

ABSTRACT, RECOMMENDATIONS & EXECUTIVE SUMMARY

ANALYSIS OF THE CASH AND CARBON FLOWS OF

BOUNDARY DAM COAL-FIRED POWER STATION

SASKATCHEWAN, CANADA.

WORLD'S FIRST

POST-COMBUSTION CARBON CAPTURE AND

ENHANCED OIL RECOVERY PROJECT

BY: SASKATCHEWAN COMMUNITY WIND



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1 ABSTRACT (MAJOR FINDINGS)

1.1 Electricity users to be liable for losses on oil industry project

This report indicates that SaskPower customers will be left carrying a loss of more than \$1-billion on a \$1.5-billion investment the principal beneficiary of which would appear to be an Alberta-based oil company. The losses on this project will mean higher electricity prices for Saskatchewan electricity consumers for the foreseeable future.

1.2 SaskPower mandate does not include cross-subsidies to oil industry

It is not clear why SaskPower funds have been used to pay for a project the main purpose of which appears to be to assist the oil industry in increasing crude oil production. Cross-subsidization of other industries, within Saskatchewan or Alberta, does not appear to be a part of SaskPower's mandate.

1.3 Minimal economic justification for Boundary Dam CCS

The analysis in this report indicates that the project is unable even to achieve an operating profit and has negative Earnings Before Interest Taxes, Depreciation and Amortisation (EBITDA). Given these weak economic metrics the justification, for the \$1.5-billion spend on Boundary Dam Unit #3 CCS, appears to be lacking.

1.4 Economically superior alternatives exist and merit serious consideration

Economically superior alternatives to Boundary Dam CCS include energy efficiency, wind energy, imports, natural gas, solar or biomass. This report considers only one of those, wind energy, and finds that the use of wind turbines, in place of Boundary Dam Unit 3 CCS, could have saved electricity consumers more than \$1-billion.

1.5 Government may consider refund to SaskPower from crude oil royalties

Systems exist to ensure that SaskPower investments are efficient and effective. It is not clear why those systems did not prevent the Boundary Dam CCS investment from taking place. Nonetheless and since the Government is, after the oil industry, the main financial beneficiary from SaskPower's \$1-billion CCS loss, it may give consideration to refunding SaskPower's loss from additional royalties raised on Weyburn crude oil.

1.6 Justification needed for additional CCS units at Boundary Dam

SaskPower is currently considering two additional CCS units at Boundary Dam Units 4 & 5. The poor economics of the Boundary Dam Unit 3 retrofit, demonstrated in this report, should cause proponents of those additional CCS retrofits to provide significantly more rigorous economic justification prior to proceeding with any investment.

1.7 Need for electricity industry reform

The issues highlighted in this report confirm that the current, monopoly, structure of Saskatchewan's electricity industry is ill-suited to the rigors of 21st century electricity markets. Consideration should be given to reforms. A 'straw man' proposal is outlined within this report: it is intended only to aid in a broader discussion about the various options.

2 REPORT SCOPE

This report considers the cash and, to a much lesser extent, carbon flows associated with the \$1.467-billion Boundary Dam Carbon Capture and Enhanced Oil Recovery Project in Estevan, Saskatchewan. It does not consider the technical viability of CCS.

The Boundary Dam project consists of two distinct components:

- 1) **New coal fired power generation capacity (BD3Gen).** The original 139 megawatt (MW) coal-fired Unit #3 was installed in 1969 and was approaching the end of its useful life. Consequently it was replaced in 2014 with a new, 160 MW, coal-fired unit. Fly Ash from it is being captured and sold.*
- 2) **Carbon and Sulphur capture facility (BD3CCS).** The second component of the project is the capture of Carbon and Sulphur Dioxide (CO₂ and SO₂) and, to a lesser extent, oxides of Nitrogen (NO_x) that are emitted from the coal-fired Unit #3 at Boundary Dam power station. Captured CO₂ is being transported by pipeline to the privately-owned Weyburn Oil Field, 66 kilometres to the north-west, where it will be sold to Alberta-based Cenovus Energy, the field operator, and used by them to increase crude oil production. SO₂ is captured and converted to Sulphuric Acid (H₂SO₄) which is being sold. This CCS component is referred to as BD3CCS throughout this report: this is to distinguish it from CCS being considered at Boundary Dam Units 4 & 5 (BD4&5CCS).*

*These two components are being pursued as a single project - the Boundary Dam Carbon Capture and Enhanced Oil Recovery Project (BD3Gen+CCS). Project 2), **BD3CCS**, is the main focus of this report. On certain occasions we have nonetheless had cause to refer to both components together in which case **BD3Gen+CCS** is employed to denote the two.*

3 REPORT STRUCTURE

INTRODUCTION, EXECUTIVE SUMMARY, FINDINGS AND RECOMMENDATIONS

Explains the rationale for this report, the scope and structure together with the major conclusions and recommendations. Includes a Table of Contents + cash and carbon flow summaries and schematics.

SECTION I. BD3Gen+CCS ECONOMIC ANALYSIS

Presents the data, used in the analysis, and the derivation thereof.

SECTION II. WIND ENERGY – A SUPERIOR ALTERNATIVE

Presents economic and technical data, together with practical experience from numerous North American jurisdictions, which demonstrates that wind energy is a superior option to BD3Gen+CCS and to the planned BD4&5CCS.

SECTION III. DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

Demonstrates why common SaskPower statements in favor of BD3Gen+CCS and against wind energy, are inaccurate and unjustifiable. Considers the calculation methodology employed throughout the analysis, examines the results, highlights specific assumptions and omissions. Finishes with conclusions and recommendations.

4 EXECUTIVE SUMMARY

The following summary is mainly drawn from 30 year cash flows calculations included in the main report. All cash flows are present value.

POWER GENERATION (BD3Gen). The capital investment in 160 MW of new coal-fired power generation capacity was \$550-million. This is estimated to generate revenue from electricity sales of \$2.0-billion and to have operating costs of \$1.1-billion, i.e. a net profit of \$391-million after deduction of the initial investment. This net profit is predicated on the fact that all electricity from the plant will be sold at \$64.5/MWh (SaskPower's estimated average cost of electricity). The profitability of the power plant is taken as a given and is, for the purposes of this analysis, a secondary issue that will receive minimal consideration.

CAPTURE FACILITY (BD3CCS). It would appear that the primary purpose of BD3CCS is to supply cheap CO₂, for Enhanced Oil Recovery (EOR), to the ageing Weyburn Oil Field 60 km. to the North-West of the facility. Weyburn is currently supplied with CO₂ from North Dakota under a contract that appears due to expire this year. It therefore needs to secure additional sources of CO₂ so that crude production can be maintained. BD3CCS is the new supplier and SaskPower/Saskatchewan ratepayers are paying for it.

ECONOMICS. The capital investment in BD3CCS was \$917-million. Operating costs are \$544-million for electricity and \$294-million for non-electrical O&M i.e. a total cost of \$1.755-billion. Offsetting this is revenue of \$690-million from the sale of CO₂ to Cenovus Energy in addition to \$23-million from the sale of Sulphuric Acid (H₂SO₄). The net result is that SaskPower/Saskatchewan ratepayers are left carrying a loss of just over \$1-billion.

Various assumptions were made about the costs of CO₂-EOR at Weyburn for Cenovus. Although there is a certain degree of uncertainty in those assumptions, they nonetheless indicate that Cenovus Energy carries minimal BD3CCS investment risk but stands to make a considerable profit from CO₂-EOR, at Weyburn, made possible by BD3CCS.

ENVIRONMENT. One of the project attributes that has been frequently touted, presumably to gain public licence to proceed, is that the project brings substantial environmental benefit in the form of reduced CO₂ emissions. BD3CCS will capture 30-million tonnes of CO₂; 3.3-million tonnes will however be lost in the capture process and 9-million tonnes will be lost during processing of the CO₂/crude mix recovered from the Weyburn oil field. Consequently a net amount of only 17.7 million tonnes is permanently sequestered and that at a cost of \$100/tonne of sequestered CO₂.

CHEAPER AND BETTER WITH WIND ENERGY

Wind energy could achieve the same thing as BD3Gen+CCS (net production of 757 GWh of CO₂- and SO₂-free electricity) at a capital cost of \$450-million. This is \$1.017-billion less than the \$1.467-billion BD3Gen+CCS. This would be a direct saving, to Saskatchewan ratepayers, of the same amount i.e. \$1.017-billion. Since operating wind turbines emit no CO₂ they would achieve this at a cost of \$0/tonne of avoided CO₂ vs. more than \$100/tonne for BD3CCS.

RECOMMENDATIONS

These are summarised in the following section;

5 RECOMMENDATIONS

5.1 Short term

5.1.1 Govt. to consider refund, to SaskPower, of \$1-billion BD3CCS loss

This report demonstrates that BD3CCS is a \$1-billion capital project which will benefit the oil industry yet which is being paid for by, carried on the balance sheet of, and will be significantly loss-making for, SaskPower.

This report also demonstrates that the BD3CCS will provide additional revenues, in the form of petroleum royalties, for the government while generating a loss of approximately \$1-billion for SaskPower even before consideration of the cost of capital employed. That loss will be passed to Saskatchewan ratepayers in the form of higher electricity prices.

The current Government may have strategic reasons for wishing to subsidize the oil industry. It is, however, not clear why Saskatchewan's electricity consumers should have to pay for those subsidies: cross-subsidization of the oil industry does not appear to be a part of SaskPower's mandate.

As a result and because both the Saskatchewan Rate Review Panel and CIC appear not to have fully exercised their oversight duties, Saskatchewan's electricity consumers might reasonably expect the Saskatchewan Government to refund the \$1-billion cost of BD3CCS to SaskPower for subsequent return to electricity consumers through rate adjustments.

If the Government is not currently able to effect such a one-off transfer, it may instead choose to commit to ensuring that all future crude oil royalties from Weyburn CO₂-EOR are transferred to SaskPower for subsequent refund to electricity consumers.

5.1.2 Reduce planning effort for Boundary Dam 4 & 5 CCS

SaskPower is planning similar CCS retrofits at Boundary Dam Units 4 & 5. Given the information outlined in this report there is no clear financial justification for such retrofits.

Unless SaskPower can demonstrate that the information in this report is flawed, it may wish to cease further planning for the BD4&5CCS retrofits. Resources may instead be diverted to new generation projects which are profitable without sizeable public subsidies.

5.1.3 Consider replacing Boundary Dam 4 & 5 with wind energy

The combined post-retrofit output of BD4&5CCS would be 1.5 terawatt hours. This amount, given expected demand growth, will be equivalent to 5 percent of total province-wide generation. If wind energy was to supply this amount it would mean that wind, after consideration of the amount of wind energy that will already be operating, will be supplying about 10 percent of Saskatchewan's electricity needs.

There is no known economic or technical reason why wind energy should not supply, as an absolute minimum, 10 percent of Saskatchewan's electricity. Iowa and South Dakota already generate more than a quarter of their total electricity using wind

turbines. If wind energy was to take the place of BD4&5CCS, it would be a profitable proposition and would reduce SaskPower's capital expenditure requirements by at least \$1.2-billion but more likely double that.

5.1.4 Engage in meaningful dialogue with wind & solar industries

There is a significant amount of material on SaskPower's web site, concerning wind energy and solar power, which is worded in such a way as to be misleading about the relative merits of those resources. Despite various requests, SaskPower has been unwilling to correct or remove that material and continues to make inaccurate public statements concerning wind energy.

SaskPower discriminates against variable renewables in other more subtle but more significant ways: principle amongst these is a Transmission and Connection tariff which is more than twice as high for wind and solar as it is for coal.

We, and others, have asked SaskPower on a number of occasions to address these deficiencies. Thus far they have been unwilling to do so.

5.1.5 Independent electro-technical study of wind (& solar) potential

In 2007 SaskPower stated that it was studying wind energy. In 2015 it said the same thing. While SaskPower has been engaged in its 8-year wind study, almost no new wind energy has been installed in Saskatchewan. As a result and given the rapid increase in electricity demand over the period, the amount of our electricity generated by wind turbines has declined from 3.0 percent to 2.8 percent. In that same 8-year period the use of wind energy has grown considerably across Canada (564 percent), the U.S. (467 percent) and the World (397 percent).

Clearly SaskPower has the technical capability to undertake the requisite electro-technical study. Given the information in this report; one suspects that the company is unwilling to act due to other priorities. Consideration should therefore be given to employing a credible third party, such as GE Energy, to undertake an independent and comprehensive electro-technical study on the potential of wind (& solar) energy in Saskatchewan. Many such studies have already been undertaken in regions across North America, Europe and Australasia.

The Pan-Canadian Wind Integration Study cannot and should not be used as justification for ignoring this recommendation.

5.2 Where do we go from here...

5.2.1 Future rate reviews might better assess cost of alternatives

The April 2014 conclusion of the Saskatchewan Rate Review Panel (SRRP) did make reference to Boundary Dam but did not appear to give significant consideration to its high price relative to significantly more cost effective options.

Had such a comparison been undertaken, it is not clear that SRRP would have concluded that SaskPower's rate request was "*reasonable and justified*".

5.2.2 Greater public scrutiny of contracts involving public funds

One of the notable features associated with the preparation of this report has been the number of instances where justification for the denial of material has been “*this information is commercially confidential*”. Some of the issues identified in this report may have been avoided if there had been greater transparency from the outset. As a matter of principle contracts involving the expenditure of public funds might usefully be subject to more, not less, public scrutiny.

5.2.3 Electricity sector reform with genuine public dialogue

The new market structure proposed in this report is not intended to be definitive. Instead it is offered as a ‘straw man’ to illustrate only one possible alternative and to assist in initiating the requisite public debate about the relative merits of this and other, alternatives.

The issues highlighted in this report, coupled with the challenges facing SaskPower as it seeks to respond to the complexities of modern electricity markets, are due in no small part to the fact that Saskatchewan’s electricity sector remains as a vertically integrated monopoly. This is a model that contains various conflicts of interest and which is increasingly challenged to respond effectively and efficiently to the demands of the modern age.

Public concerns regarding electricity market reforms are frequently based on the belief that the electricity system can only be either 100% Crown-owned or 100% privately owned. Such a view fails to recognise that a modern electricity system consists of multiple interdependent components with separate functions and interests.

A 21st century electricity system should see SaskPower continue as a Crown-owned entity located firmly at the heart of Saskatchewan’s electricity system. SaskPower would retain its existing mandate to ensure the provision of electricity networks to all Saskatchewan consumers. SaskPower would retain ownership and control of the natural monopoly portions of the network (Transmission, Distribution and Retailing).

A government-owned Independent System Operator (ISO) would be established. It would have overall control and coordination responsibilities and may include regulatory functions. It would be tasked with ensuring fair, equitable and non-discriminatory access by all to the electricity grid.

Multiple independent generators would compete to supply power to an electricity ‘pool’ which will be independently managed by the ISO and from which all consumers, including SaskPower, Saskatoon Light & Power and Swift Current Power, would source their electricity.

In order for any such reform of the electricity market to have public legitimacy it is critical that it is centrally informed by genuine, comprehensive, extensive, impartial and meaningful public dialogue and debate. Nova Scotia’s ongoing ‘Electricity System Review’ provides an excellent blueprint

6 30-YEAR CASH AND CARBON FLOWS FOR SASKPOWER AND CENOVUS ENERGY

Table 1: 30-year Cash Flow Summary for SaskPower and Cenovus Energy

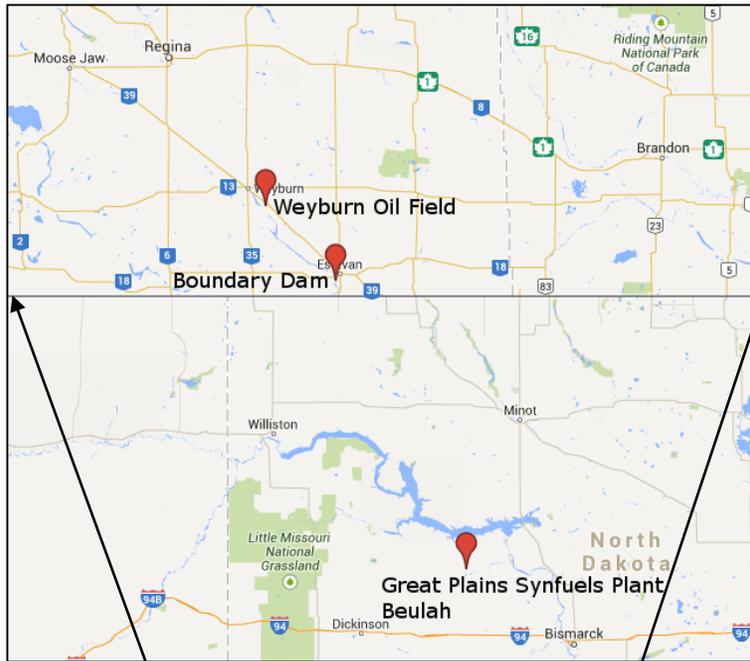
BOUNDARY DAM CCS UNIT #3. CAPITAL INVESTMENT & OPERATIONS					
30-YEAR CASH FLOWS (\$-MILLION) FOR SASKPOWER & WEYBURN CONSORTIUM/CENOVUS					
SASKPOWER/SK RATEPAYERS			WEYBURN CONSORTIUM (HEADED BY CENOVUS ENERGY)		
COAL FIRED POWER STATION		CARBON/SULPHUR CAPTURE FACILITY			
Investment			Investment		
Feds	(90)	Feds	(150)	CO ₂ -EOR investment	(2,025)
SaskPower	(460)	SaskPower	(767)		
TOTAL	(550)	TOTAL	(917)		
Operations			Operations		
Revenue			Revenue		
Electricity sales	1,954	CO ₂ sales to Cenovus	690	Crude sales	6,750
Fly ash sales	33	H ₂ SO ₄ sales	23		
Expenses			Expenses		
O&M (inc. fuel)	(1,045)	Parasitic load	(544)	O&M	(1,313)
		O&M (exc. electricity)	(294)	SK oil royalties	(900)
				CO ₂ purchase	(690)
Operating profit/(loss)	941	Operating profit/(loss)	(125)	Operating profit/(loss)	3,848
Total Investment	(550)	Total Investment	(917)	Total Investment	(2,025)
NET PROFIT/(LOSS)	391	NET PROFIT/(LOSS)	(1,042)	NET PROFIT/(LOSS)	1,823

Table 2: 30-year Carbon Flow Summary for SaskPower and Cenovus Energy

BOUNDARY DAM CCS UNIT #3	
30-YEAR CARBON FLOWS (MILLION TONNES)	
TOTAL CO ₂ RELEASED IN POWER GENERATION	33.3
TOTAL CO ₂ CAPTURED	30.0
TOTAL CO ₂ INJECTED INTO WEYBURN OIL FIELD	30.0
Fugitive CO ₂ emissions during capture process	(3.3)
CO ₂ to atmosphere during processing & recycling	(9.0)
NET CO2 PERMANENTLY SEQUESTERED (30.0 - 3.3 - 9.0)	17.7

7 MAP: BD3GEN+CCS, WEYBURN OIL FIELD & BEULAH, NORTH DAKOTA

Figure 1: Map Showing Location of BD3Gen+CCS, Weyburn Oil Field and Beulah, ND



Source: Google Maps