



HPNC

HIGH PERFORMANCE
NEW CONSTRUCTION

Supercomputing anchored by world-class energy efficient cooling

SciNet Data Centre – one of today’s fastest and greenest



The SciNet consortium was set up to deal with super-sized research projects – from understanding climate change to charting the origins of the universe. With capital and operating budgets fixed, decision makers knew they needed to improve on standard data centre energy performance in order deliver the computing speed and power needed. IBM Canada came up with a solution that incorporated energy efficiency in every aspect of the centre – from IT equipment to cooling. Design and equipment choices shaved 609 kilowatts (kW) from summer peak electricity demand and over 3 million kilowatt hours (kWh) from annual energy use, freeing as much as half a million dollars for the research budget.

Background

Canada’s scientists are tackling some of the biggest research problems in the world. What are the origins of the universe? How do cancer cells spread? How will climate change affect the Great Lakes? These super-sized projects are driving a need for bigger and faster computing resources. Canada boasts seven scientific consortiums for high performance computing. SciNet consortium, grouping scientists from the University of Toronto and affiliated research hospitals, is the first to pull its computing resources together in one location. Lead researchers were convinced that combining multiple users in one data centre would enable economies of scale, efficient scheduling of work, and faster access to stored data. Funding from the Canadian Foundation for Innovation (CFI), various University of Toronto faculties and the province of Ontario made it possible for them to pursue this vision.

Challenge

Giant data centres have an almost insatiable demand for compute cycles and storage. That alone translates into high electricity demand. The cooling needed to keep equipment from overheating can boost electricity use by a further 100% or more of the IT load. Power Usage Effectiveness (PUE) is a measure of overall power used by a data centre in proportion to the power going directly into the IT equipment. The lower the ratio, the more power is used for the computing operations and less is used to condition the environment. The PUE for a standard data centre today is typically around 2.2. For a centre 3 to 5 years old the PUE often is as high as 3. A PUE of 3 means 2/3 of the power is not used to power the computers.

The SciNet team calculated that even a “better-than-average” design with a PUE of 1.5 could result in total electrical costs approaching as much as \$2 million a year. With fixed budgets and super-sized computing goals, SciNet needed much better energy efficiency. At the same time, they were very conscious of the environmental impacts of energy use. Climate change researchers in particular wanted to ensure that their research

left the smallest environmental footprint. With these goals in mind, SciNet threw out a challenge to potential vendors, giving them the flexibility to propose equipment types and cooling methods within a general set of system requirements and a stated energy consumption target.

Solution

IBM Canada (<http://www.ibm.ca>) designed the custom solution – a 12,000 square foot, state-of-the-art green data centre that is the highest compute capacity facility in Canada. The Centre houses two computing systems. A 30,240 core General Purpose Cluster (GPC), with Intel processors, which is used for a wide variety of large-scale research projects. A 3,328 core Tightly-coupled Capability System (TCS) based on IBM’s Power 6 processors, is primarily dedicated to climate study. The GPC ranks as Canada’s fastest computer while the TCS ranks third.

IBM’s custom design uses innovative power and cooling systems and incorporates energy efficiency in every aspect of the centre’s operations.

Solution designed by:



Chilled water cooling removes heat at or near source

Cooling is a major driver of a data centre’s non-IT energy use. Typical centres use an air cooling system – blowing cool air over processors, memory, hard drives and power supplies and exhausting the heated air to the data centre for further cooling. SciNet’s IT systems feature innovative water-cooling methods. In the TCS cluster, water circulates right through the processor assemblies removing heat directly at source. In the GPC, the computer racks use a rear door heat exchanger to remove all heat from the IT gear as it is leaving the rack. These cooling techniques are so effective that the cabinets are cool to the touch.

Economies of scale are achieved by use of a single 735-ton chiller for two water loops. An evaporative cooling tower provides efficient cooling with the chiller and is also used for “free cooling” in place of the mechanical cooling for as much as a third of the year. In “free cooling” mode the cooling tower provides the cooling for the water loops via a heat exchanger, using only pump power to provide cooling.

Innovations minimize transmission losses

Power comes in from the mains at 600 volts then has to be “stepped down” for use in applications. The larger the step-down, the greater the energy lost. IBM minimized step-down losses by using equipment with the highest possible input voltage. The Power 6 gear and Uninterruptible Power System (UPS) are fed with 480V AC. The chiller is fed directly from the 600 Volt service. All remaining equipment in the IT space is powered by 208V (compared with the commonly used 120V).

All transformers are low impedance to further minimize energy losses. The UPS incorporates other loss minimization features including a high efficiency control system that enables very efficient operation even at lower load levels.

Integrated design leads to excellent PUE

Everything in the IT design was chosen for high energy efficiency – from the best new processors to half-depth servers that reduce fan loads. Intelligent controls power off nodes when not in use., Bernard Oegema, P. Eng., IBM Data Centre Consultant, says that “SciNet’s decision to request a complete package from one vendor allowed the design team to use IT hardware with the best thermal-mechanical properties coupled with a data centre designed to work with this equipment.” The fully integrated operation is achieving a PUE of 1.16 – making it one of the most efficient data centres in the world.

Designing it right. Reaping the rewards.

SciNet's biggest demand reductions came from two measures – technologies that minimize transmission losses and the use of water-cooling systems located as close as possible to heat sources.



SciNet Data Centre

Operating savings from all electricity innovations total:

Summer peak demand reduced by 609 kW

Annual energy savings of 3,184,631.9 kWh (51.4%)

Greenhouse gas reduction of 710.17 tonnes

SciNet's cost of electricity is based on spot market prices set by the Independent Electricity System Operator (IESO – www.ieso.ca) in response to electricity supply and demand. As a 24/7 operation, SciNet has limited scope to cut back during peak hours when electricity

prices are high. Chief Technology Officer Dr. Chris Loken estimates that the Centre is saving up to \$500,000 a year from the cooling efficiencies implemented as well as demand reduction.

On the basis of the electricity demand reduction, SciNet received an incentive of

\$243,600

from the Ontario Power Authority's High Performance New Construction Program.

IBM Canada received an incentive of

\$60,900

Lessons Learned

The SciNet consortium was able to achieve world class computing performance combined with a dramatic reduction in electricity demand because they opted for a holistic approach, taking energy efficiency into account in every aspect of the data centre's design. Total cost of ownership was the driver for the entire project.

“We had fixed capital and operating budgets and wanted to maximize our computing power. We knew if we could cut electricity demand we could do more computing. That's why we set our sights on a highly efficient, green data centre.”

*Dr. Chris Loken, Chief Technology Officer
SciNet Data Centre*



HIGH PERFORMANCE
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OPA's High Performance New Construction (HPNC) Program

The Ontario Power Authority's HPNC program, delivered by Enbridge Gas Distribution and Union Gas, offers incentives to incorporate electricity efficiency in the design and construction phases of new buildings, additions and major renovations.

Incentives are available for both prescriptive projects (where builders choose from the OPA's menu of pre-approved technologies) and custom projects (where building modelling is used to determine the impact of site-specific efficiency upgrades).

Eligible new building projects include: office buildings, industrial buildings, retail spaces, multi-unit residential buildings, affordable housing complexes, colleges, universities, schools, hospitals, long-term care facilities, agricultural buildings, hotels and motels. Single-family dwellings are not eligible.

Find out how you can qualify by phoning 1-888-OPA-HPNC, visiting www.hpnc.ca, or emailing hpnc@enbridge.com.

To qualify for the HPNC Program, a project must be located in Ontario (excluding the 416 area code), conform to Part 3 of the Ontario Building Code (OBC), and be intended for commercial, institutional, industrial or multi-unit residential occupancy. Agricultural buildings may apply. Applications will be accepted for approval through late fall 2010, and projects must be completed, evaluated, and delivering energy savings by December 2012. Buildings that obtained a building permit between August 2007 and March 2008 may also be eligible.

Program Highlights

\$250 per verified kW saved in the prescriptive stream

\$200-\$250 available per verified ton for alternative energy measures

Up to \$60 per eligible in-suite appliance in multi-residential new construction

\$250-\$400 per verified kW saved in the custom stream

\$50-\$100 per verified kW saved available to design decision-maker in custom stream

100% of building modelling costs, up to \$10,000

Available throughout Ontario outside 416 area code.



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