



Attitudes toward waste to energy facilities and impacts on diversion in Ontario, Canada



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ABSTRACT

Despite progress in residential waste diversion, residual waste – that fraction which cannot be recycled or composted – must continue to be managed by municipalities. Zero waste and environmental groups worry that waste-to-energy (WtE) incinerators discourage diversion, while both incineration and landfill have been stigmatized in the popular consciousness such that WtE incinerators in particular are being cancelled more often than they are approved. We conducted a mail-back survey of 217 residents in Toronto, Durham and Peel, Ontario, to understand attitudes toward diversion, levels of support for WtE incineration and WtE landfill (landfill gas recovery) facilities, and predictors of facility support. Contrary to experiences elsewhere, diversion seems threatened by WtE when measured as attitudes with 18%, and 14% agreeing that they would be less inclined to divert recyclable/compostable materials if they knew materials went to a WtE landfill or incinerator. When forced to choose between four options landfill or incineration with and without energy recovery, WtE incineration is *most* preferred (65%) and landfill without WtE is the *least* preferred option (61%). However, measurement has a large influence on public opinion results in the sense that support for WtE incineration drops to 43% when asked as a “vote in favor” question and to only 36% when measured as a 4-item index of support. When the indexes of support for landfill and WtE incineration are modeled, the prominence of odor in the landfill model distinguishes it from the WtE incinerator model which is dominated more by community and concern about health effects. Implications for policy are discussed, particularly mandatory diversion targets to accompany WtE.

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1. Introduction

Municipalities face very difficult decisions managing discards as “waste” is increasingly viewed as a resource and there is a wide range of technologies for treating it as an energy resource. Further, the waste hierarchy encourages working toward “zero waste” societies where minimization, reuse, recycling and composting result in diversion of waste from landfill and incineration facilities. Waste-to-energy (WtE) (or energy-from-waste – EfW) is now widely used worldwide as an alternative to traditional landfill and incineration without energy recovery; mainly by producing steam to heat buildings directly or by using biogas (largely methane) to run turbines for electricity production. Yet such

energy recovery is still relatively rare in the province of Ontario, Canada. Further, these technologies are highly contested both by environmental groups and local communities facing the prospect of a new facility – contributing to high levels of both expense and frustration. This study explores some of these issues by testing four hypotheses about public views of WtE facilities – particularly incineration – relative to landfill.

Canada’s WtE incineration capacity for municipal waste has grown only slightly in recent years expanding from five large (above 10,000 t/day) operating facilities in 2006 (Giroux Environmental Consulting, 2014) to six in 2015. There are 2150 WtE incineration plants worldwide, and Canada’s raw number pales in comparison to the E.U. and U.S. with 300+ (1.7 million people per facility) and 80+ (4 million people per facility) WtE facilities respectively (Waste Management World, 2014). Despite increasing interest in WtE in Canada, industry organizations continue to cast the Canadian public as “stubbornly skeptical” about

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WtE incineration (Waste Management World, 2015b), something corroborated by news media coverage of the issue (Canadian Broadcasting Corporation, 2015; Sandor, 2015) and recent decisions by three of Canada's municipalities (City of Vancouver, Regional Municipality of Peel, and the City of Sault Ste Marie) to cancel or stall proposed WtE facilities based in part on predictions of lower or uncertain waste volumes (Chan, 2015; Della-Mattia, 2016; Javed, 2016). The siting of landfills is also controversial but there are a larger number of WtE landfills in Canada than WtE incinerators. As of 2011, 14 WtE landfills were recovering landfill gas (primarily methane) for energy production (Giroux Environmental Consulting, 2014).

There is considerable policy debate about WtE and, compared to traditional incineration and landfill, surprisingly little social scientific research on WtE attitudes. A key debate is whether the presence of WtE in a community, particularly incineration, reduces recycling – one of the hypotheses tested here. Key environmental groups opposed to WtE incineration in Canada on the grounds that it will discourage the maximization of diversion include the Zero Waste Coalition (Environmental Leader, 2013), the Canadian Center for Policy Alternatives (Canadian Center for Policy Alternatives, 2015), Greenpeace Canada (Martin, 2010) and the Sierra Club (Jackson, 2015). Internationally, the Global Alliance for Incineration Alternatives (Global Alliance for Incineration Alternatives, 2013) has published a fact sheet specifically dealing with the issue of incinerators undermining recycling programs and subverting the push toward zero waste.

Municipalities are also exposed to alternative messaging about WtE incineration from industry. In Canada, groups like the Canadian Resource Recovery Council – a group supporting the waste industry's efforts to implement WtE incineration – use fact sheets to persuade the public that WtE incineration and enhanced diversion are compatible (Canadian Resource Recovery Council, 2015). However, the claims refuting that WtE (EfW) incineration reduces diversion are based largely on evidence from experiences in the U.S. and E.U. (Solomon Wood, 2014; Tracey, 2013); places which tend to be exposed to different policy drivers, particularly the E.U. which has a 1999 waste directive to phase out landfill (European Commission, 2015). This has prompted some zero waste enthusiasts to take more of a middle ground position, suggesting that incineration may be a useful stop-gap, including North (2009) who cites incineration and recycling rates in places like Denmark, Japan, Switzerland and Sweden to show that high incineration is often matched by relatively high diversion rates. Yet, two countries with the highest incineration rates in Europe – Norway (57%) and Denmark (54%) – have relatively modest diversion rates of 39% and 44% respectively (Eurostat, 2015). Seltenrich (2013a,b) reports on the more extreme case of Flanders Belgium where diversion is at 75%, largely because there is a policy mandated cap of 25% of waste management by incineration. By contrast media in Ontario point out cases like Detroit, which has an incinerator and until only very recently no municipal recycling program; suggesting that diversion has been limited and piecemeal because of a historical reliance on WtE (Porter, 2010).

Historically, waste data have been notoriously difficult to standardize for comparing between municipalities and within municipalities over time. For example, only since 2006 has Ontario had an organization to oversee the standardization and verification of municipal residential waste and diversion data (Waste Diversion Ontario, 2015). Unfortunately these data show the province has been stalled at a 47% diversion rate since 2011.

Until recently, Ontario had only one large WtE incinerator, namely a privately-owned facility in the Regional Municipality of Peel, which has been operational for over two decades managing only residential waste for most of that period (1992–2012). In 2012, Peel decided not to renew its contract with the operators

of the facility, intending to build its own more modern and larger WtE facility. Recently however, Peel Council rejected the proposed WtE in 2015 (one year after the completion of our field research), finding that the cost of construction had become prohibitive (Muir, 2015). It also heard from both staff and environmental groups that most of the waste stream currently being sent to landfill was recyclable or compostable (Javed, 2016). Council therefore chose to invest in new sorting and composting facilities while aiming for a target of reducing, reusing and recycling 75% of its waste by 2034 (Muir, 2015). Though the Peel municipal solid waste (MSW) feedstock dwindled for the privately-owned WtE facility it continued to operate by taking MSW from outside of Peel and concentrating on commercial, industrial and institutional waste. With the start of operations of the Durham-York Energy Center (DYEC) in 2015, Ontario now has two large WtE incinerators (Javed, 2015a). Further, the adjacent City of Toronto has recently embarked upon a long term waste strategy process that includes consideration of WtE (City of Toronto, 2015). These new developments make the time ripe for studying how the Ontario public views such facilities.

Though media messages about WtE incineration often center on concerns and opposition, this contrasts with industry polls, which tend to focus on support for WtE. For example, in a 2014 poll commissioned by the plastics industry in Canada, Nielsen (2014) found 66% of Canadians have a “favorable impression” of waste-to-energy compared to 29% who do not (50% and 42% if combustion-based only). This industry poll is consonant with one in Peel Region, taken before Peel's WtE review process, showing that 73% supported a new local WtE incinerator (Javed, 2015b). Further, the plastics industry poll shows that 89% of their sample of Canadians prefer non-recyclable plastics to be disposed in a WtE facility compared to only 5% preferring traditional landfill. There was no response available asking whether we should use non-recyclable plastics in the first place, while 6% did not know or refused to answer the question. Further, WtE ranked third after solar and wind as a preferred energy source (other choices were natural gas, oil, nuclear and coal). Like most polls the survey was not set up for in-depth analysis (e.g., modeling), so there is little emphasis on how such figures correlate with other preferences regarding waste and waste planning.

2. Background literature

This paper brings together literatures on: (i) attitudes toward non-WtE and WtE incineration and landfill with (ii) attitudes toward recycling. The former has its roots in the facility siting and risk literatures while the latter is embedded more in the environmental psychology and environmental economics literatures. We draw them together to construct four hypotheses about incineration and landfill both with and without energy recovery, as outlined in Section 3.

It is not always clear which types of waste facilities people prefer. In terms of relative support for various technologies, Achillas et al. (2011) were surprised to find higher levels of support for WtE incineration in Greece relative to landfill. They measured whether residents of Thessaloniki, a large city with an acute waste crisis, felt traditional landfill (LF) was considered a better solution than WtE incineration in terms of: cost (LF = 39% vs WtE = 30%), public health (LF = 31% vs WtE = 46%), aesthetic nuisance (LF = 23% vs WtE = 54%), land degradation (LF = 23% vs WtE = 50%) and energy recovery (LF = 6% vs WtE = 69%) – with cost being the only one favoring landfill. An older study of New Haven Connecticut voters found that opposition to a hypothetical WtE incinerator within one mile of the resident's home was 79% and within five miles it dropped to 49% (Lober and Green, 1994). They

argue that on the surface this implies a NIMBY attitude, but ultimately reject this idea since even at 20 miles a sizable 40% still opposed the facility. On the contrary, Lima (2006) found that within 2 km of a proposed incinerator, construction was opposed by 42% in Lisbon and 20% in Oporto Spain, but these dropped off at 10 km to 6% and 0%. The relatively lower level of opposition in the more recent study might be explained by improvements in WtE incinerator technologies since the 1990s. Nevertheless, for those opposed to WtE incineration Lober and Green (1994, 33) suggest that, “Attitude toward need is found to have as great an effect as distance on siting preferences for waste-to-energy plants”.

Davies (2006, 2005) explores discourses of anti-incineration in Ireland to highlight how discourses of health risk, facility need and trust dominate among the most active concerned citizen and opposition groups; while in the U.S. these groups are more likely to frame such issues as violations of environmental justice (e.g. Rootes and Leonard, 2009) – a discourse that does not seem to resonate in Ireland. The discourse of “need” is again prominent with locals worried that incineration facilities potentially undermine current and future efforts at diversion and zero waste in host communities. One perversity of waste management is that a proposal for a local waste facility can actually increase diversion as communities make extra efforts to show that they do not need a new disposal facility (Baxter et al., 1999).

Trust is also central, particularly in the siting process for incinerators and public participation in decision-making as suggested by Davies (2006). Likewise in a study of Portsmouth England, Snary (2002) found that efforts at well-meaning community involvement and risk communication can undermine trust when they come off as overly technical, while at the same time they often fail to address concerns about equity and fairness in the distribution of burdens associated with waste disposal facilities (see also Lima, 2006). Upreti and van der Horst's (2004) study of a 5 MW biomass waste gasification plant in the U.K. similarly revealed that (lack of) public trust in developers and operators was a primary determinant of opposition. These studies support the idea that it is not technical knowledge-deficits on the part of residents that is at the root cause of opposition *per se*; proponents and opponents are instead prioritizing different values.

Though much of the early academic research on public views toward incinerators finds that people generally support the technology, Achillas et al., 2011, 859 argue that this is set in the “between the lines” subtext of a “NIMBY” attitude of high opposition against specific local facilities despite overall support. Some older examples such as Walsh et al. (1993), where facility support is reported at 30% or less indeed support the idea of low support not NIMBY specifically, but Porteous (2001) suggests support is improving over time as incineration technology becomes cleaner and more efficient at creating energy. Similarly, Furuseth and O'Callaghan (1991, 163) find “surprisingly low opposition” – only 1/3 of a sample near an existing university waste incinerator (without energy recovery) in Charlotte North Carolina. They suggest that it was the low-key siting process that partially explained the apparent local apathy to the facility.

Academic studies in Canada find support for incineration is also somewhat mixed – but incineration is generally preferred over landfill. Elliott et al. (2004) studied the residents around six different waste facilities: three landfills and three (non-WtE) incinerators in British Columbia and Ontario. Residents were less concerned about the negative impacts of an incinerator compared to a landfill, which is partially explained by the fact that the incinerators had a long history in their locale and/or were located in fairly heavily industrialized areas with few residents. Overall though, this literature on support/opposition to incineration (with and without WtE) tends *not* to include variables that acknowledge the household labor involved in waste diversion (source separa-

tion) as well as perceived benefits and trade-offs between perceived risks and benefits of facilities such as WtE incinerators. One exception is Walsh et al. (1993) who studied Pennsylvania residents living near a failed incinerator (siting halted) and one that recently became operational and found that 41% and 31% felt such facilities are a “recycling counterincentive”.

Similarly, there are several studies on individual attitudes and recycling behaviors but few of those studies consider the structure of the entire waste system and its facilities and how those may impact views about diversion – particularly regarding WtE. Most of the studies on recycling behavior come from environmental psychology, and are based on the theory of planned behavior – that attitudes strongly predict behavior and that those attitudes involve some sort of mental calculus (Ajzen, 2011). For those who do measure actual recycling behavior and compare that to attitudes, there is indeed an extremely high correlation with intentions, with a slight tendency to overestimate actual behavior (Gamba and Oskamp, 1994). The predictors of recycling intentions and behaviors include such variables as: knowledge/information and positive feedback (e.g., Chan, 1998; Gamba and Oskamp, 1994; Hopper and Nielsen, 1991; Thomas, 2001; Timlett and Williams, 2008), attitudes toward recycling – e.g., need, effectiveness (e.g., Knussen et al., 2004; McCarty and Shrum, 1994; Werner et al., 1995), attitudes toward the environment (e.g., Gamba and Oskamp, 1994; Scott, 1999), social norms/pressure (e.g., Chan, 1998; Mannetti et al., 2004; Scott, 1999), perceived control/convenience (e.g., Barr, 2007; Gamba and Oskamp, 1994; McCarty and Shrum, 1994; Tonglet et al., 2004), past minimization and diversion behavior (e.g., Knussen et al., 2004; Scott, 1999; Tonglet et al., 2004), personal identity (Mannetti et al., 2004), community/civic mindedness (e.g., Tonglet et al., 2004), and general values/worldviews (McCarty and Shrum, 1994). It is beyond the scope of this paper to review these in detail, but the purpose here is to highlight that none of these studies measures whether type of disposal facility – particularly WtE incineration – has an impact on attitudes toward diversion in the home. However one important lesson from the recycling behavior literature is that intentions to recycle do not always translate into action (Tudor et al., 2007). We note this later as an important qualifier on our findings about intentions to divert less if waste is sent to a WtE facility.

However, some of the attitudinal research findings provided inspiration for the current study, particularly concerning the convenience/difficulty of recycling, which appears repeatedly as one of the strongest determinants of recycling behavior (Barr et al., 2003; Martin et al., 2006; Tonglet et al., 2004). McCarty and Shrum's (1994) findings based on a study of U.S. university students, for example, suggest that convenience has a stronger effect than even pro-environmental and pro-recycling attitudes. Thus, any perceived lack of convenience might translate into a willingness to dispose rather than divert. Add to this a waste regime where WtE is promoted as a green energy alternative and residents may not think twice about putting combustible materials (e.g., paper, organics, and plastics) into the bin bound for a WtE facility rather than a bin that diverts such waste for reuse/remanufacture. This may be particularly true for items whose recycling/composting status is unknown (Gamba and Oskamp, 1994) or for materials like organics that involve odors (Åberg et al., 1996). This is supported by municipal frustrations like those reported by Imrie (2013) that a low 19% participation rate in “green bin” organics collection program in Waterloo Ontario is determined largely by “offensive smell”. In the academic literature a study of household composting systems by Faverial and Sierra (2014) finds that a modest 8% of households had problems with odours. Thus, the findings about convenience lend some credence to the thesis by zero waste and environmental groups that diversion may stall or decline when combined with WtE in a waste system.

3. Methods

3.1. Community selection

We conducted two waves of a mail-back survey of residents in three communities in Ontario: Toronto (pop. 2.61 million) and two adjacent communities, the City of Brampton (pop. 523,911) in the Regional Municipality of Peel and Courtice, a community in the Municipality of Clarington (pop. 84,548), which lies within the Regional Municipality of Durham (Statistics Canada, 2011). The latter two communities were chosen because they have existing WtE incineration facilities while Toronto was used as a control without WtE. To be more precise the Durham-York Energy Facility was technically still under construction in Courtice during the first wave (Feb/Mar 2014) (12 months prior to becoming operational) and second wave (May/Jun 2014) (10 months prior) of the survey. The Region of Peel had ended its contract with the local, privately-owned WtE facility and was exporting its waste to a landfill, but had commenced an environmental screening process to build its own WtE (Waste Management World, 2015a). The privately-owned WtE continued to operate in Peel's city of Brampton while accepting waste from other sources. At the time of the survey, therefore, none of the communities was sending waste to a WtE incinerator but one would be sending it soon and one had sent it in the recent past. We believe that these contextual differences could potentially have an impact on attitudes. The literature suggests that concerns about technological hazards are highest in communities prior to a facility becoming operational – so-called anticipatory fears (Elliott et al., 2004; Porter, 2010). Thus, it was assumed that facility-related concern would be higher in Courtice (in Durham) compared to Brampton (in Peel) – the latter having had a WtE facility operating for over two decades until 2012. Toronto has a history of exporting its waste and currently sends its municipal residential waste to a landfill in Ontario owned by the city but located 200 km west of the city. The expectation is that the landfill will have capacity to produce energy from landfill gas in the future (Toronto Hydro, n.d.).

3.2. Sampling

The analysis is based on completed survey questionnaires from 217 residents randomly sampled from households in all three communities. In Brampton and Courtice this sampling was within a 5 km radius of the relevant facility. Within these specifications, random mail routes were selected in all three communities. To account for possible seasonal effects, there were two waves of the survey, one in Feb/Mar 2014 which resulted in a total of 110 returned questionnaires from 843 delivered, with a response rate of 12%; and a May/Jun 2014 wave 2 with 825 distributed questionnaires yielding 107 completes for a response rate of 13%. Though these rates are low, the sample's demographic profile aligns well with Statistics Canada (2011) figures for these communities, with the exception that there is a higher proportion of women in the sample at 60% (57% for wave 1 and 63% in wave 2) compared to Statistics Canada's estimates of slightly over 50%. The highest proportion of women in the sample was for the Courtice wave 2 group at 71% and the lowest for the Toronto wave 2 group at 56%. It is well known in the risk literature that women tend to be more inclined to express concern about technological hazards so added to the biases above there is an expected overall bias in the sample toward facility-related concerns; and especially in Courtice that was just to about to become operational.

3.3. Hypotheses, variables and indexes

Based on the review of the literature and policy debates over the impact of WtE on recycling, the following hypotheses are tested:

H1. People will be less inclined to divert materials for recycling and composting if they know discards are sent to a WtE facility (incinerator or landfill).

H2. There is more support for end-of-stream facilities for discards if they have a WtE component.

H3. Support for WtE incineration will be preferred over WtE landfill.

H4. Support for WtE incinerators (and landfill) (DV¹) will be predicted by location (place), diversion behavior, rationales for diversion, perceived negative and positive impacts, and sociodemographics (see example variables in Table 1).

The dependent variable – index of support for WtE incineration – is comprised of the following four variables: (i) “I am in favor of communities hosting incinerators to manage their own waste”, (ii) “If there was a vote in my municipality about whether my municipality should install a waste-to-energy incinerator to manage its waste I would vote in favor”, (iii) “I would have no problem living in the vicinity of a waste-to-energy incinerator” and, (iv) “Incineration needs to be a key element in handling my municipality's waste problems”. The index of support for landfill uses the same items with “WtE incineration” replaced by “landfill”, the most common residential disposal method in Ontario. All of the items were measured on a 5 point Likert scale from strongly agree to strongly disagree with a neutral middle point and summed with strongly agree scoring 5 and strongly disagree 1. Accordingly, these two scales ranged from 4 (very unsupportive) to 20 (very supportive).

The predictor variables come mainly from the risk perception, facility siting, and attitudes toward recycling literatures. The ones listed in Table 1 are the only ones significantly correlated with at least one of the two dependent variables (see Table 2). The “live close to facility” variable (PV1) was based on whether the participant said they lived within 10 km or an incinerator or landfill. The majority of these variables were measured using 5-point Likert “agree” scales for statements like – PV4: “incinerators pose a health threat to residents nearby”, PV5: “incineration creates an unacceptable legacy of environmental contamination for future generations”, PV6: “waste incinerators decrease the property values in the host community”, PV7: “incinerator (landfill) facilities take away from local recycling and composting jobs”, PV8: “I am concerned that waste incineration facilities release unpleasant odor into the environment”, PV9: “the capability of incinerators to generate energy from waste offsets the negative effects it may have on the environment”, PV10: “I am confident that regulatory authorities do a good job monitoring incinerator emissions to reduce environmental impacts” and, PV12: “Incinerator facilities contribute significantly to the job market in the host municipality”.

There are two indexes, one for expressed diversion behavior and the other for diversion intentions in a WtE system. The expressed diversion variable (PV2) is made of up four variables relating to whether “material (i – paper, ii – metal, iii – plastics, iv – food) ends up in the trash” on a five-point scale from “often” to “rarely”. The “divert less” variable (PV3) is also a summative index based on four questions in the format: “If I know my waste will be burned in a WtE incinerator to produce energy (e.g., electricity) I would put fewer *paper* products that are recyclable in the recycling bin (e.g., blue bin)” – likewise for *metal*, *plastic* and *food* and then again for WtE landfill. Two sociodemographic

¹ DV = dependent variable; PV = predictor variable or independent variable. The DV for H1 is the intention to divert less, while for H2–4 it is support for facility.

Table 1
Hypothesized relationship of key predictors of WtE incinerator and landfill support.^a

Variable	Low facility support ^b
PV1 Proximity to an existing WtE incinerator	Live close
PV2 Index of existing diversion behavior	High diversion
PV3 Index of diversion if WtE	Divert less
PV4 Concern about health impacts	Agree
PV5 Concern about environmental impacts	Agree
PV6 Concern incinerators decrease property values	Agree
PV7 Concern for loss of local recycling and composting jobs	Agree
PV8 Concern about odor	Agree
PV9 WtE/EFW risk/benefit trade-off is reasonable	Disagree
PV10 Confident that authorities monitor emissions well	Disagree
PV11 Incinerators contribute significantly to the job market	Disagree
PV12 Environmental problems will be solved with technology	Disagree
PV13 Community	Courtice (Durham)

^a These variables are in fact significantly correlated with at least one DV, others appear in Tables 2 and 3.

^b e.g., those living close to a WtE incinerator will be less likely to support it.

measures were included in the models as dummy variables– gender and community with the expectation that there would be lower support for WtE in particular from women and residents of Courtice (Durham).

3.4. Analysis

The analysis was conducted in three stages. First, frequencies were run on the “divert less” variable to address Hypothesis 1. Second, to address the remaining hypotheses all of the independent/predictor variables were correlated with the two dependent variable indexes – support for WtE incinerators, and support for landfills. Third, to address Hypothesis 4 in particular, two multiple linear regression models were run – one for each support index – against only those predictor variables that were significantly associated in the correlation analysis. This form of regression uses Likert variables to provide insight into the relative contribution of each variable to the model based on the size of the regression coefficients for each (Norman, 2010). In the interest of space, the analysis focuses mainly on WtE incineration for H4, with the landfill analysis truncated to only include the regression model.

Table 2
Correlation of predictor variables with INDEX of support for WtE incinerators.

Survey item	Agree ^a					Disagree		Mean ^b	Corr ^c
	1	2	3	4	5				
INDEX of support WtE incinerator in own municipality	11	24	28	23	11	2.98	DV		
<i>Location</i>									
Courtice (dummy)	1			0					
Brampton (dummy)	32			68		–		–0.36 ^(**) d	
Toronto (dummy)	26			74		–		0.16 ^(ns)	
Live within 10 km of incinerator (dummy)	42			58		–		0.18 ^(ns)	
	40			60		–		0.11 ^(ns)	
<i>Diversion behavior</i>									
INDEX of diversion behavior (material ends up in trash)	Often		Rarely						
	1	1	7	39	53	4.43		–0.02 ^(ns)	
	Agree		Disagree						
INDEX divert less if sent to WtE incinerator	7	8	19	22	43	3.87		–0.09 ^(ns)	
<i>Rationale for diversion</i>									
Sort waste to minimize environmental impact	65	23	7	3	1	1.50		0.08 ^(ns)	
Sort waste because it is required by my municipality	13	24	13	17	32	3.32		–0.02 ^(ns)	
Sort waste to be a good member of my community	11	24	28	23	11	2.61		–0.03 ^(ns)	
Sorting waste takes too much time	1	4	8	19	69	4.49		0.02 ^(ns)	
Sorting waste takes too much space	4	7	7	18	63	4.30		0.06 ^(ns)	
<i>Negative impacts</i>									
Incinerators pose health risks to residents	21	33	27	10	9	2.53		–0.65 ^(**)	
Pollutants from incinerators do irreversible environmental damage	21	42	17	15	6	2.42		–0.64 ^(**)	
Incinerators release unpleasant odors	19	44	18	14	6	2.42		–0.55 ^(**)	
Incinerators take away from recycling/composting jobs	4	20	44	24	7	3.09		–0.26 ^(**)	
Incinerators decrease property values	25	42	23	7	4	2.22		–0.47 ^(**)	
<i>Positive impacts</i>									
Tradeoff – WtE benefit offsets negative impacts	7	23	42	17	11	3.01		0.43 ^(**)	
Confident that authorities monitor emissions well	9	34	18	24	14	3.00		0.51 ^(**)	
Incinerators contribute significantly to local job market	6	33	40	13	8	2.84		0.31 ^(**)	
<i>Environmental views</i>									
Environmental problems only controlled through radical behavior change	42	40	9	7	1	1.87		–.01 ^(ns)	
Environmental problems not out of control, but government should have clearer rules about what is allowed	18	41	14	16	9	2.55		0.02 ^(ns)	
We do not need to worry about environmental problems because they will be resolved through technology	3	5	5	26	61	4.43		0.16 ⁽⁺⁾	
We do not know whether environmental problems will worsen or not	12	18	11	22	37	3.55		0.05 ^(ns)	
Gender (M = 0, F = 1) ^e	F				M				
	59				40	–		–0.21 ^{**}	

^a 1 = strongly agree/yes/often, 2 = somewhat agree/often, 3 = neither agree nor disagree/don't know/sometimes, 4 = somewhat disagree/rarely, 5 = strongly disagree/no never – values shown are percentages.

^b Mean score for the subsample – see note.^a

^c Spearman correlation with the dependent variable “Index of support for WtE incinerators” as scale rather than 3 or 5 categories, shaded rows represent significant relationships (Pearson correlations resulted in the same decisions).

^d Significance of correlation: *p < 0.05; **p < 0.01. ^{ns}not significant.

^e Education and income are not included as controls due to relatively low responses to these items and they are not significantly correlated with DV.

4. Results

H1. People will be less inclined to divert discards if they know it is sent to a WtE facility.

There is evidence from the survey and residential diversion data to support the idea that some people may divert less if they know their waste is going to a WtE incinerator or WtE landfill facility – but it is difficult to draw any causal connections. In terms of actual diversion, Fig. 1 represents the most recent data on diversion (from 2006 to 2013) collected by Waste Diversion Ontario. At the time of the survey only one of the regions – Peel (Brampton) had an *operating* WtE incinerator² and, supporting the hypothesis, they also have the lowest diversion rate (44%) compared to Durham (54%), Toronto (53%) and the provincial average (47%). It is difficult to attribute the lower diversion to the presence of WtE facilities as a number of factors likely account for the regional differences. One such confounder is apartment dwelling since bluebin recycling and green-bin composting programs at apartment buildings in all of these regions is notoriously poor. This is due to logistical problems, especially in older buildings not designed for such binning systems; yet these data do not falsify our hypothesis. Durham does so well diverting perhaps because only 5% of its residents live in multi-family dwellings. Nevertheless, in support of our hypothesis: Peel has only 8% multi-family dwellers while Toronto has three times that amount (23%), but with 9% *more* diversion than Peel and the province as a whole has a higher percentage (10%) of multi-family dwellers with 3% more diversion (Statistics Canada, 2011). Other factors like changes in contracts with suppliers and facility shutdowns might explain the relationship, and the “why” of this lower diversion needs to be unpacked beyond household attitudes in future research.

The survey results on attitudes also suggest that WtE is likely to have some impact on diversion rates. Given findings from some European Union countries that diversion tends to be high already or increase despite WtE, is it somewhat surprising that Fifteen percent of residents say they would divert less if they knew their waste would be disposed in a WtE incinerator and 18% say they would divert less if they knew it went to a WtE landfill. Further the neutral responses bring the total to 34% in both cases. That is, an undecided/neutral attitude toward diversion combined with what the literature says about the prominent impact of convenience on recycling behavior suggests a substantial portion of such undecided people may reasonably revert to less diversion in practice.

There are differences between communities and facility type for intending to divert less in the presence of a WtE facility, but these differences are *not* statistically significant³. Regardless of a community's experience with WtE, knowing that waste is being sent to any type of WtE facility can affect their attitudes to diversion. Fig. 2 shows that the inclination to divert less ranges from 21% in the community with the soon-to-be operational WtE incinerator (Courtice) followed by 18% in Brampton the community that has been using WtE incineration for over two decades, and more recently, a WtE landfill to as low as 9% for the Toronto which has no WtE incinerator or landfill. Recall from Fig. 1 though that Courtice is in Durham, the region with the highest residential diversion in the greater Toronto area, while Brampton is in Peel, the region with the lowest. Keeping in mind that our community differences are not significant, this *may* at least suggest that the sentiments in Courtice are yet to be realized – that what we are seeing is a *threat* of diversion sliding toward Peel's rate in the future while Peel's decline may already have been realized – a hypothesis that can be tested using future

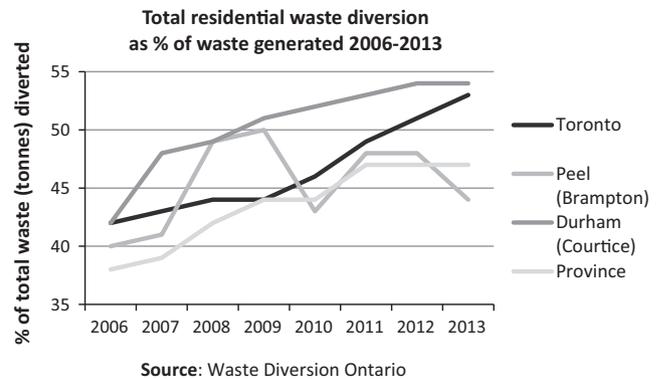


Fig. 1. Residential waste diversion in the study municipalities.

diversion data. Distance from an existing facility did *not* have a statistically significant association with intention to divert less with 16% of residents living within 10 km of a WtE incinerator (regardless of being operational or not) saying they would divert less compared to 17% who did not live near a WtE incinerator and 10% for those who did not know.

H2. There is more support for end of stream facilities for discards if they have a WtE component.

and

H3. Support for WtE incineration will be preferred over WtE landfill.

Whether there is majority support for WtE technology depends on how “support” is measured. When forced to choose between four types of disposal, as expected there is more preference for both landfill and incineration if it includes WtE, but WtE incineration is the “most preferred” of all (61%) while landfill without WtE is “most preferred” by only 3% and “least preferred” of all (65%). When “most preferred” and “more preferred” are combined the preference for WtE incineration is 81% compared to 65% for WtE landfill (Fig. 3). However, these figures drop considerably when measured as “support” for a local facility – i.e., the “vote in favor” question, and the indexes of support. Only 25% would vote in favor of a local landfill, while 43% would vote in favor of a local WtE incinerator. Measured as 4-item indexes of local support (vote in favor, live near, manage own waste, key element of waste management) landfill gets only 22% support while WtE incineration likewise drops to 36% support.

Further, there is significant variation by community. Fig. 4 shows that just over 40% of Brampton and Toronto residents support WtE incineration compared to just over 15% for Courtice, while Fig. 5 shows that support is much lower for landfill, with Brampton having the highest support (26%) and Toronto the least (16%). Further, support for a WtE incinerator is positively (and significantly $p < .05$) associated with living within 10 km of a WtE incineration facility (50% support) compared to those who do not live near a WtE incinerator (33% support) or don't know if they do (17% support). The opposite is true for those living within a 10 km of a landfill (30% support) compared to those who do not live within 10 km (49% support) or don't know if they do (21% support).

H4. Support for WtE incinerators and landfills will be predicted by...

The predictors of support for WtE incinerators include a mixture of concerns about negative impacts as well as benefits, hopefulness about technology, place and gender, but not diversion

² Keeping in mind that this WtE incinerator was not accepting residential waste at the time of the survey. Peel also was the only region of the three studied with WtE from landfill biogas.

³ Using crosstabs, chi square statistic in SPSS 21.

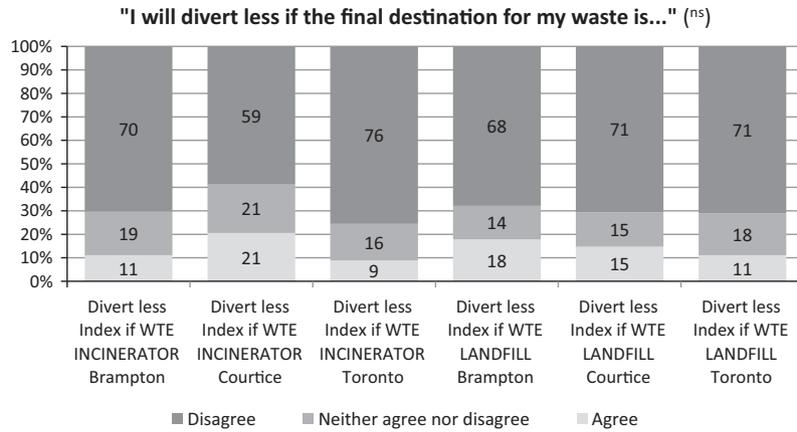


Fig. 2. Intended diversion behavior if discards go to WtE facility by community. (The 4-item index which varies from 4 to 20 was simplified to three categories in Fig. 2: disagree = 4–10; neither agree nor disagree = 11–13; agree = 14–20. The same categories are used for the support indexes in Figs. 4 and 5. Statistical significance – **0.01, *0.05, ^{ns}not significant – (upper right) is based on crosstabs chi square in SPSS 21.)

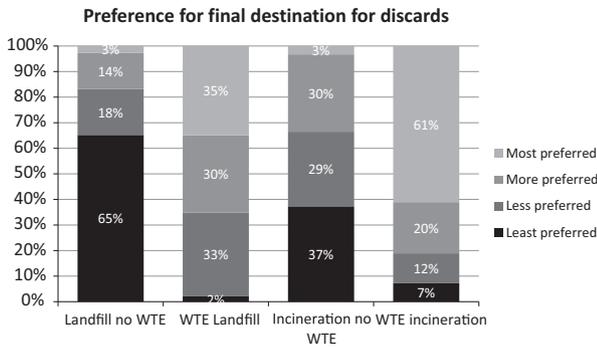


Fig. 3. Preference for four disposal methods, with and without WtE.

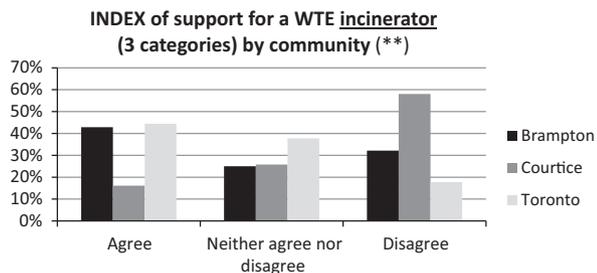


Fig. 4. Index of support for a WtE incinerator by community.

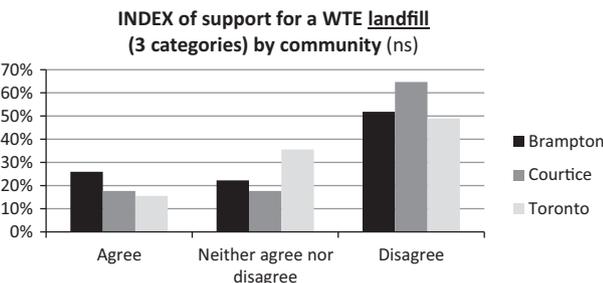


Fig. 5. Index of support (3-category version) for a WtE landfill by community.

variables. The significant bivariate correlates of the index of WtE incinerator support are (in descending order): health risk concern (–0.65**), irreversible environmental damage concern (–0.64**),

unpleasant odors concern (–0.55**), confidence in monitoring (0.51**), decreased property values concern (–0.47**), benefits offset negative impacts (0.43**), live in Courtice (–0.36**), contribute local jobs (0.31**), take away recycling/composting jobs (–0.26**), women (–0.21**), and environmental problems will be solved with technology (0.16*) (Table 2). The fact that none of the variables concerning diversion, including the divert less if sent to an incinerator index, are significantly correlated with the support for WtE incineration suggests that while diversion intentions may be influenced by whether or not a facility uses WtE technology (i.e., H1) diversion is not directly connected with facility support (H4).

The multiple linear regression model for the support for WtE incinerator index dropped the following four of the 11 variables that were significantly correlated in the bivariate analysis: unpleasant odors, take away recycling/composting jobs, trade-off – benefits offset negative impacts, and environmental problems will be solved with technology (Table 3). The fact that the “trade-off” variable is not significant is particularly surprising since the benefits of creating renewable energy are often touted as a reason for WtE popularity. Nevertheless, more localized disadvantages are important for distinguishing supporters from non-supporters. That is, those who are less supportive of WtE incinerators are concerned that they: pose a health risk (–0.29**), do irreversible environmental damage (–0.22**), are not monitored well by the authorities (0.21**), decrease property values (–0.14*), do not create significant local jobs (0.14**), or are women (0.13**); with a reasonably good adjusted R^2 of 0.64 and all relationships in the hypothesized direction. This pooled model does not include the Courtice dummy variable as that variable was only measured in wave 2 ($n = 107$) of the survey; yet a separate model run on that sub-sample shows the Courtice dummy to have a beta of -0.17^* that did not significantly increase the adjusted R^2 of that sub-sample model. This suggests community is significant but not as important as health and environmental risk variables.

The model for WtE landfill support performs much worse than the one for WtE incinerator support as the adjusted R^2 is only 0.29 and only three of the original 10 correlated (bivariate analysis) predictor variables remaining in the model (Table 4). The following variables were significant bivariate correlates but dropped out of the model: live within 10 km of a landfill, health risks, environmental damage, decreased property values, confidence in monitoring, benefits offset negative impacts and faith in technology. There are similarities with the incinerator model in that significant local job creation (0.16**) and being a woman (–0.16**) predict support for WtE landfill. The most notable differences between the landfill

Table 3
Multiple linear regression: predictors of INDEX support for WTE incinerator ($n = 217$).

	Adj R^2	Beta/ B^a
	0.64** ^b	
Constant		12.77**
Incinerators pose health risks to residents		-0.29**
Pollutants from incinerators do irreversible environmental damage		-0.22**
Incinerators release unpleasant odors		0.02 ^(ns)
Incinerators take away from recycling/composting jobs		-0.04 ^(ns)
Incinerators decrease property values		-0.14*
Confident that authorities monitor emissions well		0.21**
Tradeoff – WTE benefit offsets negative impacts		0.07 ^(ns)
Incinerators contribute significantly to local job market		0.14**
We do not need to worry about environmental problems because they will be resolved through technology		0.03 ^(ns)
Gender (0 = male, 1 = female)		-0.13**

^a Variables: Standardized regression coefficients (Beta); Constant: unstandardized coefficients (B).

^b Statistical significance: ** = $p < 0.01$; * = $p < 0.05$.

and incinerator models are that: (i) the strongest landfill (lack of) support predictor is concern about unpleasant odors (-0.23**) a variable that is not significant in the incinerator model, (ii) the odor variable may supplant the concern about health and environmental impacts variables that were significant and relatively strong predictors in the incinerator model, (iii) faith in monitoring does not distinguish landfill supporters from non-supporters and; (iv) there is no significant place-based predictor (i.e., community, living near a landfill) in the landfill model. It is worth noting that living near a landfill was significantly and positively correlated with support in the bivariate analysis – contrary to our hypothesis – suggesting that living with a facility may breed favor, but again, this relationship was not strong enough to stay in the model. Thus, there are substantive differences in predictors of support for these two types of waste facilities to warrant separate consideration in future research and policy – particularly the health and environment (incineration) vs odor (landfill) issues.

5. Discussion

All four of the hypotheses were sustained to a certain degree by the survey results. Regarding diversion, the results lend credibility to the idea that waste diversion can be threatened when the waste system includes a WtE incinerator or WtE landfill, barring other changes to the waste management system and policy (e.g., mandatory diversion targets); though further research is needed to corroborate these findings and trace whether intentions translate into behavior and declining municipal diversion rates. Future work will be able to test this idea in Durham as the DYEC WtE incineration facility began burning waste in 2015. Although the percentage of people suggesting they will divert less is 15–18% there are two reasons such a finding might be concerning from the point of view of maximizing diversion rates. First, residential diversion rates in the GTA have not yet met provincial goals of 60%. Fig. 1 represents the most recent data on residential waste diversion⁴ (from 2006 to 2013) collected by Waste Diversion Ontario and shows that Peel has the lowest diversion rate (44%) compared to Durham (54%), Toronto (53%) and the provincial average (47%). All three communities have similar diversion programs, but Peel has substantially lower organic diversion rates (and more organics in its garbage stream), perhaps

⁴ Residential waste excludes construction waste but may include small amounts of commercial waste collected by municipalities. Diverted waste includes a wide range of materials but primarily consists of paper and packaging waste, food waste and yard waste.

Table 4
Multiple linear regression: predictors of INDEX of support for landfill ($n = 217$).

	Adj R^2	Beta/ B^a
	0.26** ^b	
Constant		14.36**
Live within 10 km of a landfill (dummy)		0.12 ^(ns)
Landfills pose health risks to residents		-0.04 ^(ns)
Pollutants from landfills do irreversible environmental damage		-0.04 ^(ns)
Landfills release unpleasant odors		-0.23**
Landfills decrease property values		-0.14 ^(ns)
Confident that authorities monitor emissions well		0.09 ^(ns)
Tradeoff – benefits offsets negative impacts		0.09 ^(ns)
Landfills contribute significantly to local job market		0.16**
We do not need to worry about environmental problems because they will be resolved through technology		0.15 ^(ns)
Gender (0 = male, 1 = female)		-0.16**

^a Variables: standardized regression coefficients (Beta); constant: unstandardized coefficients (B).

^b Statistical significance: ** $p < 0.01$, * $p < 0.05$, ^{ns}not significant.

^c Multicollinearity tests revealed the highest VIFs (variance inflation factor) were between 4 and 5 for the health and environmental impacts variables for the incinerator model only. O'Brien (2007) considers VIFs in this range acceptable, and the two variables are also conceptually distinct.

because it is the only municipality of the three that offers garbage and organics collection every week rather than organics collection every week and garbage collection every two weeks (Criscione, 2015). Any drop in diversion will stall and potentially reverse progress toward achieving 60% diversion, and certainly threatens zero waste efforts. A second point of concern is that the rate could be potentially as high as 34% when the neutral responses are considered in combination with the fact that diversion seems sensitive to convenience factors – the ease with which materials can be recycled in the home. That is, past research has repeatedly shown that convenience is a strong predictor of recycling behavior (Gamba and Oskamp, 1994; McCarty and Shrum, 1994; Tonglet et al., 2004) so that opportunities to streamline and simplify waste management may readily be seized in the household. Though convenience variables are included in the models and were not significant it is important to distinguish that the dependent variable was *support* for waste facilities not *diversion*. Future research should model diversion behavior using WtE incineration as a predictor variable. Nevertheless, our findings on intention, if followed through, have the potential to contradict what has been found in several jurisdictions in the E.U. where actual diversion rates stay high or even increase in the presence of WtE incinerators; but in some of those cases the targets are actually mandated within policy (Seltenrich, 2013a,b).

In terms of facility preferences there is clear partiality toward WtE over non-WtE solutions for end of stream discards, with WtE incineration most preferred and landfill least preferred. However, measuring public support for waste facilities depends on at least two measurement issues: (i) whether or not there is a forced choice between a limited number of facilities/options and (ii) whether it is measured as a “preference” or “support”. Public favor for WtE incineration is high when measured as a forced choice preference over landfill or incineration without WtE. However, 81% “preference” for WtE incineration is almost halved to 43% when residents are asked if they would “vote in favor” of a local facility and drops to less than half of the preference measure, to 36%, when measured as a 4-item *index* of support. Future research might include waste management practices other than incineration and landfill, such as waste reduction/re-use and energy recovery from organic waste digestion (e.g., greenbin facilities). Further, control variables like population density, percent home ownership, and percent single family dwellings would add robustness to the models in future research.

The relative preference for WtE incineration vs landfill (with or without energy recovery) is corroborated in E.U. research with preference for WtE incineration ranging from 30% to 69% in the study by Achillas et al. (2011). This is also consistent with Lober and Green's (1994) finding in Connecticut that opposition to a WtE incinerator is about 50% within five miles. Nevertheless, our finding is contrary to recent polls in Canada showing a majority of 66% general support for all forms of WtE (Nielsen, 2014) and in Peel Region 73% support for a new (now cancelled) local WtE incinerator (Javed, 2015a). Likewise our results contrast Furuseth and O'Callaghan's (1991) finding of low opposition (33%) near a university WtE incinerator in North Carolina. The latter suggest that the low-key facility siting may be a central cause while the opposite situation was true in Durham where the issue was high profile and controversial (Martin, 2010; Porter, 2010). As an indication of the dynamism of this policy domain in Ontario, during the course of our study and the review process for this paper, Peel introduced, then subsequently cancelled, its plan for a new WtE incinerator that would have supplemented the one that has been operating there for decades. While the official reason is declining waste volumes and rising construction costs this is also the region with the lowest diversion in the GTA. This suggests other issues may be at play, perhaps political ones (see Javed, 2016), since our findings indicate that Peel has the highest levels of support for WtE incineration in the GTA – all fodder for longitudinal investigation. The appropriateness of facility siting, including measures for appropriate public participation in decision-making, need and justice considerations tend to be significant predictors of support for incineration facilities (Elliott et al., 2004; Lima, 2006) and could also be included in future work. Based on recent research, these are likely to be more important than NIMBY or knowledge-deficit measures (Hsu, 2006; Mcclymont and O'hare, 2008; Schultz, 2002; Van der Horst, 2007) despite the suggestion by Achillas et al. (2011) that lack of support is predicted by a concomitant lack of knowledge. Upreti and van der Horst (2004) maintain that researchers should pay particular attention to different dimensions of public participation in the siting process which they say too easily supports conflict and entrenching initial positions, rather than the intended planning outcomes of allowing compromise, consensus and policy learning.

The predictors of support for a WtE incinerator compared to those for a landfill (WtE unspecified) are mostly expected. That is, the variables that predict lack of support for WtE incineration are dominated by concerns about health risk, environmental damage, lack of confidence (trust) in monitoring, and place (the community with a recently built WtE incinerator) while the landfill model of lack of support is dominated by concern about odors and scepticism about technology being able to solve environmental problems. Both models include cynicism about local job creation and concern about property values. These findings are consistent with other findings about the important role of trust surrounding incinerators and other WtE facilities, including the siting agents and operators (e.g., Davies, 2005, 2006; Upreti and van der Horst, 2004) particularly the lack of faith in monitoring efforts. Likewise Davies (2005, 2006) finds that discourses of health risk strongly predict anti-incineration sentiments.

A relatively unique contribution of our models is the finding concerning cynicism about benefits – local job creation. That is, since WtE is often promoted as a technology that creates “green jobs” (Lee et al., 2013) such efforts must be tempered by the idea that locals will heavily scrutinize such claims, particularly in a context where zero waste groups are discrediting such assertions at larger scales (Global Alliance for Incinerator Alternatives, 2012). The significance of community in the incineration model (Table 3) likely has much to do with the recency of siting in Courtice–Durham since allied research on difficult-to-site landfill and green

energy facilities suggests that siting and construction phases of such facilities are attended by the highest levels of opposition and concern. That high level of concern is then expected to decline somewhat after the community has lived with the facility for a while – barring serious adverse facility-related events (Elliott et al., 1997; Elliott and McClure, 2009; Wolsink, 2007).

The diversion variables do not predict WtE incinerator facility support, but future research should include direct measures of felt need as a predictor variable given its prominence in the recycling behavior literature (Knussen et al., 2004; Lober and Green, 1994; McCarty and Shrum, 1994; Werner et al., 1995). Such a measure feeds into two popular notions among environmental groups in particular: (i) that WtE incinerators tend to be overbuilt so there is a propensity to seek out waste to “feed the beast” in order to sustain financial viability and; (ii) better efforts at waste reduction and diversion might remove the need for a new disposal facility in the first place (at least in the short term) (Connett, 2013). Though we had the following statement: “incineration needs to be a key element in handling my municipality's waste problems”; that measure was used as part of the four-item index that comprised the dependent variable so it could not be used as a predictor. A question like, “our community needs a new waste facility”, would be the simplest form of such a “need” variable, but could be combined with other items to measure concepts like the “feed the beast” idea. Further research into different forms of WtE (e.g., pyrolysis, gasification and anaerobic digestion) will also be useful to determine how support varies by technology.

6. Conclusion

From a policy perspective, including WtE in a waste management system warrants close consideration of ways to increase diversion rates that are already low or preserve high diversion rates since the findings here about intentions suggest diversion rates may be at risk of falling once WtE is installed. Places like Flanders, Belgium suggest hard (legislated) targets are the best way to sustain high diversion alongside WtE; so further academic research might be used to tease out the impact that this and another policy levers already being used have on household attitudes and behaviors with a view to long-term sustainability. This may help shore up the relatively low diversion rates in jurisdictions without an E.U. style state policy that clearly demands the scaled-back use of landfill. The differences in levels of support for WtE incineration uncovered in this paper likely have less to do with NIMBY and more to do with the freshness of the debate in Durham where siting happened recently and the facility was just recently commissioned. Though existing research recommends that facility-related concern should decrease over time, policy-makers should be mindful of the ongoing concerns about health, environment, perceived lack of employment generation and impacts on property values in mitigation and monitoring efforts. Since Ontario once had a moratorium on incineration, it will be interesting to watch how public opinion about WtE incineration evolves over time relative to landfill and alternative technologies that support concerted strides toward zero waste regimes.

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