From coal to wood thermoelectric energy production: Socio-economic impacts in northwestern Ontario, Canada

by

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ABSTRACT

Dampier, J.E.E. 2015. From coal to wood thermoelectric energy production: Socio-economic impacts in northwestern Ontario, Canada

The province of Ontario in Canada is the first North American jurisdiction with legislation in place to eliminate coal-fired thermoelectric production. Ontario Power Generation's (OPG) coal-fired Atikokan Generating Station (AGS) is the only facility that switched to 100% woody biomass – in 2014. However, the socio-economic impacts of this policy change on the community of Atikokan in northwestern Ontario have not been analyzed. This dissertation synthesizes and presents three separate, strongly integrated papers in journal article format. The first paper presents the current state of peer-reviewed literature relating to three common fuel burning scenarios (biomass, coal and co-firing) for thermoelectric production. Over 150 sources, which included peer-reviewed articles and non-peer-reviewed grey literature such as consultant reports, government documents, and news articles were reviewed. Knowledge gaps related to socio-economic impacts and indicators were identified. The second paper takes a qualitative data analysis approach utilizing interviews with community leaders, current newspaper articles, past consultant reports and archival data, and presents the community's lobby response to the coal ban. Four emergent themes were identified and cross validated. The third paper modeled and compared three potential scenarios at AGS, and an induced economic impact assessment model was developed to assess direct changes in employment at the power plant (and indirect employment at associated local industries), and induced spending patterns of households. The model suggests that the continuation of coal would allow for $82.7M in household spending, the shutdown reduces household spending to $72.1M, whereas the conversion to biomass increases household spending to $83.9M. As the study reveals, biomass conversion could produce a net positive induced economic impact, provided local biomass fuel supply is available. Furthermore, as power-generating authorities grapple with demands to reduce carbon emissions, the Atikokan case may provide insight for other jurisdictions evaluating renewable energy adoption.

KEYWORDS

Atikokan Generating Station, Bioenergy, Boreal forests, Electricity generation, Energy security, Forest biomass, Lignite coal, Socio-economic impacts, Wood pellets.

LIST OF PAPERS

Dampier, J.E.E., C. Shahi, R.H. Lemelin and N. Luckai. 2013. From coal to wood thermoelectric energy production: a review and discussion of potential socio-economic impacts with implications for Northwestern Ontario, Canada. Energy, Sustainability and Society 3(11). doi:10.1186/2192-0567-3-11

Dampier, J.E.E., R. H. Lemelin, C. Shahi, and N. Luckai. 2014. Small town identity and history's contribution to a response in policy change: a case study of transition from coal to biomass energy conversion. Energy, Sustainability and Society 3(11). doi: 10.1186/s13705-014-0026-4

Dampier, J.E.E., C. Shahi, R.H. Lemelin and N. Luckai. 2015. Assessment of potential local and regional induced economic impact of an energy policy change in rural Northwestern Ontario. submitted

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ACKNOWLEDGEMENTS AND FORWARD

The format of this dissertation is becoming more commonplace. Whereas in the past it was common for doctoral dissertations to be formatted in the traditional (British) book format, I, with the encouragement of my committee have taken the approach where chapters are formatted into journal article format. The individual chapters are self-contained, while the dissertation as a whole is an integrated piece of work, with linkages throughout.

Although I am the sole author for chapters 1 and 5 (Introduction and Conclusions, respectively), Chapters 2, 3 and 4 were prepared for peer-review journal submission, and co-authored along with my committee members. My committee members include Drs. Chander Shahi, Nancy Luckai, and R. Harvey Lemelin. Each of these scholars brought a unique gift to the table as they mentored me and helped me navigate the doctoral process.

- Dr. Shahi is a polite and persistent mentor and researcher. He truly modeled what a scholar should strive to become. He taught me to be flexible, to work hard and complete tasks with excellence.
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- Dr. Lemelin challenged me to increase my critical thinking skills and how to approach research from new perspectives. I entering the program with a quantitative background and Dr. Lemelin patiently worked with me as I gained a working understanding of qualitative research methods.

I must also acknowledge my officemate for three years Krishna Homagain who tolerated sharing a confined space with me. His peaceful approach to life, research and teaching is a true inspiration. Finally my wife and two daughters must be acknowledged. They have been understanding every step of the way – especially on those weekends and evenings when "Papa" had to stay home so he could spend three hours writing four sentences. And yes girls at the end of this process, your father will become a doctor… I just won't see patients, write prescriptions or diagnose illness.

CHAPTER 1 INTRODUCTION: MOVING FROM COAL TO WOODY BIOMASS ENERGY PRODUCTION

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BACKGROUND

Globally, coal remains an important fuel in electricity production. It has the world's largest market share for power production, resulting in the highest release of carbon dioxide (CO_2) per kilowatt hour (kWh) (Van Loo and Koppejan 2010). Coal is also an important fuel for North America with 39% of electricity in the USA being produced from coal (US Energy Information Administration n.d.) and 13% in Canada (Natural Resources Canada n.d.).

Although coal is an important fuel, public concern exists about environmental pollution by this exhaustible resource. For example, some studies suggest that the public perceives it is necessary to replace coal with renewable sources (Bang et al. 2000, Wustenhagen et al. 2007). Specifically woody biomass is seen as desirable since it releases less GHG emissions (relative to coal) and hence being less deleterious to the environment. A strong argument for woody biomass as a coal substitute is as follows:

> "When we burn biomass […], we release only that carbon to the atmosphere as CO_2 which the biomass had recently captured from atmosphere during its photosynthetic growth. So there is no net addition of CO_2. In contrast when we burn fossil fuels, we make a net addition of CO_2 in atmosphere because fossil fuels are derived from plants and animals that had lived millions of years back. In that era, the plants and animals had sequestered billions of tonnes of carbon over several thousand years. By burning large portions of that carbon per year, we have released (and are continuing to release) enormous quantities of CO_2 within a very short time of about 200 years. The earth's environment cannot sequester this much carbon at the rate at which it is being released by fossil fuels.

> The result is the net enhancement of CO_2 concentration in the atmosphere, which, in turn, has led to global warming (Abbasi and Abbasi 2010)."

Without replacement planting however, woody biomass burning may have similar carbon emissions to fossil fuel burning (McKendry 2002). This should not be a major concern in the Canadian context because sustainable forest management practice is widespread (Natural Resources Canada 2015), although critiques to Canadian forest management exist (May 2005, Mainville 2011). Properly managed woody biomass has the potential to bring thermal electric production closer to carbon neutrality (Eriksson and Gustavsson 2008, Insam and Knapp 2010).

With 348 million hectares of forest in Canada (Natural Resources Canada 2015), many Canadian forest-related industries remain important; including mature industries such as pulp and paper with a history spanning over 100 years, as well as new emerging industries such as biomass fuel manufacturing industries. According to the Canadian Chamber of Commerce (2011), the market value of Canada's forest products fell by 47% from 2004 to 2009. It was during this time of economic contraction in the forest sector that the Province of Ontario introduced energy policy changes, which banned coal use in thermoelectric production. As a result, all four coal burning thermoelectric generating stations publically-owned by Ontario Power Generation (OPG) were slated for closure. These stations accounted for over 3300 megawatts (MW) capacity employing approximately 770 people (Ontario Power Generation 2011a, Ontario Power Generation 2012a, Ontario Power Generation 2012b, Ontario Power Generation 2012c).

It was anticipated that these changes would cause socio-economic impacts in all four regions where Ontario Power Generation (OPG) operated coal burning stations. Ultimately, Atikokan Generating Station (AGS) ended up being saved when the plan

was established to convert it to 100% woody biomass (Marshall et al. 2010). It was anticipated that the conversion would also increase regional demand for woody biomass (Kryzanowski 2010). With the coal ban policy being enacted, the province of Ontario has become the first jurisdiction in North America banning coal in electricity production (Ministry of Energy and Infrastructure 2009, International Energy Agency 2009).

If AGS had been shut down, its closure would have likely had a detrimental effect on the town of Atikokan, Ontario (48° 45′ 0″ N, 91° 37′ 0″ W; 393 m above sea level) economy. Atikokan is a small isolated community located in Northwestern Ontario. The community's economy is based on forestry, electricity generation, and light manufacturing. There is also retail, tourism and service sectors in Atikokan (Atikokan Economic Development Corporation n.d.). The community is not serviced by passenger flights or rail and has regional bus service three times a week.

The research presented in this dissertation is relevant and important because i) it seeks to identify the gaps in knowledge in the literature related to biomass burning for the Canadian context, ii) it seeks to understand how one Canadian community dependant on jobs from a local coal-fired generating station (Atikokan, Ontario) responded to the coal ban policy over a 10 year period (2003 to 2013), and iii) it seeks to quantify local and regional economic impacts of banning coal. Since Ontario is the first North American jurisdiction to ban coal, knowledge gained may provide insight for other jurisdictions contemplating coal bans.

Theoretical Framework: Resilience Theory

Through a resilience lens this dissertation investigates a community response to the coal ban. C.S. Holling, the author of the seminal paper, "Resilience and stability of ecological systems," (Holling 1972), is often recognized as the "father of resilience

theory". Although Holling described ecological predator-prey relations, the resilience concepts introduced in the paper have been employed broadly by many researchers, across many disciplines (Walker and Salt 2006, Gallopin 2006, Hassink 2010, Simmie and Martin 2010, Daedlow et al. 2011, Stroink and Nelson 2013). Furthermore, resilience theory is increasingly being applied in social sciences research as indicated by an upward trend in citations of over a 10-year period (Swanstrom 2008); although employing caution is essential when applying a theory developed in the natural sciences to the social sciences. A tragic example of overextending a theory is the introduction of social Darwinism (Holling and Gunderson 2002).

Although there are a number of working models (within a resilience view), the adaptive cycle provides a simple yet powerful framework. It is an overarching metaphor in resilience and is often visually represented as a sideways figure-eight, with potential (or capital) on the y-axis and connectedness on the x-axis (Figure 1). Capital in social systems can be defined as the resources, which are incorporated and sequestered for the growing system (Holling and Gunderson 2002). Examples from community development and social systems might include reinvesting tax dollars into community infrastructure, expanding social programs, increasing workforce skills development, or increased matrices of human relationships which could include the individual-level, up to organizations and beyond.

Connectedness indicates the degree to which the system can internally control variables and processes. For example a jurisdiction which is highly affected by political or taxation control would possess a high degree of connectedness. Connectedness is a measure that indicates the degree of flexibility or rigidity of these controls, such as their sensitivity to exogenous forces or perturbation (Holling and Gunderson 2002).

Connectedness in social systems can be defined as the degree and strength to which the agents in social systems are linked (Holling and Gunderson 2002).

Adaptive and maladaptive examples of resilient social systems exist. For example, Levin and others provide such maladaptive illustrations including discriminatory class systems in societies, or the former Soviet Union prior to the fall; these examples maintain and preserve their structure and function over time as exogenous forces unsuccessfully disrupt the status quo; remaining resilient and unchanged (for a time) (Levin et al. 1998). Furthermore, resilience as a concept is not value laden, and highly resilient systems can actually be, "the enemy of adaptive change" (Holling and Gunderson 2002). As a system following the resilience adaptive cycle over time, it flows through four integrated system functions, which lead into one another. The growth and exploitation stage, *r* is characterized by rapid growth or development as the system begins to reorganize from remnants of the previous system and also begins to increase stored capital and connectedness. As the system moves toward the conservation *K*, stage the system builds and maintains the new emerging system with adaptability being replaced with increased efficiency and rigidity (Holling and Gunderson 2002). The rate of system growth diminishes as capital and connectedness increases to the point of over-connectedness. Eventually, enviably and suddenly the system approaches a threshold and crosses into the release Ω, stage. At this point, a perturbation (from an exogenous force) occurs and the connections and capital decrease rapidly as the system disorganizes (Holling and Gunderson 2002). Following this, the system transitions into the renewal stage α stage, where the system re-configures into something new.

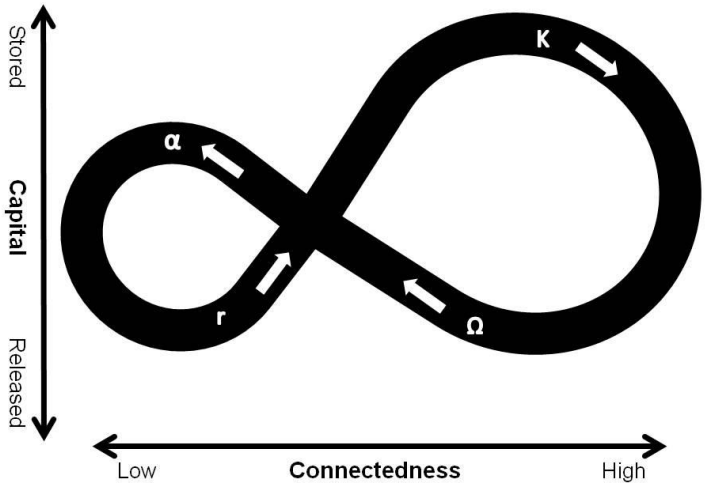

Figure 1: The adaptive cycle. A framework for understanding complex systems and community change.

The adaptive cycle is a metaphor, which is used to describe system change over time. The *r*-phase growth and exploitation eventually gives way to conservation *K* as capital and connectedness increase. The Ω phase is achieved after a threshold is crossed and a disruption causes the system to loose capital and connectedness. The renewal stage α allows for re-configuration as the system moves toward the *r*-phase again. Adapted from Holling and Gunderson (2002)

When applied to a community context, resilience broadens the classical view of growth and efficiency to also include recovery and flexibility (Holling and Gunderson 2002). Resilient systems cannot be controlled (as classical systems views hold) but rather can be directed toward broadly defined desired outcomes.

When a community (such as Atikokan which relies heavily on electricity production jobs) is exposed by exogenous forces (such as policies develop in distant cities which directly affect rural communities), the community's ability to maintain identity, structure and function can indicate its level of resilience. For the purpose of this dissertation, the primary exogenous force is the coal ban, which threatened to close the Atikokan Generating Station (AGS). It is acknowledged that resilience is determined by how well a system (in this case, community) can: i) absorb disturbances, ii) self-organize

and still remain intact, and iii) learn and adapt over time (Holling and Walker 2003). Furthermore, other social systems which do not conform to the pattern of the adaptive cycle could include ones that possess "foresight and adaptive methods that stabilize variability and exploit opportunity." (Holling and Gunderson 2002)

RESEARCH OBJECTIVE

Employing a resilience framework, this dissertation seeks to address three research objectives which collectively aim to shed light on the socio-economic impact of the originally proposed coal ban in northwestern Ontario. The first research objective is to identify the knowledge gaps in the peer reviewed literature by determining the current state of knowledge relating to socio-economic impacts of coal, biomass and co-fire burning in Ontario; and to relate this knowledge nationally and globally, looking outside of Ontario when necessary for insights into the Ontario context. These three fuel options represent coal being the baseline, biomass being a renewable option which would satisfy the coal ban, and co-firing since co-firing increasingly becoming a strategy to reduce carbon emissions.

The second research objective is to characterize Atikokan's historical pre-conditions and residents' attributes and perceptions, which likely led to the community's response to the coal ban that threatened the community's major employer, the AGS. Faced with challenges, such as the loss of a major employer (e.g. AGS), some communities collapse while others find ways to survive and adapt (Dahms 1995, Markey et al. 2008, Besser 2013). But it is not always clear why communities respond to threats in the manner that they do. This objective seeks to answer why.

As the project evolved, it became clear that studying co-firing (investigated in the first objectives) would not be useful in achieving the third research objective; which is to estimate and compare the induced economic impact of three potential scenarios at the AGS: i) continuing to use coal, ii) shutting down and iii) switching to woody biomass. This objective sought to express these three scenarios in terms of dollars, both for the Atikokan economy, as well as regionally.

DISSERTATION OUTLINE

This dissertation first presents a review and discussion of the current state of literature as it relates coal and woody biomass burning in thermoelectric power generation in Ontario. With knowledge gaps understood for the Ontario context, a qualitative case study is presented. The case study sought to elucidate how the town of Atikokan's identity and history factored into its response when faced with AGS possibly shutting down. Following the case study, an economic impact assessment model is developed to assess how an AGS shutdown, as well as the other possible scenarios would impact the local and regional economy. Finally summative conclusions are presented.

Due to the constraints of this dissertation's format, some methodological justification and background was not included in the chapters (which were peer-review journal submissions). These details are included here. A two phase approach was employed after the knowledge gaps were identified in the literature. Community level data was collected by using a qualitative case study methodology, through what Stake (1994) calls an intrinsic case study. An intrinsic case study's primary goal is to "better understand a particular case" because, "in all its particularity and ordinariness, [the] case

itself is of interest (Stake 1994).” Although typically the primary goal of a case study is not to build a theory or to generalize beyond the case (Stake 1994, Yin 2009), it can often provide specific and unique insight, and as argued by Flyvberg may lead to future generalizations from a single case (Flyvbjerg 2006). Yin (2009) also suggests that generalizations can be made from case studies, however, the approach generally does not allow for statistical generalizations, but rather analytic generalizations, where the researcher is, “striving to generalize a particular set of results to some broader theory (Yin 2009).” Furthermore, case studies are a suitable approach when: (a) how and why questions are being posed, (b) the investigator has little control over events, and (c) the focus is contemporary within a real-life context (Yin 2009). These three criteria are met in the current study. Stake (1994), however, challenges that case studies aren’t a methodological choice but rather, “a choice of object to be studied,” which also includes the town of Atikokan community leaders’ perceptions and self-identity.

Collecting robust local data is critical in case study research. Criteria for participant selection followed a purposeful sampling method. The participants have specific features and characteristics (i.e. criteria), which provide detailed exploration and understanding in order to meet the previously mentioned research objectives. Selected participants both represent and symbolise the established criteria (Ritchie et al. 2003, Creswell 2007). Full details of participant selection criteria are presented in chapter 3. The collection of interviews (as well as sources such as newspaper articles, consultant reports and archival data) continued until data saturation was achieved; which is the point where no new analytical insights were gained with additional qualitative data (Morse 1994, Ritchie et al. 2003, Schreier 2012). Saturation is an important practice

(and concept), when employing purposeful sampling because of its', "concurring and confirming" of data (Morse 1994).

Potential participants from the town of Atikokan (who met the criteria from the purposeful sampling method) were invited to participate in a semi-structured interview (DiCicco-Bloom and Crabtree 2006, Kvale and Brinkmann 2009). The data generated from the interviews as well as all other data sources underwent a qualitative content analysis (Krippendorff 2004, Elo S. 2008), which involved iterative and inductive coding, utilizing open coding[1] (Mayring 2000, Elo S. 2008, Saldana 2009). This process involved First and Second Cycle coding which included, "classifying, prioritizing, integrating, synthesizing, abstracting, conceptualizing, and theory building (Saldana 2009)." Coding was data-driven, and as new coding themes emerged they were included and integrated into the coding framework.

Coded data underwent a qualitative content analysis which integrates well with case study research - and when applied together; summary, explication and analysis, through an iterative process can elucidate complex social phenomena (Kohlbacher 2006). Both case studies and content analysis typically utilize a number of recorded communications such as the qualitative sources used in the present study. Furthermore, internal validity can be achieved from multiple sources (Patton 2002, Kohlbacher 2006, Yin 2009).

Following this, the development of an induced economic impact assessment model uses a mixed methods approach with a commitment to pragmatism and to "what

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[1] Saldana refers open coding as "initial coding."

works" (Howe 1988, Johnson 2007, Denscombe 2008, Creswell 2009). Due to the flexibility required, pragmatism allows for a "fusion of approaches" and is "expedient" (Denscombe 2008). The approach employed was inspired by the seminal Input-Output Analysis (IOA) work pioneered by Leontief (Leontief 1936, Leontief 1951, Polenske 1999, Baumol 2000). However the characterization of sectorial interrelationships (a cornerstone of IOA) in the Atikokan economy was not conducted due to lack of reliable input-output data at the town of Atikokan level. Rather, other reliable data sources from Statistics Canada were identified and pro-rated in order develop the model. The community level qualitative data for the town of Atikokan (published and unpublished data) was then incorporated into the model in order to simulate the three scenarios.

The concluding chapter refers back to the adaptive cycle describing the major findings of this research. It appears to be the first time a resilience framework has been used in the town of Atikokan. Since chapters were prepared for peer-review journal submission, the reader may notice that the "voice" in each chapter varies. This is partially a function of each paper undergoing separate independent reviews, followed by the overall dissertation being reviewed by an External Reviewer. Research presented here is part of a broader project, which is investigating other aspects of increased demand for woody biomass throughout the region (Homagain et al. 2014, Hughes et al. 2014, Homagain et al. 2015).

CHAPTER 2, PAPER 1: FROM COAL TO WOOD THERMOELECTRIC ENERGY PRODUCTION: A REVIEW AND DISCUSSION OF POTENTIAL SOCIO-ECONOMIC IMPACTS WITH IMPLICATIONS FOR NORTHWESTERN ONTARIO, CANADA

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ABSTRACT

The province of Ontario in Canada is the first North American jurisdiction with legislation in place to eliminate coal-fired thermoelectric production by the end of 2014. Ontario Power Generation (OPG) operates coal-fired stations in Ontario, with Atikokan Generating Station being the only facility slated to switch to 100% woody biomass. It is anticipated that this coal phase-out policy will have socio-economic impacts. Because of these anticipated changes, in this paper, we review the current state of peer-reviewed literature relating to three burning scenarios (biomass, coal and co-firing) in order to explore the knowledge gaps with regard to socio-economic impacts, and identify research needs which should elucidate the anticipated changes on a community level. We reviewed over 150 sources, which included peer-reviewed articles, and non-peer-reviewed grey literature such as consultant reports, government documents, and news publications. We found very few peer-reviewed articles related to Canadian studies (even fewer for Ontario) which look at woody biomass burning for thermoelectric production. We identify a number of socio-economic tools readily available, and present potential criteria required in selecting an appropriate tool for the Ontario context. For any tool to provide meaningful results, we propose appropriate and robust local data must be collected and analyzed.

Keywords: Atikokan, bioenergy, boreal, electricity generation, energy security, lignite coal, social impacts, wood pellets, gross regional product.

REVIEW

The province of Ontario in Canada has demonstrated its will to expand renewable energy production, encourage energy conservation and create "green" jobs with the passing of the Green Energy Act of 2009 (Ontario 2009, Ontario Ministry of the Environment 2010). These changes have been recognized by one of Canada's most visible environmental non-governmental organizations (ENGO), The David Suzuki Foundation, that Ontario's green energy policies are the most far reaching in North America in terms of clean energy, innovation and jobs (Holmes 2012). The province is also the first jurisdiction in North America with legislation in place to eliminate coal-fired thermoelectric production, making coal use illegal by the end of 2014 (Ontario 2007, International Energy Agency 2009, Ministry of Energy and Infrastructure 2009). In order to be in compliance, facilities are required to follow all established certificates of approval for air, water and land emissions issued by the Ontario Ministry of the Environment (MOE). Although non-compliance would be highly unlikely after the legislation goes into effect, penalties could be established by the MOE, should a generating station burn coal after 2014.

It is anticipated that these coal phase-out policy changes will have socio-economic impacts in all regions where Ontario Power Generation (OPG) operates coal-fired stations, with Atikokan Generating Station (AGS) being the only facility slated to switch to 100% woody biomass (Marshall et al. 2010)[2], while other coal-burning stations such as Lambton and Nanticoke are slated for decommissioning before the 2014

[2] Thunder Bay Generating Station has since committed to biomass conversion. At the time of this paper's writing Thunder Bay was planning to convert to natural gas.

deadline. In this paper we define socio-economic impacts in general terms as social and economic well-being of community members; with well-being defined, "as a person's quality of life. This is influenced by a range of factors, including work, family, community, health, personal values, personal freedom, and a person's financial situation (Human Resources and Skills Development Canada 2013)." Positive socio-economic impacts provided by a company's involvement in a community can include creating jobs, inducing jobs in other sectors, providing physical infrastructure such as parks and recreation centres, paying municipal taxes, and providing charitable donations to civic and community groups. Woody biomass in this paper refers to wood pellets produced from saw dust and forest harvest residues of commercial spruce, pine and fir (SPF) species. Woody biomass is also obtained from harvesting other under-utilized species like white birch (*Betula papyrifera* Marsh.) and poplar (*Populus* spp.). Depending on site conditions and tree species, Canadian boreal forest practices typically follow a 60-100 year harvesting cycle. The AGS will require a total of 90,000[3] oven-dried tonnes (ODT) of biomass wood pellets per year for full conversion, with Atikokan Renewable Fuels supplying 45,000 ODT of biomass wood pellets and Resolute Forest Products Canada providing the other 45,000 ODT[4] (McKinnon 2011, Ontario Power Generation 2011b, Ontario Power Generation 2011c, Ontario Power Generation 2012d). This value

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[3] An earlier study conducted by the Pembina Institute operated on the initial assumption that the Atikokan Generating Station would require 200,000 oven tried tonnes of biomass wood pellets. In light of demand and production costs, the power supply agreement ultimately required 90,000 ODT of pellets.

[4] Identification of the biomass wood pellet source is an important consideration in understanding and developing indirect impact on forest industry which is addressed in the later chapters.

should be easily achievable. Alam and others demonstrated that there is adequate forest harvest residue and underutilized wood biomass feedstock available in northwestern Ontario to meet demand (Alam and Pulkki,R., Shahi,C. 2012). Furthermore, woody biomass stock would also likely come from sawmill residues and waste, further reducing the pressure on forest resources.

Although Ontario is fully converting to non-coal options, many jurisdictions employ co-firing (burning coal along with woody biomass), which is often seen as more environmentally desirable than burning 100% coal, since a portion of the Green House Gas (GHG) emissions will be from fossil fuels and a portion from renewable energy (Morais et al. 2011). Co-firing is becoming more common and is being practiced at commercial scale in many countries such as the USA, Finland, Denmark, Germany, and Belgium (Van Loo and Koppejan 2010). The ratio of coal to woody biomass is very site specific and it depends on a number of factors such as furnace and boiler design, physical and chemical fuel characteristics, and fuel handing and milling units (Van Loo and Koppejan 2010). Utilizing a life cycle approach at AGS, Zhang et al. (2010) indicated that co-firing woody biomass (as an alternative to 100% coal) can be an economically feasible option to reduce GHG emissions in the Ontario context.

At present (2011 values), nuclear power generating stations[5] meet 56.9% demand, and are running at full load throughout a full 24-hour period in order to meet energy base load demand (Pansini and Smalling 2006). Base load is considered the minimum level of power demand. Nuclear power ideally meets this base load demand,

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[5] It should be noted that nuclear power proponents often promote this energy source as "green."

since it has a high electrical production capacity and relatively low production cost. However nuclear power has less capacity to adjust to fluctuations in demand. Hydroelectric power generation meets 22.2% demand, and responds to variations in load to meet the peak demand. Peak production stations are employed to make up capacity at maximum demand periods and in emergency situations (Pansini and Smalling 2006). These can transition from idle to full power production in short periods, to meet these temporary and sometimes unpredictable demands. Peak demand is variable over the course of daily and yearly cycles and is in part contingent on weather conditions, and is managed to a degree with Time-of-Use pricing.

As an important renewable energy source, hydroelectric plants provide "flexibility in base loading, peaking and energy storage applications (Brockschink et al. 2006)." Many smaller hydroelectric generating stations reduce production overnight, storing water to meet peak demand during the following day, with only the largest hydroelectric stations running throughout the night. If the demand exceeds supply by smaller hydroelectric stations, natural gas generating stations, which meet 14.7% demand, begin production. Under this regime coal, which only meets 2.7% demand, is used as a last resort for voltage support[6]. The use of coal for power generation has been on a steady decline (Figure 2). Recent additions to Ontario's power mix include wind, which meets 2.6% demand, with all other energy sources (including solar power)

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[6] All OPG thermoelectric plants produce solely electricity, with no facilities currently producing heat under a Combined Heat and Power (CHP) system, although the Ontario Power Authority is interested in developing CHP in Ontario. *c.f.* http://www.powerauthority.on.ca/update-chpcesop

meeting 0.8% of Ontario's power demand (International Energy Agency 2009, Sher 2011, Nishimura 2012).

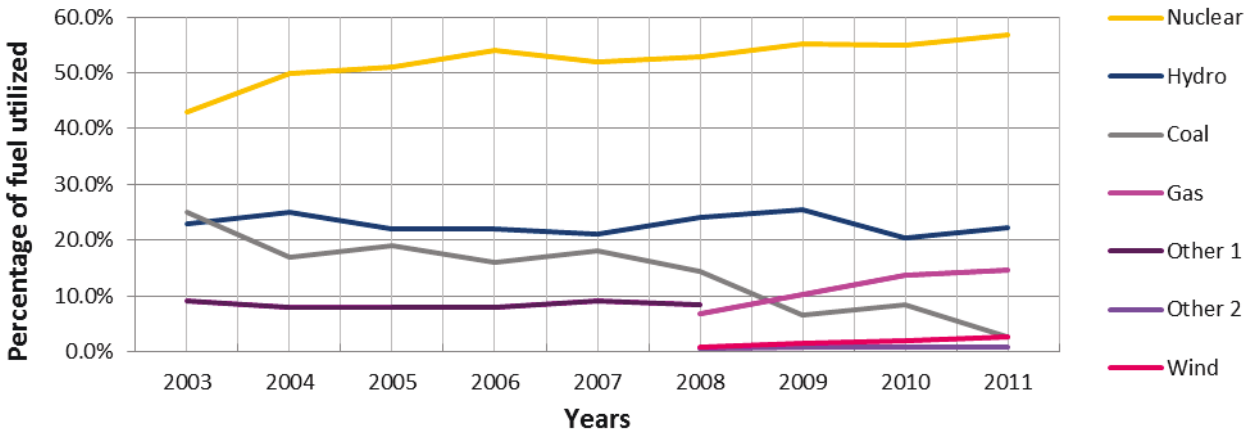

Figure 2. Historical changes in fuel supply used for electricity production from 2003 to 2011.

Raw data from Ontario's Independent Electricity System Operator News Releases from 2004 to 2012 (Independent Electricity System Operator 2011) were used to establish a nine year tread (2003 to 2011) for Ontario's electricity power mix in order to provide an Ontario context. Nuclear (yellow line) and Hydro (blue line) production levels have remained relatively constant over the period. Electricity produced from coal (grey line) has been steadily decreasing over the time period. In 2008, IESO ceased to report natural gas, oil, wind and alternative fuel sources together (Other 1, dark purple line) and broke it apart to report gas (pink line), wind (magenta) and Other 2 (light purple) separately.

Regardless of the electrical energy fuel source, each option has its own environmental consequences such as release of GHGs, particulates, nitrous oxides, and/or sulfur dioxide (Bhattacharyya 1997, Cuddihy et al. 2005). As public support for coal and other fossil fuels continues to wane, renewable sources are being sought (Farhar 1994, Farhar and Houston 1996, Bang et al. 2000, Brechin 2003, Aitken 2007) with biomass-fired power becoming a viable renewable energy option partially because this technology is "rapidly deployable, low-risk, regionally indigenous, and inherently grid-compatible (Baxter 2005)." Wind and solar energy do not possess these characteristics, since they depend on weather conditions (Pansini and Smalling 2006).

Furthermore, woody biomass can provide i) reserve capacity during peak demand, ii) capacity during routine maintenance at other generating stations, and iii) resilience in the power grid, should other generating stations go offline in an emergency.

Whenever the use of woody biomass for power generation is introduced, a variety of public opinions may arise. On the one hand, woody biomass for power generation has many of the above-mentioned benefits; on the other there is documented public opposition (Upreti and van der Horst 2004, van der Horst 2007). The Greenpeace report, "Fueling a Biomess" is critical of Canadian provinces' efforts to stimulate biomass fuel for electricity production (Mainville 2011). The report critiques are directed to the government's "biomass extraction policies and subsidies (Mainville 2011)" and it outlines a number of recommendations to government, many of which represent socio-economic impacts. These include i) Suspend the approval of new bioenergy proposals and conduct a review of existing projects, their wood allocations, and their impacts on communities, climate and forests; ii) Preclude low-efficiency electricity-only production from forest biomass and require that waste heat of biomass electric plants be utilized locally; and, iii) Support the production of higher value wood products from public forests to optimize job creation, minimize resource extraction and develop sustainable solutions for forest based communities (Mainville 2011).

Recommendations such as these imply that the forest management planning process does not routinely incorporate socio-economic considerations. In contrast, forest practitioners, with responsibility for managing public forests in Ontario, operate under the Crown Forest Sustainability Act (1994) (Ontario 1994) that includes requirements for public consultation, and recognizes the necessity for both economic and ecological sustainability. This legislation is implemented through a series of management guides

(Ontario Ministry of Natural Resources 2012) developed to ensure the protection of multiple forest values including cultural heritage (Ontario Ministry of Natural Resources 2007), resource-based tourism (Ontario Ministry of Natural Resources 2001), biodiversity (Ontario Ministry of Natural Resources 2010), natural disturbance pattern emulation (Ontario Ministry of Natural Resources 2001) and species of interest (e.g. marten (Watt et al. 1996), woodland caribou (Racey et al. 1999)). Guide revision is ongoing, science-based, overseen by a joint committee (which includes government, industry, First Nations, academia) and subject to review every five years (Ontario Ministry of Natural Resources 2003). Despite the processes in place, challenges such as those raised by Greenpeace need to be addressed through standard research protocols.

Therefore, the objectives of this paper are 1) to determine the current state of peer-reviewed literature relating to coal, biomass and co-fire burning in Ontario and to relate the current state of knowledge nationally and globally, looking outside of Ontario when necessary for insights into the Ontario context, and 2) to explore the knowledge gaps with regard to socio-economic impacts, under three scenarios, which include 100% biomass burning, 100% coal burning and co-firing.

METHODS

In order to determine generally the current state of peer-reviewed literature relating to biomass burning for thermoelectric generation in Ontario and to identify knowledge gaps in the peer-reviewed literature, the Thomson Reuters (ISI) Web of

Knowledge[7] (Thompson Reuters 2012) was used to find articles covering the utilization of wood-based biomass in thermoelectric power generating stations. This preliminary search was carried out by following the Boolean search string: **"biomass," "wood*" and "thermoelectric*"**. Asterisks were used as they provide the function of a 'wildcard' thus increasing the likelihood of words with suffixes being included in the search. We also preliminarily searched simply **"Atikokan"** in order to help us establish a baseline of all studies conducted in the Atikokan region.

Secondly, since Ontario policy dictates that alternatives to coal must be implemented, we also conducted a more in-depth literature search related to three common burning scenarios:

- **100% coal:** This was searched, since coal is the fuel source that's being phased out at AGS. Although it is not widely used in Canada, it is globally the second most important fuel after oil accounting for 27% of world primary energy demand (International Energy Agency 2009),
- **100% biomass:** This was searched, since biomass is being phased in at AGS. Furthermore biomass is experiencing more attention globally; for example, increases in demand in Europe as they seek to power industry and reduce GHG emissions concurrently (Sikkema et al. 2011) and,
- **Co-firing coal with biomass:** This was searched, since co-firing has been an experimental intermediate stage at AGS, and is employed in

[7] The Thomson Reuters (ISI) Web of Knowledge is described as a premier literature and abstract database platform, which has been designed to help researchers to "quickly find, analyze, and share information in the sciences, social sciences, arts, and humanities."

many jurisdictions as a shorter-term, low-cost option to reduce GHG emissions (Hansson et al. 2009).

In this second search, we used the following Boolean *Topic* search in Thomson Reuters (ISI) Web of Knowledge: **("biomass," "wood*," "coal," or "co-fire") and ("employ*," "product*" or "communit*") and ("electric*)**. We used the search term "electric* rather than "thermoelectric*" as we did in the preliminary search, in order to broaden our results. Then this search was narrowed down separately two more times, the first one by only adding the term **"Canada"** to the original *Topic* search, and the second one by only adding the term **"Ontario"** to the original search. Results where then presented in a pie graph.

Following this, we identified and used relevant articles indicated through forward and backward citations in Thomson Reuters (ISI) Web of Knowledge and Google Scholar[8] (Google 2012). Google Scholar was used in order to reduce the likelihood that related sources would be missed. Additionally, we also investigated the non-peer reviewed literature, such as grey literature and news publications as oftentimes useful information relevant to studies such as our can be found in these source types.

From the retrieved sources utilizing the various abovementioned methods, only those relevant to this paper were included and used to establish a relative abundance of articles categorized by *Literature Type*, *Location*, *Impacts*, *Fuel* and *Combinations*. Then based on the current state of knowledge and gaps, we discuss potential methods for

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[8] Google Scholar is a Google search engine optimized for searching scholarly literature across disciplines and sources such as articles, theses, books, professional societies and online repositories

future work, which should elucidate the anticipated policy changes on a community level.

RESULTS AND DISCUSSION

Our findings from the preliminary Thomson Reuters (ISI) Web of Knowledge search indicate that very few Canadian peer-reviewed articles investigate biomass burning in thermoelectric generating stations. For example, the search **("biomass" and "wood*" and "thermoelectri*")** yielded 6 articles of which only one (Johnson et al. 2010) has any direct bearing to this review. The search **"Atikokan"** retrieved 45 articles, with only 8 of these articles having any bearing on this review further indicating that limited work has been conducted to date which is Atikokan-specific (Wang et al. 2007, Yeheyis et al. 2008, Alam et al. 2009, Marshall et al. 2010, Johnson et al. 2010, Hosegood et al. 2011, Ter-Mikaelian et al. 2011).

The secondary search **("biomass" or "wood*"or "coal" or "co-fire") and ("employ*" or "product*" or "communit*") and ("electric*)** followed by the narrowing term (**and "Canada")** and again the narrowing term **(and "Ontario")** indicated that of the 4954 articles retrieved only 93 addressed Canada and only 10 addressed Ontario (Figure 3); of which, many from Canada or Ontario were actually not suitable sources for this study. Since the literature indicates that most research has been conducted outside of Ontario, Canada, we had to rely primarily on these studies from other jurisdictions.

From the results of our second query it was noted that the top five countries' institutional affiliations are: 1) United States, 2) Peoples Republic of China, 3) England, 4) Germany and 5) Sweden. However, this list might be misleading, since it reflects

countries where universities and other research institutions are located, but not necessarily where the research is taking place on the ground. This list also does not indicate where biomass utilization is currently being employed on a production scale, although “abundant resources and favourable policies” have allowed Northern Europe and the United States to expand biomass utilization for power (International Energy Agency 2007). Wherever possible, we have generalized and related these findings to the Ontario context, addressing the local socio-economic impacts relating to 100% biomass burning, 100% coal burning and co-firing biomass with coal.

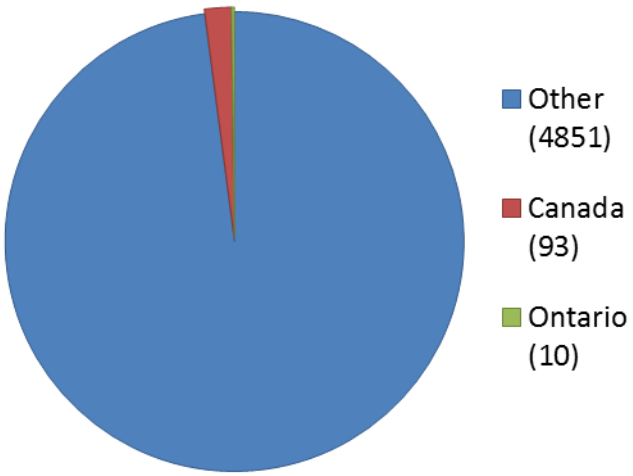

Figure 3. Relative abundance of Canada- and Ontario-based peer-reviewed papers

The search (“biomass” or “coal” or “co-fire”) and (“employ*” or “product*” or “communit*”) and (“electric*) yielded 4954 articles, of which 4851 articles were from outside Canada (Thompson Reuters 2012). The first narrowed down search which included the search term “Canada” yielded 93 articles. The second narrowed down search which included the search term “Ontario” yielded 10 articles.

We reviewed over 150 sources in depth, which included peer-reviewed articles, and non-peer-reviewed grey literature such as government documents, non-governmental organization (NGO) reports and news publications. Of those sources, 74 bearing relevance to our study were cited and summarized in Table 1. It became

apparent that a gap exists in the peer-reviewed literature related to Canadian studies investigating woody biomass burning for thermoelectric production. We found eight sources which discuss biomass burning in Canada (relevant to this study), of which only three are peer-reviewed journal articles. Out of the 74 sources cited in this paper, only 27 of these are peer-reviewed journal articles, with the other articles being classed as academic text books or government, NGO, corporation, and trade publications (Table 1). Although non-peer reviewed literature is an excellent source for knowledge, it is not always subject to the same academic critical review as peer-reviewed journal articles are subjected to.

Table 1. Publications identified and reviewed based on fuel location and impacts

Literature Type	n	%
Peer Review =	27	36.49
Government Publication =	16	21.62
Academic textbook =	6	8.11
Corporation Publication =	5	6.76
NGO Publication =	7	9.46
International Governmental Agency =	3	4.05
Trade publication =	3	4.05
Newspaper / magazine =	3	4.05
Other =	4	5.41
Total =	**74**	**100.00**

Location	n	%
Canada =	35	47.30
Generalized Global =	15	20.27
Abroad =	9	12.16
US =	6	8.11
Mulitple jurisdictions =	5	6.76
N/A =	4	5.41
Total =	**74**	**100.00**

Fuel	n	%
N/A =	22	29.73
Biomass =	*18*	24.32
Multiple fuels =	17	22.97
Coal =	10	13.51
Co-fire =	4	5.41
Other =	3	4.05
Total =	**74**	**100.00**

Combinations	n
Peer Review and Canada =	9
Canada and Biomass =	8
Peer Review and Canada and Biomass =	3

Over 150 articles were reviewed and 80 are cited here and tagged to literature type, location, impacts, fuels and novel combinations.

A primary factor in assessing local socio-economic impacts is the extent to which economic activities remain within the region. In Canada, thermoelectric stations are often built near the fuel source, commonly known as *mine-mouth*; examples include, Boundary Dam Power Station and Poplar River Power Station in Saskatchewan and Sheerness Thermal Generating Station in Alberta. However, AGS has no nearby mine

and uses lignite coal, which is shipped approximately 1000 km on rail from Bienfait, Saskatchewan. Although lignite coal and wood pellets tend to have similar energy density (Table 2), woody biomass is still more expensive to produce and hence generally requires short transportation distances to be most cost-effective (Pansini and Smalling 2006, Kryzanowski 2010) in the absence of subsidies or other incentives. The data in Table 2 is primarily quantitative in nature and generally a good indicator of differences in the three burning scenarios. However, a potential weakness of the values presented, is related to varying market conditions. It is possible that these values for coal, biomass and co-firing may fluctuate, potentially rendering these values less helpful in reality and in the Ontario context.

The phase out from coal to biomass in Atikokan has the potential to provide new local benefits such as necessitating a local biomass supply chain (Van Loo and Koppejan 2010) and it is speculated that it could not only secure current jobs, but also create new ones (Kryzanowski 2010). It has been reported that a greater number of people can benefit from woody biomass production since direct labour inputs for woody biomass production can range anywhere from 2-3 times (Abbasi and Abbasi 2010), to up to 20 times (Van Loo and Koppejan 2010) greater than coal.

Table 2. Comparison of local socio-economic impact factors of burning scenarios

Fuel	Gross calorific value (MJ/kg)	Cost per weight ($/kg)	Cost per caloric value ($/MJ)	Transportation in Canada	Transportation to Aikokan, ON	Relative GHG emissions and carbon neutrality hypothesis (g CO2/kWh*h)	Waste by-products and disposal
Coal	25-27 (McKendry 2002, Demirbas 2003, Pansini and Smalling 2006) 7-18 (lignite) (Schobert 1995)	0.05 (Coleman 2011)	$0.0019/MJ to $0.0020/MJ (lignite)	Mine mouth in many instances. 1000s of km primarily by rail, with some road depending on where production facility is located (Smith 2005, Centre for Energy 2012).	Lignite coal is currently shipped approximately 1000 km from Benoit, SK. All fuel production is located well outside Atikokan's jurisdiction.	850-1116 (Cuddihy et al. 2005, International Energy Agency 2011). Coal releases carbon which was sequester 225 million to 345 million years ago (McKendry 2002, Anderson 2010).	Fly ash can potentially be used in environmental applications (Wang et al. 2006, Wang et al. 2007, Yeheyis et al. 2008).
Wood Pellets	17-22 (McKendry 2002, Pansini and Smalling 2006, Van Loo and Koppejan 2010)	0.21-0.30 (Obernberger and Thek 2010, Pirraglia et al. 2010)	$0.012/MJ to $0.014/MJ	Transported 100s of km primarily by road with some rail should local supplies become depleted (Kryzanowski 2010).	Relatively high cost per unit energy ($/MJ) necessitates relatively short transportation distance from wood pellet production facility.	39-80 (Cuddihy et al. 2005). May be carbon neutral (Akella et al. 2009, Abbasi and Abbasi 2010, Ter-Mikaelian et al. 2011). Releasing carbon which was sequestered within the past 200 years (Marland and Schlamandinger 1997).	Can be used for agricultural and forestry purposes (Nardoslawsky and Obernberger 1996, Demeyer et al. 2001).
Co-fire	***** Depending on fuel mix, values will vary between coal and wood pellets *****					883-906 (Cuddihy et al. 2005).	A potential concrete additive (Johnson et al. 2010).

MJ/kg = Megajoule per kilogram; $/kg = dollars per kilogram; $/MJ = dollars per megajoule; g CO_2/kWh*h = grams of carbon dioxide per kilowatt hour, hour

The utilization of woody biomass in co-firing, as with 100% biomass, has the potential to develop localized wood pellet industries (albeit on a smaller scale), which can benefit local rural economies (Al-Mansour and Zuwala 2010). However, local benefit from woody biomass may not always be realized. If the quantity of required wood pellets is low relative to coal, it may be more feasible to transport biomass a greater distance, rather than create a local production facility.

The World Business Council for Sustainable Development (WBCSD) recently published a report evaluating 10 assessment tools developed for evaluating a company's socio-economic impact (World Business Council for Sustainable Development 2013). Their criteria for inclusion were twofold. Firstly, for a tool to be included it had to focus solely on socio-economic impacts and secondly it had to be developed primarily for business. The document presents and defines the 10 tools, assessing them on 9 dimensions. The dimensions fall under 2 broad categories i) strategic fit (i.e. secure license to operate, improve business enabling environment, strengthen value chains, and fuel product and service innovation), and ii) applicable levels (i.e. site, value chain, business line, company operations at the national level, and company). For each tool, the document also outlines the degree of guidance provided, data requirements, level of effort and example case studies.

In order to properly evaluate the impacts of AGS transition from coal to biomass, choosing the most appropriate method is imperative. Of the 9 dimensions outlined in the WBCSD report we identified "maintaining license to operate" as a key dimension for evaluating potential methods for an impact assessment at AGS, since this dimension is concerned with determining how business activities create "net benefits for the economies and societies in which they operate (World Business Council for Sustainable

Development 2013).” Furthermore, the “site” level is most appropriate for the Atikokan context, since we are most concerned with how the provincial coal cessation legislation affects the AGS site and nearby community. Selecting and employing a tool which address these two dimensions should effectively capture how changes at AGS affect the community.

Also, when evaluating a major change in a small town’s primary industry we feel the selected tool must be readily available in order to expedite implementation, and allow for future comparative analysis across other sites or contexts. A tool for the Atikokan context also needs to best lend itself to a developed country scenario. For example one of the tools, “Progress out of Poverty (PPI)” (World Business Council for Sustainable Development 2013) would not likely be a viable option for Atikokan. Based on these criteria possible candidate tools exist, and may include the Global Environmental Management Initiative Metrics Navigator (Global Environmental Management Initiative (GEMI) 2007), Measuring Impact Framework (Initiative for Global Development n.d.), or Socio-Economic Assessment Toolbox (SEAT) (AngloAmerican 2012). Regardless of the tool, each needs to be evaluated on their own merit and “on functionality, fit for purpose, and cost and complexity of implementation (World Business Council for Sustainable Development 2013).”

CONCLUSIONS

In this review paper, we explored the literature related to burning coal and woody biomass for thermoelectric production with specific reference to socio-economic impacts. It was identified that changes in Ontario’s energy policy which include the total ban on coal burning will have wide-reaching effects on how electricity will be produced

in the province. Since there is very little peer-reviewed research that directly relates to the province of Ontario (and Canada) and the transitions set to take place at AGS, we see this as a timely research opportunity.

We propose that the use of a carefully selected socio-economic impact tool could effectively characterize potential socio-economic impacts as a community anticipates transitions related to a wholesale change in fuel utilization in its local thermoelectric generating station. In order for socio-economic impact assessment tools to be valid and meaningful, appropriate and robust local data must be collected through various means, following an accepted and proven approach, such as one or more of the tools presented by WBCSD (World Business Council for Sustainable Development 2013), that will require local community involvement and support. This proposed research is necessary in order to address concerns raised by groups such as Greenpeace and to gain insight into the impacts of the transition from coal to woody biomass. Future research should explore these issues at a greater depth, using AGS as the only North American case study of this scale currently available.

LIST OF ABBREVIATIONS

AGS: Atikokan Generating Station

CO_2: carbon dioxide

ENGO: environmental non-governmental organization

GDP: gross domestic product

GEMI: Global Environmental Management Initiative

GHG: green house gases

GRP: gross regional product

IEA: International Energy Agency

I-O: input-output

kWh: kilowatt hour

MJ: mega joule

MOE: Ontario Ministry of the Environment

OPG: Ontario Power Generation

PPI: Progress out of Poverty Indicator

SEAT: Socio-Economic Assessment Toolbox

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

All authors contributed to this review. JEED and CS collected and sorted the sources and information material and prepared the manuscript. HL provided critical revisions and provided technical input related to literature analysis, and socio-economic impacts. NL provided critical revisions and technical input related to forest management practices in Ontario. All authors read and approved the final manuscript.

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CHAPTER 3 PAPER 2 SMALL TOWN IDENTITY AND HISTORY'S CONTRIBUTION TO A RESPONSE IN POLICY CHANGE: A CASE STUDY OF TRANSITION FROM COAL TO BIOMASS ENERGY CONVERSION

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ABSTRACT

Background

In 2002, the provincial government of Ontario first announced plans to close all coal-burning thermoelectric generating stations. Facing the loss of local jobs should the local generating station close Atikokan, Ontario residents responded. This research seeks to answer the following question; What are Atikokan's historical pre-conditions, and residents' attributes and perceptions which likely lead to the community's response, and do these characteristics relate back to the broader body of knowledge?

Methods

Our study investigates the Atikokan Generating Station (AGS) conversion from coal to biomass wood pellets as a case, exploring the extent to which the community's identity played in response to the policy change. The current study takes a qualitative data analysis approach utilizing interviews with community members, current newspaper articles, past relevant consultant reports and archival data. Data collected were coded to themes using NVivo 10 software. Four emergent themes were identified and cross-validated.

Results

The emergent themes are i) traditions of resource-based industry congruent with producing and burning forest-based renewable fuels, ii) historical linkages to a strong entrepreneurial ethic, iii) community members' recognition of AGS's multifaceted role in the community, and iv) strong community spirit and desire to fight for their town. These themes appear to have been prerequisite in order to successfully engage provincial government, and we demonstrate that these findings are somewhat corroborated back to the broader literature.

Conclusions

Furthermore, as power generating authorities elsewhere grapple with demands to reduce carbon emissions, the Atikokan case may provide insight for other jurisdictions evaluating renewable energy adoption.

KEYWORDS

Bioenergy, Atikokan Generating Station, Lignite coal, Social impacts, Wood pellets

BACKGROUND

Rural and small towns can be defined as having an urban core of less than 10,000 people, and being "outside the commuting zone of centres with population of 10,000 or more" (Bollman 2001). These communities are often seen as possessing a trusting network of strong interpersonal relationships (Tiepoh and Reimer 2004, Besser 2009). Furthermore, the history, attributes and perceptions of the citizens can be important factors contributing to this identity. How community members see themselves can contribute to the social capital which small towns use to solve problems while facing crisis.

On 9 September 2002, a trajectory regarding energy policy in Ontario was established when former Premier Dalton McGuinty publically referred to the coal used in thermoelectric power generation as, "Environmental enemy number one. It is 19th century. It is dirty. It is dangerous. And we're going to get rid of it." (Canadian Broadcasting Corporation 2013a). These were provocative statements; especially considering that in 2002 over 20% of the electricity produced in Ontario was from four coal-fired generating stations. In total, these four coal-fired stations, publically-owned by Ontario Power Generation (OPG), accounted for over 3300 megawatts (MW) capacity and employed approximately 770 people (Ontario Power Generation 2011a,

Ontario Power Generation 2012a, Ontario Power Generation 2012b, Ontario Power Generation 2012c). Shortly after the announcement, an initial plan and timeline was revealed, which would see the decommissioning and closure of all coal-based generating stations in Ontario. If implemented as originally proposed replacement generation capacity would have come from other generating stations (such as hydroelectric or nuclear) in other communities (Dampier et al. 2013). Current Ontario Premiere Kathleen Wynne framed the argument not in terms of a feasible business case for power production, but rather in terms of government savings in other domains.

> "Becoming a coal-free province is the equivalent of taking up to seven million cars off the road, which means we'll have cleaner air to breathe, while saving Ontario $4.4 billion in health, financial and environmental costs (Canadian Broadcasting Corporation 2013b)."

If implemented as originally proposed, these closures would have led to reductions in generating capacity for Ontario, the loss of direct OPG jobs, and the loss of indirect and induced benefits created by these jobs. Of the four communities where OPG operated coal-fired thermoelectric power generating stations, the small isolated community of Atikokan (48° 45′ 0″ N, 91° 37′ 0″ W; 393 m above sea level) in northwestern Ontario, was presumed to be the most vulnerable due in part to its remoteness and reduced opportunities for employment – should the generating station close. Atikokan's nearest neighbouring centres include Thunder Bay (population approximately 110,000) 200 km to the west, Fort Frances (population approximately 8000) 150 km to the east and Dryden (population approximately 7500) 200 km to the north. Adding to the sense of isolation, the community is not serviced by passenger flights or passenger rail and only has bus service three times a week. This is in stark contrast to the other three OPG generating stations which are either in a major centre, as

is the case with Thunder Bay Generating Station, or closer to major centres in more densely populated Southern Ontario, as is the case for both Lambton and Nanticoke Generating Stations.

The Town of Atikokan was established in the early 1900s when the Canadian Northern Railway (later the Canadian National Railway) built a divisional point near the town centre. Rail divisional points were required during this era in order to resupply locomotives with water and coal. They were partly responsible for establishing small communities across Canada by providing local railway jobs (Lucas 1971). During this time, Atikokan had a population of about 250 to 300 people (Boland n.d.), and train transportation was the only way to access the community. The road to Port Arthur (now Thunder Bay) was built in 1954 and the road to Fort Frances was built in 1967 (Boland n.d.), further illustrating the community's isolation for approximately half of its existence.

Despite its isolation, the town experienced some population growth in the 1930s, when high grade iron ore was discovered and mined nearby, and again, in the 1940s when the ore was used to support the war effort (Boland n.d.). After the war, the mines continued operating until the last two were closed in 1979 and 1980 (Anonymous 2004, Boland n.d.), making forestry the only remaining major employer in the post-mining era (Anonymous 1980). Without mining as the community's base industry, the town faced an uncertain future. This uncertainty sparked the community to successfully lobby the Ontario government to build the Atikokan Generating Station (AGS), which was commissioned in 1985 at a construction cost of $750 million. Adding new power generating jobs to the existing forestry jobs helped stabilize the community's economy. However, in 2008 the community experienced a collapse in the forest sector, which had

wide reaching negative effects on the community (Anonymous 2009a). This, coupled with the possibility of losing approximately 90 well-paying jobs at the AGS due to the provincial coal cessation policy (Ontario Power Generation 2011b), further exacerbated economic worries.

As details on the proposed coal cessation were being worked out, and community-level impacts anticipated, the provincial government promised the Town of Atikokan that the community would not experience negative effects by changes in the policy. The government's commitment became more clear when the Minister of Energy, Dwight Duncan, stated in the provincial legislature on 2 May 2005 that, "The people of Atikokan have had our assurance - that plant, when it is closed - will be replaced with 90 new jobs (Canadian Broadcasting Corporation 2013a)." This promise was welcomed by the community; however, without a clear commitment of resources, it was received with some doubt. According to Liberal Member of Provincial Parliament (MPP) for Thunder Bay – Atikokan, Bill Mauro, doubts were allayed when the first tangible sign of financial commitment came in the 2006 provincial budget (McKinnon 2012). In that year's budget, the government responded to the community's lobbying when $4 million were allocated to establish the Atikokan Bio-Energy Research Centre (ABRC) with its stated goal "to explore cleaner forms of electricity generation and encourage economic opportunities in Ontario's north (Ontario Centres of Excellence 2012)." The research centre was composed of 29 professors and 87 students from Ontario colleges and universities, and ran from 2007 to 2010 (Ontario Centres of Excellence 2012). The ABRC stimulated interest in non-coal fuel sources for thermoelectricity production, and

when the Liberal government signed into law legislation banning coal use in power generation (Ontario 2007), forest biomass[9] was seen as a potentially viable alternative to coal. This commitment of funds also suggest that the government's ultimate desire to fund a solution would keep the AGS operating. Research generated from the centre and other sources suggested that although the AGS was originally designed to burn lignite coal, alternative fuels existed and included peat, unutilized wood, forest harvest residues and wood mill waste (Anonymous 2006). Ultimately among the competing fuel options, the research indicated that the generating station could burn biomass wood pellets since pellets could be designed similarly to lignite (Marshall et al. 2010, Ontario Centres of Excellence 2012, Dampier et al. 2013). An additional local benefit of burning pellets included the creation of a local value chain from underutilized forest trees species and unutilized forest product wastes.

Proof of concept testing with biomass wood pellets began at the AGS in 2008. During one of these tests AGS experienced a setback, when a dust explosion occurred. Although no one was injured, the facility sustained damage (Marshall et al. 2010). The incident review ultimately led to the identification and implementation of major fuel-handling modifications in order to safely handle biomass fuels (Marshall et al. 2010). With these modifications the once 100% coal burning generating station was transformed to a 100% biomass wood pellet burning station, making this conversion one of the world's largest at this scale, and making AGS the largest 100% biomass

[9] Biomass defined herein is as plant-based products harvested from Ontario's forests for the purpose of thermoelectric energy production.

thermoelectric generating station in North America (at time of publication) (Ontario Power Generation 2013).

LITERATURE REVIEW

Academic peer-reviewed journal articles and the grey literature indicate that the most successful and resilient isolated, rural communities tend to possess at least one strong base industry which oftentimes is linked to a primary resource sector such as agriculture, fishing, forestry, energy or mining (Rosehart 2008, Ashton 2009, Beshiri 2010); or to other industries such as tourism, government administration or defense (O'Hagan and Cecil 2007). Furthermore, communities that possess an empowered and engaged populous can be successful in reaching their specific goals (de Gomez and Bullock 2012). Another important factor in community success is related to the perception of commuting distance to a larger centre, which can often provide jobs when local jobs disappear (O'Hagan and Cecil 2007, Harris et al. 2008).

The literature also indicates that communities which rely on primary resource industries can be vulnerable to external factors such as volatile commodity prices and fluctuations of the resource (Hayter 2000, Woodrow 2002, O'Hagan and Cecil 2007, Lawrie et al. 2011, Alasia and Hardie 2011). Although potentially vulnerable, rural communities with strong base industries also can experience increased employment rates, good income levels, lower cost of living, affordable housing, lower crime rates and opportunities to participate in volunteer groups (Turcotte 2005, Lawrie et al. 2011). Communities with the ability to identify potential vulnerabilities anticipate potential economic and social shocks are often more successful and resilient long-term (Besser 2009, Besser 2013).

According to Rosehart, successful communities in northwestern Ontario generally require: (i) a stabilized economy, (ii) capacity building for the new economy, and (iii) growth for a prosperous economy (Rosehart 2008). Had the coal cessation policy led to the closure of the AGS, these necessities for socio-economic well-being would have gone unmet and the decision would have likely: (i) destabilised the Atikokan economy, (ii) reduced capacity for new economic activities, and (iii) shrunk and impoverished Atikokan's population.

We developed the following problem statement for the current research. Faced with similar socio-economic challenges, such as the loss of a major employer, some communities have collapsed while others have found creative ways to survive and adapt (Dahms 1995, Markey et al. 2008, Besser 2013). But it is not always clear why communities respond to threats in the manner that they do. When Atikokan residents realized that the community's major employer, the AGS, was potentially slated for closure they did not take a passive role. This study strives to answer the following research question: What are Atikokan's historical pre-conditions and residents' attributes and perceptions which likely lead to the community's response, and do these characteristics relate back to the broader body of knowledge? Through a historical and contemporary lens, we view this as a timely research opportunity, which may provide insight for other communities facing major employer loss, evaluating the adoption of renewable energies, engage in sustainability and develop overall community readiness.

METHODS

This paper employs a qualitative data analysis approach, utilizing 1) interviews with community members, 2) current newspaper articles, 3) past relevant consultant reports and 4) archival data.

Data collection

During the summer of 2013, 25 in-depth semi-structured interviews were conducted. We purposefully sampled highly knowledgeable participants in order to gather professional and expert observations and perceptions related to Atikokan's local economy, social activities, industrial activity and conversion at the AGS. The criteria included:

a) having a direct connection to business, governance, entrepreneurship or industry activities within Atikokan,
b) having a good historical knowledge of Atikokan's natural resource based economy (i.e. forestry, mining, etc.),
c) having a knowledge of the new industrial processes which will be introduced to the Atikokan economy (i.e. wood pellet production and supply value chain).

Participant selection was conducted with the purpose of ensuring that the research question would be addressed, while including some participant diversity thus allowing for a range of participant points of view (Ritchie et al. 2003). For example, when participants from the same organization were interviewed, we looked for participants with a variety of job responsibilities or years in the community. Purposeful participant sampling continued until data saturation was reached, which was the point when "no new analytical insights [were] forthcoming (Ritchie et al. 2003)." It appeared that data saturation began to occur after interviewing the 16th participant.

Questions posed to participants were generally semi-structured (Ritchie et al. 2003, DiCicco-Bloom and Crabtree 2006), and pertained to: occupation, years in community, recreational activities, and participation levels in the local economy. Participants were also asked to what extent the AGS contributes to the local economy, and their perceptions of how future woody biomass burning might affect the town's economy.

After the initial transcription and preliminary first round of interview coding, we randomized the order of the interviews and conducted a second round of coding to help ensure interviews had sufficient coding coverage. In order to ensure our coding and content analysis was valid and replicable, direct participant quotes were included whenever possible. These direct quotes explicate our coding inferences and themes (Krippendorff 2004, Saldana 2009).

Based on the aforementioned participant selection criteria, 25 interviews were conducted with 20 community members. Due to the depth of some participants' knowledge, follow up interviews were required. Participants represented the following distinctions; municipal and provincial government, economic development, entrepreneurism and business, health care, power generation, forest products industry, tourism and culture, and education. Thirteen of the 20 participants, or 65% have lived in Atikokan for over 15 years, with 4 participants living in the community less than 5 years. Three participants do not live in Atikokan, but have a strong connection and knowledge of the community. Most interviews were audio recorded totaling over 30 h of recorded audio, with over 20 h transcribed for further analysis. In the instances where the interview was not recorded, we relied solely on research notes collected during the interview.

Participants were given the choice to either remain anonymous or disclose their identity. For individuals wishing to remain anonymous all identifying characteristics were stripped from their interview transcripts. All participants directly quoted were contacted via follow up email to ensure accuracy of the quote as well as to confirm ongoing consent. Participants were invited to review a summary of the findings via email or phone, prior to submission for publication.

In addition to interviews, local newspaper articles printed in the Atikokan Progress[10] from 2008 to 2013 were collected. Criteria for newspaper article selection followed similar criteria for participant selection (i.e. articles reporting Atikokan's local economy, social activities, industrial activity and conversion at the AGS.) We focused on this interval because it marks the time period covering the conclusion of the ABRC work, through to the commencement of approvals and conversion of the AGS.

Finally, all relevant, applicable and available community-level consultant reports (n=16) were included. Over the years, studies were commissioned by various groups (such as the now defunct Quetico Centre) as well as the currently operating Atikokan Economic Development Corporation (AEDC) which is a non-profit, community-based corporation. These reports were selected on the basis of being congruent or peripheral to our research objectives and were used to provide a basis for cross-validation and contextual depth. Reports commissioned by the AEDC were particularly useful since their mandate is somewhat aligned with the study's research question. The AEDC's

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[10] The Atikokan Progress has been publishing local news content weekly since 1950. Criteria for article selection included stories which mentioned: the AGS conversion, the community concern about the AGS, the entrepreneurial and local market conditions, and the potential pellet suppliers.

goals are to work "in partnership with the people of Atikokan and the surrounding areas, to generate and maintain permanent employment through the creation and support of self-employment initiatives and economic-based community projects (Atikokan Economic Development Corporation 2013)". Furthermore, relevant historical and archival community data were collected from the Atikokan Centennial Museum's archives.

Data analysis

Each interview was transcribed, and then checked against the audio recordings for accuracy, before being imported into the Computer Assisted Qualitative Data Analysis Software (CAQDAS) NVivo 10 (QSR International Pty Ltd 2012). Since the interviews were semi-structured and open-ended (allowing participants to speak freely), we followed a qualitative data analysis approach (Krippendorff 2004, Elo S. 2008). Upon transcription each interview was initially coded (Saldana 2009) to themes based on the research questions. New coding themes emerged through the process and were included and integrated into a nested coding structure (Appendix 1). As the NVivo 10 software was populated with more interviews, an iterative process was employed in order to "back-fill" previous interviews with appropriate codes.

Four key themes emerged, providing insight into the historical community pre-conditions which created a cultural climate conducive for the conversion to take place. These themes also provided insight into the current community attributes and perceptions which supported the transition to biomass. The themes include:

i) traditions of resource-based industry congruent with producing and burning forest-based renewable fuels,

ii) historical linkages to a strong entrepreneurial ethic,

iii) community members' recognition of AGS's multifaceted role in the community and,

iv) strong community spirit and desire to fight for their town.

After the interviews were coded, all other sources were then imported and coded in the CAQDAS. Coded content from the interviews, newspaper articles, consultant reports and archival data were then analysed using NVivo 10's *coding query* and *matrix coding query* functions. Themes were initially assessed using frequency counts based on source, *versus* themes which addressed the research question. Summary results are presented in table form (Table 3), followed by an explication of coded themes by inclusion of direct quotes and paraphrases from interview participants, newspaper articles, consultant reports and archival data.

We only accepted emerging themes as potentially valid when they reoccurred. When a theme occurred once it may have been an accident, twice was considered a coincidence, and three or more occurrences (from different participants) suggested the theme occurrence was beyond mere chance and a pattern was emerging in the data (Berg and Lune 2012).

RESULTS AND DISCUSSION

The results of the matrix coding query are presented in Table 3, and display the four emergent themes as they were coded within each data source. The table indicates that the four themes exceed the minimum three occurrence rule we established, *a priori* (Berg and Lune 2012). For example, for each of the four coded themes, occurrence rates range from 27 to 44 summed across all sources.

Table 3 also includes the number of sources where a particular theme was detected. For example, our analysis included 20 interview participants of which 19 interviews mention the *traditions of resource-based industry congruent with producing and burning forest-based renewable fuels*, 15 mention *historical linkages to a strong entrepreneurial ethic*, 17 mention *community members' recognition of AGS's multifaceted role in the community*, and 13 mention *a strong community spirit and desire to fight for their town*. Not all sources are included in the explication below since some redundancy of content occurred.

Table 3. Emergent community themes versus data source frequency counts

		Source				
		Interview participants	Consultant reports	Newspaper articles	Archival data	Total
Theme	i) traditions of resource-based industry congruent with producing and burning forest-based renewable fuels	19	8	15	2	44
	ii) historical linkages to a strong entrepreneurial ethic	15	3	7	2	27
	iii) community members' recognition of AGS's multifaceted role in the community	17	4	6	0	27
	iv) a strong community spirit to lobby and "fight for our town"	13	6	4	5	28
	Total number of sources	20	16	46	26	

Traditions of resource-based industry congruent with producing and burning forest-based renewable fuels

Data from participant interviews, newspaper articles, consultant reports, and archives indicate that the Atikokan area has a long tradition of natural resource-based industries which include forestry and forest products (as well as mining, however, mining falls outside the scope of the current study). These industries are viewed as positive contributors to the local economy and there appears to be comfort among

community members with its continuation and expansion in light of changes at AGS and the nascent wood pellet industry.

Historical underpinnings are outlined by (McEvoy and Gustafson 1985). They report that the early 1900's saw the initiation of modern forest operations when lumberman, J.D. McArthur first brought, "machinery to Atikokan and set up a sawmill two miles west of the town". The mills were mobile units, and for years this was how wood was processed in the region. McEvoy and Gastafson's report is further elaborated by material from Atikokan Mayor Dennis Brown's interview, which discussed the transition from mobile mills to stationary mills. Mayor Brown,

> "The first stationary lumber mill was constructed in Sapawe in 1945. The mill was eventually completed, renovated and updated, a dry kiln was erected, equipment to strip the bark from logs and chipping facilities installed."

Regardless of whether the forest product mills were mobile or stationary, they required a secure supply of raw material creating the necessity for local forest and logging operations. Longtime resident, Owen Boland, in an unpublished report, provides additional historical context for the Atikokan area forest operations.

> "Until the 1940's, bush operations in this area were seasonal. Trees were cut over winter, floated downstream the next summer and kept feeding the saw mills until the lakes froze over and logs could no longer be floated to the mill's jack ladder, by which they were fed to the mill's saws (Boland n.d.)."

With the mine closures in the late seventies and early eighties, forestry jobs increased in importance within the region. A 1980 article in the Atikokan Progress states, "After the mines shut down, over 400 jobs were produced in Atikokan with forestry becoming the major employer (Anonymous 1980)," and in 1993, Paulsen reported the importance of forest jobs as "the major employer." (Paulsen 1993)

But the status of the forest industry as the major employer was diminished after the 2008 housing market crash due to reductions in demand for lumber. Mayor Brown outlined the decline and rebound of the forest products industry in Atikokan, suggesting that the community may once again accept and embrace forest-related industries.

> "At one time, we had two forest-related plants operating … they both closed in 2008. Now the Fiber Tech mill is coming back; a new company, Rentech, bought it. They're going to start making the wood pellets and wood biomass."

The signs of forest industry recovery being recognized by community members are also captured in AEDC's Chairperson, Dave Elder's interview.

> "The forest industry is seeing a little bit of a turn around. Guys are cutting wood. Guys are hauling wood. The sawmill [planned to be built] of course is an obvious indication of that."

These observations are furthermore, optimistically portrayed in the Atikokan Progress in 2010.

> "And even on the forestry front, some small successes are evident. The AEDC continues to assist Atikokan Renewable Fuels[11] as it turns the former Proboard manufacturing plant into a wood pellet plant, and to press for a bio-energy fuelled future for the Atikokan Thermal Generating Station (McKinnon 2010)."

It should be noted, however, that although the aftermath of the 2008 housing crash left the forest products industry in decline, the managed forest near Atikokan has performed well relative to other forest management units within Ontario. One participant commented that the Crossroute Forest has been the busiest forest in Ontario throughout the downturn averaging over one million cubic metres per year. The Crossroute's performance during the decline suggests that the region has a strong forestry sector,

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[11] Atikokan Renewable Fuels initiated the development of the wood pellet plant in Atikokan, but since the writing of this news article, ARF was purchase by Rentech, Inc.

which could integrate well with new wood pellet production facilities. In addition to the forest sector's perceived strength, Mike McKinnon, Atikokan Progress co-editor, states how some community members support the use of locally produced biomass wood pellets, rather than a fuel source from two provinces away.

> "The nice part of it is that it's a support for the forest industry, which is something we're very familiar with here and have been involved with since day one. It makes it almost a more … an organic thing than coal from Saskatchewan, the province comes in and plops this billion-dollar facility in and then they ship the coal in from Saskatchewan …"

Furthermore, sociologist, Chris Southcott reports that "blue-collar" industry jobs (such as mining and forestry) have been the largest single group of jobs in the regional economy, suggesting that increased activity in logging, forestry and forest product manufacturing is what many in the region *know*, and thus welcomed (Southcott 2008). Although this view seems to be dominant in Atikokan, at least one community member considers a potential economic weakness with burning wood biomass,

> "Even four years ago I was still thinking coal's for burning and wood's for building. I'm not sure that woody biomass is the greatest answer. It's got to be used pretty judiciously, which pushes the cost to crazy levels."

A Community Resilience Model proposed by Akamani further develops the idea of communities doing what they *know*. It draws on rural sociology and resilience theory and suggests that a forest based community's structures and processes can lead to that community's ability to adapt and respond to change (Akamani 2012). Forest communities may tend to remain on current or historically familiar trajectories rather than assuming new and unknown ones due to its familiarity. Often communities with a strong mines, mills, or other extractive sectors tend to see those sectors as permanent. Freudenberg and Gramling in 1992 illustrate this point by reporting that "children of

miners, mill workers, and roughnecks can grow up thinking of such employment as being stable or predictable" (Freudenburg and Gramlin 1992).

Historical and current linkages to a strong entrepreneurial ethic

In addition to traditions of resource-based industries congruent with forest-based fuels, another theme emerged which was related to Atikokan's historical and current linkages to a strong entrepreneurial ethic. Having a local entrepreneurial ethic likely played an important role in how the community explored creative solutions, and petitioned government, in response to coal cessation at AGS. Interview data from Garry McKinnon, the AEDC Executive Director, explains how he believes the dynamic works in Atikokan.

> "We're evolutionary beasts. We change and adapt based on needs. If there isn't a need for entrepreneurship in that community, for you to meet those levels in the Maslow, like Maslow's Hierarchy of Needs, then you won't develop entrepreneurial skills."

This entrepreneurial notion is corroborated by longtime resident and serial entrepreneur Vic Prokopchuk, who noted that the town's isolation and independence during its early days may have been a factor in developing local entrepreneurs.

> "There was no road from Fort Frances or Thunder Bay … You wanted something done, or you want to start something or have something available, you [had to do it yourself]. So maybe the entrepreneurship was sort of forced on you … Everything [was shipped] by train you see. You came in and went out by train. I think that must be a big contributor to the incentive to be an entrepreneur."

The isolation, coupled with creative, highly skilled agricultural backgrounds of some community members, according to McKinnon, may have also played a role in the development of the community's entrepreneurship.

> "Two things emerged as a result of that need. High creativity … high skills in terms of … if you needed a part, if you needed a solution, somebody … and an

> awful lot of the population had agricultural backgrounds which is typical for farmers. If I got to fix it, I'll figure out a way to fix it."

In addition to the community's isolation, Prokopchuk also attributes the community's entrepreneurial spirit to a mine boss known as Pop Fatheringham during Atikokan's iron ore mining days. Fatheringham may have fostered a culture of entrepreneurship by creating worker incentives which contributed to Atikokan's early development.

> "I was staying at the bunkhouse at the mine site at that time. Since I had some electrical and telecommunications experience - after work I joined the crew of volunteer pipefitters, carpenters, electricians. We build that hospital. I think for every hour you volunteer, they pay you one. Something like that anyway."

Dave Elder also suggests that the entrepreneurial spirit in Atikokan may be linked to the former mining industry and the types of people the mines attracted.

> "You had a lot of people coming in that had to be self-starters. There were companies to work for, but then there was all kinds of opportunity for support and services of the various companies … It does seem to be, for whatever reasons, a spirit of entrepreneurism."

Potentially an outgrowth of the mining era's entrepreneurial spirit, the Atikokan Industrial Development (AID) Committee was established and tasked with ensuring Atikokan would survive and thrive after the mine closures. According to Paulsen's 1993 report,

> "Between 1972 and 1978, much of Atikokan's infrastructure was dramatically improved as a result of the AID Committee and the Township council's efforts. A swimming pool, nine hole golf course, curling rink, airport and a new hospital were built. Despite the impending closures, they wanted to make Atikokan a good place to live in the future." (Paulsen 1993)

Present-day community's entrepreneurial initiatives are often championed by the AEDC. Garry McKinnon, AEDC, Executive Director comments on the organization's current role in supporting entrepreneurial opportunities.

> "It's whatever is necessary to make that budding entrepreneur's dream come true. We'll do almost anything. From some of the creative stuff in terms of their marketing materials and to the mundane cash flow projections that the banks produce that are so foreign to most of them."

Although the AEDC strives to support budding entrepreneurs, one participant observed that some of the AEDC's efforts are viewed critically by local people.

> "[The AEDC] gets a lot of criticism because the other people try to do those things and the same old, "That's my tax dollars and it's used to compete against me." From Garry [McKinnon's] point of view, for the health of the community, we need that business. He may get criticized for this, but he usually does a pretty good analysis of it, like what caused the business to fail, is it just because the business shouldn't exist or is it because management did some interesting things that they shouldn't have done."

Additional interviews however, suggest that the community's entrepreneurial spirit is not that straightforward. Warren Paulsen provides an alternative view on how entrepreneurial spirit develops within the community. It can also be a function of attracting outside entrepreneurs, rather than developing them from within. "The entrepreneurship comes from outside. You have to figure out a way to draw those people in. It's a little tough." And Mayor Brown's interview reveals a similar theme.

> "We don't have enough entrepreneurs in Atikokan. We have opportunities but we have nobody to take the lead. That is something that's out there. I think that's a similar situation in most small towns."

Regardless of whether the entrepreneurial spirit develops locally, or is imported as people moved to the community, the historical and current linkages to a strong entrepreneurial ethic are certainly present. This spirit likely played a role when the community faced coal cessation and the subsequent development of a local biomass wood pellet industry. As referred to earlier, the wood pellet manufacturer (Atikokan Renewable Fuels, and then Rentech) saw the entrepreneurial opportunity of supplying

AGS, as well as growing the market. A participant with knowledge of the local economy comments,

> "What they're [Rentech] selling to OPG is the capacity of one press basically you know they're putting in four or five presses … So they are going to sell 75% or 85% of their production outside of the community. But that'll look good you know you got 25 direct jobs, probably you're going to result in 60 or 70 indirect and how many induced."

An entrepreneurial ethic in other communities seems to play a role in community resilience and prosperity, and in recent years, its value has been more broadly recognized (Dabson 2001, Drucker 2006). In a study from Costa Rica entrepreneurial drive in the community of La Fortuna was identified as an important aspect of community member identity as they had to "battled nature" to set up the town (Matarrita-Cascante and Trejos 2013). On the rural landscape, a strong entrepreneurial ethic serves many positive roles such as the delivery of goods and services and the maintaining social fabric (Gladwin et al. 1989, Redlin et al. 2010).

Entrepreneurial ethic coupled with the next two themes, (community members recognize the positive role AGS plays in the community, and strong community spirit and desire to fight for their town) seemed to have synergistically contributed to the community's overall identity and supported community efforts to effectively influence energy policy makers.

Community members' recognition of AGS's multifaceted role in the community

Base industries help keep isolated communities strong by providing jobs and other associated socio-economic benefits. When these industries face closure or a precarious future, it is not uncommon for community members to explicitly recognize the industries' contributions they once took for granted. In light of the real and perceived vulnerabilities Atikokan faced, provincially elected Member of the Provincial

Parliament (MPP) Bill Mauro recognized that if the AGS had closed due to the provincial coal cessation legislation, the town would have faced an uncertain future.

> "After my election it was obvious to me what just a simple closure with no conversion [to biomass wood pellets] would have meant to the community of Atikokan. It would have been quite frankly - at the risk of sounding a bit dramatic - it would have been catastrophic in my opinion."

Other participants, when considering the potential community impact of an AGS closure, used phrases associated with death and decline such as "ghost town" and "final nail in the coffin". The "catastrophic" outcomes from the closure would have likely included the loss of a number of socio-economic benefits AGS provides. Brent Boyko, OPG Director of Biomass Development and former AGS Station Manager, outlines some these benefits.

> "Taxes, good jobs, employees' families, but not only that, our [AGS] employees are engaged in the community extensively as well, be it minor hockey or running the ski hill. We have employees that are involved in cross country ski trails, on boards. Basically, there are a lot of folks that are well-engaged in the community."

The first benefit Boyko mentioned above is taxes. Payments made directly from AGS to the town would have ceased if the generating station had closed, causing a negative impact on town funding. Mayor Brown, outlines the extent to which AGS contributes directly to the town.

> "The amount of taxes we get from the OPG station (that's called payments in lieu, PILs), is about one-third, it's over, roughly, two million dollars a year. Two million dollars out of the … we collect approximately six million, and so about one-third."

With funding reductions of approximately one-third, services to the community would have likely been drastically cut. Other interview participants also recognized AGS's contribution to the town tax base with their estimates ranging from 25% to 60%

of the community's total tax base. In addition to providing a stable and large tax base, AGS provides many well-paying jobs. Garry McKinnon simply states,

> "The way that it contributes the local economy is through the employees, through the salaries that it generates, they're probably down to 80 employees now but they average $100,000 so there's $8 million in the local economy, $8 million available to the local economy."

Other interview participants identify the AGS as "our major employer", as providing "a lot of jobs", and those jobs being, "all pretty good paying jobs". However, interview participant, Daryl Gaudry, AGS Stationary Engineer recognizes that although some of these AGS jobs will be lost when the conversion to biomass is complete, additional new local indirect jobs will be required and created.

> "We will retain employment at Atikokan Generating Station converting to biomass, although staffing levels will probably be 10 less than you would have on coal. Extra jobs will be gained in the direct fueling of [wood] pellets from the pellet industry, additional people in the forest industry and supporting services within the town of Atikokan."

Maintaining and creating new jobs in and around Atikokan helps retain current workers and their families, which provide positive socio-economic spin-offs. A local newspaper article which included a comment from Mayor Brown, acknowledged that AGS employees are, "a vital part of the social fabric of Atikokan" (McKinnon 2012). Cast in opposite light, Wilf Thorburn, Atikokan Hydro, CEO speculates how the community's population may have declined if the AGS had closed.

> "So, without the generating station, we would lose a lot of that fabric that's needed to hold the community together. From that regard, I don't know how you could actually put a figure on it, but I would suggest that we'd probably be down to 1200 or 1500 people or less and shrinking if everything started to fall away."

With the speculated loss of AGS employees and the social fabric they maintain, Prokopchuk reflects on some of the more obvious contributions which help hold the community together, especially when AGS employees first move to the community.

> "They took part in promoting and attending cultural events, social institutions or whatever you want to call them, got on the boards; whether it was the hospital, or tourism. Maybe it was easy for them because they were from outside and got a chance to make some ties. I don't know, I don't think it was directed by OPG by any means, because that doesn't normally work. These people just went beyond the call of duty."

The AGS' community engagement appears also to be a source of pride for its employees. An AGS employee interview outlines some of the contributions employees make in the community.

> "We've built gazebos. We've built park benches. We've built barbeques. We do whatever looks like would be a community service when we're requested, within reason."

Additional employee contributions, as perceived by other participants, include volunteering as "hockey coaches and the baseball coaches", and involvement in "charity campaigns".

In addition to the abovementioned social contributions and volunteerism, AGS' financial sponsorship of community events seem to be a source of pride for AGS employees. OPG's Brent Boyko, outlines some of the sponsored initiatives. "It goes right from sponsoring pow wows to working with school education programs on sustainability initiatives." AGS also sponsors the annual Bass Classic which is "the biggest event in the community".

Additionally Atikokan Centennial Museum has been the beneficiary of a recent AGS sponsored initiative. A museum staff member commented that they received, "… almost a $10,000 grant to put up the OPG exhibit here in the museum." The exhibit, which presents the historic significance of AGS and its coal era includes, "… a pair of miniature replicas of the station's coal handling, storage, burning and power generation systems" (Smith 2013). Additionally according to Paula Sanders, AEDC, Sr.

Community Development Advisor sponsorship initiatives have included, "contributing to hockey and Entertainment Series, just to name a few."

Although Flora and Flora's (1990) context was different than Atikokan, they identified a number of important attributes successful communities have, such as having a "willingness to invest private capital locally" (Flora and Flora 1990). As recognized by the community, AGS has done this through its sponsorship of community events, and other community development initiatives. Communities (such as Atikokan) with residents that recognize and appreciated the broad benefits that primary industries provide, may possess the social fabric required to successfully face challenges (Lucas 1971, Brown et al. 2005, Besser et al. 2008). Atikokan community members recognize AGS' multi-faceted role in the community, and hence suggest that its loss would have a lasting and obvious effect on the community. This recognition leads into the final theme, that Atikokan has strong community spirit and desire to fight for their town. As will become apparent in the next section, without this community engagement, it is possible that there would have been less political will to convert the AGS to wood pellet biomass.

A strong community spirit and desire to fight for their town

Community residents' spirit to fight for their town is often spurred on by the recognition that the community faces vulnerabilities such as shrinking populations (suggested earlier in terms of social fabric loss). Warren Paulsen's interview outlines a 50-year trend in Atikokan.

> "The mines made some technical changes that allowed them to lay some people off. It was a long series of small layoffs, starting in 1961. We always talk about the mine shutting down, which was 1978, 1980 … around there. If you do a graph of our population, you can hardly tell where 1980 was. It's just a long gradual … it's a flat straight line going down from 1961 to today. It's unfortunately still going down. That may have shaped our culture. That's over 50 years of gradual decline. In a sense, it's not a boom/bust economy here."

Paulsen's observations are corroborated with more current Statistics Canada data. Atikokan's population is approximately 2800, but has been on a gradual decline over the past twenty years. In 1991 the population was over 4000 (Statistics Canada 1996, Statistics Canada 2012a). As a rural population shrinks, there are generally,

> "… two options for struggling resource towns like Atikokan. The first is to let the towns die out, implying that local residents abandon their homes and find employment elsewhere. The second is to attempt to revitalize local economies." (Ellis et al. 2003)

During the post-mining era, some community members decided to not give up on their town and let it die out. Dave Elder reflects,

> "When the mines closed, this town in 1979 [they] had a choice of packing her in or doing something about it. … The people that stayed, they were just the kind of people that said we can make this work. The town has never, ever given up on trying to attract, let's say big projects, big operations, and has been successful in a number of cases, not always."

The desire to not give up but fight may have been a legacy attributed in part to the community's past mining residents[12]. Mike Lewis, long-time resident and Ad Hoc Energy Committee[13] member, provides his view.

> "I think it has a lot to do with the culture of the mining people. Mining people came from all over the world, literally, all over the world, to work here. They're a kind of unique people. Those families grew up here and they don't give up on stuff. It's a community thing. It's hard to explain to people. Lots of people can't figure out why we live here. We do because we like it. We want to make sure we keep it alive."

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[12] It must be noted that other mining communities in the region such as Manitouwadge, Ontario and Sliver Islet, Ontario have not been as resilient and have closed.

[13] The Ad Hoc Energy Committee is a town level committee whose activities included lobbying provincial government to maintain a stable energy production and distribution system in northern Ontario, which ultimately led to the conversion of the AGS from burning coal to burning biomass wood pellets.

Although the mine jobs have been gone for years, the community "fight" has endured to present day, most recently in the wake of a provincial coal cessation policy. MPP Bill Mauro's community observations are telling.

> "Most northern communities have this level of cohesiveness and coming together to fight the good fight when there are serious issues affecting the communities. We really have no choice. We're relatively small. We're geographically isolated. If we're not going to fight, there's really nobody else to take up the fight for us."

Often successful communities have a person or small group of people who lead this fight projecting hope and a vision of how the town can transform into something new. Dave Elder acknowledged one such person who fought to keep Atikokan strong when facing the possible AGS closure.

> "It's credit [referring to the conversion to biomass, thus saving AGS] in large part, is to the community leaders of the day, and in particular the current Mayor, Mayor Brown … he's just been a mainstay of the community, politically anyway."

Wray Clement, AGS Station Manager, elaborates on Brown's role in mobilizing the community when facing the potential AGS closure.

> "Dennis Brown, got committees together, got the right people together, started looking at options, started talking about options and the biomass became one of the bigger possibilities."

Furthermore, Brown has been described as "aggressive in a good way", and as possessing the "perseverance, tenacity and commitment to the community" (Anonymous 2009b) required to help make Atikokan successful. In addition to the work of the mayor (and council), Lewis reflects on how the Ad Hoc Energy Committee, played an important role in the fight to prevent AGS closure.

> "Our general function, at the time, was to fight [Energy Minister] Dwight Duncan and his friend, [Premier of Ontario] McGuinty and make sure they did something here. They made promise after promise, and it took eight years."

The Ad Hoc Energy Committee initially fought to keep coal as the primary fuel source for the AGS thus preventing its closure, but as alternatives were considered, woody biomass became a more and more feasible option. Mike Lewis recalls,

> "Initially we were looking for ways to keep coal as the energy source through pollution controls and carbon capture, both of which were rejected by the government. We weren't thinking of [wood] pellets, we were thinking of slash and all those other kinds of things that could be burned and how much was there in the bush that could be used. Then, agreement went to pellets."

Furthermore, it was observed by Angela Sharbot, Town of Atikokan, Chief Administrative Officer (CAO), that community residents from the general population were engaged in the fight as well. "You had the people that were writing letters and Atikokan is a community that fights." This community fight and support was also recognized by OPG President Tom Mitchell in a newspaper article covering the successful approvals for biomass conversion at AGS.

> ""This would not have been possible without the unwavering support of this community," Mitchell told a packed lunch room at the plant. "Today, we look forward to working with this community for many, many years to come."" (McKinnon 2012)

A strong community identity to fight and not give up on the town is also illustrated in a longitudinal study from Utah which investigated how the community of Delta changed overtime in light of the establishment of a coal-fired powered generating station. The study indicated that residents' community attachment and high satisfaction levels helped during periods of change and contributed to weathering the "thick and thin" (Brown et al. 2005). Residents with strong attachment and higher satisfaction levels would potentially be more willing to fight for their community's long-term success. Furthermore, economic shocks (perceived or real) may play a positive role in community cohesion, civic engagement and contribute to the social fabric if residents

work together to counter the shock (Besser et al. 2008, Redlin et al. 2010). This may help explain why Atikokan residents' community spirit and desire to fight for their town lead to their activity which led to the win-win solution which included banning coal while maintaining AGS.

CONCLUSIONS

This research sought to identify Atikokan's historical pre-conditions and community members attributes and perceptions which lead to the community's response thusly saving the local thermoelectric generating station in light of new provincial energy legislation. Using a qualitative data analysis approach emergent themes from the data included i) traditions of resource-based industry congruent with producing and burning forest-based renewable fuels, ii) historical linkages to a strong entrepreneurial ethic, iii) community members' recognition of AGS's multifaceted role in the community, and iv) strong community spirit and desire to fight for their town.

Political decision makers can be more effective when creating policies if they have a better understanding of the affected community's history and identity. Increased understanding can help in evaluation and anticipation of a community's response (and readiness for change). During the provincial coal cessation deliberations it appears that the four emergent community attributes and perceptions provided a foundation for the community response to the potential AGS closure. The cessation of coal and the resultant induction of a new local forest products industry not only created new local jobs, but those jobs also aligned with Atikokan's *traditions of resource-based industry*. When communities consider new business or entrepreneurial opportunities, an evaluation of community fit, and subsequently, comfort level could be a useful strategy.

Another factor relates to a community's *entrepreneurial ethic*. Entrepreneurs are often the first people to recognize an opportunity (or threat) and the first to capitalize on that opportunity (or threat). When the conversion from coal to biomass wood pellets started to look like a feasible option, community members with entrepreneurial ability exercised these skills in their efforts to influence decision makers. Although our data doesn't make a direct correlation between entrepreneurship and the establishment of a local biomass wood pellet supplier, we felt this re-occurring theme could not be ignored, since over time it seems to have played an important role in how the community faces challenges.

Furthermore, another emergent community attribute is related to how Atikokan residents appreciate and *recognize the multifaceted role of AGS in the community*. Beyond providing livelihoods for its employees, AGS provides positive spin offs when engaging the community through sponsorship of events and other locally important initiatives. AGS has demonstrated that corporate citizenship programing (through sponsorship of community events for example) can foster increased appreciation from all residents and not only the residents who are employed by the industry. When faced with the potential closure and the obvious loss of jobs (and the less obvious loss of corporate citizenship programing), the community rallied to save the AGS.

Finally, when facing potential decline, community residents can passively allow the decline to take place, or they can rally to keep the community vital and thriving; especially if the community possesses a *strong community spirit and desire to fight for their town*. Communities with these attributes tend to understand the potential threat and engage in rejuvenation efforts (Dahms 1995). They are often led by a person or small group of people, who organize while projecting hope and a vision of transformation.

When facing AGS closure, Atikokan had residents with these characteristics; residents who took up the fight. The efforts of these Atikokan community members played an important role in influencing a climate which secured a stable and predictable employer (and attracting a new employer) for years to come.

The conversion of AGS to biomass wood pellets was not an immediately apparent option when coal cessation policy was first introduced. However, cessation's introduction has created a greater positive socio-economic impact (relative to coal-burning) for Atikokan. Burning biomass wood pellets at AGS has become a catalyst creating a new local forest product value chain, while supporting local forest and logging operations. Furthermore, biomass wood pellets are considered a value-added product relative to wood fibre, which from a public policy standpoint, is seen as another positive outcome.

> "While the traditional economy of Canada has been dominated by the natural resources sector, public policy has signaled an interest to diversify and promote value-added components to address both longer-term resource depletion and the changing markets for Canada's natural resource products (e.g. lumber and pulp and paper manufacturing) (Rosehart 2008)."

Although case studies cannot be generalized, our findings may offer insights for other jurisdictions and should have value beyond Atikokan since other Canadian communities face closure of major employers. Interests in other jurisdictions may consider monitoring Atikokan's future progress since this project is the first of its scale in North America. This study identifies four attributes of one community in one case. Due to the confounding nature of this work, it is unknown if these attributes would be effective in all cases, if they must exist together, or if there are other critical attributes not presently identified here. Future research could include testing these findings in other communities facing threats to determine their role in averting economic collapse. Future

work could also include a study investigating the three other coal burning OPG generating stations to identify if the attributes in Atikokan can be found in the other communities.

APPENDIX 1: SELECTED CODES RELEVANT TO THE CURRENT STUDY

Since this manuscript is part of a larger study, coded data (and nested coded data) which contributed to the manuscripts four themes are included below. Upper level codes may not sum the lower level codes due to overlap coding and not all codes in the overall study were included in present manuscript (due to the overall study's broader scope beyond this manuscript). Note: Counts presented here are totals of coded data occurrences, unlike Table 1 values which represent source counts.

Manuscript heading: Traditions of resource-based industry congruent with producing and burning forest-based renewable fuels
Coding Structure: Industries (n=496)
- Forest related industries (n=169)
  - Forest products (n=113)
  - Forestry (n=56)

Manuscript heading: Historical and current linkages to a strong entrepreneurial ethic
Coding Structure: Entrepreneurship (n=161)
- Community necessity (n=10)
- Counter-entrepreneurship (n=9)
- Examples (n=61)
- Government or agency's role (n=9)
- Isolated from other markets (n=16)
- Underlying factors (n=56)

Manuscript heading: Community members' recognition of AGS's multifaceted role in the community
Coding Structure: OPG / AGS' role in the community (n=135)
- Corporate donations (n=22)
- Educated professionals living in community (n=3)
- High paying jobs (n=29)
- Municipal taxes (n=31)
- Socio-economic (n=15)
- Volunteerism (n=25)

Manuscript heading: A strong community spirit and desire to fight for their town
Coding Structure: Small town challenges and opportunities (n=499)
- Community fight (n=64)

ABBREVIATIONS

AEDC: Atikokan Economic Development Corporation

AGS: Atikokan Generating Station

AID: Atikokan Industrial Development Committee

CAO: Chief Administrative Officer

MPP: Member of Provincial Parliament

MW: megawatt

OPG: Ontario Power Generation;

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHOR'S CONTRIBUTIONS

All authors have made substantive intellectual contributions to this study. The lead author under the academic tutelage of the other three authors collaboratively developed i) the field data collection methods, and ii) the content analysis of field data. All authors contributed to the drafting of the final manuscript, and all provided critical revisions and technical input. All authors read and approved the final manuscript.

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CHAPTER 4: PAPER 3
ASSESSMENT OF POTENTIAL LOCAL AND REGIONAL INDUCED ECONOMIC IMPACT OF AN ENERGY POLICY CHANGE IN RURAL NORTHWESTERN ONTARIO

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ABSTRACT

In 2002, the Province of Ontario first introduced plans to ban coal in thermoelectric power production. As more was learnt about the proposed coal ban, rural communities with a high proportion of power plant jobs (such as Atikokan, Ontario, Canada) grappled with three potential outcomes of the planned changes. These include: (i) the coal ban is overturned and power plants continue to burn non-renewable coal, (ii) the coal ban takes effect and power plants are closed, and (iii) the coal ban takes effect but power plants continue operating with an alternative renewable fuel source. The objective of this study is to model how direct changes in employment at the power plant (and indirect employment at associated local industries) impact the spending patterns of households associated with the power plant. To address the objective, an induced economic impact assessment model was developed by integrating quantitative and qualitative data sources. The model suggests that the continuation of coal would allow for $82.7M in household spending, the shutdown reduces overall household spending to $72.1M, and the conversion to biomass increases household spending relative to the coal by $1.2M. These results suggest that biomass conversion could produce a net positive induced economic effect as household spending increases, provided local biomass fuel supply is available.

KEYWORDS

Atikokan Generating Station, Bioenergy, Economic impact, Electricity generation, Energy security, Social impacts, Wood pellets

BACKGROUND

Canadian communities dependent on a resource-based single industry form an important part of a culturally distinctive Canadian landscape (Randall and Ironside 1996). The industry in these communities is sometimes viewed as "always on the verge of closing, but never actually closing" (Lucas 1971). Studies investigating community dynamics suggest that single-industry communities that acknowledge and embrace their real or perceived vulnerabilities tend to be more successful and resilient (Flint and Luloff 2005, Markey et al. 2008, Akamani 2012, Besser 2013, Wilson-Forsberg 2013). Furthermore, proximity to other communities can have both positive and negative economic impacts on the community under investigation. On one hand when a small community undergoes a contracting economy, commuting distance to a larger centre with a larger job market can increase community resilience since families can still remain in the community. On the other hand, close proximity to other larger centres can entice community members to shop outside of their own community (known as out-shopping), reducing community resilience as the positive local economic impacts are lost (Reimer 2002, Reimer 2005, Halseth and Ryser 2006, O'Hagan and Cecil 2007, Harris et al. 2008). Out-shopping can be framed in terms of a local trade area, which can be simply defined as "a geographic area from which a community generates the majority of its customers" (Kures et al. 2011).

Although population centers, (with a population of at least 1,000 and a density of 400 or more people per square kilometer) (Statistics Canada 2012b) and rural areas, are often perceived as being distinct from one another (Alasia and Rothwell 2003, Alasia and Magnusson 2005, Rothwell and Turcotte 2006, Fortin 2008), provincially elected decision makers sometimes make provincial-wide policy without fully assessing their decisions' impact on rural communities or rural areas (Grenier 2011, Canadian Broadcasting Corporation 2011, Radwanski 2013, MacGregor 2014). Indeed, these policies are sometimes criticized as being more closely aligned with interests in densely populated urban population centres than with those of sparsely populated rural areas. With 14% of Ontario's approximately 13 million residents living in rural areas (Statistics Canada 2011) the economic impact of provincial policy needs to be evaluated through the lens of people living and working in rural areas, and through the lens of people living in population centers in remote rural areas. Furthermore, these rural areas are important and support the development of Canada with industries such as manufacturing continuing to play an important role (Beshiri 2010). From 1914 to 2006 Bollman (2007), outlines three key drivers which have sustained rural Canadian economies, and they include i) advances in labour saving technology which keep production costs lower, ii) reductions in the cost of doing business in rural areas with transportation and telecommunications becoming more affordable over the past few decades, and iii) shifts in demographics which include growth in population of the Aboriginal community (a potential labour source), and young adults and early retirees being attracted to rural areas.

The economy of Atikokan, a small rural community in Northwestern Ontario, has been centered on resource-based industry with a small number of primary

employment sectors (forestry, lumber, pulp and paper, and mining) which historically employed a relatively large proportion of the workforce (Rosehart 2008). However, the forest sector faced an economic downturn since 2008 (Forest Products Association of Canada 2010), and even prior to the economic contraction (2001-2006), the region's overall gross domestic product declined by 6.7% (Rosehart 2008).

It was during this period of economic contraction, in 2002, that the Province of Ontario first established the framework and policy banning coal in thermoelectric power production (Ontario 2007, Ministry of Energy and Infrastructure 2009) in order to address health and environmental concerns of people living in population centres (Canadian Broadcasting Corporation 2013a). As more was learnt about the coal ban, people living in the rural communities with a high proportion of power plant jobs, grappled with three potential outcomes of the coal ban policy. These include: (i) the coal ban is overturned, power plants continue, business as usual, to burn coal – coal scenario, (ii) the coal ban takes effect, power plants are decommissioned and closed – shutdown scenario, and (iii) the coal ban takes effect, power plants continue operating with an alternative renewable fuel source such as woody biomass (produced in a local wood pellet plant) – biomass scenario (Dampier et al. 2014).

The coal ban policy directly impacted the four power generating stations in Ontario (i.e. Lambton, Nanticoke, Thunder Bay and Atikokan) with the power plant near the Northwestern Ontario Town of Atikokan (48° 45′ 0″ N, 91° 37′ 0″ W; 393 m above sea level) being the only one located in a remote rural area. The community is considered remote and rural due to its nearest neighbouring centres being Thunder Bay (population approximately 110,000) which is 210 km to the west, Fort Frances (population approximately 8,000) which is 150 km to the east and Dryden (population

approximately 7,500) which is 210 km to the north (Figure 4). The community is not serviced by passenger flights or rail and has regional bus service three times a week to Fort Frances and Thunder Bay.

Figure 4: Location of Atikokan and major regional communities in northwestern Ontario, Canada

Even prior to the Atikokan power plant's construction in the 1980s, the community's economy has been reliant upon resource-based industry such as forestry, forest products and mining (Dampier et al. 2014). The power plant located near Atikokan had a workforce of about 90 people with many of these individuals contributing to the community's social fabric (Ontario Power Generation 2011c). In addition to power plant jobs in Atikokan, there were approximately 200 retail and consumer service sector businesses estimated in 2010 (Olsen 2010), which generally rely on household expenditures and are vulnerable to changes in spending patterns (induced effects) (Rosehart 2008). Furthermore, the community's population (Population = 2730, Population density = 183.4 people/km^2) (Statistics Canada 2012c)

and isolation may have contributed to its potential vulnerability. An earlier stage in this project investigates how Atikokan's community members' identity and history contribute to their response to the policy change. Published and unpublished data from this earlier stage provides helpful insights for the current study. Community members recognized that the outcome of the coal ban policy would have direct, indirect and induced economic impacts on their community (Dampier et al. 2014).

Direct economic impacts are created by the sector of interest, indirect economic impacts are experienced by the sectors that provide production inputs to the sector of interest, and induced impacts result in changes in households expenditures from people employed directly and indirectly by the sector of interest (Cox and Munn 2001). Direct impacts in this study are the positive or negative direct changes in workforce participation at the power plant in Atikokan. Indirect impacts are those changes in local workforce participation from sectors providing production inputs and services to the power plant. Finally, induced impacts (which is the response variable in this study) are the local household expenditures for households with employment at the power plant and the household expenditures for households with employment from sectors that provide production inputs and services to the power plant.

A challenge lies in developing a useful model. At the community level, Statistics Canada suppresses certain data sources, necessitating an approach which doesn't rely on established higher level publically available data, hence our approach to integrate quantitative and qualitative data sources. The objective of this study is to develop a model that estimates direct, indirect and induced economic impact with respect to employment changes at the power plant (and its associated industries) based on household expenditure.

METHODS

Provincial-level household expenditure data, local-level household income data, regional shopping behavior data and local level expert knowledge, and opinion were used to develop an economic impact assessment model. Household data rather than individual jobs data, were used in calculating induced economic impacts because individual jobs data are not readily available. The Ontario-level 2010 Survey of Household Spending (SHS) was accessed through the Statistics Canada website (Statistics Canada 2015). These data provide total household expenditure partitioned into five quintiles based on before-tax household income. These values were then used uniformly for the three power plant scenarios.

The 2010 Statistics Canada National Household Survey (NHS) data for Atikokan were collected from the Statistics Canada website (Statistics Canada 2013) in order to estimate Atikokan household counts in each income quintile. Since NHS data are not organized into income quintiles (but in income classes), this presents a minor challenge of synchronizing the SHS data with NHS data. This challenge was overcome by pooling and proportioning the NHS income class counts into quintiles in order to synchronize the two data sets. These estimated expenditures per household (SHS) and household counts (NHS) were then multiplied in order to estimate total expenditure for each quintile, and summed to provide the overall expenditure. These calculated expenditure values were treated as baseline and represent the coal burning scenario, as in 2010 coal was the sole fuel at the power plant.

Household expenditure for each quintile can be described with the following equation:

$$C = A+MD$$

Where:
C = Aggregate household expenditure
A = Autonomous expenditure, which is the fixed level of household expenditure regardless of household income levels (e.g. monthly food and housing expenditures).
M = Marginal propensity to consume, which is the ratio of expenditure a household is willing to spend of its real disposable income.
D = Real disposable income, which is what money is available after deductions of taxes from the total income.

For each quintile, the SHS captures household autonomous expenditure, marginal propensity to consume and real disposable income. In addition the SHS collects the annual income of household members. The SHS expenditures values are expressed in dollar values and presented here as a total basket of goods purchased on an annual basis.

Summing each quintile household expenditure value is expressed as follows:

$$C_{tot} = \sum_{n=1}^{5} C_n$$

Where:
C_{tot} = The total household expenditure.
C_n = Total household expenditure for each quintile.

In order to estimate total expenditures by each income quintile (and subsequently overall expenditure) for the shutdown and biomass scenarios, adjustments in the baseline households counts were made by applying household income assumptions obtained from previously unpublished qualitative and coded community level data from an earlier stage in the research project (Saldana 2009, Dampier et al. 2014). The earlier stage collected

and analyzed interview transcripts from community members (n=25), consultant reports (n=16), and local newspaper articles (n=46). The earlier work focused on understanding Atikokan residents' attributes, perceptions and history as these relate to community response to the energy policy change (Dampier et al. 2014). The qualitative and coded community level data also provide insight into the shutdown and biomass scenarios' potential direct and indirect economic impacts on household incomes and induced household expenditures.

After the induced economic impacts of household expenditures for each of the three scenarios were determined, the local and regional impacts were estimated by applying published spatial spending habits multipliers for Atikokan's residents (Knowles 2013). Multipliers are pro-rated factors of proportionality, which indicate how factors such as household income can affect other segments of the economy, such as the retail sector. Local trade area estimates suggest that 50% of Atikokan households purchased goods and services locally, 10% in Fort Frances, 20% in Thunder Bay, 5 % in Dryden, 10% in the USA, and 5% in outside of these communities (Knowles 2013). Finally case studies from communities elsewhere were sought in order to provide additional insight into the results presented here.

RESULTS AND DISCUSSION

The model indicates that the Town of Atikokan would experience induced economic impacts as households were gained or lost in individual income quintiles under the three scenarios. With the coal scenario as the baseline, a general decrease in household counts and an overall decrease in induced household expenditure occurs

under the shutdown scenario. A general increase in household counts, and an overall increase in induced household expenditure occurs under the biomass scenario.

Table 4 presents total household expenditure and household counts for each quintile, as well as the total household expenditure for each quintile. The summed quintiles for the coal scenario indicate that there were 1245 households in Atikokan in 2010, with a total household expenditure of $82.7M. Due to regional shopping patterns not all of the $82.7M would be available to Atikokan's local trade area with only an estimated $41.4M staying locally (Table 5). Other neighbouring communities within the region such as Fort Frances ($8.3M), Thunder Bay ($16.5), and Dryden ($4.1M) are impacted by Atikokan household expenditures. These values for the coal scenario serve as a baseline (or basis for comparison) for the other two alternative scenarios.

Table 4: Estimated household counts and expenditure per quintile

Scenario	Households	Lowest Quintile	Second Quintile	Third Quintile	Forth Quintile	Highest Quintile	Total
Coal	Expenditure	$29K	$46K	$64K	$88K	$148K	
	Counts	299	349	224	193	180	1245
	Total Expenditure	**$8.7M**	**$15.9M**	**$14.4M**	**$17.0M**	**$26.7M**	**$82.7M**
Shutdown	Expenditure	$29K	$46K	$64K	$88K	$148K	
	Counts	299	319	204	128	165	1115
	Total Expenditure	**$8.7M**	**$14.5M**	**$13.1M**	**$11.3M**	**$24.5M**	**$72.1M**
Biomass	Expenditure	$29K	$46K	$64K	$88K	$148K	
	Counts	299	394	224	183	180	1280
	Total Expenditure	**$8.7M**	**$18.0M**	**$14.4M**	**$16.2M**	**$26.7M**	**$83.9M**

Household expenditure expressed in thousands of dollars (K=1000), Total household expenditure expressed in millions of dollars (M=1 000 000)

For the shutdown scenario, the contracting economy reduces overall households to 1115, and household expenditures down to $72.1M (Table 4). The adjustments in household counts are made based on the existing qualitative data from an earlier stage in this project. These data suggest that the power plant would lose all (or nearly all) of its

jobs. “Ninety good-paying jobs” at the power plant was a phrase that was repeatedly mentioned. Data also suggest that employees at the power plant average an annual salary of $100,000 per year. Additionally one source suggests that up to 80 indirect jobs could be lost in a shutdown scenario (Anonymous 2006), although we take a conservative approach and reduce indirect jobs by a total of 40, rather than by 80. We feel that the loss of full the 80 indirect jobs is possible, however since we’re modeling impacts shortly after the shutdown, we assume only 40 indirect jobs would be lost immediately, with the other 40 on a longer time horizon. Furthermore, it is assumed that the lowest quintile would not be immediately affected by the shutdown scenario, since technical and professional jobs directly and indirectly associated with AGS typically compensate at a higher level, and hence no adjusted.

Employing these assumptions, baseline coal scenario’s household counts are adjusted in order to simulate a power plant shutdown. Of the 40 households affected indirectly, 30 were reduced in the second quintile and 10 in the third quintile (Table 4). It is assumed that indirect jobs represent the workforce employed by establishments which provide goods and services directly to AGS, and carry compensation levels typical of second and third quintiles. The third quintile is reduced by an additional 10 households to account for households relying directly on the power plant, bringing the third quintile to 204 from the baseline of 224 households. Other reductions from the loss of the households relying directly on power plant jobs include 65 from the fourth quintile (193 households in coal to 128 in shutdown) and 15 from the highest quintile (180 households in coal to 165 in shutdown). Therefore, the loss of 90 households directly relying on the power plant occurred across the three upper quintiles.

As Table 5 indicates, the Atikokan local trade area would experience the greatest impact of the shutdown scenario. Relative to the coal scenario, this contraction from $41.4M to $36.1M, which represents a decrease of 14.7% in the household expenditure, is a substantial amount for the isolated rural community of less than 3000 people. Other neighbouring communities would also experience an economic impact from the shutdown. Fort Frances and Thunder Bay stand to lose $3.2M ($1.1 M in Fort Frances and $2.1M in Thunder Bay) in the power plant shutdown scenario. The community of Dryden, as well as cross boarder shopping into the USA would also be affected by reductions in household spending (Table 5).

Table 5: Induced economic impacts of household expenditure by community under the three power plant scenarios: continuing to burn coal, shutting down the power plant and conversion of the power plant to biomass.

				Scenarios		
Market	**Spatial**	**Distance**	**Multiplier**	**Coal**	**Shutdown**	**Biomass**
Atikokan	Locally	0 km	0.50	$41.4M	$36.1M	$42.0M
Fort Frances	Regionally	150 km	0.10	$8.3M	$7.2M	$8.4M
Thunder Bay	Regionally	210 km	0.20	$16.5M	$14.4M	$16.8M
Dryden	Regionally	210 km	0.05	$4.1M	$3.6M	$4.2M
USA	Out of region	> 210 km	0.10	$8.3M	$7.2M	$8.4M
Other	Out of region	> 210 km	0.05	$4.1M	$3.6M	$4.2M
		Est. grand total spending ($)		**$82.7M**	**$72.1M**	**$83.9M**

Regional shopping multipliers established according to Knowles (2013).

When Atikokan community leaders reflected on potential changes at the power plant, they viewed the shutdown as catastrophic for the local economy and the renewable biomass conversion as a boon (Dampier et al. 2014). While the current analysis doesn't confirm or deny that the effect would be "catastrophic", it does indicate that a shutdown would reduce household incomes leading to less spending in the local

economy by $5.3M immediately post shutdown. The general observation that small communities, which rely on one or few industries for employment seldom expand was made in 1971, by Lucas. These communities are, “vulnerable to changes in international markets, changes in technology, and in most instances it has a limited life expectancy (Lucas 1971).”

The economic impacts of the shutdown scenario presented in this study are corroborated with similar patterns from other sources. A summary from a European-wide research program, indicates that small town economies with a small number of major employers are less resilient and are more adversely affected by economic downturns (Royal Town Planning Institute 2014). A less resilient community is less likely to perform well under stressors such as the loss of a major employer. Furthermore, the community’s underling socio-economic economic profile as defined by Royal Town Planning Institute (RTPI) may also be a contributing factor into its resilience and vulnerability. According to the RTPI, a community’s profile can be defined as follows.

- residential economies, emphasize natural and built heritage, amenities and quality of life,
- productive economies emphasize specialised skills, knowledge and practices,
- knowledge economies emphasize the connectivity to metropolitan areas and attract the creative class and innovative firms (Royal Town Planning Institute 2014).

Atikokan’s economy which (at the time) centered on the power plant, is likely to be primarily a productive economy requiring a specialized workforce. Productive economies become vulnerable when a specialized workforce is no longer required.

However, Atikokan possesses characteristics of a residential economy as well. Unpublished interview data from an earlier stage of this research (Dampier et al. 2014), indicate that community members have deep appreciation for Atikokan's residential economy and reported gratefulness to living very close to fishing, hunting, canoeing and snowmobiling opportunities. Other factors leading to smaller community vulnerability include that they typically receive less government support and have less non-profit organizations, relative to larger centres. Government support and non-profits can help support recovery and transition after a shock (Besser 2013).

The current model presents the immediate impact of the power plant shutting down as detrimental due to reductions in local and regional household spending. In some instances, the loss of a major employer, however, may lead to positive outcomes sometime after the initial shock to the economy, and broader community. A case study from rural Lincoln County, Maine suggests that in the aftermath of a nuclear power plant closure that the community rebounded through reinventing itself (Phillips 2014). A concerted effort by the local economic development corporation and community stakeholders was made to "diversify the economic base". These revitalization efforts included the development of tourism facilities, local agriculture projects, and a yacht manufacturer. The case study issues a caveat, "Many communities learn the hard way about dependence on a single, major employer. Diversification is essential."

In the biomass scenario the expanding economy increases overall household counts to 1280, and household expenditures increase by $1.2M up to $83.9M (Table 4). As is the case with the shutdown scenario, the adjustments in household counts were made based on the existing qualitative data from an earlier stage in this project. These data suggest that in order to simulate the biomass scenario, the power plant would likely

lose about 10 jobs due to efficiencies introduced in handling biomass relative to coal. Employing the assumption of 10 jobs lost at the power plant, the baseline coal household counts were reduced in the fourth quintile by 10 households (193 households in coal to 183 households in biomass). Furthermore, the data also suggest that it is likely that at least 35 wood pellet production jobs would be created in Atikokan, with the wood pellet plants' supply chain being local creating 10 new forestry jobs. Based on these data and assumptions, 45 households in the second quintile were added (349 households in coal to 394 households in biomass) (Table 4).

As Table 5 suggests, the Atikokan local trade area would experience the greatest impact of the biomass scenario leaving $42.0M available for Atikokan. Relative to the coal scenario, the increase from $41.4M to $42.0M in household expenditure for Atikokan represents an increase of 1.4% for the local economy. Communities within the region such as Fort Frances, Thunder Bay, and Dryden would also see a small positive effect due to increases in Atikokan household expenditure (Table 5). The increase illustrates that when new businesses are developed from within the community or attracted from outside, an increase in induced economic impact of household expenditure can occur.

The published and unpublished data indicate that community leaders viewed woody biomass from local sources as a benefit to the local economy since it supports forest industry activity, which has a long history in Atikokan (Dampier et al. 2014), although some uncertainty exists related to Canadian woody biomass supply chains (Hughes et al. 2014). A provincially elected official was also quoted in the community newspaper, The Atikokan Progress, supporting the biomass scenario.

> "Should an alternative fuel source like wood pellets [biomass] be identified as a useable fuel source, potentially we could even source those materials in a community like Atikokan. Besides maintaining the plant, we could potentially see some job creation if we could source the wood pellets, if in fact that became a fuel source (Anonymous 2008)."

The current model presents the immediate and positive economic impact of the power plant converting to biomass as expressed with increased household expenditure. Similar studies from the southern USA echoes findings here. These studies investigate how changes in woody biomass production and utilization can generate direct, indirect and induced economic impacts such as job growth in forestry and forest products manufacturing (Perez-Verdin et al. 2008, Kebede et al. 2013). Findings also suggest that as domestic and international demand for pellets increase, (necessitating larger pellet plants), growth in regional economic activity could be expected in the South (Kebede et al. 2013). Increased global demand may also present an opportunity for woody biomass production in Atikokan.

In some instances increases in economic activity can bring problems, however. Research conducted in resource-dependent communities in Alberta, Canada (Parkins and Angell 2011) and Australia (Lawrie et al. 2011) suggest that although the economic growth can provide many socio-economic benefits, that growth can also produce many unintended negative consequences in boomtown scenarios. Therefore, a risk does exist that growth could lead to unforeseen problems in the Town of Atikokan. However the anticipated community growth in the biomass scenario would only result in a net increase of 35 households which would likely be quite manageable for a community of less than 3000 people. Available housing stock could pose a potential challenge though. The community has older, smaller houses. Unpublished interview data summarized the

potential problem this way, “I think we do have a housing challenge in Atikokan. There's a lot of little housing.”

As suggested above in the three scenarios, a neighbouring community’s proximity to Atikokan influences the extent to which it may be economically impacted; however, distance is not the sole factor. Another factor is neighbouring communities’ population size. This may help explain why Thunder Bay with a population of over 100,000 and about a 2.5 hour drive away would experience a greater induced economic impact relative to other closer communities. Increased population size suggests more amenities and consumer retail opportunities. Larger amenity-rich communities can draw people for a number of reasons such as providing physiological benefits in the form of entertainment or recreation (Burns et al. 1999). Additional factors leading to out-shopping are outlined by (Jarratt 2000), who presents a concise summary of out-shopping behavior. Generalizations include: a) people with increased income and education tend to out-shop more, b) people with increased age and length of stay in the community tend to out-shop less, and c) people engaged in out-shopping respond to better prices, variety and quality in neighbouring communities.

These out-shopping generalizations are corroborated with unpublished data from an earlier stage in this project. One interview participant suggested,

> “that the workers at OPG [Ontario Power Generation, the power plant] probably are on the higher end of the out-shoppers. Because they can afford to travel, they can afford to go on vacation, they can afford to go for entertainment, a $100 for a ticket to go to see a show doesn’t mean as much to them as to somebody else.”

Additionally, an earlier Atikokan study (Ellis et al. 2003) identifies that out-shopping could also be the result of lack of consumer choices.

A primary concern that community leaders have about out-shopping involves seeing dollars which are earned locally "migrate" to other communities, creating negative effects on local small rural communities' economies. Community leaders often recognize the benefits of community members shopping locally, and work to curb out-shopping by introducing initiatives such as the 3/50 Project (Baxter 2015), which encourages household members to shop locally, supporting mom-and-pop, bricks and mortar shops.

CONCLUSIONS

This study examined the induced economic impact of three competing outcome scenarios (business as usual – coal scenario, shutdown the power plant – shutdown scenario, convert to renewable woody biomass – biomass scenario) for a small town economy, in response to a provincial-level policy change related to the use of renewable energy. Using provincial-level household expenditure data, local-level household income data, regional shopping behavior data, and local level expert knowledge and opinion, an induced economic impact assessment model is developed to determine effects of the three scenarios.

Evaluating the economic impacts of a policy has a number of associated challenges, since evaluation tools have the obvious shortcoming of not allowing the research community to "experiment" on actual economies. However, policy makers can be more effective in their roles, if they better understand and can anticipate unintended consequences of their decisions on local and regional economies. When the Ontario government first considered banning coal, the direct, indirect and induced economic impacts may not have been fully understood by the policy makers, partially due to a

dearth of Canadian studies (Dampier et al. 2013). By understanding how the three scenarios could affect direct jobs at the power plant and indirect jobs in the Town of Atikokan, changes in induced household expenditures in the local trade area were estimated.

Although this study only takes a "snap shot" shortly after the scenarios take effect, we suggest that the three scenarios, would put Atikokan's economy on three divergent trajectories, with differing final consequences: (i) coal would lead to status quo household expenditure, (ii) shutdown would lead to reductions in household expenditure, first by households employed by the power plant, and then by households employed by other sectors, and (iii) woody biomass would lead to increases in household expenditure as more people become employed by indirect businesses (related to providing woody biomass to the power plant) and participate in the local economy. In subsequent years, if a local biomass industry expands its operations due to increase in demand for wood pellets worldwide, future household expenditure are expected to increase as well.

A potential weakness with this study is that it does not account for any economic activity related to the transitions directly associated with shutdown or biomass conversion. Shutdown and decommissioning a power plant, or construction during a biomass conversion also provides some short-term, temporary economic benefits within the local trade area through increased household expenditure. In addition to employing the local available workforce, non-local trades people are required to temporarily live and work in Atikokan. Decommissioning would require an input of labour and supplies in order to ensure future environmental or human harm does not occur; while biomass conversion is a major capital upgrade. In either case, it is recognised that these benefits

are short-lived and not sustainable after the work is complete. This temporary increase of economic activity benefits businesses operating in the local trade area. These businesses could take the opportunity to invest back into their companies. For example with an increase in revenue, businesses will be able to address deferred maintenance issues such as upgrading rooms in a motel, or updating a refrigeration system in a grocery store.

In order to gain additional insight into direct, indirect and induced impacts, further study should include using a community-level business survey with a high sampling intensity. However, this approach may be challenging as participants would likely be reluctant to disclose confidential financial data such as sales, expenses and profits; or business information such as their client and supplier lists.

LIST OF ABBREVIATIONS

NHS: National Household Survey

OPG: Ontario Power Generation

RTPI: Royal Town Planning Institute

SHS: Survey of Household Spending

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHOR CONTRIBUTIONS

All authors have made substantive intellectual contributions to this study. The lead author under the academic tutelage of the other three authors collaboratively developed i) the data source collection methods, and ii) model development. All authors

contributed to the drafting of the final manuscript, and all provided critical revisions and technical input. All authors read and approved the final manuscript.

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CHAPTER 5 CONCLUSIONS: HOW BANNING COAL CAN CREATE NEW OPPORTUNITIES

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Employing a resilience framework, this dissertation shows that changes to Ontario's energy policy, banning coal in electricity production would impact communities that rely on power generation jobs such as the town of Atikokan, Ontario. If the ban was adopted as originally proposed, closures would have led to i) reductions in generating capacity for Ontario, ii) the loss of direct power generation jobs at all coal burning generating stations, and iii) the loss of indirect and induced benefits created by these jobs. The policy did lead to closure of all but one generating station, the Atikokan Generating Station (AGS). AGS was saved and was converted from coal to woody biomass; although biomass conversion was not an immediately apparent option when the coal ban was first introduced. With the goal to elucidate the policy's impact on the town of Atikokan, this dissertation:

1. Identified the knowledge gaps in the peer reviewed literature by determining the current state of knowledge relating to socio-economic impacts of coal and biomass in Ontario related to electricity production,
2. Characterized Atikokan's historical pre-conditions and residents' attributes and perceptions, which likely led to the community's response to the coal ban that threatened the community's major employer, the AGS, and,

3. Estimated and compared the induced economic impact of three potential scenarios at the AGS i) business as usual – coal scenario, ii) shutdown the power plant – shutdown scenario, iii) convert to renewable woody biomass – biomass scenario.

Findings during the literature review stage indicate that very few Canadian peer-reviewed articles investigate biomass burning in electric generating stations, which provided a research mandate. During the case study stage, it was discovered that the town of Atikokan's identity and history influenced how the community responded to the coal ban and potential AGS closure. Specifically, four themes within the community were identified; i) traditions of resource-based industry congruent with producing and burning forest-based renewable fuels, ii) historical linkages to a strong entrepreneurial ethic, iii) community members' recognition of AGS's multifaceted role in the community, and iv) strong community spirit and desire to fight for their town. Paraphrasing participants during this phase of the study indicated that an AGS shutdown would be catastrophic and it would be the "final nail in the coffin" making Atikokan a "ghost town".

Although the induced economic impact assessment model developed in the final stage of the project doesn't confirm or deny that the effect would be "catastrophic", it does indicate that a shutdown would reduce household incomes leading to less spending in the local economy by $5.3M immediately post shutdown, when compared to business as usual. On the other hand, conversion to woody biomass created an environment which spurred on a new local forest products industry creating new local jobs. The woody biomass conversion would increase household incomes leading to more spending in the local economy by $0.6M, when compared to business as usual. Furthermore, Atikokan

community leaders recognized that the ban could create positive (and originally unanticipated) socio-economic impacts if AGS continued its operation using woody biomass.

As more was learnt during the dissertation research process, the proposed tools outlined in the past literature (during the literature review stage) had to be abandoned in order to develop a model which could address the Atikokan community's unique context. A pragmatist approach requires flexibility in method development as an induced economic impact assessment model progressed. The model simulated three competing outcome scenarios for Atikokan. The model results suggests that business as usual leads to status quo household expenditure allowing for $82.7M in household spending, the shutdown leads to reductions in household expenditure reducing overall household spending to $72.1M, and the conversion to biomass leads to increases in household expenditure as more people become employed by indirect businesses (related to supplying woody biomass to the power plant) and participate in the local economy increasing household spending relative to business as usual by $1.2M.

The three modeled scenarios at AGS could be described through resilience framework's adaptive cycle. Resilience recognizes that communities undergo change over time which can ultimately lead to system collapse (adaptive cycle's Ω phase, Figure 1). During the collapse, a threshold is crossed and a disruption causes the system to lose capital and connectedness, which ultimately allows for a new system to emerge. Communities respond in a variety of ways to potential threats that pose to disrupt the status quo. Pathways can lead to increases in resilience, status quo, or less resilience.

The shutdown scenario would have immediately sent the system[14] from *K* into Ω and in order to survive, requiring the town of Atikokan to reinvent itself. With loss of the AGS facility, attracting or developing a major, well-paying employer or; creating an attractive culture for smaller employers over the short-term poses a challenge. These jobs from new employers and resultant household expenditures would have been essential in order to maintain the induced economic benefits lost from the AGS jobs lost. Also, Atikokan community leaders anticipated the release phase would have occurred had AGS been closed; although the community would have likely not characterised the shutdown in resilience terms.

The biomass scenario would more or less maintain the *K* phase, although a minor collapse Ω could occur, as household expenditure reduces following employment reductions at the AGS. But as the new woody biomass plant established, the increase in woody biomass jobs and household expenditure would be expected to increase moving the system through the phases back to *K* phase. A quick rebound would lead to a quick re-organization and an overall increase in household incomes and household expenditure. This idea suggests that as a small town's ability to expediently reinvent itself when facing exogenous forces, the greater its chance to emerge with increased resilience. When jobs disappear and household expenditure drops, towns cannot simply attempt to revive the previously successful sector(s) hoping to recreate a strong economy by putting resources into that mature industry. Conditions change over the lifetime of a failing sector, and the likelihood of rejuvenation diminishes over time.

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[14] The system described here is the town of Atikokan's social fabric and local economy means induced household expenditure from community households.

The coal scenario would have maintained status quo and the system would have remained in the *K* phase - as AGS jobs would have relied on a relatively mature technology (and fuel source). Household expenditure would have remained constant, the systems more entrenched, and system more rigid.

IMPLICATIONS

As coal use in electricity production continues to diminish and biomass use continues to increase, findings here can provide insight for communities evaluating the adoption of renewable energies. Demand for woody biomass use in electricity production is likely to increase not only in Canada, but worldwide as fossil fuels become less desirable (Farhar 1994, Farhar and Houston 1996, Brechin 2003, Aitken 2007). As policy makers and community leaders grappled with the intended and unintended consequences of the coal ban in Ontario, some clear implications were identified.

If case studies are to be generalized great care and qualification must be taken. While acknowledging this caveat, findings here may offer insights for leaders and decision makers in other jurisdictions. These parties may consider monitoring Atikokan's future progress since this project is the first of its kind in North America. Political decision makers may be more effective if they ponder the following considerations.

1. **Listen to community entrepreneurs.** Other communities similar to Atikokan may have people with a strong entrepreneurial ethic. Entrepreneurs are often the first people to recognize an opportunity (or threat) and the first to capitalize on that opportunity (or threat) (Dabson 2001, Drucker 2006, Dampier et al. 2014). When the conversion from coal to woody biomass pellets started to look like a

feasible option, community members with entrepreneurial ability exercised these skills in their efforts to influence decision makers. This ethic likely played a role when the community faced coal cessation and the subsequent development of a local biomass wood pellet industry.

2. **Pay attention to the community residents' fighting spirit.** When Atikokan residents learned about a potential AGS closure, the community expressed a fighting spirit. Community members' fight for their town is often spurred on by recognizing that the community faces vulnerabilities such as a shrinking populations (Brown et al. 2005, Dampier et al. 2014). Movements within communities are often led by a person or small group of people, who organize while projecting hope and a vision of transformation. It is useful if policy makers recognize who the influential "fighters" are in the community early in the process. Engage them and give them an authentic hearing and consideration.
3. **Assess the available workforce.** As provincial policies can lead to job lose or gains, it is important to understand the available workforce's skills and knowledge. Industry is often viewed as a positive contributor to the local community and economy. AGS provides jobs as well as other benefits to the community. Furthermore in Atikokan, there is comfort among community members with the AGS conversation to woody biomass, and acceptance of a nascent wood pellet industry (Dampier et al. 2014). Understanding Atikokan's resource sector workforce can help politicians anticipate community response to policy. When new business or entrepreneurial opportunities present themselves, an evaluation of community fit, and subsequently, comfort level could be a useful strategy.

4. **Acknowledge community members in sparsely populated rural areas.** Provincial governments are sometimes criticized and observed as making decisions more closely aligned with interests in densely populated urban areas rather than with those of rural Canada (Grenier 2011, Canadian Broadcasting Corporation 2011, Radwanski 2013, MacGregor 2014). This was the view of some Atikokan residents as the coal ban policy was being developed (Dampier et al. 2014). As provincial decision makers consider policies, attention to rural community needs greater attention, and politicians may gain political favour if they truly engage and consider rural Canada's concerns.
5. **Make informed decisions using economic assessment tools.** As presented in chapter 4, economic assessment tools can model and help anticipate how alternative decisions may impact communities. The three scenarios at the AGS would affect direct and indirect jobs, and induced household expenditures. Had decision makers been able to forecast how the coal ban could impact the economy and the resultant local response, they could have proactively addressed concerns and worries from community members more timely. Prior to the ban taking affect, Atikokan residents recognized that staffing changes at the AGS would create a ripple through the community's social fabric and economy, and mobilized. The induced economic impact assessment model validates their worries (Dampier et al. 2014).

6. **Gain a better understanding of regional commuting patterns of isolated community members.** As discussed in chapter 4, isolated communities such as Atikokan do not have a nearby job market. If AGS had closed, community leaders anticipated the community becoming a "ghost town". Isolate towns may be more vulnerable to loss of major employer due to labor markets not being within a reasonable commuting distance. Again, the model indicates that household expenditure would drop. Acknowledging a community's vulnerability due to distant proximity to alternative job markets is an important consideration when policies are introduced which threaten jobs.
7. **Ongoing support of regional institutes of higher learning** Much of the success of this project can be attributed to the support of Lakehead University's[15] committed regional researchers working with local communities. The next nearest Canadian university to Atikokan is hundreds of kilometers further away. Furthermore, research initiatives such as the Atikokan Bio-Energy Research Centre (ABRC)[16] with its $4 million investment provided important research capital to Lakehead University as well as other participating institutions.

[15] Lakehead University is situated relatively close to Atikokan.
[16] Disclosure: This research was not funded by the ABRC, however allied and complementary research has.

FUTURE RESEARCH

The community case study and content analysis methodology employed in this dissertation could be used in other communities. Using this method, these communities could gain local insights into their own unique identity and history and employ these insights when facing exogenous forces threating their major employers. Here four attributes are identified characterizing the town of Atikokan which likely played a role in the community's response to the coal ban. Due to the confounding nature of this work, it is unknown if these attributes would be effective in isolation or if they must exist together. Future research could include comparing the findings for Atikokan in other communities facing major employer loss. Perhaps other communities possessing their own histories and peculiarities may successfully respond to exogenous threats by exercising and expressing different (or perhaps similar) attributes.

Additional future research could also include conducting a rigourous Input-Output Analysis (IOA) with modelling software such as IMPLAN (http://www.implan.com/). The IMPLAN model utilizes IOA along with region specific social accounting matrices and multipliers. However presently, IMPLAN only has social accounting matrices and multipliers at the Canadian national and province levels. When these data become more robust for rural, sparsely populated Canada, software such as IMPLAN could be an effective tool in assessing direct, indirect and induced economic impacts of industrial changes on the local and regional level. In the absence of a viable IOA model, further insights into direct, indirect and induced impacts could also include employing a community-level business survey with a high sampling intensity. However, this approach may be challenging because participants representing business and

industry would likely be reluctant to disclose confidential financial data such as sales, expenses and profits; or business information such as their client and supplier lists.

Finally, placing a community on the adaptive cycle by developing and calculating variables for capital and connectedness could provide much insight and a basis for comparison of simple isolated economies. This approach could provide a quantifiable means of characterizing communities in terms of resilience. Capital and connectedness could be plotted against each other in a time series in order to provide confirmatory evidence to the presumptions presented in this chapter.

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