Appendix 8P

Avoided Nitrogen Oxide Emissions from Energy Efficiency on High Electric Demand Days in Connecticut
A Preliminary Analysis

Resource Systems Group, Inc.

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PREFACE

This report and analysis were prepared by Colin High and Kevin Hathaway of Resource Systems Group under contract to DJ Consulting LLC. The work was conducted with the financial support of the Clean Energy/Air Quality Integration Initiative of the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

Resource Systems Group (RSG) wishes to thank staff from the Connecticut Department of the Environment (DEP) who provided extensive input to the avoided emissions analysis included in this report. The analysis of the energy savings from energy efficiency measures was provided Alden Hathaway and John Kunz of Environmental Resources Trust (ERT). The results of that work have been provided to DEP in a separate memorandum titled "Energy Efficiency Analysis for the Connecticut Department of Environmental Protection to Estimate Energy Savings from End-Use Energy Efficiency Measures by Connecticut Electric Utilities." In addition, we appreciate the review and comments on earlier work for this report provided by Debra Jacobson of DJ Consulting LLC, and Alden Hathaway of ERT. We also thank the staff of the Connecticut Light and Power Company and United Illuminating Company who provided publicly available reports and data used in the analysis.

LIST OF ACRONYMS

CEM	Continuous Emission Monitors
DEP	Connecticut Department of Environmental Protection
DOE	U.S. Department of Energy
EE	Energy Efficiency
EGU	Electric Generating Units
EPA	U.S. Environmental Protection Agency
HEDD	High Electric Demand Day
kWh	Kilowatt-Hour
ISO	Independent System Operator
MWh	Megawatt-Hour
NAAQS	National Ambient Air Quality Standards
NO_x	Nitrogen Oxides
RSG	Resource Systems Group, Inc
SIP	State Implementation Plan

1. INTRODUCTION AND PURPOSE OF THE REPORT

The purpose of this report is to provide an estimate of the avoided nitrogen oxide (NO_x) emissions that result from savings in electric power generation from electric energy efficiency (EE) on High Electric Demand Days (HEDD) in Connecticut. This report is designed to help the Connecticut Department of the Environment (DEP) quantify the avoided NO_x emissions resulting from electric EE savings. Specifically, this work is intended to support the development of the State Implementation Plan to implement requirements under the Clean Air Act to attain the 8-hour ozone standard.

The report provides a retrospective evaluation of the avoided emissions from four electric EE and load reduction measure types in 2005 and 2006 undertaken under programs administered by Connecticut Light and Power Company and the United Illuminating Company in Connecticut. These four measures types are part of an array of EE programs that have been evaluated by Environmental Resources Trust and are described in their report to the DEP.[1] The measure types included in the ERT report and our related avoided emissions analysis are as follow: commercial and industrial lighting, commercial and industrial cooling, residential lighting and residential cooling. All of these measures will impact electric generation within Connecticut.

2. THE CONNECTICUT POWER MARKET

Connecticut is part of the ISO New England Power Market Area (ISO NE). However, on HEDDs, the marginal power units and the demand response programs (DRP) that are affected by the operation of EE measures are principally in Connecticut, and particularly within the Southwest Connecticut load pocket (SW CT) – an area that is somewhat isolated from the rest of the ISO. The analysis is focused on the response to EE within SW CT area. In this analysis, the import and export of power is not considered.

3. ANALYTICAL METHODOLOGY

The analysis objective was to determine the average hourly avoided NOx emissions that result from a specific amount of EE saving in SW CT. The four EE measures analyzed are as follows:

(1) Commercial and Industrial Lighting – mainly fluorescent and high intensity lights

(2) Commercial and Industrial Cooling – mainly air conditioning

(3) Residential Lighting – mainly compact fluorescent lights

4) Residential Cooling – mainly air conditioning.

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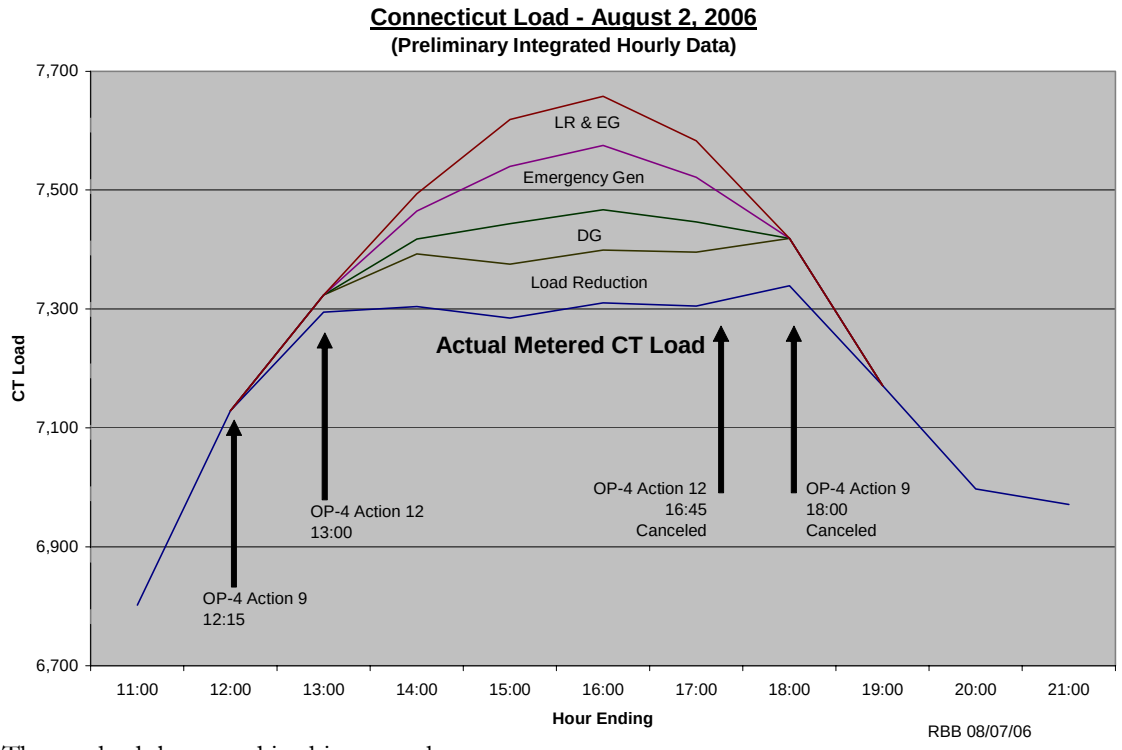
[1] Environmental Resources Trust, "Energy Efficiency Analysis for the Connecticut Department of Environmental Protection to Estimate Energy Savings from End-Use Energy Efficiency Measures by Connecticut Electric Utilities." Memorandum prepared for the Connecticut DEP with the support of the US DOE Clean Air /Air Quality Integration Initiative. March 2007.

For each of these measures, ERT provided hourly profiles of electric EE savings for typical summer days. These hourly profiles enabled us to match the EE savings for each measure against the hourly marginal fossil fueled generation that was serving the area for a sample of three days. The original intention of the project was to analyze a larger number of HEDDs. However, problems in obtaining the hourly data on both grid generation and DRP program generation for specific days limited the scope of the study. The three days analyzed were August 2, 2006 and July 26, 2005, which were both the highest HEDD in each year and June 4, 2005, which was a typical summer day (but not a HEDD).

A HEDD electric demand profile is shown in Figure 1.

Figure 1: Load Components on a Typical HEDD with DRP



The methodology used in this report has two parts.

Part 1 Grid Connected Units: The first part analyzes the emissions from the grid connected units which are the on the margin on the HEDD. The method used is the time-matched and generation-weighted average of the emissions of plants that are dispatched to meet changing demand. For a description of this method refer to the report prepared for the Metropolitan Washington Air Quality

Committee[2]. This methodology is a refinement of the generation-weighted average approach which was used in the New Jersey avoided emissions study. The first step determines the grid connected generation displaced by EE for each HEDD. In this case, the displacement occurs primarily at peaking units. The NRG Devon units were identified as typical displaced units.

Unit-level generation is estimated using the hourly carbon dioxide (CO_2) emissions from the continuous emissions monitors (CEMs) required by EPA for each fossil-fueled electric generating unit (EGU). Hourly NO_x emissions for each fossil-fueled EGU are also derived from CEM data or for typical units of this type as CEM NOx data was not complete for the NRG Devon units on the days analyzed. Estimated avoided emissions for each hour are based on a generation-weighted average of the units operating at that time

The hourly, average avoided emissions rates for NO_x (lbs/MWh) for grid connected units are shown in Figure 2. .

Figure 2: Hourly Avoided NOx Emissions for the NRG Devon Units 26 July 2005 and 4, June 2005

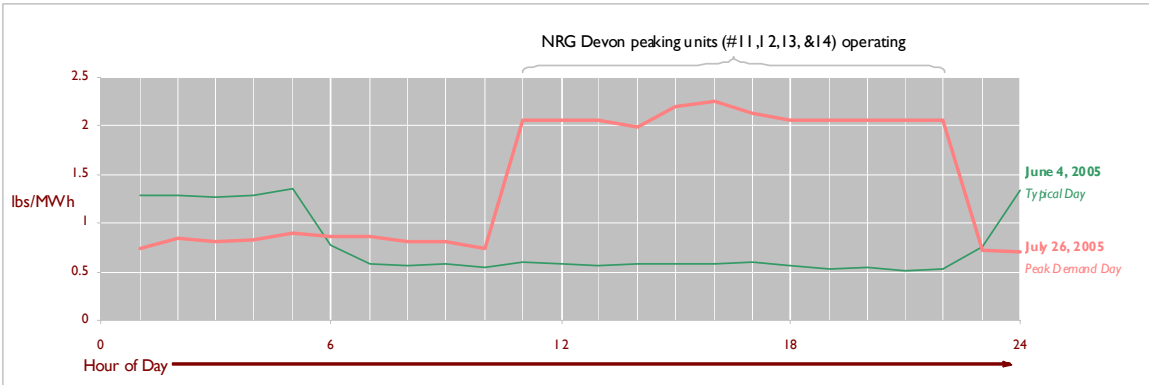


Figure 2 reveals that on July 26, which is a HEDD, the NRG Devon units were operating with high NOx emission rates during the peak period. However, on June 4 -- which is not a HEDD -- the peaking NRG Devon units are not operating and daytime NOx rates are much lower.

Part 2 Demand Response Program Emissions: The composition of the DRP load shown in Figure 1 based on data provided by ISO NE. The DRP is composed of a combination of actual load reduction (LR) by customers and additional emergency generation (EG) by customers by "behind the meter" generators. There is relatively little specific data available to us on either the type of generators or the amount of power generated as a percentage of the total LR and EG. Estimates

[2] RSG Inc, Avoided Emissions from Energy Efficiency and Renewable Electric Power Generation in the PJM Interconnection Power Market Area for the Metropolitan Washington Council of Governments, Air Quality Committee, with the support of the US DOE Clean Air /Air Quality Integration Initiative. March 2007.

received from the load-serving entities in CT and from the DEP range from 50% to 80% generation from DRP on HEDDs. In order to be conservative, we used the 50% figure where it was applicable. The emission rates for units in the DRP are based on typical emission rates for the types of units known to be in the DRP. These typical emission rates were provided by DEP and are included in the Excel Workbook which has been submitted to DEP as a supplement to this report.

4. RESULTS OF THE ANALYSIS

The results presented here for the two HEDDs are based on information from the DRP load profile in Figure 1 and a detailed analysis of the grid connected units based on data shown in Figure 2. The results are shown in Table 1. The analysis for 4 June 2005 is based on grid connected units because the DRP program was not operating. Based on an analysis of these three days, we estimated the summer NOx reductions from 610 MWh of EE savings over a 24-hour period. the EE programs analyzed represent about 66% of the total energy efficiency programs administered by the two utility companies. These estimates include reductions at grid connected units (mainly oil fired) and the emergency demand response program on the highest peak demand day. The emergency demand response program includes reductions at "behind the meter" generators. Price response programs are not included. The results for 8/2/2006 and 7/26/2005 in Table1 and Table 2 are the same because data from the two dates were merged in the analysis.

Table 1: SW CT HEDD NOx Reductions Estimates from EE Savings Programs

Day	EE Energy Savings (MWh)	Grid Unit NOx Reductions (lb/24 hours)	DRP Generation NOx Reductions (lb/24 hours)	Total NOx Reductions (lb/24 hours)
8/2/2006	610	2,952	3,350	6,302
7/26/2005	610	2,952	3,350	6,302
6/4/2005	610	397	0	397

In addition to the analysis described above, we also have also applied the same analytical approach to an EE energy savings estimate that was based on the IPM-TRUM model which was provided by Art Diem of EPA. This model has been used by EPA to make estimates of the possible avoided emissions from EE programs in States in the Ozone Transport Region. RSG did not make an independent evaluation of the EE savings from the IPM-TRUM model. We relied on the estimates of daily EE savings from the model and assumed they had the same hourly profile used in the EE savings analysis provided in the ERT report for the four EE measures.

The results of this analysis of the IPM-TRUM derived EE savings are shown in Table 2 below.

Table 2: SW CT HEDD NOx Reductions Estimates from EE Estimates Using the IPM-TRUM Model

Day	EE Energy Savings (MWh)	Grid Unit NOx Reductions (lb/24 hours)	DRP Generation NOx Reductions (lb/24 hours)	Total NOx Reductions (lb/24 hours)
8/2/2006	1,497	7,240	8,214	15,453
7/26/2005	1,497	7,240	8,214	15,453
6/4/2005	1,497	4,591	0	4,591

The IPM-TRUM model estimates EE electric savings at 1.5% of Connecticut electric demand. This results in daily estimated savings of 1,497 MWh per day compared to 610 MWh per day using the savings estimates from the utility programs in the ERT report. As a result the avoided NOx emissions are correspondingly higher.

Overall we believe that the estimates in Table 1 based on the four EE measures may be too low as there are other EE programs that could increase the estimate electric EE savings by up to about 33%. The addition of the price response program to the analysis may also produce a small increase in reductions on some days. However, data from these days were not analyzed.

5. LESSONS LEARNED FROM THE STUDY

The results of the avoided emissions analysis should be used with caution. The electric savings from the four EE measures are based upon well established methods and reliable data so that they can be used with some confidence. However, data on the grid connected units, their generation and their emission rates have required considerable interpretation and estimation. Many of the smaller grid units used on HEDDs do not have CEM NOx records. Hourly generation records are also not available.

Data on the DRP overall load reduction and generation programs from the ISO NE is adequate but data on individual units was not available. Some of the necessary data on generation is kept by the ISO, as shown from the one day of records which were provided in Figure 1. The data on both generation and the type of units is known to the utilities and/or their customers.

If the data problems can be overcome considerable benefits can be obtained as it appears from this preliminary analysis that EE measures have the potential to make significant reductions in HEDD NOx emissions. Other information indicates that these EE savings also result in cost savings to customers. Further co-operation on data availability between the DEP, ISO New England, the utilities and their customers should make it possible to demonstrate and credit these avoided emissions. This would be very beneficial to all parties and the public interest in clean air.