Savings at PMCRT will Blow You Away!

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Princess Margaret Cancer Research Tower. Photo Credit

Next in our list of exciting energy endeavors, this blog will discuss huge savings realized by a retrofit to the laboratory exhaust system at the Princess Margaret Cancer Research Tower (PMCRT). The lab exhaust system has been converted from constant speed to demand controlled to ensure more efficient operation. I'll get into all the super interesting details below, but the best part is the savings

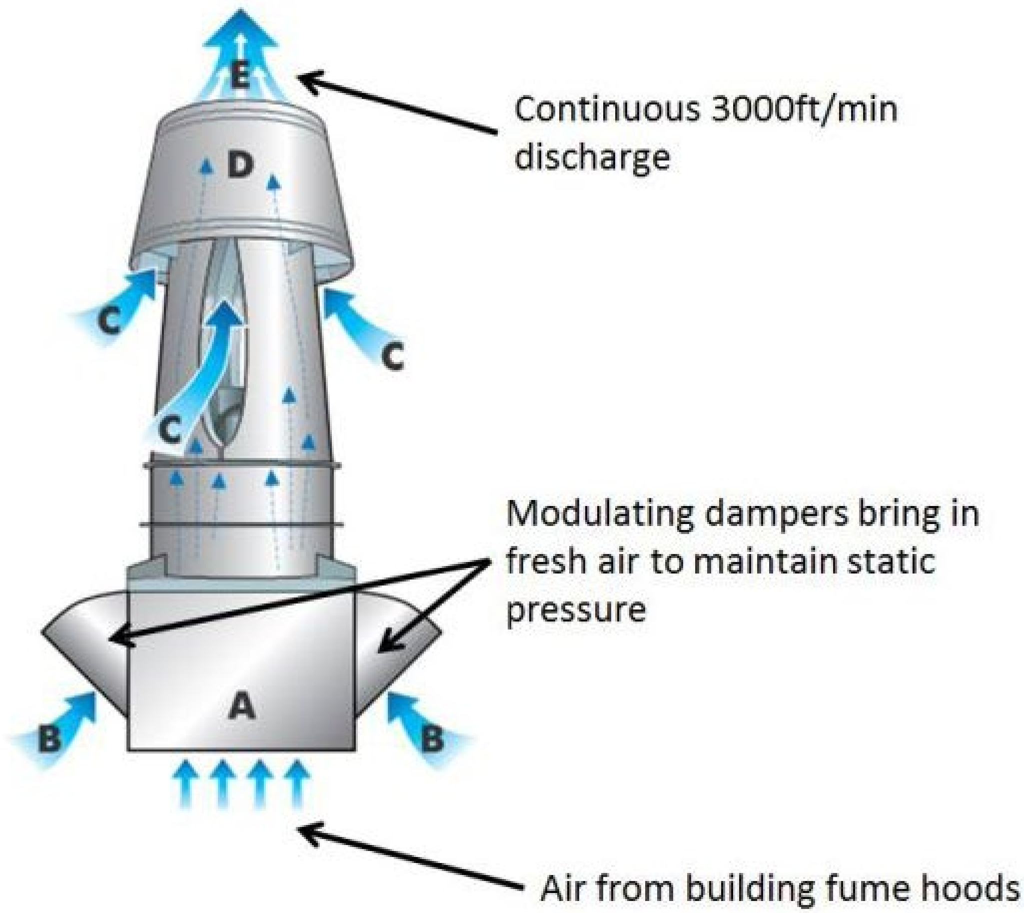
I'll start off with that.

- Annual electricity consumption savings: 1,550,000 kWh (equivalent to approximately 160 houses in Ontario)
- Electricity peak demand savings: 111.7 kW (equivalent to about 1,400 flat screen TVs running simultaneously)

Previous System

As I mentioned above, the original lab exhaust at PMCRT was constant speed. To meet regulations at the time, the exhaust system was designed to produce a continuous discharge plume with exit velocity of 3,000 ft/min. The goal here is to ensure that all pollutants that may exist in the exhaust stream are appropriately diluted to avoid re-entrainment into the building or adjacent buildings. The system consists of twelve 40HP Strobic fans that are in groups of three to serve each quadrant of the lab floor plate of the building.

The diagram below shows how the original system operated. As researchers open and close fume hoods in the labs, the amount of exhaust air exiting the building fluctuates up and down, however the fans run at constant speed to maintain the plume height. As you can imagine, at lower demand the fan running at full speed would generate extreme negative pressure in the duct work, but it can't slow down because it has to maintain the plume height. To solve this, the typical design adds fresh air dampers directly below the fan that open and close to maintain a safe pressure setpoint in the ductwork.



Previous Lab Exhaust System

New System

But wait, you're asking, isn't it a big waste of energy to take clean air that is already outside and blast it up into the sky at 3000 ft/min? Yes, but it was necessary to do because the assumption is that the lab exhaust is always contaminated and, thus, always needs to be widely diluted. This is where some new thinking and technology come into play.

Not only are we blowing a lot of clean outside air through the fans, but often times the air coming from the fume hoods is not even contaminated or is sufficiently diluted by the time it gets to the rooftop exhaust fan that it doesn't actually pose a risk. Only when there is a spill or open container does the exhaust become contaminated. The solution to this problem is to install sensors inside the ductwork that can detect to a high degree of accuracy the contamination level of the exhaust air. UHN collaborated with Airgenuity to install a system that does just that.

Aircuity Sensor Suites Installed by Airgenuity

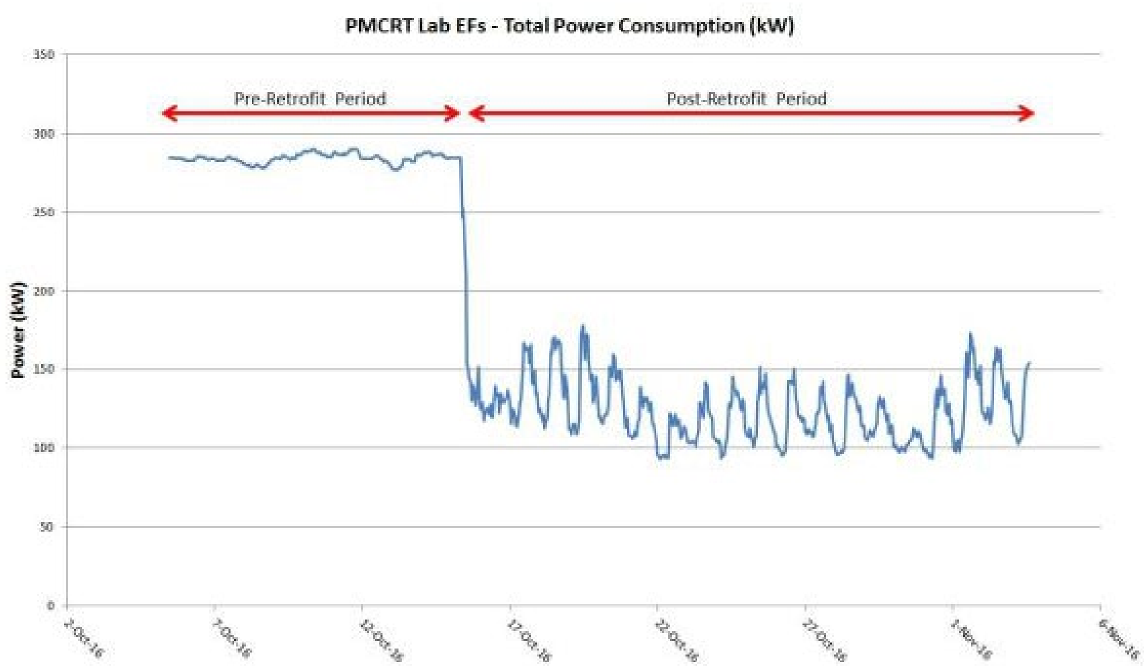
The Sensor Suites, shown above, installed as part of the project, continuously monitor air quality going to the exhaust fans and report to the building automation system whether or not the exhaust air is contaminated. When the air is proven to be clean and healthy, the exhaust system is no longer held to the standard of 3,000 ft/min discharge velocity because there are no contaminants to dilute. Now, all we need is a way to ramp down the speed of the fans, which luckily is already a common HVAC practice using variable frequency drives (VFDs). See Chad's post for here for more info on VFDs and a project he worked on at TGH.

Exhaust Fan with New VFDs Installed

With the new VFDs installed as part of the project (see picture above), we can now ramp down the fan speed according to building demand when the exhaust air is not contaminated. Without the large amount of negative pressure caused by running the fans at full speed, we also no longer need to mix large amounts of fresh air into the exhaust stream. The VFD speeds are modulated to maintain the static pressure in the duct work while the dampers remain closed. In the event that the Sensor Suites detect a contamination, the system defaults to the old mode of operation, running at full speed until the contamination is proven to be cleared.

Results

In order to measure the savings, we took advantage of the fact that all the newly installed VFDs have integrated energy metering capability. The VFDs were integrated to the building automation system to allow us to easily capture their performance data in a central location. We conducted the pre-retrofit measurements using the new system by running the VFDs at 100% speed and allowing the old sequence of operation to continue running. Once the new sequence of operation was enabled, the savings became very clear very quickly as you can see in the chart below.



Extrapolating these measurement periods over the course of a whole year, we get the following savings:

- Electric consumption savings of 1,550,000kWh (reduction of 57%)
- Electric peak demand savings of 111.7kW (reduction of 39%)
- Cost savings of approximately $200,000

Based on our detailed monitoring and verification process, we qualified for an incentive from Toronto Hydro of $155,158 to support the project. This is a good example of a major principle of many energy efficiency projects, which is using new technology to convert constant speed systems designed for the worst case scenario to variable speed systems that adjust energy consumption according to demand.

I would like to thank the following people especially, for their large contribution to the success of the project: Ian McDermott, Erica Tong (PM for UHN), Sukh Channa (PM for Airgenuity), Rick Ysidron and Khaled Ghawi (Black and McDonald facility management), Jana Jedlovska (Toronto Hydro).

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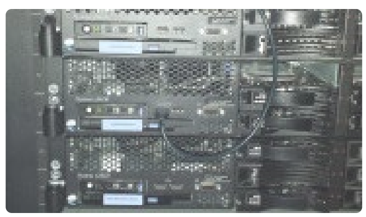

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