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DOE

Carbon Impacts from Increased Electricity Sales (Updated 2/10/98)

Attached is a rough calculation of the range of carbon emission increases which might result from increased demand associated with lower electricity prices. There are several steps in making this estimation:

- change in delivered electricity prices likely to result from restructuring
- electricity demand responsiveness to prices (elasticities)
- incremental carbon emission factor for increased demand

The POEMS model incorporates these effects, as well as others. The example here is meant to be illustrative to give a feeling for the possible ranges and magnitudes of the various components. The years 2010 and 2015 are used for the example. The last year of stranded cost recovery is 2010.

Based on recent POEMS scenarios, the drop in average delivered prices is likely to be roughly 10 percent in 2010. This includes decreases in the generation, transmission, and distribution components of rates offset by stranded cost recovery. An estimate of the combined cost of the renewable portfolio standard and green power is included as well. By 2015 all the components of the reference cost-of-service rates have fallen from their 2010 values. In the competitive case, the generation cost has risen relative to 2010, while all the other components are lower. The rates no longer include any generation stranded cost recovery charge, but the regulatory and decommissioning costs remain because they are assumed to be recovered over a longer period. The overall rate reduction between cases in 2015 also is projected to be 10 percent. The change by customer class will not be exactly uniform, but for this example the average is used for simplicity. Assuming base total retail sales in 2010 of 3,802 billion kWh, and a range of elasticities of -0.15 to -0.50, demand will increase 59 to 196 billion kWh in response to this price drop. Given side tests performed with the POEMS demand modules, the mostly likely price elasticity is -0.18. In 2015 the base demand is projected to be 4091 BkWh, and the increase in demand would be 63 to 210 BkWh.

The next step is to calculate the increase in carbon emissions associated with the increase in demand. The projected average carbon emission factor in 2010 and 2015 is roughly 0.17 MMT/BkWh of sales, which reflects a generation mix of coal, oil and gas, nuclear, and renewables. When sales are increased in the future, the change in generation mix will reflect construction of new power plants, as well as increased utilization of existing plants. The new sources of generation are likely to be less carbon intensive than the existing mix of generation. For example, emissions from gas combined cycles are roughly 0.11 MMT/BkWh. The inclusion of the renewable portfolio standard in the POEMS model simulation will also tend to lower the marginal carbon intensity. As another point of comparison, the marginal carbon intensity in 2010 associated with decreased demands was roughly 0.13 MMT/BkWh in the 1997 Climate Action Report. Preliminary runs from POEMS suggest that the marginal carbon associated with change in demand is roughly 0.15 in 2010. For the example here, a range of 0.11 to 0.17 was selected.

In 2010, with a demand elasticity of -0.18 and an increase in sales of 71 BkWh, the carbon increase would be 7.8 to 12.0 using this range of carbon factors. The full range of projected

2010 emission reductions is 6.5 to 33.3 MMT, with a best estimate of 10.6 MMT. The range is slightly higher in 2015 due to higher reference demand levels. Carbon emission reductions in 2015 are projected to be from 6.9 to 35.7 MMT, with a best estimate of 11.3 MMT. The reason the ranges are asymmetric around the best estimate is because the ranges for the individual parameters were selected to include values that EPA used in their analysis, which tends to pull up the total estimate.

Year 2010 Carbon Impact from Reduced Electricity Prices

Rates (1995$/MWh)	Reference Case	Competitive Case	Difference
Generation	35.8	26.6	
Transmission	6.2	5.4	
Distribution	18.4	14.7	
RPS and Green Power		4.9	
Stranded Cost CTC			
Generation		1.5	
Decommissioning		0.6	
Regulatory Assets		0.4	
Average Rate	60.3	54.1	-10%
Retail Sales (Bkwh)	3802		
Demand Impact (Bkwh)			Increase
Elasticities			
-0.15	1.5%	3861	59
-0.18	**1.9%**	**3873**	**71**
-0.30	3.1%	3920	118
-0.50	5.2%	3998	196

Carbon Impact from Increased electricity demand (MMT)

Carbon Factors	Demand Increases (Bkwh)			
(MMT/kwh sales)	59	71	118	196
0.11	6.5	**7.8**	12.9	21.6
0.13	7.6	**9.2**	15.3	25.5
0.15	**8.8**	**10.6**	**17.6**	**29.4**
0.17	10.0	**12.0**	20.0	33.3

Year 2015 Carbon Impact from Reduced Electricity Prices

Rates (1995$/MWh)	Reference Case	Competitive Case	Difference
Generation	33.7	28.5	
Transmission	5.9	5.0	
Distribution	17.9	13.3	
RPS and Green Power		4.1	
Stranded Cost CTC			
Generation		0.0	
Decommissioning		0.5	
Regulatory Assets		0.3	
Average Rate	57.5	51.6	-10%
Retail Sales (Bkwh)	4091		
Demand Impact (Bkwh)			Increase
Elasticities			
-0.15	1.5%	4154	63
-0.18	**1.8%**	**4167**	**76**
-0.30	3.1%	4217	126
-0.50	5.1%	4301	210

Carbon Impact from Increased electricity demand (MMT)

Carbon Factors	Demand Increases (Bkwh)			
(MMT/kwh sales)	63	76	126	210
0.11	6.9	**8.3**	13.8	23.1
0.13	8.2	**9.8**	16.4	27.3
0.15	**9.4**	**11.3**	**18.9**	**31.5**
0.17	10.7	**12.8**	21.4	35.7

Briefing on Changes in Carbon Emissions Due to Electric Retail Competition

February 1998 --DRAFT

2/11

Restructuring Is a Significant Downpayment

- Restructuring positions the electricity sector for efficient reduction in emissions under the system of tradable carbon permits that is implemented starting in 2008 under the President's climate plan.
  - Current regulated pricing treats fuel prices as an "add-on" item for which plant owners are directly reimbursed, so there is little if any incentive to retire plants based on fuel cost. Under competition, the market will force the retirement of plants whose fuel costs (including the cost of any required carbon permits) make them uncompetitive compared to cleaner and more efficient generation sources.
  - Our restructuring plan also provides valuable early experience with the market institutions (e.g. information disclosure) and technologies (e.g. renewable energy) that will needed should the Kyoto emissions reduction commitment be ratified.

Restructuring Is a Significant Downpayment -- cont'd

- Restructuring provides at least $20 billion cost-saving and price reduction. The "restructuring dividend" creates room to accommodate the costs of meeting the Kyoto commitment without harming America's families or industry.
- Restructuring itself provides a tangible reduction in carbon emissions

While the remainder of this briefing focuses on the quantification of tangible reductions, improved "readiness for trading" and the "restructuring dividend" should be considered as integral parts of the significant downpayment from restructuring.

Comparison of Key Components of DOE and EPA Emissions Estimates in 2010 (MMTCE)

Description	DOE Estimate (as of 2/2/98)	EPA Estimate (January 1998)
Demand/Generation Mix		**24**
- Lower Prices	10 to 13	20
- Time of Day Pricing	1 to 2	a
- Reduction in Primary Fuel Use	-2	-2
Incremental Nuclear Retirements	**0 to 3**	**10**
Heat Rate/Capacity Availability Improvements	**-32**	**0[c]**
Increased Renewable Energy	**-25**	**-16 to -10**
- Renewable Portfolio Standard	-9	-12 to -6
- Green Marketing	-16	-4
Public Benefit Fund	**-7**	**-11 to -4**
Integrated Energy Services	**-14**	**0**
Simple Sum	**-67 to -61**	**7 to 20**
Integrated Model Result	**-74**	

a - Not explicitly calculated.
b - Combined with *Demand* above.
c - *Heat Rate Improvements* and *Increased Capacity Availability* are assumed to net to zero.

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Non-Controversial Components

- Reduction in Primary Fuel Use
- Time of Day Pricing
- Renewable Portfolio Standard
- Public Benefit Fund

Demand Response to Competition

- Changes in carbon emissions associated with a demand response can be separated into three categories:
  - *Lower electricity prices* under competition will lead to increased electricity demand.
  - *Fuel Switching* to electricity from other primary fuels (due to lower electricity prices) will somewhat offset increased emissions.

Demand Response - Lower Prices

- DOE and EPA have estimated an increase in carbon emissions due to a demand response from lower prices of approximately 10 and 20 MMT, respectively, in 2010.
- This calculation is dependent upon three factors:
  - Sensitivity of demand to price change (elasticity):
    DOE -0.18 EPA -0.5
  - % Change in Price: DOE -10% EPA -12%
  - Electricity Carbon Coefficient (MMT C/bkWh): DOE .15 EPA ?
- The DOE elasticity is implicit in the results from the EIA NEMS demand modules, which are the structural representations of end-use demand contained in the *Annual Energy Outlook.*

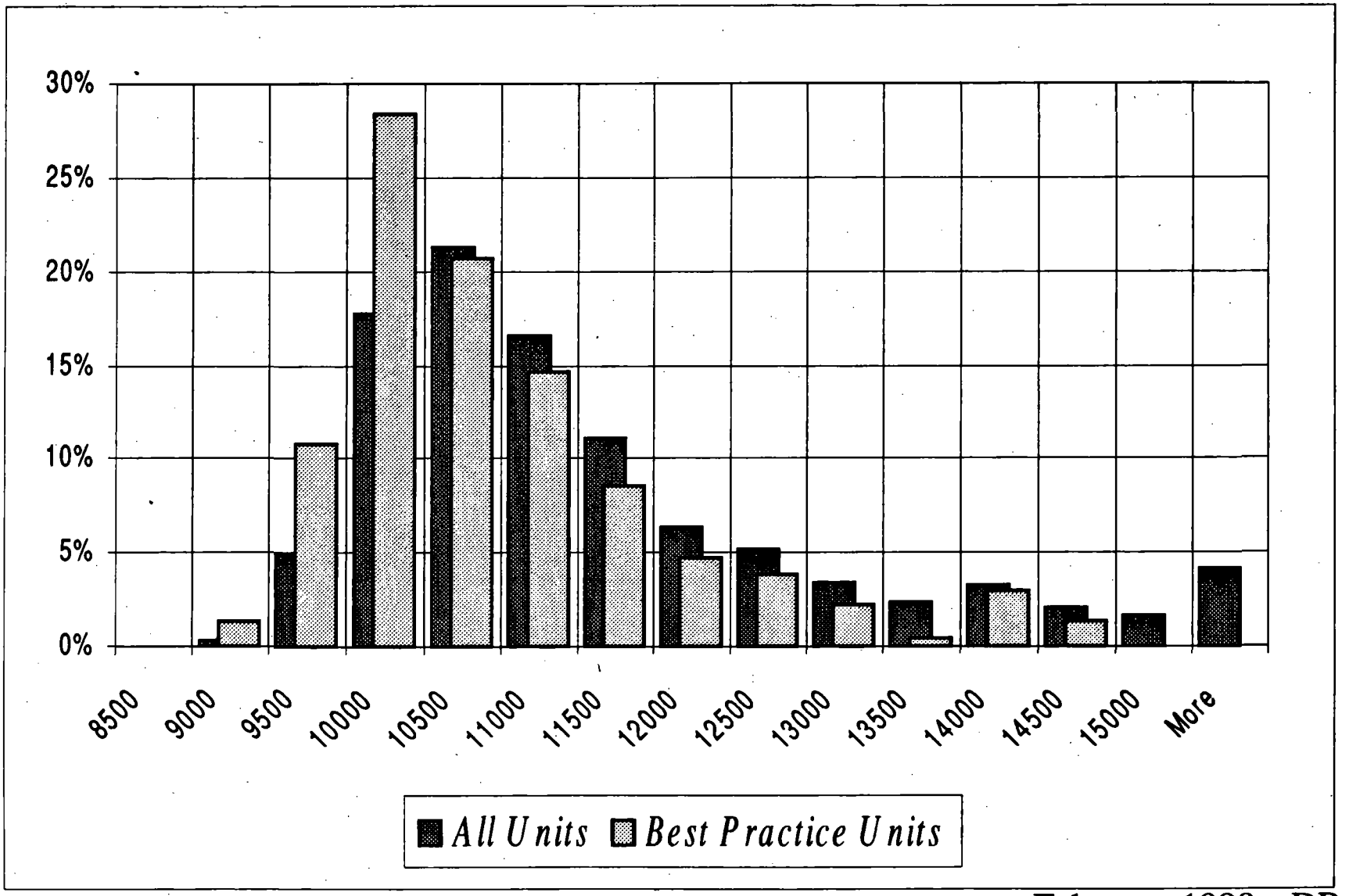
Incremental Nuclear Retirements

- Wholesale and Retail Competition are expected to result in the early retirement of some nuclear plants.
- This will occur when a nuclear plant requires a major capital investment and it becomes cheaper to meet load from another source.
- DOE believes that the only additional incentive to retire nuclear plants in a retail competition scenario occurs when the marginal price of electricity is lower, reducing the probability of being able to cover going forward costs. DOE's model internally projects economic retirements. Two scenarios were run which resulted in the economic retirement of between 0 to 3 gigawatts of capacity, which translates into an increase in carbon emissions of between 0 and 3 MMT.
- EPA believes that other differences exist between the reference and retail competitive scenarios. They estimate the increased carbon due to early retirement of nuclear plants to be between 7 and 10 MMT.

Heat Rate Improvements

- Incentive for Improvement: Competition provides a direct profit incentive for cost-effective improvements that reduce fuel input per unit of electricity output at existing plants. Cost-of-service regulation, where fuel costs are a direct pass through to end-users, offers little incentive to explore such opportunities.
- Potential Improvement: The potential for heat rate improvement is identified in the 5-lab study and in published studies by OTA and EPRI as falling in the neighborhood of 5 percent. DOE has talked with industry experts who confirm opportunities for savings in the 5% to 7% range. A recent article in Power magazine (Jan/Feb 1998) identifies opportunities in the areas of turbine steam-push components, reducing carbon and fuel losses in the fireside of the boiler, preventing air in-leakage, and upgrading the boiler steam side by adding superheater surface and upgrading economizers.
- Statistical Analysis: DOE also performed a statistical analysis of heat rates that controls for major operational characteristics outside the control of plant operators, such as fuel type, age, size, and environmental controls. The analysis establishes a "best practices" group and computes the heat rate improvement if plants outside that group are brought in line with the estimated best practices model. The model suggests overall improvement in the range of 5% to 7%.
- Estimated savings: If heat rates are improved by 4.4%, 37 MMT of carbon could be saved. EPA does not believe these savings are possible.

Distribution of Heat Rates for Coal-fired Generating Units



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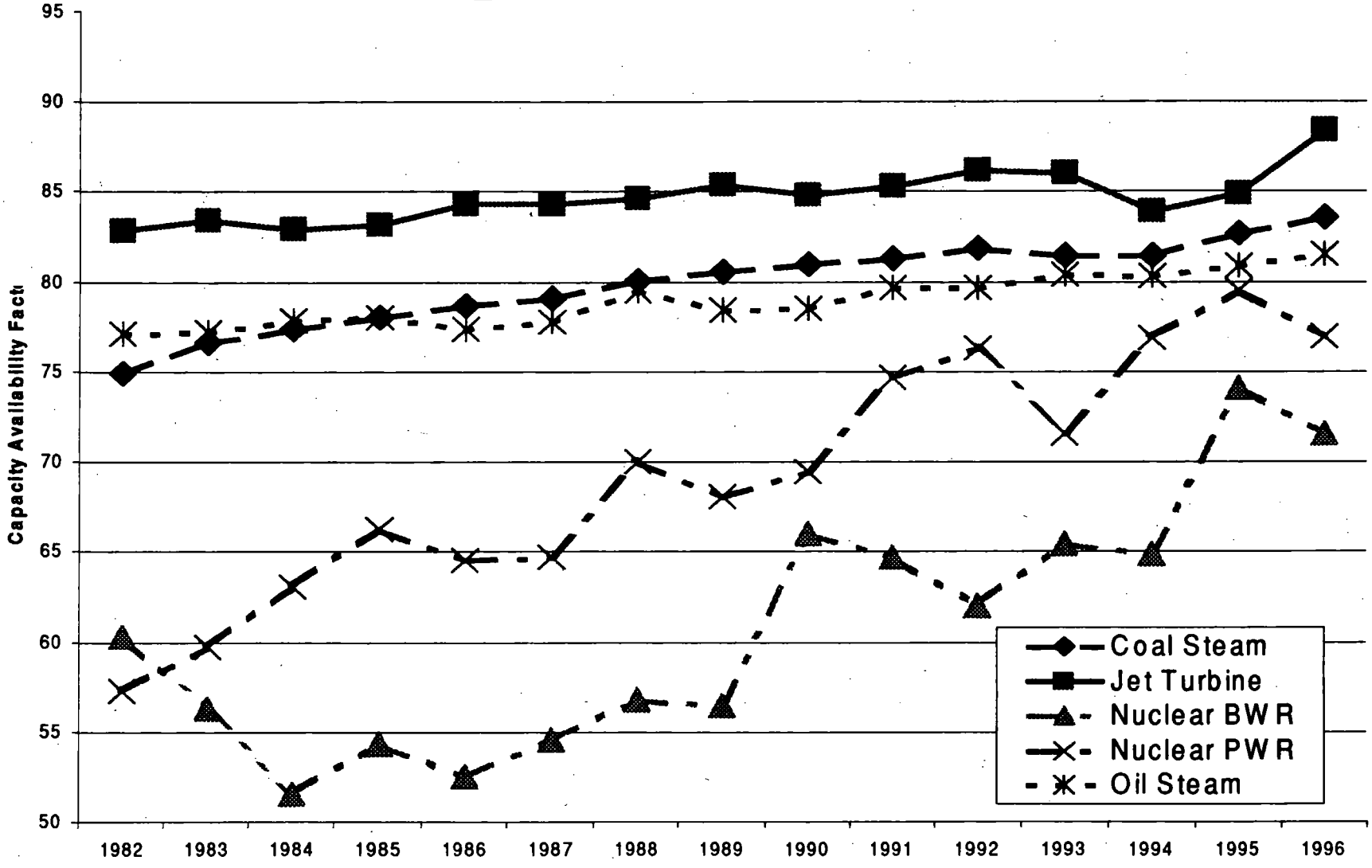
Capacity Availability

- Incentives: EPA and DOE agree that retail competition could increase incentives for plant operators to raise the availability of their low-cost plants.
- Potential Availability Change: EPA assumes that availability will improve from 85% to 90% at all existing coal plants due to retail competition, with other plants unaffected. DOE believes that the incentive for availability improvements under competition would apply to steam generating plants of all types, not just coal. (SEE FOLLOWING CHART). A model run that applies increased availability to all generating plants shows an emissions increase of 5 MMT in 2010.
- Emissions Change: Availability and utilization for coal plants can differ substantially -- coal plant availability in 1995 was 84 percent, but utilization was only 64 percent. Our run will pick up the following factors in tracing emissions implications of availability changes:
  - Increased availability at coal and non-coal units must occur when demand for additional power exists. Increases in availability during off-peak hours or off-season periods do not translate into increased utilization on a 1:1 basis.
  - Increased availability must occur at units that meet economic criteria for dispatch (e.g. a relatively expensive unit will still not be used) and where transmission capacity is available.
  - Emissions offsets at displaced units must be considered.

For all of these reasons, percentage improvements in availability do not have the same impact on emissions as percentage improvements in coal plant heat rates.

Capacity Availability



- Non-coal steam units have considerable potential for availability improvement

Energy Efficiency Marketing

- Supplier Interest: Bundling energy efficiency has emerged as a both a key competition strategy of U.S. energy marketers and a key customer retention tool for existing utilities.
  - Marketers and utilities are both aggressively acquiring energy service expertise as they prepare for differentiated product competition to supplant commoditized franchise monopoly.
- Buyer Interest: Available requests-for-proposals and qualifications (RFPs and RFQs) indicate real buyer interest in energy/efficiency packages. (Recent Electricity Journal Article + new datapoints in LBNL dataset since publication.)
  - Restructuring has strengthened role of energy managers within corporate decisionmaking structure -- cited as positive impact by Brits (EnTech)

Energy Efficiency Marketing -- Cont'd

- Announced Deals: Major contracts that bundle efficiency are already being announced (see trade press clippings)
  - (grocery chains, department stores, aggregations of light industry, printing operations, hotels, non-profits -- only latter are key markets for existing ESCOs)
- 5-lab study: The DOE estimate from bundled efficiency services reflects a fraction of the market efficiency potential identified in the 5-lab study. Instituting a market in place of a commoditized franchise monopoly addresses a crucial market barrier.
  - simply not credible to claim CCAP program impacts if markets themselves are counted as zero.
- Additional Savings: Residential integrated service offers efficiency gains not available under current regime. (trade press and Goldman article)

Green Power

DOE view of 2010 "green power" market is reasonable:

- Successful green power programs to date (Sacremento CA, Traverse City, Colorado Public Service) have all involved incremental capacity and generation.
- 2nd national green power conference (October 1997) EPRI/NREL
  - green power is still in a testing/startup phase, with growing # of programs. Generally high customer satisfaction/retention.
  - no consensus has yet developed on best approaches
  - there should not be "total reliance" on market forces to foster renewables deployment -- additional policies are also needed (CERTAINLY DOES NOT IMPLY ZERO NET EFFECT).
- "Willingness to Pay Study (NREL)"
  - Time is a crucial variable. Participation of 1 to 2% within 2 years is the norm, with subsequent growth.

Green Power -- Cont'd

- California marketers are planning for 5 percent market share in 5 years (Wiser -LBNL, based on Green-e discussions), and more later. Cavanagh (co-chair of NRDC electricity program) recently stated that demand for "clean power" from both residential and non-residential customers will exceed analysts' estimates. (PUF, Jan 1, 1998)
- Holt: " These (existing) programs may be viewed as experiments to find the best combination of elements.. It may take a decade or more, but with time, a growing awareness on the part of consumers (about green power) has the potential to transform the market for new energy supply."
- "Progressive" analysts (i.e. Moskowitz) see disclosure as a critical element. Moskowitz believes that a 10 percent or greater green power residential market share is feasible with strong disclosure.