Energy Efficiency in Commercial Kitchens

Trevor Ritchie

Supervised by Calvin Lakhan

A Major Project Report submitted to the Faculty of Environmental and Urban Change in partial fulfillment of the requirements for the degree of Master in Environmental Studies

York University

Toronto, Ontario, Canada

July 10, 2022

Abstract

The Energy Efficiency in Commercial Kitchens course project is intended to observe the presence of energy efficiency as a curriculum in post-secondary culinary institutions. It is designed to connect commercial kitchen planning and practice with emission reduction strategies as they relate to energy use.

The following reflection provides an overview of the research findings and methods used to create an energy efficiency course proposed for post-secondary culinary students. This project responds to the gap in culinary training in prospect that chefs will gain the ability to identify opportunities for energy efficiency in commercial kitchens and become activists in energy reduction endeavours.

Foreward

My focus of study is on energy efficiency, particularly as it relates to commercial kitchens. With this knowledge, through a chef participatory lens, I discovered opportunities for energy reduction and energy waste mitigation. Throughout my plan of study, several strategies were used to explore this research.

Firstly, the courses I completed during my MES program provided an array of perspectives that broadened my understanding of environment, society, and education. ENVS 5051 Fundamentals in Energy Efficiency was particularly instrumental in inspiring this research project. The course material, focused on energy services and systems, served as a bridge to connect my working knowledge of energy use in commercial kitchens to aspects of the macro energy system. I also focused on understanding how chefs use energy services in culinary practice as part of an experiential learning activity at George Brown College. Secondly, I conducted research on the presence of energy efficiency curriculum within North Americans culinary centres and hospitality sector. The findings of this research led to the creation of a course for culinary students that focuses on energy systems and services used in commercial kitchens. The course also provides space for students to consider energy saving opportunities in menu design, cooking techniques, and daily kitchen operation.

My academic experience at York University has been influential in discovering ways in which chefs can work to reduce emissions linked to excessive energy use in kitchens. The Energy Efficiency in Commercial Kitchens course project will serve as a foundation that chefs can leverage to become more aware of their influence in contributing to the reduction of green gas emissions and search for creative ways to reduce energy use in kitchens.

Project Elements

1. Project reflection.

This project reflection is intended to provide readers with an explanation of the rationale for the courses' composition. The course is written through a chef participatory lens and supports the need for commercial kitchen operators to better understand their influence on energy use and explores the challenges and opportunities in energy waste mitigation. The metaphor of a 'commercial kitchen ecosystem' is used to bed a holistic notion that both living (subjective actors) and non-living (tools and machines), working in conjunction, are instrumental for optimal energy waste mitigation.

2. 'Energy Efficiency in Commercial Kitchens' course learning schedule and topical outline.

The learning schedule and topical outline includes weekly topics, material for review, and resources. It also contains course outcomes and course marking strategy.

3. 'Energy Journal Guide.'

As a research component for my portfolio, professional chefs were provided with a guide to record independent 'energy journals.' The intent for chefs to keep an energy journal was for them to take the time to think about and reflect on how energy and energy services are used in commercial kitchens and to discover opportunities where energy demand can be reduced or used more effectively.

4. Focus group summary.

Based on my interpretation of the reflections from research participants' energy journals and virtual meeting, this summary considers menu items centered around the idea of 'energy as an ingredient.' The composition of these reflections represents a sort of unconventional 'cookbook' as a strategy for menu planning that considers not only food, but energy as an integral ingredient in food preparation. Commercial kitchen planning, space, and practice are also included.

Acknowledgments

I would like to express my thanks to York University's Dr. Calvin Lakhan, Dr. Lisa Myers, and Dr. Leesa Fawcett for their guidance and motivation throughout my studies and research. To fellow MES candidate colleagues for the tremendous amount of encouragement and collaboration.

Thanks to George Brown College's Centre of Hospitality and Culinary Arts for their support of my MES endevour.

Contents

Introduction

This research project centers around the existence of energy efficiency as a component to curriculum in culinary institutions with the goal of connecting culinary planning and practice with energy waste mitigation strategies. The goal of this project is to address the lack of energy efficiency curricula in culinary institutions and to serve the unmet need for chefs to better understand their role in improving energy efficiency in commercial kitchens. On a personal level, I support a call to action for chefs and kitchen operators to reduce overall energy use and find ways to use energy more efficiently.

As significant contributors to greenhouse gases, commercial kitchens are prime candidates to be considered in emission reduction planning. "81% of Canada's anthropogenic greenhouse gases (GHGs) come from the production and use of energy for which nearly 60% is wasted" (Love, 2018). Compounding the issue further, food service operations require more energy during 'peak times' placing further stress on the energy grid which is predominately fueled by non-renewable resources. Partly due to the "scarcity of academic and industrial literature concerning the energy use of commercial kitchens" (Mudie, et.al., 2013, p.1), it is imperative that kitchen operators contribute to the development of energy efficient strategies to reduce overall energy use.

This course is designed to be engaged with using digital services and weekly telecommunication meetings. The materials covered in this course apply mainly within a North American context, however, a limited sum of resources come from abroad. From a global perspective, energy ecosystems vary immensely, and the material covered in this course does not represent all jurisdictions.

The Energy Efficiency in Commercial Kitchens project is a course designed to be offered in a bachelor study in culinary institutions. The thirteen-week course composition takes a holistic stance on energy use in commercial kitchens and includes: introduction to energy concepts and macro energy systems, energy efficiency retrofits and incentives, technological innovations' influence on energy use, and energy waste mitigation menu planning and kitchen culture.

There is no singular approach to solving the challenge of energy over usage in commercial kitchens for a multitude of reasons. This course is designed for chefs to discover energy reduction and energy efficiency strategies that could be applied in their specific place of work. A pursuit towards a working knowledge of energy, energy systems, and emission reduction targets is a starting point for students to consider the influence of energy outside of the kitchen. Energy retrofit and incentive programs are explored to demonstrate potential energy and monetary saving opportunities that align with various energy policies. The course evolves to focus on energy saving and efficiency opportunities in menu planning, cooking practice, and technological innovation.

To my knowledge, this course design project would be the first of its kind for North American culinary institutions. It is intended to connect culinary planning and practice with energy reduction and efficiency strategies and inspire kitchen operators to serve as environmentally focused energy advocates. Chefs can be meaningful allies in the struggle to reduce global emissions and the intention here is to spark a catalyst to propel action towards energy reduction and efficiency cultures in commercial kitchens.

The adjoining reflection outlines the process of course design.

Executive Summary

The purpose of this study was to explore unconventional opportunities for energy efficiency in commercial kitchens. This study also recognizes the important role of some energy efficiency incentives and retrofits.

The findings in study demonstrate the importance of taking a holistic approach to tracing energy use and its conservation in commercial kitchens. Thinking beyond benchmarked approaches to energy efficiency could assist kitchen operators in discovering practices that reduce energy use. For example, chefs can consider how food offerings, its preparation, and behaviour play a major role in energy use.

The discourse on energy efficiency, as it relates to commercial kitchens, often lacks a 'chefs' perspective.' The energy choices chefs make, like when an oven is turned on or what cooking technique to use, profoundly impacts a kitchens energy demand. Policy influencers and researchers would be remiss not to consider the impact and uniqueness of how kitchen ecosystems operate. Equipment retrofits and technological innovation can assist in mitigating energy use but maximizing the potential for energy efficiency in commercial kitchens needs to involve menu planning, kitchen design, and cooking method, elements generally overlooked in energy efficiency discourse.

A main goal of this study was to provide chefs with an approachable framework to better understand energy ecosystems and the negative environmental impacts of energy overuse in kitchens. Perhaps the most approachable way chefs can view the importance of reducing energy use is to think of it as an 'ingredient.' Energy, like food, is a crucial component in all cooking and chefs should demonstrate care in reducing its waste and maximizing its use. Thinking of energy as an ingredient may be a key factor in lessening the negative environmental impacts linked to commercial kitchen operations.

Initial Research

Exploratory research was conducted focusing on North American culinary centres to surface curriculum centered around energy efficiency and environmentally focused energy content. Although a negligible sum of kitchen-energy related topics was found in some 'sustainability' centered curricula, energy topics do not garner the necessary focus required for kitchen operators to make meaningful change.

It is worth noting that energy efficiency curriculum is abundant in many academic centres as a key component to environmental studies, planning, and policy. What is often overlooked in energy related curricula is a holistic focus that includes energy reduction and efficiency focused pedagogy, behaviour, attitudes, and culture within commercial kitchens. For example, spaces that utilize energy services are often referred to as commercial, industrial, or transport.

Considering commercial spaces, in this case commercial kitchens, retrofits, incentives, training, monitoring of energy use, and maintenance are approached in a linear way, however, do not capture the maximum potential for energy efficiency and reduction. Every commercial kitchen is unique, and its energy use is influenced as a function of its design, tools, menu offerings, menu size, cooking methods, staffing levels, and behaviour.

Key Terms

Canada Energy Regulator (CER): Government of Canada Agency which licences and regulates interprovincial oil, gas, and electric utilities law in Canada.

Combination Oven: Oven that cooks food using convection, steam, or combination of convection and steam.

Commercial Kitchen: Facility containing a kitchen that prepares food for sale.

Demand Side Management (DSM): Approach to modifying consumer demand for energy through methods such as monetary incentives and behavioural change.

Energy Ecosystem: System that includes animate and inanimate factors and their connective influence on energy use.

Energy Efficiency: The goal of minimizing energy input into a system while simultaneously maximizing its output.

Energy Retrofit Program: A program, based on jurisdiction, designed to incentivise business owners to outfit their facilities with energy efficient equipment and systems.

Energy Service: Energy used to facilitate heating, mobility, and electrical devices.

Energy Star: Program run by the U.S. Environmental Protection Agency (EPA) and U.S. Department of Energy (DOE) that promote energy efficiency.

Food Service Technology Center: Research center located in California that collaborates with food service operators to implement and promote energy efficiency in commercial kitchens.

Minimum Energy Performance (MEP): Specification containing performance requirements for an energy service and limits the amount of energy a product can consume.

Independent Electricity System Operator (IESO): Crown corporation responsible for operating Ontario’s electricity market.

Induction Cooking: Involves the use of direct induction heating of a cooking vessel.

Light Emitting Diode (LED): Semi-conductor light source that emits light when current flows through it. Electrons in the unit combine with electron holes, releasing photons, producing light.

Research Methods

For this research project, I explored energy related material relevant to chefs and categorized them into two groups.

The first category includes material focused on forming a working knowledge of energy principles, connecting energy use and environmental impact, and commercial kitchen incentive and retrofit programs aimed at improving energy efficiency.

The Independent Electricity System Operator co. (IESO), was a primary source for research and the resources found there, have become integral components of the final course project. I understand that the IESO is only one of seven electricity operating crown corporations in North America, however there is not room in this course to explore all of them. The Canada Energy Regulator (CER) website was a major resource and served as a base for project development. Chefs should be aware of emission reduction targets, energy-related policy, and what future energy systems, economics, and planning could look like. 'Energy Star' was another key resource for connecting energy efficiency retrofits and incentive programs with commercial kitchen operation.

Secondly, research was conducted to examine energy use in commercial kitchens. A holistic approach was used to source energy related material focused on food service operator behaviour, technological innovation, kitchen space, and menu planning. York University was a source for research and its resources included energy efficiency literature and pedagogy surrounding commercial kitchen behaviour.

To explore technological innovations' influence on energy use and energy efficiency, several kitchen equipment and systems providers were examined using web-based methods.

Research was also conducted to explore the presence of activism around energy efficiency in commercial kitchens. Using web-based methods and digital media, culinary organizations, including the Canadian Culinary Federation, Restaurants Canada, and World Association of Chefs Societies were examined to discover initiatives catered to kitchen operators with the goal of improving energy efficiency and mitigating its waste.

Limitations

There were some challenges collecting data for this study. Energy efficiency, as it relates to commercial kitchens, is largely absent in post-secondary culinary centres in North America. Most post-secondary culinary centres have courses designed around sustainability in hospitality and tourism, however, lack energy related content.

Data was collected from the Food Service Technology Center. This source was very beneficial to this study because the institution works directly with chefs to discover opportunities for energy efficiency in kitchens based on their type of establishment, menu offerings, and geographic location. A more holistic approach to energy conservation is necessary to address the unique nuances of individual food service operations' energy ecosystems.

Construction Methodologies

This course is designed for synchronous and partial asynchronous online engagement. The utilization of a telecommunication platform will allow students and instructors to interact in a single, collaborative digital space. The course includes online class material for review and exchange and reading resources. Discussion forums will be created for the purpose of peer-to-peer sharing, concept exchanges, and debate around commercial kitchen energy use in connection with cooking practice, menu planning, training, and overcoming challenges.

Following Blooms Taxonomy, the course follows prescribed learning outcomes designed by the course creator and represent general statements of prescribed learning. Weeks 1-3 focus on satisfying course outcomes centred around basic energy and energy systems knowledge procurement. Weeks 4-6 are intended for students to analyze commercial kitchen energy efficiency retrofits, incentives, and their challenges including barrier to entry and rebound effect. Weeks 8-10 focus on advanced energy applications in kitchens and applying energy knowledge and analytics to conceptualize energy efficiency strategies and practice in the menu design, cooking practice, and kitchen planning.

Pedagogy

Most peer reviewed literature and reports on energy efficiency in commercial kitchens lack a 'chefs' perspective.' Some resources on the topic do a fine job of articulating the details of kitchen retrofits, energy focused incentives, energy policy, and emission targets, however, miss the importance of chefs' decision making on energy use. My extensive experience working in commercial kitchens has made me aware of how menu planning, cooking practice, and behaviour play a major role in energy use. For example, a kitchen could be outfitted with the most energy efficient, *Energy Star* dish washing machine on the market, but if a menu has fifty offerings as opposed to five, the amount of total energy required to run it will vary dramatically. Generally, more menu offerings require more cooking utensils, plate ware, and equipment to execute, increasing the number of washing cycles needed. In addition, these extra necessities have different shapes and sizes creating challenges in optimizing space in a dish washing rack. In other examples, a commercial kitchen could be designed with maximum energy efficiency in mind, however, if kitchen operators fail to close refrigerator doors, leave lights on, or turn on ovens well before needed, energy is wasted.

More meaningful improvements in energy efficiency for commercial kitchens require a holistic approach. In addition to understanding energy principles, emission targets, and kitchen retrofit programs, I suggest chefs take an unconventional, Environmental Education approach, centered around a place-based pedagogy, to consider energy use. In this approach, commercial kitchens should be considered as ‘nature’ and to approach learning with maximum effectiveness, chefs need to embrace the importance of time and place.

Michael Brody outlines his theory on learning in nature which incorporates four principles: physical, personal, social, and time (Brody, 2005). A ‘chefs’ perspective’ on energy efficiency should come from being immersed in and interacting within a physical kitchen. Acting at a social level could help chefs find creative ways of solving energy issues through collaboration. Time, Brody’s final principle, is perhaps the most challenging obstacle for chefs. Commercial kitchens are extremely fast and bustling places. Time for reflection before, during, and after experiences are scarce, but necessary.

Traci Warkentin supports the importance of having a slow pace in place-based pedagogy when nature journaling. Warkentin maintains that nature journalism is most effective when observed during a slow pace to notice “slight diurnal changes” (Warkentin, 2011, p.231). Chefs need to take time to notice subtle changes and usage of energy in day-to-day operation. This is especially important because, as Peter Love points out, “a challenge with energy conservation is that you cannot see it” (Love, 2018). If we cannot obviously see energy use, we should take time and use our senses to identify its use.

A component to this course project requires students to keep an ‘Energy Journal’ for the purpose of using their senses to observe, record, and reflect on energy use in commercial kitchens. The ‘Energy Journal’ is a tool to explore students’ awareness and feelings towards the use of energy in kitchens. Its intent is to become more engaged, caring, and interested in energy use in kitchens and discover opportunities where energy use can be reduced or used more effectively. Included in the course project is an ‘Energy Journal Guide’ to assist students in fulfilling the Energy Journal component to the course.

Main proponents on the discourse of energy efficiency in commercial kitchens will agree that both animate (people) and inanimate (machines and tools) play a major role in energy use. A rationale for selecting an energy journaling approach to place-based pedagogy was to encourage aspiring chefs to observe the connection between living and non-living influencers on energy use in kitchens through sensual engagement. When thought of holistically, animate, and inanimate energy influencers can be considered as parts of an 'energy ecosystem.' To support this view and discover creative pedagogical approaches to this projects challenge, inspiration was taken from Donna Haraway and her notion of cyborg which "rejects the boundaries between human and machine" (Haraway, 1985). Conceptualizing and embracing chefs' connection with technology in kitchens (machines, tools, automation, etc.) could be a very effective way of solving energy challenges.

Frameworks:

There are four frameworks used in the course design.

1. Macro Energy Systems
2. Energy Efficiency Initiatives
3. Technological Innovation
4. Energy-Efficiency Kitchen Community

Macro Energy Systems:

Vaclav Smil's, *Energy: A Beginners Guide* outlines a comprehensive analysis of energy principles and the evolution of energy systems. Technological advance has drastically increased energy efficiency, reducing the cost of energy throughout history. Adhering to mainly quantitative methodological approach, Smil also provides several examples of how cost declines in energy storage and efficiency has led to an increase in demand over time. The "cost of electricity fell from 325 cents per kilowatt hour (kWh) in 1900, to six cents in 2000" (Smil, 2006, p.137).

Peter Love's, Fundamentals of Energy Efficiency: *Policy, Programs, and Best Practices* provides an understanding of the difference between power and energy as it relates to both supply and consumer demand. Addressing humanities effect on and contribution to greenhouse emissions, produced largely from energy generation, one of his main stances revolves around the lack of attention put towards re-thinking energy demand. Love maintains that when it comes to energy efficiency, there needs to be greater emphasis placed on demand rather than supply, a point worth emphasising since demand side management (DSM) programs were originally implemented in response to the energy crisis of the 1970's and not with the goal of reducing Green House Gases (GSGs).

Canada's Energy Future 2019 Executive Summary reveals "the first long-term outlook from the Canada Energy Regulator" (CER, 2020) and offers a forecast of projected long term energy demand. The summary engages with economic and technological factors, climate policy, and behavioral data to predict what Canada's energy ecosystem may look like in 2040.

The International Energy Association's 2019 webinar report reveals a stall in global energy efficiency over the past several years. As energy demand increases due to societal trends, including the increase in size of homes and automobile purchases, attributed to increasing wages, the creation of a call to action has evolved in attempt to accelerate energy efficiency on a global scale. It is worth noting the impact of increased manufacturing and global weather patterns in the discourse on energy demand. The report also places emphasis on the need for improvements in energy policy development and investment from government bodies towards energy efficiency programs.

Natural Resources Canada's *Forward Regulatory Plan 2020/2022* describes the importance and challenge of defining energy efficiency. Apart from standards around minimum energy performance (MEPS), it is important to consider the methodological approach to measuring energy efficiency. Energy efficiency cannot be measured with accuracy unless the human (behavioural) factors are applied to the analysis. For example, the energy efficiency of a refrigerator is affected by how many times it is open and for how long. The design, manufacturing, and maintenance of the fridge could meet MEPS standards; however, one would be remiss not to appreciate the importance of how kitchen operators use it. In the case of a fridge, how do you accurately measure how many times and how long it has been open? Relying on pre-conceived notions and assumptions around how many times we think a fridge might be open and for how long is a faulty method. We need data to back up these claims. Energy efficiency practices also need to become a part of training processes and general meetings for institutions.

Energy systems in commercial kitchens are complex due to the diverse range of energy services required to run day-to-day operations. Adequate lighting is required to perform hands on tasks and assist constant mobility of workers. Heating, cooling, and defrosting of food in its preparation, holding, and storage are essential from a quality and safety perspective which can partly be attributed to stringent regulations set by bodies like Canada's Ministry of Health. For example, a common method of defrosting is to "run tap water over the food until it is defrosted" (Health Canada, 2017). Large foods may take hours to defrost using this method. Additionally, intensive demand for plug load and auxiliary plug load is needed for a multitude of basic and industrial equipment.

Energy Efficiency Initiatives:

Retrofit programs aimed at improving energy efficiency in commercial and industrial buildings vary depending on which jurisdiction they reside in. This course explores the IESO's 'Save on Energy Retrofit Program' as part of its conservation and demand management framework. Incentive levels of the program are based on the "amount of energy or demand savings of the new equipment" (Retrofit Program, 2021). Retrofits that attribute to greater energy efficiency receive more incentivized because of their disproportionate positive impact.

Lighting, HVAC, and equipment improvement incentives from both small and large commercial kitchens are included in the retrofit program. From a monetary perspective, it is difficult to measure the intrinsic value of these incentives, due to lack of data on pre-existing lighting, HVAC, and equipment's upfront and extended use costs. To fully appreciate the value of these incentives, businesses should be diligent in the development of a cost cycle analysis and anticipate future business demand, infrastructure, and strategy. It is important for businesses to establish a dichotomy between upfront costs of retrofits and long-term savings associated with more energy efficient systems.

Some energy efficiency improvements are straight-forward. Commercial kitchen operators can choose to outfit their lighting systems with light-emitting diode (LED) bulbs that emit "up to 90% more efficiently than incandescent or compact florescent bulbs" (Energy Star, 2020). Low-flow water faucets can also be installed to reduce the electricity needed to drive booster pumps.

An example of a component to the IESO retrofit program includes Demand Control Kitchen Ventilation (DCKV) which appears on the 'Cooking Up Savings with Incentives' section of their website. This technology uses "sensors and variable speed controls to ramp up ventilation during busy preparation times" (Retrofit Program, 2021) which is important for several reasons. Firstly, better ventilation mitigates temperature fluctuation reducing the energy required to maintain desired kitchen climate. Secondly, this improvement helps to conserve energy during peak hours. Conserving energy during peak times is essential to mitigate the need to rely on additional processing of fossil fuels to meet energy demands.

Natural Resources Canada (NRC) developed 'Recipes for Energy Savings in Your Kitchen' and 'Green Your Routine Challenge' that aim to connect energy efficiency retrofits with kitchen planning and cooking practice. Recommendations for dish washing like scrapping empty plates rather than rinsing and letting the dishwasher do the rest are suggested. NRC's website also contains resources to quantify energy costs with its 'Energy Calculator' and 'EnerGuide' that aim to help improve decisions on purchase making that positively contribute to energy efficiency. Additionally, certain retrofits can increase property value and positively contribute to brand quality through benchmarking.

Commercial kitchen operators considering energy efficiency retrofits should be aware of the 'rebound effect' as they may be inclined to purchase additional equipment or use them more frequently because of their energy efficiency.

Restaurants Canada, a not-for-profit association, introduced the 'Foodservice Energy Challenge' (Restaurants Canada, 2020) in partnership with the IESO and managed by 'NewSpring Energy,' that aims at encouraging upgrades of new, modern, and high-efficiency equipment. Food service establishments that introduce 'Energy Star' certified equipment versus standard models can reduce their energy use. Such equipment includes griddles, dishwashers, fryers, and hot and cold holding units. The ‘Energy Challenge’ involved several food service operations from large-scale restaurants to university dining halls. Each received an “American Society of Heating, Refrigeration, and Air-Conditioning Engineers’ (ASHRAE) level two energy audit, which identified conservation measures specific to their needs” (Foodservice Energy Challenge, 2020). The IESO and ‘NewSpring Energy’ worked with food service operations to educate and train in energy efficiency practices throughout the year. One of three finalists in the challenge was York Universities’ ‘Stong Dining Hall.’ The university provided two years of electricity and gas consumption data for the hall “so the audit could establish an end-use framework” (Foodservice Energy Challenge, 2020). The audit suggested several energy efficient conversion measures, some of which the university chose to implement and were projected to decrease electricity by 26% and natural gas by 23% on an annual basis. Findings in the report also showed improvements in behaviour that reduce energy demand, post energy audit, such as workers “reminding each other to close fridge doors and switch off lights” (Foodservice Energy Challenge, 2020). Collaborations like the ‘Foodservice Energy Challenge’ that unite food service and energy professionals is an excellent approach to understanding the bigger energy picture. Folks at the IESO may be experts in energy efficiency management at a theoretical and systems level, but without research that is grounded or situated in the field of study, subjective preconceptions of commercial kitchen behaviour may be displaced. For this reason, the ‘Foodservice Energy Challenge’ case study could serve as a useful methodological approach towards energy efficiency in commercial kitchens.

Another organization focused on improving energy efficiency in commercial kitchens is the ‘Leaders in Environmentally Accountable Foodservice’ (LEAF) organization. By targeting “energy, water, and waste, LEAF’s mission is to increase awareness and support of ‘green’ restaurants” (Leaf, 2020) through community partnerships. “LEAF certification offers accreditation to restaurants demonstrating efforts in environmental and sustainable foodservice practices, measured by on-site review from accredited consultants” (Leaf, 2020). Energy use is a part of this review. Although information regarding the organizations methodology on energy assessment is not found on its website, they do provide links to information on sustainability resources, rebates, and incentives including ‘Energy Star, EPA WaterSense, and Conserve,’ as well as the ‘National Restaurant Association’ program aimed at sustainable kitchen practice.

Technological Innovation:

Technological innovation is creating many opportunities for energy efficiency in commercial kitchens. Traditionally, most kitchens are fitted with gas powered stoves that displace heat unevenly and require excessive preheating times that affect kitchen operators' tendencies to "switch on appliances well before necessary, incurring excessive energy consumption" (Batty, et. al., 1988). Modern electric powered 'combination ovens' preheat rapidly and are programed with precise timers, reducing the need to have them constantly running. "Step-by-step outputs that manage proper timing and remote start and stop functions of appliances" (Hashimoto et al., 2008) are examples of how technological operation efficiencies, interacting with kitchen operators, assist in reducing energy demand by mitigating the need for them to be 'switched on.'

Technologies from companies like *Convotherm* do the work of a convection oven, kettle, steamer, and smoker in a singular unit with precision temperature, humidity, and air regulation. Alleviating the cumulative energy requirements of single purpose cooking appliances is a major step in reducing direct energy consumption and indirect energy consumption through less space and maintenance. Notable energy efficiency attributes of Convotherm ovens include 'boiler-less design' that maintains steam levels without the need of a heated water reservoir, 'structured air technology' hosting four separate cooking chambers that service vertical air curtains to control independent temperature, fan speed, and time control in one unit, quality thermal insulation, and built-in cleaning and maintenance (Alto-Shaam, 2018). Vertical curtains in structured air technology helps mitigate temperature fluctuation caused by opening the chamber, reducing the energy required to maintain a constant temperature.

'AirVantage' is a leading integrated kitchen system that uses sensible heat-based resistance temperature detectors that "recognize heat, and through smart read and react ventilation control, directs that heat accordingly" (Hobart Canada, 2018). This system can "reduce airflow as low as 30% and fan energy by 25-70%" (Hobart Canada, 2018). Connected to a touch control panel, the system also provides runtime data for energy and operational savings through its on-screen or USB download.

Further opportunity for energy efficiency lies in digital tools and apps. "Optimism surrounding the potential of artificial intelligence in programs such as Google's 'Deep Mind' in creating opportunities for energy management is growing" (Artificial Intelligence for Building Energy Management Systems – Analysis, 2019). 'Deep Mind' has the potential for improving anticipation and distribution of energy. Human programmers cannot conceive all the potential permutations of energy system problems, however, leveraging large amounts of data with iterative algorithms and compute power, technologies can get to the right answer.

Upfront costs associated with modern cooking technology like combination ovens and induction units can be a limiting factor, however, I am optimistic that they will continue to become common in commercial kitchen spaces and be adopted at an accelerated rate. Disruptive, or place taking technologies tend to withstand a period of short to moderate adoption in their infancy, which can mainly be attributed to cost. Cost, which is inherently linked to demand, is reduced as a function of increased production. To support this notion, Wright's Law provides a reliable framework for understanding cost and manufacturing phenomena. Wright's law states that "for every cumulative doubling in production, cost declines at a constant rate" (Wright, 1936). I am confident that this assertion, although originally discovered in the aerospace industry, can be applied to commercial kitchen technology. This has been the case in many disruptive technologies like batteries, computing, sequencing, etc. (excluding inflation.)

Energy-Efficiency Kitchen Community:

"Commercial kitchens are some of the most profligate users of gas, water and electricity" (Mudie, et al., 2013, p.66) and yet "industrial and academic research on their consumption and energy reduction strategies are lacking" (The Carbon Trust Corporate Sustainability Summit, 2020). To address the issue of carless energy use, chefs' holistic approach must include examining behaviour, menu planning, and culinary pedagogy.

Commercial kitchen design, in many cases, is also counterproductive to energy efficiency. Further complicating profligate energy use in commercial kitchens, fridges are often positioned close to cooking and holding equipment for easy access and increased workflow during food preparation times. Heat from cooking equipment causes increased workload for fridge compressor units. Food preparation also regularly involves multiple hot and cold items that need to be stored in proximity for ease of access. Strict health regulations around holding temperature and storage also affect energy demand. For example, storing fruits and meats beside one another is not professional practice. Regardless of cost and energy saving benefits of communal storage, different ingredients are often stored in separate fridges. kitchen operators also consider the chance of appliance failure, which, if more food items were stored in fewer fridges, could result in more food loss, should a fridge compressor or fan malfunction.

Rather than support a dichotomy between animate (people) and inanimate (technologies) components as main proponents for efficiencies in energy use, I suggest that both are heavily influenced by the other. "Behavior changes and technical advance both affect energy use" (Smil, 2008, p.129). On average, "restaurant kitchens service over 60% of businesses total energy demand" (Mudie, et al., 2013) which can be attributed mainly to cooking equipment, food storage, ventilation, and lighting. At first glance, it would seem an obvious starting point to focus energy efficiency planning on the inanimate technologies that make up culinary spaces. Working in various restaurants, hotels, and catering kitchens across the world, I have discovered that the way kitchen operators interact with technology has a profound effect on energy use. For example, traditional (conventional) ovens are often turned on for entire working days, whether in use or not. Aside from the fact that traditional ovens take a long time to preheat, we must recognize the bigger picture of why kitchen operators tend to leave ovens on all day. It is commonly understood that culinary trade is a physically demanding and strenuous profession. Commercial kitchens are busy spaces that exude excessive pace and pressure which comes from the desire to serve complicated food preparations at peak freshness and optimal temperatures. Managing temperature and timing of food preparation is made increasingly difficult due to short life cycle and rapid decomposition of foods. Food service operations, in large part, are low-profit margin businesses which causes commercial kitchen operators to keep staffing levels minimal. The many pressures placed on kitchen operators cause them to have an 'everything in its place' and 'ready to go' mindset and workspace. In culinary terms, we call this 'mise en place,' which includes having technology switched on and 'at the ready.' Improper 'mise en place' can be the difference between a successful or failed meal service. Food service times can be unpredictable, especially in cases where they serve 'all day items.' To further add pressure to energy demand, technologies such as ovens and grills are not only left on for extended periods of times without being used but are often kept at maximum heat to speed up food preparation. It is not uncommon to maintain a conventional oven at 400 degrees Fahrenheit to cook a steak that requires an internal temperature of 135 degrees Fahrenheit (medium-rare.) Faster pre-heat times and precision settings of modern cooking technologies relieve some necessity for kitchen operators to have ovens 'at the ready,' especially if they can control them via digital connectivity from their smart phone, which are, for all intents and purposes, 'fixed at the hip.'

Ovens are not the only technologies that affect kitchen operators' use of energy. Gas powered stoves are often left on during busy service times. Pilot lights are notorious for extinguishing which cause kitchen operators to scramble for lighters or other less desirable methods of lighting stovetop elements. Gas powered stoves also create carbon build up on the bottom of pots and pans which indirectly places increased pressure on hot water tanks for washing.

Electric induction units are far superior to gas burning stovetops in many ways. Firstly, their magnetic copper wire composition allows them to heat up drastically quicker than gas powered stoves, alleviating the need for them to be turned on in advance. As an added energy efficiency (and safety) benefit, induction units, because of their magnetic component, will only turn on if a pot or pan is placed on them.

In my experience, food service operations allocate most of their spending on enhancing guest experience through product offerings and in-house services. The hospitality sector, including all food service operations, is highly competitive and notorious for having low profit margins partly due to high operating costs and staff turnover rates. Food service operations may not have the excess capital of say, a software company that produces higher profit margins from lack of demand for brick-and-mortar spaces in operation.

Energy efficiency improvements can also be difficult to measure and even harder to show guests. It is not as though you see celebrity chefs and clients posing next to 'Energy Star' certified equipment on Instagram. Commercial kitchen operators could invest more effort in educating their guests on energy efficient strategies that have been implemented. Leveraging social media to communicate and celebrate energy related goals and milestones may be an effective and relatively inexpensive practice.

I would be remis not to include aspects of the COVID-19 pandemic that have influenced energy use in commercial kitchens. "The out-of-home food consumption market has witnessed substantial growth over time" (Kouwenhoven et al. 2012), however, recent events have forced an alternate paradigm, leading individuals and families to cook at home or order takeout. It is also plain to see that packaging and transport of finished food has increased.

'Ghost kitchens' or 'virtual kitchens' "prepare foods from multiple brands in one kitchen and location" (Ghost Kitchen Brands, 2021). Set up for the purpose of food preparation, delivery, and pickup, ghost kitchens require less brick-and-mortar space because they do not require seating areas for guests, decreasing energy service demand from a space heating and lighting perspective. The multiple brand and shared space model of ghost kitchens inspires thought-provoking questions around energy efficiency. Shared spaces may reduce utility bills and certain office related practices like menu printing, freeing up capitol that could be spent on energy efficiency retrofits and planning. Ghost kitchens, apart from having lower overhead costs, are often located outside of urban locations, reducing the cost of rent but increasing transportation costs.

Conclusion:

The Energy Efficiency in Commercial Kitchens course framework is designed for students to gain a holistic view of energy ecosystems at a systems level and in culinary planning and practice. To minimize energy use and maximize its efficiency in pursuit of reducing greenhouse gas emissions, kitchen operators need to think beyond energy supply, demand, and services. Technological innovation, design reconfiguration, and retrofits are promising strategies that can assist in reducing overall energy demand and improve its efficiency. Kitchen operators, as energy advocates, also need to understand how behaviour, cooking practice, and menu planning can influence energy use. Mudie, et al. maintain that commercial kitchens are "profligate use of gas, water, and electricity" (Mudie, et al., 2013). My experience working in a multitude of food service operations confirms this assertion. The route of carless energy use in commercial kitchens is complex and requires a holistic view of energy ecosystems that pays close attention to the relationship between animate and inanimate components. Opportunities for energy efficiency lie in a 'cyborg pedagogy,' by which both animate and inanimate functions work collectively and with mutual goals. I believe that the closer kitchen operators work with technology and become 'part of it,' the closer we can get to improving energy efficiency at an accelerated rate. Collaborative learning of animate and inanimate subjects coupled with domain expertise, on-site professionals, and energy regulators, (as in the case of the of 'Foodservice Energy Challenge') has great potential for energy efficiency strategies. Kitchen operators should also consider simple day-to-day habits like turning off lights that promote energy efficiency and practice energy advocacy.

References

A. (2021, April 16). *Energy Efficient Commercial Kitchen Equipment*. Alto-Shaam. https://www.alto-shaam.com/en/about-us/news/energy-efficient-kitchen-equipment

Batty, W. J., Conway, M. A., Newborough, M., & Probert, S. D. (1988). Effects of operative behaviours and management planning on energy consumptions in kitchens. *Applied Energy*, *31*(3), 205–220. https://doi.org/10.1016/0306-2619(88)90003-7

Brody, M. (2005). Learning in nature. *Environmental Education Research*, *11*(5), 603–621. https://doi.org/10.1080/13504620500169809

Canada, R. (2020). *Foodservice Energy Challenge | Restaurants Canada*. Restaurants Canada. https://info.restaurantscanada.org/energy-challenge#follow_the_journey_0

Canada's Energy Transition: Getting to Our Energy Future, Together. (2018). https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/CoucilReport_june27_English_Web.pdf

Case Study: Artificial Intelligence for Building Energy Management Systems – Analysis. (2019). IEA. https://www.iea.org/articles/case-study-artificial-intelligence-for-building-energy-management-systems

Commercial Food Service Equipment. (2020). Energy Star. https://www.energystar.gov/products/commercial_food_service_equipment

Contract catering sector - industrial energy efficiency. (2020). Carbon Trust. https://www.carbontrust.com/resources/contract-catering-sector-industrial-energy-efficiency

Convotherm - Functions. (2020). *Convotherm.Com/Functions*.

https://www.convotherm.com/Functions

ENERGY STAR® guide for commercial kitchens: spot the savings opportunities with ENERGY STAR qualified equipment: M144-240/2012E-PDF - Government of Canada Publications - Canada.ca. (2013). Government of Canada. http://www.publications.gc.ca/site/eng/420067/publication.html

Environment and Climate Change Canada. (2021, February 22). *Government of Canada charts course for clean growth by introducing bill to legislate net-zero emissions by ...* Government of Canada. https://www.canada.ca/en/environment-climate-change/news/2020/11/government-of-canada-charts-course-for-clean-growth-by-introducing-bill-to-legislate-net-zero-emissions-by-2050.html

Ghost Kitchen Brands (2021) https://www.ghostkitchenbrands.com/indexphp/about

Haraway, D. J. (1985). *A Cyborg Manifesto*

https://www.sfu.ca/~decaste/OISE/page2/files/HarawayCyborg.pdf

Hashimoto, A., Mori, N., Funatomi, T., Yamakata, Y., Kakusho, K., & Minoh, M. (2008). Smart Kitchen: A User Centric Cooking Support System. https://www.researchgate.net/profile/Michihiko_Minoh/publication/228869495_Smart_kitchen_A_user_centric_cooking_support_system/links/09e4150b6ab21e4c9c000000/Smart-kitchen-A-user-centric-cooking-support-system.pdf

Health Canada. (2017). *Safely defrosting foods - Canada.ca*. https://www.canada.ca/en/health-canada/services/general-food-safety-tips/defrosting-safety.html

Hobart Canada. (2018, September 17). *Hobart Canada | Premier Foodservice Equipment*. https://www.hobart.ca/ventilation/dcv-technology/airvantage/

International Energy Association. Energy Efficiency 2019. (2019). https://www.iea.org/reports/energy-efficiency-2019

Kouwenhoven, G. S. B. (2012, March 15). *Reducing Food Waste: An Opportunity for the Innovative Catering Entrepreneur: Gerry Kouwenhoven, Sergej Bulterman, & Vijayender Reddy | Taylor & Francis Group*. Taylor & Francis.

Leafme (2020). LEAF. https://www.leafme.org/home

Learn About LED Lighting. (2020). Learn About LED Lighting. https://www.energystar.gov/products/lighting_fans/light_bulbs/learn_about_led_bulbs

Love, Peter (2018). Fundamentals of Energy Efficiency: *Policy, Programs, and Best Practices*

https://energyefficiencyfundamentals.org/

Mudie, S., Essah, E. A., Grandison, A., & Felgate, R. (2013). Electricity use in the commercial kitchen. *International Journal of Low-Carbon Technologies*, ctt068. https://doi.org/10.1093/ijlct/ctt068

Retrofit program | Business and Industry incentives | Save on Energy. (2021). Independent Electricity System Operator. https://saveonenergy.ca/en/For-Business-and-Industry/Programs-and-incentives/Retrofit-Program

Smil, V. (2008). *Energy: A Beginner's Guide*. Oneworld Publications.

_ebooksclub.org__Energy__A_Beginner__039_s_Guide__Beginner__039_s_Guides_(1).pdf

The Carbon Trust Corporate Sustainability Summit 2020. (2021, July 29). The Carbon Trust. https://www.carbontrust.com/news-and-events/events/2020/10/the-carbon-trust-corporate-sustainability-summit-2020

Warkentin, T. (2011). Cultivating Urban Naturalists: Teaching Experiential, Place-based Learning through Nature Journaling in Central Park. *Journal of Geography*, *110*(6), 227–238. https://doi.org/10.1080/00221341.2011.566345

WaterSense. (2021, March 8). US EPA.

https://www.epa.gov/watersense

WRIGHT, T. P. (1936). Factors Affecting the Cost of Airplanes. *Journal of the Aeronautical Sciences*, *3*(4), 122–128. https://doi.org/10.2514/8.155

Energy Journaling Guide:

Background

In the kitchen, energy is all around us. It's in the lighting, water, fridges, stoves, hoods, and equipment that run our operations. Without energy, there would be no breakfast, lunch, or dinner service. Chefs often don't take the time to observe and reflect on how we use energy, where energy comes from, or the negative effects of energy use.

Although energy is a crucial ingredient in all cooking, chefs should understand and appreciate that the transfer of energy in and out of the things we use in our kitchens needs to come from somewhere. The conversion, transfer, and storage of energy result in the formation of harmful emissions. Chefs concerned with their role in reducing greenhouse gas emissions should search for ways to reduce energy use in their kitchens.

There are many challenges associated with reducing energy in kitchens including: cost, training, and awareness. Another, most obvious one, is that you simply cannot 'see' energy. Although energy considerations are not always at the top of the list, many chefs care about the impact their kitchens have on the environment. Chefs work to reduce their carbon footprint by buying local products and reducing waste. What is often overlooked in environmentally focused kitchen practice is how energy fits in.

Chefs searching for ways to improve energy efficiency and reduce energy use in kitchens can consider retrofits, purchase energy efficient equipment, and/or monitor their monthly energy bills. These conventional methods can be very useful in reducing energy demand; however, experts have discovered that there are other considerations to be mindful of on the topic. Thinking about what equipment, fridges, lighting, or HVAC we use are important, but we must also consider how we interact with and use energy.

Thinking beyond the numbers, like the amount of money on an energy bill or the wattage required to power a piece of equipment, chefs should also consider when and how energy is used. One way to consider energy use in kitchens, from a more holistic view, is through observation, recording, and reflecting in unconventional ways. This activity encourages chefs to keep an 'Energy Journal' for the purpose of exploring their awareness and feelings towards the use of energy in kitchens.

Study Description

Keeping an 'Energy Journal' may be an effective way for you to track and record energy related observations in your daily kitchen operation. This study does not require you to record 'quantitative' (numbers) data associated with energy services such as the amount of wattage required for a light bulb, but rather focuses on concepts like when we turn on an oven in preparation, how long is that oven turned on for during cooking, and how long is that oven left on after the cooking is complete.

There is no right or wrong way to do an 'Energy Journal.' The journal can contain written excerpts, drawings, pictures, stories, information, or even poetry. Another type of journaling that could be compared to this approach is 'nature journaling.' There is no right or wrong way to do a 'Nature Journal.' The intent of doing one is to become more engaged, caring, and interested in nature, or in this case, energy! Think of the 'Energy Journal' like you would a 'Nature Journal.'

The goal of this study is for chefs to take time to think about and reflect on how energy and energy services are used in commercial kitchens and to discover opportunities where energy demand can be reduced or used more effectively.

Duration**:** 3 weeks. Recording in your 'Energy Journal' can happen at any time. Contributing to the journal can also occur outside of the kitchen.

Materials/Resources Required: Writing instrument of your choosing, paper booklet or digital platform for recording, computer with internet access

Instructions:

Step 1: Energy systems can often be complex, but you don't have to be an expert in the space to find better ways of using energy. Watch this video interview to gain some perspective on energy in commercial kitchens and start thinking about '*Energy as an Ingredient.*'

https://latest.worldchefs.org/webcast/food-service-energy-efficiency/

Step 2**:** Consider what you have learned from the video and, using your senses, begin observing your kitchen and how energy fits into daily operation. Guiding questions have been created to help you along your energy journey. Record thoughts, feelings, observations, and questions you have pertaining to energy.

Step 3*:* Using your 'Energy Journal' as inspiration, write a 3-course menu centered around the idea of '*energy as an ingredient*.' Rather than quantifying how much energy would be required from energy services to cook your menu, think about ways to reduce energy needed or increase the effectiveness of the energy that you use.

When chefs create a dish, we often think about how we can maximize the ingredients we use to eliminate waste. We should do the same thing with energy. Not only is maximizing energy efficiency more helpful for the environment, but it also saves money! When we butcher chicken, we usually don't just throw away the bones. We make chicken stock. In fact, without energy, we couldn't even make chicken stock!

*Please refer to the attached document "*Energy as an Ingredient Example Menu*" for inspiration in writing your menu.

Step 4: Attend a recorded Zoom meeting (date TBD) with other study participants to share thoughts about energy efficiency and energy use in commercial kitchens. The meeting will give chefs an opportunity to reflect and discuss the 'Energy Journal' process, talk about its effectiveness, and discover ways in which we can make our kitchens more energy efficient.

Facts About Energy:

Energy is neither created nor destroyed. When you use energy, it doesn't disappear. Energy only changes form when it's used, like when electricity or gas (both are energy) are used for heating and cooling.

When energy is transferred from one form to the next, some of it is wasted. When you hear the term 'energy efficiency,' it usually refers to the amount of 'useful' energy obtained from an energy transfer.

Key Terms:

Energy**:** The universe is composed of matter (physical things) and energy is about the interaction of matter. Energy can be defined as the ability to work.

Heat: Relates to thermal energy or moving heat. Work and heat allow for energy transfer between systems or services.

Energy Efficiency: The amount of useful energy obtained from a system. Energy efficiency can also be thought of as getting more energy output out of less energy input or wasting less energy through the transfer of energy.

Example: A gas stove may be only 30-35% energy efficient. Meaning that only 30-35% of that energy is transferred to the actual pot or pan and 70% is wasted. That wasted energy ends up heating the air and stove top range instead of the actual food. In this case, for every $1 spent on energy, 70 cents are wasted.

Energy Services: What we use energy for. The main energy services are heating, cooling, transportation, and electrical devices (plug load). In this study, water is also considered an energy service because chefs use so much of it, and it requires energy to use.

Guiding Questions:

1. What kind of energy services (heating, cooling, electricity, natural gas, HVAC) are required to run your kitchen?
2. In terms of kitchen climate, do you notice any difference in temperature or humidity at certain times of the day?
3. Describe what type of cooking equipment you use. Do you use induction cooktops, gas cooktops, or a combination of both? What about the ovens?
4. How does the position or placement of energy services work for or against ease of workflow and food preparation?
5. Do you use modern cooking techniques in your food preparation? Sous-vide, for example.
6. How do different cooking techniques influence how much energy is required?
7. When it comes to energy services, are you aware of kitchen retrofit programs your jurisdiction may offer?
8. Can you identify any ways in which energy use could be reduced in your kitchen?
9. How many guests does your kitchen provide food for daily? How does the number of guests you serve affect energy use?
10. How many menu offerings do you have? Do you have different menus throughout the day?
11. When you develop new dishes for a menu, what are the main considerations?
12. Do you know who supplies the energy (electricity, gas) in your kitchen?
13. How do you defrost food in the kitchen?
14. What kind of fridge maintenance practices are in place in your kitchen?

Focus Group Summary:

Based on my experience working in the culinary field and research conducted in this project, the challenge of maintaining an energy efficient commercial kitchen 'ecosystem' is extraordinary for any commercial kitchen operation.

To broaden my understanding of the challenges kitchen operators face in increasing energy efficiency, five professional chef participants were tasked with keeping 'energy journals' as a means of tracking their thoughts, feelings, and inquiries around energy use. Participants were selected to represent a diverse range of food service operations including 'quick serve,' 'fine dinning,' 'casual dinning,' and catering. Research participants were, for the most part, limited to the province of Ontario.

Post completion of contributing to their 'energy journals' over a four-week time frame, chef participants considered how energy use could be thought of as an 'ingredient' in food preparation recipes. This reflection was documented and later discussed with other research participants who completed 'energy journals' using *Zoom.* The reflections and meeting discussion were rich with insights into the challenges chefs face in maintaining energy efficient practices in kitchens.

In analyzing the data gathered from research participants, I discovered a wide range of perspectives, themes, and influences that affect energy use in kitchens. Each participants viewpoints and considerations around energy use were unique, however, certain commonalities were present in each reflection.

Firstly, participants identified several 'factors' bedded in commercial kitchen energy use. 'Energy factors' included:

1. Menu
2. Design
3. Storage
4. Method
5. Service
6. Maintenance

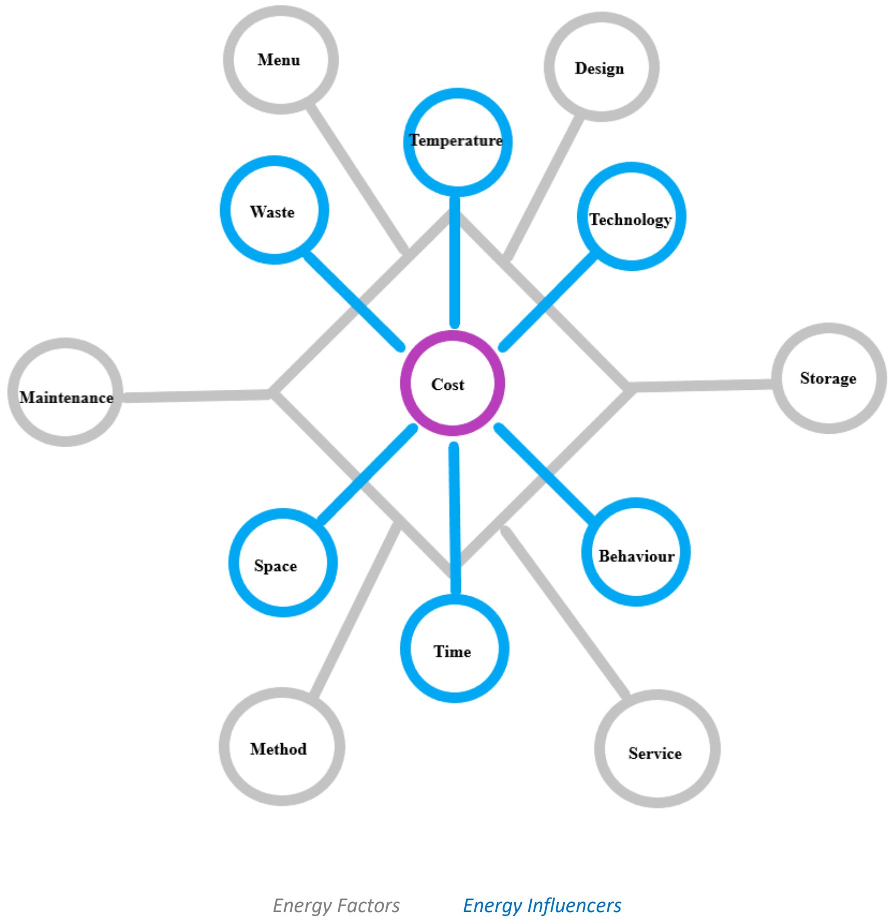
Secondly, research participants referenced a multitude of energy use ‘influencers’ in kitchen operations. ‘Energy influencers’ were accredited to provide rationale and context to how ‘energy factors’ can be accelerated or decelerated. ‘Energy influencers’ included:

1. Waste
2. Space
3. Time
4. Temperature
5. Technology
6. Behaviour

Finally, all participants referenced one foundation that was evidently paramount to aspects of both ‘energy factors’ and ‘energy influencers.’ Notably, monetary considerations were interwoven with many aspects of participants reflections and played a major role in considering energy efficiency and its ecosystem.

The data in this study, illustrates the immense complexity and multitude of elements that influence energy use in commercial kitchens. Its results support the need for a holistic approach to solving energy related challenges. One way of visualizing complex and interwoven elements is presenting them as a nexus. The following nexus represents a holistic view on energy use in commercial kitchen. Cost sits at the nexus’ core to emphasize its significance and connectivity with ‘energy factors’ and ‘energy influencers.’

Commercial Kitchen Energy Nexus



Further analysis of study participants' energy reflections reveals valuable insights into energy use in commercial kitchens. The proceeding analysis highlights various perspectives from research participants on 'energy factors' that contribute to energy use. 'Energy influencers' are identified to support rationale and consideration towards 'energy factors.'

Menus and Energy:

Although menu offerings may not be the first consideration for discovering ways in which chefs can reduce energy use, each study participant pointed to the food they prepare as an important metric in understanding energy efficiency. Participants maintained that offering less items on a menu would reduce overall energy demand in several ways.

Fewer menu offerings result in a reduced number of unique ingredients which results in less overall specialty equipment, waste, and training. In addition to the number of food offerings, participants noted that the frequency of menu changes also influences energy use. The duration of a food service operations' menu offerings is unique to that specific entity or corporation. Some change their menus weekly, while others serve the same food year in and year out. If a food service establishment changes their menu offerings frequently, it adds to the challenge of streamlining consistent, energy-efficient practices. Constant menu changes also require additional work and attention which distract chefs from focusing on other initiatives, like energy conservation.

Participants noted that limiting menu offerings results in a reduction of orders, transportation, receiving, processing, storing, cooking, cooling, and re-heating of food. One Chef suggested that having fewer food offerings, coupled with locally sourced ingredients, reduces emissions caused by transportation and is the optimal strategy for energy efficiency in menu planning.

Design and Energy:

The findings in this study show that the type and placement of equipment that enable energy services greatly affects energy use. One participant articulated that restaurants tend to allocate excessive resources and effort to create customized spaces to make guest feel cared for regardless of energy use considerations. When it comes to food service operations, the resources allocated to designing and creating dinning spaces usually outweigh those spent on the kitchen.

In certain cases, energy efficiency considerations were baked into commercial design. Some study participants expressed pride in explaining how the kitchens they work in are outfitted with induction stoves, modern combination-cooking ovens, and electric broilers which use less energy. Some participants also identified the use of plastic strips on ‘walk-in fridge’ doors to reduce the amount of cold air escaping when opening.

Participants identified some cooking equipment that did not directly require energy services to function, however, impacted energy use because of their use. Wood burning ovens do not require gas or electricity, however, utilizing them causes indirect energy use in several ways. Excessive heat emits outside of a wood burning oven when in use, increasing the workload of space-cooling systems. Wood burning ovens also leave more carbon build up on the exterior of baking trays and pans, requiring more soap and water to remove.

The size of a commercial kitchen affects its energy ecosystem. Participants noted that working in a small space limited the type and amount of equipment they utilize to prepare food, decreasing energy use. Large food service operations, although benefiting from reduced energy demand per number of guests as result of economies of scale, have their own energy challenges. Due to the immense size of one study participant’s restaurant, three separate kitchens were constructed to prepare food for various outlets in its operation to reduce the time it takes servers to get food to a table. The three kitchens are all outfitted with their own set of ovens and stovetops.

Storage and Energy:

Although this study focuses on energy use in commercial kitchens, many participants referenced the frequency of deliveries and storage of products as major contributors to energy use. Purchasing more foods that require refrigeration increases the number and size of fridges required to keep them at their best.

One energy consideration in determining the amount of food Chefs should order is storage. Ordering large quantities of food for a whole week to reduce emissions caused by transportation may seem like an energy-efficient strategy, however, when viewed holistically, may not reduce overall energy use. Larger quantities of food require more fridge space. Additionally, some foods that could be stored at room temperature over short periods, may need to be refrigerated if not used before they spoil. For example, a case of tomatoes is just fine sitting at room temperature for three days but may then spoil quickly and must be discarded. If a Chef orders two weeks worth of tomatoes, they will likely be forced to refrigerate them to avoid spoilage. If that Chef were to order the number of tomatoes needed for three days, they may not need to refrigerate the tomatoes at all.

Method and Energy:

Participants in this study pointed to cooking method as a key factor in determining energy use. Foods prepared without the use of heat often required less energy in production and, in some cases, reduced or eliminated the need for heating foods during service times.

When considering the method of food preparation, more cooking steps often required more energy. Energy use was mitigated when chefs relied on 'combination cooking' tools to perform multiple cooking applications.

Like other 'energy factors', study participants determined their approach to cooking method based on achieving the best food and cost results, not energy efficiency.

Service and Energy:

In this study, the term 'service' refers the periods when customers or guests place an order for food until the time that food arrives to them for consumption. Generally, these periods center around breakfast, lunch, and dinner.

Study participants unanimously noted that during 'service' times, there is greater demand for energy services. Food service operations who offer 'quick serve meals' that must be prepared in under ten minutes from the time a customer orders them, required additional energy use. In some cases, more energy was needed to speed up cooking times and keep food hot to lessen the time it takes to serve food. For example, a deep fat fryer, oven, or grill may need to be kept on its highest temperature setting to cook food fast enough to meet customer expectations.

Food service operations that have extended 'service' times, outside of breakfast, lunch, and dinner require additional demand for energy service to power equipment and systems.

Generally, the longer the ‘service’ time is, the longer equipment must be turned on. In certain cases, some food service operations keep their equipment running all day, even when outside of a ‘service’ period. Participants stated that having everything ‘tuned on’ was part of daily routine in preparation for ‘service’ periods. The actual time when equipment is turned on is not considered, so long as it is turned on before ‘service.’

Maintenance and Energy:

Although minimal, study participants referenced maintenance as a factor in measuring energy demand. One participant outlined how their food service operation carried out routine cleaning of fridge compressor fans to reduce the energy needed to power it and prolong its effectiveness.

When appropriate, leaking water taps were promptly fixed to reduce water waste.

Summary Statistics

Study participants in this research project were professional chefs with a minimum of five years working experience in a food service operation kitchen. The following table outlines statistics that pertain to each study participant.

Participant	Age Range	Location of Work in Study	Type of Food Service Establishment
1.	25 - 30	Toronto, ON	Fine Dining Restaurant
2.	30 - 35	Burlington, ON	Casual Dining Restaurant
3.	35 - 40	Toronto, ON	Quick Service Food Truck
4.	20 - 25	London, ENG	Bistro
5.	40 - 45	Toronto, ON	Culinary Education Institution

Energy Efficiency in Commercial Kitchens: Theory, Planning, and Practice in a North American Context

Instructor: Trevor Ritchie

Email:

Phone:

Office:

Out of Class Assistance: e-mail

Course Number:

Academic Level: Degree-Undergraduate

Course Description: This course focuses on energy services and energy systems. It aims to expand chefs' knowledge of energy use in commercial kitchens in connection to the macro energy system. It also provides a better understanding of how chefs use energy services in cooking related applications and the affects they have on the creation of harmful emissions.

The course provides space for students to consider energy saving opportunities in menu design, cooking techniques, and daily kitchen operation. This course serves as a foundation that kitchen operators can leverage to become more aware of the influence their kitchen ecosystems have in contributing to green gas emissions and to search for creative ways of reducing energy use.

Learning Schedule / Topical Outline (subject to change with notification)

Class	Topic	Reading
1	**Introduction to Energy and Energy Efficiency**	Review: 1. Energy: Beginners Guide (Vaclav Smil, 2006) Chapter 1: Energy in Our Minds: Concepts and Measures https://yunus.hacettepe.edu.tr/~alitiftikci/NEM143/ebooksclub.org__Energy__A_Beginner__039_s_Guide__Beginner__039_s_Guides_%20(1).pdf 2. Energy Efficiency 2019: The Authoritative Tracker of Global Energy Efficiency Trends Report (International Energy Agency, 2019) Pg. 9 – 39 https://iea.blob.core.windows.net/assets/8441ab46-9d86-47eb-b1fc-cb36fc3e7143/Energy_Efficiency_2019.pdf Resources: 1. https://info.ameresco.com/destination-net-zero-white-paper?gclid=CjwKCAiAtouOBhA6EiwA2nLKH8qGl61HiMa1YgaPFNToqaN81vnzIAzv6CuXu2kUMlCSM3nnLCLSgxoCm_sQAvD_BwE 2. https://fishnick.com/fstc/

2	**Emission Reduction Targets at the Macro Level**	Review: 1. The 2020 State Energy Efficiency Scorecard (American Council for an Energy-Efficient Economy, 2020) Chapter 4: Building Energy Efficiency Policies https://www.aceee.org/sites/default/files/pdfs/u2011.pdf 2. Canada's Energy Transition: Getting to Our Energy Future, Together (Generation Energy Council Report, 2018) https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/CoucilReport_june27_English_Web.pdf Resources: 1. https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2019/executive-summary/index.html 2. https://www.nrcan.gc.ca/science-and-data/data-and-analysis/energy-data-and-analysis/energy-facts/energy-and-economy/20062 https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/energystar/Commercial-Kitchen-Guide_E_acc.pdf 3. https://doi.org/10.1016/j.erss.2019.101312
3	**Energy Services in Commercial Kitchens** **Discuss Final Group Project: Designing Menus Focused on 'Energy as an Ingredient.'** **Groups of 3-4 students will be organized**	Review: 1. On Food and Cooking (Harold McGee, 2004) Forms of Heat Transfer pg.780 – 791 http://wtf.tw/ref/mcgee.pdf 2. Benefits of Energy Efficiency in Commercial Kitchens (Energy Star Webinar, 2019) https://www.youtube.com/watch?v=1d3iiU1EbZ4 Resources: 1. https://www.energystar.gov/products/lighting_fans/light_bulbs/learn_about_led_bulbs 2. https://www.epa.gov/watersense/commercial-buildings 3. https://www.youtube.com/watch?v=bXCn4afb7Gg&t=661s 4. https://www.energystar.gov/sites/default/files/asset/document/CR%20ES%20Restaurant%20Guide%202015%20v8_0.pdf 5. https://www.epa.gov/sites/default/files/2017-01/documents/ws-commercial-webinar-slides-kitchens.pdf
4	**Commercial Kitchen Energy Efficiency Incentives**	Review: 1. Energy Star: Guide for Commercial Kitchens (Energy Star, 2012) https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/energystar/Commercial-Kitchen-Guide_E_acc.pdf 2. Restaurant Energy Efficiency: Case Studies (DTE, 2016) https://webtools.dnvgl.com/projects/Portals/8/Public%20Files/Energy%20Efficient%20Cooking%20Equipment%20Technical%20Session%20Presentation%20-%206.30.16.pdf?ver=2018-10-05-204828-190

		Resources: 1. https://www.tandfonline.com/doi/full/10.1080/10789669.2013.842819 2. http://businessdocbox.com/Green_Solutions/73872393-Commercial-cooking-appliance-technology-assessment.html 3. https://thekitchenspot.com/resources/guide-to-streamlining-restaurant-operations/energy-savings-for-restaurants/ 4. https://caenergywise.com/
5	**Commercial Kitchen Energy Efficiency Focused Retrofits**	Review: 1. Save on Energy: Food Service Distributor Discount Program https://saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Foodservice-Distributor-Discount-Program 2. Energy Rates: Retrofits and Energy Efficiency Programs https://energyrates.ca/retrofit-business-ontario Resources: 1. https://www.energy.gov/eere/femp/best-management-practice-11-commercial-kitchen-equipment 2. https://www.energystar.gov/products/commercial_food_service_equipment
6	**Managing Energy in Kitchens: Creating Cultures of Energy Conservation**	Review: 1. Fundamentals of Energy Efficiency (Peter Love, 2018) Section 1, Chapter 4: Conservation Behaviour, System Operations, New Technology and Demand Response https://energyefficiencyfundamentals.org/ 2. Electricity Use in the Commercial Kitchens (Samantha Mudie, et. al, 2013) https://www.reading.ac.uk/web/files/tsbe/Mudie_TSBE_Conference_Paper_2013.pdf Resources: 1. https://academic.oup.com/ijlct/article/11/1/66/2363520?login=true 2. https://info.restaurantscanada.org/energy-challenge#follow_the_journey_0 3. https://pdfslide.net/reader/f/energy-reduction-in-commercial-kitchens-energy-reduction-in-commercial-kitchens 4. https://www.allianceforwaterefficiency.org/impact/our-work/commercial-kitchens-guide
7	**In-Class Quiz**	This quiz will test students' ability to discern key concepts and terminology covered in course content reviews.

8	**Connecting Technological Innovation and Energy Use in Kitchens**	Review: 1. Benefits of Induction Cooking in Commercial Kitchens (Pacific Gas and Electric Company, 2021) https://www.youtube.com/watch?v=0azUPTlJzK4 2. Catering Insight: How Much Energy Could be Saved in Smart Kitchens? https://www.cateringinsight.com/how-much-energy-could-be-saved-in-smart-kitchens/ Resources: 1. https://www.alto-shaam.com/en/about-us/news/energy-efficient-kitchen-equipment 2. https://www.hobart.ca/ventilation/dcv-technology/airvantage/ 3. https://www.iea.org/articles/case-study-artificial-intelligence-for-building-energy-management-systems 4. https://www.convotherm.com/Functions
9	**Designing Menus from an Energy Perspective**	Review: 1. World Association of Chefs Societies: Food Service Energy Efficiency (Richard Young, 2021) https://worldchefs.org/webcast/food-service-energy-efficiency/ 2. Energy Use for Cooking and Other Stages in the Life Cycle of Food (Environmental Strategies Research Group, 2001) https://www.researchgate.net/profile/Annika-Carlsson-Kanyama-2/publication/242408078_Energy_Use_for_Cooking_and_Other_Stages_in_the_Life_Cycle_of_Food Resources: 1. https://www.wsj.com/articles/cities-try-to-phase-out-gas-stovesbut-cooks-are-pushing-back-11626514200 2. https://www.anglianhome.co.uk/goodtobehome/home-news/10-ways-waste-energy-kitchen/ 3. https://www.anglianhome.co.uk/goodtobehome/home-news/10-ways-waste-energy-kitchen/
10	**Cooking Practice and Energy Use: A Chefs Perspective**	Review: 1. The Invisible Ingredient in Every Kitchen (Harold McGee, 2008) https://www.nytimes.com/2008/01/02/dining/02curi.html 2. The Food Lab (J. Kenji Lopez-Alt, 2015) Pg. 36-42 https://archive.org/details/the-food-lab-better-home-cooking-through-science-by-j.-kenji-lopez-alt/page/n33/mode/2up?view=theater Resources: 1. https://www.buildinggreen.com/feature/can-commercial-kitchens-go-electric 2. https://environment-review.yale.edu/how-cooking-method-and-practice-affects-energy-consumption-0

		3. https://www.uswitch.com/energy-saving/guides/energy-efficient-cooking/
11	**Class Discussion and Project Strategy Session**	Inspired by their 'Energy Journals,' student groups will present a 3-course menu centered around the notion of 'Energy as an Ingredient.' Presenting groups are required to provide rationale for how energy use could be limited or used more efficiently in their menus' execution. Students are encouraged to explore energy and cooking from a holistic perspective and should include, but not be limited to behaviour, training, equipment, technology, cooking method, space, timing, holding, storage, etc.… The goal of this project is to strategize and plan ways in which cooking can be performed using energy efficiently and mitigating its waste. Successful projects will critically examine how the connection between chefs (living entities) and inanimate (non-living) entities influence energy ecosystems in commercial kitchens.
12	**Group Presentations**	TBD based on enrollment.
13	**Group Presentations**	TBD based on enrollment.

Mark Structure

Item	Weight
Participation	20
Reflections	25
Energy Terminology and Concepts Quiz	25
Final Project	30
	100%

Course Learning Outcomes

1. Understand the basic principles of energy and energy services used in kitchens.
2. Understand the importance of energy use and energy waste mitigation.
3. Identify types of energy saving actions through incentives and kitchen retrofits.
4. Understand the role of energy efficiency in energy system planning and design in kitchens.
5. Identify opportunities for reducing energy use in cooking method and menu design.

Passing Grades & Good Standing

The passing grade for this course is 50% (D, 1.0). However, across all courses, students must maintain a minimum overall semester GPA (TGPA) of 67% (C+, 2.30) to be considered "in good standing" by the Registrar's Office. All students who fail one course and/or obtain a TGPA below 2.30 will have their academic records evaluated by the Promotion Committee, which will assign a promotion status and set conditions under which a student may or may not continue their studies. Probationary status usually lasts for one term and may be cleared by passing all courses and obtaining a cumulative GPA of 2.30. Students who do not clear probation within the period of one semester will have failed the program and may be removed from the program (after notification from their academic division). The Promotion Committees may advise the Registrar to permit an extension of probationary status for one additional term. Students who fail a course in their declared program of study will have to repeat the course.

Late Penalty

Professors are under no obligation to accept late assignments, tests, exams, or other course materials. Professors may occasionally accept late material when students present documentation of extenuating circumstances, although whether to grant an exception, and the type of documentation required, are at the discretion of the Professor. If a student is unable to complete work in the designated time, they should discuss this matter with the faculty in advance of the due date, although Professors reserve the right to decline requests to complete late work.

Academic Honesty

The minimal consequence for submitting a plagiarized, purchased, contracted, or in any manner inappropriately negotiated or falsified assignment, test, essay, project, or any evaluated material will be a grade of zero on that material.

Assessments

Participation: Students are expected to contribute to dialogue during regular class sessions. Students are encouraged to think critically about the course material and share their thoughts, opinions, feelings, and questions around reducing energy and increasing energy efficiency in commercial kitchens through planning and practice.

Reflections: Students are required to submit reflections based on both weekly 'review' materials (each 400 words max.) outlined in the 'learning schedule.' Classes 7 and 11-13 will not require reflections. Students should utilize this time to work on their final group project.

In-Class Quiz: Quiz to tests students' ability to discern key concepts and terminology covered in course content reviews.

Final Project: The objective of the final group project is to combine the areas of discussion and research covered throughout the course and use the material to apply energy savings considerations in planning and executing menus in commercial kitchens.

Student groups will present their 3-course menu centered around the notion of 'Energy as an Ingredient.' Student groups are required to provide rationale for how energy use could be limited or used more efficiently in their menus' execution. Students are encouraged to explore energy and cooking from a holistic perspective and should include, but not be limited to behaviour, training, equipment, technology, cooking method, space, timing, holding, storage, etc.. Successful projects will critically examine how the connection between chefs (living entities) and inanimate (non-living) entities influence energy ecosystems in commercial kitchens.

Group projects need to be completed in digital format and must be shared and presented during assigned class sessions. Groups will have 30 minutes to present including a 10-minute discussion period for reflective questions. Presentations can include various visual and lecture elements including artistic works, interactive, photography, and/or visual media.

Lesson Plan (Weeks 1)

Lesson: Week 1, Introduction to Energy and Energy Efficiency Duration: 3 Hours Equipment Required: Telecommunications Service, Internet Connection

Learning Objectives: i) Explain key energy concepts and principles ii) Define major units for quantifying energy iii) Identify energy services in commercial kitchens

Pre-learning Review: i) Energy: Beginners Guide (Vaclav Smil, 2006) Chapter 1: Energy in Our Minds: Concepts and Measures https://yunus.hacettepe.edu.tr/~alitiftikci/NEM143/ebooksclub.org__Energy__A_Beginner__039_s_Guide__Beginner__039_s_Guides_%20(1).pdf ii) Energy Efficiency 2019: The Authoritative Tracker of Global Energy Efficiency Trends Report (International Energy Agency, 2019) Pg. 9 – 39 https://iea.blob.core.windows.net/assets/8441ab46-9d86-47eb-b1fc-cb36fc3e7143/Energy_Efficiency_2019.pdf

Timing	Instructor Participation	Student Participation
30 min	Welcome Introduction, Contact Information, Course Syllabus	- Meet and introductory conversation
60 min	**Agenda**: - Defining energy - Energy terms and concepts - Measuring energy - Energy systems - Energy providers	- Lecture format

10 min	- Energy services - Introduction to the concept of energy efficiency - The limitations of energy efficiency - Role of the Chef in energy efficiency **Break**	
30 min	Introduction to final group project Promote team engagement and connect course material to final project Groupings to be finalized by week 3	Listen and discuss
30 min	**Group Discussion** Purpose: Opportunity to recognize the importance of energy use in commercial kitchens. Students encouraged to share thoughts on the presence of energy efficiency in kitchens and discuss energy use in food service operation. Instruction: Share an experience of engaging in a commercial kitchen (lab or professional) that sparked your curiosity on energy use. - Search for common themes within experiences - Discover presence of energy efficiency - Identify diversity in commercial kitchens by jurisdiction, style, size, and output - Identify gaps in training	
20 min	**Review**	

	How did the class material influence your awareness and feeling toward the role of Chefs in energy efficiency? Example: How can kitchen operators contribute to energy efficiency planning and practice? Preparation: - Introduction to Class 2 material review - Briefly discuss Class 2 learning objectives	