Northwest Power and Conservation Council

September 11, 2012

MEMORANDUM

TO: Power Committee

FROM: Tom Eckman and Massoud Jourabchi

SUBJECT: Briefing on Residential Building Stock Assessment, Single Family Home Results

Staff will brief the Power Committee the major findings from the recently completed Residential Building Stock Assessment (RBSA). The RBSA, which was funded through Northwest Energy Efficiency Alliance (NEEA), is the first region-wide, comprehensive survey of housing characteristics in 20 years. The RBSA data was collected through nearly 6200 phone surveys, 1400 onsite audits, including 452 heat loss assessments. In addition, the RBSA has installed detailed end-use metering equipment in just over 100 single family homes to collect energy (electric and gas) use and load shape (5-minute interval) data. The briefing is the first of a three part series focused on updating the Council on state of residential buildings in the region. Subsequent reports will summarize the findings for manufactured homes and multifamily dwellings. The findings from this research will provide critical inputs to both the Council's load forecast and its assessment of regional conservation potential for the 7th plan.

The RBSA was designed and carried out by for Northwest Energy Efficiency Alliance with input from a wide range of regional stakeholders. NEEA undertook this research to fill one of the data gaps identified by the NEET "Measuring What Matters" work group. Field data collection began in the late spring of 2011 and the final "meters" for the end-use monitoring component of the project were installed in mid-December.

The RBSA's sample was designed to provide statistically representative (90% confidence/10% precision) data at the state level. It included all public and investor owned utilities in Washington, Oregon, Idaho, and western Montana. The final RBSA sample includes 100 utilities; 90 public power utilities, seven investor-owned utilities, and three gas-only utilities. The sample design reflects a substantial oversample by Bonneville and seven individual utilities in order to achieve a statistically significant number of sample points in each of their service territories and in five Bonneville sub-regions.

Data collected during the field surveys included general demographic information, occupant attitudes and participation in efficiency programs, a detailed lighting inventory, building

851 S.W. Sixth Avenue, Suite 1100
Portland, Oregon 97204-1348
www.nwcouncil.org

Steve Crow
Executive Director

503-222-5161
800-452-5161
Fax: 503-820-2370

envelope characteristics, and end-use characteristics for electronics, major appliances, and heating, ventilation, and air conditioning (HVAC) equipment.

To add a little excitement to the presentation on RBSA, a portion of the presentation will be made in a Jeopardy game format (with an appropriate prize). The section below covers most of the questions in the game.

There are a few salient findings that can be drawn out of the analysis presented in the single-family report:

- The ability to sample the residential population to address the needs of the public power system and the needs of the rural customers required a complex sample design so that results can be easily weighted to allow summaries for each target population.
- Characteristics of Northwest housing have a distinct east/west divide. The use of basements for example is very common in eastern climates and very uncommon in western climates. It appears, however, that with the development of more common codes and standards many of these distinctions with respect to energy efficiency are being reduced. The review of overall heat loss shows surprisingly small differences between the states and climates.
- When reviewing the overall heat loss rate by vintage, the development of the codes in Oregon and Washington offer some clear insights on the short-term impacts of energy codes on construction practices and insulation levels. The improvement in energy efficiency of homes coincident with the effective date of new codes is clearly evident in the characteristics data.
- The lighting audit conducted as part of the overall field survey collected information on lamp and fixture types. This information will allow the development of an estimate of the impacts of Energy Independence and Security Act (EISA) on the region's residential lighting systems. Based on RBSA data it appears that approximately 27% of all lamps in single family homes would not be affected (i.e. are exempt) by the EISA standards. Of those lamps covered by the EISA standards when they are fully implemented in 2014, a roughly half are EISA compliant today and the other half of the lamps are not yet compliant.
- The overall lighting power density (LPD) for the single-family homes across the region is about 1.4 Watt/Sq.Ft. This LPD includes about 36% of all lamps that are compact florescent lamps (CFL) or other types of florescent lamps.
- Single family homes in the region have an average of almost 16 CFLs installed and another 5 CFLs "in storage," with homes in Washington having the greatest number installed (17) and Montana the fewest (12).
- Fuel selection is based on the availability of natural gas to some extent. About 57% of homes have natural gas supply. Montana has the highest fraction of homes heated with natural gas. About 49% of primary heating systems are gas fired in that state.
- Wood heat is used throughout the region. About 25% of all households report either wood or pellet use for space heating. The amount of fuel used is almost always supplemental to a more conventional heating system, although nearly 10% of homes claim wood heat as their primary heat source.
- Oil or propane fuel about 6.5% of the primary heating systems.

- Domestic hot water (DHW) fuel choice is dominated by electric with approximately 55% of the water heating use supplied by electric DHW tanks.
- Across the region, homes have about 2.3 TVs and 1.5 set-top boxes. Nearly 30% of the set-top boxes have digital video recorder (DVR) capability.
- While half of all televisions are cathode ray tube (CRT) types only 5% of televisions purchased after 2009 are CRTs; the rest are flat screens.
- About a third of all homes have an electronic gaming system. The average number of gaming systems in those homes is 1.5.
- 90% of all homes surveyed have a computer.
- The average single family household does about 5 loads of laundry per week, but in Idaho the average household does almost 6 loads per week.
- Nearly 90 percent of single family homes in the region already have double or triple pane windows.
- Oregon homes are the "leakiest" overall, but the ductwork in Montana's homes leaks the most.
- The use of air conditioning has grown from 24 percent of single family homes in 1992 to 42 percent today.
- The share of single family homes with dishwashers has grown from about two-thirds in 1992 to nearly 90 percent today.
- The average single family household does about 170 dishwasher loads of per year, averaging just over 3 times per week.
- Over 40% of refrigerators now in use were built prior to 2000.
- Nearly half (48%) of single family households reported that they made recent energy efficiency investments on their own, while only16% indicated that they had recently participated in a utility sponsored program.
- Even though they are larger and located in a much colder climate, single family homes that heat with electricity in Montana use only 90% of the electricity for space heating than does the average electrically space heated home in Washington.

A fully detailed report on Residential Building Stock Assessment will become available through NEEA's website once the work is finalized.

Residential Building Stock Assessment (RBSA)

Tom Eckman

&

Massoud Jourabchi

September 11, 2012

The Unknown

As we know,
There are known knowns.
There are things we know we know.
We also know
There are known unknowns.
That is to say
We know there are some things
We do not know.
But there are also unknown unknowns,
The ones we don't know
We don't know.

Donald Rumsfeld. Feb. 12, 2002, Department of Defense news briefing

The Chances of Making A Better Decision Increase With Accurate Data

- Council's load forecast and assessment of conservation potential rely on *current* and *detailed* data about housing and appliance characteristics
- Conservation program planners rely on market data to inform program design and evaluations
- Acquisition of statistically meaningful data is both essential and expensive

Data Sources for the 6th Power Plan

PNWRES (1992)
- 20,000 interviews across the region
- Self reported building characteristics
- Primary source of residential sector characterization

RLW Existing Single-Family Report (2007)
- 489 audits in 5 areas.
  - I-5 corridor
  - Bend, Boise, Tri-Cities
- Sample designed for a different purpose and adapted
- 11 utilities participated
- Similar characterization to current RBSA

Other Similar Studies
- Heat Pumps (2005)
- New Construction (1994-2007)
- NORIS (1987)

RBSA Objectives

Characterize Residential Sector

- Single-family homes (SF)
- Manufactured homes (MH)
- Multifamily buildings and units (MF)

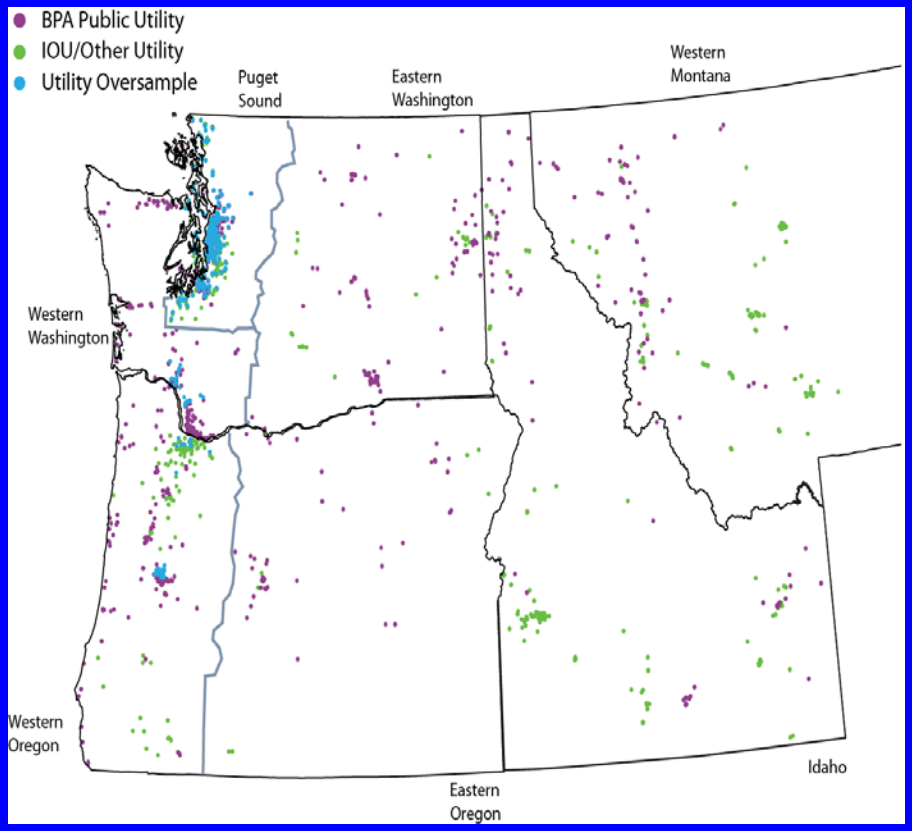
Provide Representative Sample

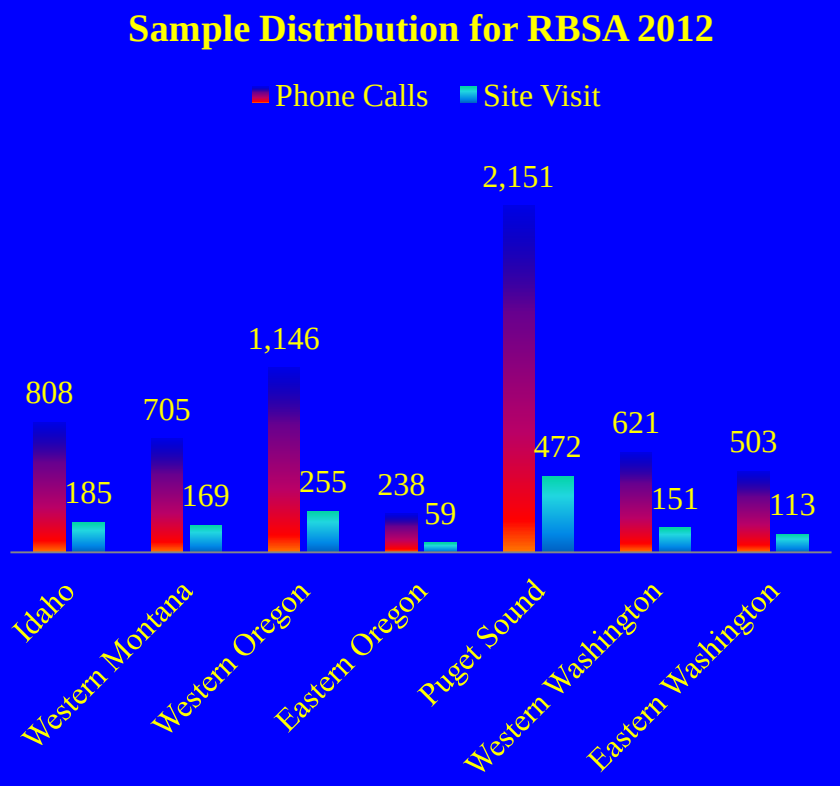
- Characterize the region and each state
- Provide characterization for BPA customers
- Provide a framework for individual utility oversamples.

Characterize Buildings

- Energy audit
- Lighting survey
- Survey of appliances and electronics
- Demographics

RBSA Study Coverage



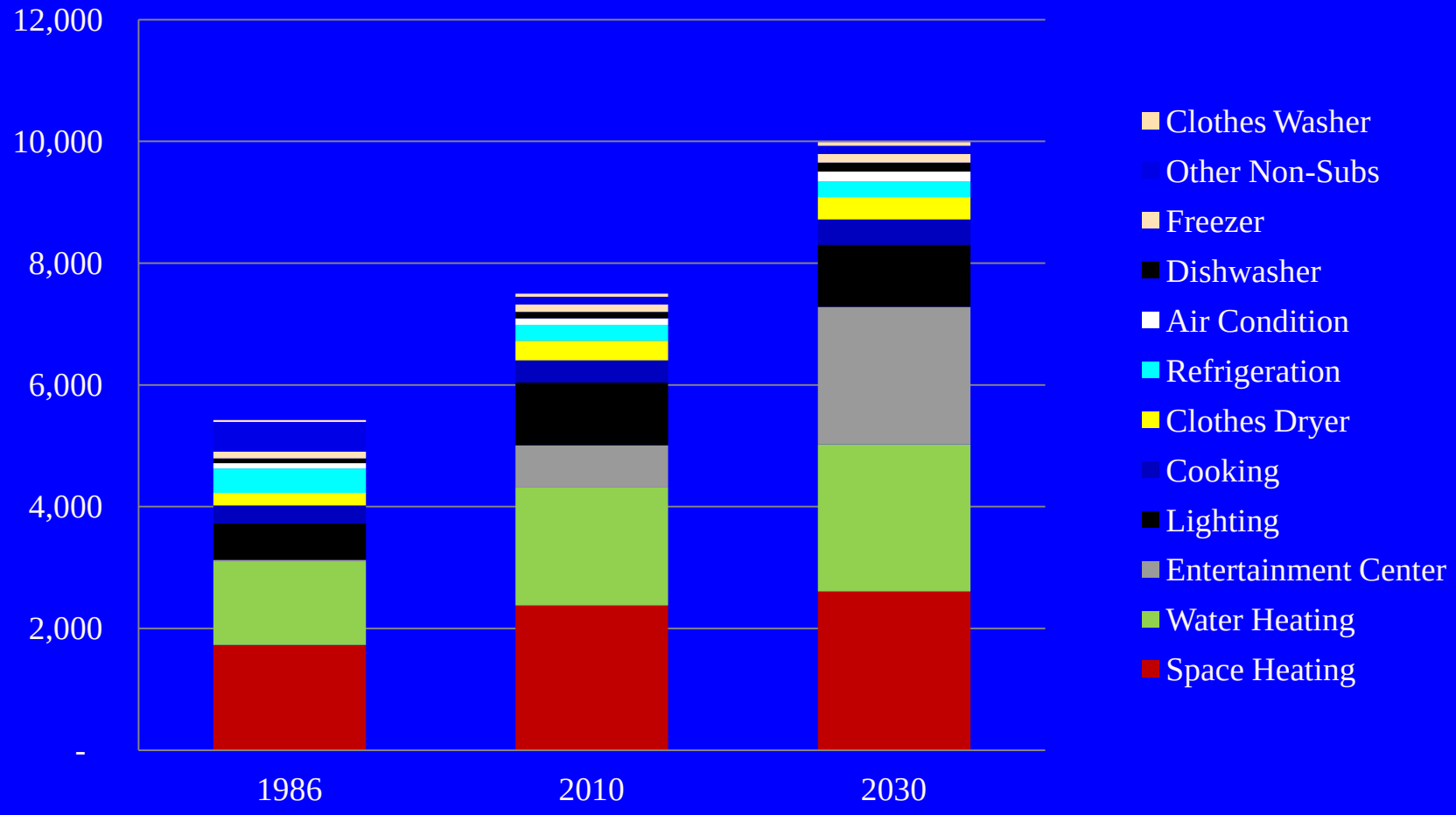


Last Comprehensive Regional Survey of Residential Customer Characteristics Was Conducted in 1992

How This Data Will Be Used

- Supports both Load Forecasting and Assessment of Conservation Potential
  - Provides Baseline Building Characteristics
  - Updates Heating and Cooling Equipment Market Shares
  - Revises Appliance Saturations and Characteristics
- Key input into determination of “non-programmatic” efficiency improvements (i.e., what consumers did on the own)
- Assist in program design & implementation

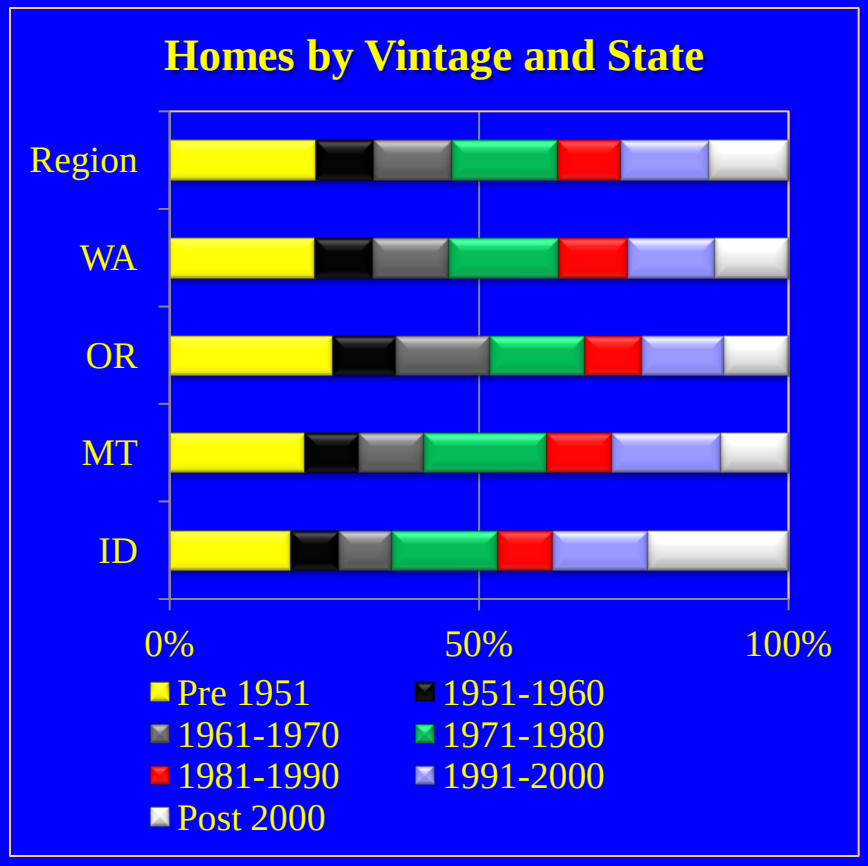
Estimated Load in Residential Sector Prior to Conservation initiatives or Federal Standards



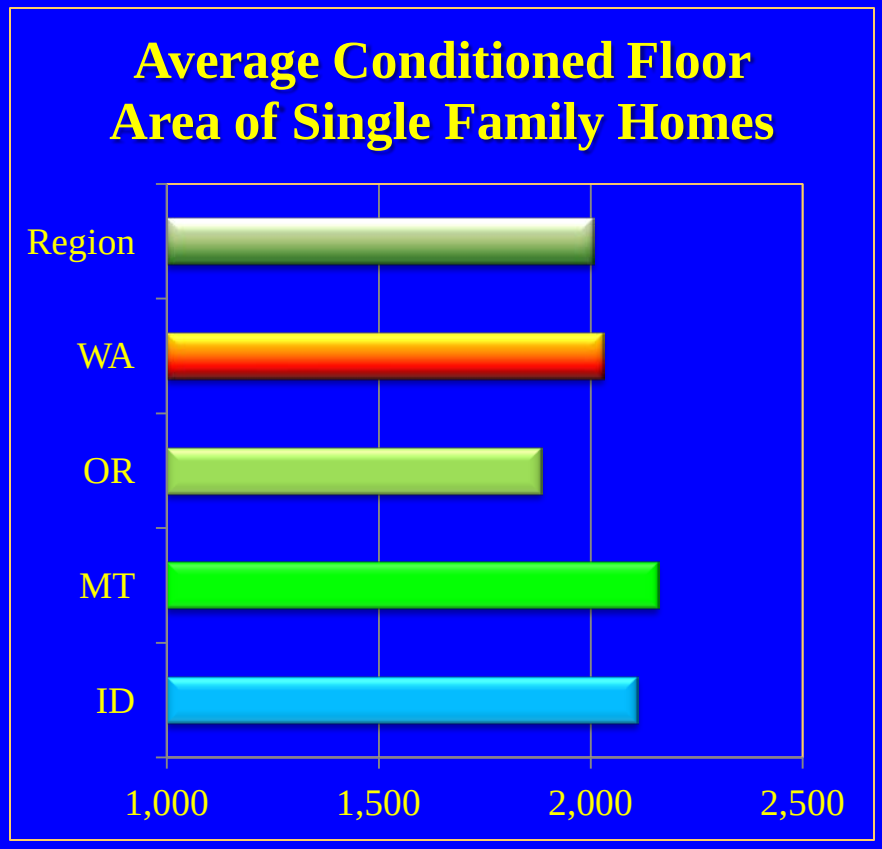
2012 RBSA Jeopardy

Category: Home Characteristics

This state has the largest average home size



What is Montana?



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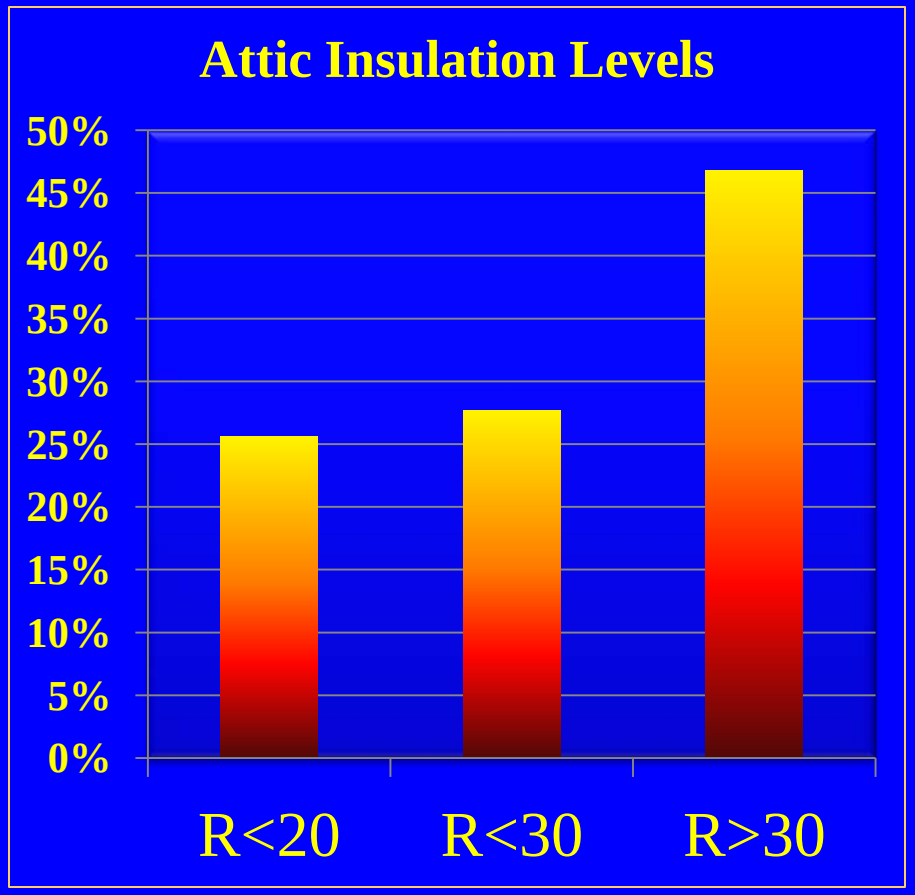
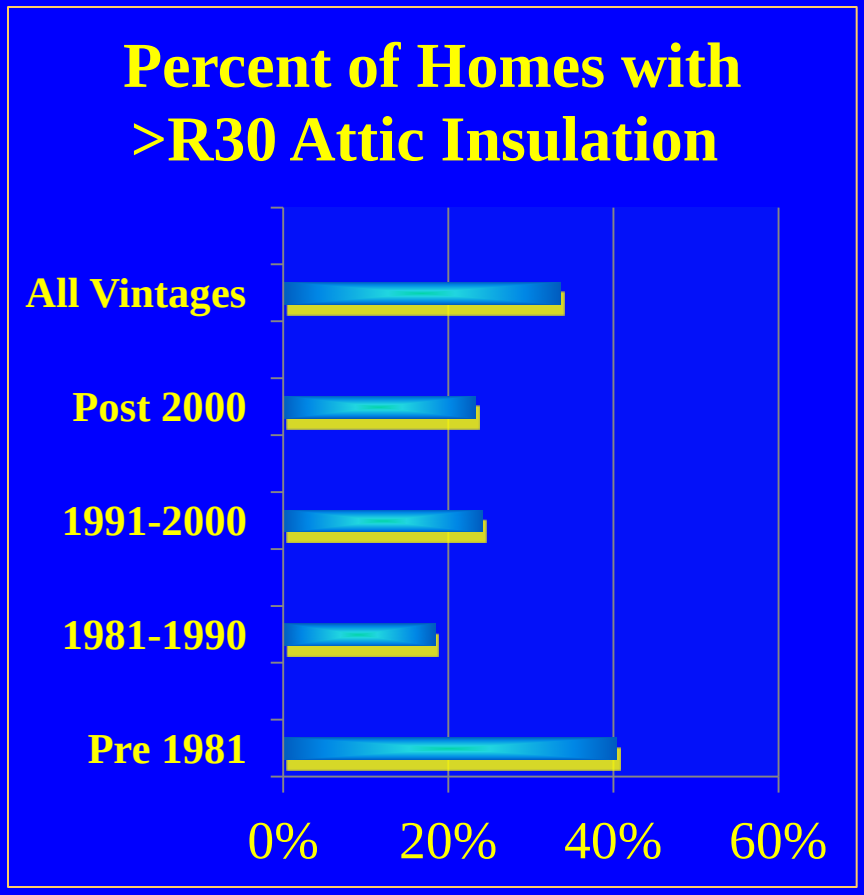
Category: Attic Insulation

One third of homes have at least this level of attic insulation.

What is R30 insulation?





Opportunity: 18% of homes have no attic Insulation

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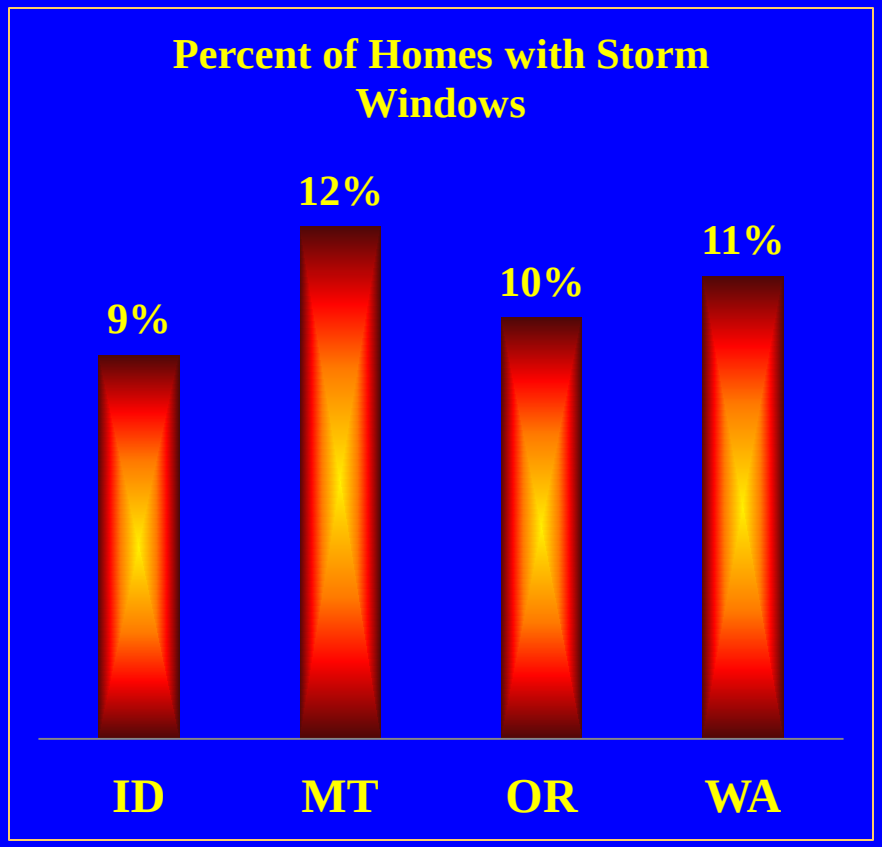
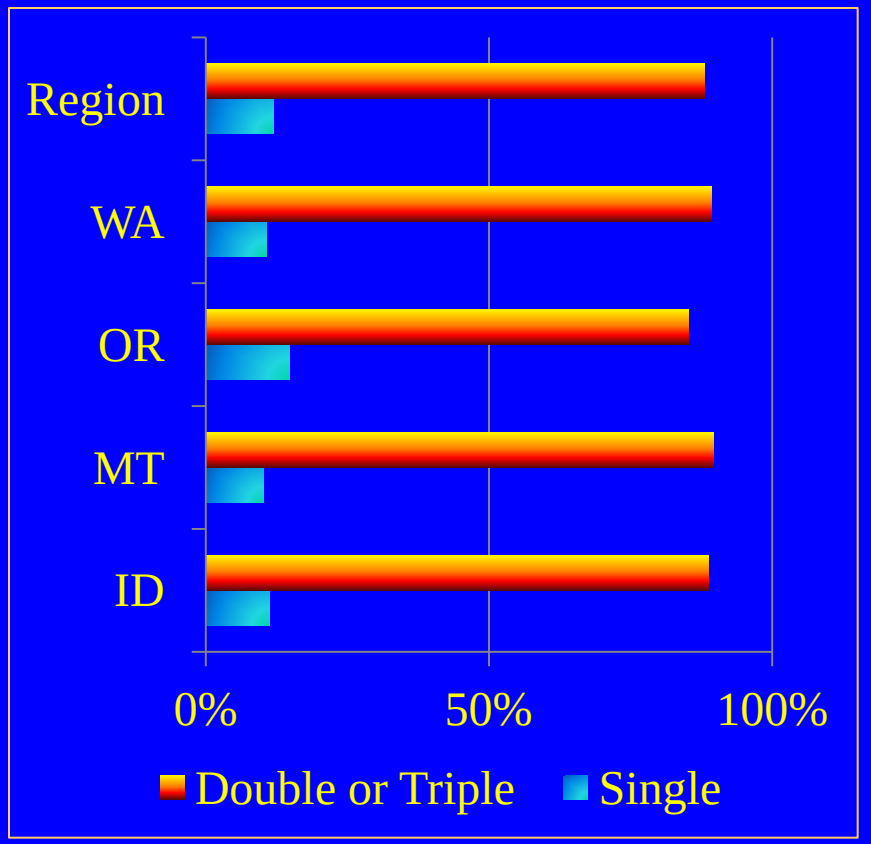
Category: Windows

Less than one in ten homes have windows with this many panes of glass



What are single pane (or glazed) windows?



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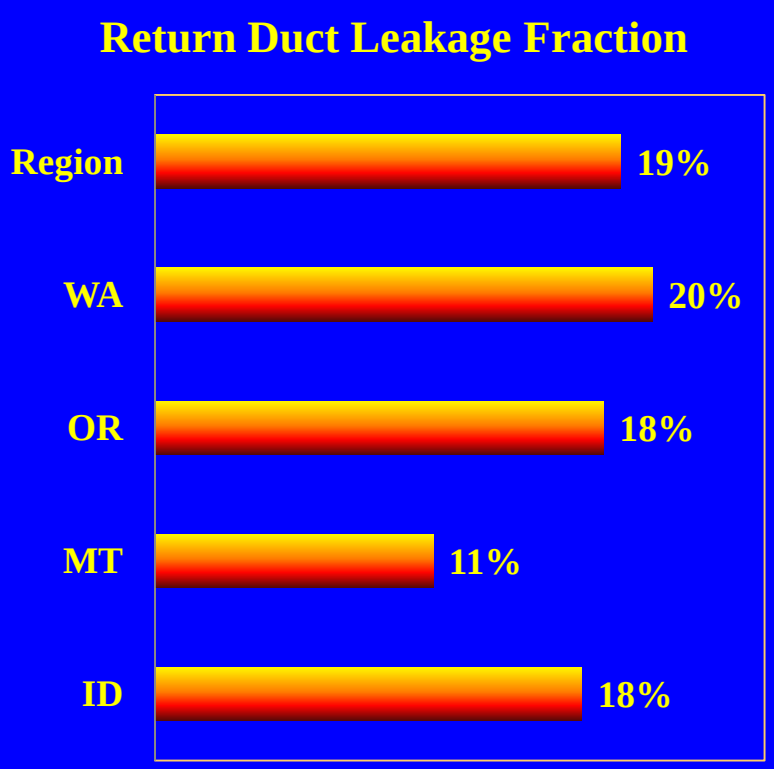
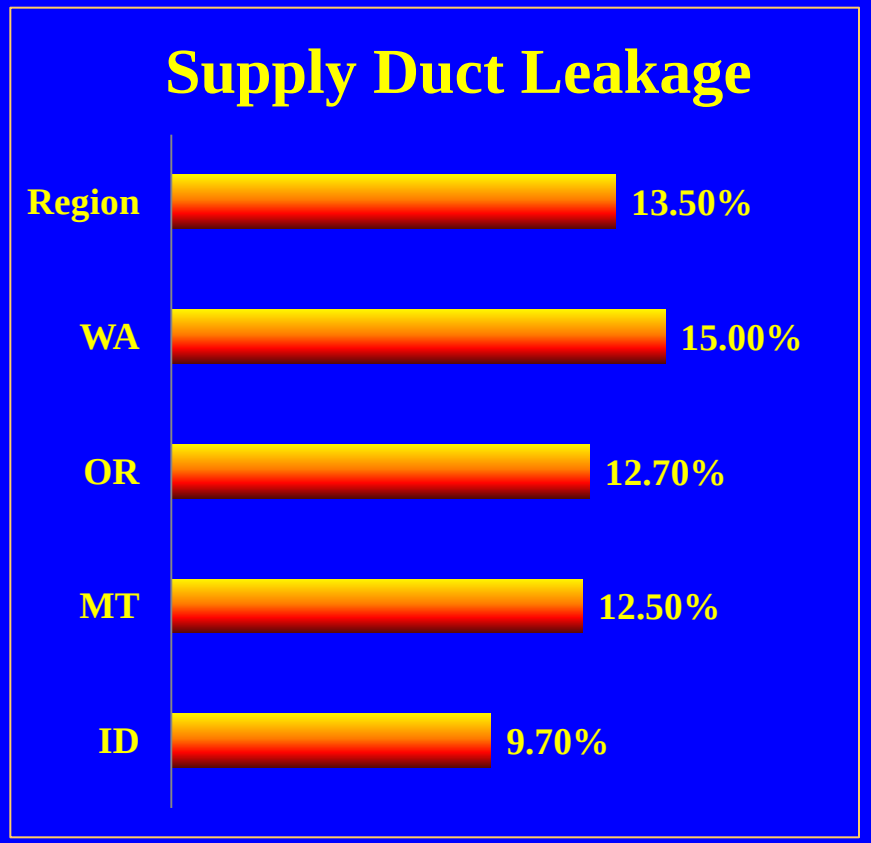
Category: Duct Leakage

This state's duct "leak" the most.

What is Idaho?





Opportunity: Duct sealing across the region

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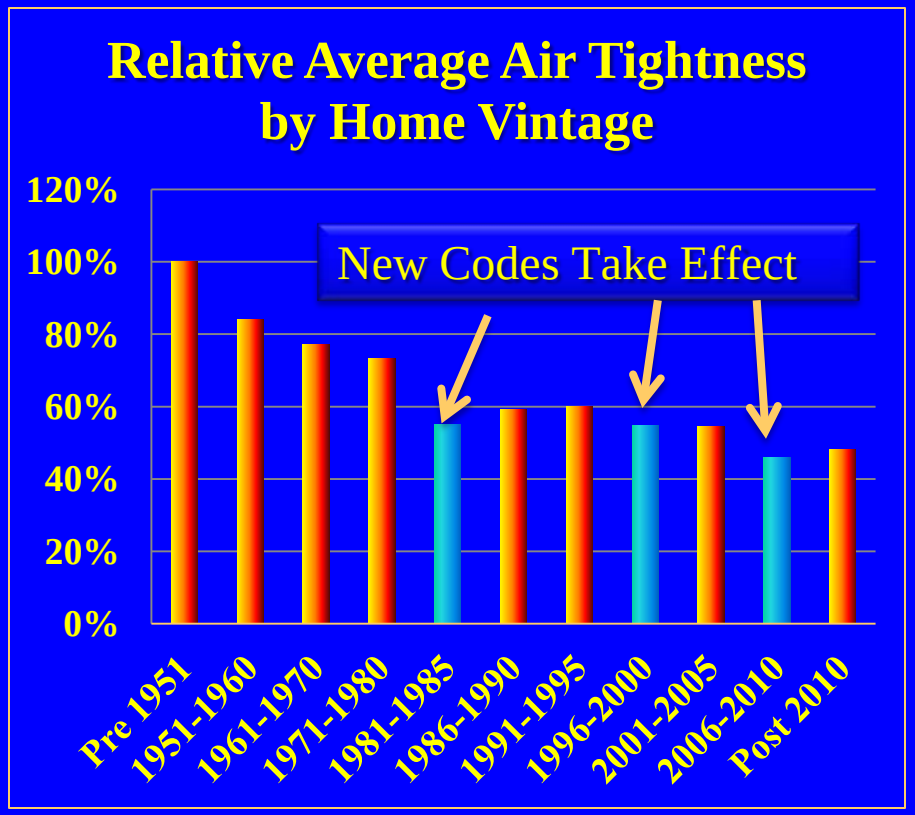
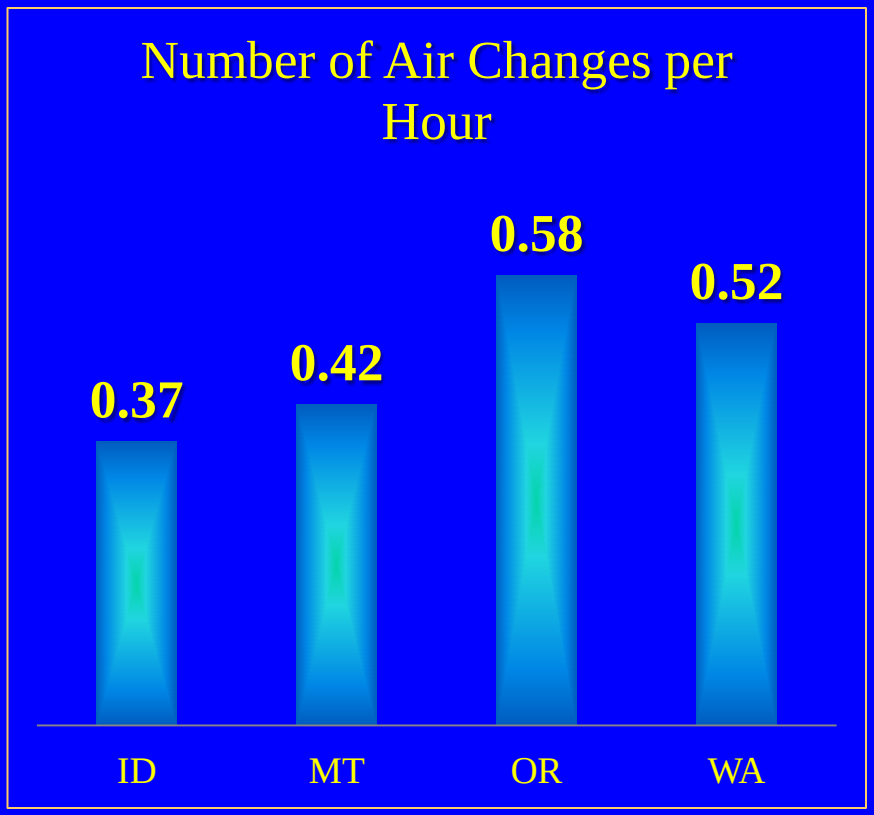
Category: Air Tightness

More air blows through this state's homes than any others

What is Oregon?





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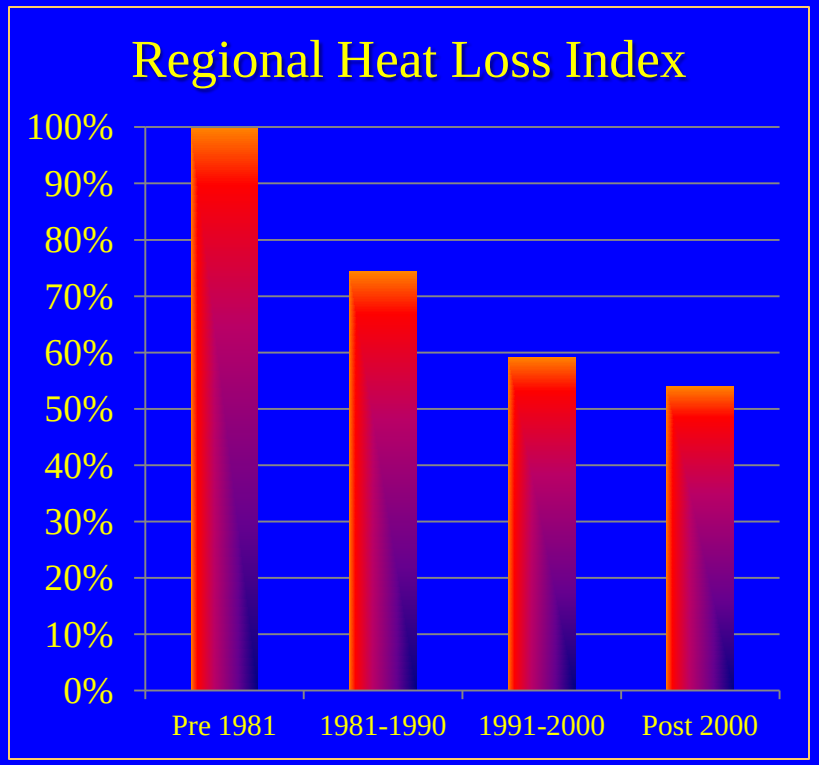
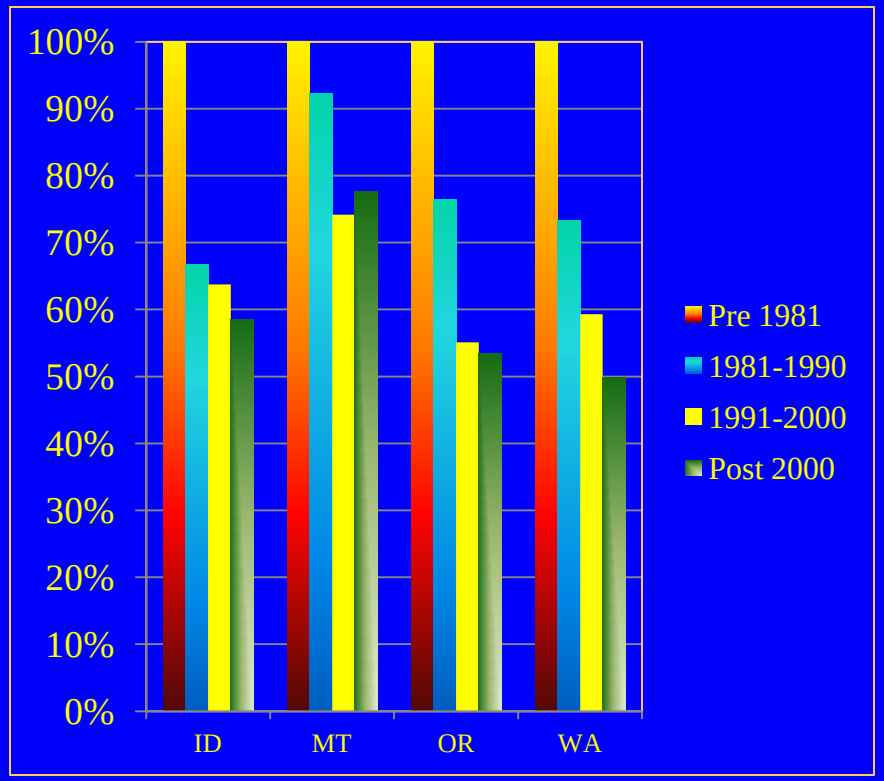
Category: Heat Loss

The energy efficiency of this state's new construction has improved the most since 1980



What is Washington?



Opportunity : Building codes enhancements

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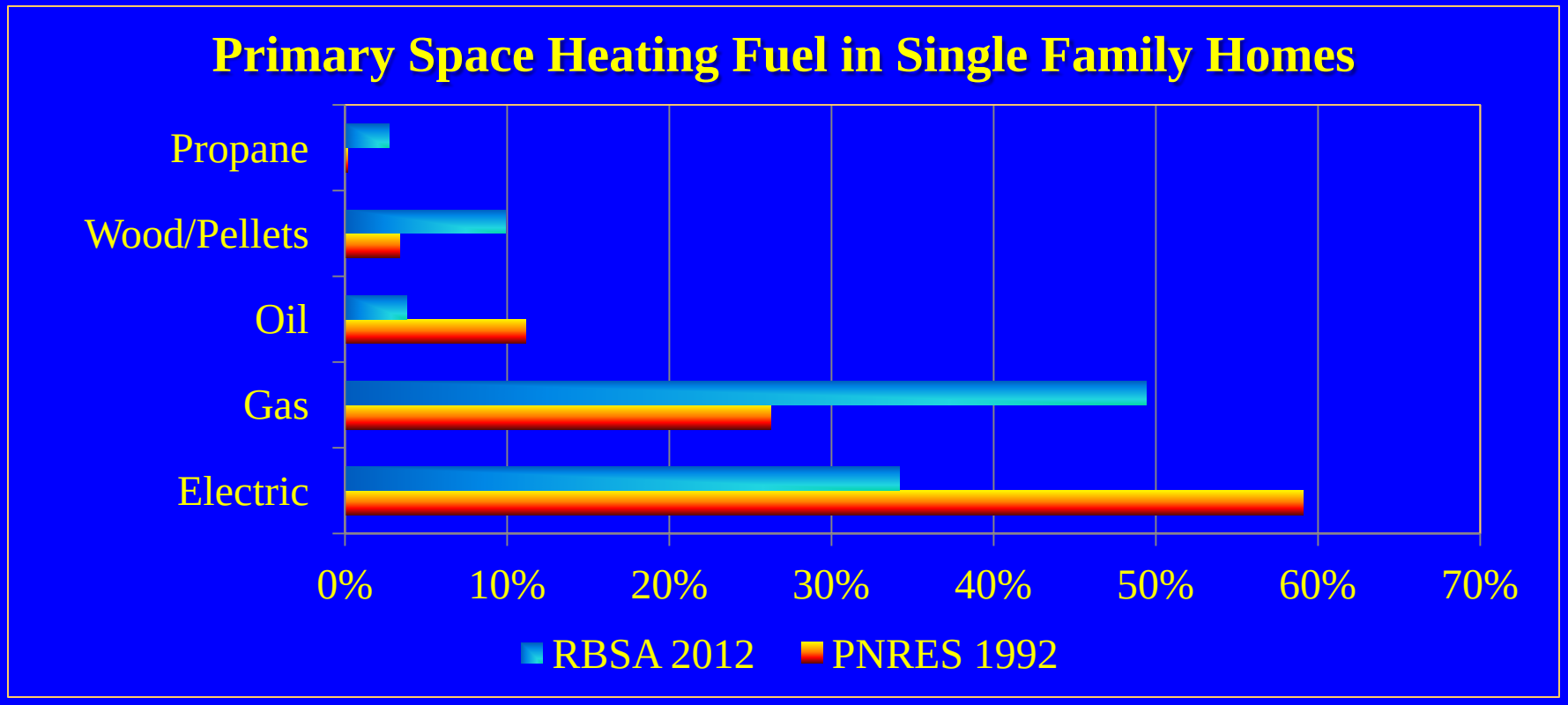
Category: Primary Heating Fuel

This space heating fuel has increased the most since 1992

What is natural gas?



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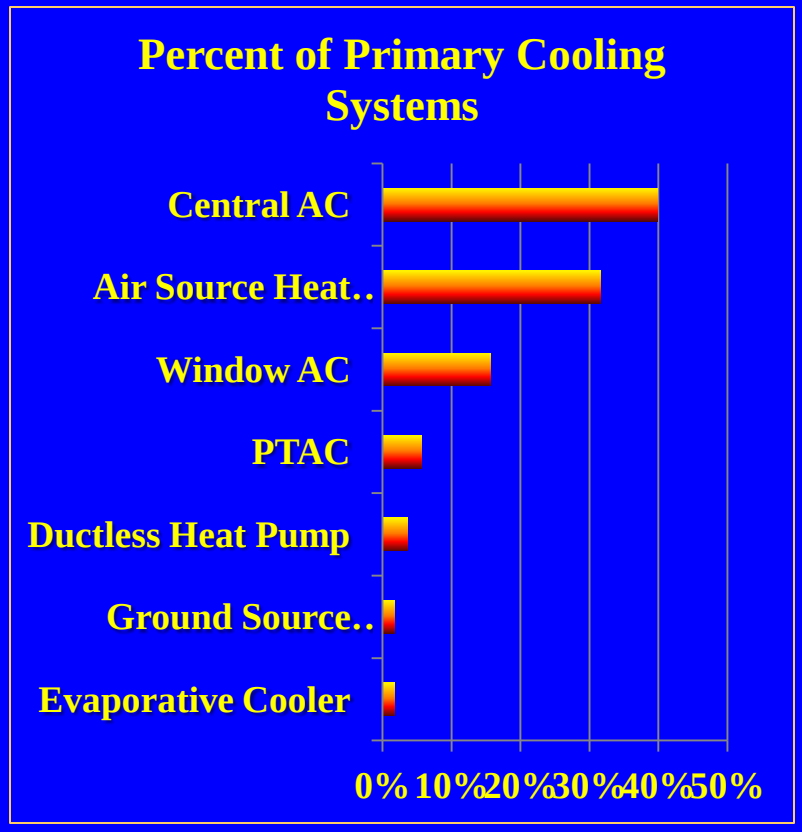
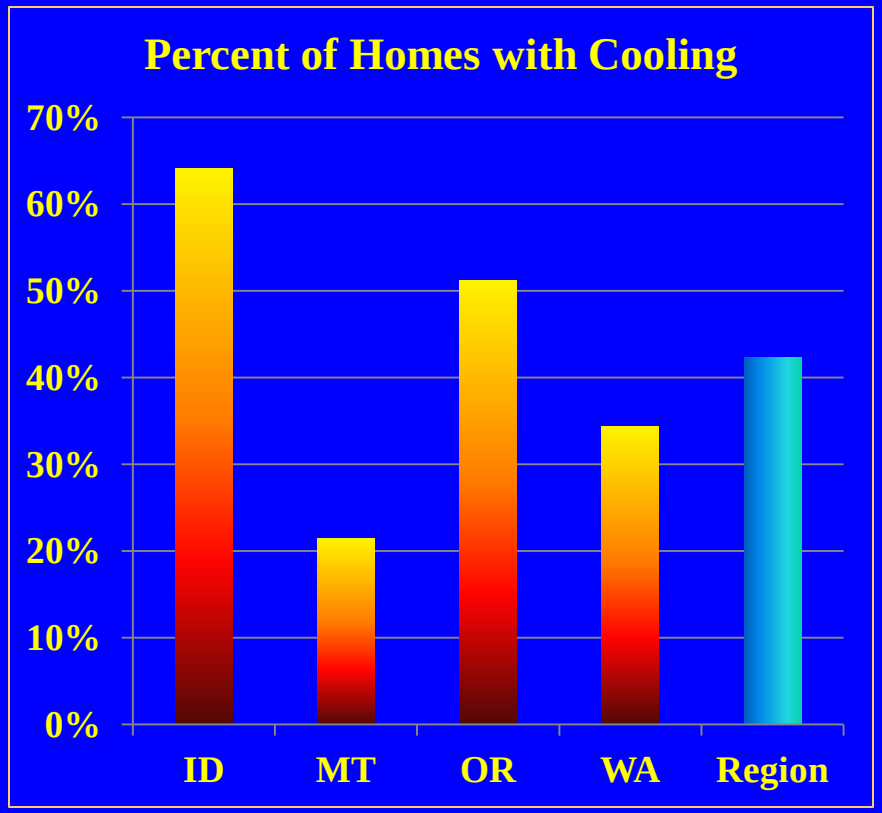
Category: Space Cooling

42%

What is the answer to life, the universe and everything ?

What share of SF homes have air conditioning?





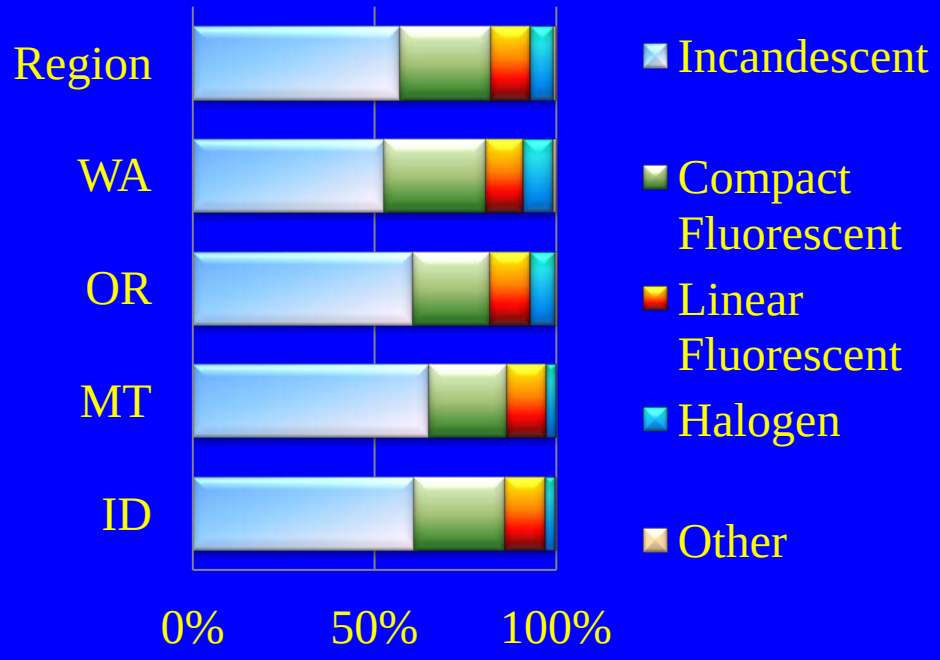
1992 PNRES: 24% of homes had AC

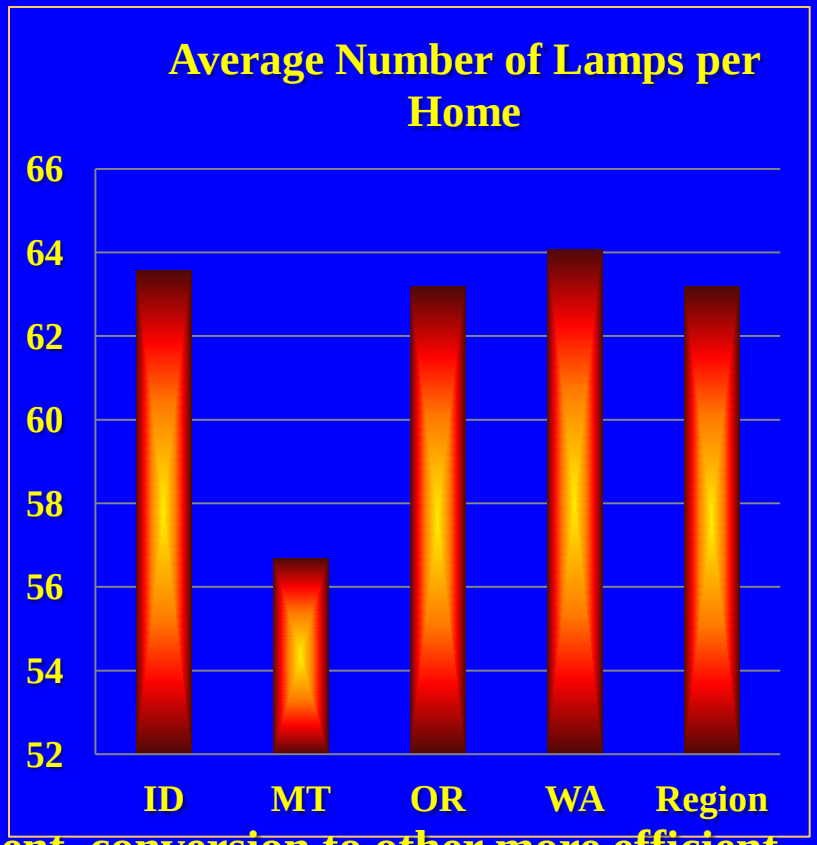
Category: Lighting

This state has the largest number of lamps per home

What is Washington?

Distribution of Lamps by type





Opportunity: Over 57% of lamps are incandescent, conversion to other more efficient alternatives.

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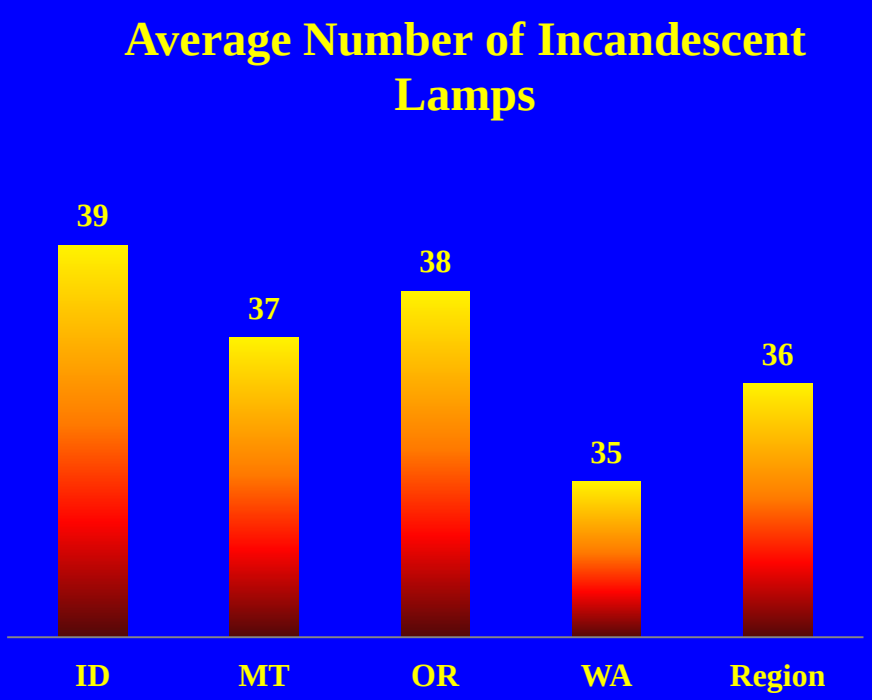
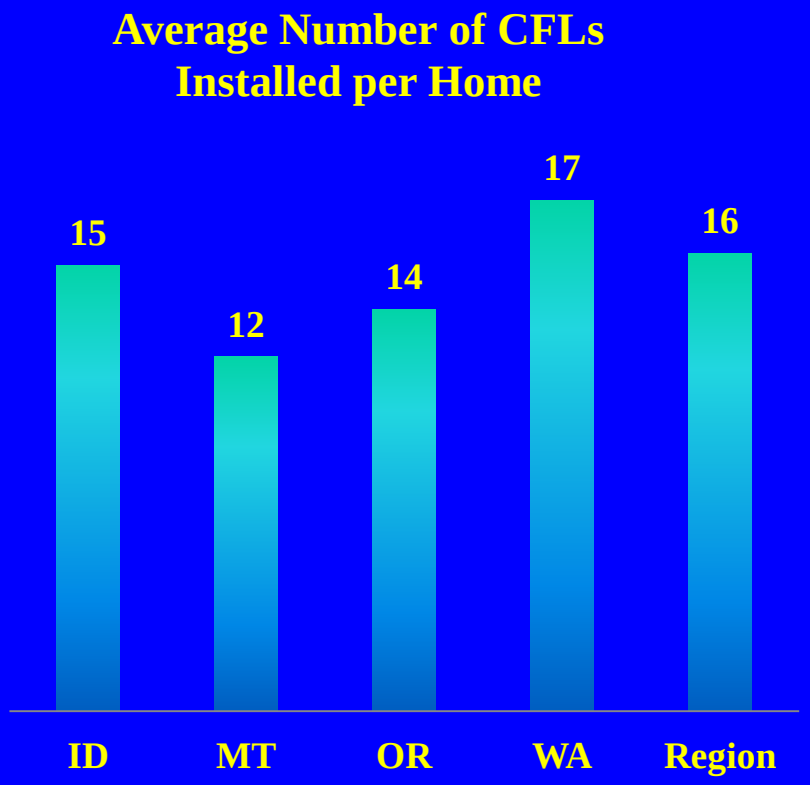
Category: Lighting 2

This state has the fewest CFLs per home

What is Montana?





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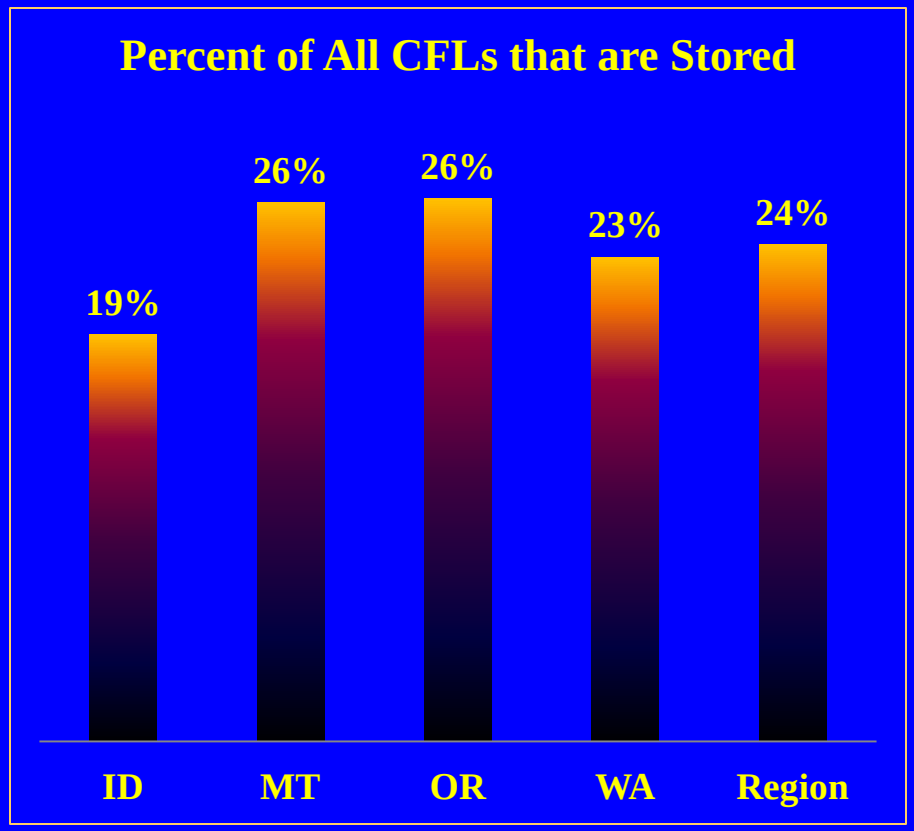
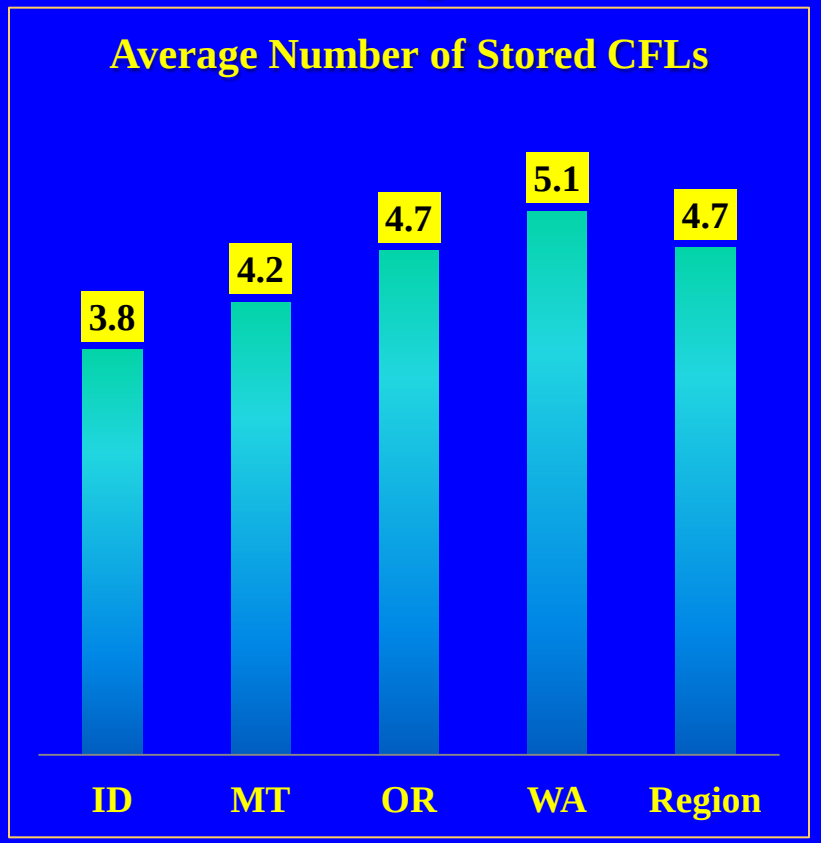
Category: Lighting 3

This state stores more CFLs than any other in the region



What is Washington?



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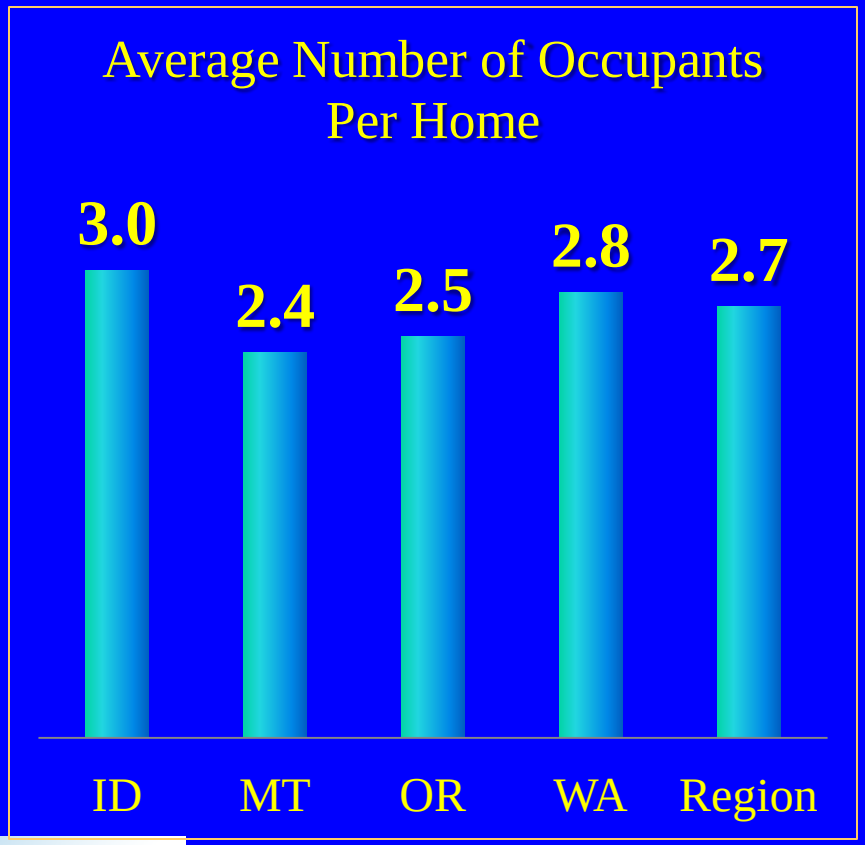
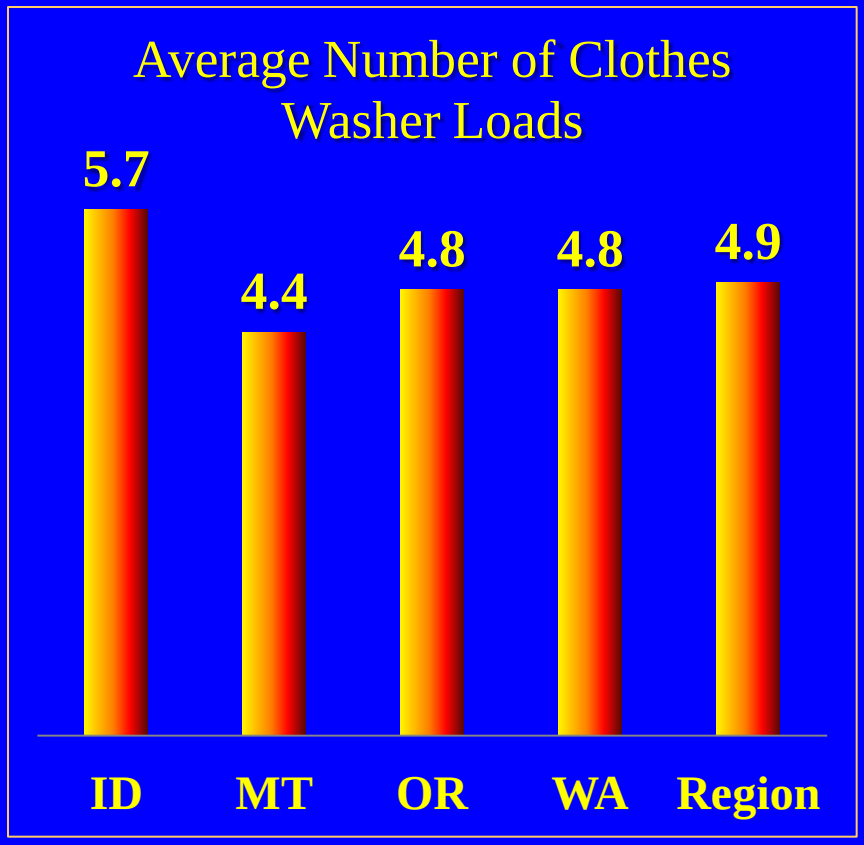
Category: Appliances 1

The average NW resident does this nearly 5 times per week.

What is wash clothes?





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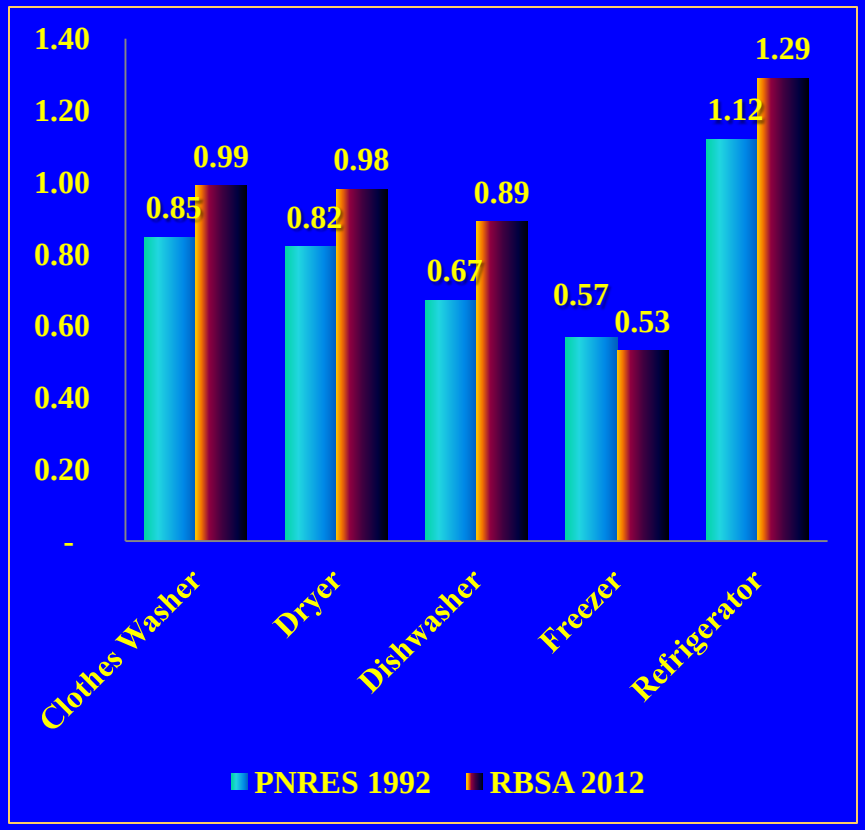
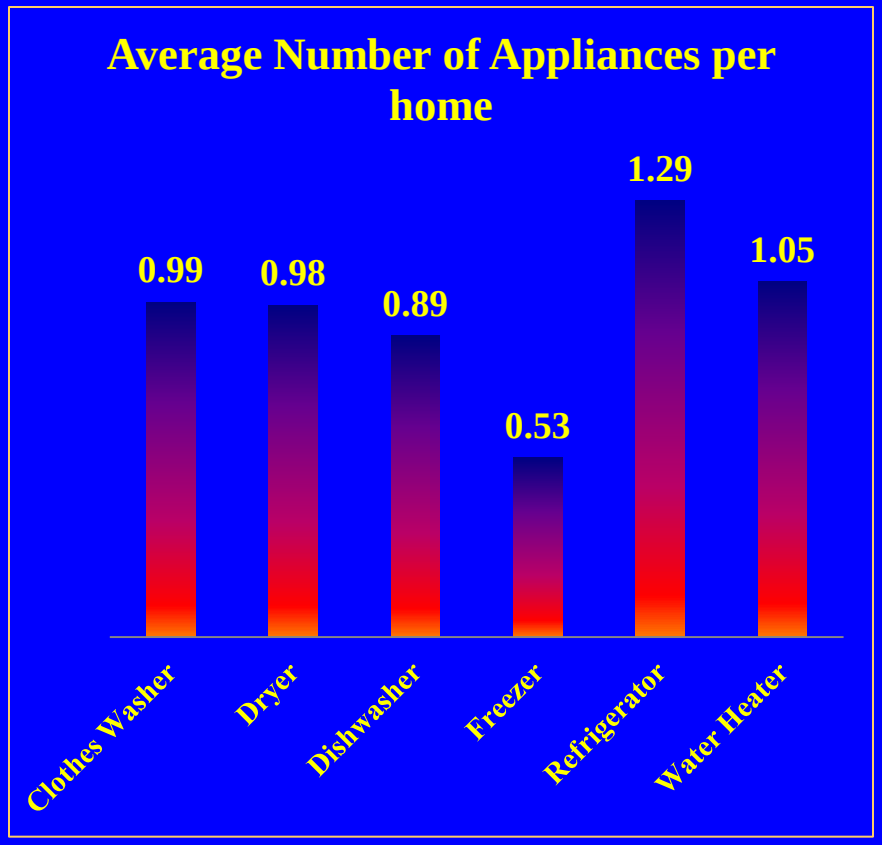
Category: Appliances 2

The share of homes with this appliance has grown the most since 1992.

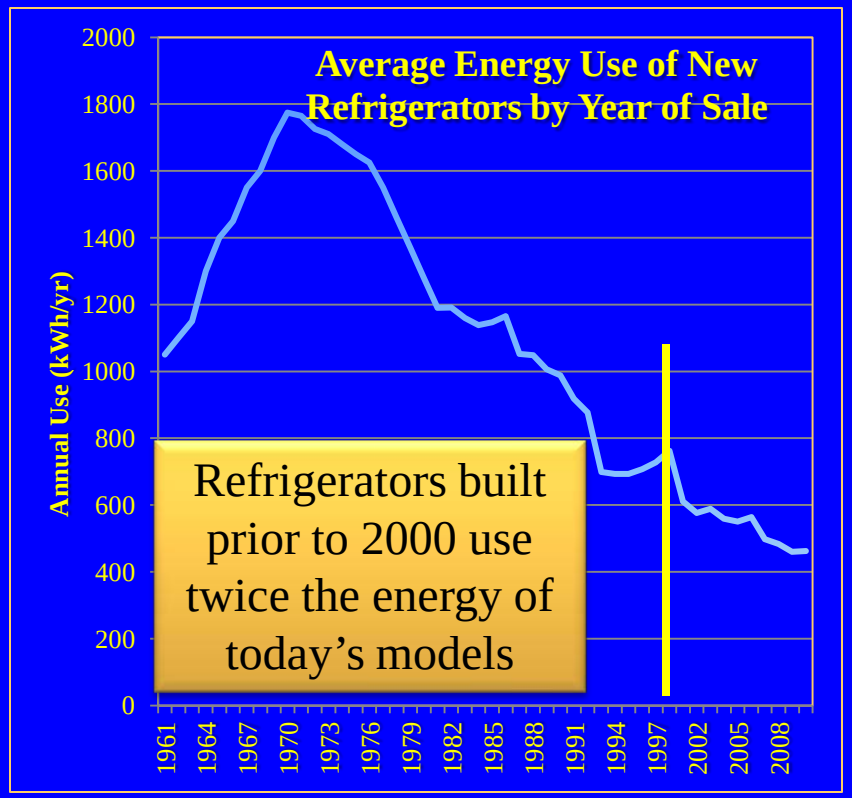


What is a dishwasher?

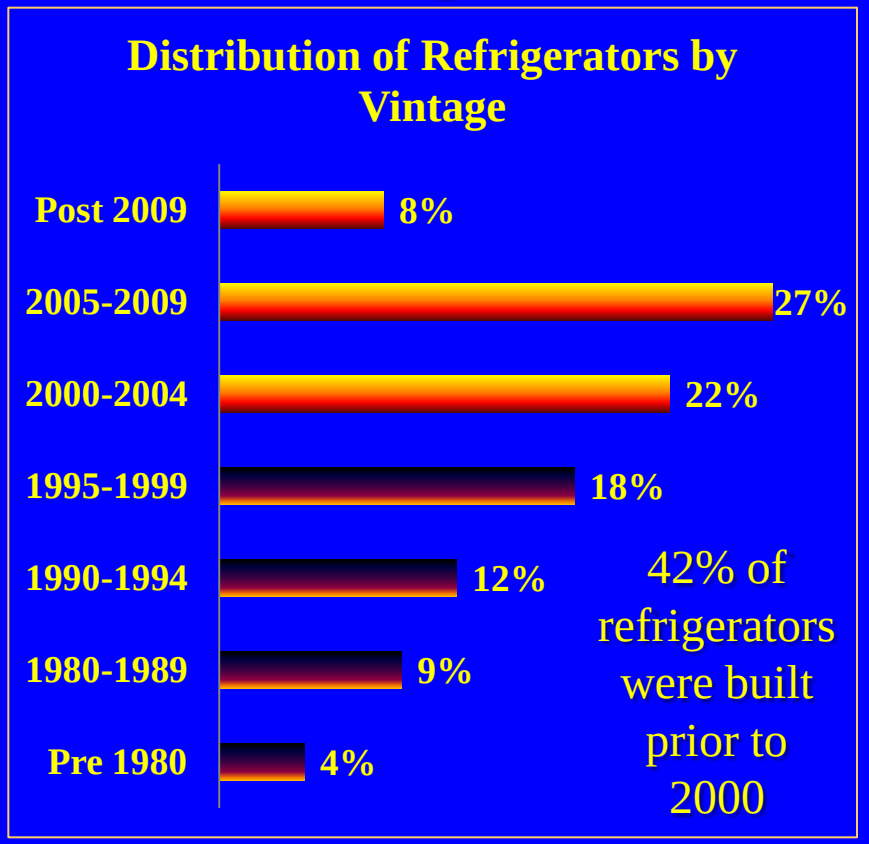


Category: Appliances 3

Early replacement of this appliance has the largest potential savings



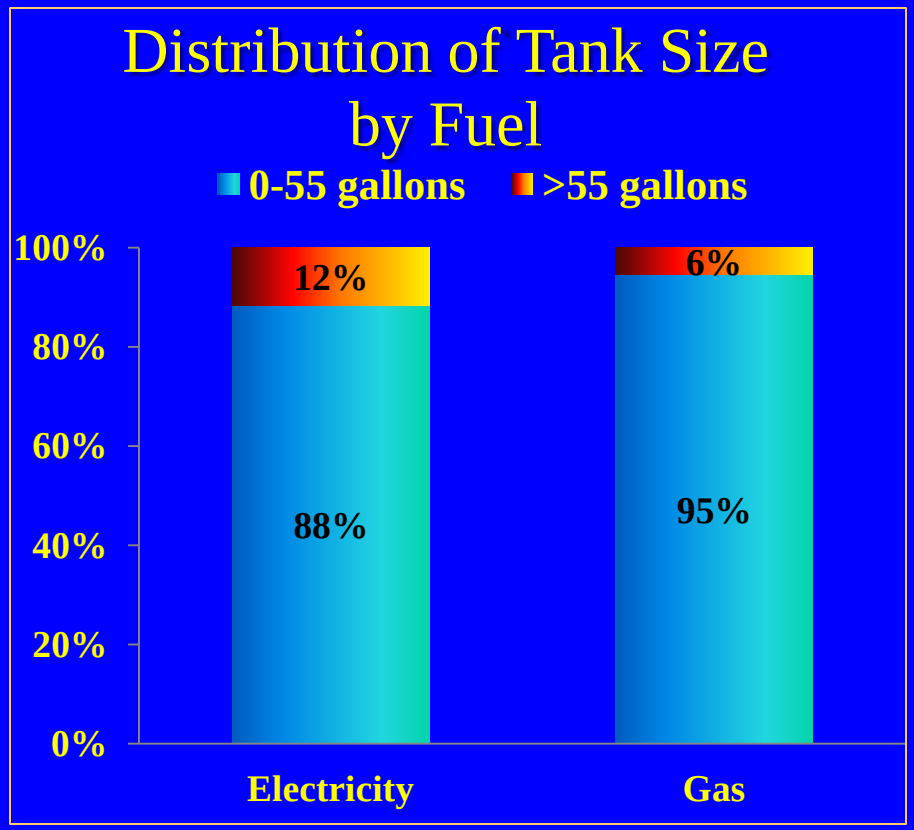
What is a refrigerator?



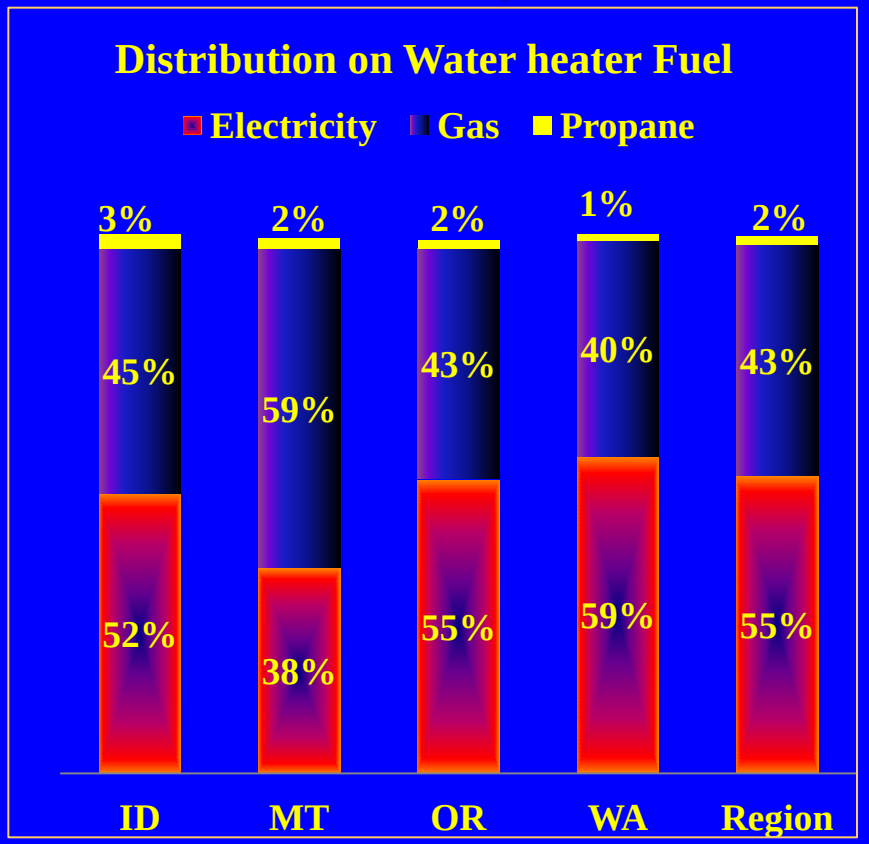
Opportunity: Replacing the 40% of refrigerators that were built before 2000 with Energy Star units cold save 270 aMW.

Category: Water Heating

This fuel heats the most hot water in single family homes in the NW



What is electricity?

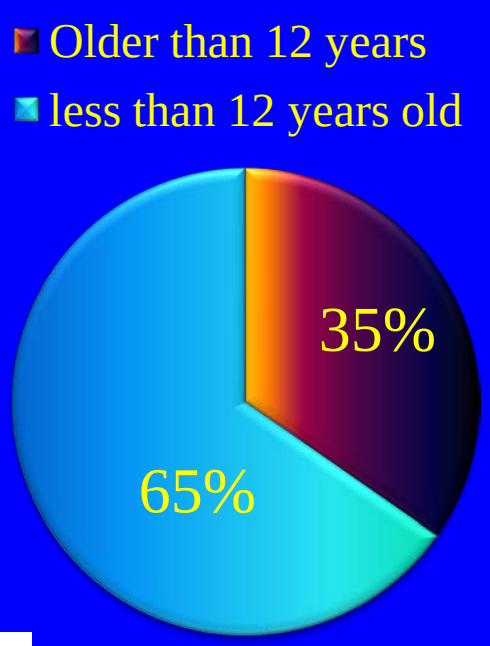


Opportunity: Conversion of >55 gallon water heaters to heat pump water heaters.

Category: Water Heating 2

This state's consumers use the most water for showers

Distribution of Water Heaters



What is Idaho?

Showerhead Flow Rate	ID	MT	OR	WA	Region
<1.5	7%	22%	18%	17%	16%
1.6-3.5	89%	73%	70%	79%	76%
3.6+	4%	5%	12%	5%	7%

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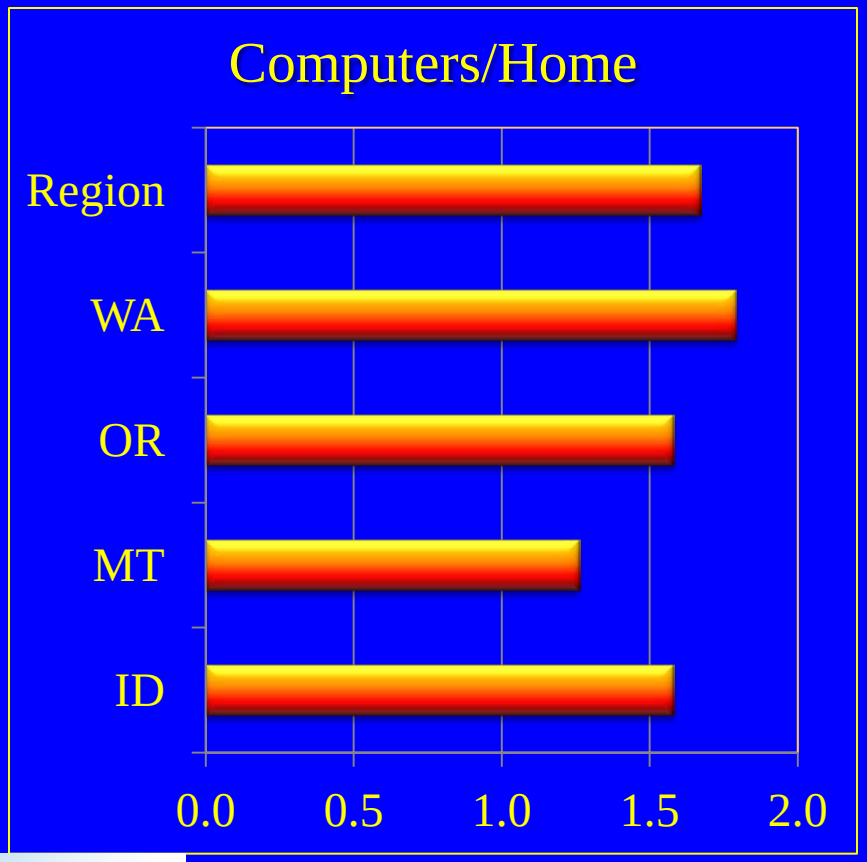
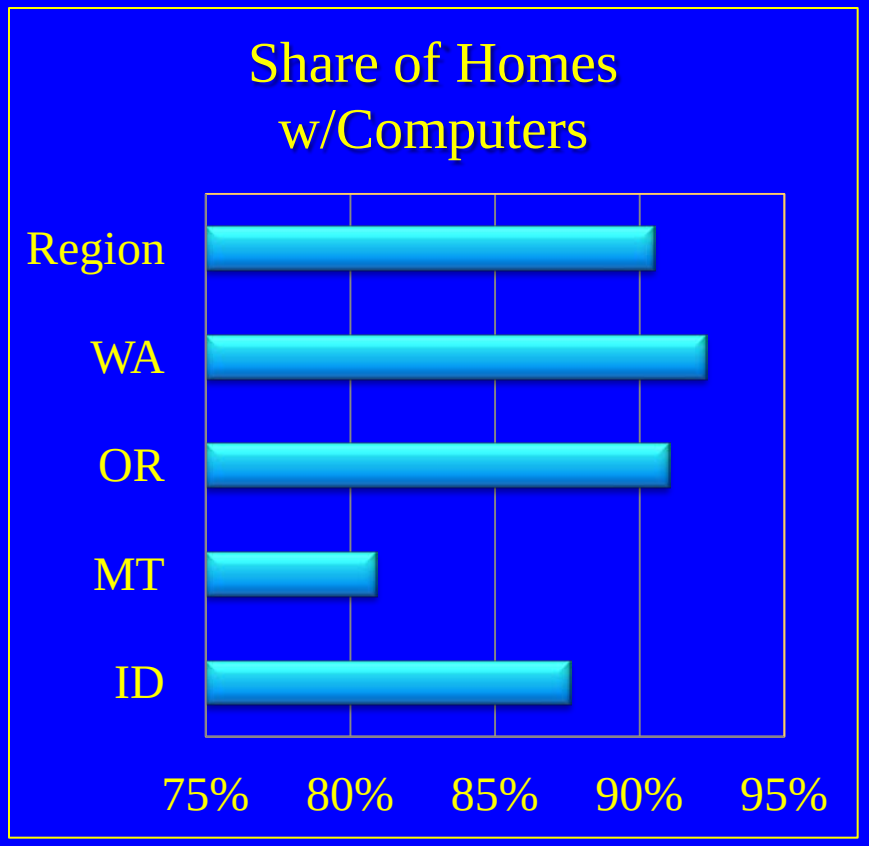
Category: Consumer Electronics

Just over 90% of the single family homes in the region own one.



What is a computer?



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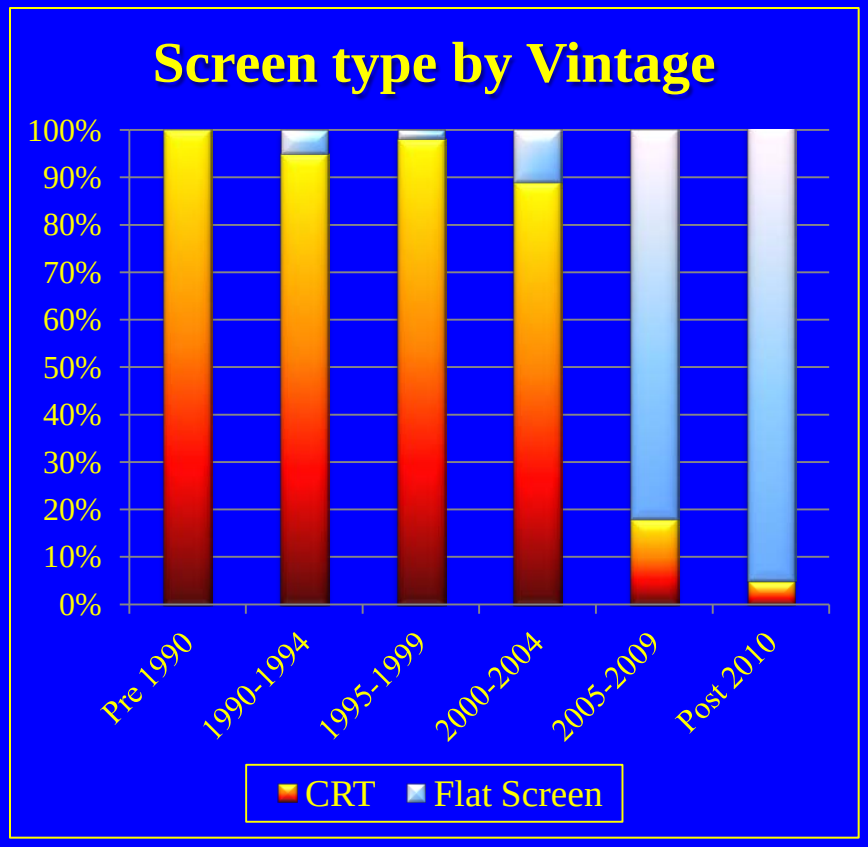
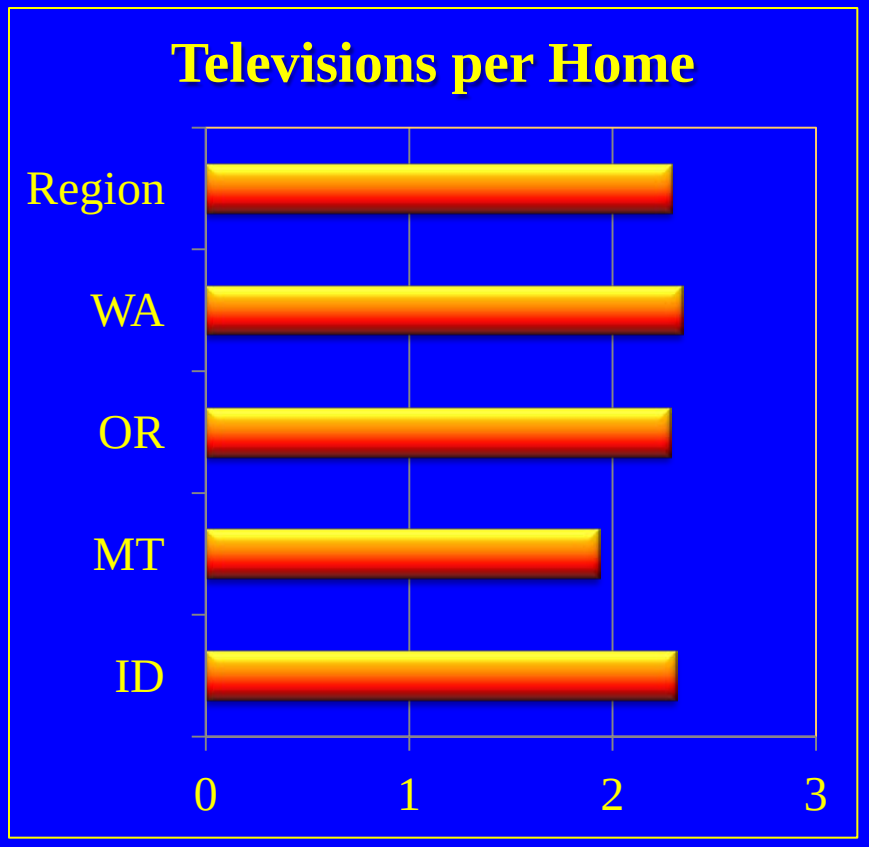
Category: Consumer Electronics 2

The average home has 2.3 of these devices.

What is a television?

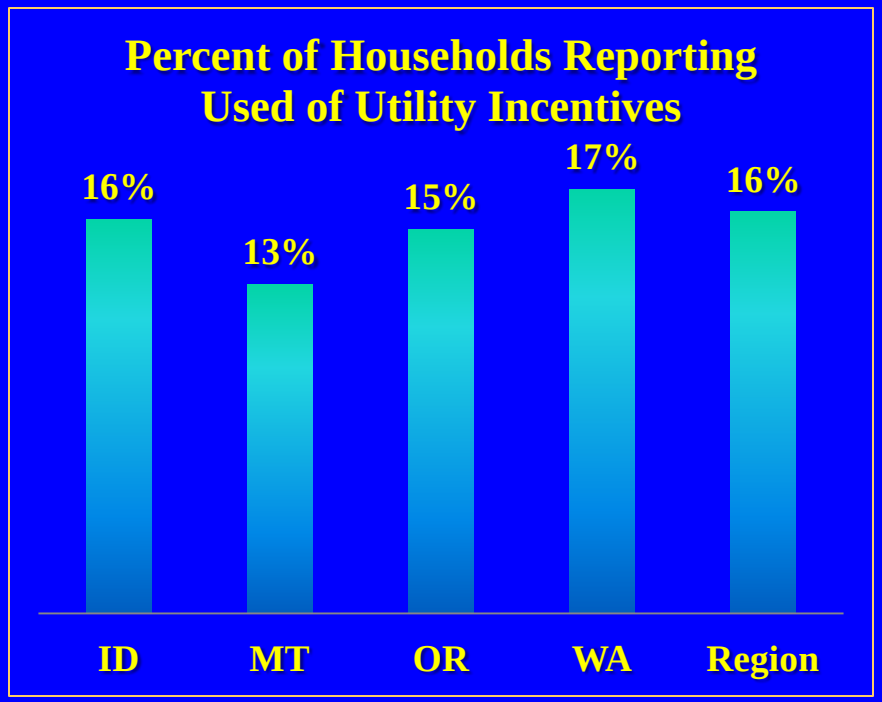


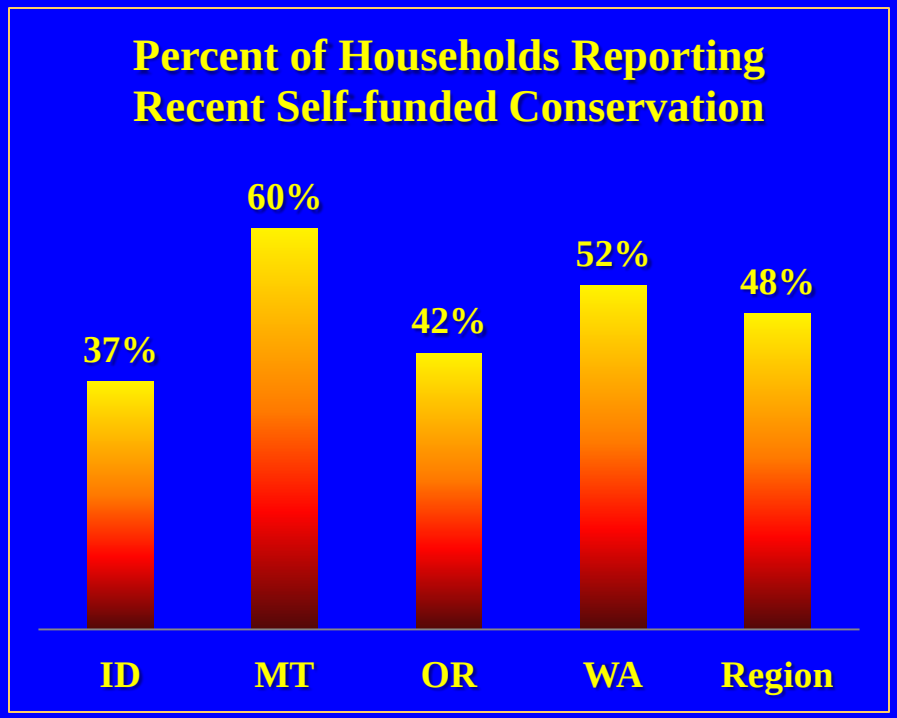


Category: Energy Efficiency

Consumer's in this state say they funded the most conservation on their own

What is Montana?



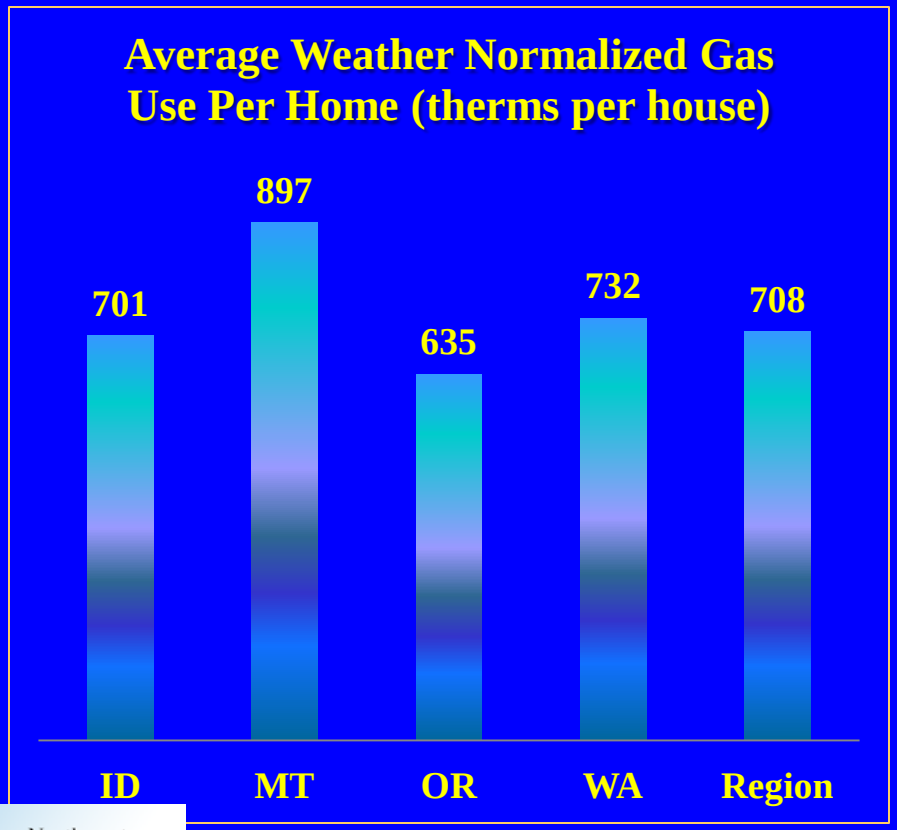


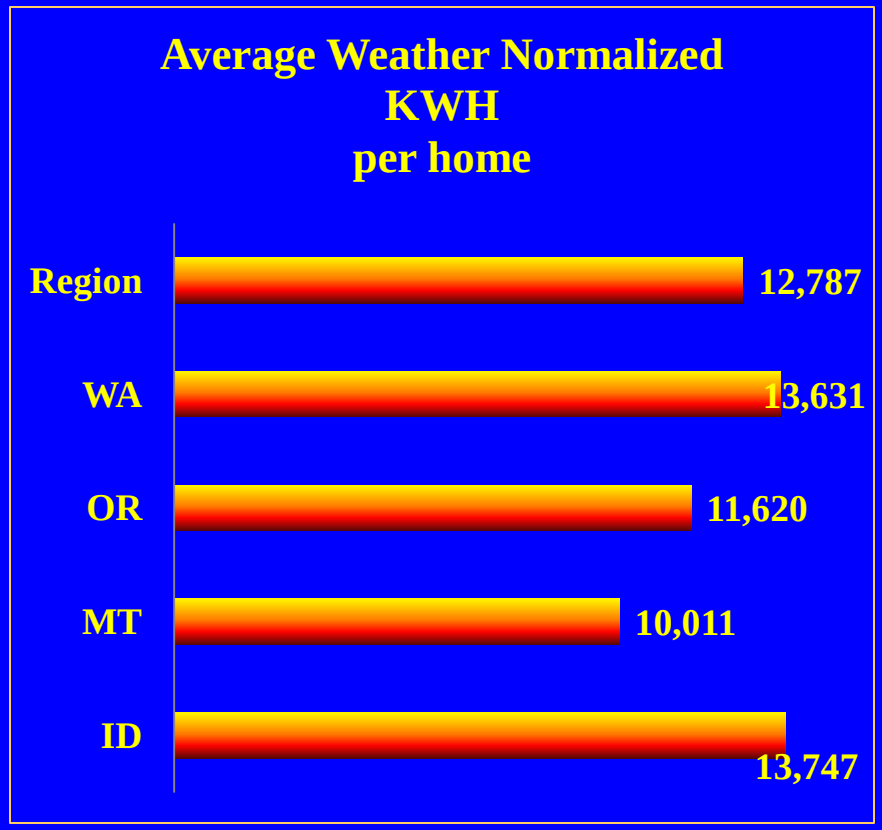
Northwest Power and Conservation Council

Category: Energy Efficiency 2

This state's single family homes used the least electricity

What is Montana?

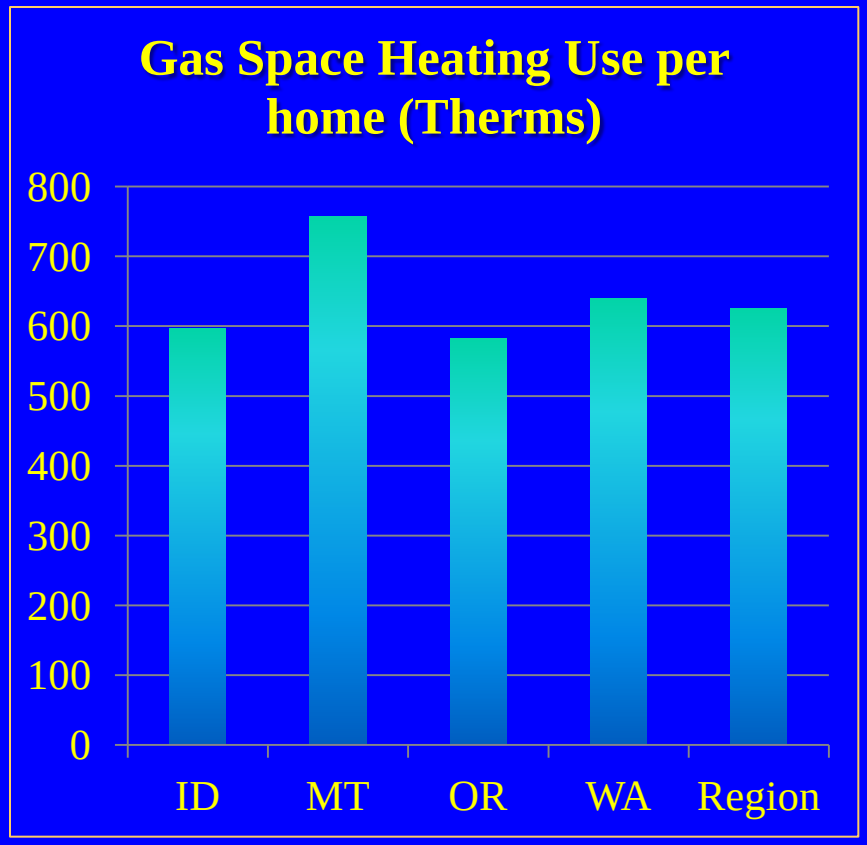




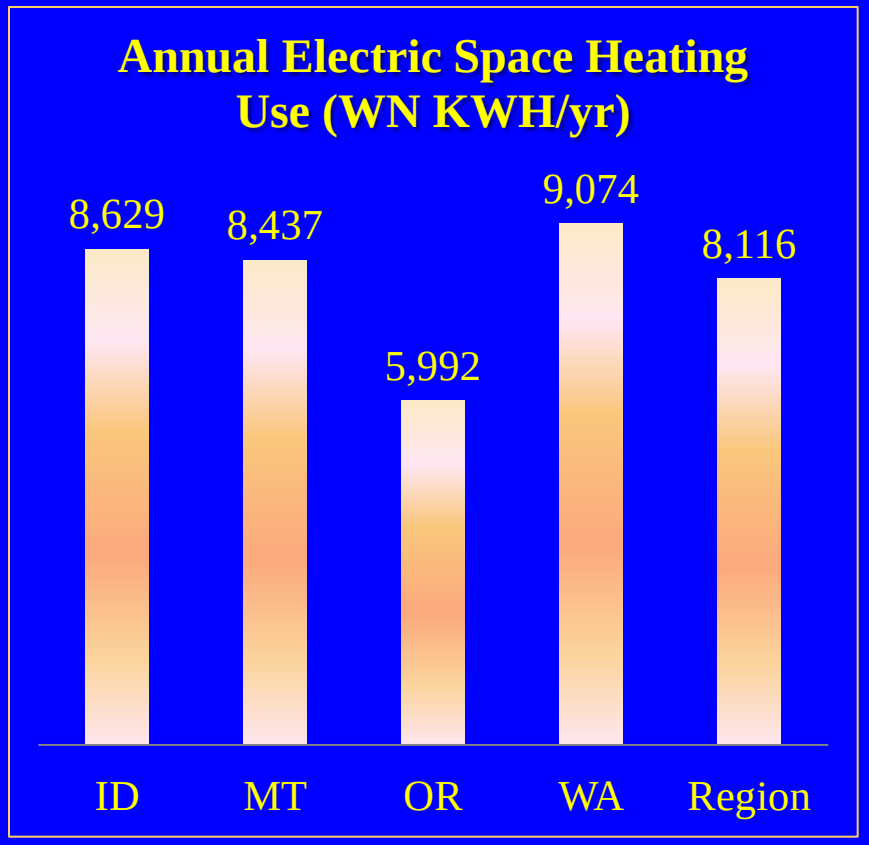
Northwest Power and Conservation Council

Category: Electric Energy Use

This state's electrically heated single family homes use the most electricity



What is Washington?



Question: what is impact of RBSA on Council's Planning

Answer: Many areas

Better Baseline for 7th plan

Load Forecasting

Conservation assessment

Program design & implementation

Special thanks to:

NEEA team

Utility teams

NEET (working group 1)

Measuring what matters