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# Energy Efficiency Improvements in Existing Buildings

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Kate Brown

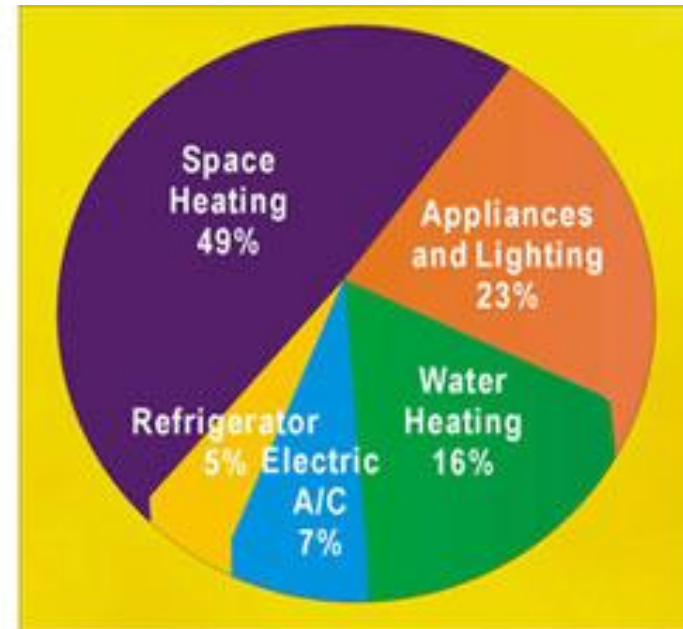
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# Energy Cost Reduction Measures in Households

- Appliances
- Refrigerators
- Phantom Loads
- Lighting
- Heating and Cooling
- Water Efficiency



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# Residential Building Basics

- 116 million US residential households
  - Average of 500,000 new homes built annually
  - Account for 21.5% of national energy consumption and carbon emissions
  - About 38% of electricity use.
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# Age of Housing Stock

- About 85% of the stock was constructed before prior to 2000
  - Older buildings generally have less stringent energy codes'
  - Older homes may be poorly insulated, suffer from excessive air leakage, have old inefficient mechanical equipment and appliances
  - High percentage of incandescent lights
  - High percentage of older appliances
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# Most Cost Effective Way to Reduce Energy Use and Carbon Emissions

- Energy retrofits of existing homes and new construction of high performance homes



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# Primary Barriers to ECRM

- Lack of information on reliability
  - Lack of information on costs
  - Lack of information on savings and paybacks
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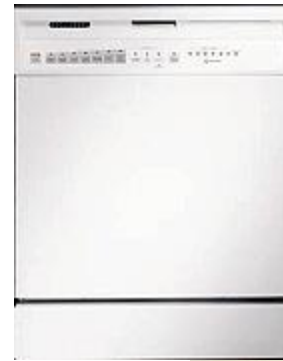
# Findings From Site Visits

- Recommendations for energy cost reductions measures
- Recommendations for Energy Star appliances, products, and homes



# Growing Importance of Appliance Load

- Percent of households with various appliances 1980 & 2001
  - ❑ Dishwashers: 29% in 1980; 47% in 2001
  - ❑ Computers: 15% in 1990; 58% in 2001
  - ❑ Microwave: 15% in 1980; 90% in 2001
  - ❑ Dehumidifier: 18% in 1980; 24% in 2001





# Energy Star Background

- *Energy Star* is a national, US government-backed symbol for energy efficiency
- Grown to products across 50+ categories
  - 1995 - new homes
- Generally, *Energy Star* labeled models 10% to 50% less energy than standard models
- Prevented greenhouse gas emissions equivalent to those from 20 million vehicles



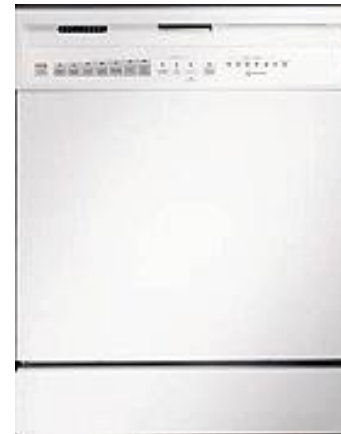
Old



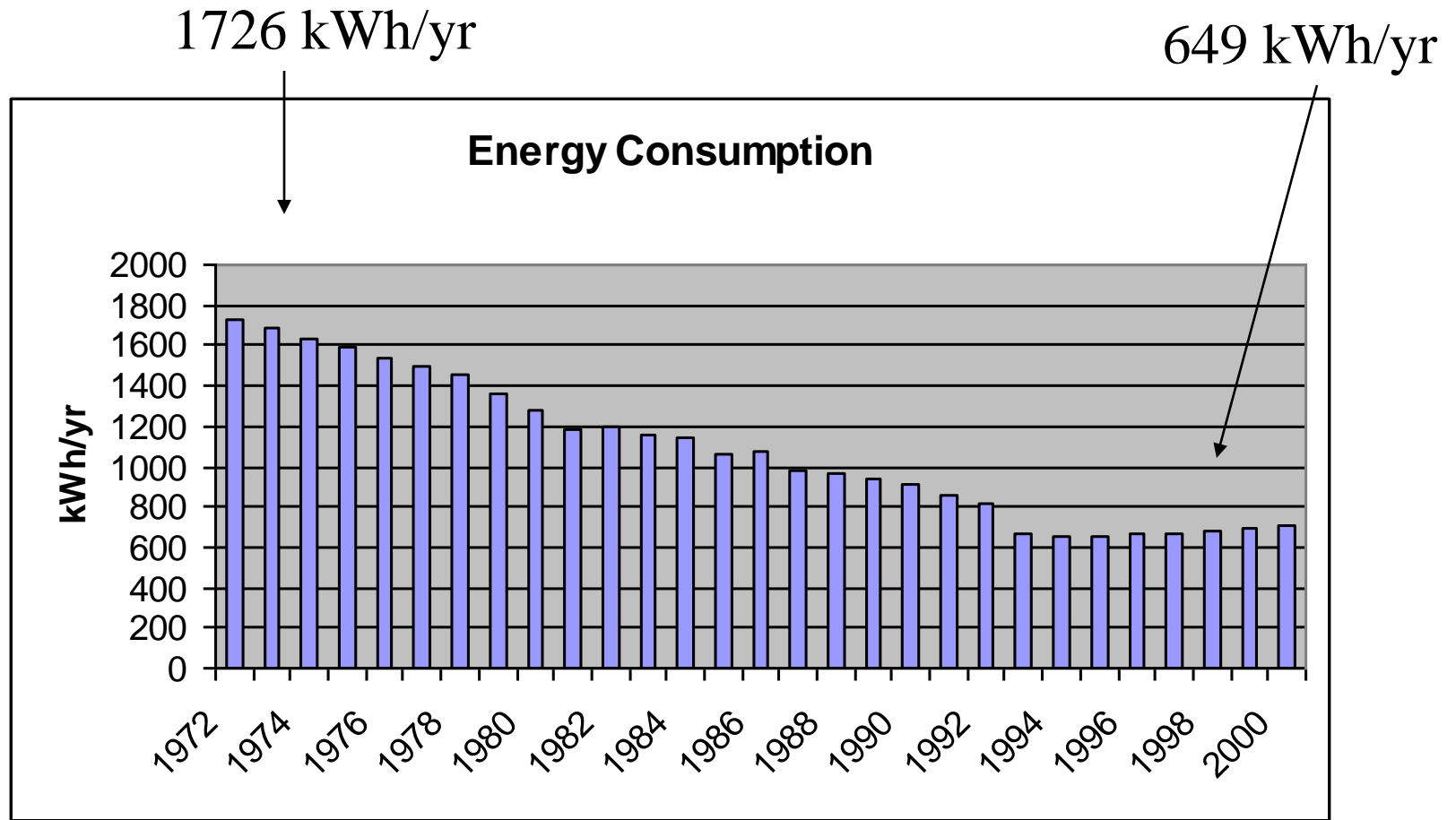
New

# Appliances

- *Energy Star*
  - Dishwashers
    - can save \$90 over new conventional models
    - can save \$30 per year over dishwashers made in 1994
  - Refrigerators
  - Freezers



# Refrigerators - Improvements in Efficiency



Shipment Weighted Energy Consumption from Association of Home Appliance Manufacturers

# Refrigerators & Freezers

- ▶ In most households, the refrigerator is the single biggest energy consuming kitchen appliance. ENERGY STAR qualified refrigerator models use high efficiency compressors, improved insulation, and more precise temperature and defrost mechanisms to improve energy efficiency. With an ENERGY STAR qualified refrigerator, energy and dollar savings can be maximized without sacrificing the features.
- ▶ Use 15-20% less energy



# Changes in Federal Standards

Year of Standard	15 ft <sup>3</sup>	18 ft <sup>3</sup>	22 ft <sup>3</sup>
1990	883 kWh/yr	968 kWh/yr	1092 kWh/yr
1993	635 kWh/yr	693 kWh/yr	778 kWh/yr
2001	448 kWh/yr	483 kWh/yr	535 kWh/yr

The federal standards represent the maximum allowable energy consumption (based on DOE energy rating) for refrigerators with top mounted freezers.

# Energy Star Refrigerators

- Must be at least 15% more efficient than allowed by federal standards
- *Energy Star* web site for product search ([www.energystar.gov](http://www.energystar.gov))

[Definitions of terms used in column headers](#)

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<a href="#">Brand</a>	<a href="#">Model</a>	<a href="#">Volume (ft3)</a>	<a href="#">Configuration</a>	<a href="#">Ice?</a>	<a href="#">KWH/Year</a>	<a href="#">NAECA std.</a>	<a href="#">% Less Energy</a>
General Electric	DSR23UGT	23.1	Side-by-Side	Yes	582	685	15%
General Electric	DSR23UST	23.1	Side-by-Side	Yes	582	685	15%
General Electric	DSR23USW	23.1	Side-by-Side	Yes	582	685	15%
General Electric	GLM23KES	23.1	Side-by-Side	Yes	582	685	15%
General Electric	GLM23KESF	23.1	Side-by-Side	Yes	582	685	15%
General Electric	GLM23KET	23.1	Side-by-Side	Yes	582	685	15%
General Electric	GLM23KETF	23.1	Side-by-Side	Yes	582	685	15%

**1944 kWh – 582 kWh = 1,362 kWh savings/year (\$136.20 at \$.10/kWh)**

# Refrigerators Payback Calculation

Age	Size	Annual Operating Cost	Annual kWhs	Annual kWhs Savings	Annual Savings	5 Yrs Savings
1990	19 cubic ft	\$129	1,285			
2010	19 cubic ft	\$41	530	755	\$88	\$440

# Appliances

- *Energy Star*
  - Clothes Washers
    - uses 40% less energy than standard models
    - can save over \$110 a year
    - Modified Energy Factor
    - higher MEF, the more efficient
  - Dryers
    - no *Energy Star* rating





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# Phantom Loads

- Standby usage is often called “phantom” load
- Using electricity when you think the appliance is off



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# Standby Power Waste

- Responsible for 4% to 7% of residential electricity usage nationally
  - For individuals, standby electricity usage can reach above 10% of total annual electricity consumption
  
  - 1 watt for 1 year =
    - 8.76 kWh
    - 29,898 Btus
    - \$.88/year at \$.10/kWh
-

# Home Computers and Equipment

- Old *Deskjet*: 10 watts
  - \$8.80
- Monitor: 3 watts
  - \$2.64
- Desktop Computer: 1 watt
  - \$0.88
- Scanner: 2 watts
  - \$1.76



Power strips can make sure off is off

# Kitchen Phantom Load

- Microwave: 3 watts
  - \$2.64
- Stove & Oven: 2 watts
  - \$1.76
- Rechargeable vacuum: 1.6 watts
  - \$1.41
- Portable TV: 3 watts
  - \$2.64



# Various Appliances on Standby

- Room AC: 2-2.5 watts
- Cordless Phone: 5 watts
- Clock Radio: 1-2 watts
- TV: 5 watts
- VCR: 8 watts
- Fax machine: 2 watt
- DVD Player: 3 watts
- Cable Box: 7-8 watts
- Digital Cable Box: 15 - 30 watts
  - \$13.20 to \$26.40
- Boom Box - Radio Mode: 1 watt
- Boom Box- CD Mode: 4 watts

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# Lighting: Did you Know?

- 10% to 15%, or \$90 per year of the average home's electricity costs can be controlled with the flip of a light switch.



# HOW?

- Compact fluorescent bulbs (CFLs) use up to 75% less energy, last up to 10 times longer than incandescent bulbs.



# Equivalence of Incandescent and Compact Fluorescent Lamps (CFLs)

Incandescent Bulb

Equivalent CFL

40 Watts

9 Watts

60 Watts

14 Watts

75 Watts

18 Watts

100 Watts

24 Watts





# Lighting

- Lighting consumes almost 35% of the electricity used in buildings
- T12 fluorescent lighting fixtures use 1/3 more energy than T8 electronic ballast counterparts, making the change an instant money saver.



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# Color Temperatures of CFLs

- Soft White    2700 Kelvin (K)
- Bright White    3500 K
- Daylight    5500 K

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# Kelvin Temperature K

- *What is the perfect color temperature for you?* 2700K - Homes, Restaurants, Hotel lobbies, Boutiques  
3000K - Libraries, Office Areas, Retail Stores
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# The Economics of Incandescent

- An average home has about 45 lights
- Suppose we look at 10 bulbs that are used on average 5 hours per day and are 60 watts
- That's 1095 kWh per year just for those 10 bulbs
- At \$.10/kWh, that's \$109.50 per year for those bulbs

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# The Economics of CFLs

- Again we look at those 10 bulbs that are used on average 5 hours per day and now are 14 watts
- That's 255.5 kWh per year for the 10 CFLs at \$.10/kWh, that's \$25.55 per year for those bulbs
- Savings from replacing the incandescents with CFLs:  
**\$83.95**

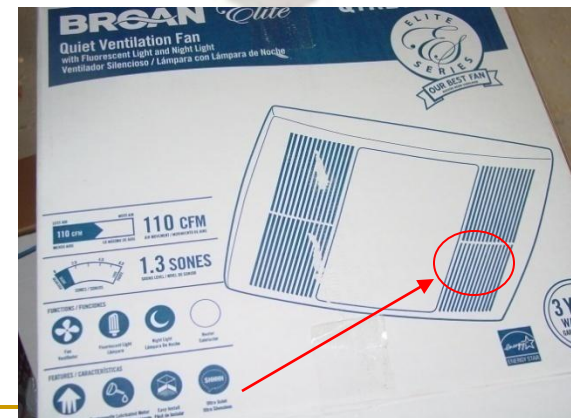
# ENERGY STAR *Advanced Lighting Package (ALP)*

- 60% ENERGY STAR qualified hard-wired light fixtures
  - ¼ the energy needed
  - Over 20,000 ES rated fixtures
- 100% ENERGY STAR qualified ceiling fans (where installed)
  - Improved motor & blade design
  - 50% more efficient than standard ceiling fans



# Bathroom Exhaust Fans

- ENERGY STAR rated
- Use 70% less energy than standard models
- Quiet (1.5 sones or less)
- Proper exhaust capacity (minimum 70 CFM)
- Correct vent installation
  - smooth metal or metallic flex
  - minimize length & bends
- Vented to the outside



# Testing of Bathroom Fans

Day	Address	Main Fan (CFM)	2nd Fan (CFM)
1-1		No bath fan	
1-2		18	
1-3			
2-1		56	
2-2		Not measured	
2-3		0	26
2-4	28	46	
2-5	35 Summer ST	50	
2-6	116 Summer ST.	15	20
3-1		30	



- Measuring bath fan exhaust flow
- Toilet paper can be used to identify really poor fans



# Heating & Cooling Homes: Did You Know?

- According to DOE, the average household in the U. S. spends about \$1,300 each year on home energy.



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# Why Develop Energy Consciousness?

- The energy use of two households that look exactly alike can vary by 100 percent—which means that how you use what's in your home can double or halve your energy bill.
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# Programmable Thermostat

- The thermostat controls the heating & cooling system that consumes more than half of the energy in homes-the biggest chunk of household energy budget.



# Window A/C Units

- Old window air conditioning units
- Minimum EER for new room AC units is 10.8
- Energy Star units use at least 10% less energy and often include timers for better temperature control
- Replacement units with EER less than 8.8



# 90% AFUE<sup>1</sup> Furnace w/ Electrically Commutated Motor (ECM)

- High efficiency furnaces, but poor electrical efficiency
- Air handlers can draw over 700 watts
- Efficient air handlers draw between 200 and 400 watts
- 40% to 70% more efficient than standard furnaces



<sup>1</sup> – Annual Fuel Utilization Efficiency

# Hot Water Heater

- Heating water accounts for 5-20% of the total energy
- Energy Star water heater uses 10-50% less energy
- Lower water heating setting (120 degrees)





# Water Efficiency

- Toilets
  - If installed before 1994, should replace
    - High Efficiency Toilets (1.0 gpf)
    - Dual flush (1.0 gpf<sup>1</sup> or 0.8 gpf)
  - Toiletology ([www.toiletology.com](http://www.toiletology.com))



<sup>1</sup>- gallons per flush





# Hot Water

- Producing hot water uses about 14% or more of your home energy budget.
- A simple and least expensive option is a low-flow shower head.
- It can cut your shower water use in half while maintaining the same pressure as before.



# Cold Climate



**Ranch: Built 1987    1,176 sqft**

**Basement                    Windows: SG with storms**

**Wood frame construction**

<b>Roof:</b>	<b>R33</b>
<b>Sidewalls:</b>	<b>R11</b>
<b>Basement Walls:</b>	<b>R10</b>
<b>Window U-value:</b>	<b>0.65</b>
<b>Air Leakage:</b>	<b>11.48 ACH50</b>
<b>Furnace:</b>	<b>80% AFUE (propane)</b>
<b>Water Heater:</b>	<b>56% EF (propane)</b>
<b>Refrigerator:</b>	<b>1100 kWh/yr</b>
<b>Lighting:</b>	<b>Incandescent</b>
<b>Dishwasher:</b>	<b>Old</b>
<b>HERS Index:</b>	<b>114</b>

# Cold Climate – Energy Efficient



Ranch: Built 1987    1,176 sqft

Basement                      Windows: SG with storms

Wood frame construction

<b>Roof:</b>	<b>R43</b>
<b>Sidewalls:</b>	<b>R11</b>
<b>Basement Walls:</b>	<b>R10</b>
<b>Window U-value:</b>	<b>0.65</b>
<b>Air Leakage:</b>	<b>7.01 ACH50</b>
<b>Furnace:</b>	<b>92% AFUE (propane)</b>
<b>Water Heater:</b>	<b>62% EF (propane)</b>
<b>Refrigerator:</b>	<b>420 kWh/yr</b>
<b>Lighting:</b>	<b>50% CFLs</b>
<b>Dishwasher:</b>	<b><i>Energy Star</i></b>
<b>HERS Index:</b>	<b>87</b>
<b>Annual Savings:</b>	<b>\$613</b>

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# Put Your Home on an Energy Diet

1. Do you adjust thermostats for low energy use when you go to sleep?
  2. Do you adjust thermostats for low energy use when you go out?
  3. Do you adjust heating & cooling systems to work more efficiently?
  4. Do you cool your home the natural way?
  5. Do you let the sun heat your home in cold weather?
  6. Do you keep yourself comfortably warm or cool?
  7. Do you use less hot water in the bathroom, kitchen, and laundry?
  8. Do you use lights, TV, appliances in an energy-conserving way?
  9. Have purchased better light bulbs?
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# Thermostats Settings

- One of the best way to save energy dollars is using less heating & cooling
- Cooling Season: 76-78 degrees
- Heating Season: 66-68 degrees
- Comfortable dress



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# When Sleeping Set Thermostat for Low Energy Use

- 1/3 of time is spend asleep (8 hours a night)
- Cooling: 76-78 degrees
- Heating: 55-60 degrees
- In hot weather, the gentle flow of air from an electric fan may be all you need
- In cold weather, use more blankets





# Adjust Heating & Cooling Systems to Work More Efficiently

- Make sure duct system is not leaking
- Make sure the system is balanced
- Clean or replace filters
- Clear away obstructions



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# Cool and Heat Your Home Natural Way

- Let the cool air in at night. Experiment to see which windows & doors to open to create the best air flow
- Use electric fans
- Let the sun help heat your home in cold weather by pulling up shades or open draperies to let the sun warm rays in.





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# Button Up Your Home

- Cold weather use storm doors and windows
- Cold nights close curtains
- Watch out for open fireplace chimneys



# Energy Payback Savings

Total Energy Costs	10% Reduction	20% Reduction	30% Reduction
\$ 50 a month	\$ 60 a year	\$120 a year	\$ 180 a year
\$ 100 a month	\$ 120 a year	\$ 240 a year	\$ 360 a year
\$ 150 a month	\$ 180 a year	\$ 360 a year	\$ 540 a year
\$ 200 a month	\$ 240 a year	\$ 480 a year	\$ 720 a year

# Tribal Housing Authority Savings

IHBG Funds	ECRM	Projected Savings	5 Year Savings
\$ 100,000	Refrigerators	\$ 30,000	\$ 150,000
51 LR Units	High Efficiency Furnaces Regulators on Heating System		

# Summary

- Use compact fluorescent lamps (CFL's)
  - lighting output
  - quality of light
  - lights that are on the most
- Lower water heater setting (120°F)
- Consider Energy Factor (EF) when replacing
- Don't forget about water



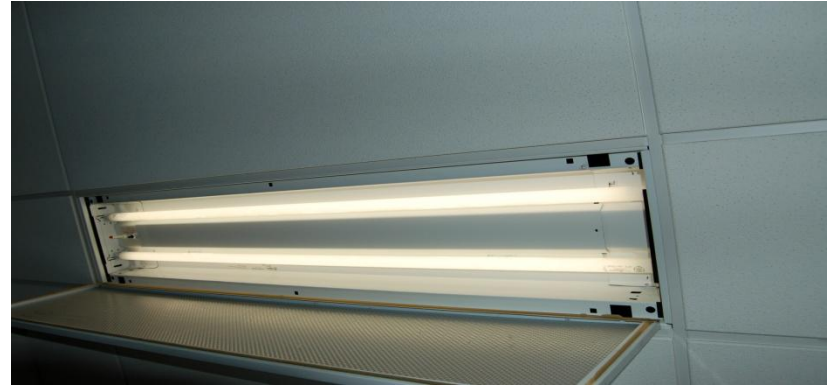
# Summary: Put Your Home on Energy Diet

- Mix and match choices with energy saving habits and technology
- Conduct an Power\$mart assessment of your home

	<b>Caulk around wall, ceiling, and floor penetrations.</b>	The biggest culprits are furnace exhaust vents penetrating the ceiling, water pipes going through walls and floors, and around kitchen and bathroom exhaust fans.
	<b>Install foam gaskets behind faceplates of electrical outlets and light switches.</b>	Air leaks around outlets and lightswitches is common in exterior walls, but interior wall outlets can also let air escape up the walls and into the attic.
	<b>Weatherstrip around windows, doors, and attic hatches.</b>	Weatherstripping should be compressed when the door or window is shut. Also make sure door sweeps and thresholds are in good condition.
	<b>Seal duct joints with duct mastic, mastic tape, or butyl-aluminum tape.</b>	All supply and return duct joints should be sealed to ensure proper air distribution. Ducts in unconditioned spaces (attics, garages, crawlspace) should be insulated to a minimum of R6 after air sealing.
	<b>Replace incandescent bulbs with compact fluorescent lamps.</b>	Compact fluorescents save significantly on electricity costs and usually last six or seven years. T8 tubular fluorescents are another efficient way of lighting the home.
	<b>Install and use programmable thermostats.</b>	These automatically reduce/increase temperatures in the heating/cooling season during the night and while people are away in the day time. Occupants can also temporarily override the settings when desired.
	<b>Lower the temperature of water heaters to 120 degrees.</b>	Most households don't need water any hotter than 120 degrees. For each 10°F reduction in water temperature, you can save between 3%–5% in energy costs.
	<b>Insulate hot water pipes.</b>	Domestic hot water lines should be insulated to prevent heat loss, and cold water lines should be insulated to reduce surface condensation problems.
	<b>Put an insulating jacket on your water heater.</b>	A water heater tank that's warm to the touch needs additional insulation. Doing so can reduce standby heat losses by 25%–45%. This will save you around 4%–9% in water heating costs.
	<b>Install low-flow high-pressure showerheads.</b>	If it takes less than 20 seconds for your shower flow to fill a one gallon bucket, a low-flow shower head could help save on water heating costs.
	<b>Buy ENERGY STAR® appliances</b>	Changing to ENERGY STAR labeled appliances can save the average home \$80 a year in energy costs.
	<b>Replace Older Furnaces with High-Efficiency Units</b>	Switching to a 90+ AFUE furnace from an 80 AFUE furnace will save at least 10% on annual heating costs. It is recommended that furnaces that are more than 15 years old be replaced with high-efficiency units.
	<b>Change Lifestyle Habits</b>	Provide education and training on energy conservation measure in Tribal homes.

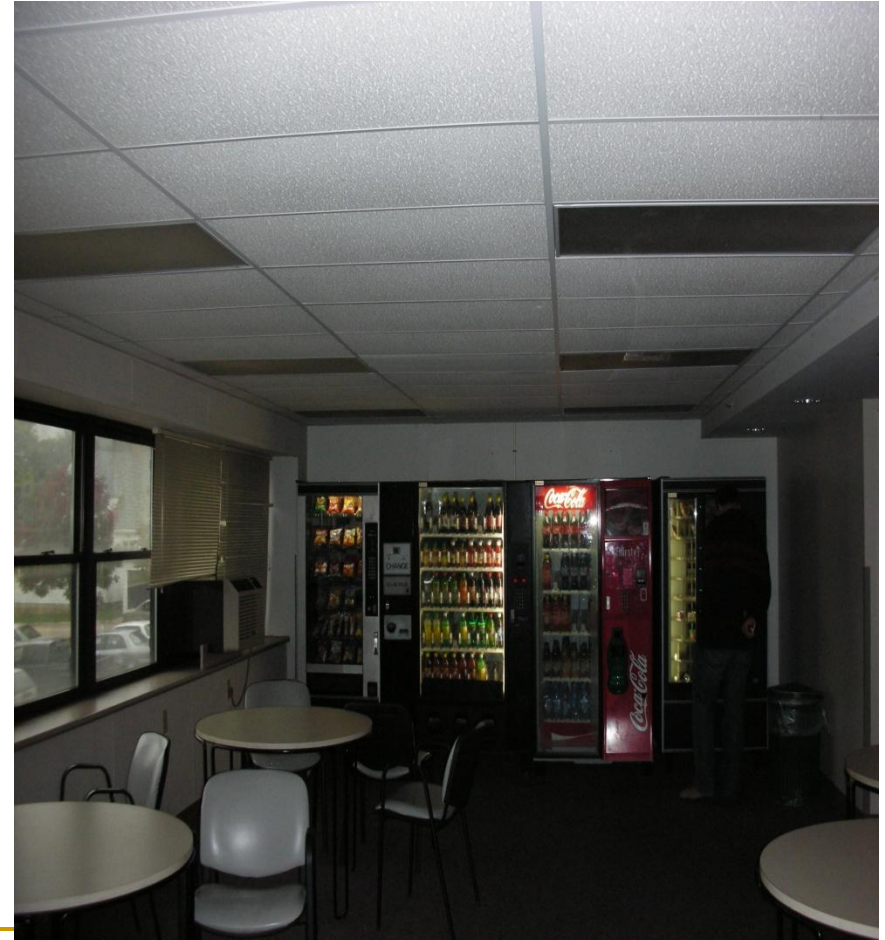
# ECRM in Large Tribal Buildings

- Lighting consumes almost 35% of the electricity used in buildings
- T-12 fluorescent lighting fixtures use 1/3 more energy than T8 electronic ballast counterparts, making the change an instant money saver.



# Vending Machines

- New DOE Standards for cold beverage vending machines—42% reduction.
- About 3 million vending machines in the US, new standard will save enough electricity to meet the needs of about 1.4 million US households.
- Many machines use 3,000 to 5,000 kWh annually.
- New standards will use 1,400 to 1,800 kWh annually.
- Over \$100 a year savings, per machine, with potential greater for larger machines.



# Vending Machine Miser

- Reduce energy costs of cold drink vending machines by 40%
- Typical cost is \$300; reduce by \$125.
- Vending Miser uses a passive infrared sensor to power down when no one is in the area and power up if a customer approaches.





# Findings: Exit Signs

- Older exit signs with incandescent bulbs
- Incandescent bulbs are highly inefficient, have a very short life span.
- LED, energy savings signs for quick payback.



# Summary

- Use *Energy Star* refrigerators
- Use *Energy Star* appliances
  - Dishwashers
  - Clothes Washers
- Beware of phantom loads
- Consider savings potentials in your larger buildings

