High Electricity Demand Days: Clean Energy Strategies for Improving Air Quality

USDOE Clean Energy Air Quality Integration Webcast

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Clean Energy Environment
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MARKET PROGRAMS

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Outline

- High Electricity Demand Day (HEDD) Initiative
  - Concept and scope
  - NOx emissions reduction potential
  - Next steps
- Clean Energy Strategies
  - Energy Efficiency
  - Demand Response
  - Clean Distributed Generation (DG)
- EPA Guidance on Incorporating Clean Energy Initiatives in SIPs

HEDD Initiative

HEDD Initiative: Concept and Scope

- Air quality issues associated with peak electric demand on hot summer days:
  - High levels of NOx emissions from electric generating units (EGUs).
  - Meteorological conditions that contribute to ground-level ozone formation.
- Emissions standards and trading programs have had limited success in reducing emissions from EGUs that mostly operate during periods of peak demand.

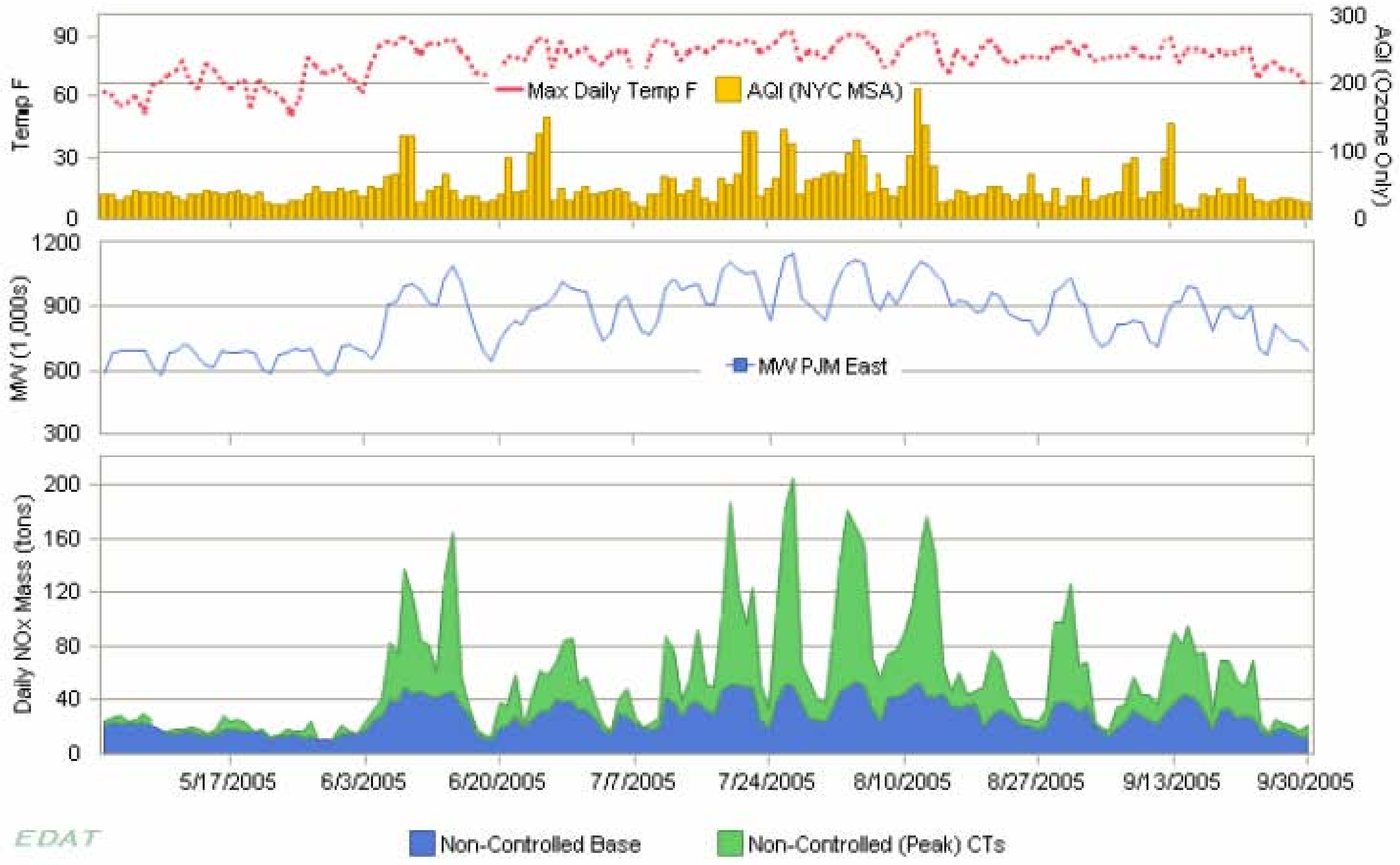
Daily PJM Load, NOx Emissions, CASTNET Met and AQI Ozone Season 2005

NOTES: Daily Max Temperature (F) is at CASTNET site in Washington Crossing, NJ 'WSP144'.
AQI is ozone value only for MSA indicated.
PJM-East Load is aggregated daily total from telemetry data.
Daily NOx Emissions in tons. Analysis considers all electrical generating and large industrial sources in select counties* from the New York City and Philadelphia metropolitan areas which report data to EPA under 40 CFR Part 75.
Peak units defined at <= 1,100 hours of operation in 2005 ozone season. Includes only unit type CT (Combustion Turbines).
Base units defined at > 1,100 hours during the 2005 ozone season. Includes all unit types.

Metro NYC, NY

MSA 5600
Non-Controlled Units

- Selecting 2005 ozone season days with a maximum daily temp of approximately 90 F will capture most AQI ozone days >100 (orange or higher) in MSA 5600.
- There appears to be a close correlation between PJM East load and the dispatch of non-controlled units in metro NYC area. Note that PJM only called the peaking units during periods of warm temperatures. PJM maximum load for 2005 was on July 26.



Data Sources: EPA, PJM

CLEAN AIR MARKETS DIVISION

HEDD Initiative: Concept and Scope

- In 2006, the Ozone Transport Commission (OTC) convened a workgroup to evaluate strategies for reducing HEDD NOx emissions.
- Stakeholder process included representatives from:
  - State air quality agencies
  - Public utility commissions (PUCs)
  - Electric power generators
  - Regional transmission organizations (RTOs)
  - EPA

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HEDD Initiative: Concept and Scope

- EPA support included:
  - Modeling to estimate regional NOx emissions reduction achievable through cost-effective clean energy strategies:
    - Energy efficiency
    - Demand response
    - Solar photovoltaic (PV) technology
    - Combined heat and power (CHP) technology
  - Set of policy and program-level clean energy best practices to support attainment of HEDD emissions reduction goals.

Clean Energy Strategies for Reducing HEDD Emissions

- Energy efficiency programs targeting leading drivers of peak summer electric demand:
  - Residential air conditioning (AC)
  - Commercial heating, ventilation & air conditioning (HVAC)
  - Commercial lighting
- Demand response programs designed to reduce electricity consumption during peak demand periods without increasing the use of emissions-intensive backup generation.
- Clean distributed generation (DG) technologies:
  - Solar PV
  - CHP

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Estimating NOx Emissions Reduction Potential

- TRUM = The Technology Retrofit and Updating Model (TRUM)
  - Macro-driven spreadsheet model, developed by ICF to supplement the use of its Integrated Planning Model (IPM).
  - Uses a linear programming formulation to select investment options and to dispatch generation and load management resources to meet overall electricity demand and energy requirements (Load duration curve).
  - More simple and streamlined compared to IPM.
  - Runs quickly but does not provide exact solutions.

TRUM Inputs

- Modeling performed by the Clean Air Markets Division.
- Started with 2010 CAIR scenario as a base case.
- Reconfigured the modeling exercise to look at episodic period (twelve high electric demand days based on recent load projected to 2010).
- Included smaller units not subject to cap and trade programs.

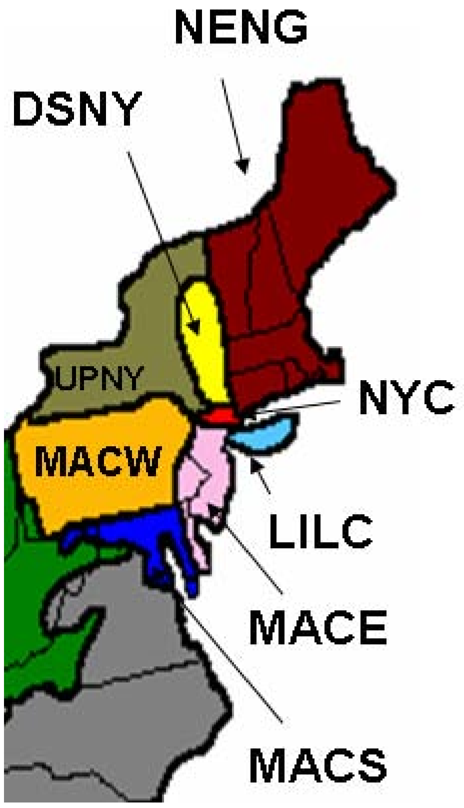
Technology Retrofit and Updating Model Version 2.1.9

Table of Contents

i

TRUM Inputs: Geographic Extent

- 8 IPM Regions encompassing:
  - “Classic” PJM
  - New York
  - New England



TRUM Inputs: Clean Energy Strategies

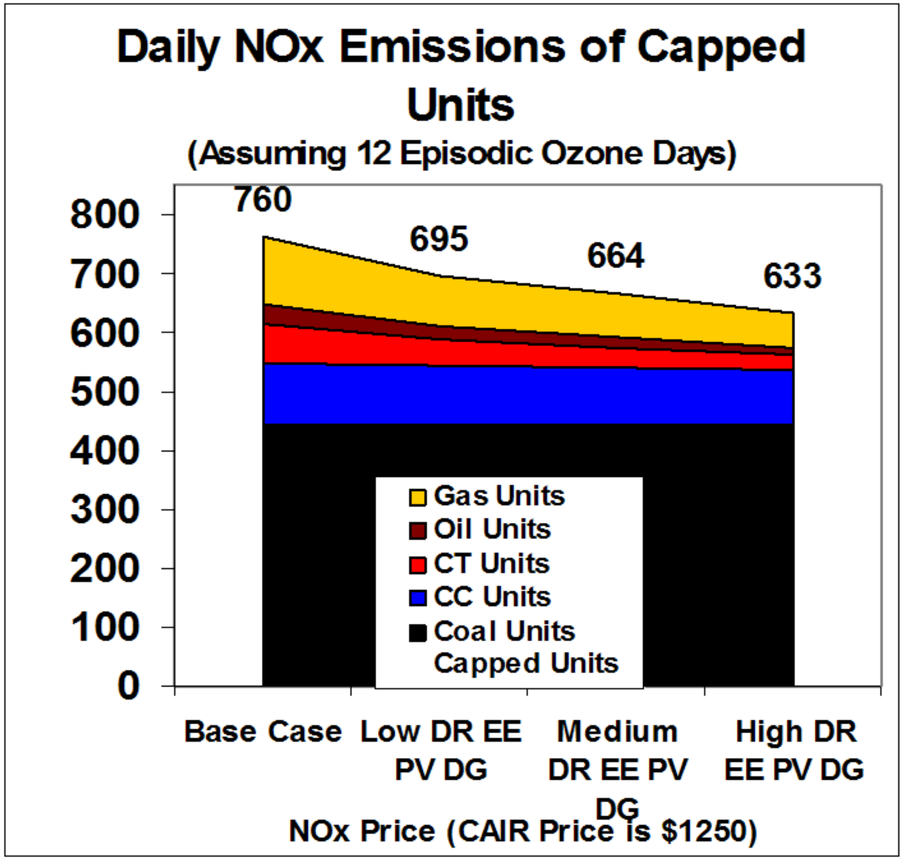
2010 *Measures beginning in 2008*	Low	Medium	High
Energy Efficiency (EE)	1% cumulative reduction in load (1,083 MW at peak)	1.5% cumulative reduction in load (1,624 MW at peak)	2.0% cumulative reduction in load (2,166 MW at peak)
Demand Response (DR)	3% reduction at peak hours (3,216 MW at peak)	4% reduction at peak hours (4,266 MW at peak)	5% reduction at peak hours (5,306 MW at peak)
Solar PV, installed capacity	56 MW	112 MW	168 MW
CHP, installed capacity	771 MW	1,884 MW	2,975 MW

NOx Emission Reduction Estimates: Results

- EPA estimated that by 2010, a portfolio of enhanced clean energy initiatives could reduce peak day NOx emissions by 4% to 8% across the OTC states, and achieve emissions reductions of 13% to more than 20% by 2015.
- Emissions reductions could be even greater with appropriate provisions to address increased emissions from the use of high-emitting back-up generators.

NOx Emission Reduction Estimates: Results (OTC wide 2010 model results)

Daily NOx reduced from ***All*** Units	Low	Medium	High
Tons	**29**	**46**	**64**
Percent of total	**-3.6%**	**-5.7%**	**-7.8%**



Daily NOx Decrease from Capped Units

LO	MED	HI
65	96	127

Daily NOx Increase from Back Up Generation

LO	MED	HI
42	55	68

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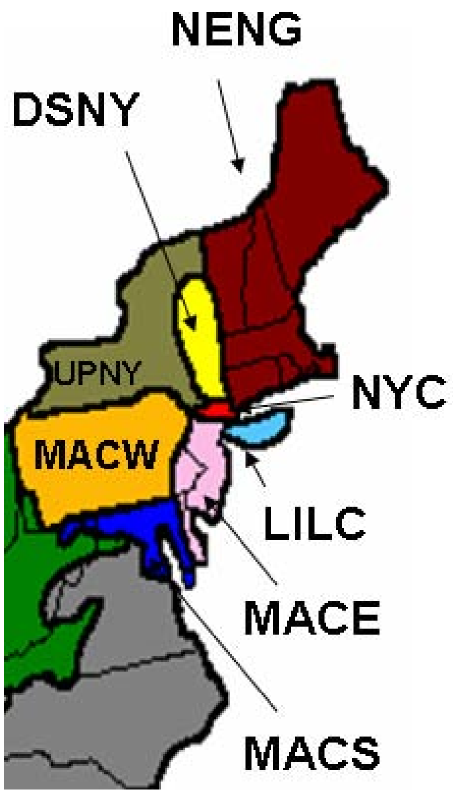
NOx Emission Reduction Estimates: Energy Efficiency

Energy Efficiency

	(lb/MWh per HEDD)
DSNY (*NY*)	2.10
LILC (*NY*)	3.71
MACE (NJ, DE, *PA*)	1.87
MACW (*PA*)	1.53
NENG (CT)	0.87
NYC (*NY*)	1.67
UPNY (*NY*)	1.37
MACS (*MD*, DC, *NoVA*)	3.85



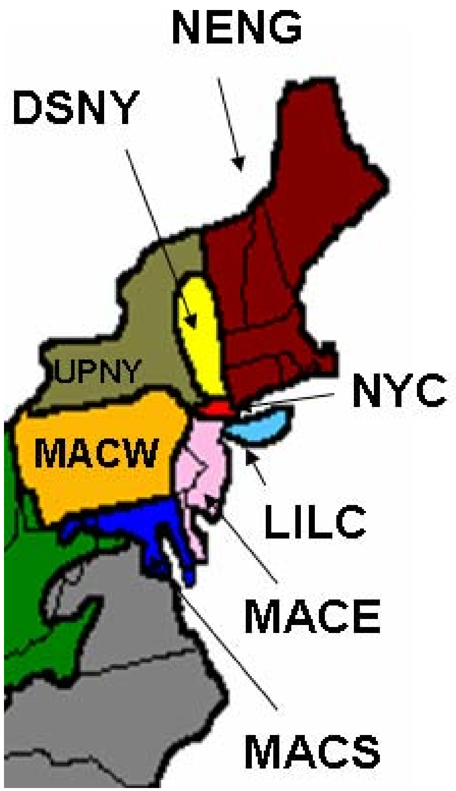
NOx Emission Reduction Estimates: Solar PV

Solar PV

OTC Wide = 1.74 lb/MWh per HEDD

- OTC Wide PV installation modeled at 112 MW, not enough to produce subregion-specific figures

OTC Wide = 0.0311 lbs NOx reduced per HEDD per kW installed capacity



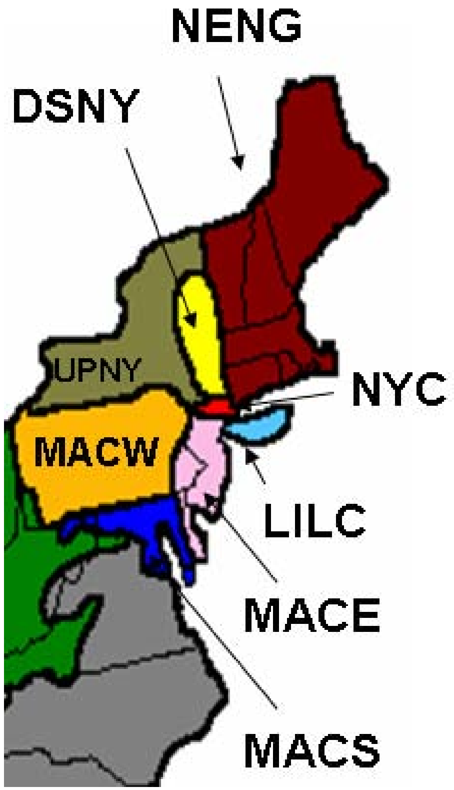
NOx Emission Reduction Estimates: CHP

CHP Applications

Includes affect on grid-connected CHP only.

Does not include changes in emissions on-site.

	(lb/MWh per HEDD)
DSNY (*NY*)	2.06
LILC (*NY*)	3.12
MACE (NJ, DE, *PA*)	1.67
MACW (*PA*)	1.45
NENG (CT)	0.79
NYC (*NY*)	1.63
UPNY (*NY*)	1.38
MACS (*MD*, DC, *NoVA*)	3.69



NOx Emission Reduction Estimates: Demand Response

- To ensure demand response programs produce a net decrease in NOx emissions, careful policy implementation is needed regarding participation of backup generation in demand response programs:
  - Exclude or limit use of backup generation in demand response incentive programs.
    - Example: NYISO's Day Ahead Demand Response Program: "Beginning in 2003, the program will be open only to resources that provide load reduction through interruptible load; load reduction through on-site generation will not be permitted."
  - Require emissions limits for generators that participate in demand response programs.

HEDD Initiative: Next Steps

- Several OTC states signed Memorandum of Understanding (MOU) in March 2007:
  - Beginning with the 2009 ozone season, six states (CT DE MD NJ NY PA) have NOx emissions reductions targets on HEDDs.
  - States are developing tailored strategies for achieving these reductions through mechanisms such as:
    - Emissions caps on HEDD units
    - Performance standards
    - State/generator HEDD partnership agreements
    - Energy efficiency programs
    - Demand response programs that preclude installation of high-emissions backup power generation
    - Regulatory standards/controls for behind-the-meter generators
    - Adjustment of NOx retirement ratios to provide for HEDD reductions

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Clean Energy Strategies

Energy Efficiency Program Best Practices

- ENERGY STAR New Homes
- Home Performance with ENERGY STAR
- Quality HVAC Installation & Maintenance
- Appliance Retirement & Recycling
- PC Power Management
- Commercial Lighting, Cooling, & Refrigeration
- Commercial Whole Building Performance
- Cool Roofs

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Demand Response Best Practices

- Demand response programs should be structured to avoid a net emissions increase through the use of emissions-intensive sources of backup power generation.
  - Exclude or limit use of backup generation in demand response incentive programs.
  - Require emissions limits for generators that participate in demand response programs.
- A portfolio of demand response incentive offerings comprised of voluntary (nonfirm) and mandatory (firm) reduction commitments offers customers the flexibility to select the demand response option that is best suited to their risk tolerance.
- Enabling technologies (advanced metering, load control devices, and energy management systems) increase the effectiveness of demand response initiatives.

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Clean Distributed Generation

- Two low-emissions DG technologies represent key opportunities for peak demand reduction:
  - **Solar PV:** Peak summer demand on hot summer days corresponds with maximum solar resource. PV systems employ modular configurations, and can be utilized in a range of facility types and locations.
  - **CHP:** CHP systems generate electrical and thermal energy in a single integrated system, and require less fuel to produce a given energy output. CHP systems also eliminate the substantial transmission and distribution losses associated with grid-supplied electricity.

EPA SIP Guidance for Clean Energy Initiatives

EPA Guidance: Emission Reductions from Clean Energy Initiatives

- Guidance on State Implementation Plan for Emission Reductions from Electric-Sector Energy Efficiency and Renewable Energy Measures (August 2004)
  - Four steps for quantification
  - Statements regarding criteria:
    - Enforceable
    - Quantifiable
    - Surplus
    - Permanent

Conclusions

Conclusions

- EE & Clean Energy programs are part of the solution to reduce NOx emissions on HEDDs
  - Meaningful emission reductions
  - Cost effective
  - Established policy mechanisms and technologies

- EPA Guidance allows for inclusion of Clean Energy in SIPs
  - Forthcoming "Clean Energy Options for Addressing High Electric Demand Day Emissions" will be available at www.epa.gov/cleanenergy/stateandlocal

- Continued EPA support to provide tools to ease quantification efforts

Many Places to Look for More Information and Assistance

Clean Energy Environment
STATE PARTNERSHIP

energy
ENERGY STAR

CHP
EPA COMBINED HEAT AND POWER PARTNERSHIP

EPA
GREEN POWER PARTNERSHIP

http://www.epa.gov/cleanenergy/

US EPA, US DOE, ISOs, PUCs, Energy Offices,

National and Regional Organizations,

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Appendix

Cross-Cutting Policy Best Practices

Clean Energy Policy Best Practices

- **Energy portfolio standards:** Establish quantitative and enforceable goals for energy efficiency, renewable energy, and/or CHP.
- **Lead by example:** Establish guidelines for government agencies to follow such as building energy performance standards, energy efficiency procurement policies, and renewable energy purchase requirements.
- **Tax incentives:** Promote clean energy investment through personal or corporate income tax credits, tax reductions or exemptions, or tax deductions.
- **Public benefits funds:** Creating clean energy funding mechanisms such as public benefits funds that entail a small per-kWh charge on customer electric bills to fund grants, loans, rebates, technical assistance, and other strategies for enhancing clean energy investment.

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Clean Energy Policy Best Practices

- **Utility incentives:** Develop regulatory structures to promote utility investment in clean energy programs, such as mechanisms for program cost recovery, revenue stability, and performance-based incentives.
- **Standby rates:** Promote utility rate structures that ensure appropriate cost recovery for utilities but preclude practices that inhibit investment in clean DG (e.g., excessive rates for supplying backup power, high standby connection charges, and exit fees).
- **Interconnection requirements:** Establish uniform rules, processes, and technical requirements for connecting DG applications to the grid, ensuring that such requirements are commensurate with the size, nature, and scope of the DG project.
- **Infrastructure development:** Facilitate deployment of technologies that support demand response, such as advanced metering and communications infrastructure, automated load control devices, and energy management systems.

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Clean Energy Policy Best Practices: Resources for Additional Information

- EPA's *Clean Energy-Environment Guide to Action: Policies, Best Practices and Action Steps for States*.
  - Identifies and describes 16 clean energy policies and strategies that states have used to meet their clean energy objectives.
  - Web site: http://www.epa.gov/cleanenergy/stateandlocal/guidetoaction.htm.
- *National Action Plan for Energy Efficiency,* facilitated by EPA and DOE.
  - A plan developed by more than 50 leading organizations in pursuit of energy savings and environmental benefits through electric and natural gas energy efficiency.
  - Web site: http://www.epa.gov/cleanenergy/actionplan/eeactionplan.htm.

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Clean Energy Options for Addressing High Electric Demand Day Emissions

Energy Efficiency Program Best Practices

- ENERGY STAR New Homes
  - Description: Program sponsor works with builders to promote construction of homes earning the ENERGY STAR label (20-30% more energy-efficient than prevailing code in some areas), as verified by an independent HERS rater.
  - Strategies: Capacity-building for HERS rater infrastructure, builder sales training, marketing to stimulate demand for ENERGY STAR homes, builder incentives.
  - Results:
    - Peak demand reduction: ~1 kW/home
    - Cost-effectiveness: ~$0.01-0.08/kWh
    - Additional information at: www.energystar.gov/homes

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Energy Efficiency Program Best Practices

- Home Performance with ENERGY STAR
  - Description: Home improvement contractor-driven program that provides a comprehensive assessment of energy efficiency opportunities in existing homes.
  - Strategies: Contractor training in conducting whole home performance assessments and improvements, contractor oversight, marketing support, incentives and/or assistance with homeowner financing of energy efficiency improvements.
  - Results:
    - Peak demand reduction: ~1.6 kW/home
    - Cost-effectiveness: ~$0.05/kWh
    - Additional information at: www.energystar.gov/homeperformance

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Energy Efficiency Program Best Practices

- Quality HVAC Installation & Maintenance
  - Description: Contractor-driven program promoting industry best practices for HVAC installation and maintenance (e.g., ACCA HVAC spec). Participating contractors meet the standards by ensuring proper equipment sizing, refrigerant charge, airflow over the indoor coil, and minimization of duct air leakage.
  - Strategies: Contractor training and performance oversight, contractor incentives and marketing assistance.
  - Results:
    - Peak demand reduction: ~0.2-0.7/kW/home
    - Cost-effectiveness: ~0.03-0.04/kWh

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Energy Efficiency Program Best Practices

- Appliance Retirement & Recycling
  - Description: Remove old, inefficient refrigerators, freezers, and room air-conditioners from the grid and ensure they are not put back on the secondary market.
  - Strategies: Turnkey implementation outsourced to an appliance recycling company, free pickup, customer incentives, consumer education on the costs of running old, inefficient appliances.
  - Results:
    - Peak demand reduction: ~0.16-0.4/kW per unit
    - Cost-effectiveness: ~0.03-0.05/kWh

Energy Efficiency Program Best Practices

- PC Power Management
  - Description: Education and technical assistance programs that promote power management for CPUs and monitors in commercial office buildings.
  - Strategies: Consumer education, technical assistance, technical support, incentives for implementing network-wide power management software/protocols.
  - Results:
    - Peak demand reduction: ~1/kW per 120 PCs
    - Cost-effectiveness: ~0.01-0.02/kWh
    - Additional information at: www.energystar.gov/powermanagement

Energy Efficiency Program Best Practices

- Commercial Lighting, Cooling, & Refrigeration
  - Description: Prescriptive programs that provide standard incentives covering a portion of the incremental cost of installing energy-efficient technology.
  - Strategies: Program marketing via trade allies (lighting & HVAC contractors, equipment vendors); simple, straightforward incentive process.
  - Results:
    - Peak demand reduction:
      - Small commercial market: ~0.6-7 kW/participant
      - Large C&I market: ~20-200 kW/participant
    - Cost-effectiveness:
      - Lighting: $0.005-$0.02/kWh
      - HVAC: $0.01-$0.06/kWh

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Energy Efficiency Program Best Practices

- Commercial Whole Building Performance
  - Description: Custom incentive programs promoting a comprehensive approach to energy efficiency improvement in commercial buildings.
  - Strategies: Energy benchmarking with EPA's Energy Performance Rating System, walk-through energy audits, technical assistance (energy modeling, feasibility studies), custom incentives based on energy savings.
  - Results:
    - Peak demand reduction: ~16-600 kW/participant
    - Cost-effectiveness: ~$0.01-0.04/kWh
    - Additional information at: www.energystar.gov/buildings

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Energy Efficiency Program Best Practices

- Cool Roofs
  - Description: Building codes or incentive programs that promote the use of energy-efficient roofing materials (high reflectance and surface emittance) in commercial buildings.
  - Strategies: Building code mandates, roofer education, training & incentives.
  - Results:
    - Peak demand reduction: ~0.19-0.4 kW per 1000 sq. ft.
    - Cost-effectiveness: ~$0.03-0.11/kWh

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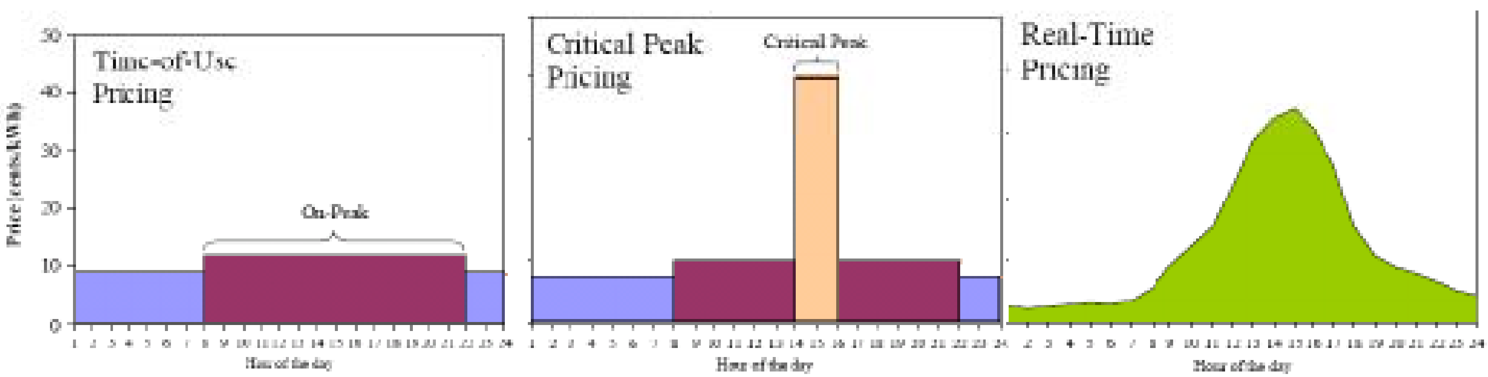
Dynamic Pricing Structures

- **Time of Use (TOU) Pricing:** A TOU rate employs different unit prices for electricity usage and/or demand during different blocks of time throughout a day (e.g., peak, shoulder, and off-peak periods). TOU rates reflect the average cost of generating and delivering power during those time periods.
- **Critical Peak Pricing (CPP):** CPP rates are designed to reduce energy use during extreme peaks, where the customer receives advance notice of a CPP event and is subject to a rate 3-5 times higher than the usual peak price during the CPP period.
- **Real Time Pricing (RTP):** RTP rates fluctuate hourly to reflect changes in the wholesale price of electricity. RTP prices are typically known to customers on a day-ahead or hour-ahead basis.



Source: Federal Energy Regulatory Commission (August 2006). *Assessment of Demand Response and Advanced Metering*

Dynamic Pricing Best Practices

- Customers need access to information about rate changes in a timely manner.
- Under all structures but particularly for CPP and RTP rates, customers must be capable of responding to price changes, with automated load control systems facilitating demand response.
- Advanced metering infrastructure must be installed to provide hourly consumption data.
- Dynamic pricing and demand response incentive programs can complement each other and reinforce demand reduction objectives:
  - Wide-scale implementation of time-based rates reduces the severity or frequency of reserve shortages, in turn reducing the need for mandatory curtailments and customer risk.

Best Practices for Promoting CHP

- Ensure equitable utility rate structures for grid-connected CHP (prohibit high standby connection charges, exit fees, and excessive rates for backup power).
- Establish standardized interconnection requirements that are commensurate with system size.
- Develop long-term financial incentives and/or procurement contracts to decrease the risks associated with investment in CHP and other clean DG applications, and support market development by assuring project developers of a viable revenue stream.
- Institute collaborative forums for state agencies, utilities, and regional grid operators to develop policy approaches to promote clean DG as a strategy for meeting grid capacity requirements.
- Open a generic PUC docket to explore the potential of targeted clean energy solutions to address grid congestion and utility-proposed grid upgrades and/or new power plants.

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Best Practices for Promoting Solar PV

- Incentives and financing mechanisms to offset the high cost of solar PV installations.
- Incentives based on energy production ($/kWh) promote optimal system performance.
- Consumer education and technical assistance:
  - Training & certification for solar installers to ensure quality installations.
  - Information to educate consumers and overcome risk perceptions.

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