Air Quality Impacts of Diesel Generators Participating in Electricity Peak Shave and Demand Response Programs

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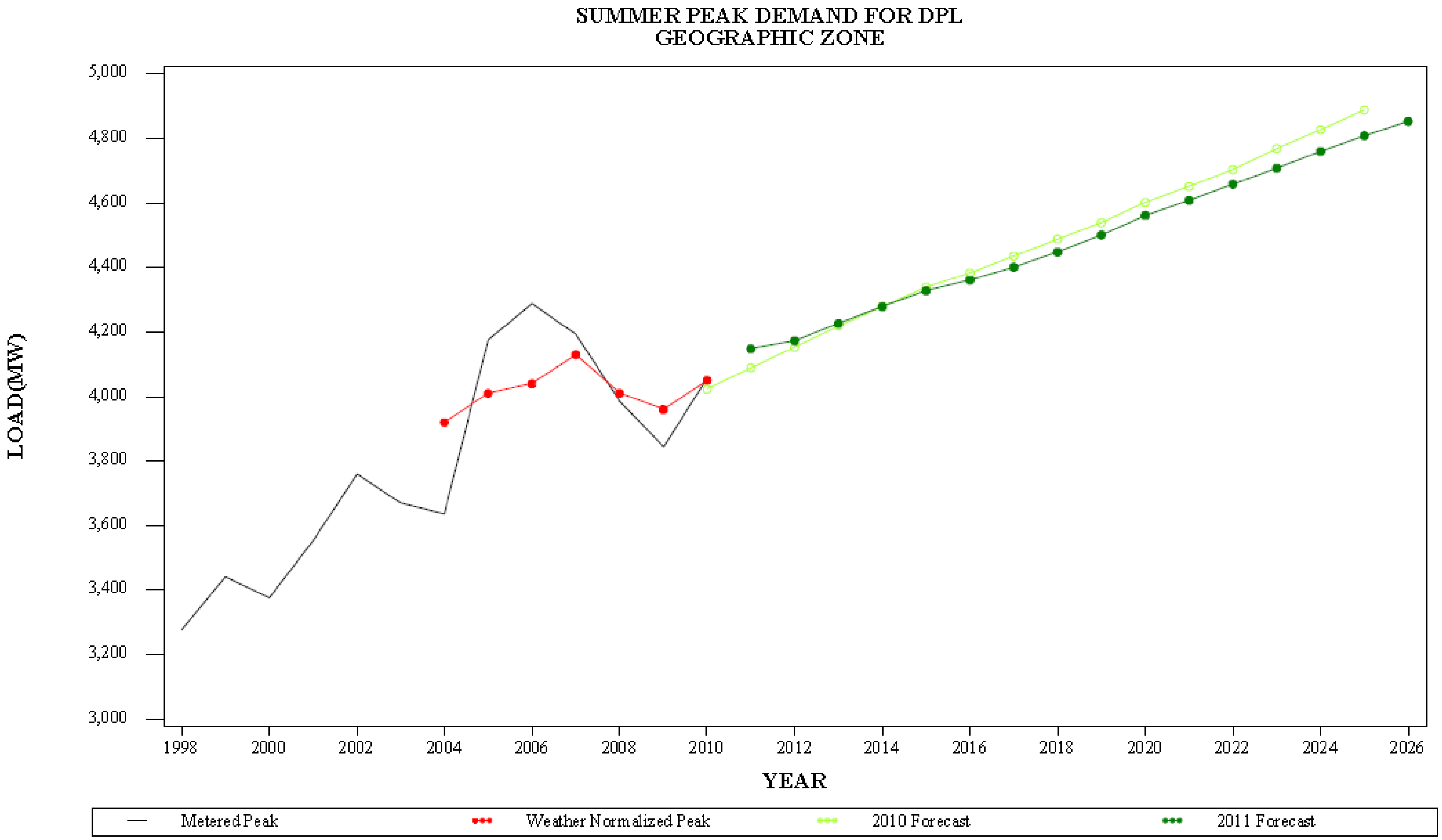
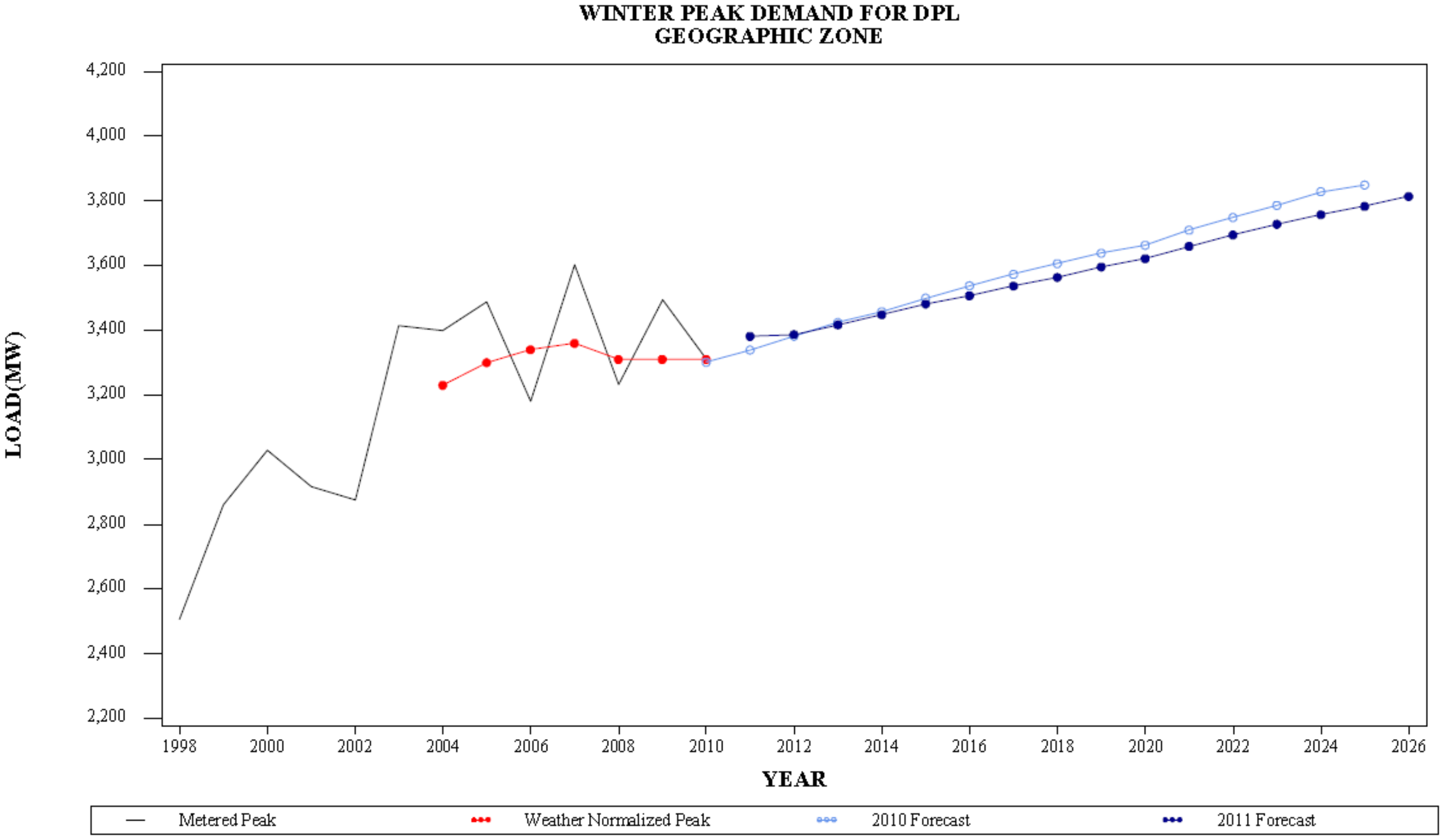
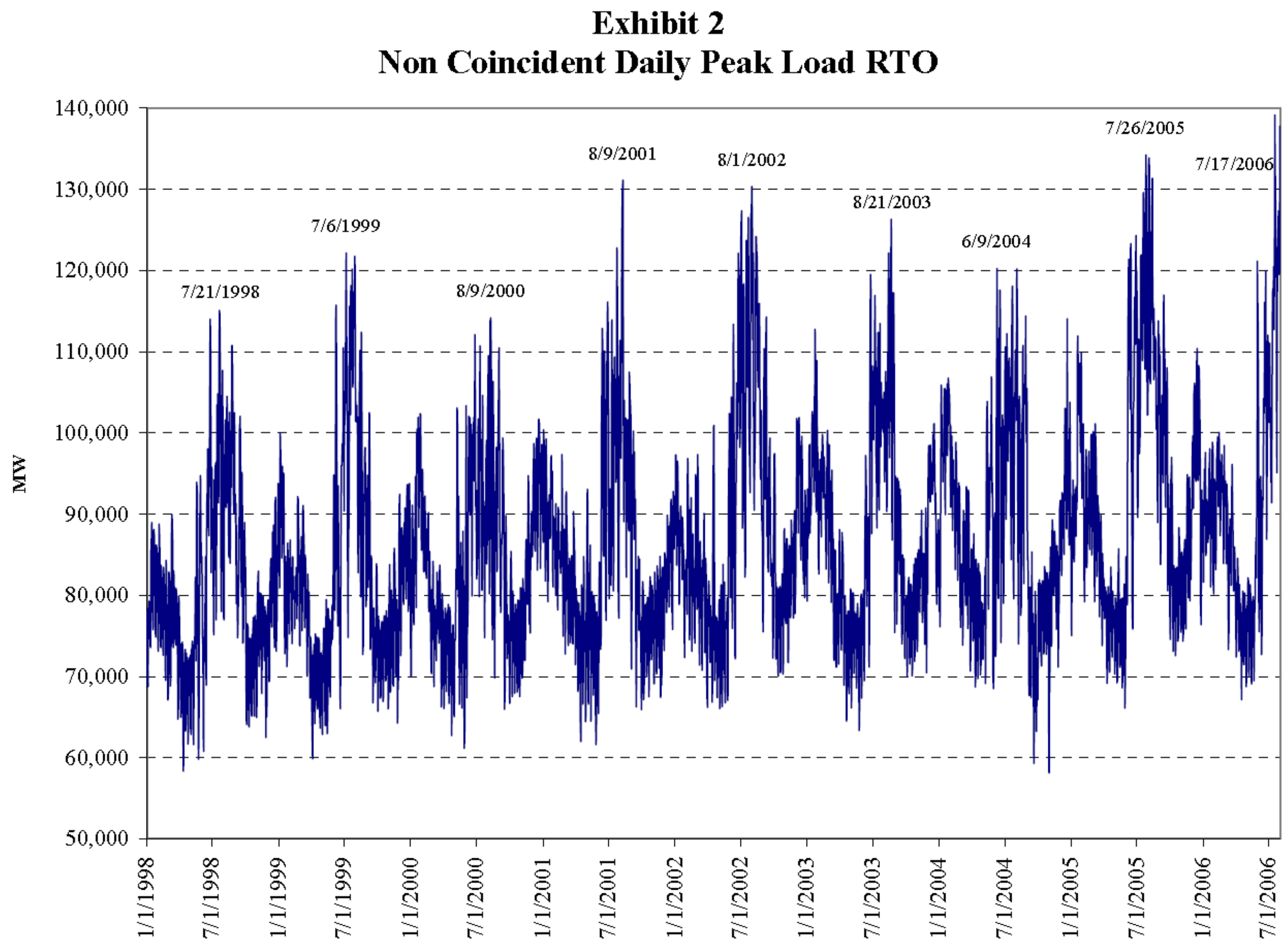
Summer Peak Demand Forecast



Winter Peak Demand Forecast



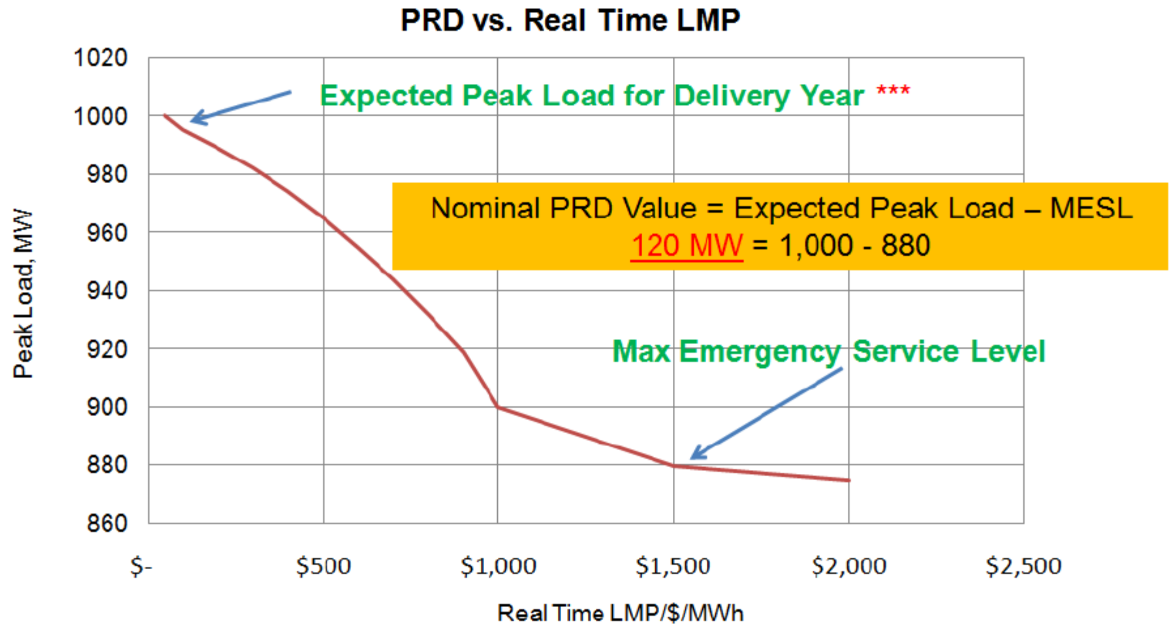
Load Not Constant



The Brattle Group, December 5, 2006

Price During Peak Load Can Be 10 to 20 Times Higher Than Normal

The graph below shows an example of a Price Consumption Curve with an MESL set greater than $1,000./MWh



****determined consistent with the 50/50 load forecast that is the input to RPM Auction*

Diesel Generators to the Rescue

- Estimates of installed diesel generator capacity in the United States range as high as 350,000 units totaling more than 127 Gigawatts (GW)

Northeast States for Coordinated Air Use Management, June 2003

Generate New Payments for Your Business

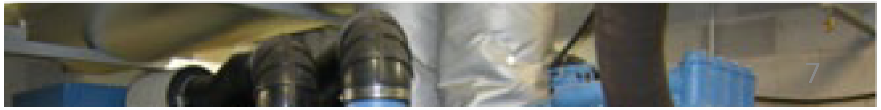
Through EnerNOC and Demand Response

If your business has a generator set, you may qualify for a simple and lucrative opportunity to be paid to run your generator. Demand response programs pay businesses to switch to on-site generation when the electrical grid experiences spikes in demand or shortages of supply, typically for just a few hours per year. Demand response participants earn substantial payments, increase the reliability of the electrical grid, and get advanced notice of irregular conditions on the grid.

By enrolling in demand response with EnerNOC, you will join the world's largest "virtual power plant," a network of more than 10,000 energy users worldwide. You will also enjoy a range of benefits.

EMERGENCY PREPAREDNESS

What would you do if you knew there would be a blackout in two



Behind-the-Meter Generation is <u>Not</u> DR

What is Demand Response?

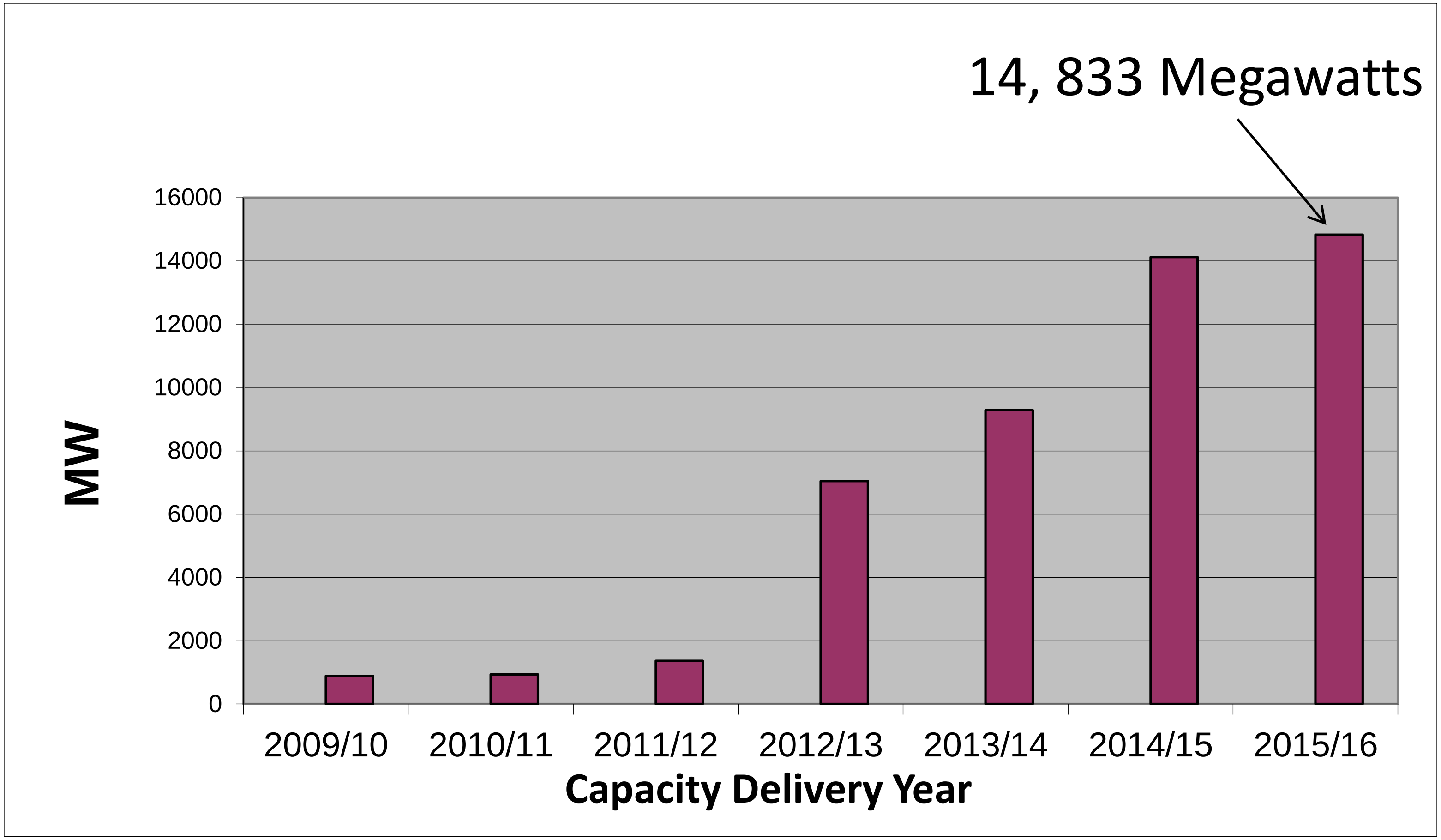
“Demand response means a reduction in the consumption of electric energy by customers from their expected consumption in response to an increase in the price of electric energy or to incentive payments designed to induce lower consumption of electric energy.” (FERC National Action Plan on Demand Response, June 17, 2010, emphasis added)

Delaware Regulations define Emergency

- an electric power outage due to: a failure of the electrical grid; on-site disaster; local equipment failure; or public service emergencies such as flood, fire, natural disaster, or severe weather conditions (e.g., hurricane, tornado, blizzard, etc.); or
- when there is a deviation of voltage or frequency from the electrical provider to the premises of 3% or greater above, or 5% or greater below, standard voltage or frequency.

7 DE Admin Code 1144 – Control of Stationary Generator Emissions

DR Has Grown Dramatically in PJM



Scale of DR in PJM Raises Issues

- 14,000 Megawatts (14 Gigawatts) is just under 10% of PJM's total capacity requirement
- It is roughly equivalent to 28 large-scale new power plants
- We don't know how much of this is actually BTM generation instead of real DR, but some estimates suggest it could be up to 50% (i.e. 7,000 MW)
  – Why isn't there more transparency?

16 cyl MAN Diesel generator_3

http://www.youtube.com/watch?v=lfOJPV369-U

Air Quality Impacts

- Modeled impact from a single unit using AERSCREEN with the following assumptions:
  - Emission rate: 4.15 lbs/hr Nox
  - NOx to NO2 conversion PVMRM @ 10%
  - Ozone concentration 40 ppb
  - Stack Height 5.5 ft
  - Stack diameter 0.58 ft
  - Exit flow rate 1250 cfm
  - Exit Temperature 900 F

Emissions Characterization

Pollutant	Emission Estimates In lbs/MWh
Nitrogen Oxides	41.5
Carbon Dioxide	1541
Particulate Matter	3
Carbon Monoxide	8.95

AP-42 Chapter 3

National Ambient Air Quality Standards

Pollutant [final rule cite]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide [76 FR 54294, Aug 31, 2011]		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]		primary	1-hour	100 ppb	
		98th percentile, averaged over 3 years			
primary and secondary	Annual	53 ppb [(2)]	Annual Mean		
Particle Pollution [71 FR 61144, Oct 17, 2006]	$PM_{2.5}$	primary and secondary	Annual	15 µg/m^3	annual mean, averaged over 3 years
			24-hour	35 µg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years

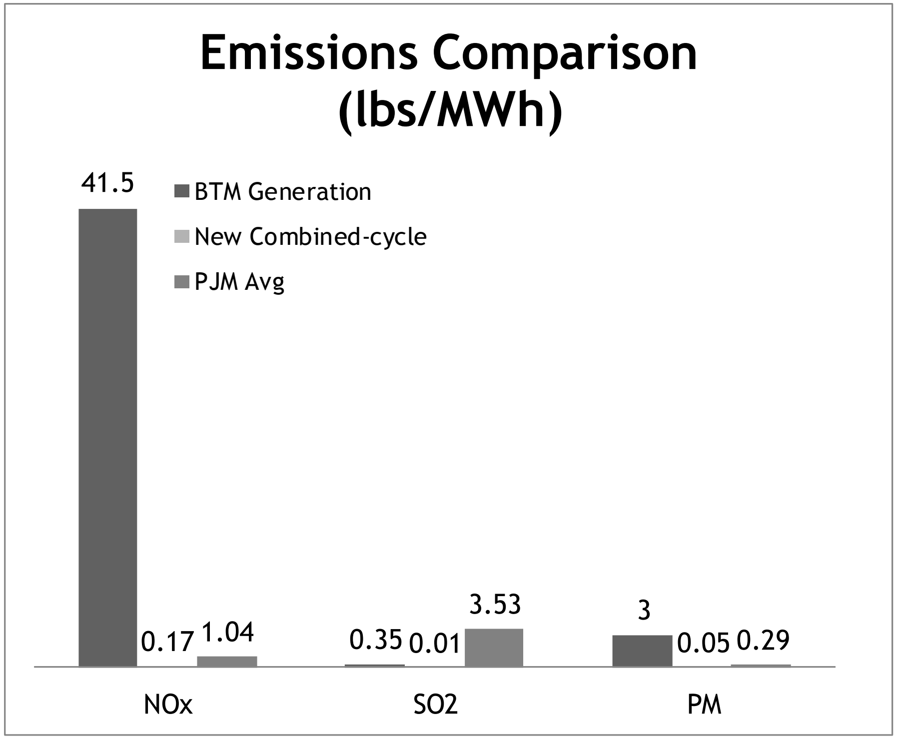
Analysis of Results

- Emissions from a single engine will likely exceed 1-hour NO_2 NAAQS considering background;
- Emissions from multiple units in close proximity violates NAAQS for NO_2 regardless of background;
- Emissions from a single engine will likely violate the daily $PM_{2.5}$ standard considering background;
- Emissions from multiple units in close proximity violate the daily $PM_{2.5}$ NAAQS regardless of background;
- CARB's estimate of 3 EE–4 (ug/m3)–1 means that a person exposed to a concentration of 1 ug/m3 of diesel PM has a 3 per 10,000 chance of contracting cancer in their lifetime.

Additional Impacts

- Most PJM DR is called upon during peak-day conditions, often during periods of poor air quality.

- BTM DR engines have limited operating hours, but a real impact is that they displace cleaner capacity resources that would provide significant clean air benefits to the PJM region and beyond.



PJM System Mix - Year: 2011 - System Mix By Fuel

(Contribution to 1 MWh of System Mix emissions from each Fuel in lbs/MWh)

Year	Fuel	# of Certificates	Percentage by Fuel	Carbon Dioxide	Nitrogen Oxides	Sulphur Dioxides
2011	Biomass - Other Biomass Liquids	1,218	0.0002	0.0036	0.0000	0.0001
2011	Biomass - Other Biomass Solids	151	0.0000	0.0004	0.0000	0.0000
2011	Captured Methane - Coal Mine Gas	35,683	0.0047	0.0529	0.0000	0.0000
2011	Captured Methane - Landfill Gas	1,900,988	0.2520	0.5513	0.0031	0.0006
2011	Coal - Bituminous and Anthracite	306,606,057	40.6459	829.2815	0.7555	2.8897
2011	Coal - Sub-Bituminous	39,908,807	5.2906	121.0559	0.1408	0.2939
2011	Coal - Waste/Other	11,325,594	1.5014	36.3437	0.0270	0.1542
2011	Gas - Natural Gas	104,414,727	13.8420	133.1639	0.0283	0.0039
2011	Gas - Other	44,847	0.0059	0.0625	0.0001	0.0000
2011	Hydro - Conventional	8,244,316	1.0929	0.0000	0.0000	0.0000
2011	Nuclear	262,812,146	34.8402	0.0000	0.0000	0.0000
2011	Oil - Distillate Fuel Oil	318,827	0.0423	0.9408	0.0027	0.0023
2011	Oil - Jet Fuel	56	0.0000	0.0002	0.0000	0.0000
2011	Oil - Kerosene	11,178	0.0015	0.0385	0.0001	0.0000
2011	Oil - Petroleum Coke	675,787	0.0896	1.8446	0.0033	0.0058
2011	Oil - Residual Fuel Oil	1,889,914	0.2505	4.7251	0.0067	0.0079
2011	Other	147	0.0000	0.0004	0.0000	0.0000
2011	Solar - Photovoltaic	59,307	0.0079	0.0000	0.0000	0.0000
2011	Solid Waste - Municipal Solid Waste	4,013,792	0.5321	17.7756	0.0667	0.1723
2011	Solid Waste - Tire Derived Fuel	7,607	0.0010	0.0367	0.0000	0.0000
2011	Wind	11,033,926	1.4627	0.0000	0.0000	0.0000
2011	Wood - Black Liquor	451,360	0.0598	0.1504	0.0009	0.0026
2011	Wood - Wood/Wood Waste Solids	578,595	0.0767	0.0004	0.0023	0.0003
Total		754,335,030	100.0000	1,146.0283	1.0375	3.5337

Climate Change Considerations

- CO_2 emission rate per MW of generation for diesel generators are roughly twice that of a modern combined cycle electric generating unit.
- Diesel generators compare even less favorably with renewable sources of generation and fuel cells.

Emissions Standards

- Emergency generators:
  - Existing – no actual emissions limits; just follow manufacturers maintenance and operating requirements/instructions.
  - New – generator must meet the emissions standards set by the US EPA in the New Source Performance Standards for engines.

Feasible Emission Controls and Cost

Regulatory Scenario			HP Range				
			50-174	175-749	750-1206	1207-1999	>2000
	Average Horsepower:		112	462	978	1604	2630
Scenario 1: DPF Retrofit of Tier 2/3 engine	Cost Increase Due to Controls	PM	$4,300	$17,600	$37,200	$60,900	$99,900
		NOx	N/A	N/A	N/A	N/A	N/A
	Emission Reductions (lbs)	PM	8	33	70	115	189
		NOx	N/A	N/A	N/A	N/A	N/A
	Cost Effectiveness ($/lb)	PM	$540	$530	$530	$530	$530
		NOx	N/A	N/A	N/A	N/A	N/A
Scenario 2: DPF/SCR Retrofit of Tier 2/3 engine	Cost Increase Due to Controls	PM	$4,400	$18,200	$38,500	$63,100	$103,400
		NOx	$8,800	$36,300	$76,900	$126,100	$206,900
	Emission Reductions (lbs)	PM	8	33	70	115	189
		NOx	100	413	1456	2280	3740
	Cost Effectiveness ($/lb)	PM	$550	$550	$550	$550	$550
		NOx	$90	$90	$54	$56	$56

Assumptions: Emergency standby engine operates 31 hours per year at 30 percent load; 22 hours for

Source: California Air Resources Board

Long-Term Air Emission Impacts

- DR that clears the PJM capacity auction displaces other resources on a MW-for-MW basis
- The long-term impact is that we are relying on increasing amounts of diesel-based BTM generation instead of cleaner fossil and renewable resources
- Unlike BTM generation, new grid-scale generating capacity (e.g. wind and gas combined-cycle) would tend to operate more frequently, potentially displacing generation from older, dirtier power plants:
  - Diesel-based "DR" is preventing us from being able to capture these significant air quality benefits

Additional Thoughts

- BTM generation essentially operates in the market as peaking capacity. We should call it what it is:
  - Peak Shaving and/or Distributed Generation
- All generation – BTM or otherwise – should be subject to appropriate environmental requirements before they are allowed to bid into the market. Air pollution controls are feasible and cost effective.
- BTM generation has no unique value as a planned reliability resource compared with other forms of generation:
  - PJM will acquire sufficient capacity to ensure reliability, irrespective of technology type. Annual auctions take place three years ahead of delivery year.

Policy Implications

- Are we relying on dirty DR to replace retired coal capacity, instead of providing appropriate market signals to help develop cleaner alternatives?
  - Allowing the use of diesel generators for meeting peak electricity demand will discourage construction of new and cleaner resources
- Only 74% of the DR offered into this year's PJM capacity auction cleared the market:
  - Is BTM generation the "low hanging fruit" in the DR world? Is it displacing opportunities for real DR implementation (in addition to new gas and renewables)?

Policy Implications

- Are we creating “winners” and “losers”? The health costs associated with the air pollution from these sources are significant and are borne by the public while the “private” costs are minimized by avoiding installation of controls.
- Dirty BTM generation is inconsistent with other national efforts to clean diesel pollution such as Diesel Emissions Reductions Act (DERA).
- BTM generation takes incentives away from real DR.
- Aggregating existing emergency backup generators as DR is lucrative, but is it good public policy?


The News
In 2008-2010
4 out of 10 people
in the U.S.A. lived in counties with an
F for air quality
AMERICAN LUNG ASSOCIATION.
Fighting for Air