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Energy East

Taking Manitoba in the Wrong Direction

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Energy East: Taking Manitoba in the Wrong Direction

The Energy East pipeline (EE), if approved, will run from Hardisty Alberta to St. John, New Brunswick and will carry bitumen from Alberta's Tar Sands to refineries in Quebec and New Brunswick. Up to half of the crude that will flow through the pipeline will be exported to other countries.

The project will be built and managed by TransCanada Pipeline (TCPL). Most of Energy East involves the conversion of part of an existing natural gas pipeline — the Canadian Mainline — and its connection with a new section called the Eastern Mainline, to be built in Ontario.

Several analyses have been produced which claim to tally the potential economic benefits of the Energy East. This study suggests that these benefits have been considerably overstated for Manitoba, and considers the potential of Energy East relative to alternative investments in non-fossil fuel technology and infrastructure.

The first section offers an analysis of the purported economic benefits as presented in three different impact reports. We draw from the three reports to present impacts for Manitoba, including the effect on GDP, the projected increase in tax revenue, as well as job creation numbers. We also present concerns about the methodology used in the three reports.

The first section also discusses the need to use a cost-benefit analysis that would consider the impact of possible pipeline ruptures and the Social Cost of Carbon (SCC) from increased greenhouse gas emissions. Estimates for the SCC are presented which greatly reduce the positive economic impact presented in the three reports.

The second section considers the impact of oil price volatility, the risk to water supplies, and the climate impacts of fossil fuel development. It draws from Manitoba Hydro studies to illustrate how demand-side management represents a better investment strategy than investing in Energy East.

Section I: Estimated Economic Impact of Energy East on GDP and Jobs in Manitoba

Energy East will have to be approved by the National Energy Board (NEB) and will be subject to many conditions. Given the controversy around pipelines, much has been invested in presenting a strong case in favour of the project. Three reports in particular present detailed and favourable economic impact estimates:

- The Canadian Energy Research Institute's (CERI) *An Economic Analysis of TransCanada's Energy East Pipeline Project* was published in May, 2014;
- The Conference Board of Canada published its *Energy East Pipeline Project: Understanding the Economic Benefits for Canada and its Regions* in 2014;
- Deloitte's *Energy East. The economic benefits of TransCanada's Canadian Mainline conversion project* was published in September, 2013. This report was commissioned by TCPL and is referred to by the company to support its claims about the major economic benefits the entire country will realize should the project go ahead (TCPL, 2013).

The benefits noted in the reports vary in magnitude, but all three studies claim the project will cause considerable direct and indirect increases to GDP and that tens of thousands of jobs will be created throughout the country. Here we will present the results from the three studies as they apply to Manitoba and raise concerns about the methodology used in all three reports.

The three reports are of the type often prepared by proponents of large infrastructure projects. They use input/output models to estimate the economic impact of the project. Critics point out that these models provide imprecise estimates at best and that any conclusions derived from such methodology need to be treated with great caution (Carlson et al, 2015; Skinner and Sweeney, 2012; Lee, 2012). The reports themselves admit the limitations imposed by the methodology[1] but nonetheless assert, for example, that the project is "expected to deliver significant economic benefit to Canada, equating to a total of $35.3B in additional GDP over the next five decades" (Deloitte 2013, 2). The other two reports refer to similarly impressive gains in GDP and job creation.

Another paper by Carlson et al (2015) and published by the Mowat Centre's Energy Research Hub at the University of Toronto analyses the estimates from the three reports as they apply to

Ontario. Many of the conclusions in the Mowat Energy study regarding the impact on Ontario will apply to Manitoba as little construction will take place in either province.[2] Most of the benefits for Manitoba, like Ontario, are realized in the operating phase of the project. Carlson et al also provides a thorough critique of input/output models and discusses other weaknesses of the three reports. The highlights of these concerns appear next.

Carlson et al 2015 (15–18) describe several problems with the methodology used to estimate the benefits of the project. All three reports use input/output (I/O) models. I/O models measure the impact that spending on labour and materials will have on the local economy; these impacts are referred to as 'shocks'. Using historical data, the model also calculates the effect that the increase in spending will have throughout the economy. Direct spending and employment from the initial investment by TCPL are estimated, and multipliers (see discussion below) calculate the secondary effects that spin off from this first round of spending. Secondary effects include indirect and induced spending. Indirect spending comes from the growth in employment and output in the industries providing the various inputs for construction. Induced effects are those that come from the growth in regional household spending caused by the increased economic activity.

Calculating direct benefits is fairly straight forward as studying employment and service spending for past pipelines will provide relevant information. Nonetheless, we cannot assume that TCPL would not invest in a different project if Energy East weren't built, or that labour and capital resources would not be used by other players in the economy. Estimating indirect spending is even less straight forward as it may not be known where supplies will be produced.

Calculating induced benefits is even trickier because of the difficulty in establishing causation. We cannot we be sure, for example, that increased economic activity would be the result of increased direct and indirect spending related to the project, and any such projection needs to be treated with caution.

Input/Output Models

The problem has become, however, that in an era in which segments of the media no longer have the time or inclination to examine claims before they are reported, bad economic modelling [using I/O models] is preferred by many advocacy and industry groups to good economic modelling for three main reasons:

1. It is cheaper
2. It is quicker
3. It is far more likely to yield the result preferred by the client (Richard Denniss quoted in Carlson et al 2015, 16).

The above concerns are explained in detail in the Carlson et al report which states:

> In addition, I/O models have limited reliability when assessing large infrastructure projects such as pipeline projects. The concerns are:
>
> - The way indirect and induced benefits are calculated
> - Supply constraints in the labour market are not considered
> - Reliance on the present to estimate the future (2015, 17).

Carlson et al also note that induced and indirect effects largely depend on prevailing economic conditions, something the I/O model does not consider. For example, the model assumes that there are no skilled labour shortages and goods and services are idle, waiting to be put to use at prevailing market prices. In reality, many inputs are not idle and will have to be pulled away from other uses; such inputs cannot be counted as adding spending to GDP or new jobs, but all three reports do just that (19). Multipliers often

overstate direct and indirect benefits in particular because they do not consider the availability of resources or the opportunity cost of pulling resources from one project to another (25).

I/O models also assume that present economic conditions will prevail for the duration of the project, yet there is no reason to assume that the exchange rate, interest rates or price of oil will not change over the next 20 to 40 years (as discussed in Section II).

The CERI report does acknowledge the above limitations in its Appendix (14,15), and none of the foregoing suggest that I/O modeling is useless. But the public and policy makers considering the costs and benefits of projects need to understand that the numbers I/O models generate — particularly looking at a volatile commodity like oil — are unstable and uncertain.

Comparison of Conference Board of Canada, Deloitte and CERI Reports

The figures in Table 1 were taken from the three studies noted above; all numbers are in 2013 inflation-adjusted dollars. Numbers from Deloitte are Net Present Value (NPV) with a discount rate of 2.46 per cent. These figures are not directly comparable as the three reports being looked at use different underlying assumptions to derive their estimates. Table 1 simply collects and presents data from the three reports.

The figures in Table 1 do not include the upstream benefits arising from the production of the oil it will transport.

The reported impact of Energy East on Manitoba is small compared to other regions, Ontario in particular. The GDP effect for all of Canada varies between $44.7 billion (CBOC), $35.3 billion (Deloitte), and $33.9 billion (CERI) (Carlson et al 2015, 13). As a percentage of these total effects, Manitoba's portions are 4.92 per cent, 5.0 per cent and 8.8 per cent respectively.

The relative impact on Manitoba is small because most of the pipeline in the province already exists and new construction will only take place for a feeder pipeline connecting the Bakken formation to the Mainline (Deloitte 2013, 6, 7). Deloitte also reports that crude oil storage tank terminals will be built in Manitoba and Saskatchewan; it is not known how many will be in Manitoba (2013, 6). Four existing oil pumping stations in Manitoba will be expanded and four new pumping stations will be built (Owen, 2014). The existing pipeline will be 'repurposed' to carry diluted bitumen which is more corrosive than the natural gas the pipeline was originally built to carry.

All the reports consider three main economic components: increases in GDP, increases in tax revenue paid to governments and number of jobs created. All the reports break their GDP and jobs estimates into two stages: development and construction, and operation. The estimates for the impact on GDP in the operating stage are similar for each report, but the CERI estimates for the development and construction period are much higher ($1.2 billion vs $0.410 billion and $0.361 billion). CERI's estimates for the number of full time equivalent jobs created in both periods are also higher than the other two reports (with totals of 32,000 vs 11.546 and 13,858).

There are other differences between the three forecasts. The Conference Board's inclusion of the construction of the Eastern Mainline pipeline is not part of the other two estimates. As well, each study used a different economic lifespan for the project — varying from 20 to 25 to 40 years. Both the Conference Board and Deloitte use the same input/output model (from Statistics Canada) to arrive at their results; the CERI study uses its own regional input/output model. All studies use 2009 figures.

The Deloitte estimates include a discount rate of 2.46 per cent; the other two do not include a discount rate (Carlson et al 2015, 7). The higher the discount rate, the less future costs or benefits are worth in present dollars. The Mowat study found that Deloitte should have used a

TABLE 1 **Effect on GDP — Tax Revenue and FTEs for Manitoba**

Manitoba		Conference Board of Canada (20 year lifespan)			Deloitte (40 year lifespan)			CERI (25 year lifespan)		
		Devel. & Constr.	Operation	Total	Devel. & Constr.	Operation	Total	Devel. & Constr.	Operation	Total
Effect on GDP $Billions	Direct	0.190	1.36	1.55	0.177	0.419	0.596			
	Indirect	0.102	0.308	0.41	0.115	0.760	0.875			
	Induced	0.117	0.139	0.256	0.069	0.267	0.336	1.2	1.8	3.0[i]
	Total	0.410	1.81	2.22	0.361	1.446	1.807			
Tax Revenue $Billions		0.368[ii]			0.616[iii]			0.635[iv]		
FTEs (Full Time Equivalent Jobs)	Direct	2581	1752	4333	1341	2800	4141			
	Indirect	1182	3425	4607	1251	5040	6291			
	Induced	1191	1416	2607	666	2760	3426	10,000	12,000	32,000[i]
	Total	4954	6593	11,547	3258	10,600	13,858			

SOURCES: Numbers from: *An Economic Analysis of TransCanada's Energy East Project* by The Canadian Energy Research Institute (CERI), May 2014 – Tables 3.1, 3.5, 3.6, 3.7; *Energy East — The economic benefits of TransCanada's Canadian Mainline conversion project* by Deloitte, September, 2013 – Tables 2, 3 and 4; and, *Energy East Pipeline Project: Understanding the Economic Benefits for Canada and its Regions* by The Conference Board of Canada, 2014 – Tables 2 and 4.
i CERI estimates are not clearly divided between direct, indirect and induced as in the other two reports.
ii CBOC 2014; Table 6, page 47
iii Deloitte 2013; Table 5, page 15
iv CERI 2014; Figure 3.12, page 24

higher discount rate to evaluate the benefits of Energy East. To illustrate how much difference it can make, the report compares discount rate sensitivities for the Ontario estimates.

If the CBOC report had used the same discount rate (2.46 percent) as Deloitte, the estimated impact on Ontario's GDP for the 20 year period would go down over $5 billion. If Deloitte had not used the 2.46 percent discount rate, the GDP impact over 40 years would have been close to $9 billion higher. But, if Deloitte had used a higher discount rate (5 percent) the impact would have been $4.5 billion less. The report does not recommend a discount rate, but notes that the Auditor General of Ontario recommended a 6 percent discount rate for estimating the costs of relocating two gas plants (Carlson et al 2015, 24, 25).

Effect on Manitoba's GDP and Tax Revenue

Taken at face value, the effect on Manitoba's GDP ($2.22 billion for the CBOC, $1.807 billion for Deloitte and $3 billion for CERI) is significant. But these amounts are spread out between the number of years the project will take (between 20 and 40 years, depending on the study). Although yearly impacts will vary, for instructive purposes we can amortize the estimates over the lifespan of each estimate. The CBOC estimate yields $110 million/year; Deloitte, $45 million/year; the CERI estimate equals $120 million/year.

Each study divides the project into two phases: development and construction, and operation. In all three scenarios the operating phase will generate the largest GDP impact (varying between $1.446 and $1.8 billion). But these numbers should not be taken at face value. Not only is the methodology for calculating the effect on GDP questionable, looking at alternative investment in non-fossil fuel energy shows how we could get more 'bang for our buck' (see Section II).

The estimates for increases in tax revenue (federal, provincial and municipal) vary between $.368, $.616 and $.635 billion. The estimates are difficult to compare as each report calculates them differently. The Conference Board tax

revenues include direct provincial revenues and the per capita share of federal revenues (CBOC 2014, 47). The Conference Board assumption that federal tax revenue will be distributed on a per capita basis may not be the case (Carlson et al 2015, 23). CERI estimates include federal, provincial and municipal taxes (including personal income tax, corporate taxes and indirect taxes) (CERI 2014, 23). Deloitte's estimate includes all taxes on products, production taxes (including property taxes) and personal income tax. It does not include corporate income tax (Deloitte 2013, 15).

TCPL already pays taxes on the Canadian Mainline, so any tax revenue increases to municipalities will come from the building/improvements of the pumping stations and any physical changes to the pipeline, should they occur. Such changes would generate little change in revenue. Jurisdictions in the southwest part of the province - where the feeder pipeline will be built - and wherever the storage tanks and pumping stations are located will realize the largest increase in municipal tax revenue. Carlson et al estimate that the addition of one pumping station would increase the City of Dryden's tax revenue by a mere $125,000/year (2014, 43), so benefits to individual municipalities are unlikely to be significant. None of the reports consider the possibility that property values could decrease in the event of a spill or explosion. Such devaluation could cause tax revenues to decrease in tandem (23).

Fulltime Equivalent Jobs (FTEs)

At first glance the number of estimated jobs seems impressive. But an FTE is merely one job that lasts one year. If one person were to work fulltime for 20 years, it would be counted as 20 FTEs.So, the 32,000 FTEs estimated in the CERI report, for example, has to be divided by the lifetime of the project — in this case — 25 years, giving us a total of 1,280 jobs in any single year. The Conference Board's 11,547 FTEs divided by 20 years yields 577 jobs and Deloitte's 13,858 FTEs divided by 40 years delivers 346 jobs.

An FTE does not have to be held by one person on a fulltime basis. It could be two people working part-time, or three people with short-term temporary positions that add up to one year of work. None of the papers speculate as to the number of part-time vs. fulltime jobs.

As noted, we cannot assume that there will be an equal number of unemployed workers waiting for this work; they may be pulled from existing jobs or temporarily move from other provinces to do the work. Furthermore, calculating induced employment relies on assumptions about consumer spending and business decisions that are impossible to confirm, so such estimates need to be considered very cautiously (Lee 2012, 12). For example, the CBOC report estimates that 168 induced FTEs will be supported in the regional agricultural sector because of the increase in demand for food created by pipeline workers (2014, 28). The food industry's highly globalized supply chain makes this impact difficult to estimate and unless there is a net gain in population, it is unlikely there will be an increase in demand for food. These workers will be buying food regardless of where they are working, or whether they are working or not.

All three reports discuss what kind of jobs will need to be filled. As well as induced jobs in the agricultural sector, the CBOC estimates that Manitoba, BC and Saskatchewan will experience a combined induced impact of 221 FTEs in transportation and warehousing and 403 FTEs in accommodation and food services (2014, 28). Indirect job creation is estimated in these three provinces at 208 FTEs for truck transportation, 64 FTEs for air and rail transportation and 133 FTEs for shipping container, boiler and tank manufacturing. The CBOC estimates 474 FTEs will be created in architectural and engineering (2014, 25).

The Deloitte report also provides detailed estimates of the type of employment the project

should generate (2013, 26). The 3,255 total FTEs Deloitte estimates are mostly found in two categories: oil and gas engineering (1339) and construction and 'other' (943). There is a broad range of other categories including architectural and engineering, food services and drinking places, machinery, equipment and supplies wholesalers, accounting and bookkeeping, steel production, etc. (26).

The CERI report explains that the direct jobs created will be construction and administrative, as well as those "directly related to the development and ongoing operation of the pipeline" (2014, 21). Indirect jobs will be found in industries "tangential" to the pipeline industry (21).

Externalities

None of the three reports use full-cost accounting when estimating benefits. At no point do they consider the environmental damage caused by the project; they keep these costs 'external' to their projections. These externalities take a number of forms, some of which result from the increased extraction enabled by Energy East, and some of which result from the construction and operation of the pipeline itself. The costs of these are notoriously difficult to estimate and are often more appropriately represented as a range of possible cost. As a result, we do not attempt a full quantification of all of the environmental and health externalities arising, for example, from reduced air and water quality resulting from increased refining, or the environmental costs of additional tailings ponds, all of which would result in a reduction in the calculated net benefit of the pipeline. However, it is poor practice to ignore these entirely, as the three reports do, as we consider the public costs and benefits of any project. Two obvious considerations are the potential for costly accidents, and the pipeline's contribution to greenhouse gas emissions.

Research by historian Dr. Sean Kheraj demonstrates that when it comes to spills, the questions are "when" and "how much," rather than "if." Kheraj shows that between 2000 and 2009, there were 427 separate spills along the pipeline network regulated by the National Energy Board, totalling almost 64,000 barrels of liquid hydrocarbons. In Manitoba there were four pipeline ruptures between 1994 and 2002 (see Table 2).

The damage caused from these ruptures varied from spillage of 4,000 cubic metres of synthetic crude oil (St. Leon spill) to the burning of 19,600,000 cubic metres of natural gas (Rapid City).

The St. Norbert (a south Winnipeg subdivision through which the Energy East pipeline will run) incident is described by the Transportation Safety Board of Canada:

> The explosion and fire resulted in the loss of one house, which was 178.1 m (584 feet) south of the rupture site. Hydro-electric power lines, poles, transformers and associated equipment in the general area of the rupture were damaged and had to be replaced. Trees and other vegetation on both sides of the river located within the burn impact area were damaged or destroyed by the explosion and fire and had to be removed.
>
> An estimated 97,800 m^3 (3,470,000 cubic feet) of natural gas was lost, a result of the initial, 12-minute release, and the subsequent fire *(Transportation Safety Board of Canada, 1999).*

An examination of the Transportation Safety Board investigations in the St. Leon and Rapid City incidents (see links in table to the reports) reveals that the leakages occurred because of external stress corrosion. The Brookdale failure was more complex and had to do with the coating on the exterior of the pipe, changes in environmental conditions around the pipe, the presence of anaerobic bacteria, a susceptible high-strength steel pipe, and a variety of other technical occurrences. The St. Norbert failure was related to stress on the pipeline caused by

TABLE 2 **Past Pipeline Blasts in Manitoba**

Place	Date	Company	Report
St. Leon	Oct. 3, 1994	Interprovincial Pipeline	http://tinyurl.com/knenkua
Rapid City	July 29, 1995	TransCanada Pipelines	http://tinyurl.com/k2hgdv9
St. Norbert	April 15, 1996	TransCanada Pipelines	http://tinyurl.com/kwukyw5
Brookdale	April 14, 2002	TransCanada Pipelines	http://tinyurl.com/lmrc3da

SOURCE: CBCNews, January 27, 2014: http://www.cbc.ca/news/canada/manitoba/transcanada-pipelines-seeking-cause-of-manitoba-explosion-1.2512312

movement of the slope the pipe was buried in, and from an initial crack that was likely present when the line was built.

The most recent rupture — in a TransCanada pipeline — in January 2014 caused a huge explosion in Otterburne, just south of Winnipeg (CBC News, 2014). The Transportation Safety Board's report is not available yet, but these five incidents demonstrate that pipeline failure is likely. The fact that the majority of the pipeline passing through Manitoba will be a repurposed, forty-year old natural gas line provides cause for even greater concern.

The substance that will be moving through the Mainline is diluted bitumen (dilbit). Bitumen extracted from Alberta's tar sands is treated/diluted with a mixture of hydrocarbons, including natural gas condensate (LeNeveu 2015, 4). Dilbit contains relatively high levels of sulphur which can form hydrogen sulphide in the line. Hydrogen sulphide is highly toxic, corrosive, flammable and explosive and can cause serious damage to health when inhaled (LeNeveu 2015, 13). Leneveu explains that the concentration of hydrogen sulphide may actually increase when the sulphur compounds decompose and microbial action increases as the dilbit flows through the line (2015, 3). Small, continuous leaks could pose a real risk as hydrogen sulphide gas escapes undetected. The risk is amplified with the possibility of rupture and explosion in one of the nearby natural gas pipelines (such as has occurred five times in Manitoba). In a worse-case scenario, such an explosion could require the evacuation of a large part of Winnipeg (2015, 3).

Drinking water supplies throughout the province could be contaminated by pipeline leaks. The aqueduct from Shoal Lake to Winnipeg is at risk of being contaminated from large spills that could occur anywhere along the pipeline east of Winnipeg, or from small, undetected leaks where the line runs close to the aqueduct (between Hadashville and Falcon Lake) (LeNeveu 2015, 3). (See Section II for more discussion on leaks and spills.)

Pipeline spills are expensive. The 2010 800,000 oil spill in the Kalamazoo River, in the US, from an Enbridge pipeline will cost more than US$500 million to clean up and initially required more than 2500 Environmental Protection Agency (EPA), state and Enbridge personnel to respond to the spill. A year after the spill, more than 500 EPA employees were still working on the cleanup (Skinner et al 2012, 30). Other recent spills in the US include Romeoville, Illinois (US$45 million) in 2010 and the 2011 1,000 barrel crude oil spill into the Yellowstone River (US$42.6 million) (Skinner et al 2012, 30).

Not only is it difficult to clean up spills or the aftermath of explosions, but the long-term effects of such disasters must also be considered. The Carlson et al report explains that natural capital accounting should be considered in order to:

> get beyond simple GDP calculations of costs and benefits to also account for the depletion of non-renewable resources (such as oil and natural gas), timber, groundwater, as well as degradation from pollution (2014, 36).

Full Cost Accounting and Greenhouse Gas Emissions

None of the three reports referenced above discusses the very substantial cost of increased emissions of greenhouse gases (GHGs) — costs which are otherwise widely recognized by the private sector, by international institutions, and by governments worldwide. A full and responsible accounting of the costs and benefits of the pipeline should include the costs of these increased emissions. While establishing a precise dollar value for the social costs of an additional unit of carbon dioxide emitted is difficult, we can point with a high degree of confidence to a range of possible values. In order to do so, we need to calculate the volume of additional GHG emissions likely to result from the pipeline's construction and operation, and establish a credible value or range of values for each unit of GHG emitted over the project's lifetime.

Additional GHGs: A Pan-Canadian View

In the calculations that follow, we assume that the oil that passes through the Energy East pipeline would otherwise stay in the ground, which might not be the case. However, growth in output from the oil sands is dependent on increased transportation infrastructure. According to CERI (2014: 3): "Western Canadian oil production is increasing, but its future growth would be constrained due to saturated demand in existing North American markets if new markets are not accessible. With pipeline projects to the West and South being delayed, it is becoming increasingly essential that Western Canadian oil producers find diversified infrastructure to transport their oil to newer markets." Also according to CERI, by 2018, estimated export potential will have outstripped existing capacity as of 2007 plus the capacity of rail systems, and the Alberta Clipper (Enbridge Line 67) and its expansion. Realizing estimated potential by 2030 will require new capacity equal to the Northern Gateway, the Kinder Morgan Trans-Mountain expansion, Energy East, and the recently denied Keystone XL combined. The Deloitte study makes a similar argument (Deloitte 2013: 10). So, it is not unreasonable to suggest that every barrel of new pipeline capacity added from this point on will result in an additional barrel of Canadian oil combusted somewhere.

The proposed Energy East pipeline will enable the transport and combustion of 1.1 million barrels of crude per day (Deloitte 2013, 3). TCPL has obtained firm commitment from producers for 995,000 barrels per day of this capacity. In order to err on the side of caution, and allow for some underused capacity in our GHG calculations, we assume that the pipeline will transport an average of 900,000 barrels per day of diluted bitumen. This is equivalent to 1.74 times the capacity of Enbridge's proposed Northern Gateway pipeline. We draw on economist Marc Lee's (2012) methodology for calculating the additional emissions from the Northern Gateway in order to calculate the additional emissions for Energy East.

The carbon content of 900,000 barrels of diluted bitumen transported per day translates into annual global emissions of approximately 99.47 megatonnes of carbon dioxide equivalent ($MtCO_2e$).[3] In addition, there are emissions of 11.31 Mt CO_2e associated with extraction of the resource.[4] Finally, there are emissions from upgrading and refining bitumen into oil and other petroleum products of 13.92 Mt CO_2e per year.[5] All in, annual emissions associated with the pipeline would likely be in the range of 125 Mt CO_2e per year, excluding emissions associated with construction (manufacturing and transport of steel pipe, and machinery and equipment on-site).

These calculations do not net out the contribution of currently transported natural gas through the Canada Mainline, which might normally be appropriate since Energy East would convert the Mainline from natural gas to diluted bitumen. However, TCPL has recently reached agreements

TABLE 3 **Social Cost per metric ton of CO_2. ($2007 US)**

Discount Rate	5.0%	3.0%	2.5%	3.0%
Year	Avg	Avg	Avg	95th
2010	10	31	50	86
2015	11	36	56	105
2020	12	42	62	123
2025	14	46	68	138
2030	16	50	73	152
2035	18	55	78	168
2040	21	60	84	183
2045	23	64	89	197
2050	26	69	95	212

to maintain natural gas supplies to Ontario and Quebec customers who rely on the Canadian Mainline through alternative transport networks and sources. As a result, we assume there will be no reduction in natural gas-based emissions resulting from the pipeline conversion.

The Social Cost of Carbon

The next step involves selecting an estimated dollar value for the social cost of each additional unit of carbon.[6] These, unfortunately, vary widely. Lee (2012) cites a range of $150–500/tonne of CO_2, based on estimates from a 2011 study (Ackerman and Stanton). Lee then uses a conservative range of $50-$200/tonne, applied to 80–100 Mt CO_2 per year, to find a range of $4 billion to $20 billion per year. If we apply the same range of costs to our estimate of 125 Mt CO_2e burned by the oil passing through Energy East, we get an annual externalized GHG cost of $6.25 Billion to $25 Billion. At a 3% discount rate, that is a total present value of $CDN 78.92 billion to $CDN 597 billion over 25 years.

More recent estimates of the Social Cost of Carbon have been produced by the US Government's Interagency Working Group (IWG) on the Social Costs of Carbon, in their 2015 updated model. The IWG uses three models, five scenarios, and three constant discount rates to produce 45 separate distributions for the global Social Cost of Carbon. Costs increase based on the assumption of increased damage over time of a marginal unit of CO_2 emitted (United States Government, 2015). The figures below show the averages of the estimates at each discount rate, for each 5 year period of the forecast.

Using the IWG's numbers for each year from 2018 to 2043 (25 years of the pipeline's potentially longer lifespan) and the averages from all scenarios at each discount rate, the present value of the social costs of the additional carbon dioxide emitted from oil transported through Energy East would be as follows:

> Present Value of Externalized Costs of GHG Emissions, 2018–2043($2007 US) , by discount rate.
>
> 5.0%: $US 53.25 billion
>
> 3.0%: $US 165.27 billion
>
> 2.5%: $US 238.88 billion

Note that we do not include the higher possible costs (those that appear within the 95th percentile of the distribution), but they are shown in the table above to demonstrate how high costs could potentially get.

These externalized costs can be compared to the undiscounted CERI estimate of a total $33.9

billion ($US 24.83 billion) economic contribution over 25 years to Canadian GDP from direct, indirect, and induced effects should the pipeline be built (CERI 2014, 13). If we look at the only one of the three studies to use a discount rate, the Deloitte study (which uses a rate of 2.46%), and compare it to the present value of social costs discounted at 2.5%, the comparison is even more striking. Building, refitting, and operating the Energy East pipeline over 40 years, will, according to Deloitte, yield a net present benefit to the Canadian economy of $CDN 35.3 billion ($US 27.5 billion). In just 25 years, at a very slightly higher discount rate of 2.5%, the social costs of the greenhouse gases additional to the project will amount to an estimated $CDN 307 billion ($US 238.88 billion) — almost 9 times the projected benefit.

Divestment Movement and Future Demand

As shown in Table 1, Conference Board and Deloitte estimates show that Manitoba will derive most benefit in the operational phase of Energy East. But no report considers the impact the anti-fossil fuel movement is having on the geopolitical landscape. According to 350.org (2015), "The divestment movement has been gathering pace and building momentum ahead of the climate summit in Paris, where we announced today that *more than 500 institutions representing over $3.4 trillion in assets* have made some form of divestment commitment". Carlson et al remind us that there are many environmental NGOs (ENGOs) calling for a boycott of the tar sands and some US corporations have already switched suppliers to avoid buying oil from the tar sands. The UK energy secretary wants a debate to determine if companies should have to disclose their exposure to fossil fuel assets so investors know the risks involved (2015, 32–33).

The difficulties the Keystone XL project (another TCPL pipeline endeavour) is experiencing in the US reminds us just how contentious pipelines and tar sands bitumen are becoming. As claims of "ethical oil" are challenged (Skinner et al 2012, 3) and the public learns more about greenhouse gas emissions from tar sands production and the probability of pipeline ruptures, the future for Canada's bitumen does not look bright. The push against pipelines is fueled by the growing global consensus that we need to keep fossil fuels in the ground in order to mitigate catastrophic climate change.

Pipelines vs Rail

Proponents often argue that if pipelines are not built, the public will be put at greater risk when railcars are used to move bitumen. While incidents like Lac Megantic remind us of the many dangers of using rail to move such materials, building pipelines will not stop its use. The CERI study predicts the volume of bitumen available for transportation will be such that both rail *and* pipelines are required (1). Both modes of transport are inherently dangerous, but more to the point, it has been estimated that between 78 and 85 per cent of Canada's proven fossil fuel reserves needs to stay in the ground if we are to avoid catastrophic climate change (Carlson et al 2015, 32; Leneveu 2015, 25). As we will see in the following section, the Manitoba government has a clear responsibility to deter further bitumen extraction regardless of how it's transported, and to dedicate its resources to renewable energy development.

Section II: Alternatives to Energy East: Jobs and Innovation Without Costly Climate Disruption

Demand Side Management Highlights Green Job Potential While Mitigating Climate Change

The Energy East pipeline presents greater long-term risk to Manitoba than is acknowledged by the Conference Board, Canadian Energy Research Institute or Deloitte reports. Furthermore, it is obvious that pure economic cost-benefit projections based upon the historical price of oil are proving inaccurate. The current volatility of the oil sector currently renders Energy East uneconomical *even without considering environmental costs*. As with many other provinces sharing the length of this pipeline, Manitobans see fewer benefits compared to oil producing regions and we will carry a disproportionate amount of liability rising from pipeline's contribution to climate instability and by the exposure of our water supply to contamination from pipeline ruptures. As demonstrated in Section I, when the costs associated with climate destabilization and water contamination are factored into what is presently a money-losing proposition, Energy East fails the simple cost-benefit analysis required for it to be considered a sound investment.

What is an alternative strategy to provide decent livelihoods while also mitigating the risk of water contamination or further climate destabilization? To provide some context for the pipeline's meagre contribution to jobs in Manitoba, the province's existing plan to create a demand-side management (DSM) utility actually creates a far greater number of highly-skilled green jobs at the same time as it fosters green energy innovation and keeps dollars circulating within the province.

Demand-side management is a strategy that would see Manitoba Hydro reduce the overall demand for hydroelectricity with conservation efforts such as fuel switching to renewables like wind, geothermal, solar, and biomass; direct load control and behavioural change through the use of smart monitoring systems and more robust data analysis; as well as the energy efficiency measures associated with the current PowerSmart program (Poirier et al, 2014). DSM delivers more jobs than Energy East, and existing efforts could be augmented to deliver even greater job benefits for Manitobans.

Our province is well-positioned to capitalize on DSM because its potential has already been studied in detail through the Public Utilities Board hearing process. While the pipeline fails a simple cost-benefit analysis, it is also incompatible with Manitoba's economic and en-

vironmental objectives because its contribution to greenhouse gas (GHG) emissions growth undermines the gains offered by a sound, made-in-Manitoba DSM strategy.

The Problem With Costs and Benefits for Pipelines

We saw in Section I that the additional costs associated with either the contamination of drinking water or with climate change could prove to be incalculable. Drinking water supplies across Manitoba may be contaminated by pipeline leaks or spills, potentially including Winnipeg's drinking water supply at Shoal Lake. Manitoba's cottage country throughout the Whiteshell will be exposed to leaks and spills, including Falcon Lake and Lake of the Woods. The costs associated with climate change, of course, grow with every passing year.

Beyond environmental risks, however, the most straightforward reason to pause and reflect on Energy East development is that it is not very economical to invest in pipeline infrastructure for heavy Canadian crude at present oil prices. The following three points explain why.

1. Oil price volatility impacts production potential

Any cost-benefit analysis requires stable financial benchmarks against which to predict future outcomes. Unfortunately the price of oil is proving difficult to predict due to the quickly evolving nature of crude markets. Two broad factors include the impact of the divestment movement, and the impact of a supply glut of light crude on the global market. For the purpose of forecasting, oil prices are currently unstable and unreliable.

Over the course of the last year the world has experienced a supply glut of more economical light crude, and the consumer prices of oil are presently far below the cost of a number of new oil sands projects even without considering externalities such as carbon emissions, water contamination, or wildfires. The price of oil (including WTI/Brent) at the time of authorship is hovering around $50.00 per barrel (May 24, 2016). By cross-referencing that price with one study by CITI Capital Markets, new oil sands break-even points range from $68–96 (an average of $81/barrel), making the growth of oil sands production unlikely in the near future even without factoring in the impact of the Fort McMurray wildfires.

Returns For New Oil Sands Projects
May, 2016; in USD/barrel

Average production cost:*	$81.00
Market price:	$50.00
Loss:	$31.00

*Source: CitiGroup Global Markets/National Post, 2015; oil prices from Bloomberg (May 24, 2016)

The market has been subject to great volatility over the course of the last year. As of January 2016, the price of oil was sitting at $33 a barrel, and had remained below $40 since August 2015.[7] Price speculations over the course of the next year range from the mid-teens to the upper-40s, and throughout 2016 some oil companies will need to either cut spending, sell assets, or delay projects in order to sustain dividends to investors or avoid bankruptcy.[8]

The recent supply glut is slowing rates of production in the heavy crude sector and the costs of production in Canada remain high. In their 2015 report, written prior to the August price decline, the Canadian Association of Petroleum Producers suggested that production for unconventional crude would grow until 2020 due to present project commitments, after which it would slow (CAPP, 2015). Whether investment slows now or in four years, the case for a pipeline is tenuous.

2. Water risks and potential responses

One of the greatest concerns voiced in Manitoba and across the country is the potential for

TABLE 4 **Economics of Major New Oilsands Projects**

	Company	Incremental Production (thousands of barrels/day)	WTI Breakeven (US$/barrel)
Mining Projects			
Kearl with Debottleneck	Imperial Oil Ltd.	235	$85
Horizon Expansion	Canadian Natural Resources Ltd.	127	$90
Kearl Expansion	Imperial Oil Ltd.	110	$95
Fort Hills	Suncor Energy Inc. – Total SA	164	$96
In-Situ Projects			
Christina Lake (F & G)	Cenovus Energy Inc.	122	$68
Foster Creek (F, G & H)	Cenovus Energy Inc.	120	$73
Jackfish Phase 3	Devon Energy group	35	$76
Surmont Phase 2	ConocoPhillips Co. – Total E&P Canada	125	$76
Nabiye	Imperial Oil Ltd.	40	$70
Kirby North	Canadian Natural Resources Ltd.	40	$80
Sunrise	Husky Energy Ltd.	60	$82

SOURCE: Citi Research. Andrew Barr/National Post. Original article: http://business.financialpost.com/news/energy/how-high-break-even-costs-are-challenging-new-oilsands-projects?__lsa=6e2e-03e6

spills to contaminate drinking water and destroy recreational areas. The Kalamazoo oil spill of 2010 — the costliest onshore oil spill in history — demonstrated the extreme difficulty associated with cleaning up the diluted bitumen ("dilbit"). The difficulty of the clean-up effort led the American Environmental Protection Agency (EPA) to recommend that pipelines carrying heavy Canadian crude no longer be treated like conventional oil pipelines (Shogren, 2013). The risk to our drinking water associated with a pipeline includes the possibility that Winnipeg will need to identify a new drinking water source, build a new aqueduct, or face the irony of importing water using fossil fuels.

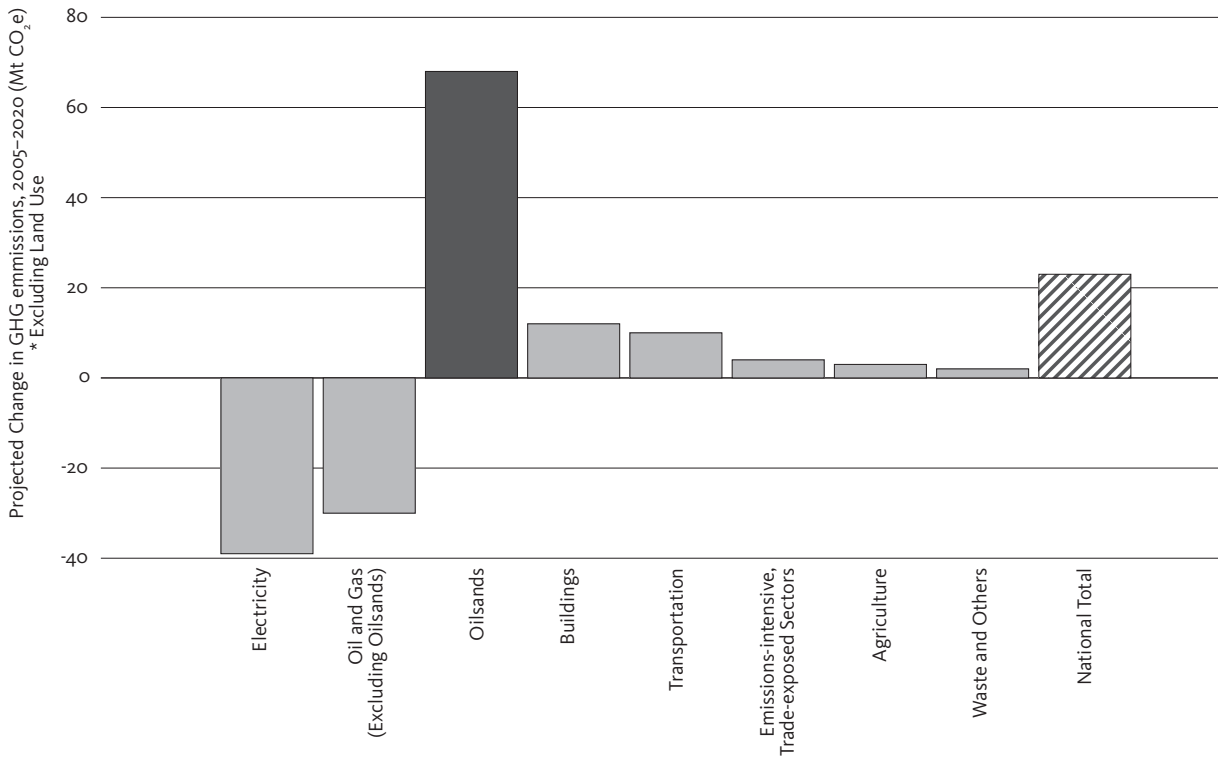
One potential response to potential water contamination proposed by the Ontario Energy Board was to examine where the pipeline intersects with critical water supplies and infrastructure, and re-route it accordingly. Taken seriously, this proposal would likely render the pipeline east of Winnipeg useless for the purpose of carrying diluted bitumen. The cost of re-routing Energy East to avoid vulnerable ecosystems and drinking water supplies would have to be established as a reasonable expectation if Winnipeg is to entirely avoid the risk of drinking water contamination.

3. Climate impacts and potential responses

The costs of climate instability will accrue over time, and Energy East facilitates the expansion of tar sands development — Canada's fastest-growing source of emissions. According to a Pembina Institute report, the emissions associated with the Energy East Pipeline would cancel out the effects of phasing out coal power in Ontario. They write that "the emissions associated with Energy East would cancel out most or all of the reductions generated by Canada's single most effective climate policy" (Flanagan and Demerse 2014, 21).

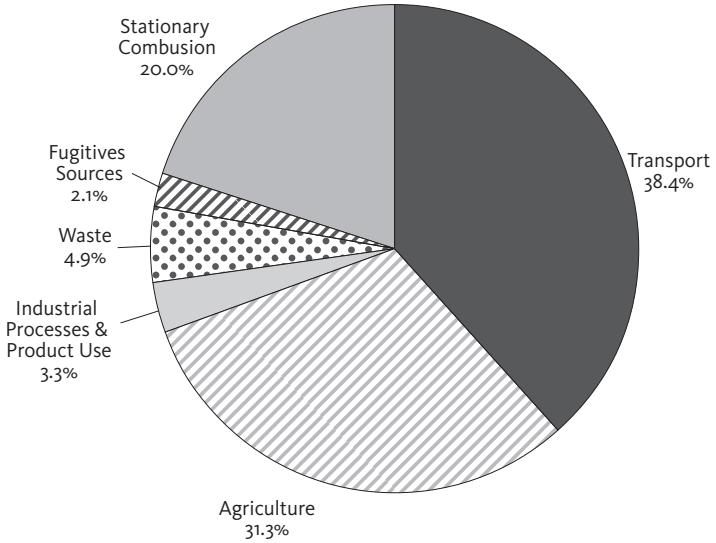
Whether or not one embraces the convention of a Social Price on Carbon, this estimate highlights the reality that the pipeline will add dramatically to Canada's emissions profile. Following COP-21, in which the world has agreed to pursue efforts to limit warming to 1.5 degrees, Manitoba and Canada will have to abandon pipe-

FIGURE 1 **Change in GHG Emissions by Economic Sector, 2005–2020**



DATA SOURCE: Environment Canada.
GRAPHIC SOURCE: The Pembina Institute as per Flanagan and Demerse, 2014.

FIGURE 2 **GHG Emissions in Manitoba by Sector (2013)**



SOURCE: IISD, Nov. 2015

line projects if we are to take this more ambitious target seriously.

Hydro already gives Manitoba an advantage over other provinces, and yet our carbon emissions continue to rise due to the consumption of fossil fuels. Greenhouse gas (GHG) emissions in Manitoba have risen from 18,300 kt of CO_2 equivalent from 1990 to 21,400 kt in 2013, driven mainly by the rise in light and heavy truck use for personal and commercial purposes and because of increases in agricultural production.[9] This is some 21.7% more than the target set by the Kyoto protocol and the provincial government's own Climate Change and Emissions Reduction Act of 6% below 1990 levels.

Since the majority of emissions in Manitoba are from transportation (38.4%), home heating (20%), and agriculture (31.3%), a made-in-Manitoba response to the pipeline will also have to mitigate our dependence upon fossil fuel for these emissions-intensive activities.

4. The opportunity costs of investing in low energy returns

Energy sources can be evaluated on the basis of their Energy Return on Investment (EROI), which is the amount of energy gained for the amount of energy invested. A high ratio of 50:1 means that we will retrieve 50 units of energy for every unit invested, while a ratio of 2:1 means that we can retrieve only two units for one unit invested. A high ratio will support more livelihoods and value-added economic activities; a low ratio will support fewer.

$$\text{EROI} = \frac{\text{Energy returned to society}}{\text{Energy required to get that energy}}$$

Energy sources that have a low EROI ratio are both biophysically and financially unsustainable. The tar sands provide a very low EROI, which means that they provide less overall value to society when compared with renewables. By investing scarce dollars in an energy source with low returns, we invariably constrain the transition to renewable energy sources and deplete financial resources. Development of energy sources with poor returns actually prevents further indirect job creation because more labour and capital have to be directly invested just to access the energy in the first place.

Energy returns on *capital* investment may not correlate with the biophysical reality of *energy* investment. The real world of biophysical limits is not subject to the fickle world of finance, which can be arbitrary or political in nature (as demonstrated by present oil prices). It is therefore important that we understand the EROI concept when making a decision to invest in path-defining infrastructure such as a pipeline.

Energy Returns (EROI)

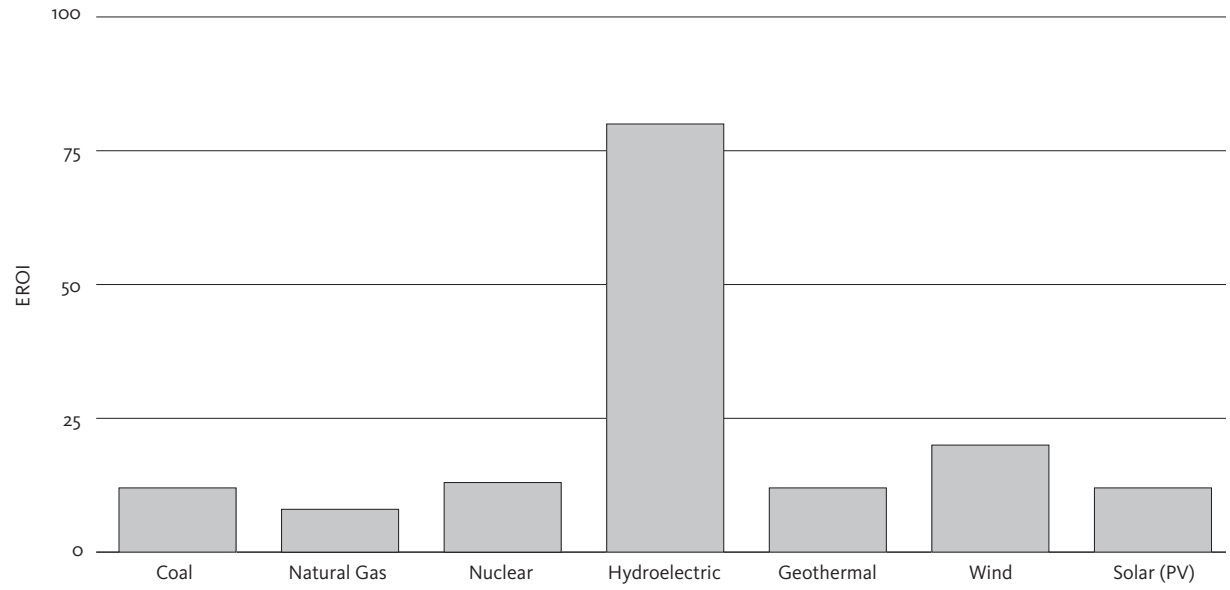
Hydro:	84:1
Wind	20:1
Solar PV	10:1
Oil sands	4:1

Source: Hall et al, 2013

Hall et al have recently compared rates of EROI for renewable and non-renewable sources. They found that the EROI of Canada's unconventional heavy crude is poor (4:1), while hydroelectricity — Manitoba's staple fuel source — is comparatively much better (84:1); even wind and solar photovoltaic have better returns than oil sands ("tar sands"), with a ratios of about 20:1 and 10:1, respectively.

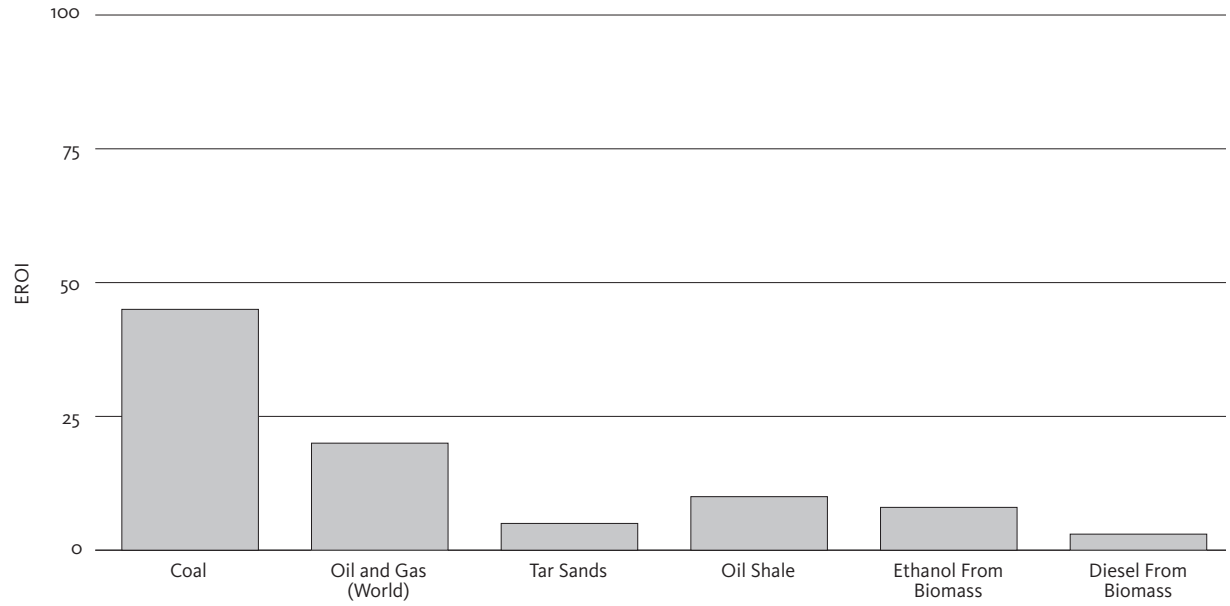
Perhaps the most glaring problem stemming from an EROI analysis is that Hydro's proposed Keeyask dam — a provider of high-quality energy — is supposed to provide pipeline pumping stations with round-the-clock energy. The pipeline would require "roughly half the dependable energy of Keeyask," according to Ed Wojczynski,

FIGURE 3 **EROI for Power Generation Methods**



SOURCE: Hall et al, 2013.

FIGURE 4 **EROI for Thermal Fuel Sources (Primarily Transportation and Heating)**



SOURCE: Hall et al, 2013.

Hydro's manager of portfolio projects (Owens, 2014). From an EROI perspective, this is the biophysical equivalent of turning gold into lead.

Hall et al caution that energy sources with declining EROI require more energy and money to be invested in just getting energy to drive the economy, leaving less energy to be invested in the kinds of activities which drive value-added development like manufacturing and services. Of course, energy sources have particular characteristics, and petroleum products have a range of uses and characteristics that cannot be easily substituted. Nonetheless, renewables like solar, hydro, and wind are better for providing electricity. Manitoba should also consider how the electrification of transportation, with an emphasis on low-carbon community planning, would diminish the need for mass long-range commuting.

In sum, with declining EROI in the tar sands, Manitobans would be wise to invest in energy sources with higher returns, such as hydro, wind, or even solar, and use it to (1) directly power our economy, (2) export it to offset emissions in other jurisdictions, or (3) accelerate the electrification of our transportation system, which opens up a whole other set of economic opportunities.

Alternatives: DSM Provides More Jobs and Mitigates Risk

If the allure of the pipeline is the prospect of job creation, then there are better ways to achieve this while mitigating climate impacts and delivering higher quality energy directly to the economy. Manitoba's demand-side management plan highlights the potential for green energy to deliver good jobs.

Highlighting Green Job Potential: Demand-Side Management Vs. Energy East

The Manitoba government is acting on the Public Utilities Board's recommendation to create an independent Demand Side Management (DSM) subsidiary of Manitoba Hydro. Building off Manitoba Hydro's Power Smart program, this new entity will "develop and deliver energy efficiency and conservation programs to meet new legislated targets for electricity and natural gas saving" (Province of Manitoba 2015, 16).

Comparing Job Potential
In FTE Job Years (Manitoba)

DSM:	~40,000
Energy East:	~12,000

Sources: Dunsky Energy Consulting, Deloitte, Conference Board

Philippe Dunsky, who participated in Manitoba Hydro's latest Public Utilities Board hearing process, estimates that enhanced DSM in Manitoba could create up to 18 job-years per million dollars of spending. He estimates that "new targets, such as 1.5 per cent per year of forecast domestic electricity demand and 0.75 per cent per year of forecast natural gas demand over 15 years, would lead to over 40,000 job years of employment (2,666 jobs) with an annual investment of approximately $150 million" (Province of Manitoba, 2015). Compare this number to the Conference Board's estimate for pipeline jobs in Manitoba, which stands at 11,546 over a 20 year time period (577 jobs), Deloitte's estimate of 13,858 over 40 years (346 jobs), or CERI's 32,000 over 25 years (1,280 jobs).

DSM would create jobs in a variety of areas, including in the installation and servicing of renewable energy generation from geothermal, solar, and biomass. Smart monitoring systems would create jobs in data analysis and grid control, and energy efficiency measures would create jobs related to home improvements and eco-retrofits. Demand-side management could improve on Manitoba Hydro's existing Power Smart program through savings audits and energy reduction initiatives. An important caveat, however, is that a re-imagined DSM entity should avoid ex-

panding natural gas infrastructure. The negative implications for climate change are increasingly apparent (see http://www.thenation.com/article/global-warming-terrifying-new-chemistry/).

One area of further potential job growth is the new DSM entity's commitment to work with social enterprises and purpose-driven businesses to foster demand reduction while providing indirect social and economic value (Fernandez, 2016). If appropriately structured, the new DSM entity could foster even greater job growth by enabling small-scale renewable energy enterprises to add to grid capacity, thereby reducing the emissions of our energy trading partners.

Pipeline Undermines DSM Emissions Gains and Adds To Climate Costs

Manitoba's DSM strategy helps motivate the transition to a greener economy, particularly in the areas of building efficiency and home heating,[10] but the pipeline's contribution to GHG emissions would undermine the gains offered by a robust DSM strategy.

While DSM provides a promising way of creating jobs and reducing emissions through efficiency measures, other opportunities will need to be cultivated to reduce our substantial emissions from the transportation and agriculture sectors (~70%). Through the 2015 *Climate Change and Green Economy Action Plan*, the Province of Manitoba has made a number of new commitments to tackle climate change through cap and trade for large emitters, and by partnering with farm and trucking associations and municipalities to lower GHGs in their respective areas.

Climate researcher Robert Sandford argues that Manitoba's climate is changing even more rapidly than the Arctic, interfering with our ability to effectively manage floods and droughts. Our need to repeatedly rebuild following extreme weather events could cause persisting fiscal challenges for government, and "the costs of ongoing flood damage may reach a magnitude that could easily bankrupt Manitoba" (Sandford, 2012). Faced with the ongoing challenge of reducing emissions and coping with new realities, Manitobans would be foolish to add to our emissions profile with the expansion of a pipeline.

Living well — within our means

Energy East is neither financially nor environmentally sustainable, and it provides energy with a poor return on investment. Living "sustainably" means that we must meet the needs of the present without compromising the ability of future generations to meet their needs. Energy East compromises the ability of future generations to meet their needs by adding substantially to Canada's emissions profile, burdening another generation of Manitobans with potentially catastrophic costs.

Of course, oil is required in the production process for just about everything ranging from manufacturing to transportation. Since oil use is nested so deeply in our socio-economic system, turning away from Energy East requires low-carbon development that helps us live with the natural limits of our world.

Conclusions

The three reports referred to in Section I use a flawed methodology to arrive at inflated estimates of the economic benefits of Energy East. I/O modelling, initially developed to identify potential shortages in labour and supplies, is instead used to predict significant economic growth with no growing pains. In reality, I/O models are unreliable when it comes to estimating:

- Indirect and induced benefits;
- Labour and other supply shortages. The studies assume that resources are idle: they are not;
- Future impacts; we cannot assume that interest rates or the exchange rate, price of oil or policy environment will remain constant. Possible changes in the broader macro economy and/or on the geo-political stage are not considered. One need only consider the recent dramatic fall in the price of oil and the Canadian dollar to appreciate just how quickly I/O results can be rendered outdated.

Only the Deloitte report uses a discount rate to account for future benefits and that rate is unrealistically low. If the reports had included a realistic discount rate, the supposed benefits would be considerably lower (Carlson et al 2015, 25).

None of the reports use a cost/benefit analysis to estimate the environmental damage, potential loss of life and property value depreciation caused by pipeline leaks, spills or explosions. Issues of concern include:

- The present prices of crude make the project uneconomical even without considering potential environmental costs;
- The project carries the potential to contaminate drinking water — including Winnipeg's water source at Shoal Lake — warranting a re-evaluation of its present route;
- The project contributes heavily to Canada's (and Manitoba's) emissions profile, with associated future costs;
- The Social Cost of Carbon is not considered in any of the reports.

The lack of discussion around climate change and the growing sense of the urgency to move away from fossil fuels are not considered. Energy East will facilitate growth in tar sands development which is the fastest growing source of greenhouse pollution in Canada. Enabling tar sands produc-

tion will make it difficult to impossible for Canada to meet its targets to reduce GHGs (Laxer, 2016).

As argued in Section II of this paper, it makes more sense for Manitoba to invest in alternative sources of energy. The EROI of unconventional oil makes it a poor quality energy source when compared with hydro and other renewables. A broader alternative to pipeline development includes incentivizing active transportation, public transit, and electric vehicle use. The following considerations must be top of mind:

- DSM is estimated to provide more jobs than the Energy East pipeline project (~40,000 FTE job-years for DSM; ~12,000 FTE job-years for Energy East), highlighting the potential for green energy to provide good jobs;
- The pipeline cancels the potential emissions gains offered by DSM;
- The new DSM entity could foster opportunities in other renewable sectors with higher EROI;
- A broader alternative to the pipeline includes low-carbon development, including complete communities that can be travelled by foot, bike, or transit.

Proponents of Energy East have not presented a compelling case for Energy East: it does not make sense economically or environmentally. If Manitoba is to follow through on its ambition to achieve carbon neutrality by 2080, as stated only months ago, it is imperative that we abandon fossil-fuel intensive infrastructure.

The path to carbon neutrality and sustainable economic activity lies in a different direction from Energy East; it is up to our political leaders to chart a course in that direction.

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Endnotes

1 Deloitte, for example states that "the output economic impacts of this study's I/O Model runs should be considered directionally correct rather than scientifically precise." p. 22.

2 Up to 70 per cent of EE will entail partially converting the existing Canadian Mainline (Carlson et al 2015, 9).

3 900,000 barrels per day result in 328,500,000 barrels per year. Converted, that is 52,285,714 cubic metres at 2.71834 $MtCO_2e$ per million cubic metres = 142.1 $MtCO_2e$ per year. Estimating that 30% of volume is accounted for by diluent (and hence not contributing to additional GHG emissions) yields the final calculation of 0.7(142.1)=99.47 $MtCO_2e$ per year.

4 Calculated proportional to Energy East's capacity as a percentage of Northern Gateway's (174%) and using Lee's (2012) estimate for Northern Gateway, following Brown, Moorehouse, and Grant (2009).

5 Calculated as above, proportional to capacity as a percentage of Northern Gateway's.

6 The US Environmental Protection Agency (EPA) defines the social cost of carbon as "an estimate of the economic damages associated with a small increase in carbon dioxide (CO_2) emissions, conventionally one metric ton, in a given year. This dollar figure also represents the value of damages avoided for a small emission reduction (i.e., the benefit of a CO_2 reduction)".

7 Figures for the price of Canadian production were retrieved from UCube by Rystad Energy, as published by CNN Money; price of oil retrieved from http://www.bloomberg.com/energy and correlated with http://ca.reuters.com/article/businessNews/idCAKCN0QO25I20150819.

8 http://www.reuters.com/article/us-oil-companies-investments-idUSKBN0UH0AB20160103

9 http://climatechangeconnection.org/emissions/manitoba-ghg-emissions/

10 Building heating ("stationary combustion") accounts for 20% of Manitoba's emissions profile.

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