Energy Efficiency:
The first and most profitable way to delay Climate Change
Law Seminars International
ENERGY IN CALIFORNIA
Sept. 22, 2008

Arthur H. Rosenfeld, Commissioner
California Energy Commission
(916) 654-4930
ARosenfe@Energy.State.CA.US

http://www.energy.ca.gov/commissioners/rosenfeld.html
or just Google “Art Rosenfeld”
California Energy Commission Responsibilities

Both Regulation and R&D

• California Building and Appliance Standards
  – Started 1977
  – Updated every few years
• Siting Thermal Power Plants Larger than 50 MW
• Forecasting Supply and Demand (electricity and fuels)
• Research and Development
  – ~ $80 million per year
• CPUC & CEC are collaborating to introduce communicating electric meters and thermostats that are programmable to respond to time-dependent electric tariffs.

If intensity dropped at pre-1973 rate of 0.4%/year

Actual (E/GDP drops 2.1%/year)

France

12% of GDP = $1.7 Trillion in 2005

7% of GDP = $1.0 Trillion in 2005

If intensity dropped at pre-1973 rate of 0.4%/year
Energy Consumption in the United States 1949 - 2005

In 2005
$1.7 Trillion

Avoided Supply = 70 Quads in 2005

If E/GDP had dropped 0.4% per year

$1.0 Trillion

New Physical Supply = 25 Q

Actual (E/GDP drops 2.1% per year)

70 Quads per year saved or avoided corresponds to 1 Billion cars off the road
How Much of The Savings Come from Efficiency

• Some examples of estimated savings in 2006 based on 1974 efficiencies minus 2006 efficiencies

<table>
<thead>
<tr>
<th></th>
<th>Billion $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Heating</td>
<td>40</td>
</tr>
<tr>
<td>Air Conditioning</td>
<td>30</td>
</tr>
<tr>
<td>Refrigerators</td>
<td>15</td>
</tr>
<tr>
<td>Fluorescent Tube Lamps</td>
<td>5</td>
</tr>
<tr>
<td>Compact Fluorescent Lamps</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>95</strong></td>
</tr>
</tbody>
</table>

• Beginning in 2007 in California, reduction of “vampire” or standby losses
  – This will save $10 Billion when finally implemented, nation-wide

• Out of a total $700 Billion, a crude summary is that 1/3 is structural, 1/3 is from transportation, and 1/3 from buildings and industry.
Two Energy Agencies in California

• The California Public Utilities Commission (CPUC) was formed in 1890 to regulate natural monopolies, like railroads, and later electric and gas utilities.

• The California Energy Commission (CEC) was formed in 1974 to regulate the environmental side of energy production and use.

• Now the two agencies work very closely, particularly to delay climate change.

• The Investor-Owned Utilities, under the guidance of the CPUC, spend “Public Goods Charge” money (rate-payer money) to do everything they can that is cost effective to beat existing standards.

• The Publicly-Owned utilities (20% of the power), under loose supervision by the CEC, do the same.
California’s Energy Action Plan

• California’s Energy Agencies first adopted an Energy Action Plan in 2003. Central to this is the State’s preferred “Loading Order” for resource expansion.

• 1. Energy efficiency and Demand Response
• 2. Renewable Generation,
• 3. Increased development of affordable & reliable conventional generation
• 4. Transmission expansion to support all of California’s energy goals.

• The Energy Action Plan has been updated since 2003 and provides overall policy direction to the various state agencies involved with the energy sectors
Per Capita Electricity Sales (not including self-generation)
(kWh/person) (2006 to 2008 are forecast data)

Per Capita Income in Constant 2000 $

2005 Differences
= 5,300 kWh/yr
= $165/capita

US GDP/capita
1975: 16,241
2005: 31,442
% change: 94%

Cal GSP/capita
1975: 18,760
2005: 33,536
% change: 79%
Annual Energy Savings from Efficiency Programs and Standards

~15% of Annual Electricity Use in California in 2003

Utility Efficiency Programs at a cost of ~1% of electric bill

Appliance Standards
Building Standards

GWh/year

Impact of Standards on Efficiency of 3 Appliances

New United States Refrigerator Use v. Time
and Retail Prices

Source: David Goldstein

- Average Annual Energy Use (kWh) or Price ($)
- Refrigerator Size (cubic ft)
- Energy Use per Refrigerator (kWh/Year)
- Refrigerator Price in 1983 ($)
- ~ 100 gallons Gasoline/year
- ~ 1 Ton CO2/year

Source: David Goldstein
Annual Energy Saved vs. Several Sources of Supply
In the United States

- **Refrigerator Stds**: 0 Billion kWh/year
- **100 Million 1 KW PV systems**: Approximately 200 Billion kWh/year
- **Conventional hydro**: Approximately 400 Billion kWh/year
- **Nuclear energy**: Approximately 800 Billion kWh/year

In the United States:

- Nuclear energy equals approximately 80 power plants of 500 MW each.
In the United States

Value of Energy to be Saved (at 8.5 cents/kWh, retail price) vs. Several Sources of Supply in 2005 (at 3 cents/kWh, wholesale price)

<table>
<thead>
<tr>
<th>Source of Supply</th>
<th>Energy Saved (Billion $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerator Stds</td>
<td>20</td>
</tr>
<tr>
<td>100 Million 1 KW PV systems</td>
<td>15</td>
</tr>
<tr>
<td>Conventional hydro</td>
<td>10</td>
</tr>
<tr>
<td>Renewables</td>
<td>5</td>
</tr>
<tr>
<td>Nuclear energy</td>
<td>25</td>
</tr>
</tbody>
</table>
Air Conditioning Energy Use in Single Family Homes in PG&E
The effect of AC Standards (SEER) and Title 24 standards

If only increases in house size -- no efficiency gains
Change due to SEER improvements
SEER plus Title 24
Comparison of 3 Gorges to Refrigerator and AC Efficiency Improvements

三峡电量与电冰箱、空调能效对比

Savings calculated 10 years after standard takes effect. Calculations provided by David Fridley, LBNL
Annual Energy Savings from Efficiency Programs and Standards

~15% of Annual Electricity Use in California in 2003

Utility Efficiency Programs at a cost of ~1% of electric bill

Appliance Standards

Building Standards

GWh/year

0

5,000

10,000

15,000

20,000

25,000

30,000

35,000

40,000

45,000

California IOU’s Investment in Energy Efficiency

Millions of $2002 per Year

- Profits decoupled from sales
- 2% of 2004 IOU Electric Revenues
- Performance Incentives
- Market Restructuring
- Crisis
- IRP
- Public Goods Charges
- Forecast
Energy Efficiency Incentive Mechanism Earnings/Penalty Curve

(D.07-09-043, p. 8)

Earnings capped at $450 million

ER = 12%

ER = 9%

Penalty capped at $450 million.

Reward (% of PEB)

Penalty (per unit below CPUC goal)

5¢/kWh, $25/kW, 45¢/therm below goals, or payback of negative net benefits (cost-effectiveness guarantee), whichever is greater.

\[ \text{Earnings} = ER \times PEB \]

PEB = Performance Earnings Basis

ER = Earnings Rate (or Shared-Savings Rate)

Source: NRDC; Chang and Wang, 9/26/2007
1000 ft$^2$ of a white roof, replacing a dark roof, offset the emission of 10 tonnes of CO$_2$
CO₂ Equivalency of Cool Roofs and Pavements

- 44 GT CO₂ is over one year of the world 2025 emission of 37 GT CO₂
- At a growth rate of 1.5% in the world’s CO₂-equivalent emission rate, 44 GT CO₂ would offset the effect of the growth in CO₂-equivalent emissions for 11 years
Equivalent Value of Avoided CO₂

- CO₂ emissions currently trade at ~$25/tonne
- 44 GT worth $1100, for changing albedo of roofs and paved surface
- Cooler roofs alone worth $600B
- Cooler roofs also save air conditioning (and provide comfort) worth several times $600B

US Greenhouse Gas Abatement Mapping Initiative

December 12, 2007
U.S. mid-range abatement curve – 2030

Source: McKinsey analysis
Global cost curve for greenhouse gas abatement measures beyond 'business as usual'; greenhouse gases measured in GtCO₂e

- Approximate abatement required beyond 'business as usual,' 2030

- Carbon capture and storage (CCS); new coal
- Medium-cost forestation
- Cofiring biomass
- Wind; low penetration
- Industrial feedstock substitution
- CCS, enhanced oil recovery, new coal
- Low-cost forestation
- Livestock
- Nuclear
- Industrial non-CO₂
- Standby losses
- Sugarcane biofuel
- Fuel efficiency in vehicles
- Water heating
- Air-conditioning
- Lighting systems
- Fuel efficiency in commercial vehicles
- Biodiesel
- Industrial CCS
- Coal-to-gas shift
- CCS; coal retrofit
- Industrial motor systems
- Avoided deforestation
- Higher-cost abatement
- Further potential

- Marginal cost, € per tCO₂e

Abatement beyond 'business as usual,' GtCO₂e per year in 2030

- Building insulation: 8% (5 GtCO₂e)
- 17% (10 GtCO₂e)
- 25% (15 GtCO₂e)
- 33% (20 GtCO₂e)
- 42% (25 GtCO₂e)
- 50% (30 GtCO₂e)
- 58% (35 GtCO₂e)
Possible Strategies to Reduce Electricity Sector Carbon Emissions in California, ignoring ramp up times and other implementation issues -- The ELECTRICITY Perspective

Source: Pat McAuliffe, pmcaulif@energy.state.ca.us
Possible Strategies to Reduce Electricity Sector Carbon Emissions in California, ignoring ramp up times and other implementation issues -- The CARBON Perspective

Source: Pat McAuliffe, pmcaulif@energy.state.ca.us
The End

For More Information:

http://www.energy.ca.gov/commission/commissioners/rosenfeld.html

or just Google “Art Rosenfeld”