Distributed Energy Systems

Energy generation, storage, monitoring and control systems

ADVANCED ENERGY CENTRE
MaRS Cleantech | Ontario, Canada

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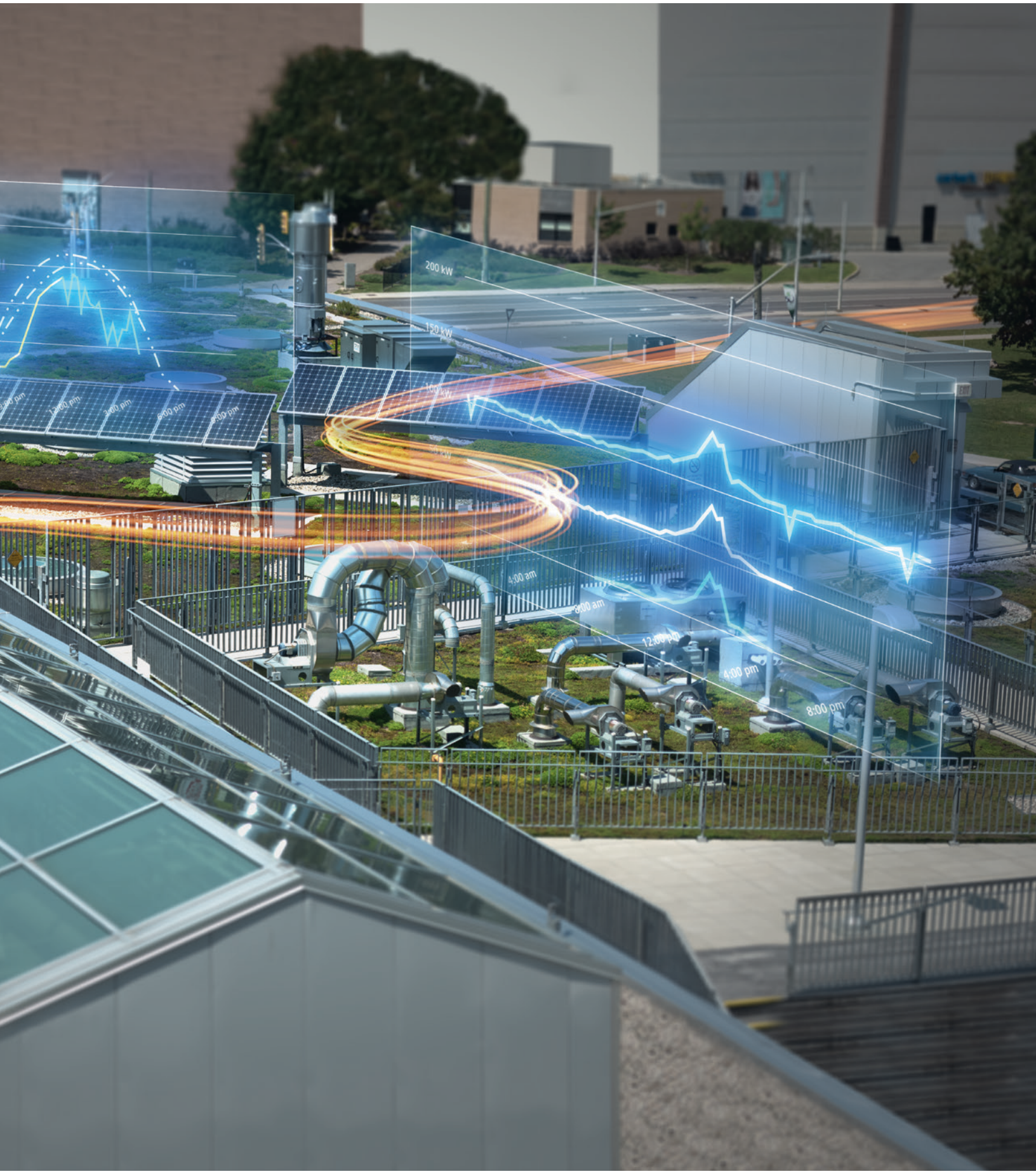
Ingenuity for life

A joint activity from the Advanced Energy Centre and Siemens

Utilities and commercial and industrial customers are turning to distributed energy systems (DES) as answers for their power resource challenges. DES encompasses energy generation and storage close to the load, with both local and remote monitoring and control solution technologies. For commercial, industrial, residential, and institutional customers, as well as communities at large, DES offers an array of opportunities, ranging from increasing cost savings, improving reliability and resilience, and reducing environmental impacts. Through a series of case studies, this paper will highlight these benefits.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1. Energy savings

DES can provide energy savings to Canadian businesses and residences

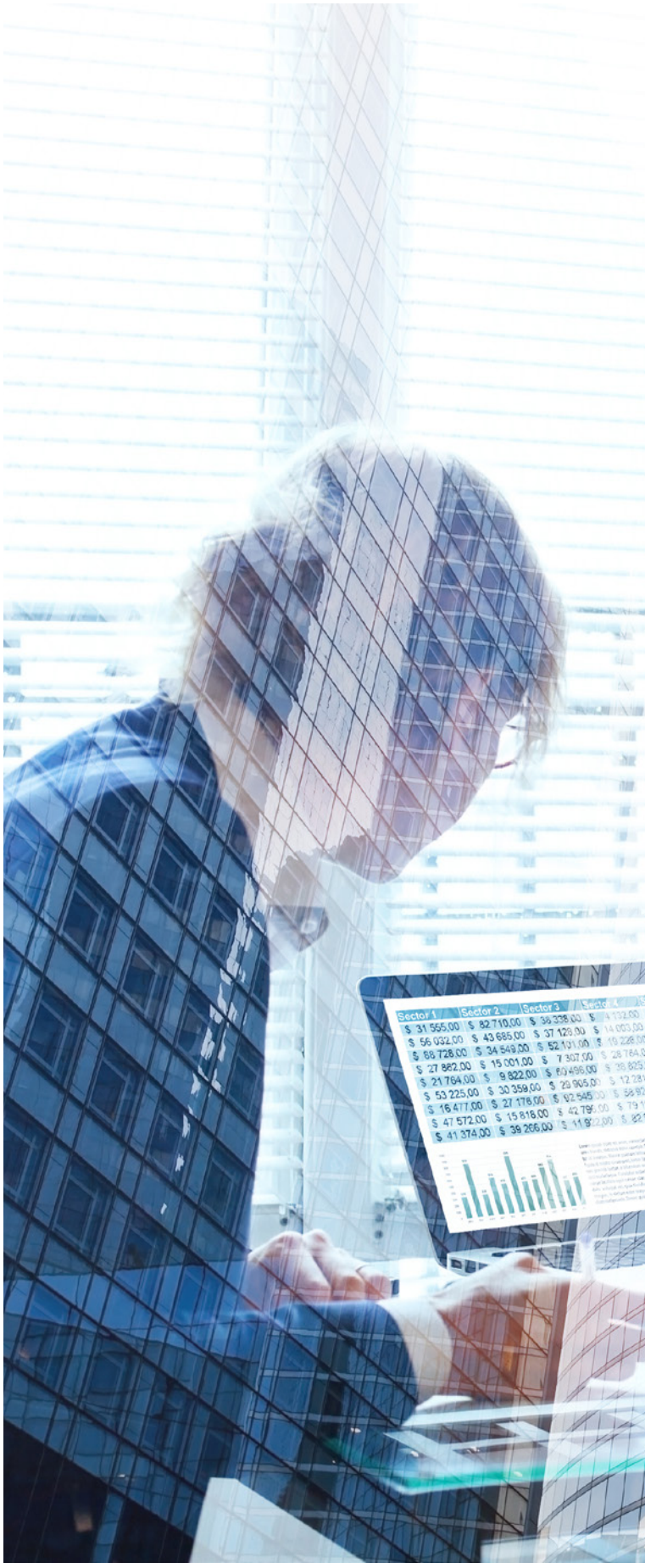
DES can help various energy players achieve lower overall costs for energy by enabling them to shape local generation and consumption in response to market signals. For example a building with embedded generation and storage can implement a dynamic management regime: when network demand is low and the price falls, local generation can be switched off and energy can be taken from the grid for use and local storage. When there are peaks in network demand, the owner can reduce load, switch on local generation and earn income from higher value sales to the grid.

In a country like Canada where prices for energy vary from province to province, the economic rationale for DES varies across jurisdictions. However, there are already examples where there is a financial incentive for businesses or individuals to invest in DES based on energy costs alone. For example, 3M in London, Ontario used DES (among other energy saving methods) to reduce energy demand by 12GWh over five years, saving $1.5M annually.[1]

Energy sector trends, such as falling costs of distributed energy solutions including wind, solar and storage, are anticipated to accelerate the adoption of DES. For example, the average electricity rate for industrial customers in Canada ranges from $0.06–0.10/kWh.[2] Compare this to the levelized cost of electricity (LCOE) for distributed energy sources[3]:

- Commercial & Industrial PV LCOE: $0.09–0.19/kWh
- Wind LCOE: $0.03–0.06/kWh (only relevant to unique DES applications)
- Microturbine LCOE: $0.06–0.09/kWh

Distributed energy option price decreases are expected to continue[4] at the same time that grid electricity processes are expected to increase,[5] which will continue to augment the economic rationale for DES.



2. Power System Benefits

DES can help avoid and eliminate the need for costly grid and generation upgrades.

DES can offset the need for supply from the power systems and has the potential to eliminate the need for capital expenditures on costly grid and generation upgrades. This in turn can save ratepayers money by avoiding expensive grid infrastructure upgrades.

Examples of avoided infrastructure investments and cost savings are already being seen. In New York, a 375 kW / 940 kWh energy storage project implemented at the headquarters of GHG realty, and supported by Con Edison, is helping reduce the need for power from Con Edison's grid, especially during peak summer months.[6]

In California, initiatives involving rooftop solar and energy efficiency have enabled the California Independent System operator (CAISO) to cancel 13 transmission projects planned in Pacific Gas & Electric territory. The result has been a $192 million in transmission cost savings for PG&E customers.[7]

Through DES, utilities, who traditionally plan and design for peak load scenarios, can manage those peaks, and help avoid large capital investments on line improvements, transformer replacements and bus upgrades.

3. Resiliency & Reliability

DES provides effective redundancy in case of grid outages

Grid resiliency and reliability cannot be taken for granted and often traditional solutions leave much to be desired. For many businesses, it is worthwhile to invest in redundancy through DES.

Local, decentralized and controllable DES generation and storage sources can be designed to provide the end user with local resilience or even full independence from the grid. The benefits accrue to grid operators as well: DES can manage demand to reduce peak loads and maintain power quality when infrastructure is nearing capacity, avoiding the risk of blackouts and postponing the need for major grid reinforcement investments.

Experts forecast increasing risk to grid resiliency and reliability due to increasing weather related outages, aging infrastructure leading to equipment failure.[8] For example, power outages caused by extreme weather across the US have doubled between 2003 and 2012.[9]

In 2017, 399 blackouts were witnessed across Canada.[10] While some sectors such as healthcare and security need to prioritize resiliency and reliability, reliability is also crucial for other sectors such as transportation, manufacturing facilities and data processing. In 2016, estimates demonstrated that an outage costs roughly $750k for an average data centre.[11] The 2003 northeast blackout, the largest in North American history impacting 61,800 MW of electric power in Ontario, Ohio, Michigan, Pennsylvania, New York, Vermont, Massachusetts, Connecticut and New Jersey, affected an estimated 50 million people and caused an estimated $4 billion to $10 billion (USD) in economic losses.[12]

Furthermore, rapid population growth is driving urbanization with increasingly dense cities and large energy demands. These trends coupled with large scale environmental changes make cities a priority for increased resilience to extreme events. DES are a potential solution to this problem as energy could be stored in small pockets within the affected areas. For example, cities want to increase local resiliency instead of incurring high costs from 'reacting' to events afterwards, and tenants want increased reliability and are willing to pay for it.

4. Environmental Outcomes

DES can reduce environmental impact of commercial operations

DES includes renewable and low carbon technologies and controls, which enable the integration of such technologies into the network. This can help in the reduction in carbon intensity and local environmental impact of the system. The continuing reliance on fossil fuels for energy generation is one of the leading causes of significant air quality issues. DES that relies on clean energy generation, or hybrid systems, have a reduced impact on air quality and help maintain a greener and cleaner ecosystem.

Furthermore, environmental benefits associated with DES provide value to Canadian businesses through appeal to consumers, long term fit with government objectives and, in most cases, alignment with business preferences:

1. **Increase appeal to consumers.** Studies demonstrate that 31% of Canadian consumers are willing to pay up to 10% more for "green" products, and 10% are willing to pay up to 20% more.

2. **Long term fit with government objectives.** DES regulatory supports or incentives are anticipated to become increasingly relevant if Canada is expected to fulfill its Paris 2015 commitments to cut emissions by 30% (from 2005 base) by 2030.[13]

3. **Alignment with business goals.** Studies demonstrate that 80% of Canadian entrepreneurs motivated to reduce environmental impact was based on personal views.[14] Furthermore, as societal expectations change, companies will be expected to perform to higher standards and strategic corporate goals.

Industrial Plants

- Manufacturing plants generally work around the clock to maximize productivity. A disruption in their activity results in financial loss.
- DES can offer continuity and reliability for large manufacturers, while at the same time increasing efficiency and avoid peak demand charges.
- Combined heat and power generation is an effective DES application, where heating is required by industrial processes.

Commercial Buildings

- DES finds natural applications to address the various requirements of commercial customers. Greenfield commercial buildings have environmental requirements to obtain permitting, as well as targeting cost reduction while satisfying business needs.
- Data centres and the banking sector particularly value business continuity.
- Energy efficiency adds value to real estate property portfolios.

Residential Communities

- Residential developments, especially when part of mixed use developments, represent an important application for DES.
- Immediate benefits include energy security and reduction in utility bills for the residents.

Institutions

- Specialized campuses such as universities, hospitals and schools are implementing a range of DES technologies; from Combined Heat and Power (CHP) with thermal storage to high-tech microgrids.
- Universities are among the first to invest in emerging technologies and act as centres for future development using these facilities as a 'Living Lab' for researchers and students.
- Energy savings, cost reduction and sustainability are the key drivers.

Rural Electrification

- In the absence of a grid connection, communities usually rely on expensive and unsustainable fossil fuels to generate electricity.
- DES can provide off-grid electrification stability while reducing fossil fuel consumption by running existing generators less often.
- Harvesting local, green energy resources such as solar and wind power, DES in rural areas can provide energy access and acts as an enabler of economic growth.

Success stories and research focus

In practice, Siemens has proved its expertise in this area and delivered tangible results in various projects:

- At Algonquin College in Canada, an overall reduction of annual energy costs of 48% is anticipated by installing a complete energy supply and data management solution, including renewable generation and storage.
- The island of Ventotene, Italy, gained electrical independence and reduced its carbon footprint by up to 15%. In addition, the integration of renewables with the existing gensets led to substantial fuel savings.
- With a low-carbon microgrid that manages and controls diverse renewable energy sources and a battery storage system, the Blue Lake Rancheria in the United States can operate for up to seven days independent from the grid.

Case study example

Algonquin College of Applied Arts and Technology

Location:
Ottawa, Canada

In January of 2014 Algonquin College, one of the largest institutes in Ontario with 18,000 full-time and 36,000 part-time students, commenced on a journey to become the pioneer in sustainable education. Focusing on reducing the use of electricity, water and gas, the college set up collaborations to push the boundaries of energy efficiency and signed off a $51 million investment over 20 years.

The college incorporated not just renewable generation but also sustainability courses as part of its core curriculum. Various improvements to the campus' water, heating and cooling systems are planned. In addition, the college intends to set up a research facility that targets the reduction of consumer power consumption. These changes have resulted in substantial cost savings, $3.2 million in annual operating costs, all while making the campus greener. Today, it stands as an example and a catalyst for educational institutions all over the world.

Case study example

IRENE (Integration of Regenerative Energy and Electric Mobility) project

Location: Wildpoldsried, Germany (AKA The Smart Energy Village)

In the municipality of Wildpoldsried in the Allgäu region of southern Germany – an exemplary community with regard to the transformation to power generation supported by prosumers – a portion of the low-voltage grid has successfully been decoupled from the public power grid for the first time. This network, a so-called intelligent microgrid, has been operated with a high level of stability and without interruptions. What's more, additional decentralized, electricity-generating capacity, such as photovoltaic or biogas facilities, can be easily added to the community's energy mix. Such local, independent networks could make an important contribution to maintaining a secure energy supply in the future by helping to fill demand gaps created by storms, flooding or blackouts.

With solar and wind power, biogas, biomass – Wildpoldsried generates five times more energy from renewable resources than it requires for its own consumption. The overall goal of this project was to balance out power generation and consumption and thus maintaining a reliable and resilient grid.

Case study example

Blue Lake Rancheria Microgrid

Location: Northern California, USA

Blue Lake Rancheria, a century-old Native American reservation in Northern California, has launched its low-carbon community microgrid that is helping power government offices, economic enterprises, and critical Red Cross safety shelter-in-place facilities across 100 acres. The tribe at Blue Lake Rancheria uses Siemens digital technology and decentralized energy resources to seamlessly distribute and control self-generated power. By doing so, they're reducing their carbon footprint and energy costs. In cases of severe weather, natural disasters or power blackouts they can island from the central grid, allowing them to be ready for anything. The microgrid provides the ability to island and supply uninterrupted electric power for at least 7 days during a real or simulated grid outage.

Microgrid powering critical infrastructure will save $200,000 per year, reduce 150 tons CO_2 emissions annually and create clean energy jobs

- Achieves renewable energy generation > 40% of annual production
- Enables participation in one or more PG&E demand response programs
- Reduces annual electrical consumption from the grid of at least 680 MWh
- Achieves at least 25% energy cost savings over 1 year of operation
- Reduces annual greenhouse gas emissions by at least 195 metric tons CO_2
- Deployment represents industry-leading standard for collaboration between state, tribal, federal, and local entities, academia, technology providers, and utility partners

A perfect place in numbers

24,000,000 visitors in 2016

102,000 square metres of gross leasable area

1,500 energy and HVAC data points

1st shopping centre in Europe with LEED EB Platinum certification

€93,000 heat and electricity cost savings

1 shopping centre

Case study example

Sello shopping centre: This building is a community

Location:
Espoo, Finland

Sello is Finland's most visited and most sustainable shopping centre. Its 102,000 square meters of gross leasable area, welcomes 24 million visitors per year from all over the world. There are over 170 shops as well as a concert hall, a library, hypermarkets and entertainment attractions. Sello offers more than just shopping – its aim is to be more city centre than shopping centre.

Sello was the first shopping centre in Europe to become Leadership in Energy and Environmental Design (LEED) EB Gold-certified in 2010. It was also the first shopping centre – and one of only nine such buildings in Europe – to achieve the LEED EB Platinum certification in 2015. Sello aims to remain the greenest shopping centre in Europe, providing its over 170 tenants with a sustainable business environment.

The relationship between Sello and Siemens started over 25 years ago and led to the shopping centre's first LEED certification as well as a 50% reduction in energy consumption and savings of $200,000 CAD per year. The current efficiency program sees energy savings of $165,000 CAD per year, a 20% reduction in CO_2, and a 50% reduction in district heating.

The measures put in place have led to better air flow in certain areas, including restaurants where people spend the most time in a static position. When snowy weather is in the forecast, district heating can be used to proactively heat entrances and reduce ice buildup.

All of this helps provide a high-quality visitor experience and keeps emissions, operating costs and rents for shop owners as low as possible.


Grid Connected

Conclusion

Distributed energy systems are evolving locally and globally to provide alternate options to customers that are reliable and clean.

Given the variety of DES options that exist, industries, commercial areas, buildings, municipalities and communities will need to find the right partner to help customize the best DES solution for them. It is increasingly important as these stakeholders are facing four main challenges: power system stability, energy savings, security of supply and CO_2 reduction. As power demands are rising, pressure is being placed on electricity grids and the environment. Energy availability and reliability are becoming primary concerns for many sectors – all of which need solutions to help provide a reliable and cost-efficient electricity supply.

Distributed energy system solutions are quickly offering alternatives that can turn these challenges into opportunities to save costs, increase reliability, and reduce emissions. The solutions can include targeted use of renewable energy, combined heating and power stations, or provision of storage solutions up to energy-as-a-service. DES technologies represent a paradigm shift and offer building owners and energy consumers significant opportunities to reduce cost, improve reliability and secure additional revenue through on-site generation and dynamic load management.

There are already several examples of DES applications that demonstrate the benefits DES can bring to industries, commercial buildings, residential communities, institutions, and remote communities. Through the proliferation of DES adoption, these customers are already experiencing the following benefits:

- Power System benefits: DES can offset the need for peak load scenaries, reducing capital expenditures leading to cost savings.
- Energy savings: through low-cost energy savings options, advanced controls and optimization, DES are helping customers achieve energy savings.
- Improved power reliability: through the use of more dynamic, flexible and smart controls and power supply, DES helps customers avoid costly outages and improve processes.
- Environmental outcomes: through the use of renewable or cleaner sources, DES helps customers achieve environmental outcomes, and comply with environmental regulations.

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The Advanced Energy Centre (AEC) is a public-private partnership with the mission of fostering the adoption of innovative energy technologies in Canada, and leveraging those successes and experiences into international markets. The AEC is a part of MaRS Discovery District, one of the world's largest urban innovation hubs. Recognizing the difficulty of adopting innovation in a highly regulated energy sector, the AEC works through its network key sector players to enact change. Using strategic programming to overcome the systemic barriers to market entry, scale-up and export, the AEC is a catalyst for the adoption of leading edge energy technologies. It works with over 150 Canadian ventures in the cleantech and energy sectors, actively developing partnerships that will help bring their technologies to global markets.

Contact the AEC

Advanced Energy Centre
101 College Street, Suite 420
Toronto, ON M5G 1L7

advancedenergycentre@marsdd.com
marsdd.com/aec

SIEMENS

Since 1912 Siemens Canada has stood for engineering excellence, innovation, quality and reliability. Siemens technology in the fields of electrification, automation and digitalization helps make real what matters to Canadians. From the Atlantic to Pacific oceans, Siemens Canada employees deliver solutions for sustainable energy, smart infrastructure, and the digital enterprise. One of the world's largest producers of energy-efficient, resource-saving technologies, Siemens is a leading supplier of efficient power generation and power transmission solutions and a pioneer in infrastructure solutions as well as automation, drive and software solutions for industry. With its separately managed subsidiary Siemens Healthineers Limited, the company is also a foremost provider of medical imaging equipment – such as computed tomography and magnetic resonance imaging systems – and a leader in laboratory diagnostics as well as clinical IT. Sales for Siemens Canada in fiscal 2018 (ended September 30), were $3 billion CAD. The company has approximately 4,800 employees and 44 locations including nine production facilities across Canada. Further information is available at **siemens.ca**

Contact Siemens

Siemens Canada Limited
1577 North Service Road East
Oakville, ON L6H0H6

siemenscanada.ca@siemens.com
siemens.ca

[1] http://www.ieso.ca/en/get-involved/for-business/for-business
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