Watching the Superbowl as a Means to Understand A Community's Energy Use

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ABSTRACT

Limited metering data, coupled with knowledge of concurrent events, can be used to better understand a community's energy use. This insight can then be used as a starting point to develop energy reduction strategies.

INTRODUCTION

Each winter, the Superbowl offers entertainment for its fans and a spotlight for athletes at the top of their professional football careers. But we can use it as a unique opportunity to study patterns of energy use as well. A comparison of power use on the Princeton University campus and the larger Pennsylvania-New Jersey-Maryland (PJM) Interconnection is a source of interesting social commentary and informative energy engineering data.

WATCHING A COMMUNITY'S POWER USE

By observing electric power use during recent Superbowl games, we are able to see how this single event captures the attention of our society. Through the use of simple electric metering data and correlation to key events during the games, it is also possible to infer the collective activities of our community. By careful review of these records and consideration of the larger process, we can begin to understand how and when energy is being used. With that knowledge we are better prepared to identify and eliminate energy waste.

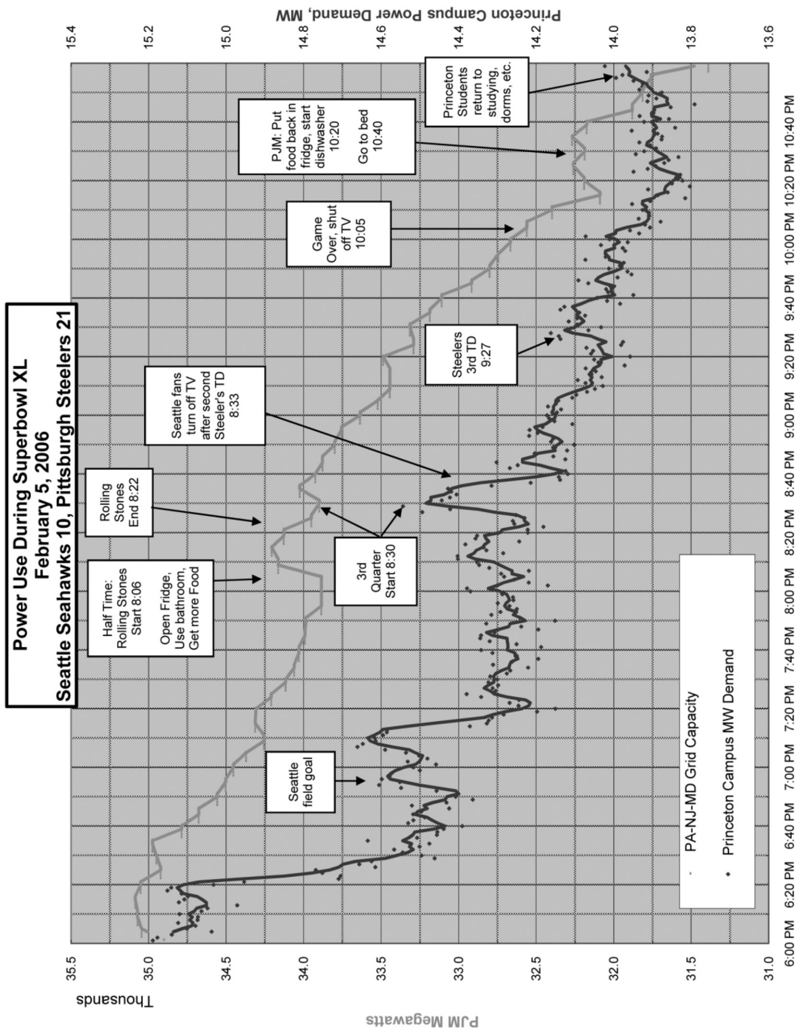
Prior to the start of Superbowl XL in February 2006, Princeton University's main campus power demand was 15,100 kilowatts. Within five minutes of the coin toss, campus power use dropped by 600 kilowatts. This instantaneous drop of nearly 4 percent represents an average reduction of 120 watts for each of the 5000 students who would typically be on campus on a Sunday evening.

What happened? We can easily imagine students shutting off laptops and lights and heading to a common room to sit down and watch the game. At the same time power use in the PJM Interconnection dropped by 129,000 kilowatts.

Shortly after the first points were scored (a field goal by the Seattle Seahawks) and the subsequent commercial break, power use on campus climbed by approximately 200 kilowatts. Off campus it rose by 56,000 kilowatts. Can we guess what happened? Picture millions of people flushing toilets, washing their hands, and then opening refrigerators and starting microwave ovens. Behind the scenes, millions of pumps and compressors ran briefly for a few minutes. As the commercials ended, power use dropped.

At half-time in the tri-state area, power use climbed by 250,000 kilowatts. But on campus it remained steady until half-time was over. Wonder why? Perhaps the students were more interested in the commercials and watching the Rolling Stones than a football game whose outcome had become obvious. People in the rest of PJM territory left the television on but heated up food, ran the dish washer, flushed, washed, opened and closed the refrigerator, and sat back down. Then, when half-time ended and the students were still hungry, they went off to re-heat the nachos, grab a pizza slice, and pour another beer. Power use on campus settled down again about five minutes after the commercials ended.

Patterns of use in 2008 and 2009 were similar. As the game wrapped up, PJM power use rose by a few hundred thousand kilowatts for about 45 minutes and then fell again—just enough time for most of the community to put leftovers in the refrigerator, start the dish washer, take a shower, and head to bed. But as soon as the post-game commentary ended, power use on campus *rose* by 5 percent (800 kilowatts) and returned to steady demand at the same level as five hours earlier, prior to the start of the game. We can easily imagine several thousand students returning to their Sunday night studies.



Power Use During Superbowl XL
February 5, 2006
Seattle Seahawks 10, Pittsburgh Steelers 21
Half Time: Rolling Stones Start 8:06
Open Fridge, Use bathroom, Get more Food
Rolling Stones End 8:22
Seattle fans turn off TV after second Steeler's TD 8:33
3rd Quarter Start 8:30
Steelers 3rd TD 9:27
Game Over, shut off TV 10:05
PJM: Put food back in fridge, start dishwasher 10:20
Go to bed 10:40
Princeton Students return to studying, dorms, etc.
Seattle field goal
PA-NJ-MD Grid Capacity
Princeton Campus MW Demand
Princeton Campus Power Demand, MW
PJM Megawatts
Thousands
6:00 PM
6:20 PM
6:40 PM
7:00 PM
7:20 PM
7:40 PM
8:00 PM
8:20 PM
8:40 PM
9:00 PM
9:20 PM
9:40 PM
10:00 PM
10:20 PM
10:40 PM
35.5
35.0
34.5
34.0
33.5
33.0
32.5
32.0
31.5
31.0
15.4
15.2
15.0
14.8
14.6
14.4
14.2
14.0
13.8
13.6

Figure 1

How can we reduce wasted energy on campus and beyond? We can develop systems that produce and deliver it more efficiently, and we can eliminate unnecessary and inefficient use. Improved efficiency can be developed through steady improvements in technology. But reduction in use involves the use of both efficient equipment and, ultimately, some measure of social change. How do we determine what's being wasted, what our opportunities are, and where to focus our efforts? We need to study patterns of use.

This analysis shows that we can learn a lot with simple tools and careful reasoning. It's typical of the situation faced by many energy reduction studies—an impossibly large task coupled with an apparent lack of useful data. But by recording the output of only two electric meters and superimposing our knowledge of what was happening at the time, we were able to better understand the patterns of power use in our community for a few hours. Can we tell what any individual was doing? Of course not! Can we tell whether Bruce Springsteen is more popular than the Rolling Stones? It's doubtful. But we can begin to understand how the community uses energy. We can confirm these observations with customer surveys and additional measurements. We can already take encouragement from the fact that people do appear to switch off some unnecessary power use when they sit down to watch the game. We can develop methods of communication better targeted at the energy users and their interests. And we can quantify the benefits of those actions to the community when promoting further energy reductions.

CONCLUSIONS

1. You can't manage what you don't measure. Don't guess. Measure it!

2. Use all the instrumentation you've got as creatively as you can.

3. Study energy use closely over time, and you'll learn more than you realize is possible.

4. The better you understand a process and your own customers, the more effective you can be at controlling energy use.

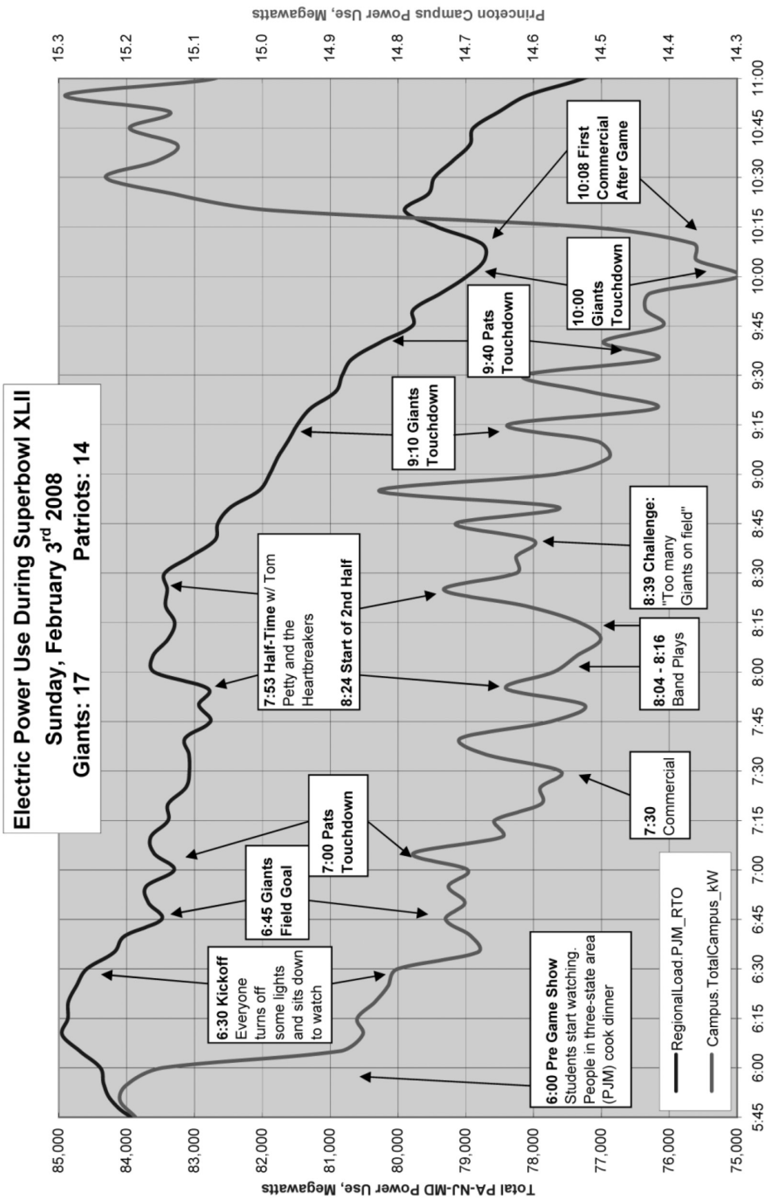
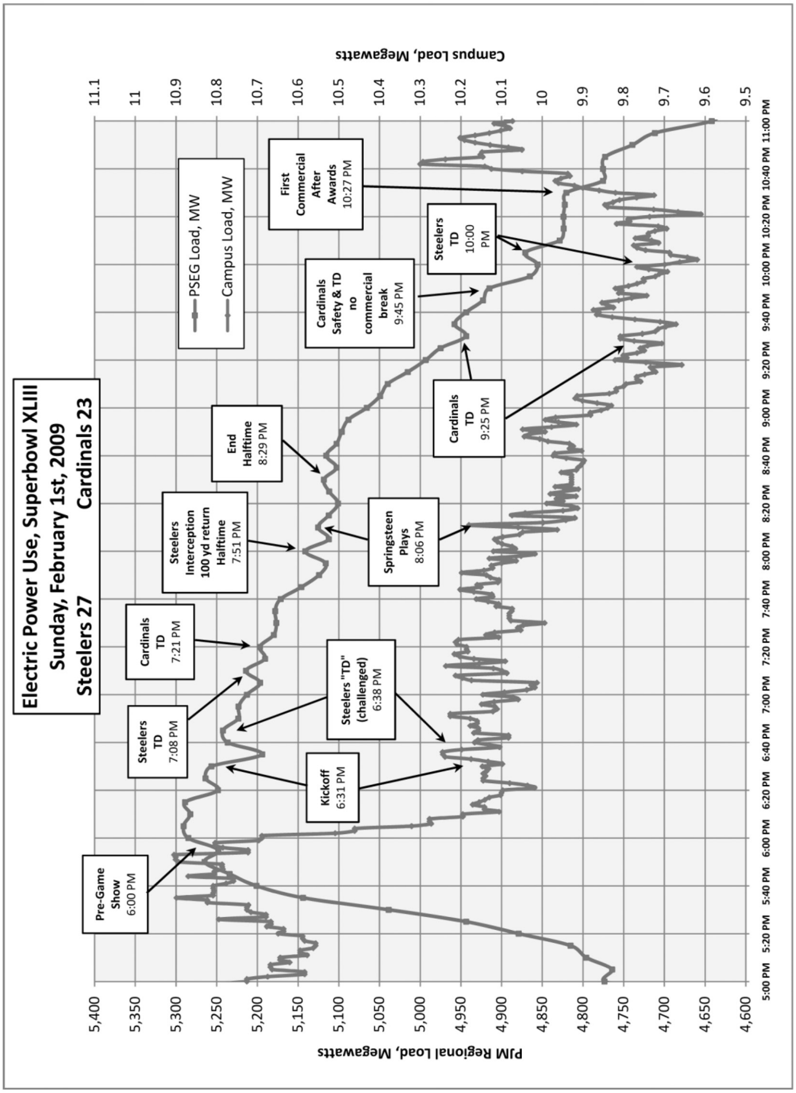

Electric Power Use During Superbowl XLII
Sunday, February 3rd 2008
Giants: 17 Patriots: 14
Total PA-NJ-MD Power Use, Megawatts
Princeton Campus Power Use, Megawatts
85,000
84,000
83,000
82,000
81,000
80,000
79,000
78,000
77,000
76,000
75,000
15.3
15.2
15.1
15.0
14.9
14.8
14.7
14.6
14.5
14.4
14.3
5:45 PM
6:00 PM
6:15 PM
6:30 PM
6:45 PM
7:00 PM
7:15 PM
7:30 PM
7:45 PM
8:00 PM
8:15 PM
8:30 PM
8:45 PM
9:00 PM
9:15 PM
9:30 PM
9:45 PM
10:00 PM
10:15 PM
10:30 PM
10:45 PM
11:00 PM
6:00 Pre Game Show Students start watching. People in three-state area (PJM) cook dinner
6:30 Kickoff Everyone turns off some lights and sits down to watch
6:45 Giants Field Goal
7:00 Pats Touchdown
7:30 Commercial
7:53 Half-Time w/ Tom Petty and the Heartbreakers
8:24 Start of 2nd Half
8:04 - 8:16 Band Plays
8:39 Challenge: "Too many Giants on field"
9:10 Giants Touchdown
9:40 Pats Touchdown
10:00 Giants Touchdown
10:08 First Commercial After Game
RegionalLoad.PJM_RTO
Campus.TotalCampus_kW

Figure 2


Electric Power Use, Superbowl XLIII
Sunday, February 1st, 2009
Steelers 27 Cardinals 23
PSEG Load, MW
Campus Load, MW
PJM Regional Load, Megawatts
Campus Load, Megawatts
Pre-Game Show 6:00 PM
Kickoff 6:31 PM
Steelers TD 7:08 PM
Steelers "TD" (challenged) 6:38 PM
Cardinals TD 7:21 PM
Steelers Interception 100 yd return Halftime 7:51 PM
Springsteen Plays 8:06 PM
End Halftime 8:29 PM
Cardinals TD 9:25 PM
Cardinals Safety & TD no commercial break 9:45 PM
Steelers TD 10:00 PM
First Commercial After Awards 10:27 PM
5,400
5,350
5,300
5,250
5,200
5,150
5,100
5,050
5,000
4,950
4,900
4,850
4,800
4,750
4,700
4,650
4,600
11.1
11
10.9
10.8
10.7
10.6
10.5
10.4
10.3
10.2
10.1
10
9.9
9.8
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10:40 PM
11:00 PM

Figure 3

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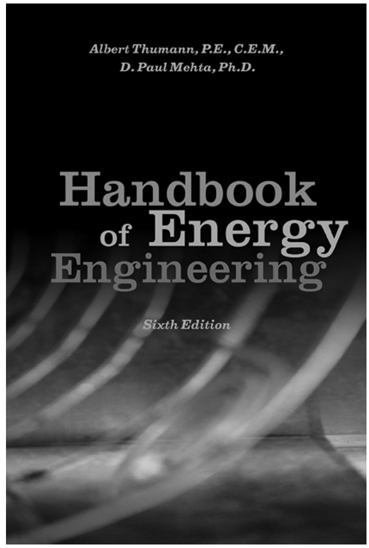

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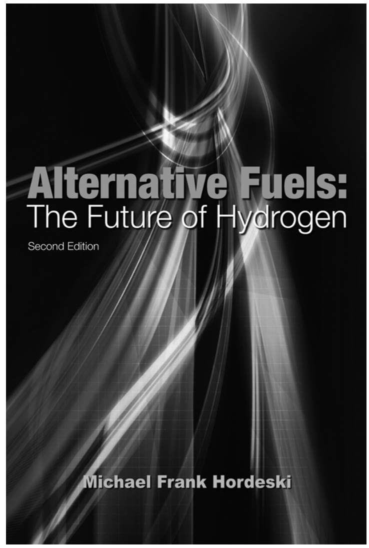

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