# Tennessee Valley Authority (TVA) Demand Management Strategic Planning Input Summary

## Overview

Through its TVA EnergyRight® suite of programs and services, TVA partners with local power companies (LPCs), industries, businesses, and households to bring the benefits of energy efficiency and demand management solutions to local communities. As TVA strives to balance its aspiration for a carbon-free future with maintaining low rates and a stable grid, energy efficiency and demand response programs are a cost-effective resource that foster economic growth through job creation and community savings, reduce carbon emissions and air pollution, and strengthen the partnership between TVA, LPCs and end-use consumers.

Since the Summer of 2021, TVA has endeavored to define, evaluate, and optimize a long-term strategy for TVA's demand management portfolio. This process has included:

- Multiple analyses and market research efforts to help inform TVA of market potential for energy efficiency and demand response,
- Internal analyses to determine optimal costs and volume of energy programs needed to support TVA's system and strategic needs, and
- Program-level inputs informed by the Energy Programs Potential Study provided into TVA's resource planning process to assess strategic outcomes for the long-term demand management portfolio.

Through this process, TVA is encouraging and rewarding people and businesses to join us in building a more resilient grid with over $1.5 billion in funding for our energy efficiency and demand management portfolio through FY28. Strategic direction from the 2024 Integrated Resource Plan (IRP), which will be published in Fall 2024, will inform a long-term demand management strategy through 2035 and beyond.

# Key Planning Inputs

## TVA 2019 Integrated Resource Plan (IRP)

TVA's 2019 IRP recommendation included the potential for expansion of energy efficiency programs and included a near-term action to conduct an updated market Potential Study with results to influence planning and overall asset strategy.

## Energy Programs Potential Study, conducted by DNV

Conducted throughout 2021 and 2022, the Energy Programs Potential Study was a collaborative effort between TVA and DNV, a worldwide leader in the field. This study offers a detailed snapshot of regional opportunities for influencing electric load through various solutions, such as energy efficiency, demand response and electrification. The study estimates the volumes of energy programs that are ultimately achievable in our market by evaluating prevalent technologies, economic value, and barriers to market adoption.

## Energy Efficiency & Efficient Electrification Potential Study for Industrial Customers, conducted by Electric Power Research Institute (EPRI)

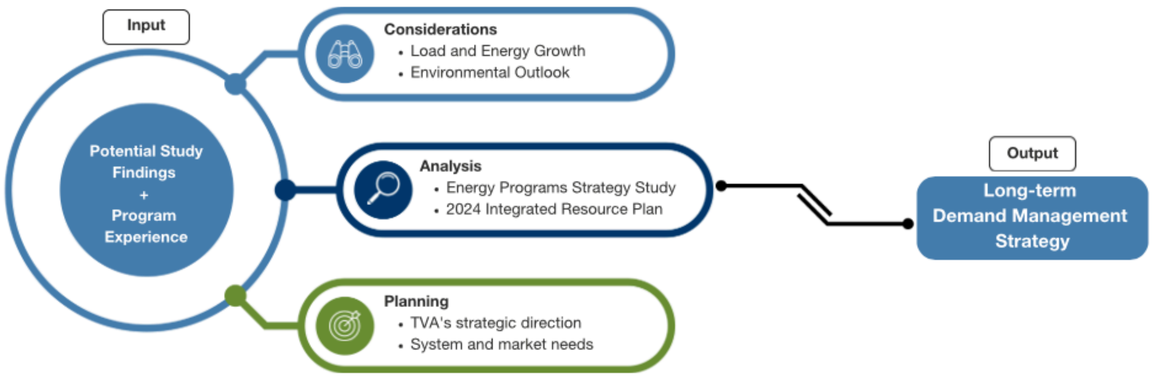
Completed in 2023, the industrial-focused Potential Study was a collaborative effort between TVA and EPRI, who was commissioned to obtain precise information related to industrial process efficiency that was not included in the Energy Programs Potential Study conducted by DNV. This study quantifies energy efficiency and efficient electrification potential among industrial consumers within TVA's service territory.

## TVA Energy Programs Strategy Study

During 2023, TVA endeavored to test how insights from the potential studies, along with our experience with executing programs in the marketplace, could be used to develop a near and long-term demand management strategy. This evaluation utilized information from the DNV and EPRI-conducted potential studies to create more sophisticated, tailored, and data-informed analyses. A key tool in this evaluation was TVA's resource planning process, which considers how TVA will meet energy needs. The demand management program options are part of a suite of resources to fulfill those needs and the outcomes help inform near-term program design.

## How Key Inputs Work Together

TVA subject matter experts utilized findings from the DNV and EPRI potential studies along with historical knowledge of energy program operation and performance to inform the development of demand management resources utilized for the resource planning processes, including TVA's next Integrated Resource Plan. Historical program knowledge may include a program's previously achieved volume and associated costs, how technologies or incentives impacted consumer uptake and participation, how the market may have changed, projects already in the pipeline for a program, and changes based on measurement and verification.




## Near-term Actions

As part of TVA's commitment to meet the Valley's growing energy needs, we are partnering with local power companies to make profound investments to expand our energy efficiency and demand management programs, with over $1.5 billion in funding over five years (FY24-28). Through this investment, TVA's energy efficiency and demand management programs will help balance system needs by lowering costs, shaping energy usage, and increasing capacity. Programs will also help meet increasing consumer demand for clean energy, electric vehicle, and resiliency-based offerings along with maintaining impactful energy equity programs in the Valley.

# Appendix Item: Energy Programs Potential Study Summary Report

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# Energy Programs Potential Study Summary Report

## Overview

This report summarizes the collaborative efforts of TVA's Enterprise Planning and Commercial Energy Solutions teams with third-party support and analysis conducted by DNV. TVA's most recent Potential Study was completed in 2012 and is now outdated due to changes in codes & standards, as well as technology advancements since that time. TVA's 2019 Integrated Resource Plan included a near-term action to "Conduct market potential study for energy efficiency and demand response" ahead of the next IRP (currently planned for 2024).

The results of this study are intended to inform TVA's inputs to various program and system planning projects, including the next IRP. The findings can support planning processes as an asset strategy is developed and help align energy programs to TVA's mission and evolving carbon strategy.

A potential study offers a detailed snapshot of regional opportunities for influencing electric load through various utility programs. This snapshot is the first step in program planning, analyzing the availability of a particular end-use resource. It helps frame expectations by identifying high-value measures and incentive scenarios.

This study considers three resource types: energy efficiency (EE), demand response (DR) and electrification (E) in the TVA region. The analyses conducted in this study estimate the range of possibilities for the three resource types in each primary market sector (residential, commercial, industrial) given certain conditions. The results of these analyses provide insight regarding the market sectors and high-value measures that have the potential to provide the greatest impact for the valley. These results are foundational to program planning: they do not provide a prescriptive guide for obtaining the end-use resource nor should the results be considered plug and play. Additional research and modeling beyond the scope of this study should be considered in selecting optimal levels to pursue.

The project team assessed the potential for each resource at multiple levels, leveraging TVA-specific forecasts and projections where possible. External data supplemented these datasets when necessary. Results assume a 2023 base year; program activity that starts in later years will impact the achievable potential. Results are shown through 2032; however, results through late 2040's are available. For all resources, measure cost-effectiveness is a primary focus.

### LEVELS OF POTENTIAL

**Technical** includes all available technology with no cost considerations and assumes consumer willingness to adopt all measures.

**Economic** is a subset of technical that includes measures that are considered cost-effective when compared to supply-side alternatives and considers consumer costs.

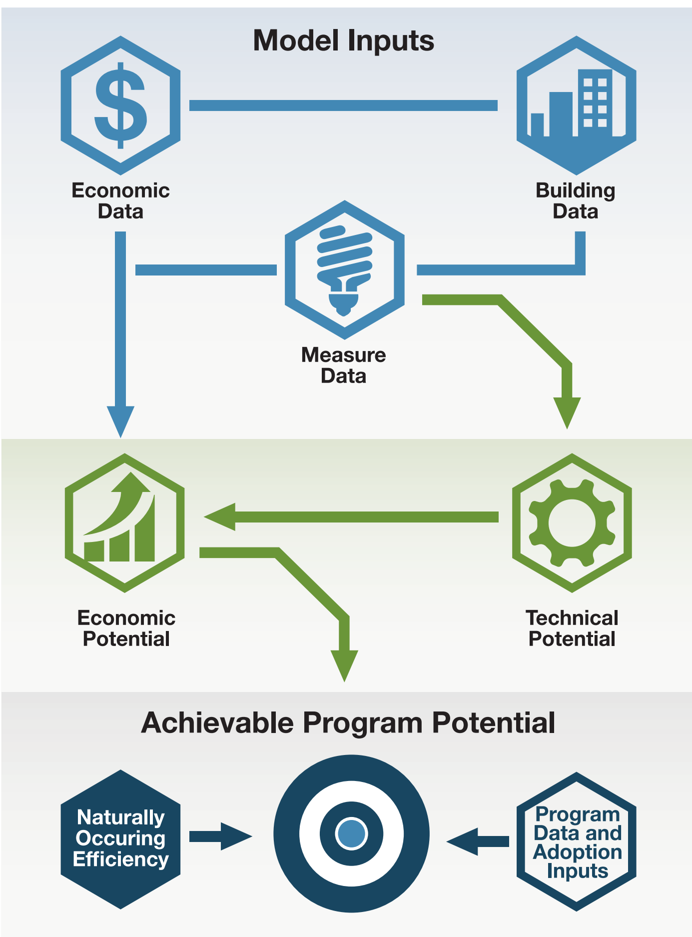
**Achievable** is best described as the realistic potential, what would occur in response to specific program funding, marketing, and incentive levels. Considerations for market and program barriers are included. Naturally occurring activities that results from codes and standards, or typical market adoption are removed as they are would have happened anyway. Achievable potential is segmented into tiered scenarios to support program planning.

**This summary report focuses on achievable levels of potential.**

# Approach

A sequential series of analyses began with the collection of model input data and the creation of a baseline market characterization. The market characterizations leveraged valley and region specific building and economic data as the basis for estimation. Measure-level analysis was conducted utilizing accepted cost estimates and region specific impacts for tailored analysis. Technical and economic potential were then calculated, followed by estimations of naturally occurring and achievable potential.

This general approach was used for all three resources. Costs were also specific to each resource and nuances of resource type were taken into account for overlapping measures between resources. Interactive effects between resources are not directly accounted for in the analysis, but should be minimal given specificity of analysis.




## KEY CONSIDERATIONS

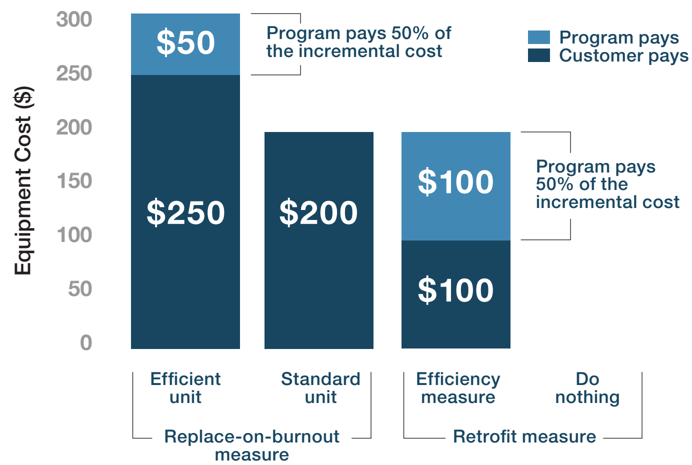
- Program costs include operations/administration, limited marketing and incentives; they do not include costs such as Evaluation, Measurement and Verification (EM&V), other infrastructure/reporting costs, or expanded marketing campaigns. These additional cost considerations could add up to 20%1 to the program cost estimates.
- Leveraged TVA program designs and Technical Resource Manuals (TRM).
- Leveraged TVA saturation data, regional end-use intensities, TVA avoided costs, program participation rates, and historical implementation costs.
- Considered proven measures from other utilities.
- Augmentation data from peer utilities was used where possible; EIA or other regional/national data was used for remaining gaps.
- Staged bottom-up analysis to avoid double counting and other common estimation risks.
- Potential for all resource types are driven by electric fuel saturations.
- Developed an internal forecast of naturally occurring adoption to inform net and gross savings forecasts.
- Achievable potential is reflected through three scenarios (A, B, C).
- High or upper bound cases have the most uncertainty due to assumed market restrictions.
- Future codes and standards could erode potential impacts.
- Future technology improvements could understate EE potential, while overstating E and DR
- Changes to TVA's avoided energy and capacity costs will alter achievable potential for all resources

# Energy Efficiency Findings Summary

## MODELING

DNV used its DSM Assyst™ model to estimate energy efficiency potential. The model integrates technology-specific engineering and customer behavior data with utility market saturation data, load shapes, rate projections, and marginal costs into an easily updated data management system. Three scenarios representing different levels of program incentives and costs were modeled as part of the study, each based on a fixed percentage of each measure's incremental cost. Scenario A assumes 50%; Scenario B assumes 75%; Scenario C assumes 100%. Incremental cost is the difference between the cost of the energy efficiency measure and the alternative. For replace-on-burnout measures, the alternative is standard-efficiency equipment. For retrofit measures, the alternative is to do nothing (no cost). An EE incentive example is provided in the figure.

### Incentive example, 50% Scenario




## FINDINGS

DNV's analysis looked at potential impacts of scenarios assuming sustained utility program operations over TVA's planning horizon across the residential, commercial, and industrial sectors. Given longer-run uncertainty regarding technologies and general market trends, results focus more on near-term impacts to best support 10-year business planning needs. The following graphs represent the 10-year cumulative valley potential across all market sectors as a percentage of estimated 2032 base sales (GWh) and 2032 base peak (MW).

## HIGHLIGHTS

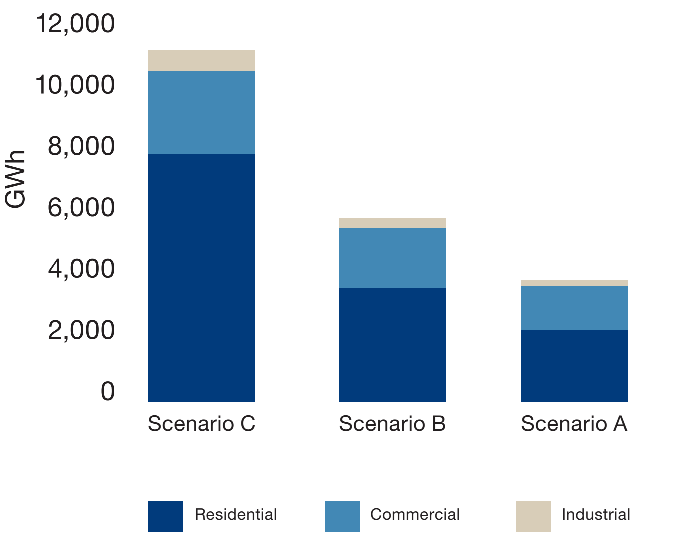
- 10-Year potential for EE ranges from 2%-7% of base sales, 2%-9% of summer peak demand, and 4%-16% of winter peak demand.
- All scenarios are driven by the residential sector, particularly homes utilizing electric space heating.
- Commercial and industrial impacts are less seasonal and weather-driven relative to residential.
- Both commercial and industrial sectors are driven by linear fluorescent and H.ID. fixtures, which are less common in residential applications.

## SECTOR-LEVEL DISCUSSION

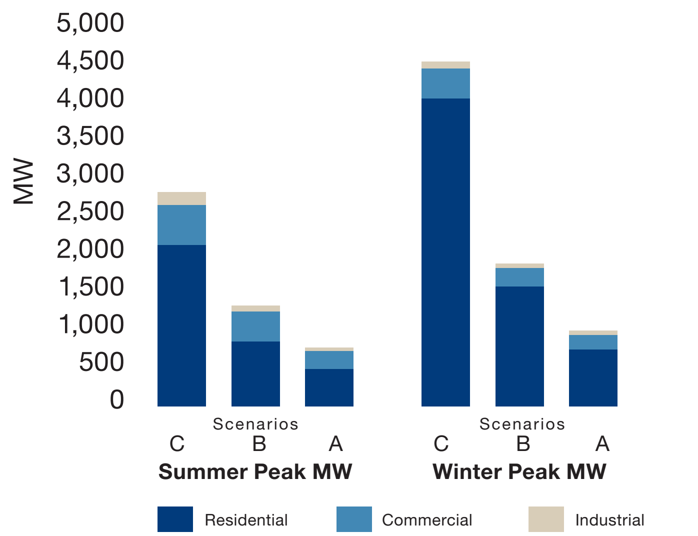
The following graphics highlight the cumulative contributions in 2032 by sector for each scenario. In all scenarios, residential offered the largest share of potential contributions, followed by commercial. The industrial segment had the largest uncertainty due to the unique nature of site-specific processes. This study focused on the general building characteristics for industrial facilities. Additional site-specific research should be conducted to fully estimate the potential for the industrial sector.

The common theme among these scenarios is that space types utilizing electric heating offered the most cost-effective potential for utility programs. This was true for both the residential and commercial sector. Lighting efforts in commercial and industrial settings offered the largest potential outside residential shell and HVAC measures. Residential lighting potential is greatly reduced due to pending standards changes. Further evaluation will be needed to monitor transformative efforts and attribution, particularly with lighting, in all sectors, given the known standards, potential future standards, and general market trends (costs and consumer preference). The 100% scenario stretches model adoption assumptions and represents something similar to stock turnover-based economic level or a more theoretical upper bound presented in other studies.

### EE Energy/Impacts, GWh




### EE Demand Impacts, MW



# Residential EE

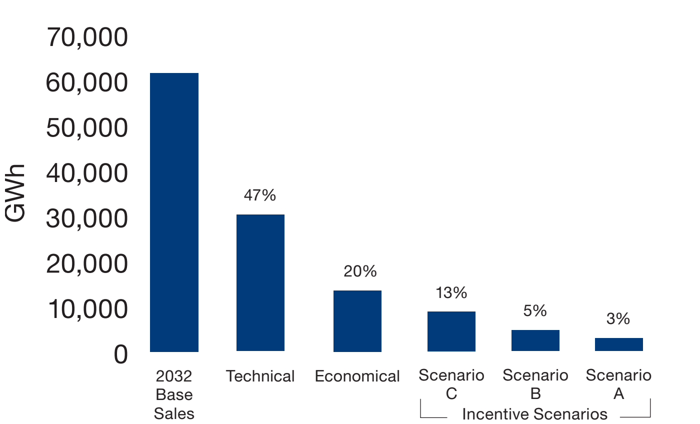
## SECTOR-LEVEL DISCUSSION

The residential sector analysis included retrofits and new construction for single-family, multi-family, and manufactured homes in both low-income and non-low-income segments. Total residential EE potential ranged from 3%-13% of sector specific base energy sales by 2032; demand impacts ranged from 3%-15% in the summer and 4%-20% in the winter. Winter savings were largely driven by potential from homes utilizing electric heat. The greater winter demand was from reductions in less-efficient auxiliary/supplemental heating loads needed at colder temperatures.

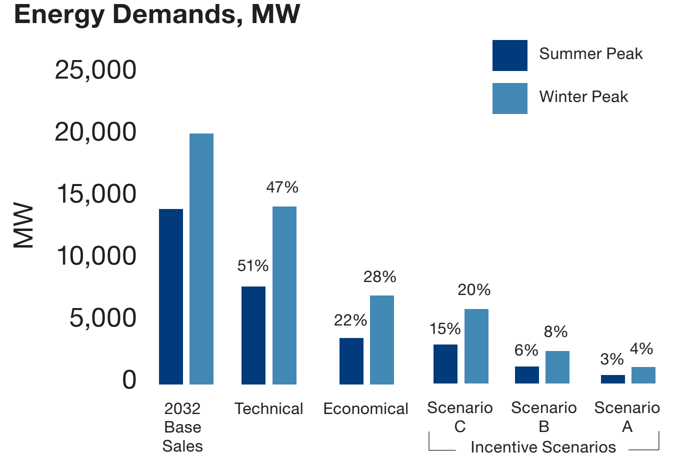
The low income modeling represents an exception to the scenario assumptions in that 100% of incremental costs were assumed for this segment across the scenarios. This was done to explore a potential level under different costs and design structures than have been historically used for this segment (absent more traditional budget constraints and market adoption assumptions). Modeling maintained use of incremental cost-based assumptions, which deviated from programmatic realities where full costs are often incurred by low-income programs.


**The following charts summarize the potential and costs relative to 2032 TVA Base Sales and Base Peak Demand.**

### Energy Impacts, GWh



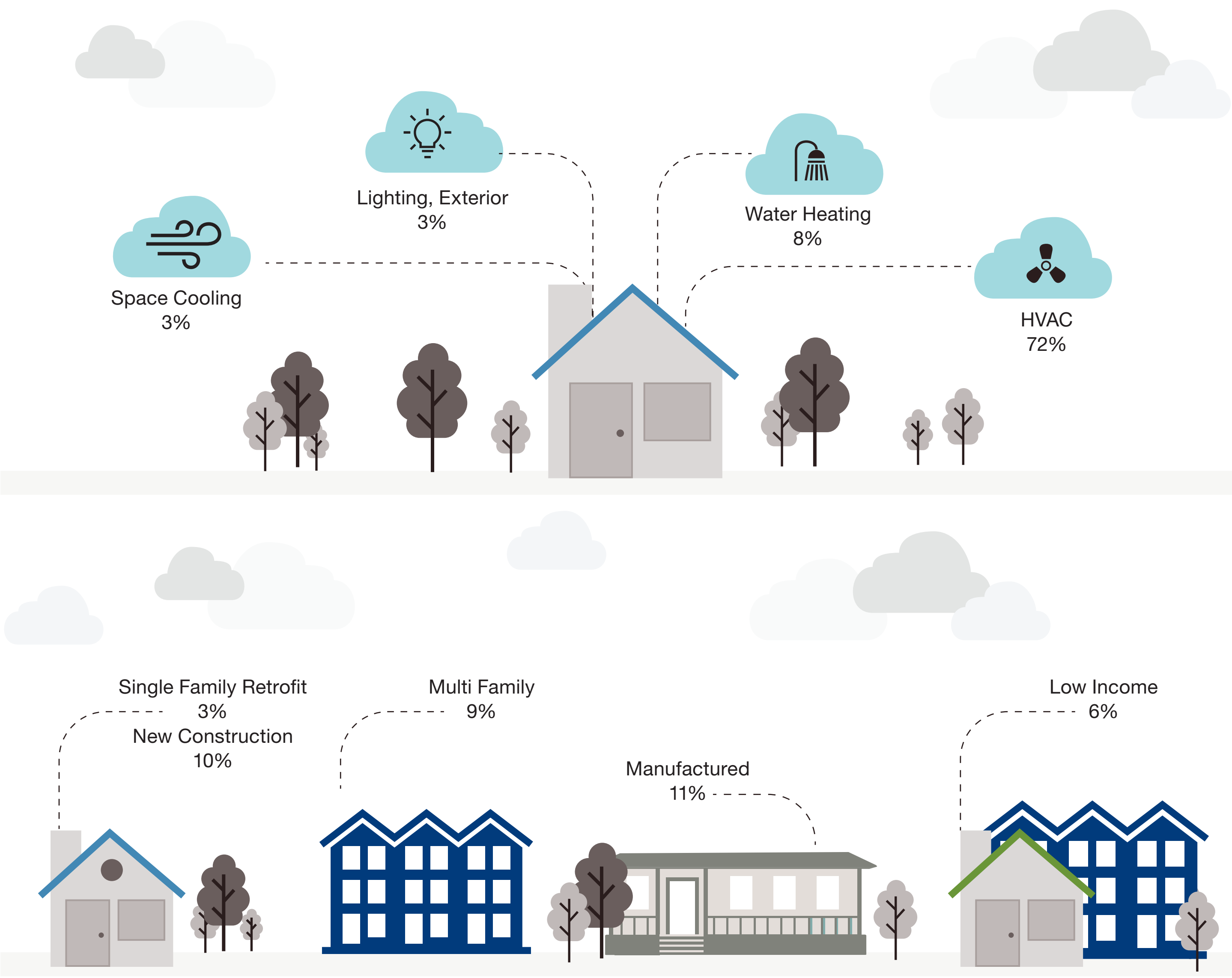

### Energy Demands, MW



The largest area for potential under Scenario A was for HVAC retrofits in the single-family segment.

Single-family retrofit measures offered the greatest potential of any building type. New construction opportunities exist for the different building types but are most impactful for single-family. Manufactured homes offered significant potential from HVAC and weatherization measures, particularly for existing or previously-sited homes.

Low-income programs were modeled using each measure's incremental cost. Current residential low-income program design covers the entire measure cost, not only the incremental costs. Stated low-income potential could be understated relative to the full project cost approach of current designs. The following graphic illustrates the potential by housing type under Scenario A.



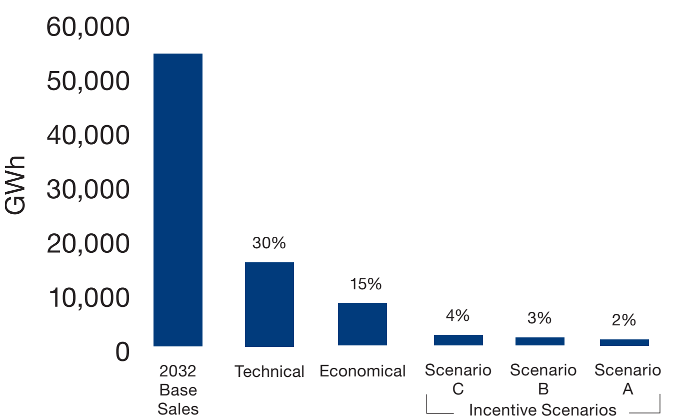
# Commercial EE

The commercial sector analysis included retrofits and new construction across 15 different business/space types. Commercial impacts were mostly derived from lighting measures replacing existing fluorescent or HID fixtures. 2032 commercial potential ranged between 2%-4% of annual sales, with similar seasonal demand impacts.

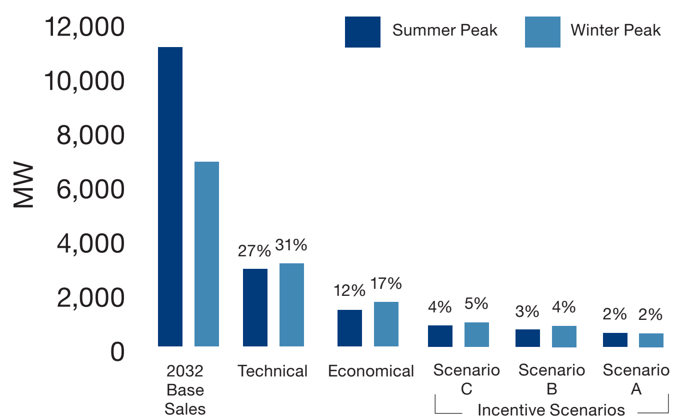
Among business segments, restaurants, retail (small and large), warehouses, grocery, and healthcare represented the spaces with the largest potential across the scenarios. From a measures perspective, above-code construction efforts, lighting, and HVAC offered the greatest opportunities for the commercial sector.


**The following charts summarize the potential and costs relative to 2032 TVA Base Sales and Base Peak Demand. Commercial achievable potential was less reliant on weather-sensitive measures than residential. This contributed to more consistent peak contributions between the seasons.**

### Energy Impacts, GWh




### Demand Impacts, MW



The following graphic contains the ranking of commercial energy efficiency measures by 2032 energy contributions from all building types. Lighting comprises the largest potential, followed by refrigeration and new construction. Interior LED light fixtures have the highest potential, followed by outdoor lighting measures replacing H.ID. fixtures.

| | |
|---|---|
| Indoor Lighting | 31% |
| Outdoor Lighting | 18% |
| Refrigeration | 13% |
| New Construction | 13% |
| Office Equipment | 10% |
| Ventilation | 9% |
| Cooling | 4% |
| Cooking | 2% |
| Water Heating | 1% |
| Heating | 0% |

End-use potential across all commercial space types is shown below, with restaurants and large retail facilities offering the greatest potential under Scenario A.

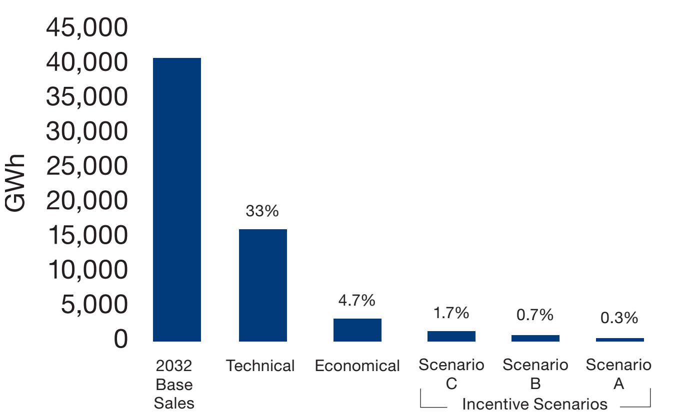
| | |
|---|---|
| Restaurant | 14% |
| Large Retail | 10% |
| Warehouse | 9% |
| Grocery | 8% |
| Other | 8% |
| Large Office | 7% |
| Assembly | 7% |
| Small Retail | 6% |
| Small Office | 6% |
| Hospital | 6% |
| School | 4% |
| College | 4% |
| Healthcare | 4% |
| Municipal | 4% |
| Lodging | 2% |

# Industrial EE

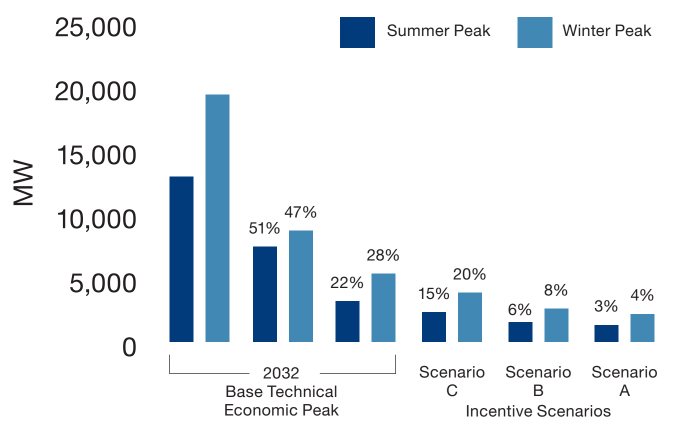
Industrial potential ranged from 2%-4% of base sector energy sales by 2032, with similar peak reductions. Industrial achievable potential was lower than other sectors. This was in part driven by lack of site-specific end-use intensity data and uncertainty regarding process load. The end-use intensities of diverse industrial customers was not well represented by the generalized Commercial Buildings Energy Consumption Survey (CBCES) data. Also, custom and process measures may be cost prohibitive on energy economics alone, with adoption being driven by other factors.


**The following charts summarize the potential and costs relative to 2032 TVA Base Sales and Base Peak Demand.**

## Energy Impacts, GWh



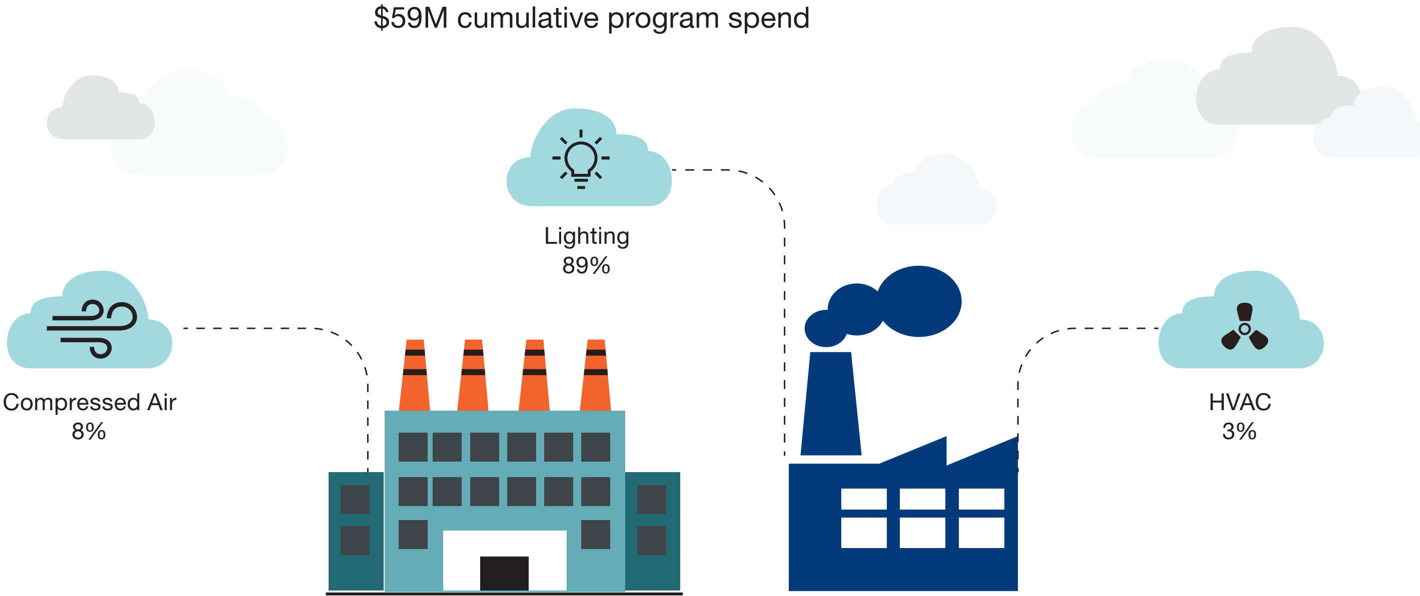

## Demand Impacts, MW



Prescriptive lighting, compressed air, variable speed drives for HVAC, and efficient chargers for forklifts passed economic screens. Compressed air is considered custom, though it has more generalized applicability due to prevalence of compressed air in most industrial applications. In general, lighting dominated the potential for non-process specific industrial measures.

# End Use

125 GWh @ 50% Achievable Potential in 2032
$59M cumulative program spend




**The top industrial measures were interior and exterior lighting, followed by compressed air. As noted, the more generalized data for industrial customers obfuscated site-level effectiveness caused by looking at the average customer. Project-specific analysis can be helpful to identify cost effective opportunities within the sector. Given the relative scale of industrial projects, likelihood of free ridership should also be considered in the analysis.**

# Demand Response Findings Summary

### MODELING

DNV used its Non-Wires Alternative model for the analysis. The analysis leveraged TVA-specific evaluation results and estimates where possible. Augmentation data from peer utilities was used where TVA data was not available. Proven programs from other utilities were used to inform adoption rates and develop program caps. The cost-effectiveness screening used TVA's system marginal value data and was based on an annual levelized cost per kW/year. Analysis was limited to customers served by LPC's to minimize overlap with TVA's existing Interruptible Power Programs. TVA's existing aggregated demand response capacity was used to help inform initial model calibrations and was included within the commercial and industrial capacity.

### KEY CONSIDERATIONS

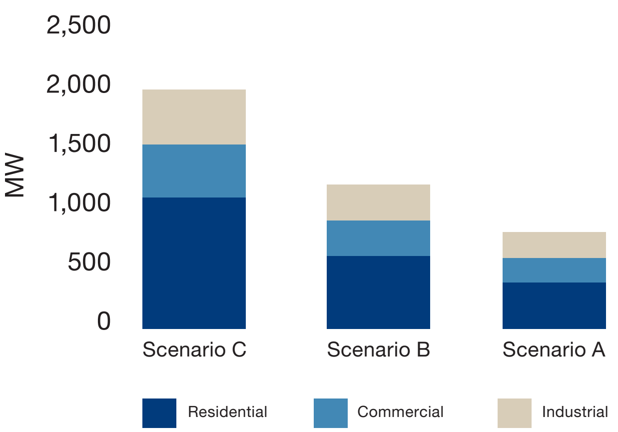
- Modeled impacts assume optimal dispatch coincident with seasonal peaks
- Events during milder weather or off-peak times will likely have different impacts
- Capacity from HVAC programs is more sensitive to off-peak/mild weather dispatch
- Prevalence of non-electric heating drives lower winter capacity relative
- Commercial and Industrial results have overlap with existing TVA aggregated programs
- Boundary scenario modeled on high-performing programs
- Assumes implementation to each measure's boundary level and optimal dispatch

### FINDINGS

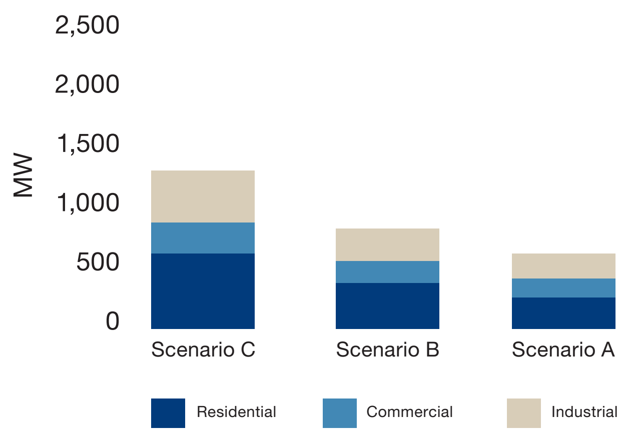
- Residential programs offered the most new capacity.
- Including existing ADR efforts, residential comprised nearly half of the potential.
- HVAC impacts will likely be diminished if dispatched in moderate or non-peak weather conditions.
- Winter potential was lower than summer for all sectors; residential winter capacity was approximately two-thirds of summer capacity.

**The following graphs represent the 10-year cumulative valley potential across all market sectors as a percentage of estimated 2032 base peak (MW). Demand Response results ranged from 3%-6% of the 2032 summer peak and 2%-4% of winter peak sales. HVAC controls drive incremental program potential overall, particularly for residential programs.**

**Demand Response Seasonal Impacts, 2032: Summer Peak**




**Demand Response Seasonal Impacts, 2032: Summer Peak**

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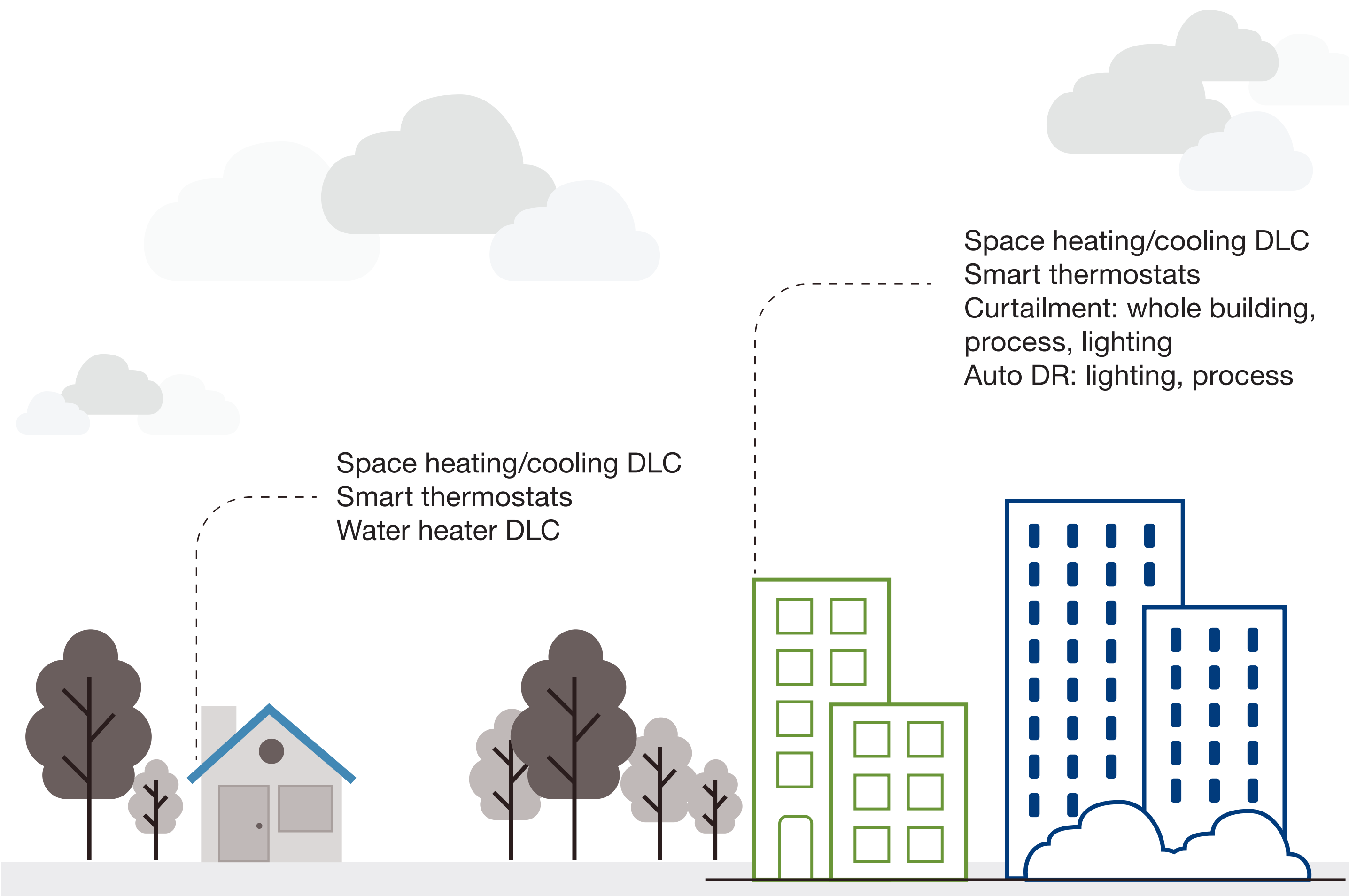
## Demand Response Findings Summary (cont.)

For summer, residential offered the greatest overall potential and most new potential. During the winter season, commercial and industrial had a greater share of overall potential, though some of this capacity was captured through existing programs.

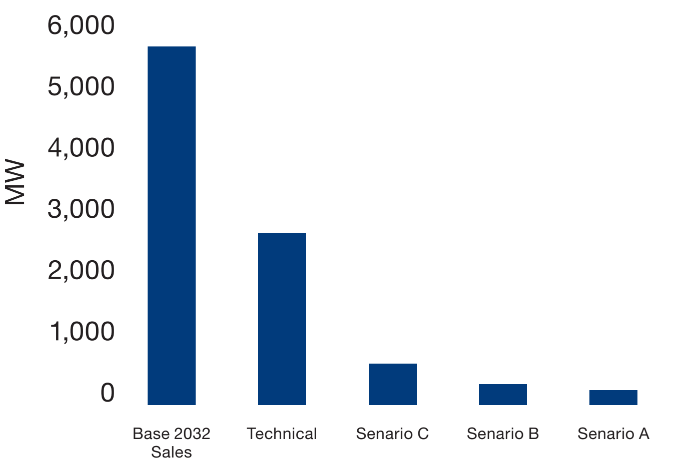
**The following illustrates potential applications within the residential and commercial sectors.**



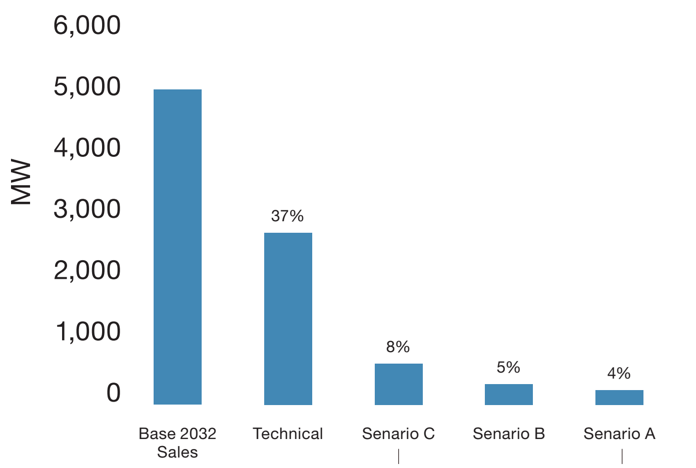
# Residential DR

Both smart controls/thermostats and traditional load control switches were modeled. Results shown focused more heavily on smart thermostat driven program designs. This resulted in lower costs than traditional load control efforts. Modeled HVAC impacts assumed coincidence with seasonal peak weather and traditional peak time windows. Dispatch at different times of the day or during milder weather will likely result in diminished impacts. Water heater controls are more impactful during the winter than summer due to use age patterns and intake water temperatures.


## Demand Impacts, MW: Summer Peak




## Demand Impacts, MW: Winter Peak

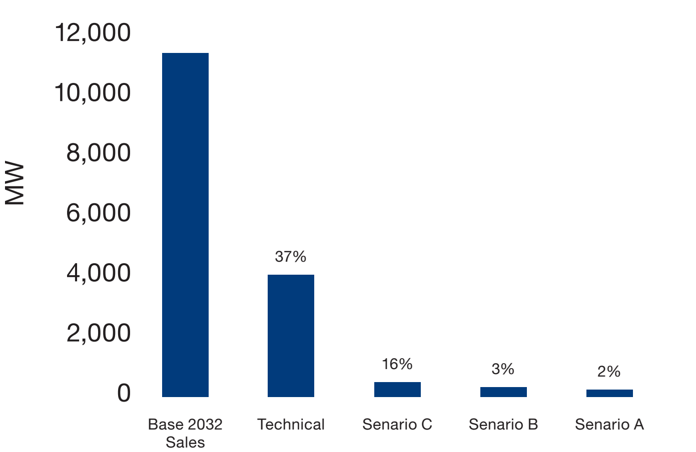


# Commercial DR

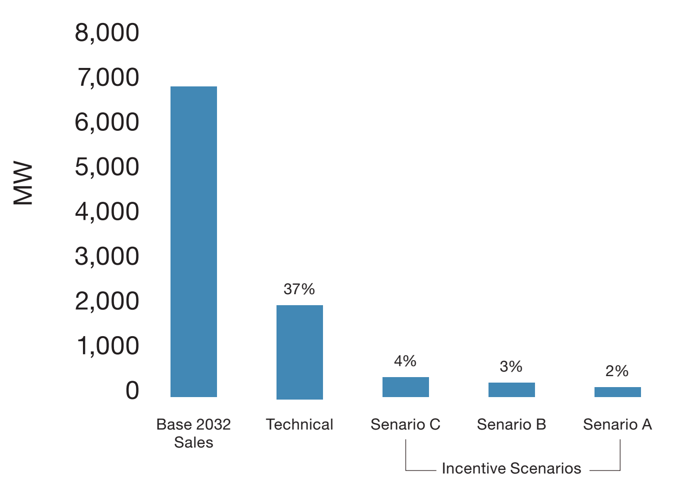
Commercial DR was driven by HVAC controls for both summer and winter. The remainder of capacity was comprised of whole-building curtailment and lighting controls efforts. As with residential, commercial winter capacity is lower than summer due to prevalence of non-electric heating.

Cooling and heating offered the greatest potential through 2032 and the overall study horizon. Lighting-controls capacity comprised the Automated Demand Response potential. Lighting and whole building curtailment have less variation than the programs targeting HVAC controls exclusively. Results were not available by building type for commercial or industrial demand response.


### Demand Impacts, MW: Summer Peak



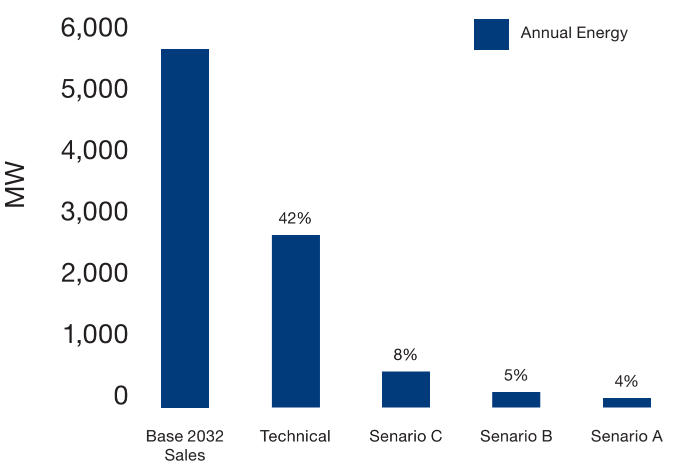

### Demand Impacts, MW: Winter Peak



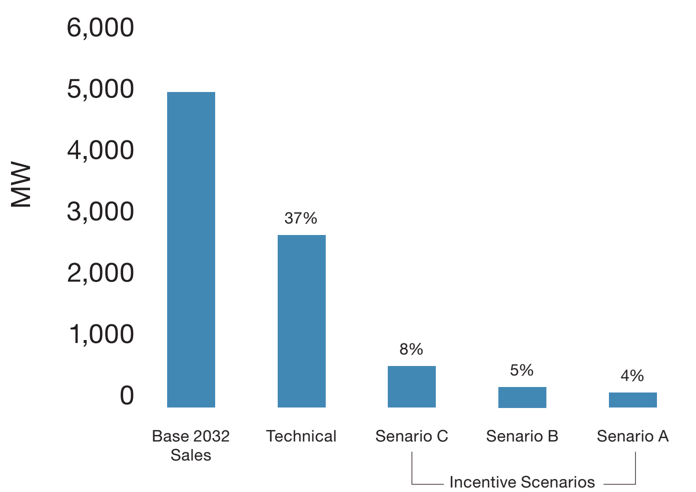
# Industrial DR

Industrial DR capacity was driven by whole-building and process curtailment of small industrial customers. Given TVA's experience with industrial DR and prior internal analysis, the study focused on LPC-served customers to minimize overlap with TVA's interruptible initiatives. Looking across the sectors, industrial capacity was also the most consistent between seasons, as customers are generally less weather-sensitive.


## Demand Impacts, MW: Summer Peak




## Demand Impacts, MW: Winter Peak

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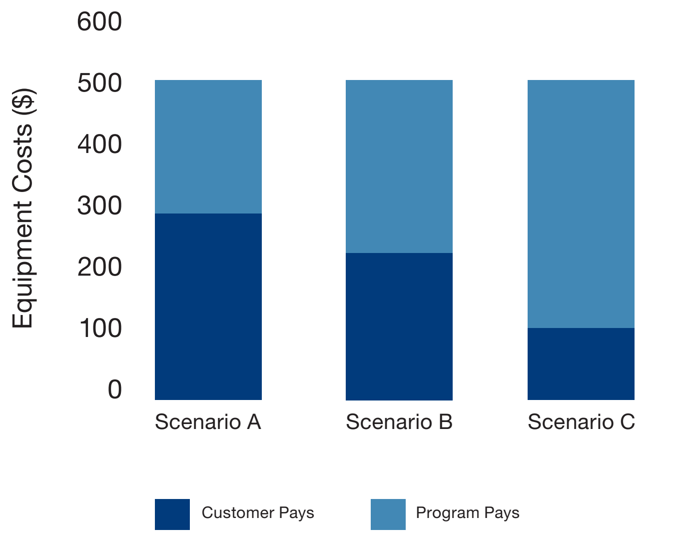
# Electrification Findings Summary

## MODELING

DNV considered a specific subset of electrification measures for inclusion in the study. As with energy efficiency, the measures could be grouped into two over-arching types: replace-on-burnout or retrofit. Most measures were fuel switching options, i.e. retrofit or new construction using electricity in lieu of a fossil fuel. The primary exceptions to this were ultraviolet lighting HVAC measures and comfort cooling.

A mix of TVA and EIA (RECS, CBECS, MECS) data was used to estimate the saturation and energy use of the base equipment (natural gas, fuel oil, propane, or gasoline). For each measure, estimates of the fuel saving and added kWh were calculated. Customer cost effectiveness and payback metrics were calculated; these were later used as screens for achievable potential. Adoption curves were applied to the measures; these are driven by awareness and implementation curves. The implementation curves are also driven by measure cost effectiveness.

**Electrification Incentive Example, All Scenarios**




Electrification was modeled at three incentive tiers based on first year energy impacts. These were set at 5 cents for Scenario A, 7.5 cents for Scenario B, and 10 cents for Scenario C. The example provided assumed a measure has 4,000 kWh annual load addition and cost $500. In the 5-cent case, the program would pay $200; in the 7.5-cent case it would pay $300; in the 10-cent case, it would pay $400.

## FINDINGS

Technical electrification potential was quite high; at 32,000 GWh, it represented a 20% increase over TVA's projected 2032 base sales. Only 44% of technical potential was found to be cost effective based on customer economics under current rate projections. Barriers to adoption were assumed to be high, specifically in the residential sector, where electrification of major end-uses may involve significant electrical work, including panel upgrades. Beyond cost, such work requires coordinating multiple tradespeople (electrician, plumber, HVAC contractor) and permits. It also requires the customer to plan ahead; because work is often done only when equipment fails, a like-for-like replacement is faster and easier. Further decarbonization initiatives could alter the forecast as greater emphasis is placed on reduction of source emissions.

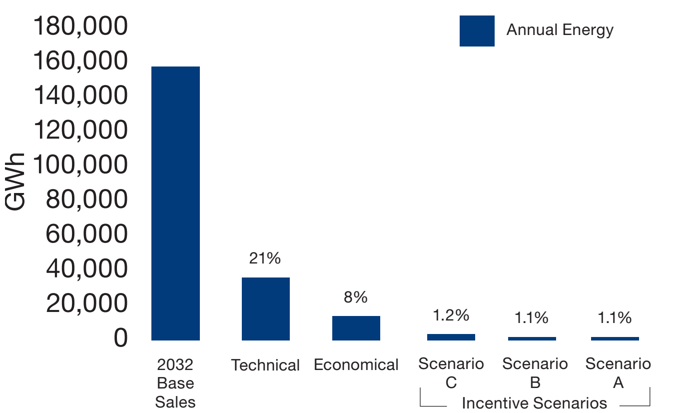
The low lift for the higher incentive scenarios reflected the underlying assumption that first cost is less of a factor than market barriers like awareness or perceived risk. Most of the lift from the measures came from outreach and technical assistance, which did not vary between the scenarios. High saturations of existing air conditioning and electric heating (space conditioning and water heating) equipment also limited achievable market potential.

## Electrification Findings Summary (cont.)

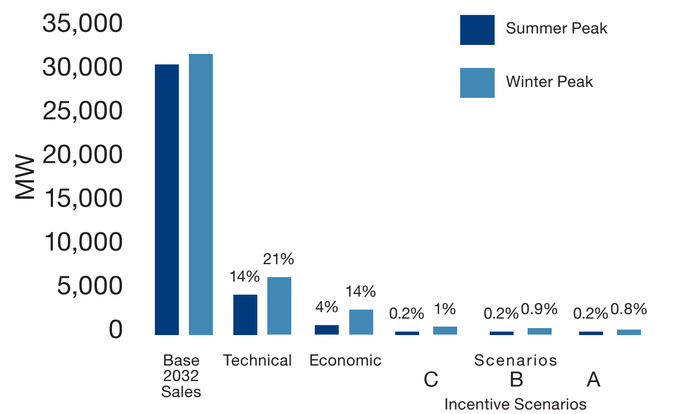
### ELECTRIFICATION KEY TAKEAWAYS

1. Commercial segment has the most potential in all scenarios, residential offers the least.
2. Current modeling is more market driven than incentive due to calibration to program results.
3. Induction drying/heating offers greatest industrial potential
4. Both commercial and residential are HVAC driven
5. Does not include on-road EV's.

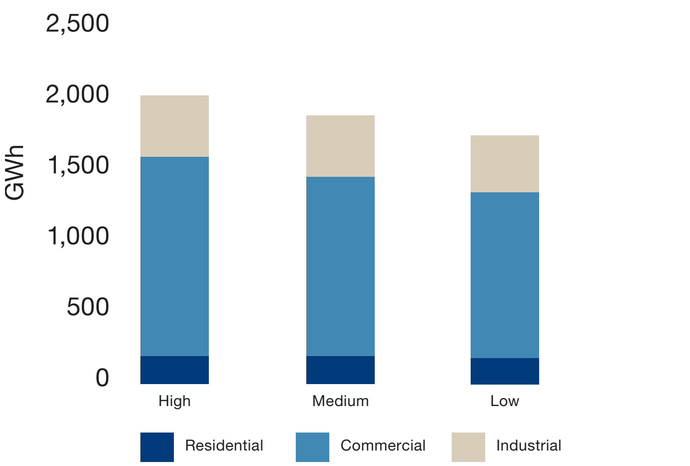
### Energy Impacts, GWh



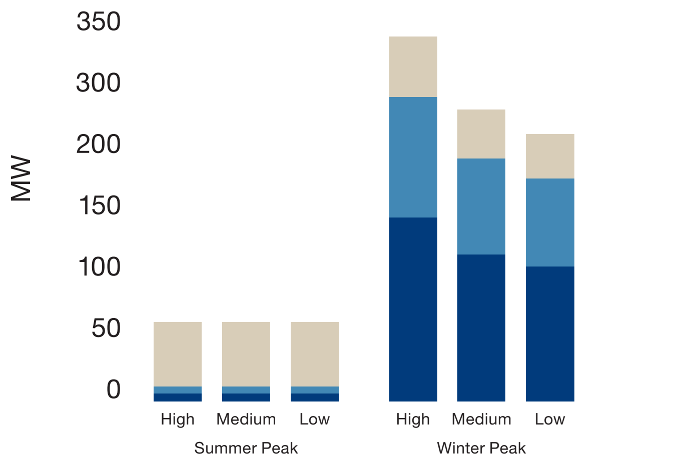

### Demand Impacts, MW




### Energy Impacts, GWh




### Demand Impacts, MW



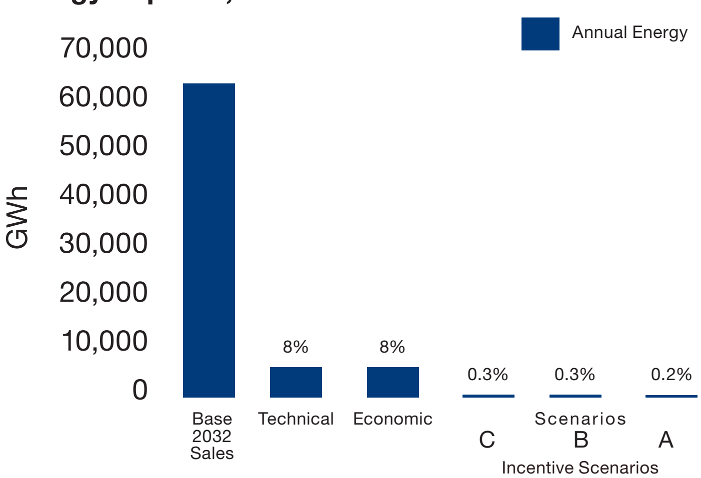
# Residential Electrification

Space heating made up the largest share of residential electrification potential, ranging from 80% to 83% of achievable potential, depending on the scenario. Whereas water heating made up 23% of economic potential, it made up only 6% of achievable potential. Due to high barriers to adoption, achievable potential ranged from only 1.7% of economic potential with incentives of 5 cents per kWh to 2.1% when incentives were raised to 10 cents per kWh. Market barriers were lowest for non-low-income single-family homes, and these homes accounted for 98% of achievable potential under each of the three scenarios.

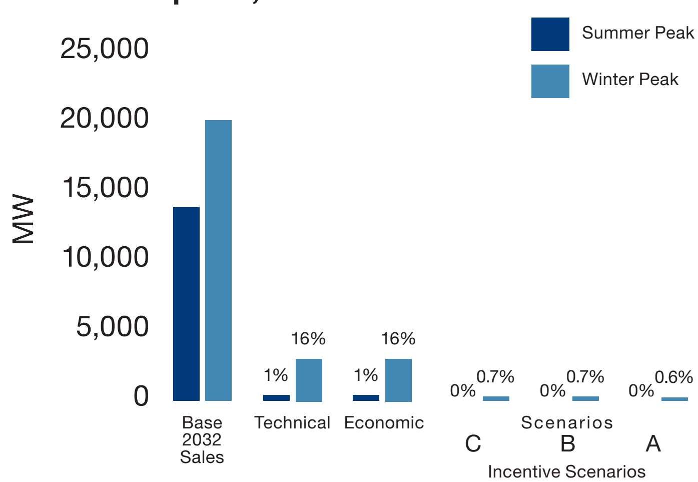
**RESIDENTIAL ELECTRIFICATION KEY TAKEAWAYS**

1. Space heating offers the greatest potential.
2. New construction and water heating retrofits offer similar potential.
3. High saturations of electric equipment and added installation costs limit potential.
4. Single family homes offer the greatest potential.
5. Energy impacts are lexx than 0.5% of sales for all scenarios. Winter peaks could increase by less than 1%.

## Energy Impacts, GWh




## Demand Impacts, MW



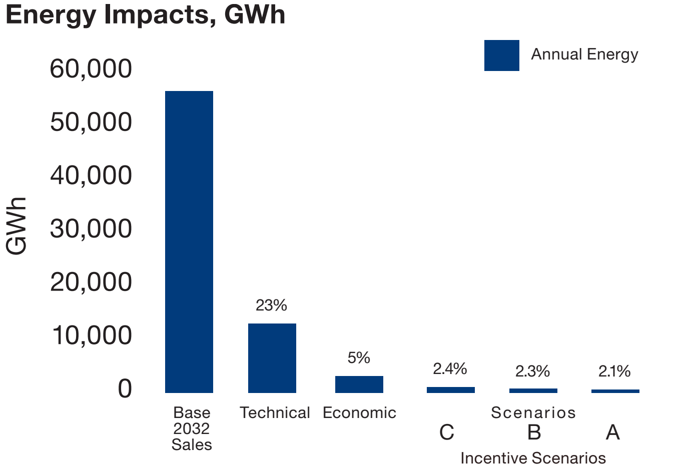
# Commercial Electrification

Space heating accounted for the largest share of commercial potential, followed by new construction, which is also heavily driven by HVAC consumption. Annual sales increases were around 2% in the modeled scenarios, with similar increases to winter peak. Given high AC saturation, the impact to summer peaks was less pronounced. Space conditioning offered the greatest potential (65% of summer, 57% of winter).

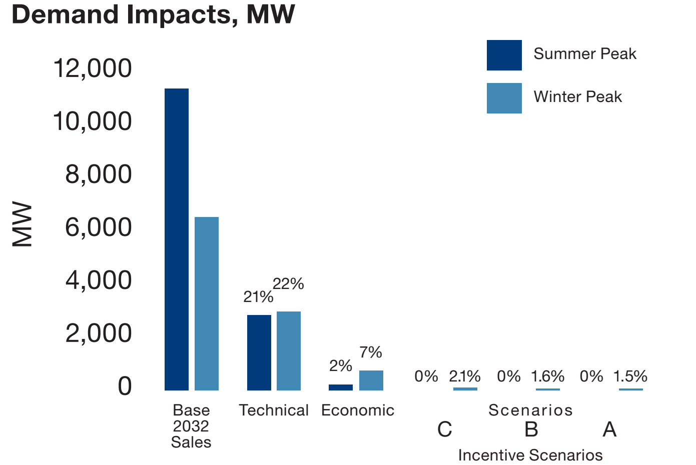
**COMMERCIAL ELECTRIFICATION KEY TAKEAWAYS**

1. HVAC offers the greatest potential; followed by new construction.
2. High existing air conditioning saturation limits potential.
3. Greatest opportunities exist in building types without air conditioning and non-electric heat.
4. Hospitals offer the greatest potential outside the misc./other spaces type.
5. Programs could increase sector sales by 2%; with winter peak impacts being more impactful.

**Energy Impacts, GWh**



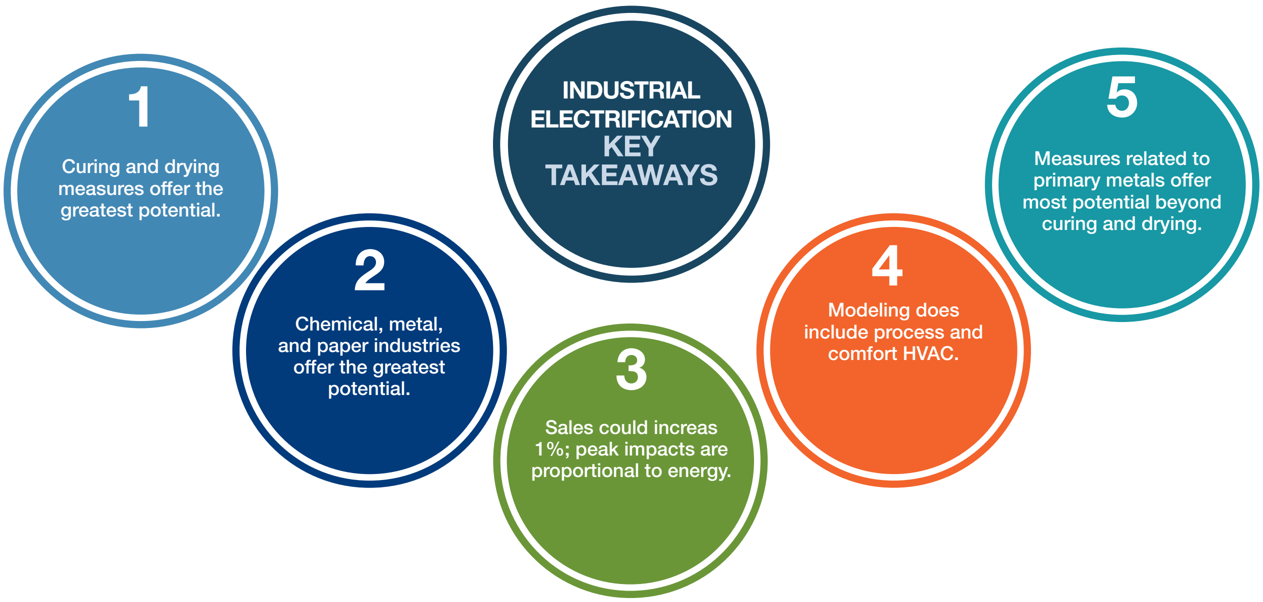

**Demand Impacts, MW**



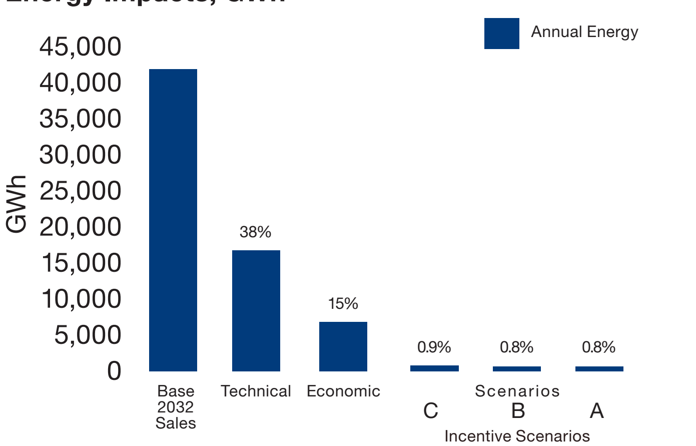

TVA

# Industrial Electrification

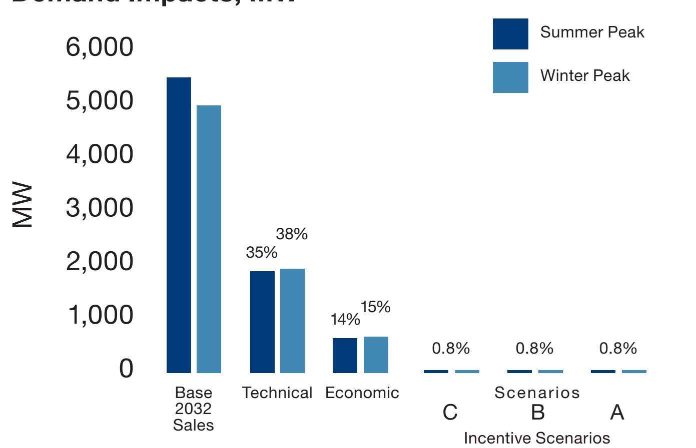
Process heating, curing, and metals represented the majority of achievable potential in the industrial sector. Measures for the chemicals industry represented about 40% of achievable potential across the three scenarios, followed by primary metals and paper industries. Total sales increases were around 1% of base 2032 sales.




## Energy Impacts, GWh



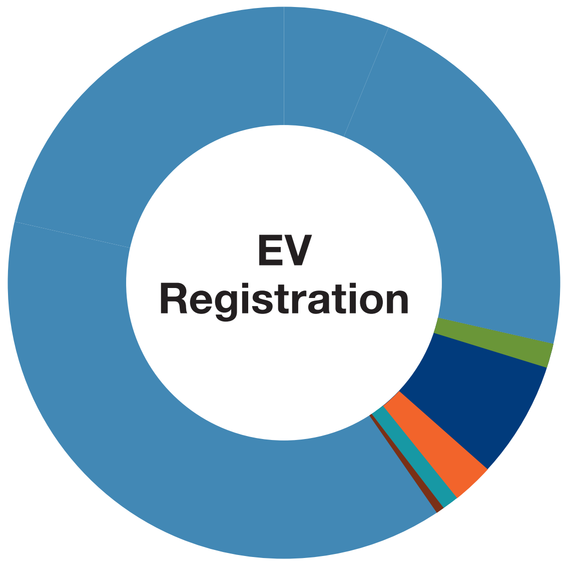

## Demand Impacts, MW



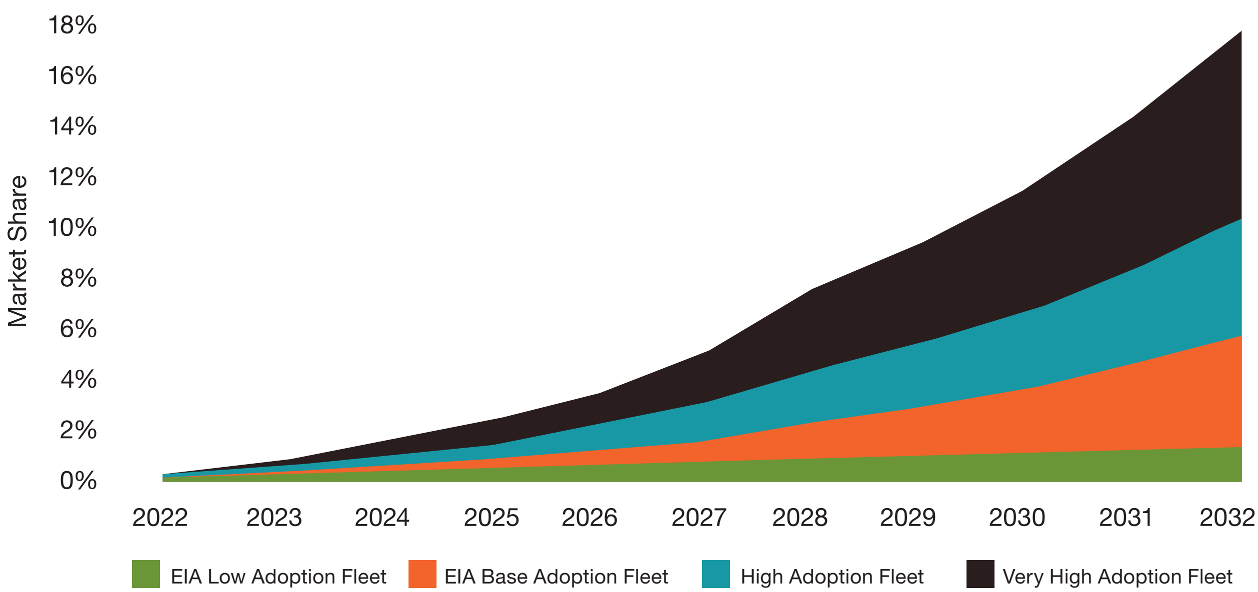
# Electric Vehicles

TVA asked DNV to provide potential impacts associated with electric vehicles, with a focus on fleet vehicles. There was a standalone report with accompanying holistic market characterization, electric vehicle landscape, and market potential projections at various levels. The study did not delve into programmatic attribution but did look at multiple adoption scenarios to gauge potential load impacts over the planning horizon. The study primarily focused on the potential associated with fleets; results were generated for all vehicles. A summary of existing vehicle registrations is provided below.

| Registration Type | |
|---|---|
| Personal | 92.21% |
| Small Fleet | 4.61% |
| Large Fleet | 1.63% |
| Government | 0.78% |
| Rental | 0.41% |
| Dealer/Manufacturer | 0.XX% |




DNV modeled four adoption scenarios for electric vehicles. Two cases mirrored EIA forecast rates over the study period: EIA Low and EIA Base. The High and Very High adoption cases represented boundary scenarios of realistic potential. The Base forecast represented a realistic achievable potential; the high was similar to a high achievable.



# Citations


### Technical Resource Manuals

TVA, Arkansas, Dominion, Illinois/Missouri (Ameren)

### Data Sources

TVA FY23 BPSP Load Forecast

TVA FY23 BPSP Escalation/Economic Outlook

TVA FY23 BPSP System Marginal Value Forecast

2014 EIA Manufacturing Energy Consumption Survey

2012 EIA Commercial Building Energy Consumption Survey

2015 EIA Residential Energy Consumption Survey

TVA Residential Saturation Surveys 2016 - 2020

TVA Commercial Saturation Survey 2019

FY23 Strategic/Budget Power Supply Plan

### Electric Vehicles

Fox-Penner, P., W. Gorman, J. Hatch, Long-term U.S. Transportation electricity use considering the effect of autonomous-vehicles: Estimates & policy observations, Energy Policy 122 (2018) 203–213

Greenblatt, et. al, LBNL, Quantifying the Potential of Electric Vehicles to Provide Electric Grid Benefits in the MISO Area

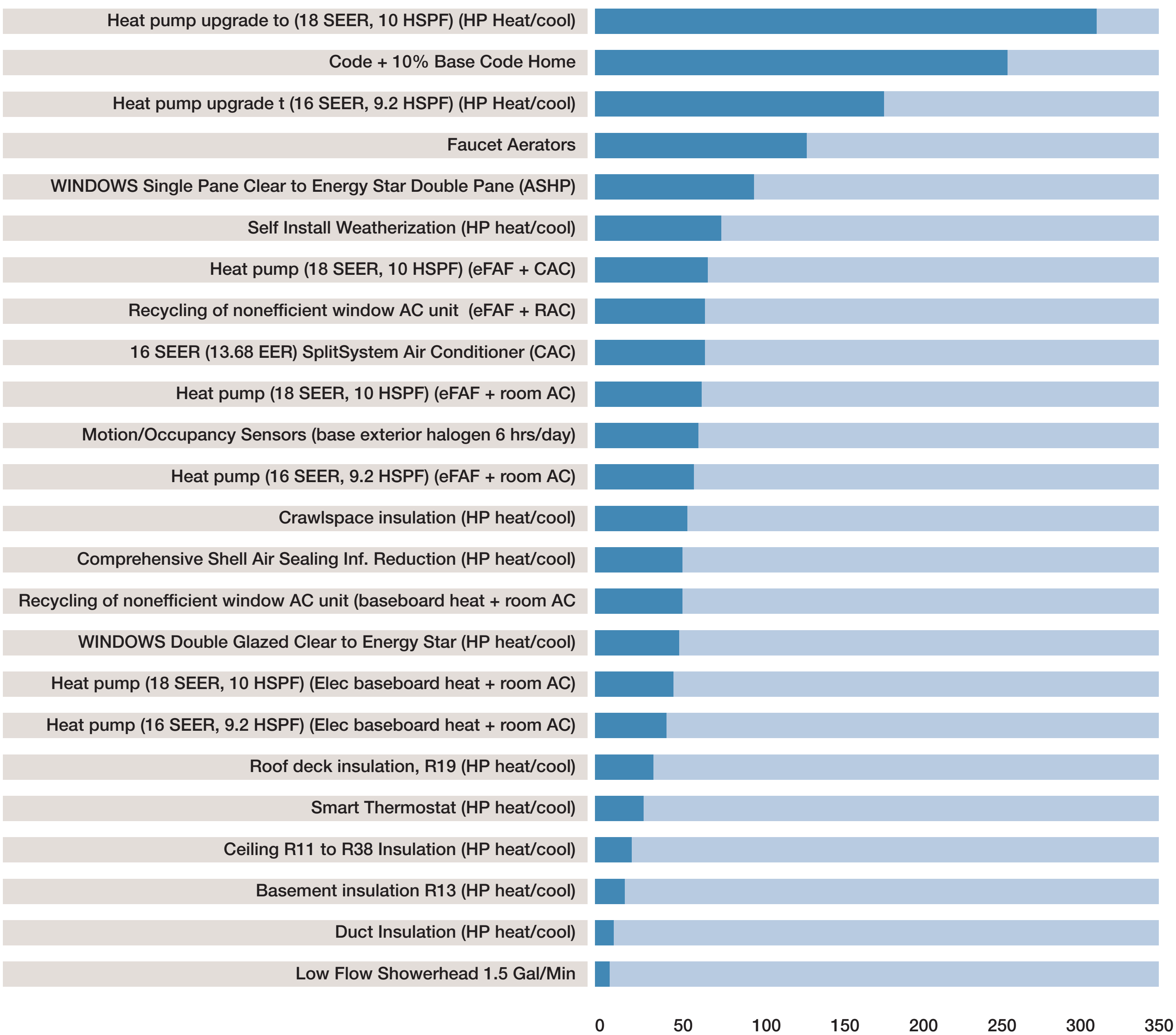
# Appendix

## Measure-level detail

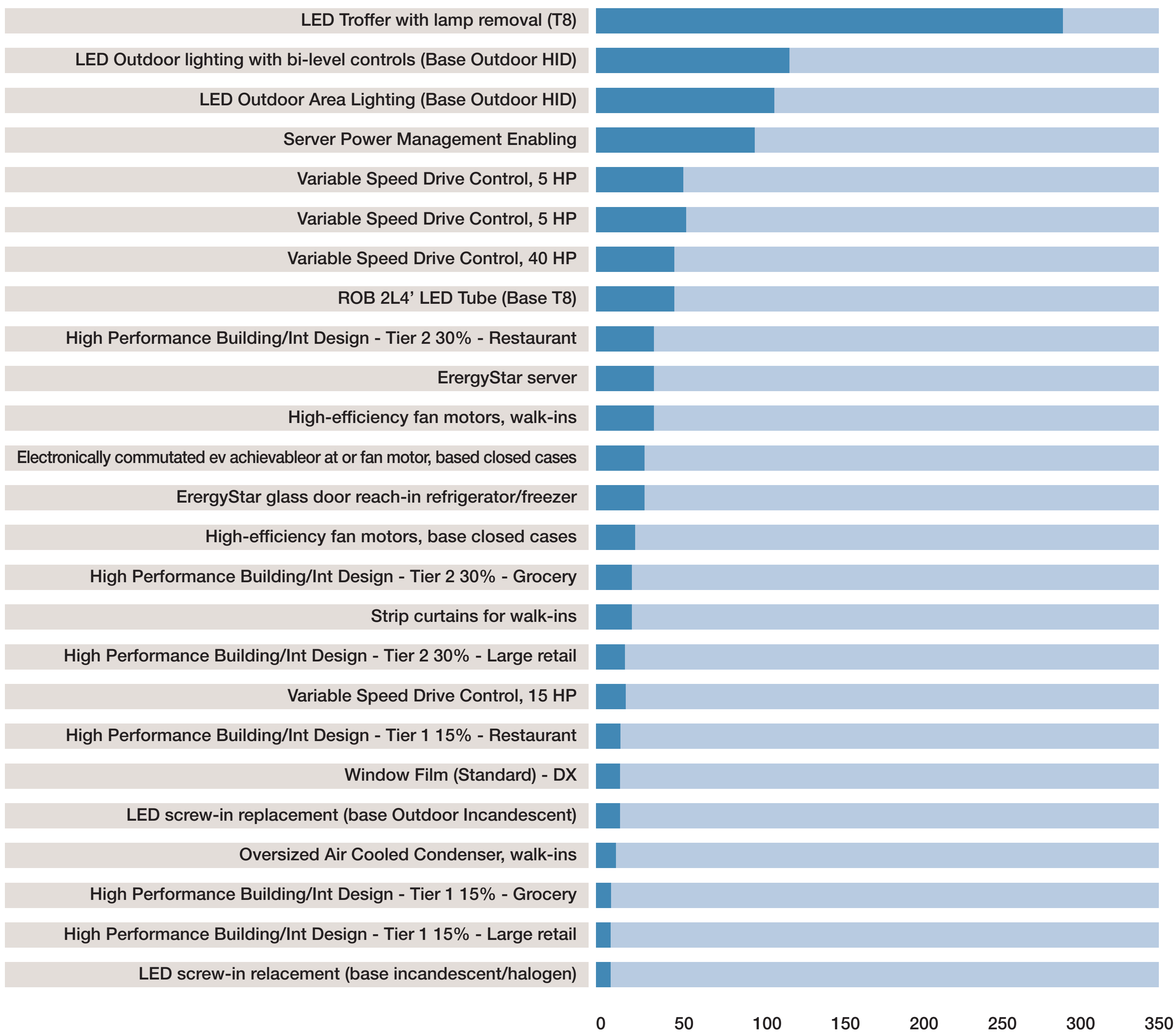
### Residential

Looking at 2032 savings by measure (Scenario A), the largest contributors were weatherization and HVAC replacements. Because of the modeling framework, measures were broken out by building and HVAC type to more granularly estimate both measure and segments potential for the region.

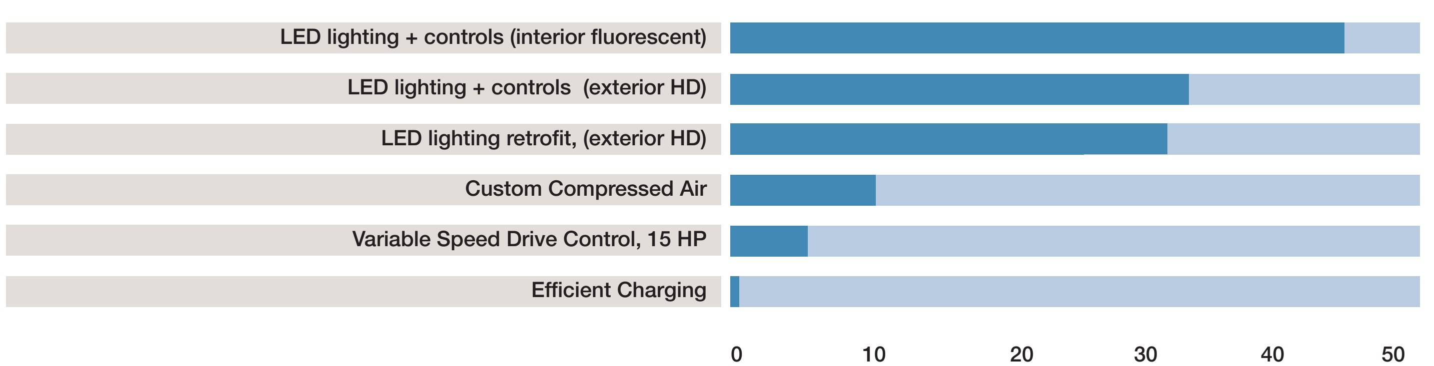
### Top Residential Measures



## Top Commercial Measures




## Top Industrial Measures



# Appendix Item: Energy Efficiency Efficient Electrification Potential Study for Industrial Customers Summary Report

TVA TENNESSEE VALLEY AUTHORITY

# Energy Efficiency & Efficient Electrification Potential Study for TVA Industrial Customers

## TVA Industrial Study

Baskar Vairamohan
Sreenidhi Krishnamoorthy
Aparna Menon

Final Report Presentation
March 29, 2023

# Executive Summary

# Executive Summary: Slide 1/3

**PROJECT OBJECTIVES**

- Identify untapped energy efficiency and efficient electrification applications for industrial customers in TVA's service territory
- Quantify energy efficiency and efficient electrification industrial technical, economic and achievable potential for TVA's service territory
- Evaluate cost-effectiveness of identified industrial opportunities for customers and utility
- Evaluate environmental impacts of potential industrial opportunities to customers, utility, and society

- **Focus timeframe:** Achievable potential up to 2050
- **Technologies reviewed:** Commercially available, proven technologies in the field.
  - Potential impact of emerging technologies evaluated at high level

**EE and Electrification Potential Results**

| Study | Technical Potential Results for 2050 for entire TVA service territory | Achievable Potential Results for 2050 for entire TVA service territory | |
|---|---|---|---|
| Energy Efficiency | 13,375 GWh | Low Scenario: 7,067 GWh | High Scenario: 7,803 GWh |
| Electrification | 26,135 GWh | 10,705 GWh | |



EPRI

# Executive Summary: Slide 2/3
# Achievable Potential Results for Energy Efficiency in 2050 for Whole TVA Service Territory

| Industry | NAICS Code | Energy Efficiency Savings Achievable Potential- Low Scenario | Energy Efficiency Savings Achievable Potential- High Scenario |
|---|---|---|---|
| | All values are in GWh | | |
| Fabricated Metals and Machinery | 332-336 | 1,845 | 2,013 |
| Chemicals and Plastics | 325-326 | 1,717 | 1,904 |
| Food and Beverage | 311-312 | 1,190 | 1,313 |
| Wood, Pulp and Paper | 321-323 | 794 | 879 |
| Primary Metals | 331 | 774 | 868 |
| Stone, Clay, Cement, Glass | 327 | 268 | 298 |
| Others | 337, 339 | 199 | 216 |
| Petroleum | 324 | 186 | 207 |
| Textiles, Apparels and Leather | 313-316 | 96 | 105 |
| **TOTAL** | | **7,067** | **7,803** |

**The achievable potential for savings from energy efficiency for low scenario is 7,067 GWh and high scenario is 7,803 GWh**

# Executive Summary: Slide 3/3
# Achievable Potential for Electrification in 2050 for Whole TVA Service Territory

| Industry | NAICS Code | Total Electrification Achievable Potential (GWh) |
|---|---|---|
| Chemicals and Plastics | 325-326 | 2,942 |
| Primary Metals | 331 | 2,288 |
| Stone, Clay, Cement, Glass | 327 | 1,745 |
| Petroleum | 324 | 1,087 |
| Food and Beverage | 311-312 | 1,052 |
| Fabricated Metals and Machinery | 332-336 | 799 |
| Wood, Pulp and Paper | 321-323 | 770 |
| Textiles, Apparels and Leather | 313-316 | 22 |
| | **TOTAL** | **10,705** |

**The total achievable potential for electrification in TVA service territory is 10,705 GWh**