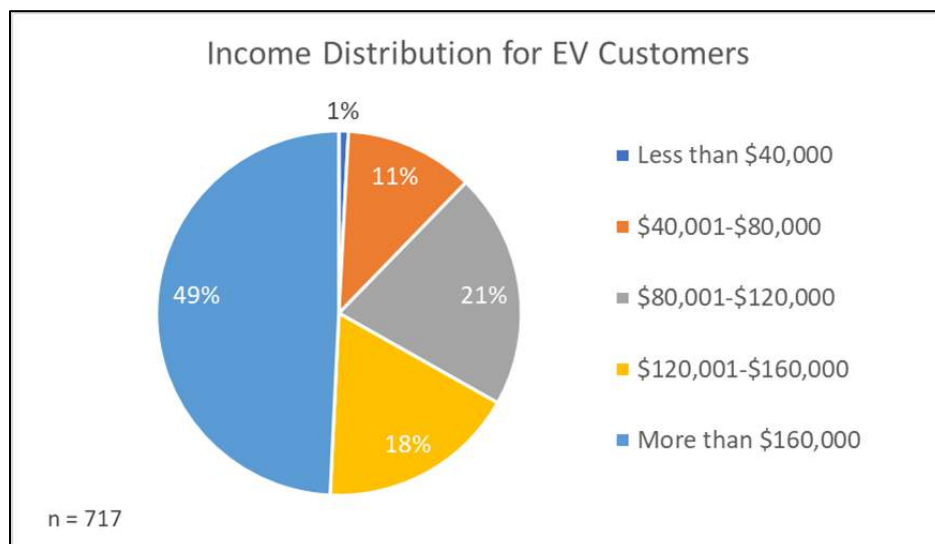


Figure 10: Income Distribution for Electric Vehicle Adopters

Despite this skew towards wealthier consumers, the cost of gas proved to be one of the most important factors when considering an EV purchase. Figure 11 demonstrates that three-quarters of respondents ranked this factor as important in their decision-making process.

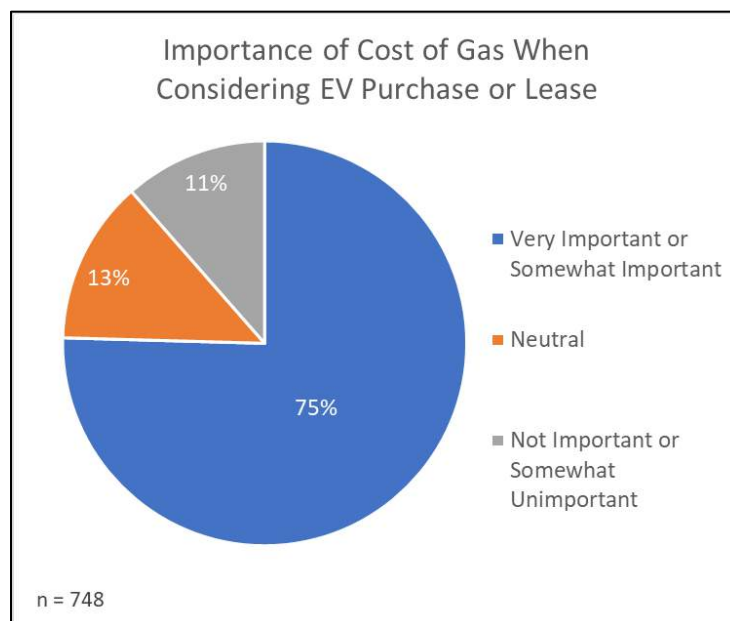


Figure 11: Importance of Gas Prices When Considering Electric Vehicle Purchase

Vehicle quality and performance and maintenance received the highest levels of satisfaction, while respondents were least satisfied with access to charging stations and federal tax credits

(see Figure 12). Overall, survey results indicate that NC residents are generally satisfied with their EV purchase or lease.

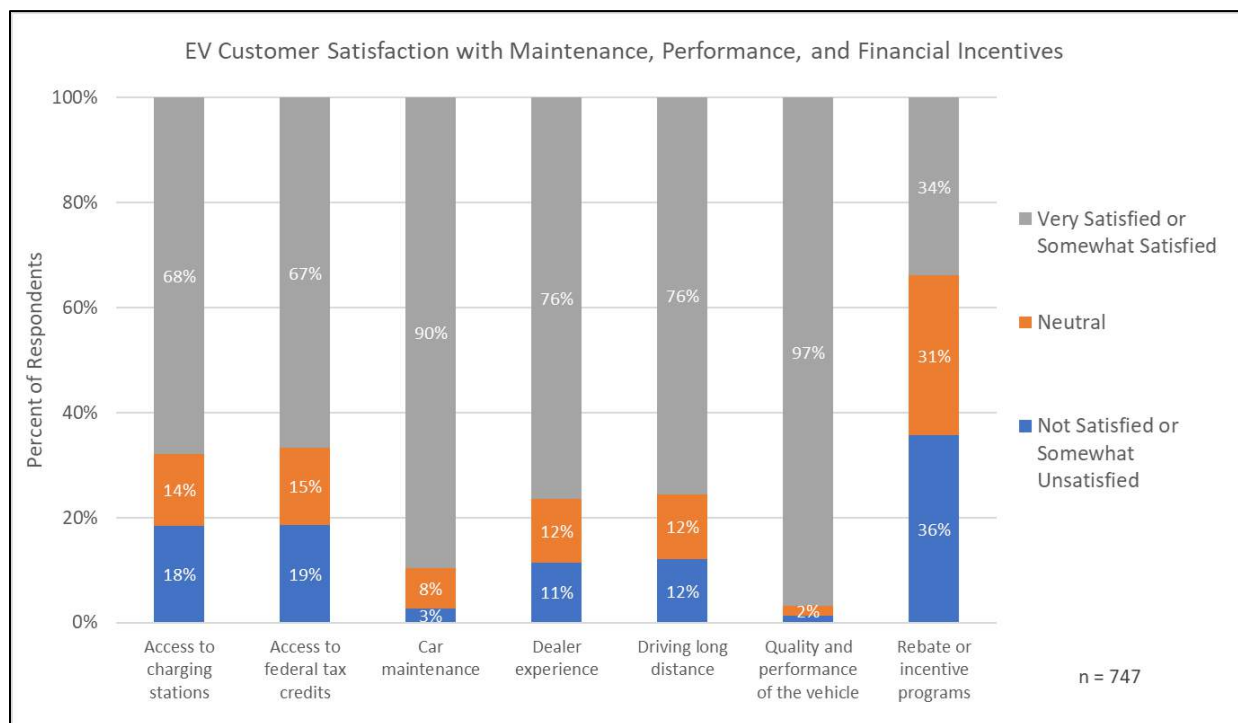


Figure 12: Satisfaction Levels Associated with Electric Vehicle Adoption

## Solar Thermal

Solar thermal systems harness the energy from sunlight to heat water. These systems convert solar radiation into thermal energy, which can be used for domestic hot water supply and space heating. Although solar thermal systems have a shorter lifespan and don't directly produce electricity, they typically require a smaller upfront investment than solar panels. Compared to approximately 30% of solar PV adopters, over 50% of solar thermal adopters expect to recoup their initial investment in 10 years or less (see Figure 13).

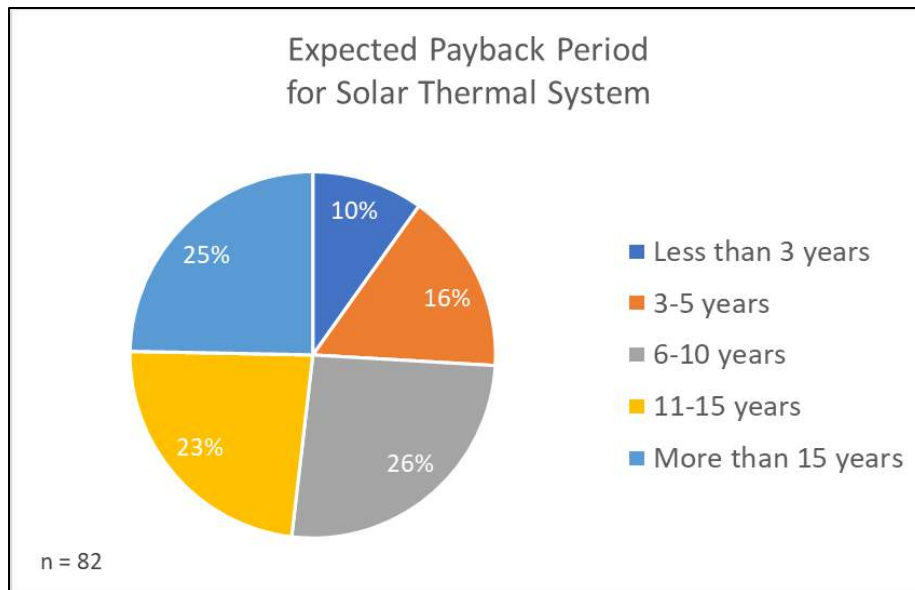


Figure 13: Expected Payback Period for Solar Thermal Systems

Over 60% of survey respondents that have adopted solar thermal reported a decrease in their utility bills. Of respondents reporting a decrease in their bills, over 40% estimated their cost savings at 20-30% (see Figure 14).

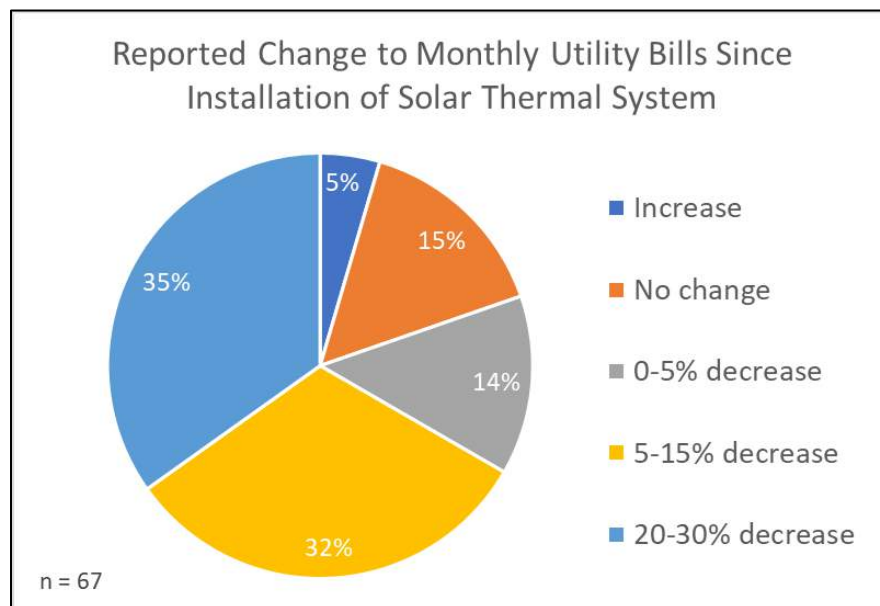


Figure 14: Reported Change to Monthly Utility Bills Since Installation of Solar Thermal System

### Geothermal Ground Source Heat Pumps (GSHPs)

Geothermal ground source heat pumps (GSHPs) are heating and cooling systems that utilize the stable temperature of the earth to provide efficient thermal comfort. These systems tap into the heat stored in the ground to heat buildings in the winter and extract heat from buildings to cool

them in the summer. Over 85% of those surveyed reported a decrease in their utility bills, and three-quarters of respondents who reported a decrease noted a decline of over 30% in their monthly costs (see Figure 15).

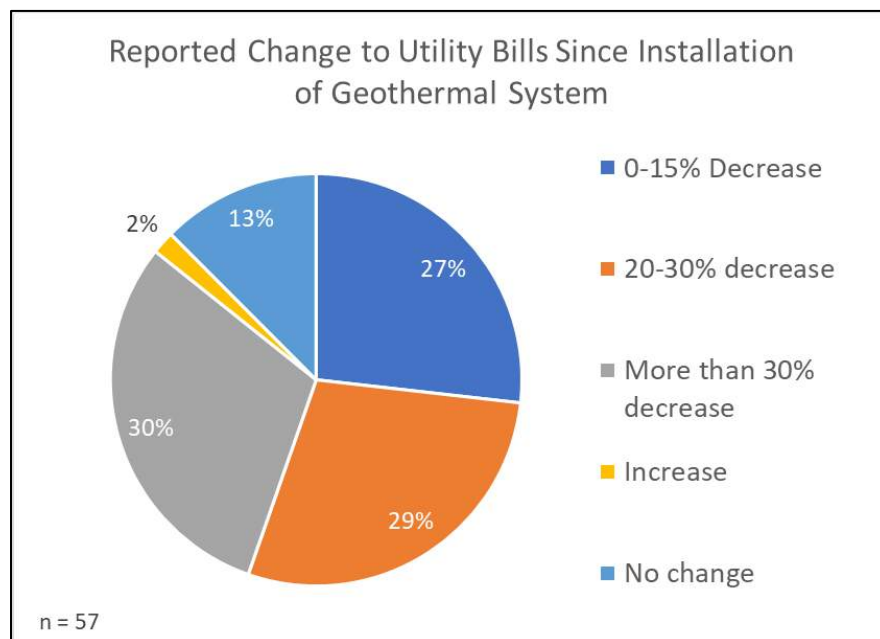


Figure 15: Reported Change to Utility Bills Since Installation of Geothermal System

The cost or initial investment of a GSHP depends on a variety of factors such as system type, equipment options, and site conditions. Generally, the cost of excavation and set-up makes GSHP more expensive than residential solar. However, according to survey results, 70% of respondents that have installed residential GSHP systems expect to fully recover their investment in 10 years or less (see Figure 16).

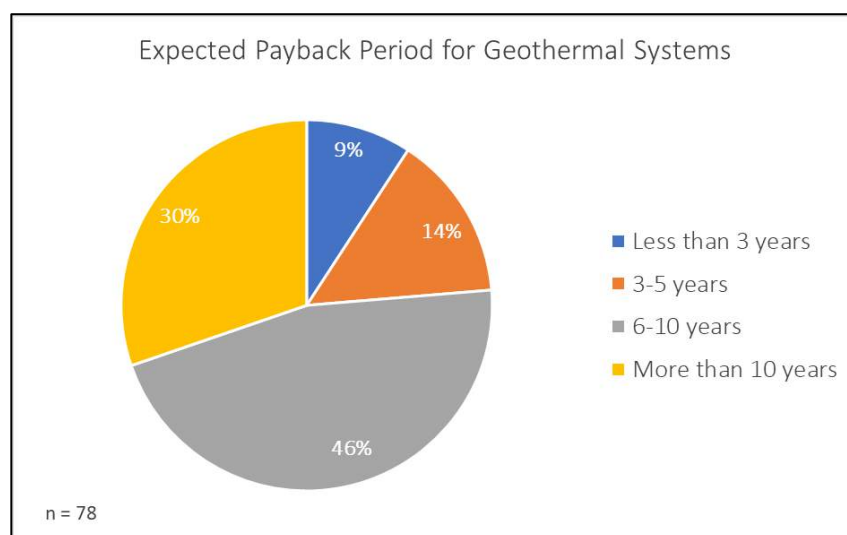


Figure 16: Expected Payback Period for Geothermal Systems



## Solar PV Adopter Demographics

Demographic data collected from survey responses identified a variety of noteworthy trends. Solar adopters in NC span all household (HH) income levels, from less than \$40,000 to more than \$160,000 (see Figure 17). A large fraction of these adopters are considered middle income, with nearly 50% of respondents reporting HH incomes between \$40,000 and \$120,000. Although solar adopter incomes are still generally higher than the median NC HH income, the groups experiencing the greatest increases in adoption rates since 2015 are on the lower end of the distribution.<sup>6</sup> Since 2015, the \$40,001 - \$80,000 bracket has witnessed a doubling in its proportion of state solar PV adoption rates, whereas the highest income classification (>\$160,000) has declined by almost half.

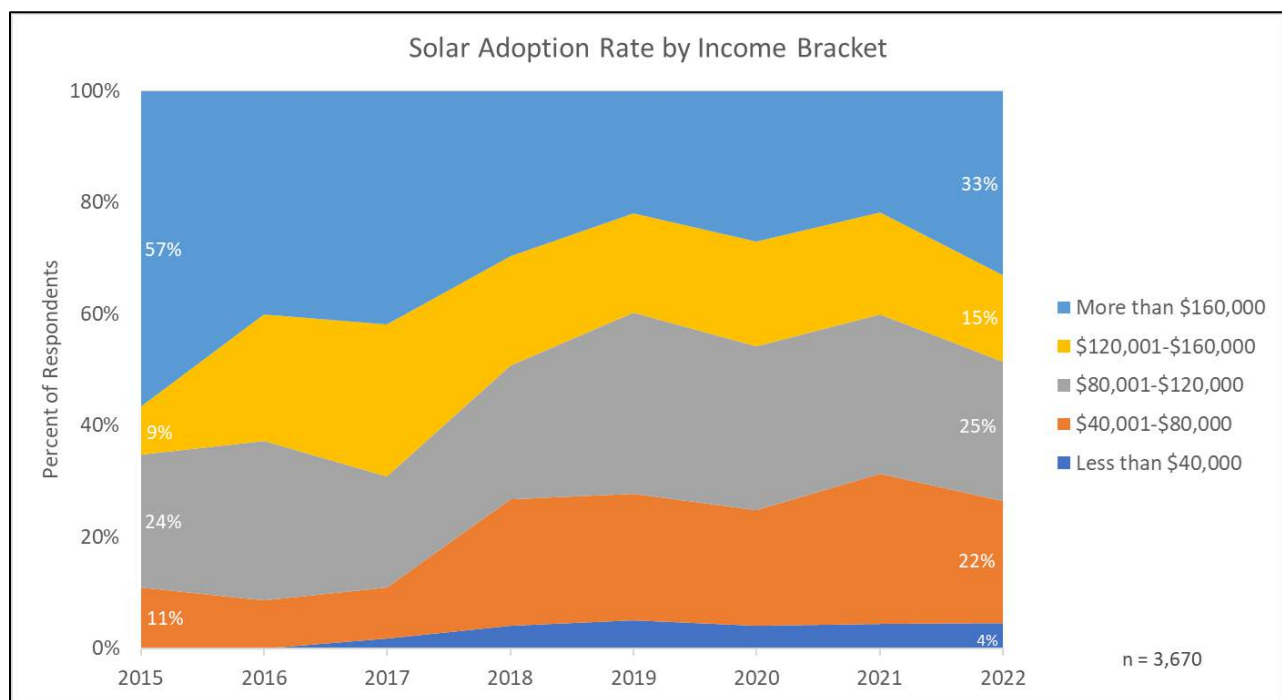


Figure 17: Solar Adoption Rate by Income Bracket

Similar to HH income, home size has changed drastically over the years with the largest homes witnessing a decline in their overall share of solar adoption. From 2015 to 2022, homes over 3,000 square feet (sq ft) with installed solar fell in representation from 40% to 23%. Figure 18 demonstrates that during this same period, smaller homes (1,000-2,000 sq ft) saw their proportion more than double. The majority of survey respondents reported home dimensions between 2,000-3,000 sq ft, placing the most reported home size for solar adopters in line with the NC average of 2,152 sq ft.<sup>7</sup>

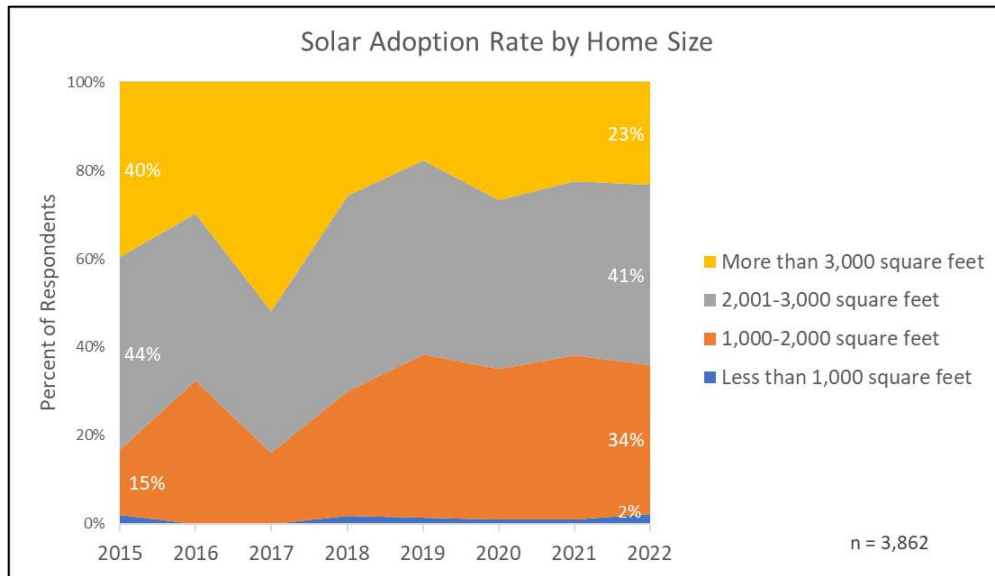


Figure 18: Solar Adoption Rate by Home Size

North Carolina's Department of Commerce (NC Commerce) publishes an annual ranking of the state's 100 counties based on economic well-being and assigns each a corresponding tier designation. The 40 most distressed counties are designated as Tier 1, the next 40 as Tier 2, and the 20 least distressed as Tier 3.<sup>8</sup> While most solar PV adopters live within Tier 3 counties, this category's percentage has declined from 88% in 2015 to 70% in 2022. Concurrently, Tier 1 and 2 counties more than doubled their respective shares of solar adoption (see Figure 19).

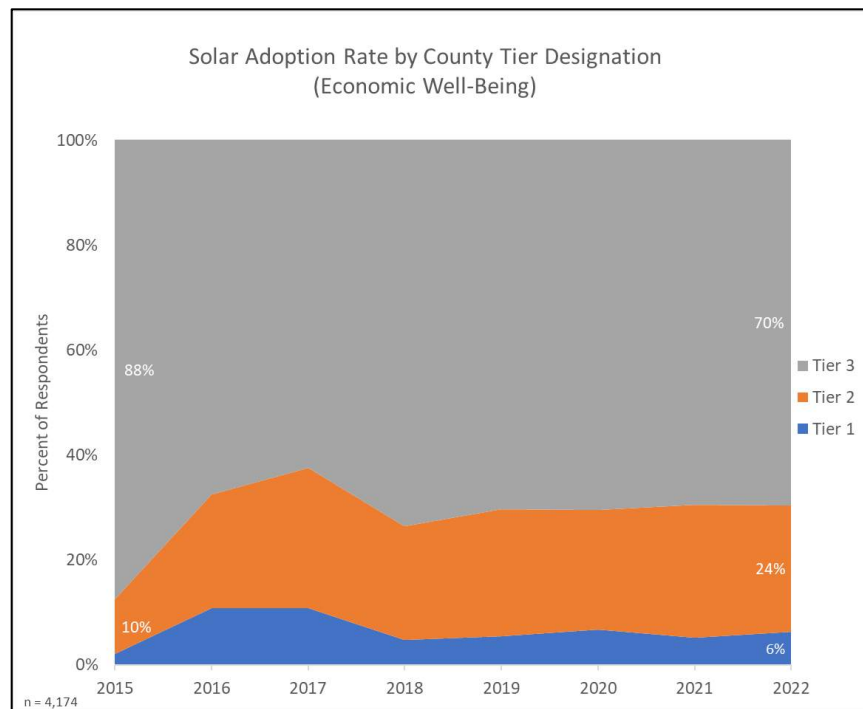


Figure 19: Solar Adoption Rate by County Tier Designation (Economic Well-Being). Data derived from NCSEA's Renewable Energy Database (REDB) and NC Department of Commerce's County Distress Rankings.

In addition to economic development metrics, NC's 100 counties can be categorized geographically as urban (6), suburban (16), and rural (78).<sup>9</sup> In 2015, solar adoption rates were slightly more comparable across this metric than NC Commerce's distress tiers, but urban counties still accounted for a majority of installed solar across the state. The period between 2015 and 2016 witnessed a surge in solar PV adoption in rural counties, with rates increasing more than three-fold from 10% to 35% (see Figure 20). However, this expansion proved short-lived with adoption rates in rural counties decreasing and ultimately plateauing to around 20% since 2017. From 2016 onwards, urban counties experienced a growing share of solar adoption, and in 2022 they reclaimed majority status with 52% of adoption share.

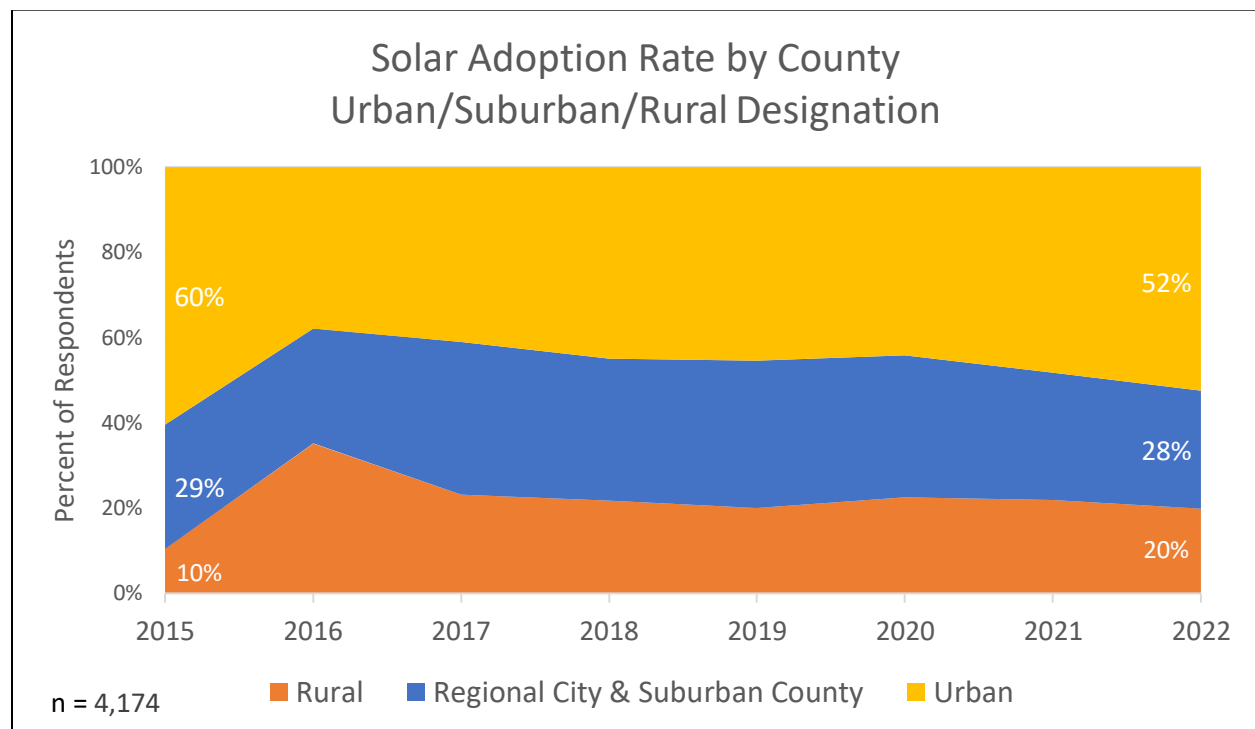


Figure 20: Solar Adoption Rate by County Urban/Suburban/Rural Designation (since 2015). Data derived from NCSEA's Renewable Energy Database (REDB) and NC Rural Center County Data.

## Conclusion

NCSEA's 2022 Sustainable Energy Survey was designed and administered to capture the motivations and dynamics of clean energy adoption in NC. Demographic questions were also included to gain a better understanding of the current population of clean energy adopters, as well as the barriers impeding underserved groups and communities of color from pursuing clean energy options. Notable findings include:

- Household incomes among solar adopters are still generally higher than the state average. This finding is supported by assessing solar adoption by county. In 2022, NC's 20 most prosperous counties still accounted for more than two-thirds (69.59%) of residential solar adoption. In a state where race and income (among other key economic indicators) are highly correlated, this finding demonstrates one instance of energy inequity facing NC's communities of color.<sup>10</sup>
- Federal and state policies have played an integral role in shaping and influencing consumer behavior. NCSEA is proactively engaged in assessing the impacts that current programs and policies have on the clean energy landscape. The 2022 Sustainable Energy Survey was designed to further evaluate these effects in the context of consumer habits, motivations, and equity, and the following trends stood out in this analysis:
  - Federal tax credits such as the Federal Residential Solar Energy Credit appear to be highly impactful in consumers' decisions to invest in clean energy systems.
  - Additionally, utility rebates such as Duke Energy's Solar Rebate Program were ranked highly among survey respondents. These incentives have been vital to expanding residential solar in NC, however, the demographic data collected from the 2022 survey indicates that these financing options may not be enough to broaden adoption into low-income communities and communities of color. As such, the state could investigate diversifying ownership models such as third-party power purchase agreements which have been demonstrated to enhance adoption rates in low-income households.<sup>11</sup>

## *Areas for Further Research*

This report serves primarily to describe key trends in NC's clean energy landscape. These findings may allude to additional research questions which require even more targeted analysis, such as:

- Has the expiration of NC's Renewable Energy Investment Tax Credit (2015) impacted rates of solar adoption in low-income communities?
- Could the expansion of solar loan offerings increase adoption by low-income households in NC?
- Are solar costs (including those associated with permitting and interconnection) higher for households located in NC's disadvantaged communities?



- How would changes in net metering rates and associated compensation structures impact the demographics of solar adoption?
- Could the development of community solar programs raise residential solar adoption rates?

The data presented in this report offers valuable insight into consumer attitudes and issues of energy accessibility. Ultimately, these findings and analysis demonstrate that NC's clean energy landscape has experienced robust growth at the residential level. Consumer attitudes are generally positive and the clean energy systems, whether they are rooftop solar or electric vehicles, are saving residents money. With this in mind, the demographic data collected from the survey also suggests that there is a significant opportunity to expand clean energy adoption into low-income and historically disadvantaged communities. Empowering these households to pursue such options is a vital step in securing an affordable, resilient, and sustainable clean energy future for NC.

## Appendix: Sustainable Energy Survey Questions

### Sustainable Technologies

1. Which of the following sustainable technologies have you adopted? (Select all that apply.)

- Solar photovoltaics (PV)
- Energy storage system (whole-house battery)
- Electric vehicle (EV)
- Solar thermal
- Geothermal ground source heat pump (GSHP)
- None of the above

### Solar Photovoltaic (PV) System

2. Where is your solar PV system located?

- Rooftop
- Ground-mount

3. What year did you install your solar PV system? (leave blank if unknown)

4. What is the expected payback period for your solar PV system?

- Less than 5 years
- 5-10 years
- 10-15 years
- More than 15 years

5. How important were the following factors in paying for your solar PV system?

|                                                                                             | Unaware<br>of Option | Not<br>used | Not<br>Important | Somewhat<br>Unimportant | Neutral | Somewhat<br>Important | Very<br>Important |
|---------------------------------------------------------------------------------------------|----------------------|-------------|------------------|-------------------------|---------|-----------------------|-------------------|
| Federal tax credit                                                                          |                      |             |                  |                         |         |                       |                   |
| State tax credit                                                                            |                      |             |                  |                         |         |                       |                   |
| Loan or lease program                                                                       |                      |             |                  |                         |         |                       |                   |
| Rebate or incentive from electric utility provider (e.g., Duke Energy solar rebate program) |                      |             |                  |                         |         |                       |                   |
| Other rebate program                                                                        |                      |             |                  |                         |         |                       |                   |
| Cash on hand                                                                                |                      |             |                  |                         |         |                       |                   |
| Grant                                                                                       |                      |             |                  |                         |         |                       |                   |

6. How have your utility bills changed **per month** since installation?

- Increase
- No change
- 0-5% decrease
- 5-15% decrease
- 15-20% decrease
- 20-30% decrease
- More than 30% decrease
- Not applicable

7. What company installed your solar PV system?

8. How did you hear about this company? (Select all that apply.)

- On-site signage
- User-review website (e.g., Angie's List, Yelp, Better Business Bureau)
- Newspaper, TV, or Radio advertisement
- Mail advertisement
- Customer referral or word of mouth
- Internet search
- Social media (e.g. Facebook, Twitter, Instagram)
- Door-to-door sales

9. What other companies did you consider?

10. What were some of the reasons why you didn't select those other companies?

11. Did you experience any issues with a Homeowners Association (HOA) when installing your solar PV system? If so, please list them below.

12. Do you live in a neighborhood with other visible PV systems?

- Yes
- No

13. What information did you consider when purchasing your solar PV system? (Select all that apply.)

- Internet search
- Social media (e.g., Facebook, Twitter, Instagram)
- Personal referral
- Local installer
- Electric utility company
- State agency
- City or county government
- Non-profit organization(s)

14. What energy efficiency measures did you implement along with the installation of your solar PV system? (Select all that apply.)

- Home automation



- Insulation
- Lighting
- Smart thermostat
- Water conservation
- Windows
- None

15. How important were the following factors in your decision to adopt a solar PV system?

|                                                   | Not applicable | Not important | Somewhat unimportant | Neutral | Somewhat important | Very important |
|---------------------------------------------------|----------------|---------------|----------------------|---------|--------------------|----------------|
| Current cost of electric bills                    |                |               |                      |         |                    |                |
| Future cost of electric bills                     |                |               |                      |         |                    |                |
| Concern about environmental impact                |                |               |                      |         |                    |                |
| Financial incentives (e.g., rebates, tax credits) |                |               |                      |         |                    |                |
| Referral of a neighbor or friend                  |                |               |                      |         |                    |                |
| Increase in property value                        |                |               |                      |         |                    |                |

16. How satisfied are you with the following aspects of system installation, performance, and financial incentives?

|                          | Not applicable | Not satisfied | Somewhat unsatisfied | Neutral | Somewhat satisfied | Very satisfied |
|--------------------------|----------------|---------------|----------------------|---------|--------------------|----------------|
| Securing project permits |                |               |                      |         |                    |                |

|                                                                    |  |  |  |  |  |  |
|--------------------------------------------------------------------|--|--|--|--|--|--|
| Installer company                                                  |  |  |  |  |  |  |
| Connecting the system to the utility provider                      |  |  |  |  |  |  |
| System performance                                                 |  |  |  |  |  |  |
| Installer support, monitoring, and maintenance after installation. |  |  |  |  |  |  |
| Utility bill savings                                               |  |  |  |  |  |  |
| Access to federal tax credits                                      |  |  |  |  |  |  |
| Access to state tax credits                                        |  |  |  |  |  |  |
| Rebate or incentive programs                                       |  |  |  |  |  |  |

## Energy Storage

17. Did you install your energy storage system along with a solar PV system?

- Yes
- No

18. What year did you install your energy storage system? (leave blank if unknown)

19. What is the nameplate capacity of your energy storage system? (kW) (Leave blank if you don't know nameplate capacity)

20. What is your energy storage system's duration? (in hours) (Leave blank if you don't know the system's duration)

21. What company installed your energy storage system?

22. How did you hear about this company? (Select all that apply.)

- On-site signage
- User-review website (e.g., Angie's List, Yelp, Better Business Bureau)
- Newspaper, TV, or Radio advertisement
- Mail advertisement
- Customer referral or word of mouth
- Internet search
- Social media (e.g., Facebook, Twitter, Instagram)
- Door-to-door sales

23. What do you primarily use your energy storage system for? (Select all that apply.)

- Electric vehicle charging
- Emergency backup electricity
- Peak energy load reduction

24. How important were the following factors in paying for your energy storage system?

|                                                    | Unaware of option | Not used | Not important | Somewhat unimportant | Neutral | Somewhat important | Very important |
|----------------------------------------------------|-------------------|----------|---------------|----------------------|---------|--------------------|----------------|
| Federal tax credit                                 |                   |          |               |                      |         |                    |                |
| State tax credit                                   |                   |          |               |                      |         |                    |                |
| Loan or lease program                              |                   |          |               |                      |         |                    |                |
| Rebate or incentive from electric utility provider |                   |          |               |                      |         |                    |                |
| Other rebate program                               |                   |          |               |                      |         |                    |                |

|              |  |  |  |  |  |  |  |
|--------------|--|--|--|--|--|--|--|
| Cash on hand |  |  |  |  |  |  |  |
| Grant        |  |  |  |  |  |  |  |

25. How have your utility bills changed on average since installation?

- Increase
- No change
- 0-5% decrease
- 5-15% decrease
- 20-30% decrease
- More than 30% decrease
- Not applicable

26. How important were the following factors in your decision to adopt an energy storage system?

|                                                   | Not applicable | Not important | Somewhat unimportant | Neutral | Somewhat important | Very important |
|---------------------------------------------------|----------------|---------------|----------------------|---------|--------------------|----------------|
| Current cost of electric bills                    |                |               |                      |         |                    |                |
| Future cost of electric bills                     |                |               |                      |         |                    |                |
| Concern about environmental impact                |                |               |                      |         |                    |                |
| Financial incentives (e.g., rebates, tax credits) |                |               |                      |         |                    |                |
| Referral of a neighbor or friend                  |                |               |                      |         |                    |                |
| Increase in property value                        |                |               |                      |         |                    |                |

27. What information did you use when considering purchasing your energy storage system? (Select all that apply.)

- Internet search
- Social media (e.g., Facebook, Twitter, Instagram)
- Personal referral
- Local installer
- Electric utility company
- State agency
- City or county government
- Non-profit organization(s)

28. What energy efficiency measures did you enact along with the installation of your energy storage system? (Select all that apply.)

- Insulation
- Lighting
- Windows
- Water conservation
- Home automation
- None

29. How satisfied are you with the following aspects of system installation, performance, and financial incentives?

|                                                 | Not applicable | Not satisfied | Somewhat unsatisfied | Neutral | Somewhat Satisfied | Very satisfied |
|-------------------------------------------------|----------------|---------------|----------------------|---------|--------------------|----------------|
| Securing project permits                        |                |               |                      |         |                    |                |
| Installer company                               |                |               |                      |         |                    |                |
| Connecting your system to your utility provider |                |               |                      |         |                    |                |
| System performance                              |                |               |                      |         |                    |                |

|                                           |  |  |  |  |  |  |
|-------------------------------------------|--|--|--|--|--|--|
| Maintaining the system after installation |  |  |  |  |  |  |
| Utility bill savings                      |  |  |  |  |  |  |
| Access to federal tax credits             |  |  |  |  |  |  |
| Access to state tax credits               |  |  |  |  |  |  |
| Rebate or incentive programs              |  |  |  |  |  |  |

## Electric Vehicle (EV)

30. Do you own or lease your electric vehicle?

- Own
- Lease

31. What year did you purchase or lease your electric vehicle? (leave blank if unknown)

32. What is the make of your electric vehicle?

33. What is the model of your electric vehicle?

34. What was the value of your electric vehicle when you purchased or leased it?

- Less than \$15,000
- \$15,001-\$30,000
- \$30,001-\$50,000
- \$50,001-\$75,000
- \$75,001-\$100,000
- More than \$100,000

35. How important were the following factors in paying for your electric vehicle?

|                          | Unaware<br>of option | Not<br>used | Not<br>important | Somewhat<br>unimportant | Neutral | Somewhat<br>important | Very<br>important |
|--------------------------|----------------------|-------------|------------------|-------------------------|---------|-----------------------|-------------------|
| Federal tax credit       |                      |             |                  |                         |         |                       |                   |
| State tax credit         |                      |             |                  |                         |         |                       |                   |
| Loan or lease<br>program |                      |             |                  |                         |         |                       |                   |
| Grants                   |                      |             |                  |                         |         |                       |                   |
| Cash on hand             |                      |             |                  |                         |         |                       |                   |

36. Where do you primarily charge your electric vehicle?

- Home
- Work
- Retail parking lots
- Municipal charger

37. Do you go out of your way to find charging stations when planning local travel?

- Yes
- No
- Sometimes

38. How did you hear about the vehicle dealer? (Select all that apply.)

- On-site signage
- User review website (e.g., Angie's List, Yelp, Better Business Bureau)
- Newspaper, TV, or Radio advertisement
- Mail advertisement
- Customer referral or word of mouth
- Internet search
- Social media (e.g., Facebook, Twitter, Instagram)
- Door-to-door sales



39. How important were the following factors in your decision to purchase or lease an electric vehicle?

|                                                           | Not applicable | Not important | Somewhat unimportant | Neutral | Somewhat important | Very important |
|-----------------------------------------------------------|----------------|---------------|----------------------|---------|--------------------|----------------|
| Access to charging station                                |                |               |                      |         |                    |                |
| Cost of gas                                               |                |               |                      |         |                    |                |
| Financial incentives (e.g., rebates, tax credits, grants) |                |               |                      |         |                    |                |
| HOV lane exemption                                        |                |               |                      |         |                    |                |
| Lifecycle cost and payback period                         |                |               |                      |         |                    |                |
| Concern about environmental impact                        |                |               |                      |         |                    |                |

40. What sources of information did you use when choosing your electric vehicle? (Select all that apply.)

- City or county government
- Dealership or manufacturer
- Internet search
- Non-profit organization(s)
- State agency
- Personal referral
- Social media (e.g., Facebook, Twitter, Instagram)

41. How satisfied are you with the following aspects of maintenance, performance, and financial incentives?

|                                                       | Not applicable | Not satisfied | Somewhat unsatisfied | Neutral | Somewhat satisfied | Very satisfied |
|-------------------------------------------------------|----------------|---------------|----------------------|---------|--------------------|----------------|
| Dealer experience                                     |                |               |                      |         |                    |                |
| Quality and performance of the vehicle                |                |               |                      |         |                    |                |
| Driving long distance                                 |                |               |                      |         |                    |                |
| Access to charging stations                           |                |               |                      |         |                    |                |
| Car maintenance                                       |                |               |                      |         |                    |                |
| Access to federal tax credits                         |                |               |                      |         |                    |                |
| Rebate or incentive programs (e.g., employee benefit) |                |               |                      |         |                    |                |

## Solar Thermal System

42. What is the total tank volume (gallons) of your solar thermal system? (Leave blank if you don't know the total tank volume)

43. What is the total area of collectors (square feet) of your solar thermal system? (Leave blank if you don't know the total area of collectors)

44. How did you heat your water before you installed your solar thermal system?

- Electric
- Gas
- Don't know

45. What type of solar thermal panels do you use?

- Flat plate collector
- Evacuated tub collector
- Hybrid (PV thermal) collector

46. What year did you install your solar thermal system? (leave blank if unknown)

47. What company installed your solar thermal system?

48. How did you hear about the company? (Select all that apply.)

- On-site signage
- User review website (e.g., Angie's List, Yelp, Better Business Bureau)
- Newspaper, TV, or Radio advertisement
- Mail advertisement
- Customer referral or word of mouth
- Internet search
- Social media (e.g., Facebook, Twitter, Instagram)
- Door-to-door sales

49. What is the expected payback period for your solar thermal system?

- Less than 3 years
- 3-5 years
- 6-10 years
- 11-15 years
- More than 15 years

50. How important were the following factors in paying for your solar thermal system?

|                    | Unaware of option | Not used | Not important | Somewhat unimportant | Neutral | Somewhat important | Very important |
|--------------------|-------------------|----------|---------------|----------------------|---------|--------------------|----------------|
| Federal tax credit |                   |          |               |                      |         |                    |                |
| State tax credit   |                   |          |               |                      |         |                    |                |

|                                           |  |  |  |  |  |  |  |
|-------------------------------------------|--|--|--|--|--|--|--|
| Loan or lease program                     |  |  |  |  |  |  |  |
| Rebate or incentive from utility provider |  |  |  |  |  |  |  |
| Other rebate program                      |  |  |  |  |  |  |  |
| Cash on hand                              |  |  |  |  |  |  |  |
| Grant                                     |  |  |  |  |  |  |  |

51. How have your utility bills changed **per month** since installation?

- Increase
- No change
- 0-5% decrease
- 5-15% decrease
- 20-30% decrease
- Not applicable

52. How important were the following factors in your decision to adopt a solar thermal system?

|                                    | Not applicable | Not important | Somewhat unimportant | Neutral | Somewhat important | Very important |
|------------------------------------|----------------|---------------|----------------------|---------|--------------------|----------------|
| Current cost of electric bills     |                |               |                      |         |                    |                |
| Future cost of electric bills      |                |               |                      |         |                    |                |
| Concern about environmental impact |                |               |                      |         |                    |                |

|                                                      |  |  |  |  |  |  |
|------------------------------------------------------|--|--|--|--|--|--|
| Financial incentives<br>(e.g., rebates, tax credits) |  |  |  |  |  |  |
| Referral of a neighbor or friend                     |  |  |  |  |  |  |
| Increase in property value                           |  |  |  |  |  |  |

53. What sources of information did you use when considering purchasing your solar thermal system? (Select all that apply.)

- Internet search
- Social media (e.g., Facebook, Twitter, Instagram)
- Personal referral
- Local installer
- Electric utility company
- State agency
- City or county government
- Non-profit organization(s)

54. What other energy efficiency measures did you enact along with the installation of your solar thermal system? (Select all that apply.)

- Insulation
- Lighting
- Windows
- Water conservation
- Home automation
- None

55. How satisfied are you with the following aspects of system installation, performance, and financial incentives?

|  |                |               |                      |         |                    |                |
|--|----------------|---------------|----------------------|---------|--------------------|----------------|
|  | Not applicable | Not satisfied | Somewhat unsatisfied | Neutral | Somewhat satisfied | Very satisfied |
|--|----------------|---------------|----------------------|---------|--------------------|----------------|

|                                           |  |  |  |  |  |  |
|-------------------------------------------|--|--|--|--|--|--|
| Securing project permits                  |  |  |  |  |  |  |
| Installer company                         |  |  |  |  |  |  |
| Performance of your system                |  |  |  |  |  |  |
| Maintaining the system after installation |  |  |  |  |  |  |
| Utility bill savings                      |  |  |  |  |  |  |
| Access to federal tax credits             |  |  |  |  |  |  |
| Access to state tax credits               |  |  |  |  |  |  |
| Rebate or incentive programs              |  |  |  |  |  |  |

## Geothermal Ground Source Heat Pump (GSHP) System

56. What type of geothermal system do you have? (Select all that apply.)

- Closed-loop system
- Open-loop system
- Horizontal configuration
- Vertical configuration
- Lake/pond configuration
- Don't know

57. What is the capacity (tons) of your geothermal system?

- Less than 1 ton
- 1-3 tons
- 3-5 tons
- 6-10 tons
- More than 10 tons

- Don't know

58. What year was your geothermal system installed? (leave blank if unknown)

59. What is the name of the company that installed your geothermal system?

60. How did you hear about the company? (Select all that apply.)

- On-site signage
- User review website (e.g., Angie's List, Yelp, Better Business Bureau)
- Newspaper, TV, or Radio advertisement
- Mail advertisement
- Customer referral or word of mouth
- Internet search
- Social media (e.g., Facebook, Twitter, Instagram)
- Door-to-door sales

61. What is the payback period for your geothermal system?

- Less than 3 years
- 3-5 years
- 6-10 years
- More than 10 years

62. How important were the following factors in paying for your geothermal system?

|                          | Unaware of option | Not used | Not important | Somewhat unimportant | Neutral | Somewhat important | Very important |
|--------------------------|-------------------|----------|---------------|----------------------|---------|--------------------|----------------|
| Federal tax credit       |                   |          |               |                      |         |                    |                |
| State tax credit         |                   |          |               |                      |         |                    |                |
| Loan or lease program    |                   |          |               |                      |         |                    |                |
| Rebate or incentive from |                   |          |               |                      |         |                    |                |



|                           |  |  |  |  |  |  |  |
|---------------------------|--|--|--|--|--|--|--|
| electric utility provider |  |  |  |  |  |  |  |
| Other rebate program      |  |  |  |  |  |  |  |
| Cash on hand              |  |  |  |  |  |  |  |
| Grant                     |  |  |  |  |  |  |  |

63. How have your utility bills changed **per month** since installation?

- Increase
- No change
- 0-5% decrease
- 5-15% decrease
- 20-30% decrease
- More than 30% decrease
- Not applicable

64. How important were the following factors in your decision to adopt a geothermal system?

|                                                   | Not applicable | Not important | Somewhat unimportant | Neutral | Somewhat important | Very important |
|---------------------------------------------------|----------------|---------------|----------------------|---------|--------------------|----------------|
| Current cost of electric bills                    |                |               |                      |         |                    |                |
| Future cost of electric bills                     |                |               |                      |         |                    |                |
| Concern about environmental impact                |                |               |                      |         |                    |                |
| Financial incentives (e.g., rebates, tax credits) |                |               |                      |         |                    |                |

|                                  |  |  |  |  |  |  |
|----------------------------------|--|--|--|--|--|--|
| Referral of a neighbor or friend |  |  |  |  |  |  |
| Increase in property value       |  |  |  |  |  |  |

65. What sources of information did you use when considering purchasing your geothermal system? (Select all that apply.)

- City or county government
- Internet search
- Non-profit organization(s)
- State agency
- Personal referral
- Social media (e.g., Facebook, Twitter, Instagram)
- Local installer
- Electric utility company

66. What energy efficiency measures did you enact along with the installation of your geothermal system? (Select all that apply.)

- Insulation
- Lighting
- Windows
- Water conservation
- Home automation
- None

67. How satisfied are you with the following aspects of system installation, performance, and financial incentives?

|                          | Not applicable | Not satisfied | Somewhat unsatisfied | Neutral | Somewhat satisfied | Very satisfied |
|--------------------------|----------------|---------------|----------------------|---------|--------------------|----------------|
| Securing project permits |                |               |                      |         |                    |                |
| Installer company        |                |               |                      |         |                    |                |

|                                                 |  |  |  |  |  |  |
|-------------------------------------------------|--|--|--|--|--|--|
| Connecting your system to your utility provider |  |  |  |  |  |  |
| Performance of your system                      |  |  |  |  |  |  |
| Maintaining the system after installation       |  |  |  |  |  |  |
| Utility bill savings                            |  |  |  |  |  |  |
| Access to federal tax credits                   |  |  |  |  |  |  |
| Access to state tax credits                     |  |  |  |  |  |  |

## COVID-19 Pandemic Questions

68. Did you install your clean energy system(s) during the COVID-19 pandemic?

- Yes
- No

69. How did the pandemic change your interest in purchasing a clean energy system?

- Increased
- Decreased
- No change

70. How did the pandemic affect your ability to purchase a clean energy system?

- Easier
- More difficult
- No change

71. How did the pandemic change your attitude on improving your home's energy efficiency?

- More interested
- Less interested
- No change

## Demographic Questions

The following 8 questions are optional but will allow NCSEA to better understand consumers like you who are adopting clean energy technologies.

72. How many people live in your home?

73. How many years have you lived at your home?

- Less than 2 years
- 2-5 years
- 5-10 years
- More than 10 years

74. When was your home built?

- Before 1950
- 1951-1970
- 1971-1990
- 1991-2000
- 2001-2010
- 2011-2020
- After 2020
- Don't know

75. What type of home do you reside in?

- Single family
- Multi-family
- Semi-detached
- Mobile home
- Townhome
- Apartment
- Condo

76. What is the square footage of your home?

- Less than 1,000 square feet
- 1,000-2,000 square feet
- 2,001-3,000 square feet
- More than 3,000 square feet
- Don't know

77. Do you own or rent your home?

- Own
- Rent

78. What is your age?

- 18-24 years
- 25-34 years
- 35-44 years
- 45-64 years
- 65-74 years
- 75 years or older

79. What is the highest level of education you have completed?

- 12th grade or less (no high school diploma)
- High school graduate/GED
- Some college (no degree)
- Associate or technical degree
- Bachelor's degree
- Graduate degree

80. What is your race/ethnicity? (Select all that apply.)

- White/Caucasian
- Black/African American
- American Indian or Alaska Native
- Asian
- Native Hawaiian or Pacific Islander

81. Are you of Hispanic or Latino origin?

- Yes
- No

82. What is your annual household income?

- Less than \$40,000
- \$40,001-\$80,000
- \$80,001-\$120,000
- \$120,001-\$160,000
- More than \$160,000

## End Section

83. What obstacles did you face during your decision to adopt sustainable energy technologies?

- Cost
- HOA
- Unavailability of sufficient rebates
- Lack of direct sunlight
- Lack of net metering
- Lack of sufficient charging stations
- Permitting approvals
- Final inspection issues
- None

84. What additional clean energy purchases are you likely to make in the next year?  
(Select all that apply.)

- I am not planning on making clean energy purchases
- Solar photovoltaic (PV) system
- Electric vehicle(s)
- Energy storage
- Solar thermal system
- Geothermal ground source heat pump (GSHP)

85. Do you have any additional comments you would like to share with us?

## Resources

<sup>1</sup> <https://www.seia.org/research-resources/top-10-solar-states-0>

<sup>2</sup> Ibid.

<sup>3</sup> <https://cleanenergyconservatives.com/wp-content/uploads/2019/02/CCENC-2023-NC-Energy-Poll-Presentation-5-17-23.pdf>

<sup>4</sup> <https://www.kbb.com/car-advice/how-much-electric-car-cost/>

<sup>5</sup> [https://www.sog.unc.edu/sites/default/files/articles/article3\\_11.pdf](https://www.sog.unc.edu/sites/default/files/articles/article3_11.pdf)

<sup>6</sup> <https://www.census.gov/quickfacts/fact/table/NC/PST045222>

<sup>7</sup> <https://www.ahs.com/home-matters/real-estate/the-2022-american-home-size-index/>

<sup>8</sup> <https://www.commerce.nc.gov/grants-incentives/county-distress-rankings-tiers>

<sup>9</sup> <https://www.ncruralcenter.org/advocacy-and-research/county-data/>

<sup>10</sup> <https://www.census.gov/content/dam/Census/library/publications/2020/acs/acsbr19-07.pdf>

<sup>11</sup> [https://eta-publications.lbl.gov/sites/default/files/solar-adopter\\_income\\_trends\\_nov\\_2022.pdf](https://eta-publications.lbl.gov/sites/default/files/solar-adopter_income_trends_nov_2022.pdf)