AEP ENERGY

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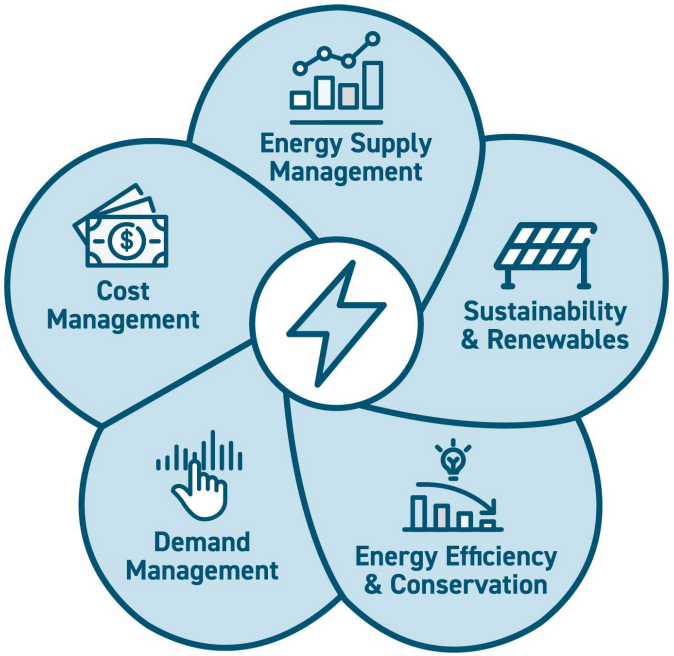
Decarbonization: Focus on Efficiency and Conservation

Superior insights. Sustainable solutions. Brighter future.

Comprehensive Approach to Energy Management



Holistic

Examination of each element of energy management in a systematic approach rather than individually allows for the discovery of more improvement opportunities, risk mitigation, value optimization and optimized results.

Integrated and inter-disciplinary

Integrated expertise in energy markets/rates, energy usage and technologies enabling effective oversight across all energy domains driving the generation of unique insights and high-value solutions.

Programmatic

Ongoing collaboration with customers through the life of the program, creating the opportunity for adjustments and recalibrations as circumstances change and learnings are incorporated.

End-to-End

Application of a consistent, end-to-end approach to energy management through our five-stage approach

Survey Landscape → Assess Opportunities → Develop Plan → Execute Solutions → Manage Programs

Integrated, Holistic Energy Management

Sustainability and Renewables

Decarbonization Roadmap Development

Renewable Energy Advisory

Turnkey Net-zero Emission Solutions

Efficiency and Technology

Energy Efficiency Program and Turnkey Execution

Technology and Asset Optimization

Data Analytics (Sector, Portfolio and Facility)

Cost Management

Cost Management with Forecasting and Variance Analysis

Rate Analysis and Optimization

Bill Pay Management and Coordination

Demand Management

Load Management as a Service

Generation and Transmission Peak Management

Demand Response

Energy Supply Management

Strategic Purchasing

Product Modeling and Risk Analysis

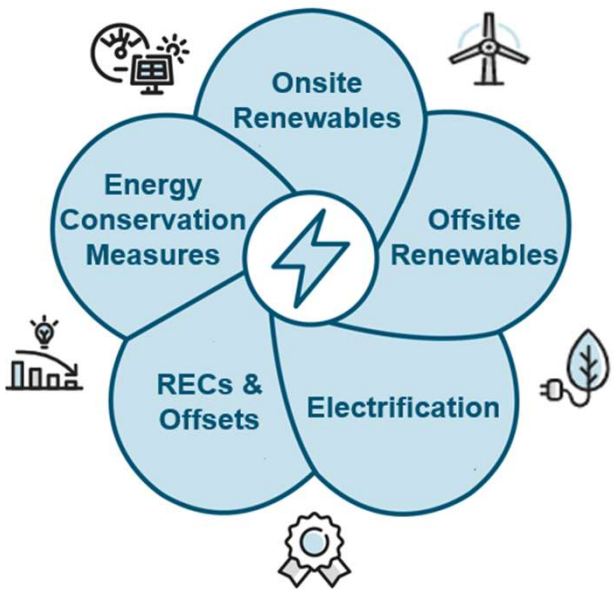
Market and Procurement Advisory

Decarbonization Complexities

- Diverse range of facility characteristics
- Complex energy utility rates and market structures globally
- Availability and profile of off-site renewable resources
- Energy efficiency assessments
- Onsite renewable resource potential and production profile
- Data collection, standardization and analytics
- Varying financial and environmental impacts of projects
- Diverse asset and program portfolio management

Net-zero Strategy Planning and Execution

Implement a strategic net-zero framework that identifies all decarbonization measures in a scenario planning model based on market, technology and risks.



1. ***Landscape Survey*** to uncover all measures, including emerging technologies to reduce scope emissions
2. ***Opportunity Assessment*** to evaluate project feasibility, emissions impact and economic viability
3. ***Strategy Development*** based on risk analysis, corporate objectives and scenario modeling
4. ***Project Execution*** and delegation of authority to execute on measures based on strategy scenario planning
5. ***Program Management*** to measure success, track emission reductions and cost savings

Comprehensive Review of Mechanisms

Assessing a range of discrete options to form integrated solutions results in an optimized approach. Investing in high-value solutions early in the roadmap will provide an opportunity to capitalize on favorable markets.

Energy Conservation Measures

Projects that reduce energy and demand consumption and associated cost

Onsite Renewables

Behind-the-meter renewable energy assets to offset all or a percentage of load

Offsite Renewables

Virtual purchased power agreements or integrated retail products

Renewable Energy Certificates & Offsets

Ability to claim renewable energy without a direct offset or asset commitment

Electrification

Beneficial or transportation electrification to reduce emissions

Focus on Energy Conservation First

Regardless of where you are in your net-zero journey, deep energy efficiency and conservation.

- The best MW is the one not used with zero emissions and ongoing energy spend. Reduction in usage provides grid support in resiliency needs
- Reducing usage through conservation and efficiency reduces quantity of renewable energy procurement and offset needs
- Mature technologies with many projects with a short payback period and high ROI
- Direct impact on climate as emissions are not being released and meets high ambition net zero targets and abatement strategies

Energy Conservation Principles

Energy Recovery

Extract unused energy potential for maximum conservation and emission reductions.

- Process Heat
- Cooling potential (economizing)

Energy Controls

Matching energy consumption/output to actual needs (controls).

- Equipment turnoff/turndown
- Heating and cooling set points
- Speed variation
- Trade hot water for steam

Eliminate Leakage

Eliminating leakage will improve performance and maximize efficiency – sustainable practice.

- Insulation/weatherization
- Compressed air, other

Equipment Upgrades

Basic facility equipment upgrades to maximize efficiency.

- Lighting, heating and cooling systems, retrocommissioning, air distribution systems

Efficiency and Conservation Measures

Noteworthy Measures to Explore in Addition to Common Measures


Building Improvements – lighting, HVAC, Smart Systems


Steam system to hot water conversation


Waste Energy Recovery


Heat Pump Configurations


Process Control Modification

Common Measures

- Building Automation Systems
- Retrocommissioning
- Steam Trap Audits
- Compressed Air Leak Audit & Supply-side Performance Review
- Water Economizers (free cooling)
- Boiler Room Thermodynamic efficiency audit
- Plug Load Audit

Efficiency and Conservation Measures

Building Improvements (HVAC, Lighting, Behavioral Technologies):

- Inflation Reduction Act dramatically increased tax deductions for HVAC, lighting and building envelopment – more attractive economics
- Building improvements may also qualify in capacity auctions yielding additional returns
- Lighting controls and behavioral systems can bring significant additional value in meeting energy reduction goals

Steam System to Hot Water Conversion

- Hot water delivery system solutions need to be considered in thermal system evaluations (upgrades or new construction) are an essential measure to consider to yield higher efficiency
- Hot water delivery has fewer losses than steam delivery systems and operationally is a more cost-effective solution
- Hot water systems are more flexible in the fuel types used for generation, which can help meet emission reduction objectives

Efficiency and Conservation Measures

Waste Energy Recovery (WER):

- Inflation Reduction Act improved investment opportunities in WER generators
- Where high volumes of gases (steam, compressed air, natural gas, process gasses) are reduced in pressure using a throttling value, expansion turbines can be used
- High temperatures can also be captured and converted into usable energy
  - "Low temperature" heat recovery generators (~75 kW - 1000 kW) need waste heat of > 200°F. Applications include: dryer/furnace exhaust, flares stacks, product cooling before packaging or storage
  - "High temperature" heat recovery generators (~2 MW - 10 MW) need waste heat of >600°F. Applications Include: cement manufacturing, steel production, and stacks from gas-powered equipment

Efficiency and Conservation Measures

Heat Pumps

- Transferring heat from one flow stream to another is far more efficient than generating heat outright
- When there are simultaneous functions of heating and cooling a heat pump can add significant value. For example, one vessel may be heating where another may be transferring, and needs cooled.

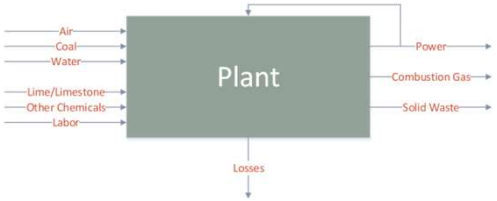
Process Controls

- Many auxiliary processes are designed to run at a fixed demand. Upgrading these to variable demand systems helps improve EE and reduces costs.
- Most fans and pumps have a cubic relationship between power and rate. Slowing these down can have dramatic impacts. Some examples are transferring products to storage and upgrading a cooling loop to be temperature controlled.

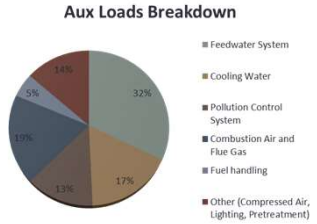
Methodical Approach

Determining the right measures for your organization can be daunting. Having a structured methodology is key ingredient for your team and partners to have success.

1 Start at a high level



2 Break down into functional areas. Attempt to see energy by area to determine impact to overall consumption

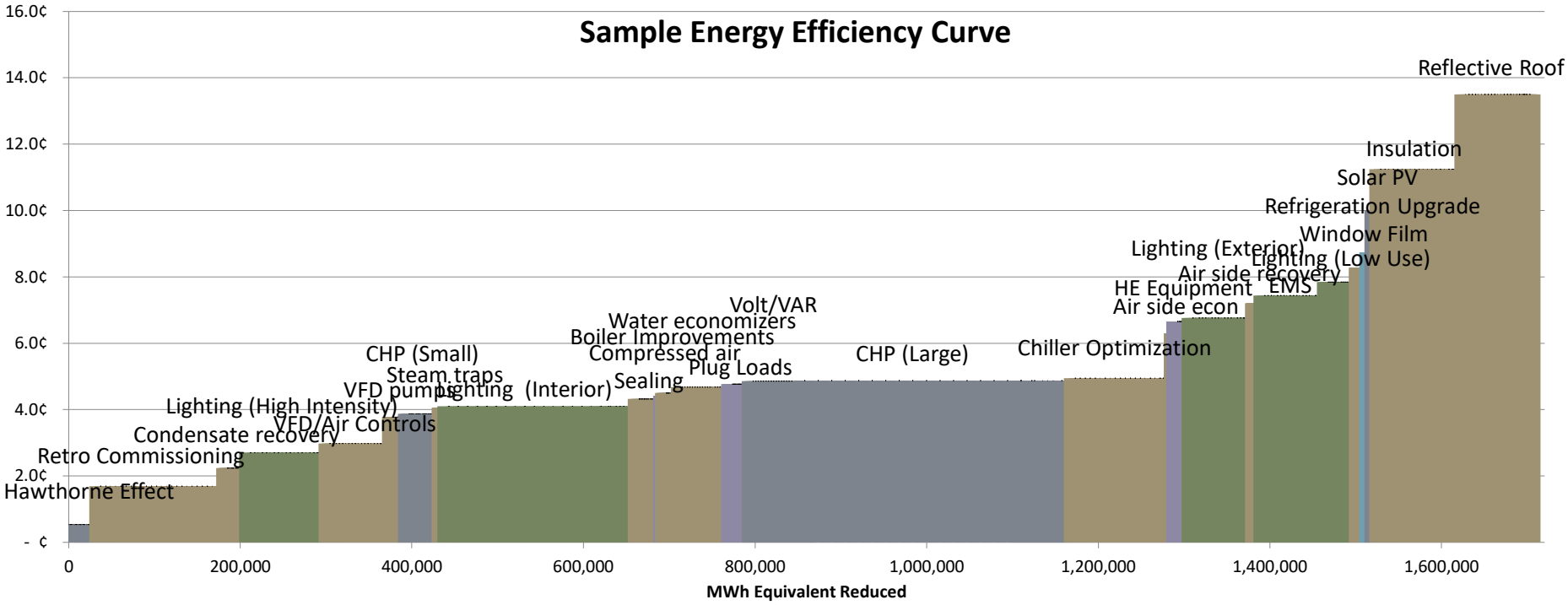


3 Every site is different, but the energy systems are the same. Identify the energy systems within the areas (Utilities, lighting, motors, fluid flow, steam, cooling, heating…)

4 Compare actual energy use to theoretical

Energy Efficiency Curve

Rank the oppurtunities



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Appendix

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