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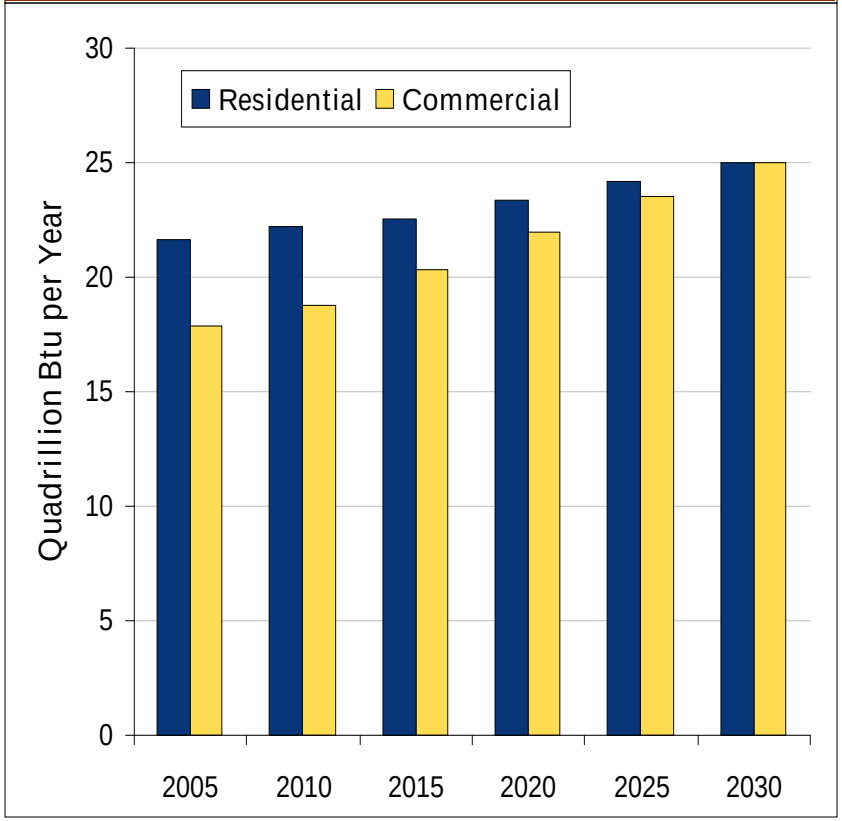
Energy Efficiency
Challenges and Solutions

Energy demand in the United States is projected to increase 21% by 2030, with the largest increase in the commercial sector.

AEO Buildings Sector Energy Consumption 2005-2030



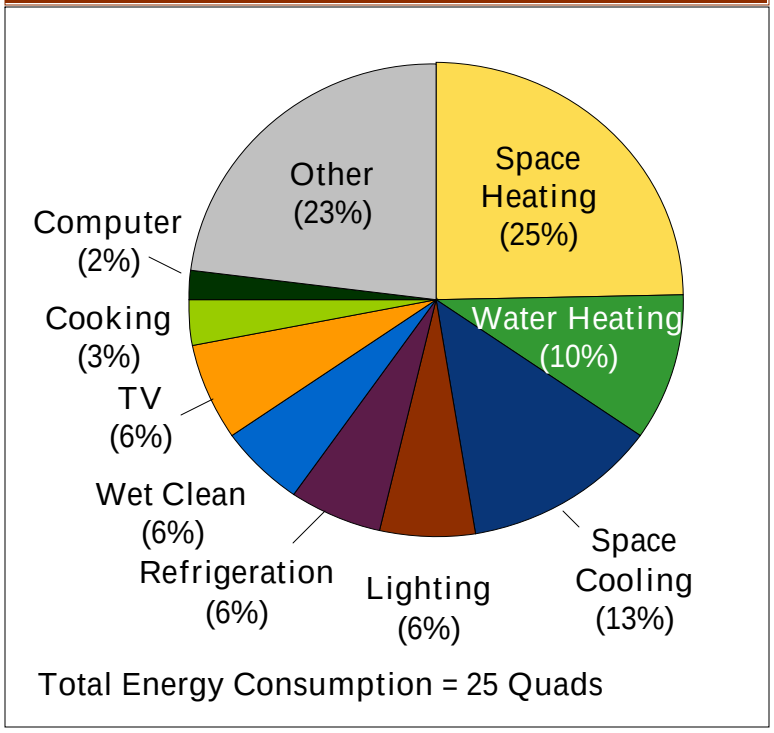
Energy Consumption Overview

- Current energy use is 22 quadrillion Btu for residential and 17 quadrillion Btu for commercial.
- Residential energy consumption is projected to grow at an average annual rate of 0.8% percent per year between 2005 and 2030.
- Commercial energy demand is projected to grow at an average annual rate of 1.4% percent between 2005 and 2030.
- Commercial energy consumption will essentially match residential in 2030, reaching 25 quadrillion Btu.

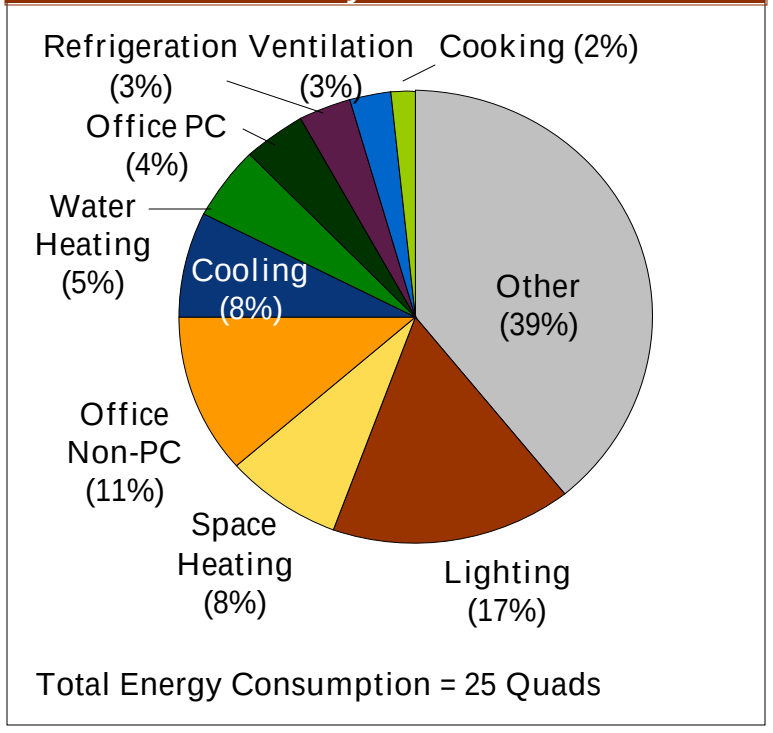
Source: Annual Energy Outlook 2008 with Projections to 2030 (Revised Early Release), http://www.eia.doe.gov/oiaf/aeo/.

The end use category "other" continues to grow faster than average consumption, leading to the following end use break down in 2030.

2030 Residential Building Energy Use by End Use



2030 Commercial Buildings Energy Use by End Use



Source: Annual Energy Outlook 2008 with Projections to 2030 (Revised Early Release), http://www.eia.doe.gov/oiaf/aeo/.

There are several drivers contributing to energy efficiency's increased focus.

Consumer Awareness

- More awareness of their environmental impact.
- View energy efficiency as a way to reduce the carbon footprint and combat global climate change.
- Realization that energy efficiency is the most cost-effective way to reduce energy demand associated with coal-fired electricity generation, natural gas and oil.

Energy Security

- Reduction in energy demand decrease the vulnerability to energy supply disruptions and related price spikes.
- The U.S. annual energy bill is around $1 trillion, with $370 billion in buildings, and reduction in the energy expenditures will be significant.

Greenhouse Gas Emissions

- Improvement in energy efficiency reduces the need to burn fossil fuels.
- Reduction of fossil fuel consumption diminishes related airborne emissions including carbon dioxide.

Growing Demand

- Increased population increases the demand for energy.
- New appliances and market saturation of certain amenities such as, air conditioning, televisions, washing machines and dishwashers increase energy demand.

Although energy efficiency addresses a multitude of economic and environmental drivers, challenges still exist.

Challenges	Solutions
Development of New Technologies • Slow moving, risk-averse technology adoption rates. • Relatively low levels of investment in research and development.	Improve the efficiency of current technologies. Accelerate investment and development of new technologies.
Market Acceptance of Technologies • Small market penetration. • Incentive programs have only scratched the surface of energy efficiency potential. • Average consumer has not embraced efficient technologies.	Continued development of energy efficiency programs and incentives. Increased coalitions with manufacturers, governments, retailers, and customer groups.

New and Emerging Energy Efficient Technologies

Future Energy Efficient Technologies: Residential

There are a number of potential future residential technologies that appear to be effective solutions to reduce energy demand.

	Today's Technology Status (Example)	Potential Future Technologies
Space Conditioning	Natural gas and oil furnaces/boilers, electric heat pumps and air-conditioners, both air-source and ground-source.	Advanced absorption cycle heating/cooling, ultra-high efficiency systems using variable speed compressor technology, and integrated heat pump (heating/cooling/water heating)
Water Heating	Natural gas - EF 0.62 Electric - 0.95 EF	CO_2 heat pump water heaters - EF 4.0+ Natural gas absorption units with COPs 1.4+
Lighting	Advanced incandescent and Compact Fluorescent Lamp (CFL)	120 to 160 lumen per watt Solid State Lighting (SSL)
Windows	R value range (R2 – 5) Solar Heat Gain Coefficient (SHGC) as low as 0.30	Highly insulating (R5 – R10), dynamic windows.
Other (Miscellaneous Electric Loads)	Increased use of electronics in the home	Reduction in standby power, and power supplies

And for commercial, there are similar future technologies that could reduce energy demand.

	Today's Technology Status (Example)	Potential Future Technologies
Lighting	Fluorescent: 80 to 105 lumens per watt system	190 lumen per watt Solid State Lighting
Windows	Typical static glazing	Dynamic windows SHGC (0.08 to 0.53)
Space Conditioning	Variable depending on building type, from natural gas boilers and furnaces, electric heat pumps for heating to chillers and unitary systems for air conditioning	Advanced absorption cycle heating/cooling, ultra-high efficiency systems using variable speed compressor technology
Building Controls	Seldom used for energy efficiency, except in advanced buildings	Increased use of building control systems. Fault detection diagnostics to insure buildings continue to operate as designed. Daylighting solutions
Water Heating	Gas fired water heaters – Thermal efficiency 80% - 94% Electric resistance water heater – Thermal efficiency 98%	CO_2 heat pump water heater and natural gas condensing and absorption units
Other end uses	Includes increasing use of office equipment and electronics	Reduction in standby power, and power supplies

Solid State Lighting has the potential to produce light at twice the efficiency of today's fluorescent lamps.

Solid State Lighting

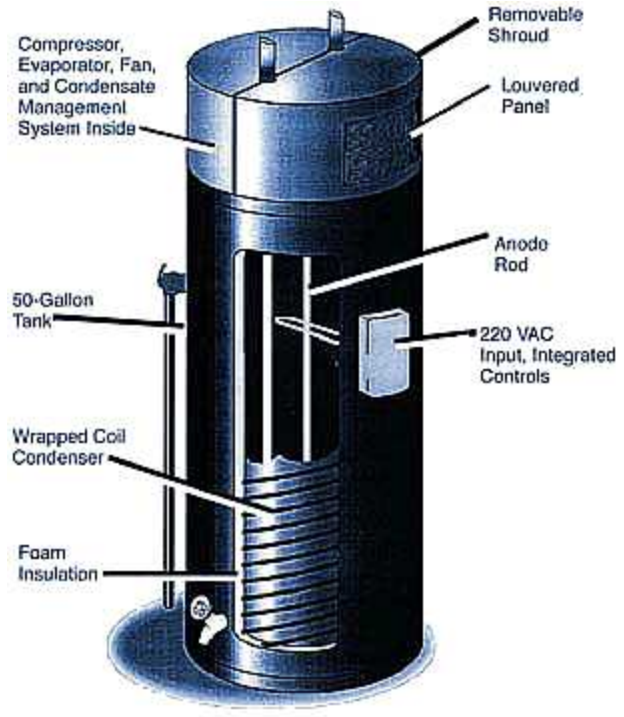
LED Walkway Lighting at the Federal Aviation Administration (FAA) William J. Hughes Technical Center in Atlantic City, New Jersey. http://www.netl.doe.gov/ssl/PDFs/Gateway_FAA.pdf

Key Attributes

- Light Emitting Diodes (LEDs) have the potential to revolutionize the lighting market through the introduction of highly energy efficient, longer-lasting, and more versatile light sources.
- At the end of a 20-year period LEDs could save the country approximately 3.75 quads of energy annually, or the equivalent annual output of forty 1000 MW power plants.
- On the market now is a LED downlight that consumes 12W. For the same light output, a typical compact fluorescent downlight would consume 15W and a typical incandescent downlight would consume 60W.

Heat pump water heaters more than double the efficiency of current electric resistance water heaters.

Heat Pump Water Heaters



Source: Oak Ridge National Laboratory, www.ornl.gov

Key Attributes

- Electric heat pump water heaters offer significant energy savings over conventional products, but still have high price premiums
- Use vapor compression cycle instead of electric resistance to heat water.
- Of the 4 to 5 million residential electric water heaters sold annually in the U.S., only a few thousand are heat pump water heaters.
- Heat pump water heaters can achieve a EF over 2.0, with some CO2 systems over 4.0 EF

Highly insulating dynamic windows have the potential to reduce heating, cooling and lighting building energy demands.

Key Attributes

- Switchable electrochromatic coatings for glass or plastic are being developed that monitor the needs of the building user and the window's heat flow.
- The first window using electrochromatic technology is commercially available in limited quantities. The technology is still very costly.
- Current R&D focuses on improving the coating of electrochromatic windows as well as exploring thermochromatic and photochromatic coatings.
- Also, R&D is being conducted to combine the best of electrochromics and highly insulating technologies to create a "superwindow"
- Sunlight represents a peak energy flow rate and is a large energy flow into buildings. Windows can control this energy flow, perhaps moving from a loser of energy to a provider.

Power supplies are another emerging area with opportunity for efficiency gains.

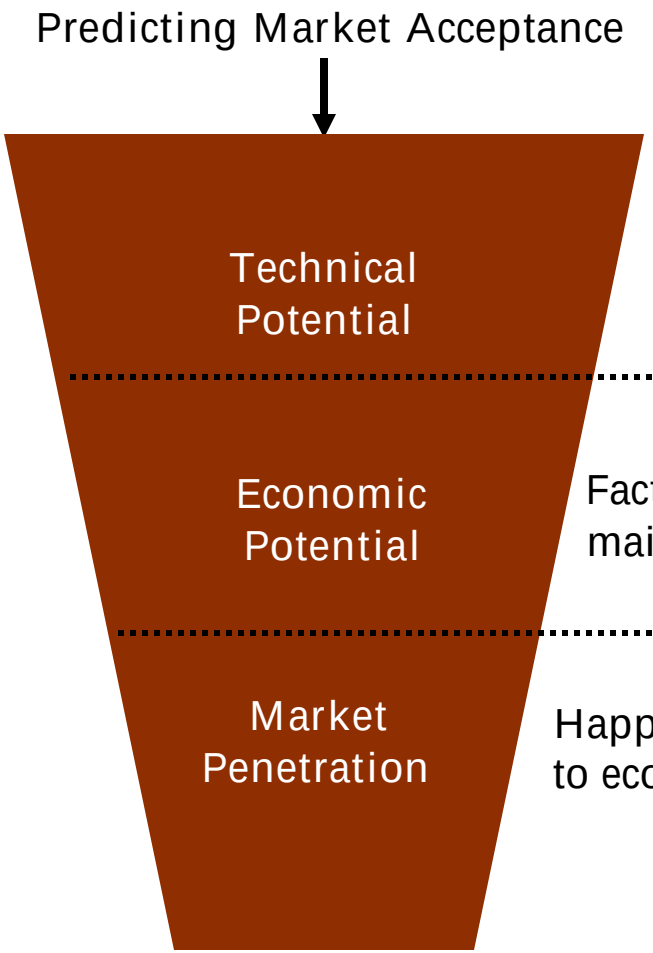
Power Supplies

Key Attributes

- A typical laptop power supply is approximately 85% efficient, but could be 90%+ in the future.
- Consumer products can further limit their power consumption through increased use of sleep modes
  - Certain products can turn off selected components after a period of non-use
  - These modes can improve energy-efficiency, particularly for products that users frequently leave on, e.g., computers, TV set-top boxes

Market Acceptance of Technologies

There are a lot of potential new energy efficient technologies, but benefits will only be realized through market adoption.



Begins to examine technologies while not worrying about economic issues, such as installation applicability.

Factors in energy prices, operation and maintenance costs, capital constraints.

Happens after addressing marketplace considerations related to economics and maturity of the options.

Advanced technology is only great if someone is using it, some attributes to keep in mind during development.

Market Attributes	Challenges to Technology Adoption
Awareness	Does the market know about the technology? What is the overall level of awareness among all market players with respect to the more efficient technology being evaluated?
Accessibility	Does the market have easy access to the technology through traditional distribution channels? Once a technology is available and people are aware of it, the market needs to have easy access to purchasing the technology.
Affordability	Is the market able to bear the selling price? Does the higher purchase price of the more efficient technology represent a market barrier? Some sectors (e.g., residential) can be particularly first cost sensitive, while others (e.g., commercial) are more likely to look at life-cycle cost and payback periods.
Acceptance	Are the attributes attractive to consumers? - the form, fit and function of a product.

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