Summing Up
Energy Symposium: The “Rosenfeld Effect”
April 28, 2006

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

A Course Given by ENRICO FERMI
at the University of Chicago. Notes Compiled by
Jay Orear, A. H. Rosenfeld, and R. A. Schluter
AIP Conference Proceedings
No. 25

Efficient Use of Energy
(The APS Studies on the Technical Aspects of the More Efficient Use of Energy)
1980  Leading Researchers form ACEEE

1982  National experts gather for first “Buildings” Summer Study

1987  Manufacturers, advocates and Congress agree on appliance standards


2030 Our children inherit the fruits of the work we do today, and tomorrow.
Brickhouse Press, 1981

A New PROSPERITY
Building a Sustainable Energy Future

Banned by Reagan Transition Team, brought into public domain as House Committee print.
1983

Meier, Rosenfeld and Wright

*Supplying Energy Through Greater Efficiency: The Potential for Conservation in California's Residential Sector*
Figure 4  Macro supply curve of conserved residential lighting in California. Although the last cost-effective step costs 7.6 cents/kWh, the average CCE is only 4.8 c/kWh. This is adapted from Figures 3–12 of Meier et al (20).
Scenarios of U.S. Carbon Reductions
Potential Impacts of Energy Technologies by 2010 and Beyond

Prepared by the Interlabatory Working Group on Energy-Efficient and Low-Carbon Technologies
California Peak Power Demand: Planned in 1974, and Actual to 1984
California Peak Demand 1965 - 2004

- At 5% growth rate
- Actual (2.2% year)
- If CA had grown at US rate

GW

$10 \text{ bbl}

$40 \text{ bbl}

$15 \text{ bbl}

Arthur Rosenfeld, 12
Arthur Rosenfeld, 13

Per Capita Electricity Consumption
kWh/person

California
United States

Californian’s have a net savings of $1,000 per family

Source: http://www.eia.doe.gov/emeu/states/sep_use/total/csv/use_csv
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
Annual Peak Savings from Efficiency Programs and Standards

~ 22% of Annual Peak in California in 2003

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

Building Standards

Appliance Standards

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Figure 2  Scatter plot and cost data on 22 1976 refrigerators. The scatter plot (and Table on page 47) show little correlation between purchase price and efficiency. Source: Goldstein & Rosenfeld (13).
**United States Refrigerator Use v. Time**

Average Energy Use per Unit Sold (kWh/yr)

- Refrigerator Size (cubic ft)
- Energy Use per Unit (KWH/Year)

75% reduction in 30 yrs = 5%/yr.

Source: David Goldstein

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Refrigerator Energy Use: 75% has been saved

At 1974 Efficiency

Energy Needed

At 2001 Efficiency

Energy Saved
Energy Saved vs Energy Generation in Billion KWH

- Energy Saved Refrigerator Stds
- 100 Million 1 KW PV systems
- Conventional hydro
- Renewables
- Nuclear energy
The Value of Energy Saved and Produced
Valuing a kWh at 3 cents wholesale (busbar) and 8.5 cents to buildings

- Refrigerator Stds
- 100 Million 1 KW PV systems
- Conventional hydro
- Renewables
- Nuclear energy

Billion $ (US)/year
Comparison of 3 Gorges to Refrigerator and AC Efficiency Improvements

Savings calculated 10 years after standard takes effect. Calculations provided by David Fridley, LBNL

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<td><strong>4. SAVINGS 1985-1993</strong></td>
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<td>e. Equivalent power plants (10)</td>
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<td>f. Equivalent offshore platforms (10)</td>
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<td>g. Autos offset (11)</td>
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<td><strong>6. PROJECT BENEFITS</strong></td>
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<td>a. Advance in Commercialization</td>
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<td>b. Net Project Savings [6a x 5d]</td>
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<td>a. Wholesale</td>
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<td><strong>8. BENEFITS/ R&amp;D COST [6b/7]</strong></td>
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Baseline carbon emissions for year 2010 = 1736 Mt C/year = zero savings point.
2010 carbon permit price = $50/ton carbon (1995$)
Program/policy costs = 7-15% for demand sectors and 1-3% for electricity supply side options.
Real discount rates: 7-15% for buildings, 12.5-20% for industry, and 10-20% for transport.
Lower program/policy costs and discount rates for optimistic case;
pessimistic case has higher program/policy costs and discount rates
and assumes only 80% of savings achieved.
Temperature Trends in Downtown Los Angeles

From Orchards to Blacktops

Eruption of Krakatau, August 27, 1883

Slope = \( \frac{6^\circ F}{50 \text{ yr}} / \frac{3.3^\circ C}{50 \text{ yr}} = \frac{1^\circ F}{8 \text{ yr}} / \frac{1^\circ C}{14 \text{ yr}} \)
Cool and Standard Color-Matched Coatings for Concrete Tiles

Can increase solar reflectance by 0.3 or more

Gain greatest for dark colors

Courtesy: American Rooftile Coatings

ΔR=0.37  ΔR=0.26  ΔR=0.23  ΔR=0.15  ΔR=0.29  ΔR=0.29
**Cool Metal Panel**

*Source: Hashem Akbari, LBNL*

- **Cool Green**
  - Solar reflectance: 0.36
  - Thermal emittance: 0.85
  - Roof temp - air temp: 31°C (56°F)

- **Standard Green**
  - Solar reflectance: 0.24
  - Thermal emittance: 0.85
  - Roof temp - air temp: 38°C (68°F)
If cool roofs are good for buildings, then cool pigments are good for cars.

- Fleets should start ordering only white, silver, or gold cars
  - thus reducing emissions by ~4%
- Cars world-wide should use light colors or cool-colored pigments.
  - This allows the manufacturer to downsize the air conditioner and thus reduce first cost and reduce emissions.
Critical Peak Pricing (CPP)
with additional curtailment option

Potential Annual Customer Savings:
10 afternoons x 4 hours x 1 kw = 40 kWh at 70 cents/kWh = ~ $30/year
Tariffs being Tested in California Pilot

Hour Ending

FLAT RATE
TOU RATE
CPP-F RATE (NON CRITICAL DAY)
CPP-F RATE (CRITICAL DAY)
2005

Climate Zone 4 (Very Hot Areas) on CPP Days

Graph showing the control, CPP - F, and TOU kW usage over 24 hours for Climate Zone 4 on CPP days.

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1993
UV Water Works

[Diagram of a UV water disinfection system with labels for UV lamp, aluminum reflector, curved stainless steel pan, biologically contaminated water in, and disinfected water out.]
UV Water Works

- Unique water purification system
- Effective on all water-borne bacteria and viruses
- Inexpensive to buy and operate
- Simple to use, low maintenance
- Uses 6,000 times less energy than boiling
- Accepted by villagers, universal use
- Works with the flow from a standard hand pump (treats 4 gallons/min)

Source: EETD.LBL.gov or WaterHealth.com
Afghan Refugee Housing, 2002
Truck Supported by Panels
(6” expanded polystyrene clad with plywood. Pickup supported by 2 panels each 4’ x 24’

[Image of a truck supported by panels against a wooden building]