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Future of Energy Efficiency in Buildings: Drivers and Market Expectations

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We also thank our interviewees and questionnaire respondents (see list later in this report) and E9 Insight for their research assistance. Any errors or misrepresentations of the

Contents

Key Takeaways – Based on Research (including Literature Review, Interviews, and Questionnaire)

Interacting categories of drivers that will influence the future of energy efficiency in buildings

Two major driver categories:

- Public policies and regulations, particularly those associated with greenhouse gas (GHG) emission mitigation and adaptation
- Cost of energy (relative to the cost of delivering efficiency)

Four other important driver categories:

- Efficiency technologies
- Economic conditions
- Societal priorities
- Efficiency industry (including utility) business practices for increasing the uptake of efficiency in buildings

Predictions for energy efficiency in buildings over the next ten years

- Some efficiency technologies (e.g., heat pumps, building shell measures) and technologies that support efficiency (e.g., data access, artificial intelligence) are primed for significant performance improvements. However, for some end-uses and technologies (e.g., lighting, heating systems) efficiency improvements will not advance as fast as historic rates.
- Electric efficiency actions will become more focused on demand flexibility and energy use reductions during specific times via controls and integration with other distributed energy resources (DERs) in grid-interactive efficient buildings and communities. Efficiency will also be an important component of electrification efforts.
- Marketing of efficient products and services will increasingly focus on grid services, decarbonization, DER integration, non-energy benefits (for consumers), and Environmental, Social and Governance (ESG) criteria (for investors).
- Public investment will increase in historically-underserved, disadvantaged communities in recognition of the social, health, and safety benefits of reducing energy usage and to redress historical underserving of these communities' energy needs.
- While state-specific actions will vary, overall state and local governments will increase their efficiency achievements. Our research suggests low-to-moderate national growth in efficiency-based energy savings – unless public policy mandates ramp up requirements, particularly with respect to GHG emission reductions, which would yield moderate-to-high growth for efficiency-based impacts.

Executive Summary

Project Objective, Importance, and Approach

Objectives and Focus

- Primary objective: Identify drivers (influencing factors) of energy efficiency in buildings over the next ten years.
- Secondary objective: Provide insights on what the future of efficiency may look like in that time period. (While the future is hard to predict, its drivers can be more reliably identified.)
- Project focus: Energy efficiency in buildings—all fuels. Other DERs as well as decarbonization and demand flexibility are included to the extent they are intertwined with energy efficiency activities.

Importance

- U.S. consumers spend over $400 billion each year to power homes and commercial buildings that account for 40% of the nation's energy use and account for 35% of U.S. CO_2 emissions. Much of this money and energy is wasted—over 30% on average. The energy efficiency market that addresses this waste supports over two million jobs across the country. (U.S. Department of Energy, 2021a and 2021b)
- Understanding efficiency market drivers and possible future efficiency market attributes can help policy makers, regulators, utilities, and the efficiency industry make informed decisions—for example, how best to design policies and investments to support desired outcomes.

Approach

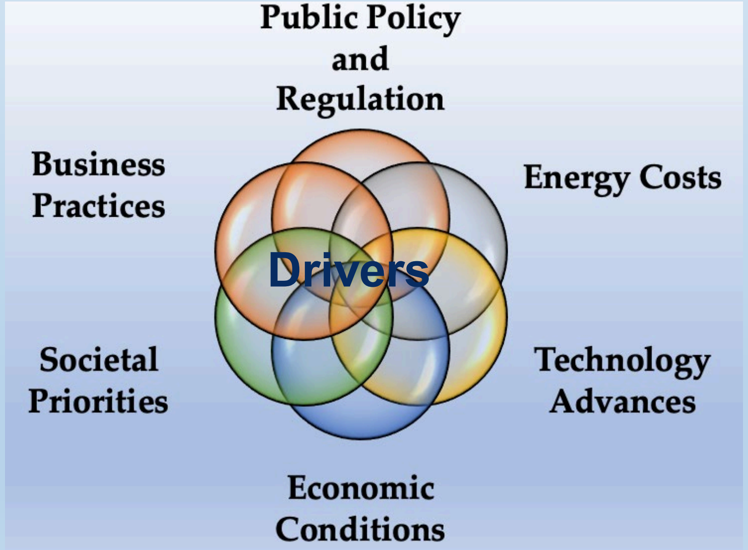
- Survey of legislation, regulations and executive orders in 12 states: November-December 2020
- Structured interviews with 22 experts: November 2020 - January 2021
- Detailed questionnaires completed by 41 efficiency practitioners: August-September 2021
- Extensive literature review: throughout 2021
- Analysis of this research informed findings of this report

Notes

- We include a number of results from our questionnaire. However, these results should be understood as illustrative, as our respondents may not be representative of the efficiency industry in general. Moreover, the questionnaire was only one of several sources of data (as noted above).
- No individual attributions from interviews or questionnaires are used in accordance with interview and questionnaire protocols.

Drivers of Energy Efficiency in Buildings*

Energy efficiency in buildings does not have a singular future. Instead, its attributes will vary across different jurisdictions and market sectors (e.g., residential, low-income, commercial, urban and rural). Attributes will be defined (driven) primarily by the unique characteristics of each of these sectors and by six interacting and overlapping categories of market drivers.

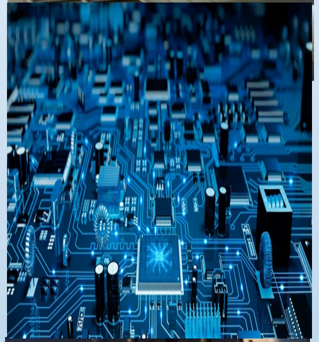


Based on structured interviews and detailed questionnaires

- **Drivers likely to be very important: *Policy and Energy Costs***
  - **Energy and climate policies and regulations**, including building and economy-wide decarbonization and performance-based regulation for utilities
  - **Cost of energy to consumers** (and rate structures, e.g., fixed vs. variable prices) relative to cost of implementing efficiency actions and other options to reduce energy costs
- **Drivers likely to be important: *Technology Advances, Economic Conditions, and Societal Priorities***
  - Advances in **efficiency of some electricity-consuming equipment** (e.g., more efficient heat pumps)
  - **Extrinsic technological advances** (e.g., advances in sensor and control technologies)
  - Increasing **importance of the time and (to a lesser degree) locational value of savings**
  - Status of the **overall economy** and changes in U.S. **building stock demographics** (e.g., building occupancy, density and energy use patterns, and population migration)
  - Increased recognition of **energy burdens in disadvantaged and underserved communities**
  - Societal emphasis on improving **resilience and reliability** of energy services, personal interest in addressing the **environmental impacts** of energy use, and use of **ESG criteria for investments**
- **Driver potentially important: *Business Practices to Increase Uptake of Efficiency in Buildings***
  - Wide implementation of **innovative business models** for marketing and implementing efficiency
  - Access to **skilled labor**
  - Increased availability of and access to **low-cost financing options**

Expectations for Future of Energy Efficiency in Buildings

1. While jurisdiction-specific actions will vary, overall state and local governments will increase their energy efficiency goals.
2. Low-to-moderate growth is expected in efficiency-based energy savings across commercial, residential, and low-income buildings, unless public policy mandates ramp up requirements yielding moderate-to-high growth.
3. Efficiency investments will continue to consist of a mix of incentive-supported actions, adoption driven by codes and standards, and routine market adoption.
4. Electricity efficiency actions will become more focused on demand flexibility and reductions in energy usage during specific times, rather than just annual or seasonal impacts.
5. Efficiency improvements in some technologies will result in greater, cost-effective efficiency impacts—for example, heat pumps for space and water heating, building energy controls, and building shell components like windows. However, for some end-uses and technologies (e.g., lighting, motors and boilers), we will not see efficiency advances at the rate they have occurred in the past given existing high efficiency levels.



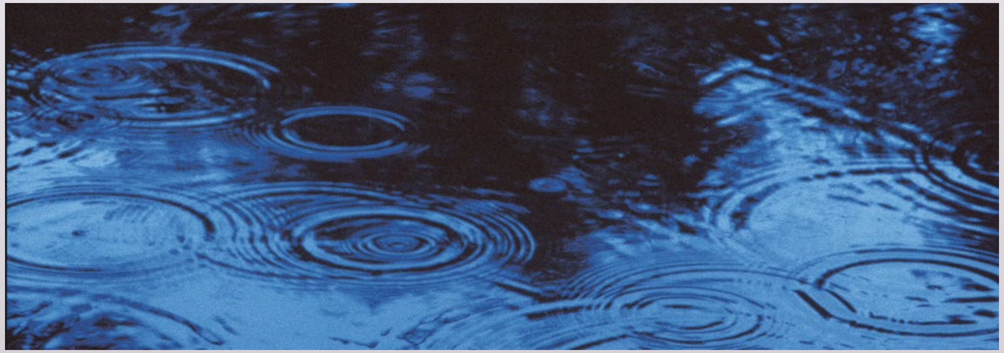
6. Technological advances that support efficiency, such as interoperability of building systems and equipment, artificial intelligence, and universal internet access, will improve the efficacy of efficiency actions.
7. The efficiency industry will increasingly focus marketing on:
   - Grid services and demand flexibility
   - Building decarbonization
   - Efficiency's non-energy benefits
   - Efficiency in a package of other DERs
8. Low-income programs will see increased investment and continue to take a separate route from other residential and commercial programs, with a specific portion of the efficiency industry continuing to focus on energy-burdened communities and households, including direct install/no-cost retrofits (e.g., weatherization). Low-income program designs will increasingly emphasize social benefits of reducing energy bills, the value of improving the health, safety and comfort of program participants, and the importance of addressing historic discrimination and lack of attention to such communities.

Project Scope, Approach, Assumptions and Definitions

Project Scope and Approach

Scope

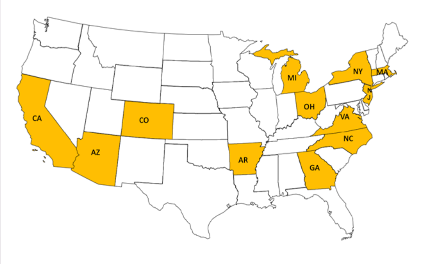
- Primary objective: Identify and describe drivers that have the potential to define the future of energy efficiency markets for U.S. buildings over the next decade



- Secondary objective: Provide heuristic descriptions of possible future attributes of efficiency markets
- No specific predictions of the future, such as what will be the newest and best technologies or business models

Approach

- Literature review of nearly 100 documents, from academic papers to government publications to blog posts — see references at the end of this report
- Review of recent demand-side management actions (regulatory, executive, and legislative) in twelve states representing a mix of perspectives and status of efficiency activity



- Interviews of 21 experts in efficiency and energy markets from industry, utilities, research groups and academics
- Extensive questionnaire completed by 41 efficiency practitioners covering market attribute drivers and predictions
- Review and analysis of collected information

Key Assumptions and Definitions

Focus – Efficiency in the Built Environment

- *Energy efficiency*: Using less energy to provide the same or an improved level of service for energy consumers; or using less energy to perform the same function
  - *Naturally occurring efficiency*: Efficiency actions that result from (1) codes or standards and (2) routine market adoption (actions that customarily occur without a rebate, unique financing option, or other types of incentives)
  - *Incremental efficiency*: Actions beyond naturally occurring efficiency, including actions caused by rebates, subsidized financing options, or other types of incentives.

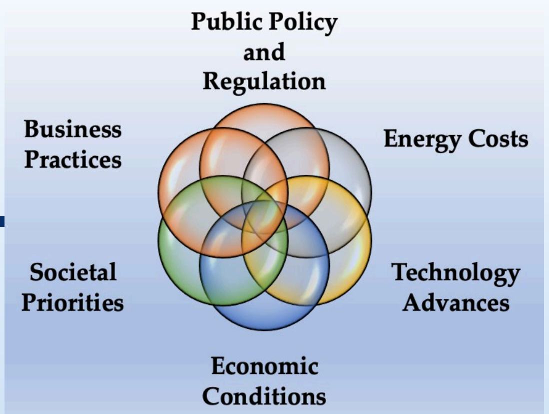
  Efficiency is a relative term as equipment considered efficient today may not be considered efficient in the future. Thus, naturally occurring and incremental efficiency are moving targets.
- *Distributed energy resource (DER)*: A resource sited close to customers that can provide all or some of their immediate power needs and/or can be used by the utility system to either reduce demand or provide supply to satisfy the energy, capacity, or ancillary service needs of the grid.

Focus – Efficiency Market Attributes

- *Energy efficiency markets*: Private, public, and nonprofit mechanisms or venues that allow buyers and sellers to exchange energy efficiency-related products, services, and information
- Attributes of energy efficiency markets:
  - Buyers and sellers (market actors) including the private sector, utilities, and public and non-profit entities
  - Products (e.g., energy-saving technologies) and services, and the affected end-uses in buildings, that are bought and sold in efficiency markets
  - Delivery mechanisms to implement energy efficiency products and services in buildings
  - The level of integration/interaction of efficiency with other types of DERs
  - Scale of the market (e.g., measured by dollars invested or annual units of energy saved)

Drivers of Energy Efficiency in Buildings

Six Identified Drivers of **Energy Efficiency in Buildings**



Identified six categories of interrelated and overlapping drivers (determinants) that influence the attributes of energy efficiency markets:

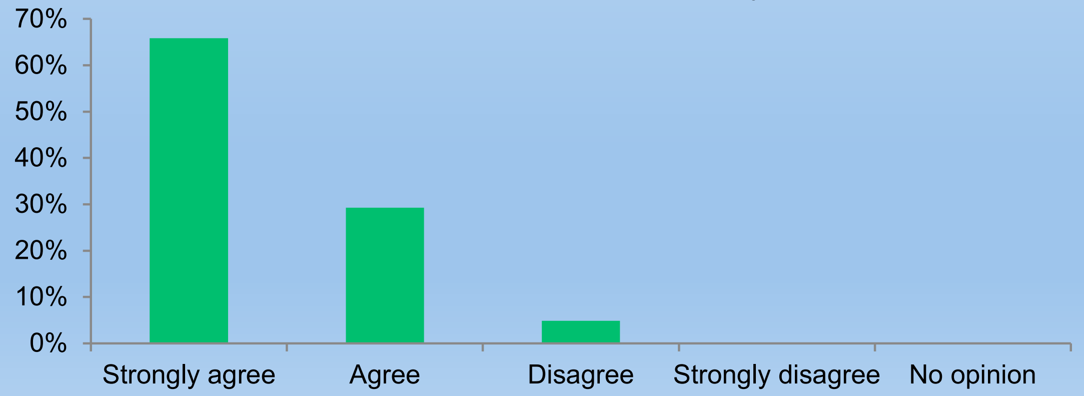
1. **Public Policy and Regulation**
   - 1A. Federal policies and regulation—*example:* GHG policies
   - 1B. Regional, state, and local policies and regulation—*examples:* building energy codes, appliance standards, efficiency incentives or mandates, and performance-based regulation
2. **Energy Costs**
   - 2A. Cost of energy—*example:* consumer energy prices
   - 2B. Cost of implementing energy efficiency or other options for reducing the energy cost burden of buildings—*examples:* the cost of efficiency and the cost of other DERs
3. **Technology Advances** – Incremental and disruptive technology change, including:
   - 3A. Technologies *intrinsic* to efficiency—*examples:* efficient motors, LEDs, control systems, and commissioning
   - 3B. Technologies *extrinsic* to efficiency—*examples:* data access and data science, universal internet access, renewable energy resources, and energy storage
4. **Economic Conditions**
   - 4A. Status of the U.S. economy—*examples:* expansion, recession, unemployment levels, interest rates, access to capital
   - 4B. Demographic changes—*examples:* family size, housing density, commercial building usage patterns, working from home patterns, and population migration to different climates
5. **Societal Priorities** – Societal practices and norms and valuation of efficiency energy and non-energy benefits for society as a whole and individuals—*examples:* increasing use of air conditioning and energy-consuming consumer products, and society's expectation for government's role in energy sector (e.g., mandates versus voluntary action)
6. **Business Practices for Increasing the Uptake of Efficiency in Buildings** – Means for providing and maintaining products and services and providing information—*examples:* performance contracting, utility business models related to customer-funded efficiency programs, market consolidation, behavior-based programs, workforce resources and training, and ESG investing

For questionnaire responses regarding the relative importance of these drivers, see Appendix slide A1.

1. Public Policy and Regulation – Very Important Driver of Efficiency Actions

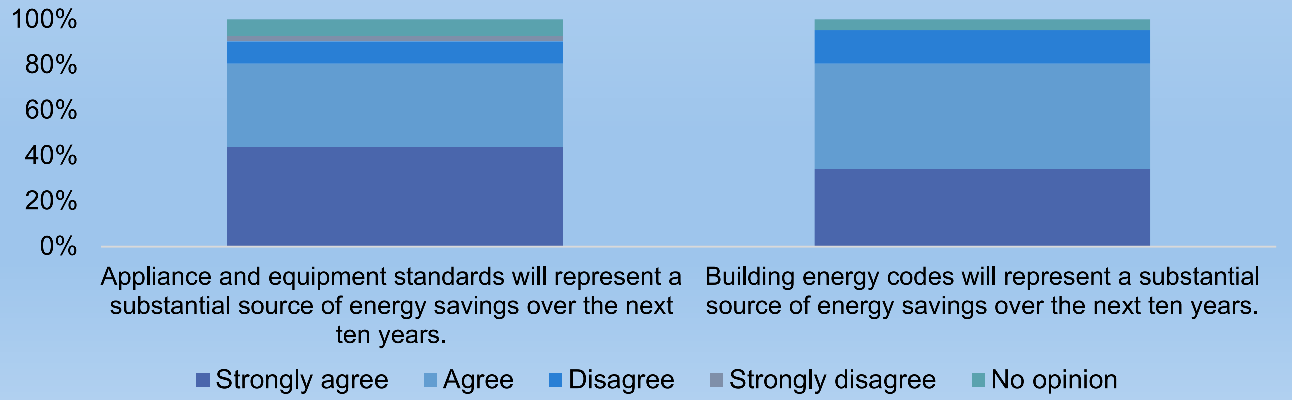
- **Looking back**: *"Six key energy efficiency policies and programs (fuel economy standards, appliance and equipment energy efficiency standards, ENERGY STAR®, utility sector efficiency programs, federal research and development, and building energy codes) saved an estimated 25 quadrillion British thermal units of energy in 2017 – without these savings, annual U.S. energy use would have been about 23% higher."* (Alliance to Save Energy et al., 2020)
- **Looking forward**: Literature review, interviews and questionnaires show near-universal agreement that energy and climate policies and regulations have and will continue to be the most important driver of efficiency investments in buildings.

Questionnaire responses: Government energy and climate policies and regulations will be one of the most important drivers of efficiency markets.



- **Policy and regulation drivers**
  - GHG emission reduction policies are expected to be the most important policy driver for energy efficiency in buildings over the next decade. Reducing other forms of pollution is also an important consideration.
    - *"As we begin this new decade, a major front line for combating climate change will be through increasing building energy efficiency."* (Dockser, 2020)
    - *"Cost is important, but climate is the driver; cost closes the deal, but climate is what generates excitement/leadership."* (Questionnaire respondent)
  - Appliance and equipment standards also are a key driver of efficiency. Building energy codes are an important driver, as well, but they only apply to new construction and major retrofits.
    - *"Policy and regulations can be an effective way to shape markets and encourage the adoption of technologies and behaviors that will change how energy is used. These include building codes, energy sales taxes and financial incentives."* (DNV GL 2020)

Questionnaire responses: Importance of standards and codes



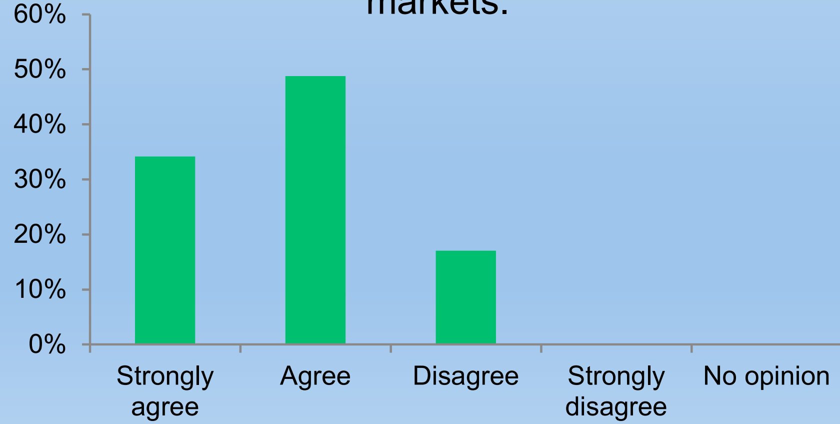
Policy and Regulatory Drivers – Discussion of Options and Issues

- Public policies that can influence efficiency actions may take the form of regulations, mandates and incentives such as:
  - Federal and state equipment and appliance standards
  - Building energy codes incenting or mandating building energy use budgets, inclusion of efficiency features, and decarbonization, including potentially requirements affecting the future of natural gas in buildings (and natural gas efficiency investments)
  - Consumer awareness programs, including benchmarking and disclosure of building energy use and carbon footprints
  - Efficiency workforce-related programs (e.g., for education and training) and requirements (e.g., for prevailing wages)
  - Efficiency investments in government buildings
  - Utility-related regulations for tariff structures (e.g., time of use versus flat rates, demand charges, fixed charges, etc.), decoupling utility profits from retail energy sales, efficiency planning and spending for reducing generation, transmission and distribution capacity requirements, and source requirements (e.g., energy efficiency resource standards)
- The effectiveness of efficiency policies as drivers depends on:
  - Successful implementation of policies via effective regulations, mandates and incentives, such as those listed above
  - Policies keeping up with technology and market innovation, via updates that take advantage of such innovations
- An area of particular policy interest is addressing diversity, equity, inclusion and environmental justice, particularly for low-wealth communities. Efficiency investments in these communities are growing—for example:
  - The Consortium for Energy Efficiency estimates that in 2019, low-income programs led total spending. For comparison, during the previous five years, Commercial and Industrial Mixed Offerings were the most commonly funded program types. (Consortium for Energy Efficiency, 2021)
  - The 2021 Infrastructure Investment and Jobs Act will invest a historic $3.5 billion in the Weatherization Assistance Program for low-income households. (White House, 2021)
- Policies to assist low-wealth communities and communities of color are expected to continue to be a particularly important driver for efficiency actions.
  - *"… low-income and disadvantaged communities will be targeted first to repair some of the environmental and financial disadvantages they have suffered …" (Questionnaire respondent)*
  - Of all U.S. households, 44%, or about 50 million, are defined as low-income. The national average energy cost burden (% of income) for low-income households is 8.6% — three times higher than for other households. In some areas, depending on location and income, energy burden can be as high as 30%. (U.S. Department of Energy, 2021c)
  - There is potential for low-income communities, including rural communities, and non-adopters of new technologies to experience higher energy cost burdens from unequally distributed cleaner energy infrastructure benefits, exacerbating inequality. (Farley et al., 2021)

2. Cost of Energy – Very Important Driver of Efficiency Actions

- Basic economics matter. Higher energy prices (more expensive energy bills) lead to reduced consumption, potentially in part due to efficiency actions.
- Considerations associated with energy costs as a driver:
  - The general inelasticity of building energy consumption is due in part to classic efficiency barriers, such as first costs, that can thwart cost-effective efficiency actions. (U.S. Energy Information Agency, 2021a)
  - The role of energy prices (as compared to energy bills) as a driver of efficiency actions depends on consumers "seeing" the price signal in order to make reasoned economic decisions. However, price signals may be hidden by tariff designs and landlord/tenant split incentives, among other factors.
  - The importance of energy costs as a driver is relative to the cost of implementing efficiency. Many factors determine the cost of efficiency, including material and labor costs (which in turn can be affected by economic conditions, another driver), business strategies, and technology advances.
  - While energy bill savings are a major factor for most consumers, they are not the only benefit consumers consider when making investments. Other direct consumer non-energy benefits, NEBs, (e.g., reliability and resilience benefits, comfort, environmental protection) will likely grow in importance. These benefits will increasingly be included in energy efficiency benefit-cost analyses.
    - *"Non-energy co benefits are typically worth much more [than energy costs]"* (Questionnaire respondent)
    - *"[more] often than not, NEBs far exceed the energy benefits"* (Questionnaire respondent)

Questionnaire responses: The cost of energy to consumers will be one of the most important drivers of efficiency markets.



Cost as a Driver – Discussion of Energy Rates and Rate Structures

- Energy prices – According to U.S. Energy Information Agency's 2021 Energy Outlook (U.S. EIA, 2021b):
  - *"Residential and commercial electricity prices decline slightly in the AEO2020 Reference case through 2050"*
  - *"[N]atural gas prices rise, moderating natural gas consumption"*
  - Implication – While energy prices are a key determinant of efficiency activity levels, major changes in average energy prices are not expected over the next ten years. Therefore, if these predictions are correct, energy prices likely will not drive major changes in efficiency markets.
- Electricity rate design – If the *structure of retail electricity rates* change significantly with, for example, increased fixed charges* and more time-varying rates, such changes could have a significant impact on the cost-effectiveness of efficiency actions.
  - Implication – The cost-effectiveness of conventional efficiency investments may decrease if consumers cannot avoid high fixed charges in electricity bills.
    - *"If and more likely when the electricity system's cost of providing service is dominated by fixed cost, then the economically appropriate price signal should focus on capacity (kW) not kWh..."* (Interview comment)
  - Implication – Efficiency initiatives will increasingly focus on on-peak savings, demand flexibility and efficiency measures that deliver such benefits (e.g., cooling).
    - *"Strongest drivers for EE and demand flexibility are becoming their impact upon peak loads and ability to protect reliability and resiliency, not old kWh energy goals."* (Questionnaire respondent)
- "Wild Cards" for energy prices
  - Electricity: Speed of electricity grid decarbonization, which could affect timing of retail rate changes (magnitude of rates and rate design) and level of building and transportation electrification.
  - Natural gas: If natural gas use in buildings declines,** higher natural gas rates due to stranded costs (and fewer therms over which to spread those costs) could lead to more cost-effective efficiency (assuming volumetric prices, and not just fixed charges, increase). Higher natural gas rates could also lead to more public policy support for efficiency investments in low-wealth communities.

* For example, due to more wind and solar, with lower capacity factors than traditional power plants, and greater investment in transmission and distribution systems to increase capacity, reliability, safety, and resilience.

** Due to decarbonization policies, decreasing population in cold climates, warmer winters, and greater availability of energy-efficient equipment.

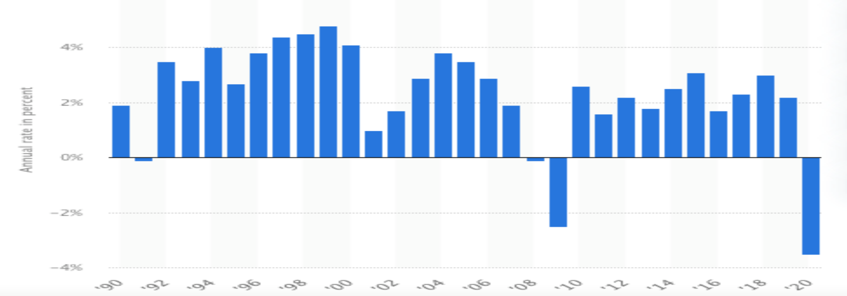
3. Technology Advances – Important Driver of Efficiency Actions

- Incremental and disruptive technology change and competition between technologies are important drivers of efficiency actions.
- Technologies may be:
  - *Intrinsic to efficiency*
  - *Extrinsic to efficiency, but within the energy sector* (and potential competitors to efficiency)
  - *Extrinsic to efficiency, and not specific to the energy sector* (e.g., data accessibility and data science, universal internet access, and artificial intelligence)
- Important considerations
  - Technology advances can take many forms. They are most important as a driver with respect to reducing the cost of implementation and improving performance: (1) making efficiency cost-competitive with the cost of consuming energy as well as non-efficiency solutions for reducing energy costs, and (2) providing other utility system, participant and societal benefits.
  - Technology advances are typically not self-realizing. Instead, they are driven by consumer need and demand. Customers of all types (e.g., residential, commercial) are not always aware of new technologies and may not be able to easily purchase them. New business models and marketplaces can help bring new technologies to customers.
  - Technology advances are interrelated with government policies and regulations as well as energy costs and business practices.

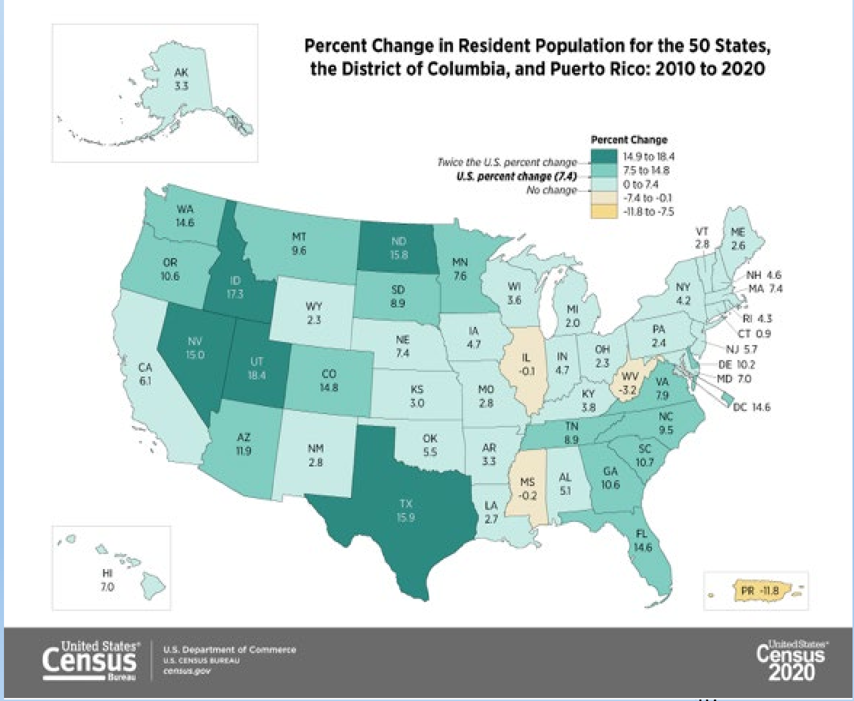
4. Economic Conditions (the Economy and Demographics) – Important Driver of Efficiency Actions

- **Status of the overall economy** – Whether the economy is expanding or contracting, employment and inflation levels, interest rates, and access to capital influence investment activity, including efficiency-based investments.
  - As with other forms of investment, poor economic conditions have historically resulted in less efficiency activity—for example, the COVID-19 pandemic led to a 11.4% decline in energy efficiency employment (down to 2.1 million jobs) with many, but not all, of those jobs recovering in 2021. (Environmental Entrepreneurs and E4theFuture, 2021 and U.S. Department of Energy, 2021a).
  - The U.S. economy tends to run in cycles. Thus, its role as an influencer of efficiency investments is difficult to determine for any given cycle.
- **Changes in U.S. building stock demographics** - Building occupancy, density, and energy use patterns impact overall energy use as well as how energy is used. Two demographic factors may be particularly relevant to efficiency:
  - **Population migration** (currently to states with warmer climates). The EIA predicts that as a result of population shifts, overall U.S. heating needs will decrease and cooling needs will increase, resulting in **more cooling-related efficiency and demand management opportunities**. (U.S. EIA 2020a)
  - **COVID-19-related shifts** (which may have lasting impacts) - *"The COVID-19 pandemic … has caused a significant decrease in demand for electricity, with a load shift from the commercial sector to the residential sector. As economies reopen, it is expected that this shift will partially remain.... Because of the large potential for energy savings and better access to capital, the focus on energy efficiency has been largely on the commercial and industrial sector. But the resulting shift to residential energy use is providing an opportunity to* ***improve energy efficiency in homes****, moving beyond lighting measures to grid-enabled technologies and core building operations." (DNV GL 2020)*

Annual Growth of U.S. Real Gross Domestic Product: 1990–2020



https://www.statista.com/statistics/188165/annual-gdp-growth-of-the-united-states-since-1990/



5. Societal Priorities – Important Driver of Efficiency Actions

- The wants and needs of consumers, collectively as a society, drive markets. Societal priorities (or social norms) can be seen as a “meta” driver of the five other categories of efficiency market drivers, from public policy to business practices.
- Examples of how changes in societal priorities—new social norms—can impact efficiency markets:
  - Practices – Increasing use of air conditioning and consumer (energy-consuming) products
  - Cultural concerns – Greater priority to reduce energy burden for disadvantaged and historically-underserved households and changing expectations for government’s role in advancing energy equity
  - Environmental concerns – Increased personal interest in reducing the environmental impacts of energy use
  - Societal benefits – Greater value applied to resilience as well as energy use externalities (e.g., mitigating pollution, decarbonization)
  - Individual preferences – Increased interest in energy choices that are flexible (e.g., dynamic, intelligent, and connected energy solutions), autonomous (e.g., local, distributed assets and democratized control over energy use), and individualized (e.g., highly personalized energy products and services)
  - Individual and company benefits – Changing value applied to comfort, satisfaction/pride, health, asset value, and corporate internal mandates (e.g., sustainability via “clean” and low carbon energy products and services)

6. Business Practices – Potentially Important Driver of Efficiency Actions

- Business practices and models are the means for implementing and maintaining products and services and providing information, including marketing strategies and approaches to providing material and labor resources. Examples include performance contracting, customer-funded efficiency programs, market consolidation, distributor and retailer stocking practices, behavior-based programs, workforce training and education, and ESG investment criteria.
- Businesses implementing efficiency actions provide a diverse set of offerings. Differences can be summarized across at least three considerations:
  - Market(s) served by geography and by consumer type, for example: residential, commercial, MUSH (municipal buildings, universities, schools and hospitals), low-income, and multi-family.
  - Range of energy measures: Many firms aspire to provide a broad range of efficiency (and other DER) measures, while some focus on specific types of measures.
  - Product and service models: Models range widely, from conventional product and construction sales contracts, to long-term performance contracts, to efficiency as a service offerings (and end-use service offerings—e.g., heating, cooling, lighting), to packaged financing.
- Business practice innovation may have a large influence in a given market, particularly in response to other drivers identified in this report. Any changes in the role of utilities, and their customers' funding of efficiency programs, might have significant implications for business model innovation. However, such innovation may just be focused on specific markets and not have an overarching impact on all building efficiency markets due to broad diversity in building types, energy consumption, ownership, urban vs. rural, and other factors.

Our research indicates a wide range of potential future approaches to marketing and implementing efficiency actions, but no dominant models.

- *"… vendors do not provide homogenous offerings. Their differences can be summarized across three considerations: range of energy measures,… significance of the as-a-service model, … and financial terms …"* (Aamidor, 2019)
- *"Business models will not be a driver because the commercial building space is large and fragmented."* (Interview comment)
- *"Everybody will need to offer efficiency services of some nature, especially if we define efficiency broadly to include grid flexibility and emissions reductions."* (Questionnaire respondent)

Energy Efficiency in Buildings: Future Expectations

The Efficiency Market: Future Expectations and Unknowns

While our research focused on market drivers, as a secondary objective we delved into predictions for the future of energy efficiency in buildings. Based on concepts and expectations deduced from this project's research, we offer:

- Two potential scenarios that summarize the market expectations found via our research,
- Some specific expectations, and
- Some specific unknowns.

Bottom Line

- Energy efficiency in buildings does not have a singular future. Instead, its attributes will vary by market sector, jurisdiction and geography. Attributes will be defined primarily by:
  - The six categories of interrelated and overlapping drivers
  - Divergent characteristics of each market sector, e.g., residential, low-income, commercial, urban, rural

"It's tough to make predictions, especially about the future." Danish Proverb

"Significant opportunities for clean energy innovation are presented by the changing U.S. energy supply profile; by advances in platform technologies such as digitalization and big data analytics; by expansion of electrification in the transportation and industrial sectors of the U.S. economy and the resulting electricity dependence of these sectors; by increases in urbanization and the emergence of smart cities; and by broad social and economic forces pushing to decarbonize energy systems in response to the risks posed by global warming and associated climate change."
(IHS Markit and Energy Futures Initiative, 2019).

The Efficiency Market – Future Scenarios

The following are two potential efficiency scenarios for buildings over the next ten years. These scenarios are intended to provide a heuristic overview of the market expectations provided on the following slides. Each scenario may play out differently in different parts of the country, depending on the scope and reach of federal regulations and the level of state and local policymaker effort in addressing climate change (mitigation and adaptation) using demand-side resources.

Scenario 1:

- Accelerated efficiency impacts scenario – Moderate-to-high levels of national savings growth driven primarily by strong policies and regulations aimed at reducing GHG emissions
  - GHG emission reduction goals at the local, state, or federal levels, result in more stringent federal equipment efficiency standards and state and local building energy codes, low-income efficiency investments, and increased targets for state energy efficiency resource standards
  - Increased load growth due to building and transportation electrification creates upward pressure on cost of electricity
  - Increased private sector GHG emission reduction goals stemming from societal preferences and ESG investment criteria
- GHG policies also may drive higher natural gas prices and possibly electricity retail rates (for electricity generators with high carbon footprints), as well as technology and business model innovation, all of which can also reinforce accelerated efficiency actions.

Scenario 2:

Low-to-moderate efficiency impacts scenario – Low-to-moderate levels of national savings growth due to:

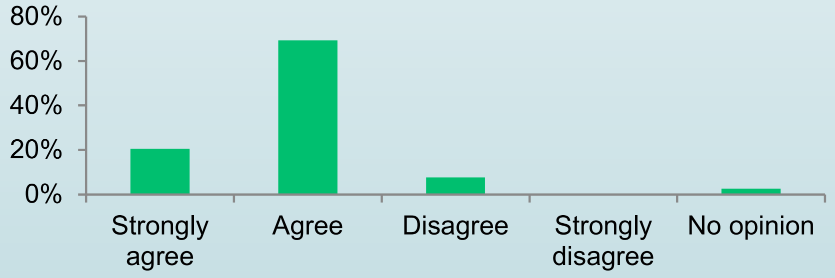
- Static or declining federal climate-related interventions
- Status-quo levels of efficiency-driven policies in many states
- Economy-wide issues (e.g., inflation and on-going labor constraints)
- Technology and business model innovation and strong GHG emission reduction targets in some states and parts of the private sector

Questionnaire responses: Expected rate of national savings growth by sector

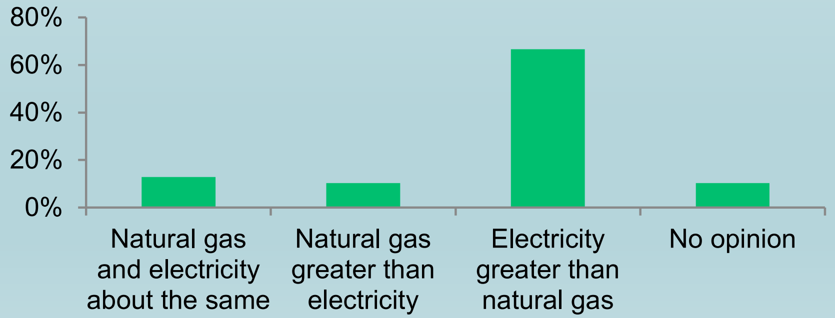
Discussion – General Expectations for the Future of Building Efficiency Over the Next Ten Years

- While state- and local jurisdiction-specific actions have and will likely continue to vary widely, overall local and state governments (including municipal utilities and regulators of investor-owned utilities) will increase their energy efficiency goals—for example, as measured by dollars invested or annual units of energy saved.
- The United States can continue to expect a mix of incremental (incentive-driven) and naturally occurring (primarily driven by codes and standards—C&S) efficiency. This mix will continue because markets have not transformed to entirely naturally occurring, consumer-driven efficiency and are not likely to do so in a ten-year timeframe.
- Appliance and equipment standards (both existing and future) will represent a substantial source of energy savings from efficiency actions. Existing and future building energy codes also will be an important source of efficiency savings, but less important than standards, because codes only affect new construction and major retrofits.
- Electricity efficiency investments will grow faster than efficiency for natural gas and other fossil-based fuels. Decarbonization through electrification will increase the market share of electricity-consuming equipment, motivating greater efforts to make this equipment as efficient as possible.
  - *"The focus will shift to electrification vs. increasing gas efficiency"* (Questionnaire respondent)
  - *"Focus will be on decarbonization not gas efficiency. For example, remove gas appliances, don't spend public money on replacing them."* (Questionnaire respondent)
  - *"Traditional efficiency may diminish but IDSM investment and goals, increase."* (Questionnaire respondent)

Questionnaire responses: While state-specific actions will vary, overall state and local governments will increase their energy efficiency goals



Questionnaire responses: Will electricity efficiency or natural gas efficiency grow faster in the next ten years?



Discussion – Expectations for Intrinsic Technology Advances

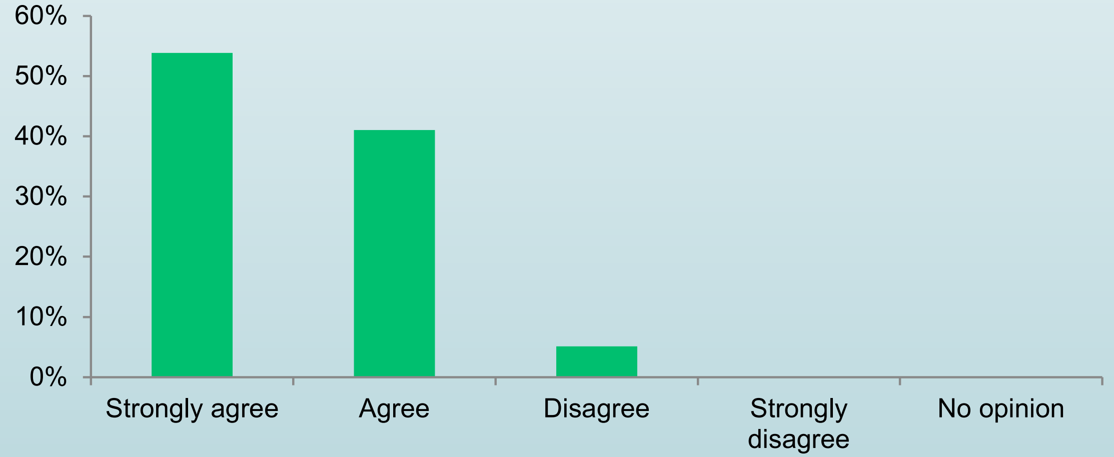
There are at least two components to technology advances: (1) actual improvements in equipment/system performance, and (2) the rate at which improved equipment/systems are adopted by energy consumers. Irrespective of the pace of efficiency technology advances, there is a collective expectation for higher penetrations of efficient technologies, as well as advanced building energy controls and metering, in new and existing buildings.

- Our literature review, interviews, and questionnaire responses revealed a lack of consistent expectations for the rate of advances in efficiency technologies, in terms of both performance (efficiency level) and cost.
- Some experts think (or perhaps hope) that efficiency technology advances will continue at the rapid pace of the past. Other experts call out specific technologies for such significant improvement potential, including building controls, heat pumps, and building facade technologies (e.g., windows, insulation and cool walls/roofs). For questionnaire responses regarding specific technologies, see Appendix slide A2.
- In addition, some experts expect that for many equipment-specific efficiency technologies, efficiency improvements and cost reduction advances over the next ten years will be important but comparatively modest compared to historic trends. This is due to, for example:
  - Technology advancement-related barriers: Relatively high efficiency levels for today's commercially available natural gas- and electricity-consuming equipment (e.g., furnaces, motors, lighting), leaving less room for technological progress
    - *"Not sure how much more we can get from incremental improvement of existing equipment but they may be controlled better."* (Questionnaire respondent)
    - *"Even if you continue to achieve 50% reduction in consumption it is becoming incrementally smaller from an absolute perspective (e.g., CFLs to LEDs)."* (Questionnaire respondent)
  - Adoption-related barriers: Long life of many building components (e.g., insulation, boilers, chillers), labor supply constraints, increasing labor costs, and product cost inflation may limit the rate of adoption of more efficient technologies.

Discussion – Expectations for Extrinsic Technology Advances

- There are strong indications that the overall efficiency of energy consumption will benefit from non-efficiency specific technological advances and cost reductions over the next 10 years. Examples include advances in sensor technology, advances and application of artificial intelligence (e.g., smart appliances), improvements in equipment and systems interoperability, data accessibility and data science, manufacturing (e.g., 3-D printing) and installation (prefabricated construction) practices, and universal internet access. These trends will continue to give rise to new and better energy management options and improved efficiency performance.
  - *"We'll also move to decarbonization, which will require electrification, which will require digitization to enable buildings to optimize carbon impact."* (Interview comment).
  - *"Hi Alexa. I want to save some money on my electric bill."* (Questionnaire respondent)
- Two specific examples:
  - Grid modernization including technology changes will enable greater utility-to-customer engagement and market adoption of utility digital communications that will support DERs, including efficiency.
  - New data-gathering and analytical methods present opportunities for the efficiency market, from marketing to delivery of customized projects that can be targeted to location and timing needs at potentially lower cost.

Questionnaire responses: Energy efficiency technologies will benefit from extrinsic technological advances, giving rise to new and better energy management options

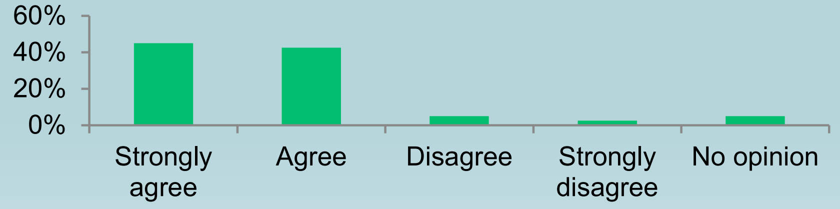


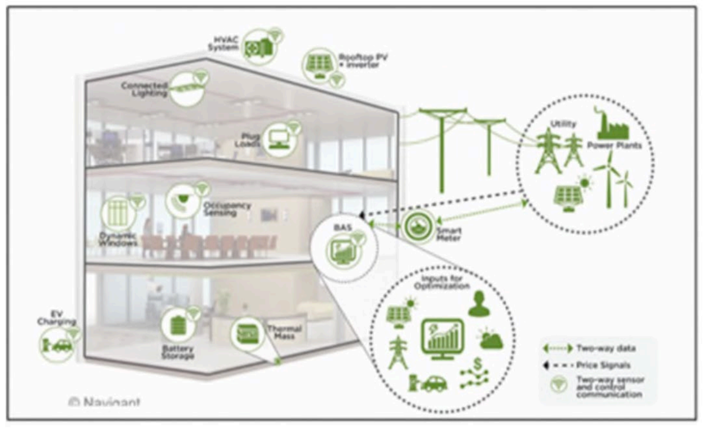
- In addition, improvements in the cost-effectiveness and performance of other DER technologies (storage, generation, demand response)—which, like efficiency, can reduce consumer energy costs and provide reliability and resilience benefits—may either complement or compete with efficiency measures. This trend may have a neutral, supportive or deterrent impact on efficiency markets.

Discussion – Expectations for DER Integration and Demand Flexibility

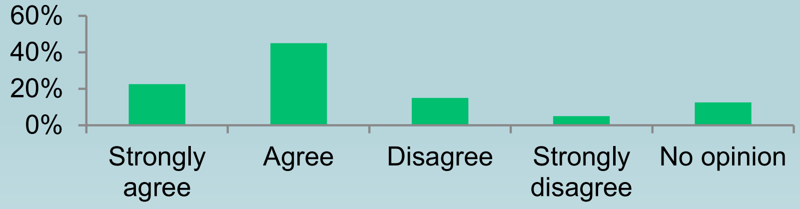
- Electric efficiency actions will become more focused on **demand flexibility and reductions in energy usage during specific times** (e.g., weekday summer evenings) versus annual electricity savings goals.
  - Integration of renewable energy supply resources, reliability and resilience needs, and retail rate designs (e.g., with increased percentage of bills allocated to fixed charges and time-varying pricing) will influence efficiency and demand flexibility actions to the extent that consumers or third parties (e.g., aggregators) respond to these price signals.
  - Total energy reductions (e.g., annual kWh reductions) will continue to be a goal and metric for electricity efficiency in buildings, but perhaps no longer the primary goal compared to capacity-related, demand reductions (e.g., peak-period kW reductions).
  - The market will increase its focus on developing grid-interactive efficient buildings.
    - *"As the grid continues to modernize, timing of consumption will be increasingly important. The value of efficiency actions will be greatly impacted by these timing needs."* (Questionnaire respondent)
    - *"…flexibility will increasingly become a standard feature of electricity using equipment."* (Questionnaire respondent)
- Electric efficiency actions also will focus more on reducing load in specific locations (likely distribution-constrained areas), rather than system-wide.

Questionnaire responses: Electric efficiency actions will become more and more focused on reductions in energy usage during specific times.





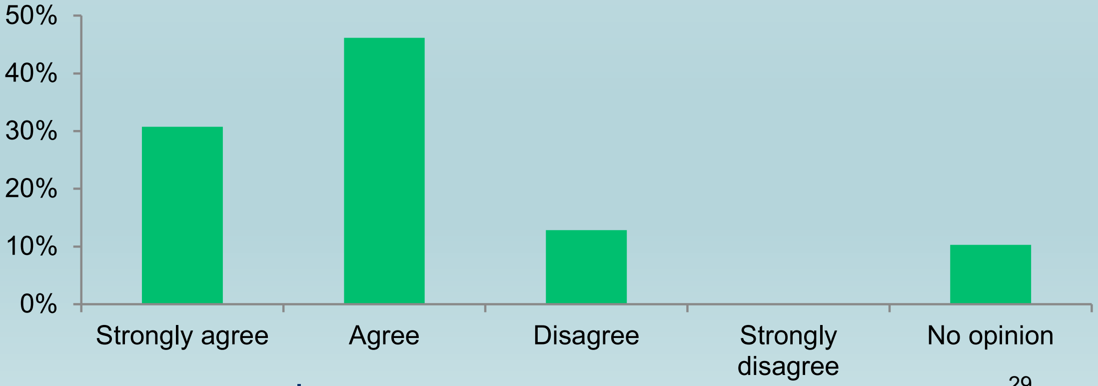
Questionnaire responses: Electric efficiency actions will become more and more focused on reductions in energy usage in specific locations.



Discussion – Expectations for Efficiency in Disadvantaged and Underserved Communities

- Low-income programs (including for homes and small businesses in disadvantaged and underserved communities) will continue to take a separate route from other residential and commercial programs, with a portion of the efficiency industry continuing to focus on low-income programs through direct install and other “no-cost” implementation mechanisms.
- Such programs will likely see increased investment from public and utility customer funds.
  - *“Commissioners have expressed concern that electrification will exacerbate low-income households’ energy burdens.”* (Interview comment)
  - *“[What’s next for energy efficiency] …value of targeting programs to customers with the highest energy burdens, often in rural areas or underserved communities of color.”* (Gold, 2019)
- These programs will increasingly recognize the social benefits of reducing energy bills, improving occupant health and safety, and addressing the historic neglect of underserved communities, rather than focusing mostly on cost-effectiveness of investments through reduced energy consumption and demand on the utility system.
  - *“… there are real risks that the gains of clean energy might be unequally distributed, while the costs fall on rural communities and non-adopters of new technologies, thus exacerbating inequality while greening the grid.”* (Welton and Eisen 2019)

Questionnaire responses: Low-income efficiency efforts will increasingly recognize social benefits rather than focus on reduced energy consumption



Discussion – Expectations for Efficiency Business Practices

Research indicates that there is a wide range of opinions about what direction efficiency business practices will take over the next ten years, and how much of an influence changes (and innovation) in such practices will have on the attributes (including scale) of efficiency markets. The following are a few consensus (or near-consensus) expectations for business practice changes.

- Efficiency services and product businesses will increasingly focus their marketing on:
  - Grid services, demand flexibility and time value of efficiency
  - Building decarbonization and carbon metrics
  - Efficiency's non-energy benefits (for consumers), such as comfort, reliability, resilience, and indoor health benefits
  - Efficiency in a package of other DERs (demand response, distributed generation and storage options)
- There will be a greater focus on systems versus components and on communities versus individual buildings—optimizing, for example, for a downtown business district versus one building at a time. This presents more opportunity for efficiency and demand flexibility, but also more complexity. This could be encouraged through increased:
  - Capability and cost-effectiveness of integrated system packages, given improved controls and data collection
  - Demand for grid services and building reliability, resilience, and carbon neutrality through integration of efficiency with other DERs
  - *"In next ten years, we will go from being focused on components to systems, from buildings to communities—from selling fixtures to selling services. If you draw the boundary bigger than the building, efficiency's definition grows."* (Interview comment)

Discussion – Some Unknowns for the Future of Energy Efficiency in Buildings

Direction for some aspects of energy efficiency markets, that can have important impacts, are not as clear— the "known unknowns."

- Will there be a greater emphasis on deep, comprehensive efficiency retrofits? Or will the emphasis be on more focused retrofits of just the high value component/system efficiency opportunities, with perhaps somewhat lower savings per buildings, but presumably reaching larger numbers of buildings?
- How will the role of utilities change with respect to administering and implementing efficiency actions? For example, will there be more third-party administrators of efficiency programs or more outsourcing of programs?
- Will existing constraints in the availability of skilled energy efficiency workers, and workers in related fields, limit the future success of energy efficiency markets?
  - *"Industry is already feeling labor constraints."* (Interview comment)
  - *"Workforce development will be badly needed, but it is an opportunity since a lot of people in the industry are aging out."* (Interview comment)
- Will there be further consolidation among companies offering efficiency services and products – manufacturers, retailers, contractors, utility program implementers, etc.? How would this impact the cost and range of efficiency offerings?
- Considering decarbonization efforts, will governments and utilities actively encourage consumers to shift from using natural gas in buildings in favor of non-fossil fuel based technologies? If so, how will that impact energy efficiency activities and markets? For example, will there continue to be financial support for efficient natural gas equipment retrofits and new construction?
- What *black swans* will impact the future of building efficiency (hard to predict, rare events beyond the realm of normal expectations)? For example:
  - Significant changes to national and state leadership, public policy and social norms that significantly change the national approach to GHG emission reductions and climate change mitigation, the role of government in directing energy markets through efficiency and other energy or environmental mandates
  - Supply chain issues (including severe energy shortages) that are human-caused or natural, short-term or long-term

Implications and Uses of This Research

Applications of this Report

Implications for the Future of Efficiency

Given the identified six categories of drivers and expectations for what efficiency markets will look like in the next ten years, here are some implications for the industry and policy makers:

- Over the next decade, as in the last 50 years, building efficiency markets will likely see significant swings in investment and uncertainty regarding future directions.
- The rate of progress toward climate-related building decarbonization and grid integration of renewables goals will significantly impact the pace of efficiency actions.
- Achieving large efficiency impacts requires supportive policies and regulations, as well as their effective implementation. Thus, meaningful stakeholder engagement, including by environmental, consumer, industry (utility and non-utility), and community-based organizations is critical both for development of effective policies and regulations as well as effective implementation.
- As energy transitions occur, increased support is needed for those with the heaviest energy burdens, and the fewest resources to address them, through public and ratepayer efficiency investments.

Using This Research to Support Efficiency's Preferred Future

Research, development, demonstration, & deployment (RDD&D) and technical assistance can support development and implementation of effective efficiency policies, regulations and programs. Among the areas to focus on are benefits of and opportunities for:

- Support for state utility regulators and other local, state, regional and federal decision makers
- Intrinsic and extrinsic technological developments
- Building decarbonization strategies
- Tariff design
- Market transformation, including increasing consumer demand for efficiency via building energy disclosure and benchmarking as well as consumer education on multiple benefits of energy efficiency in buildings
- Innovative business practice experimentation, including demand flexibility and DER integration, system/community approaches, and financing and (efficiency as a) service options
- Labor force development, including workforce education and training

Efficiency Industry Expert Acknowledgements

We thank the industry experts listed on the following slides for their input through interviews and a questionnaire.

All opinions, errors, and omissions remain the responsibility of the authors.

Interviewees

- Serj Berelson, Director of Policy & Strategy, California Efficiency + Demand Management Council
- Severin Borenstein, Professor, Faculty Director, E.T. Grether Chair in Business Administration and Public Policy, Energy Institute at Haas School of Business
- Donald Brundage, Codes & Standards Expert, ASHRAE 90.1 Committee Chair; Principal Engineer, Southern Company
- Lee Evans, Manager, Demand Side Support, Southern Company
- Peter Fox-Penner, Professor of Practice, Questrom School of Business
- Donald Gilligan, President, National Association of Energy Service Companies
- Charles Goldman, Staff Scientist, Berkeley Lab
- Val Jensen, Senior Fellow, Energy Advisory, Policy, and Program Implementation, ICF
- Peter Larsen, Staff Scientist, Berkeley Lab
- Richard Lord, Sr Carrier Fellow & ASHRAE Fellow, Carrier Corporation
- Mandy Mahoney, President, Southeast Energy Efficiency Alliance
- Paul Mathew, Staff Scientist, Berkeley Lab
- J. Andrew McAllister, Commissioner, California Energy Commission
- Natalie Mims Frick, Energy Efficiency Program Manager, Berkeley Lab
- Steve Nadel, Executive Director, American Council for an Energy-Efficient Economy
- Clay Nesler, Global Lead, Buildings, World Resources Institute, Ross Center for Sustainable Cities
- Mary Ann Piette, Senior Scientist and Director of the Building Technology and Urban Systems Division, Berkeley Lab
- Kenneth Shiver, Director of Planning and Regulatory Support, Southern Company
- Jay Stein, Senior Fellow Emeritus, E Source
- Timothy D. Unruh, Executive Director, National Association of Energy Service Companies
- Greg Wikler, Executive Director, California Efficiency + Demand Management Council
- Ed Wisniewski, Executive Director, Consortium for Energy Efficiency

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Questionnaire Respondents

- Cyrus Bhedwar, Policy Director, Southeast Energy Efficiency Alliance
- Dave Birr, President, Synchronous Energy Solutions
- Aaron Block, CEO, Allumia
- Andrew G. Campbell, Executive Director, Energy Institute at Haas
- Nicholas Cooper, Utility Engineer, Georgia Public Service Commission
- Charlie Culp, Professor, Department of Architecture, Texas A&M University
- Andrew deLaski, Executive Director, Appliance Standards Awareness Project
- Dan Delurey, President, The Wedgemere Group
- Nick Dreher, Policy Director, Midwest Energy Efficiency Alliance
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- Colm Otten, Sr. Program Manager, Seattle City Light
- Ted Pope, Founder and Principal, 2050 Partners
- Cynthia Bruno Rafferty, CEO, RHA
- Deborah Reynolds, Assistant Director, Conservation and Energy Planning, Washington Utilities & Transportation Commission
- Matthew Sachs, Senior Vice President, Strategic Planning and Business, CPower
- Arah Schuur, Executive Director, Northeast Energy Efficiency Partnerships
- Alison Silverstein, Project Manager, North American SynchroPhasor Initiative
- Naomi Simpson, Manager of Resource Optimization & Certification, Michigan Public Service Commission
- Craig Smith, Energy Consultant
- Rodney Sobin, Senior Program Director, National Association of State Energy Officials
- Jay Stein, Senior Fellow Emeritus, E Source
- Tim Unruh, Executive Director, National Association of Energy Service Companies
- Greg Wikler, Executive Director, California Efficiency + Demand Management Council
- Additional respondents who wished to remain anonymous

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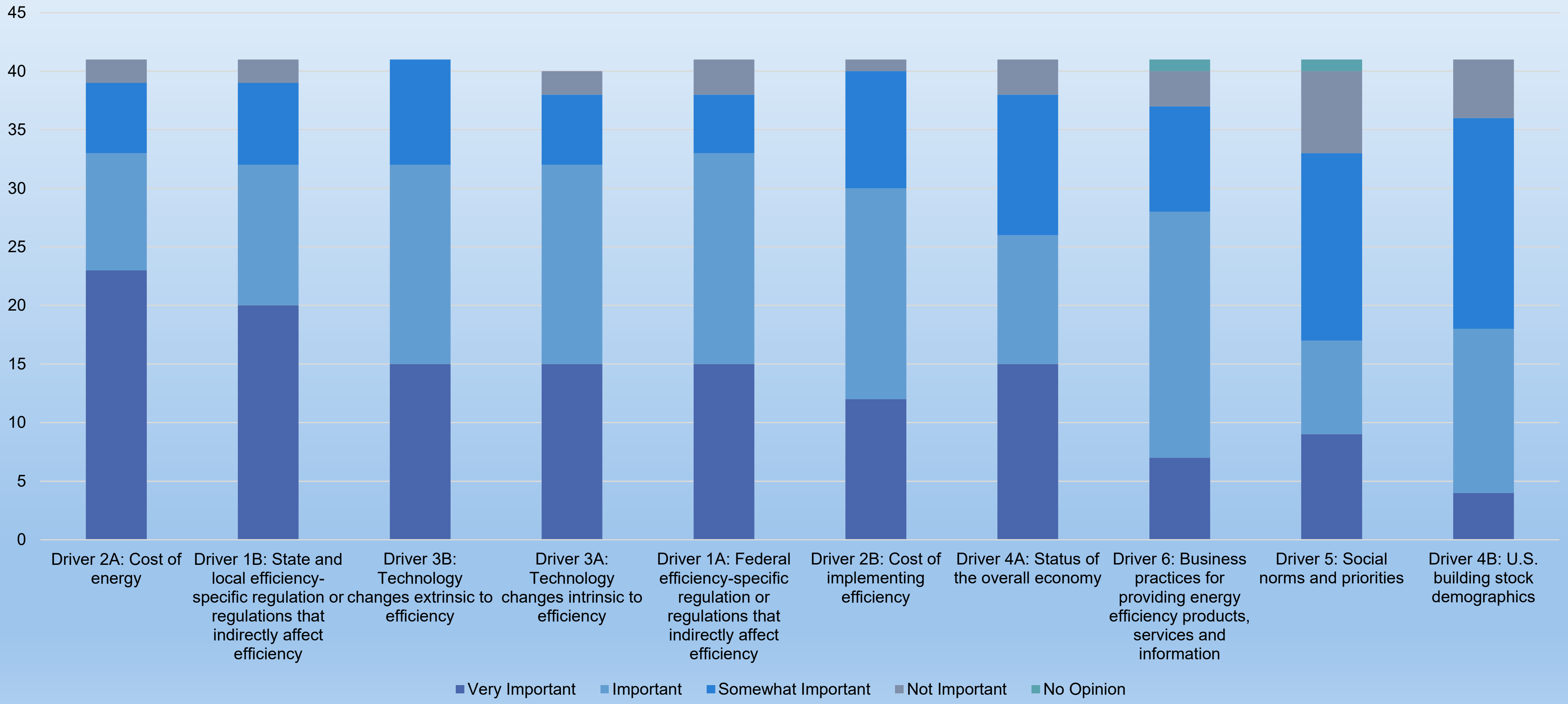
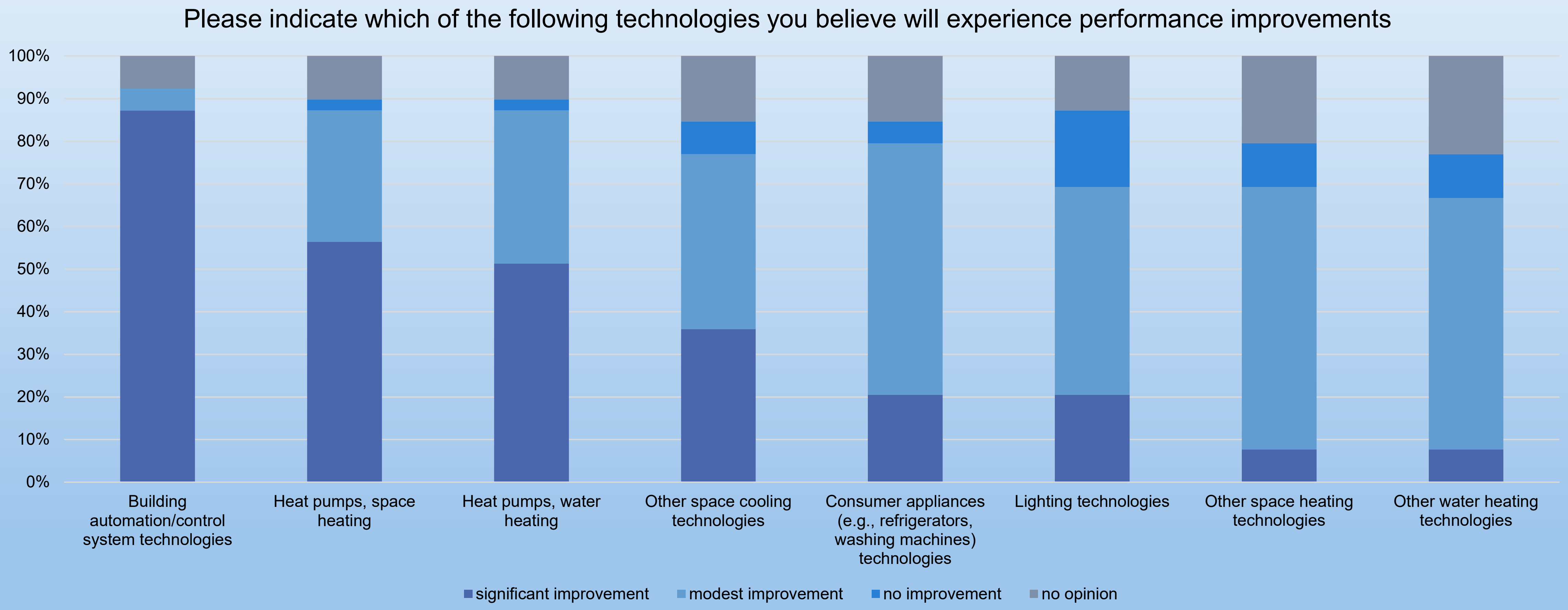
Appendix – Select Questionnaire Responses

A1. Questionnaire Responses: Drivers Ordered By Importance



A2. Questionnaire Responses: Technology Improvements



Note: Our questionnaire respondents were energy efficiency market experts but not specifically technology experts.