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ENG 505 - ENERGY SURETY AND SYSTEMS

World Your Behavior is in Question

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Outline

- Team
- Introduction
- Human behavior is a complex system
- What Effects Behavior
- Example of Behavior - Case Studies
- Some Solutions
- Question & Answer Session

Team Members – Dept. 6123

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Introduction:

- Problem statement: As more countries strive to become 1st world countries, resource and energy usage will increase to meet the wants, desires, demands and needs of each individual. This puts a strain on resource production, energy surety, and pollution controls. Human behavior affects all aspects of resource usage.

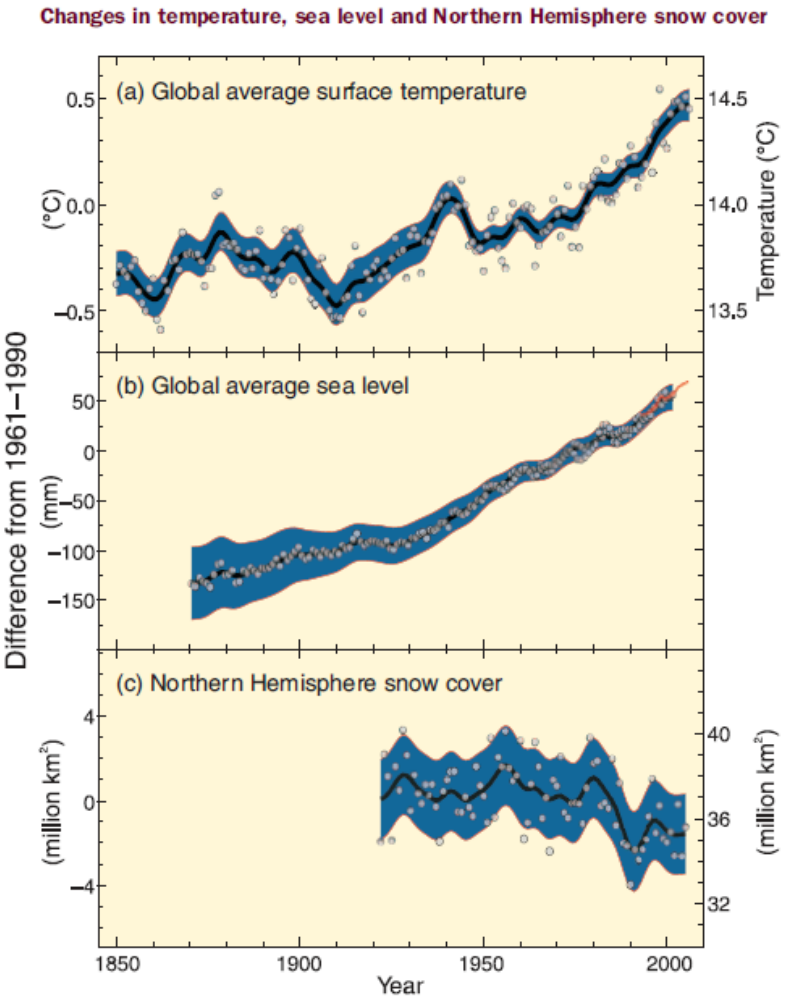
- Most complex system?
  - Space shuttle: considered one of the most complex engineered systems
  - Human behavior is far more complex and far more unpredictable

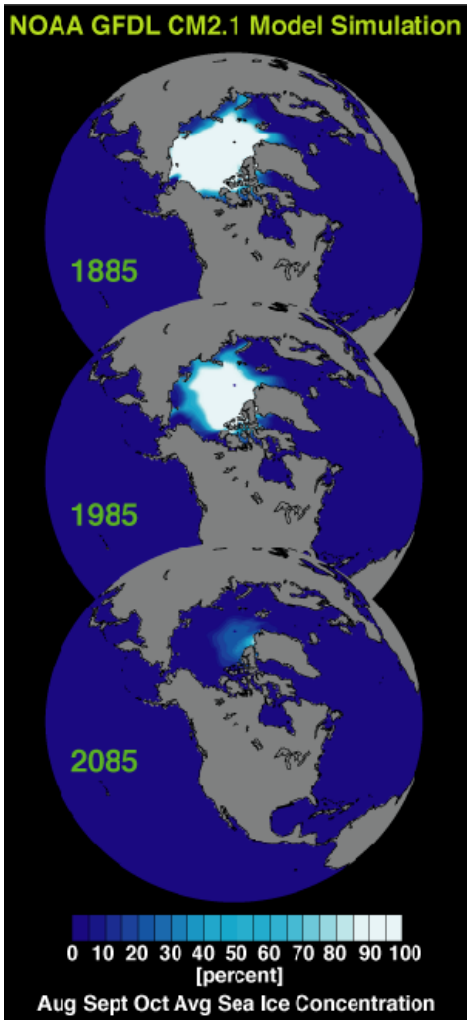
How human behavior fits into a complex system

- A complex system is a system composed of interacting elements that as a whole exhibit one or more properties (such as behavior) not obvious from the properties of the individual parts
- Common Attributes
  - Multiple interacting phenomena – human behavior together with physics and engineering
  - Heterogeneous element – everyone's behavior is different
  - Non-linear dynamics and effects – very dynamic, very non-linear
  - Adaptive behavior – it's what people do
  - Tradition– human behavior is somewhat 'sticky'
  - Large network of elements or nested complexity – behavior as an individual, mother/father, employee, consumer, etc. all nested in one individual
  - The keeping up with the "Jones" – typically as we compete we strive to one up our neighbors.

Why does our behavior towards resource use need to change?

- To attain a socially desirable goal
  - Mitigate climate change
  - Sustain resources
  - Reduce pollution – air and water
- Why target behavior?
  - Faster – technology tends to take years to mature
  - Cost effective
  - Regulations - more difficult to implement, examples are cap & trade and EPA





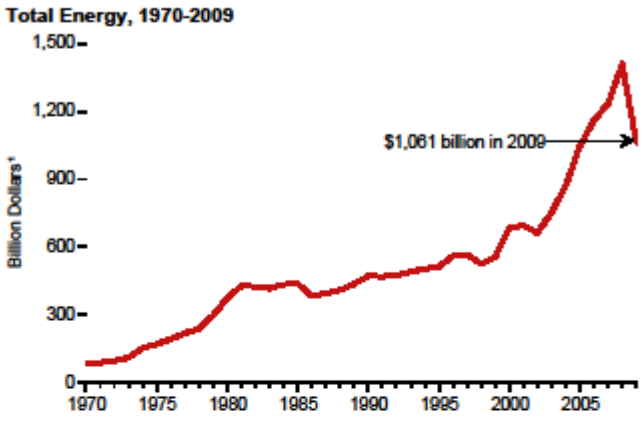
What effects bring about changes in human behavior in resource usage?

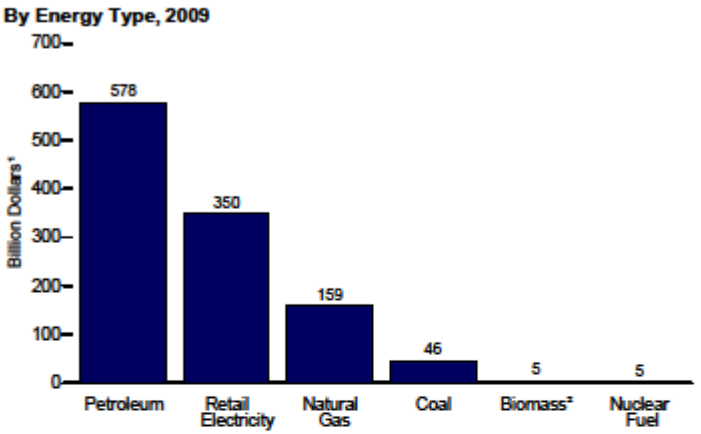
- Financial incentives
  - Rebates, reduced interest rates, tax incentives
  - Cost of energy - Europe consistently high prices has reduced auto usage and increased rail and bike usage
- Regulation – Policy, regulations, tax incentives, increased taxes
- Education
- Belief system
- Peer pressure or Bandwagon effect

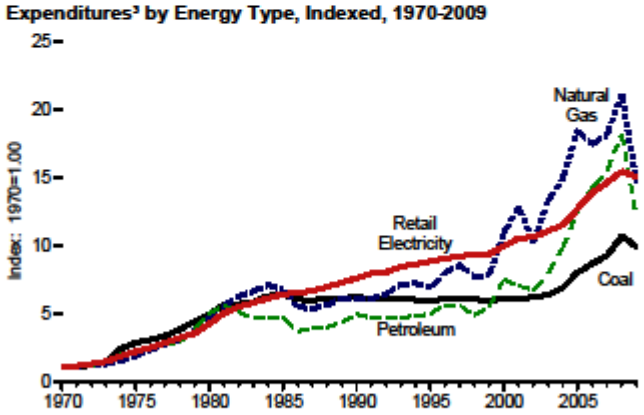
Financial

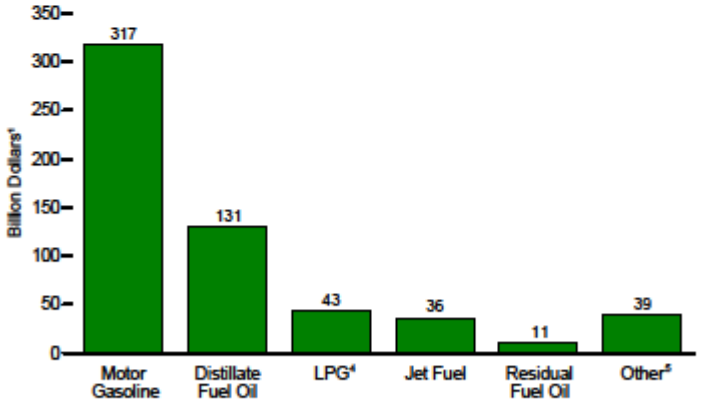
USA –Cost of energy by total cost and by energy type as a function of time

Figure 3.5 Consumer Expenditure Estimates for Energy by Source









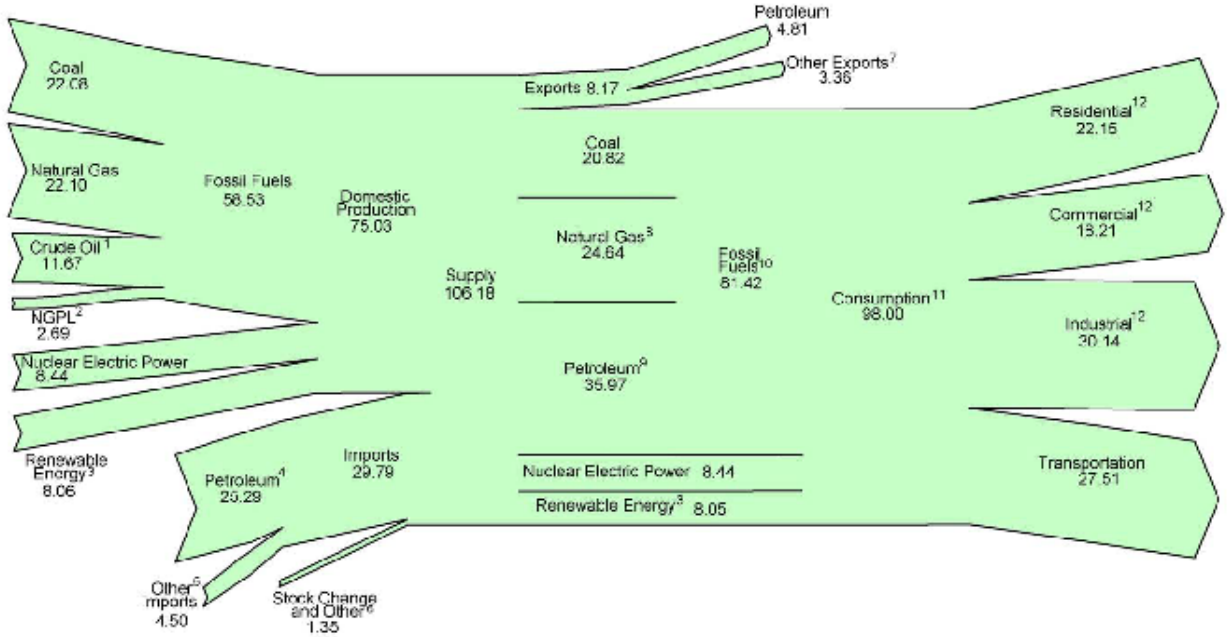
[1] Prices are not adjusted for inflation. See "Nominal Dollars" in Glossary.
[2] Wood and wood-derived fuels, and biomass waste; excludes fuel ethanol and biodiesel.
[3] Based on nominal dollars.
[4] Liquefied petroleum gases.
[5] Asphalt and road oil, aviation gasoline, kerosene, lubricants, petrochemical feedstocks, petroleum coke, special naphthas, waxes, and miscellaneous petroleum products.
Source: Table 3.5.

Human behavior affects all aspects of energy usage

Energy usage breakdown

- Industrial – 30%
- Transportation – 27%
  - 2/3's Passenger cars & light trucks
  - 1/3 Trains, trucks, buses, and planes
- Residential – 22%
- Commercial – 19%

Figure 1.0 Energy Flow, 2010
(Quadrillion Btu)

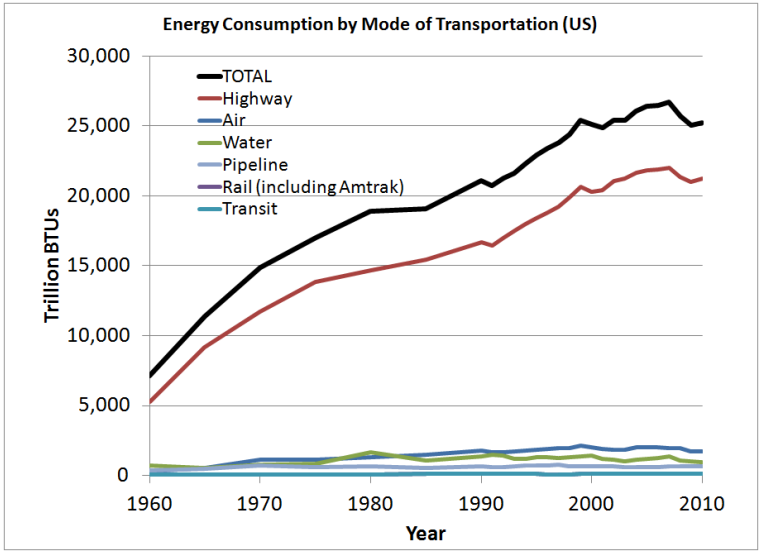


[1] Includes lease condensate.
[2] Natural gas plant liquids.
[3] Conventional hydroelectric power, biomass, geothermal, solar/photovoltaic, and wind.
[4] Crude oil and petroleum products. Includes imports into the Strategic Petroleum Reserve.
[5] Natural gas, coal, coal coke, biofuels, and electricity.
[6] Adjustments, losses, and unaccounted for.
[7] Coal, natural gas, coal coke, electricity, and biofuels.
[8] Natural gas only; excludes supplemental gaseous fuels.
[9] Petroleum products, including natural gas plant liquids, and crude oil burned as fuel.
[10] Includes 0.01 quadrillion Btu of coal coke net exports.
[11] Includes 0.09 quadrillion Btu of electricity net imports.
[12] Total energy consumption, which is the sum of primary energy consumption, electricity retail sales, and electrical system energy losses. Losses are allocated to the end-use sectors in proportion to each sector's share of total electricity retail sales. See Note, "Electrical Systems Energy Losses," at end of Section 2.

Notes: • Data are preliminary. • Values are derived from source data prior to rounding for publication. • Totals may not equal sum of components due to independent rounding.
Sources: Tables 1.1, 1.2, 1.3, 1.4, and 2.1a.

Financial

- Transportation, cars & light trucks – 19% of all energy used in USA
  - DOT estimated 254.4 million registered **passenger vehicles in the United States** in 2007 study. This number has increased steadily since 1960
  - Average fuel economy rating is 17.1 MPG - DOT
  - Annual average mileage is 16,550, which equals an average of 968 gallons/vehicle
- Monitoring driving habits – Fun Family Competition
  - Honda Accord – No feedback other than at the pump
    - Teenager – 23 to 24 MPG
    - ***Mom – 26 to 28 MPG – Mom wins***
    - Dad – 25 to 27 MPG
  - Hyundai Elantra - Instant dashboard feedback – Truly affected behavior
    - Teenager – 34 to 35 MPG
    - Mom – 34 to 35 MPG
    - Dad – 34 to 35 MPG
    - ***The pocket book and the environment win***



Data Source: Bureau of Transportation Statistics, National Transportation Statistics, http://www.bts.gov/publications/national_transportation_statistics/

Financial

- Transportation – assuming new behaviors from instant feedback
  - An estimated 254.4 million registered passenger vehicles in the United States
  - Increasing the average fuel economy by 10%, from 17.1 to 18.8 mpg
    - Saves an estimated 97 gallons/year/vehicle
    - For 254.4 million vehicles in US this comes to 24.7 billion gallons/year
  - The US DOE estimates US used 142 billion gallons in 2011
  - Increasing average vehicle fuel economy by 10% decreases total gas usage by about 10%

Behavior or Action	Fuel Savings
Drive Sensibly	5-33%
Observe Speed Limit	7-23%
Proper Tuneup	4%
Keep Tires Properly Inflated	3%
Buy an Efficient Vehicle	0-50%

  - For this example the mpg increased from 26 to 34
    - MPG increased 31%
    - Assuming average annual mileage, there would be 300 gallons saved
    - 300 gallons X $4/gallon equals saving $1,200/year
    - All assuming actual mileage does not change
- What Changed?
  - Decision to buy a car that gets better gas mileage
  - Instant feedback and monitoring
  - In other words - Behavior

Financial

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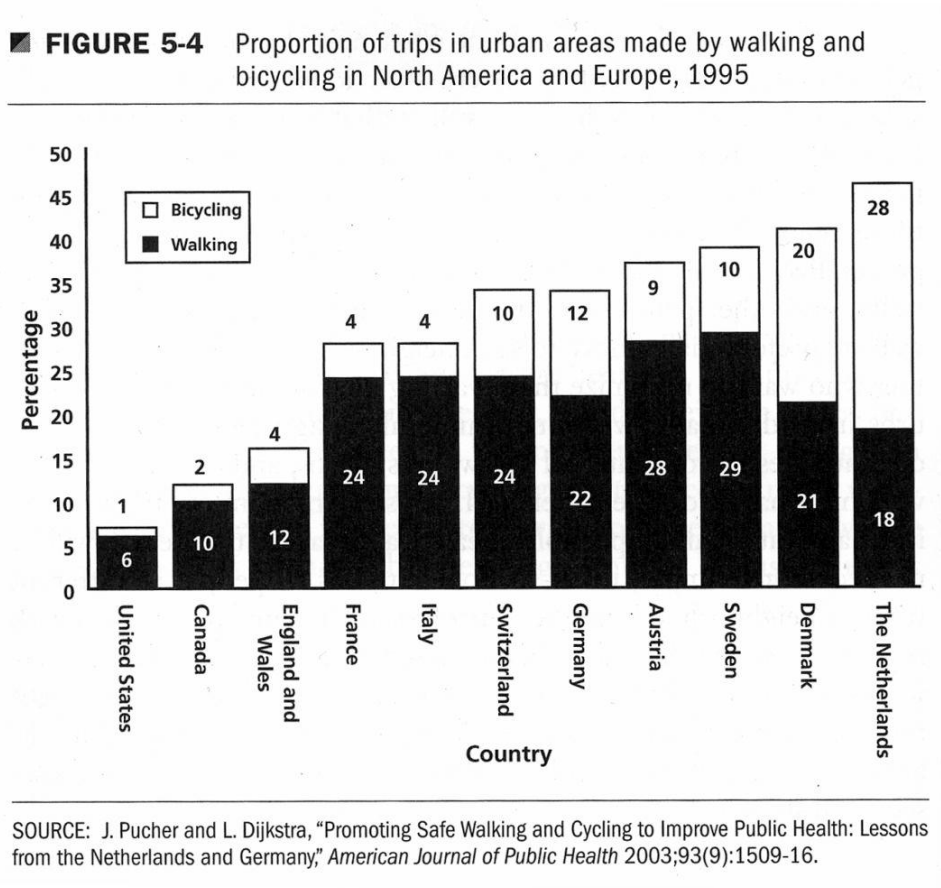
Observations:

Bus and Bike Ridership verses cost of petro

- 84% of trips in the US were made by car
- Up to 46% of trips in other developed countries
- Personnel observations: as gas approached $4 again, ridership did not increase as in 2008 due to people being pre-conditioned to this price



Financial

The problem is money doesn't address other barriers to behavior

- Logic vs. emotion
  - Incentives are logical but ineffective at changing behavior
  - Appealing to ones emotions is more effective at changing behavior

- Financial (Dis)Incentives can be successful, but they often have disappointing results
  - A review of 7 utility-sponsored incentive programs to promote home retrofits
    - each offered a 93% rebate – they almost completely paid for the retrofit – on average, only 5% of homeowners made these retrofits
    - some offered zero interest rate loans - had slightly better outcome

Regulations

Energy laws govern the use and taxation of energy resources (renewable & non-renewable)
Energy policy, on the other hand, refer to the strategy, plan, and politics of energy to execute energy laws.

There are 480 U.S. Departments and Agencies responsible for legislation, regulations, and standards as of September 2011

Example - US government Energy Star program

Regulations are slow to enact and hard to change - example: switching from gas to natural gas in vehicles to reduce emissions

- regulations stated fuel tank must be below passenger level
  - Good regulation when using gas since its vapors are heavier than air
  - Natural gas is lighter than air
  - Took years to change this regulation

Education

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"An Annotated Bibliography of Research-verified Energy Education Programs", Version 2 – July 1994 from the Professional Assn. of Consumer Energy Education

- 1984, Timothy Dunsworth attributed 4.3% savings to lost-cost weatherization training provided by Minneapolis Energy Office via the Neighborhood Energy Workshop program
- 1987, Tom Lent estimated the 7% incremental effect resulting from an in-home energy education visit by the Energy Coordinating Agency of Philadelphia via PA WAP
- 1989, Patti Witti and Martin Kushler found a similar 7% impact via Michigan's Low-Income weatherization Energy Education and Incentives Program
- 1991, Marilee Harrigan of the Alliance to Save Energy found an 8% incremental effect when 3 in-home education visits were added to PECO's load management program
- 1993, Marialena Selvaggio found a small but significant difference between of 'high intensity' education services over the 'low intensity' and 'medium intensity' offerings.
- 1992, Judy Gregory studied recipients of Ohio's Home Weatherization Assistance Program who participated in the Client Education Pilot Program (CEPP). She estimated an incremental effect of energy education to be 6.7%. While participants of the 1989 HWAP program realized just over a 3% incremental effect for energy education.
  - Taking both reports into consideration, Judy Gregory indicated that energy education without a follow-up visit may yield lower savings than programs including a follow-up education visits.
- 1994, Financial Energy Management, modest, statistically insignificant, decreases in energy but significant increases in energy efficient resulting from tenant education in multi-unit, HUD-managed housing in Colorado.

Belief System

- Religious institutions enjoy moral authority and a grassroots presence that shape the worldviews and lifestyles of billions of people
- The 44 percent of the American public who regularly visit a church, synagogue, or mosque constitutes a huge pool of potential converts to energy efficiency and green energy sources
  - an Environmental Protection Agency (EPA) survey in 2003 calculates that an energy efficiency upgrade of the 269,000 houses of worship, ~5% of commercial building floor space, would reduce CO_2 emissions by 6 million tons and save congregations more than $500 million
- California's Regeneration Project, an initiative of the Episcopal Church, includes Episcopal Power and Light (EP&L), started in 1996 to persuade the state's Episcopalians to choose energy generated from renewable sources
  - Includes California Interfaith Power and Light that does political advocacy to promote renewable energy.
  - Has spread to seven states
  - Could substantially effect energy consumption if adopted by religious groups nationwide
  - Could provide a boost for emerging renewable energy companies

Peer pressure or bandwagon effect

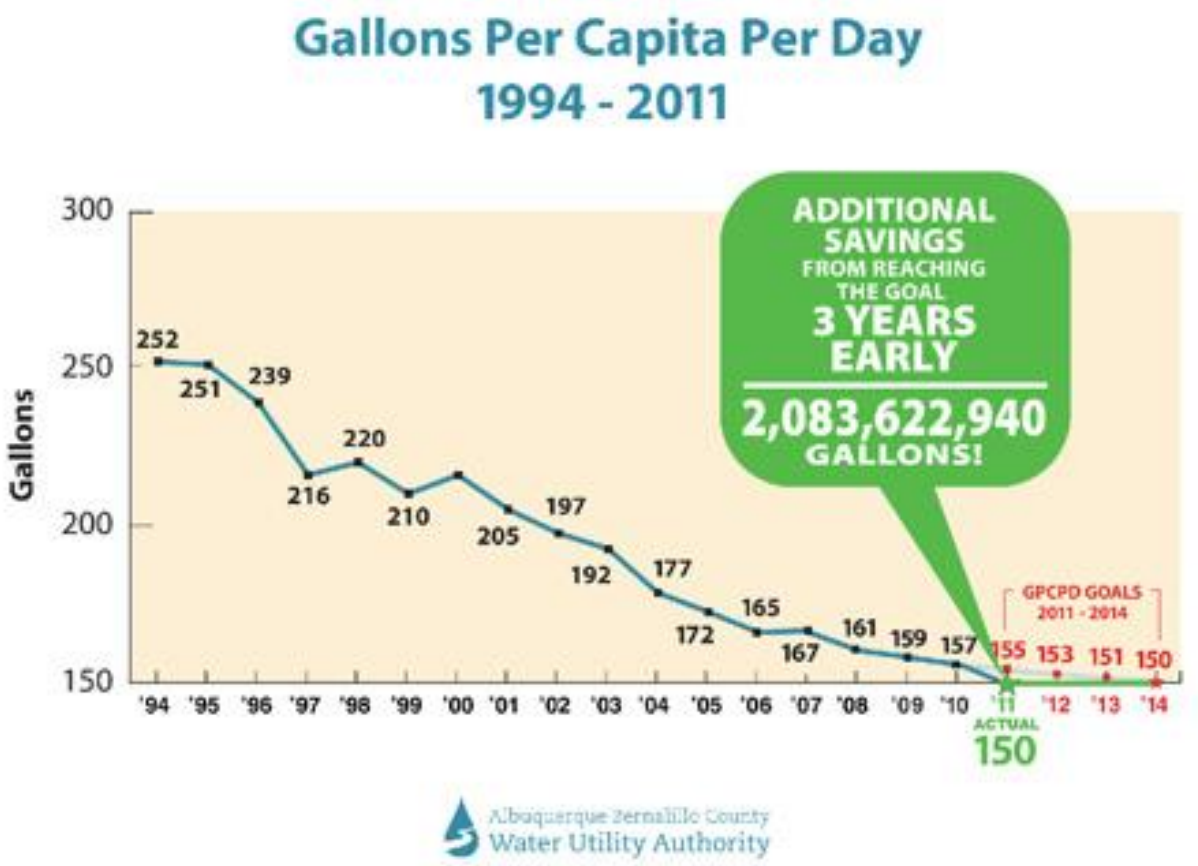
- It is difficult to maintain energy savings - people tend to offset savings say a new efficient appliance to buying a new TV
- Standard marketing techniques tend to focus on small shifts in market share for behaviors that people are already engaged in, like drinking coffee, that tend to encourage indulgence not restraint. In contrast, with energy efficiency we want to change behavior in a significant portion of the population, as well as shifting people to new behaviors that aren't inherently motivating.
- Sandia has efficiency programs
  - Building-to-building energy savings competition

Peer pressure or bandwagon effect

- Face to face contact - involves personal contact, whether it be from friends, block leaders, or representatives of organizations
  - Hood River weatherizing project, undertaken by the NRDC and the Pacific Northwest's largest electricity suppliers. Initially, less than 10% of customers signed up for the voluntary program. However, when the project switched to relying heavily on local residents, such as Citizen Advisory Councils and speakers at schools and churches, 85% of households had enrolled in 2 years (Cavanagh and Hirst, 1987; Engels, Kaplan and Peach, 1987).
  - Facebook created an app called "one app" to put your energy usage for all to see hoping competition and peer pressure will encourage better habits
  - OPOWER – developed a successful strategy of dealing with this for utilities
    - Increased participation in energy efficiency programs from 5 to 80%
    - Approach is based on people wanting to "fit in" by comparing their energy usage to their neighbors

Solutions

- Conserving another kind of resource – water
- Peer pressure – not financial incentives



*Consider this: At **150 gal/day/person**, each average Albuquerque family (3.0 persons) uses enough water to fill their entire lot (~¼ acre) **18 inch deep each year!***

Solutions

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Recycling Impacts Resource Use

- Throw Away Society
  - Europe changed packaging regulations that made the manufacturer pay for returning all packaging material. This resulted is a 80% reduction of packaging needed to be used

Question: Who knows the proper process to dispose of fluorescent tubes which contain mercury?

Answer: Bernalillo County residents can take used CFLs to (free):

Home Depot locations statewide and select Wal-Mart stores

Also, Rinchem Company, Inc., 6133 Edith Blvd. NE, Open to Public: M-W-F 8:30 AM - 4:30 PM; Sat. 8 AM - 3 PM

Or Albuquerque Lighting Company, 2100 Osuna Rd. NE

Or Advanced Chemical Transport, ACT, 6137 Edith Blvd NE, Open to Public: M-W-F 8:30AM to 4:30PM; Sat 8AM-3PM

Solutions

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Peer pressure most effective method to conserve resources

- Competition
- Setting an example
- Face-to-face contact

Behavior can apply pressure to enable faster technology changes

Regulations, incentives, and education are required and serve as the foundation of conserving resources

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Thank you for listening

Questions?