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Leveraging the Internet of Things and Open Data to Support Clean Energy in the Greenhouse Sector

Preliminary Summary of Research Findings February 2020

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Overview of the Study

The current study, the first within a five-year program of research, focuses on understanding the energy needs of greenhouses, their energy management motivations, energy management practices, and the challenges and opportunities for sustainable energy. From June to October 2020, we interviewed nine people involved in the Canadian greenhouse industry. While we continue to collect data, this report provides a summary of key findings to date. The study explores energy management across diverse greenhouse sectors - vegetables, fruits, and flowers – in two Canadian provinces (Alberta and Ontario). We summarize the main findings below.

Energy management motivations

The need for energy management in Canadian greenhouses is driven primarily by increasing energy prices, harsh climatic conditions, and market competition. Also, for many greenhouses, energy is the second largest input cost after labor. After costs, enhanced productivity and environmental concerns also influence the implementation of energy management solutions and strategies within greenhouses. Being the producers of natural products, many growers believe in adopting natural ways and environment-friendly production practices and hence, are motivated to adopt and implement energy management in their businesses. Greenhouse growers' educational background, previous occupations, socio-economic status, and technology literacy were also found to drive the selection and implementation of innovative solutions and strategies.

Energy management practices

In response to their energy management requirements, greenhouse growers implement various information technologies (IT) and other energy management solutions and strategies. Some of the prominent non-IT solutions include installing LED lights, implementing combined heat and power generation (CHP or cogen), and renewable electricity generation (solar). Greenhouses are also turning to advanced IT solutions that utilize artificial intelligence (AI) and computer vision image analysis to manage greenhouse activities. Apart from controlling the greenhouse climate and plant growth assessment, innovative IT techniques are helpful in flagging potential problems and recommending solutions. Most growers implement energy management strategies and solutions after consulting various information sources, such as newsletters, online information, experts in the industry, and market research. The growers work with and adapt these technological solutions to obtain beneficial results according to the requirements of their greenhouse structure and crops. During the adoption and implementation of energy management solutions, growers can gain insights about the solutions' effectiveness and limitations. Various solutions were found to provide benefits in terms of energy savings, cost savings, market competitiveness, and sustainable resource management.

Challenges and opportunities for sustainable energy

While the findings are still preliminary, they suggest an increasing interest in implementing IT and non-IT strategies for energy management. However, there is still much room for improving technology and reaching maximum efficiency. Although most solutions have provided expected results in terms of energy-saving, CO_2 and heat management, many are still not cost-effective and adapted to Canadian climatic conditions. The upfront cost of energy management solutions makes growers dependent on governmental incentives and grants to make these solutions financially feasible. Also, many technologies are borrowed from the international market, so discrepancies are observed between the expected and actual benefits. Growers try to address limitations of the technology and look for ways to improve or upgrade their solutions (such as through algorithm development, taking correct measures during installation, and time to time upgradation) to respond to their particular greenhouse conditions.

Other significant obstacles to effective energy management include governmental regulations and policies, and a lack of information and education among greenhouse growers. We also found that understanding the physiological and biological components and the plant systems' functioning is important for enhancing sustainable greenhouse production. This comprehension can aid the implementation and successful exploitation of energy management tools and solutions.

Recommendations

Based on the above findings, we offer the following recommendations:

1. **Improve efficiency to fulfill the energy needed to support the growth of the greenhouse sector**

The energy needed to support the entirety of the greenhouse needs can be met by the combined use of both IT and non-IT solutions. The combined use of these technologies will help address the energy issues within the sector and curb the upfront cost of innovative technologies, such as AI and automation.

2. **Invest in education and learning to foster the effective use of innovative energy management technologies**

Educating growers and increasing their knowledge about plant management systems, energy systems, and how to utilize the technologies can be beneficial for effective energy management. Formal education, experiential learning, and knowledge sharing can encourage the efficient and sustainable use of available resources, while also ensuring energy reliability and resilience.