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Does the South African Carbon Tax Incentivise Mines to Invest in Solar Photovoltaic?

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ABSTRACT

The aim of this study was to evaluate the adequacy of South Africa's carbon pricing policy in incentivising adoption of Solar photovoltaic in South African mines. A qualitative study was conducted to evaluate the adequacy of South Africa's carbon tax policy design to encourage adoption of solar photovoltaic in mines. The study further establishes the carbon pricing level that will induce South African miners to invest in Solar photovoltaic through a net present value simulation. A review of South Africa's Carbon Tax regime highlights that the policy shortcomings can be attributable to low carbon prices, excessive free emission allowances, and continued subsidy support of fossil fuels. Furthermore, the carbon price needs to exceed cost of abatement to encourage investment in decarbonisation measures. A net present value simulation finds that a carbon price of ZAR 668.62 per tonne of CO2 would need to be levied to incentivise mining entities to invest in solar photovoltaic. The study recommends higher carbon prices be levied for carbon for emissions to encourage mining entities to adopt solar photovoltaic renewable energy. The paper contributes to tax policy scholarship on designing a carbon pricing model for South Africa's mining sector. Decarbonising the mining industry, a significant contributor of GHG emissions, will advance the decarbonisation efforts of South Africa.

1. Introduction

The planet is currently experiencing its greatest environmental threat due to climate change (Department of Environment Affairs and Tourism, 2004, Ginanjar & Mubarrok, 2020; Mikhaylov et al., 2020). Climate change is caused by the release of greenhouse gases emissions into the atmosphere from industrialisation and burning of fossil fuels (Intergovernmental Panel on Climate Change, 2014). Mining as an energy-intensive industry, significantly contributes to climate change through the consumption of fossil fuel-generated energy and release of greenhouse gasses from business processes (Farjana et. al., 2019; Katta et. al., 2020). Climate change is a critical challenge in South Africa, with average yearly temperatures increasing at a minimum of 1.5 times in comparison to the global average of 0.65°C between 2004 and 2014 (Ziervogel et al., 2014). Intensified temperature increases of 1.5°C temperature increase above pre-industrial levels will result in intensified occurrence of droughts and heatwaves in South Africa (Hoegh-Guldberg et al., 2019).

Extreme weather conditions caused by climate change, pose a significant risk on mining operations causing disruptions to mining operations and damaging infrastructure (Odell et al., 2017; Lim-Camacho et al., 2019). The adverse climate change effects further threaten South Africa's socio-economic development (Department of Environment Forestry & Fisheries, 2020). Advancing decarbonisation measures is an urgent necessity to mitigate the advancement of climate change. Mitigating the advancement of climate changes requires significant decarbonisation, that can be achieved when the biggest contributors such as mining entities transition to low carbon operations. The use of energy-efficient technologies, renewable technologies, and carbon capture and storage are climate mitigation options that many scholars endorse to significantly decarbonise mining operations (Haszeldine et al., 2018; Igogo et al., 2021; Katta et al., 2020; Sugiyama et al., 2014; Beck et al., 2017). Substantial decarbonisation measures require the combined use of renewable energy sources and carbon capture to lessen fossil fuel use (Igogo et al., 2021). Carbon capture is still in the exploratory phase in South Africa and therefore the study will focus on the solar photovoltaic as the most feasible renewable energy source available decarbonise mines in South Africa (Votteler & Brent, 2016).

Globally carbon pricing has been instrumental to encourage decarbonisation measures (McKitrick, 2016; Steinebach et al.,2021). Research on the ability of carbon pricing to encourage decarbonisation in the mining industry has been minimal. Carbon pricing research has focused on the negative impact on GDP, competitiveness, and profits (Datta, 2017; Modiba, 2019; Van der Meijdena & Withagen, 2019; Van Heerden et al., 2016). Thus, a gap exists in the literature on evaluating the adequacy of the ability of carbon pricing policies to decarbonise mining industries. This study offers carbon pricing lessons that can be incorporated into South Africa's carbon pricing policy to aid decarbonisation in mines and slow down the advancement of climate change.

The research question for this study is: Does the South African carbon pricing regime incentivise mines to invest in solar photovoltaic. The research objective of the study examines the suitability of South Africa's carbon pricing to encourage solar photovoltaic adoption. The study will formulate a minimum carbon price that will incentivise solar photovoltaic adoption in mines. This will be achieved from a net present value simulation, evaluating the costs against the benefits of the solar photovoltaic investment. This paper adopts a qualitive review approach. The net present value simulation is conducted to support the literature findings that low carbon prices do not incentivise investment in carbon reducing technologies such as solar photovoltaic. To assess the effectiveness of the South African carbon pricing mitigation regime, it is vital to investigate if the country's present carbon prices motivate mining to invest in renewable energy sources like solar photovoltaic. The study further suggests a carbon price that will encourage solar photovoltaic adoption in mines, and slow the advancement of climate change.

The paper proceeds as follows: the following section reviews carbon pricing as a mechanism to encourage decarbonisation. First, a review on carbon pricing as a Pigouvian tax. Second, a review is conducted of South Africa's carbon pricing regime and policy impediments. Third, a net present value simulation is conducted to evaluate the solar photovoltaic investment decision. Four, recommendations of the carbon price level that will encourage solar photovoltaic adoption in South African mines.

2. Literature review

Carbon pricing puts a price on carbon emissions through emissions trading schemes and carbon taxes. Carbon pricing utilises financial incentivise to influence behaviour towards more environmentally friendly solutions (Gupta, 2020; National Treasury, 2010; Steinebach, 2019; Zhang et al., 2018). In general, carbon tax policies are created using the Pigouvian paradigm (Halkos & Kitsou, 2018; Heal & Schlenker, 2019). Pigou first proposed the use of economic incentives, to correct the unaccounted negative externalities caused by pollution (Jaqua, & Schaffa, 2021; Li & Deng, 2022; Wang & Zhang, 2019). Negative externalities are defined in economic theory, as the omitted cost of pollution in final costs of goods resulting in a market failure (National Treasury, 2018). Levying a carbon tax would correct the market failure, by internalising the cost of pollution, and increase cost of goods and service (Dissanayake et al., 2020; Halkos & Kitsou, 2018; Li & Deng, 2022; Wang & Zhang, 2019). The increased cost of goods reduces the quantity of goods consumed, reducing the profitability of entities. This then creates an incentive for entities to change behaviour towards environmentally friendly solutions (Dissanayake et al., 2020; Jaqua & Schafa, 2021; National Treasury, 2010; Sterner & Robinson, 2018; Tan et al., 2022).

The effectiveness of a carbon tax is dependent on the design of the carbon tax. The carbon tax should be high enough to incentives decarbonisation efforts (Organisation for Economic Co-operation and Development, 2017; Sumner et al., 2011). Higher carbon tax rates encourage consumer behaviour towards transitioning into low carbon operations (Sumner et al., 2011) due to carbon tax liabilities exceeding the cost of decarbonising in the long term. The carbon price must be higher than the price of investing in renewable energy projects for entities to immediately invest in renewable energy projects (Gong & Li, 2016). When the cost of reducing pollution exceeds the carbon tax payable, then entities would rather pay the tax than invest in pollution reducing technology (Gupta, 2020). Lack of investment in decarbonising technologies further exacerbate the climate change problem. Carbon taxes can promote investment in decarbonising technologies when it is reasonably designed to encourage decarbonisation (Luo et al., 2022).

Decarbonisation involves investments in green technologies and tax rates charged influence investment decisions (Haites, 2018). The tax levels imposed directly affect the return investors earn and higher tax costs conflict with the profit-making objective (Saidu, 2007). The mining entity will select the cheaper course of action between carbon tax and investing in decarbonising technologies. Investment decisions are evaluated under capital budgeting theory and evaluation techniques (Hanlon & Heitzman, 2010). Under this model, future cash flows benefits are evaluated against the cost of the investment, with a positive NPV[1] signifying acceptance of investment (Drury, 2019; Oke & Conteh, 2020). An entity would invest in a project so long as benefits exceeded the costs (Hanlon & Heitzman, 2010). Carbon tax rates need to exceed the cost of investing in decarbonising technologies to incentivise decarbonisation efforts.

[1] The projected cashflow generated by an investment discounted for their present value in today's South African rand terms. It is assumed that an investment with a positive NPV will be profitable and a negative NPV will result in a net loss.

South Africa introduced a carbon tax at a rate of ZAR 120 (USD 6.32[2]) per tonne of carbon dioxide equivalent in June 2019. Effective from 1 January 2023, the carbon tax rate changed to ZAR 159 (USD 8.37[3]) per tonne of CO2 equivalent (National Treasury, 2023). The carbon tax is levied on direct emissions from fuel combustion, fugitive emissions, and industrial process emissions. Entities are allocated free emission allowances to allow them to transition to low carbon operations. The mining sector can obtain a maximum of 90% of their emissions carbon tax free as depicted in table 1:

Table 1: Carbon emission free allowances for mines

Carbon Tax Act	Allowance	Mining sector emission allowances
Section 7	Fossil fuel combustion	60%
Section 8	Industrial process emissions	0
Section 9	Fugitive emissions	0
Section 10	Trade exposure	10%
Section 11	Performance allowance	5%
Section 12	Carbon budget allowance	5%
Section 13	Offset allowance	10%
Total Allowances *		90%

Source: own compilation based on the Second Schedule of the Carbon Tax Act (National Treasury, 2019).

The current ZAR 159 (USD 8.37) carbon price level is significantly lower than the suggested price range of between ZAR 950(USD 50) and ZAR 1900 (USD 100) to limit temperature increase to 1.5°C above pre-industrial levels (Beck et al., 2017). Low carbon prices are too insignificant to have substantial impacts on the country's emission levels and the low carbon economic transformation. Low carbon prices have resulted in ineffectiveness of the policy instrument, to mitigate climate change (Baranzini et al., 2017; Boyce, 2018; Haites, 2018; Rosenbloom et al., 2020). Two-thirds of existing carbon prices are below ZAR 380 (USD 20) per carbon tonne of CO2, and at these prices ineffective in encouraging the decarbonisation of operations (Rosenbloom et al.,2020). Nong (2020) evaluated the 2019 South African carbon price of ZAR 120 (USD 6.32) and found it to be ineffective to reach the Paris emission reduction pledges of 34% below the baseline by 2020 and another 42 % by the year 2025. The ZAR 120 (USD 6.32) was found to only reduce up to half the Paris emission reduction pledges.

Carbon pricing schemes are further limited by excessive tax-free emission allowances (Baranzini et al.,2017) that reduce the overall effective carbon price. The free emission allowances in South Africa further reduce the overall effective carbon price per tonne of CO2 to ZAR 15.9 (USD 0.837). Van Heerden et al. (2016) asserts that for South Africa to reduce emissions by the Paris reduction pledges, the excessive emissions allowances need to be removed in the current carbon tax system. Van Heerden et al. (2016) found that for South Africa to cumulatively reduce 52.5% from the baseline 2016 by the year 2035, emissions allowances should be ceased in the year 2022, and the revenue is recycled through a renewable electricity generation subsidy. This cumulative reduction in emissions will significantly contribute to the mitigation of climate change.

[2] Translated at ZAR 19: USD 1

[3] Translated at ZAR 19: USD 1

Boyce (2018) has linked low carbon prices to the vested interests of political influence on the continued use of fossil fuels. This influence is evident in the continuation of fossil fuel subsidies, contradicting the objectives of a carbon pricing (Boyce, 2018). South Africa continues to, directly and indirectly, subsidize the production of fossil fuels to the value of 0.7 percent of GDP or 2.4 percent of South Africa's general government revenue (International Institute for Sustainable Development,2019). Skovgaard and Van Asselt (2019) affirm that government's continued support of fossil fuel subsidies is counterproductive in the transitioning to a low-carbon economy. Skovgaard and Van Asselt (2019) suggest that these fossil fuel subsidies could be reformed into renewable energy subsidies, expanding the adoption of renewable energy reducing reliance on fossil fuels that advance climate change.

Evaluation of South Africa's carbon pricing policy has identified the policy impediments that limit the ability to encourage investment in decarbonisation technologies. Insufficient carbon tax rates, excessive free emission allowances, and continued support of fossil fuels are impediments identified in the South African carbon pricing regime. The South African carbon tax design needs to be set at a higher rate to can promote investment in decarbonising technologies.

3. Methodology

This study is non-doctrinal tax research adopting qualitative research. This study conducts a thematic qualitative review of South Africa's carbon pricing policy design adequacy in incentivising investments in solar photovoltaic. The study further conducts a cost benefit analysis of solar integration in mining entities. The cost benefit analysis is used to supplement the overall qualitative review inquiry in this study. The study gathers secondary data available from literature (Johnston, 2014) on the role of carbon pricing in mitigating climate change and cost of solar photovoltaic investment. This study applied purposive sampling as the sample is selected based on the attributes they possess (Etikan et al., 2016). The carbon pricing theme was purposefully used for sampling literature and costing data to answer to the research objectives (Campbell et al., 2020). The sample included disclosed costs of renewable energy investments, in order fulfil the research objective of performing a cost benefit analysis. The reported CO2 emissions and costs will enable a recalculation of carbon tax to compare to the cost and benefits associated with investing in carbon mitigating technologies. The numerical data is collated and onto a Microsoft Excel spreadsheet, and analysed using the net present value functionality.

4. Discussion and Results

Mining entities can either invest in solar photovoltaic for the electricity saving or because the carbon tax level influence the investment. The two variables need to be isolated and evaluated separately to show the impact of each variable on the investment decision. The net present value simulation is conducted under three scenarios. The first scenario will be looking at the impact of carbon tax on the 30-megawatt solar photovoltaic investment decision. Secondly, the simulation will evaluate the electricity costs saving on the 30-megawatt solar photovoltaic investment decision. Lastly, both variables will be combined in the net present valuation to show all the cashflows associated with the 30-megawatt solar photovoltaic investment decision. The net present value simulations assume a discount rate of 11.75% and solar photovoltaic investment period of 20 years.

Net present value simulation 1: Carbon tax effect (Annexture1)

The net present value in this scenario is negative ZAR 321,905,394.70, meaning that a mining entity would not invest in a 30-megawatt solar photovoltaic plant to decarbonise operations due to the investment cost exceeding the carbon tax cost saving over the investment period. A sensitivity analysis is conducted to determine the minimum carbon price that would be charged to encourage mining entities to invest in solar photovoltaic plants using the equivalent annual annuity method.

The equivalent annual annuity represents the fixed annual cash flows an investment generates during its lifespan (Cai 2022:788). The equivalent annual annuity forms part of the sensitivity analysis conducted to determine the break-even carbon price that would have to be charged for a mining entity to be indifferent from investing in solar or continuing to pay a carbon price. The equivalent annual annuity is divided by the annual carbon emissions avoided to get to derive the additional carbon price charge per tonne of emissions. The equivalent annual annuity in the net present valuation illustrates that the ZAR159 carbon price would have to be increased by ZAR 509.61 per tonne of CO2. The increase leads to the break-even carbon price where a mining entity would be indifferent from investing in solar photovoltaic technology or continuing to pay carbon tax for continued pollution. A ZAR 0.01 increase in the break-even carbon price will lead to a positive net present value, signifying that the investment should be adopted based on net present value rules.

Net present value simulation 2: Electricity saving effect (Annexure 2)

The net present value in this scenario is positive ZAR 352,720,743.93 signifying that a mining entity would invest in a 30-megawatt solar photovoltaic plant purely for savings in electricity without a carbon tax charged on emissions. The change in net present value from scenario one highlights the importance of separately evaluating the variables to illustrate the individual effect of the two variables and avoid incorrect conclusions. The savings on the high electricity costs in South Africa are significant enough for mining entities to integrate solar photovoltaic in operations and would strengthen the energy security amid South Africa's energy supply crisis.

Net present value simulation3: Overall cashflow effect (Annexure 3)

The carbon tax and electricity savings variables were only separated to isolate the impact of each. A mining entity's investment decision assess the holistic differential cashflows that arises from a decision under review. The net present value in this scenario is positive ZAR 502 299 279.73 signifying that a mining entity would invest in a 30-megawatt solar photovoltaic plant due to the overall net cashflow benefits from the investment. Introducing the carbon tax saving increased the cashflow benefits from the investment. However, based on scenario one when the electricity saving is removed, the carbon tax saving on its own is not sufficient to persuade mines to invest in solar photovoltaic. This displays that the carbon tax saving is an additional benefit and not the main driver of the investment decision.

5. Conclusion

One barrier to South Africa's carbon pricing was that it was set too low to promote decarbonisation. Net present value simulation one illustrated that the carbon tax on its own does not encourage investment in solar photovoltaic. The carbon tax rate would have to be increased by ZAR 509.61 to reach a break-even price. At break-even point a mining entity is indifferent from investing in solar photovoltaic or continued pollution and paying a carbon tax.

An increase of ZAR 0.01 in the breakeven price would result in a positive net present value of ZAR 6316.69 per tonne of CO2, signifying acceptance of investing in a solar photovoltaic plant based on net present value rules. Net present value simulation two illustrates that the saving on electricity costs without a carbon tax charged would incentivise a mining entity to invest in solar photovoltaic technology. The saving on carbon tax in net present value simulation three enhance the cashflow benefits of investing in solar. The holistic cashflow benefit from investment decision analysis signifies that it will be beneficial from a mining entity to invest in 30-megawatt solar plant. The investment will result in a double dividend costing savings, and reducing carbon emissions.

South Africa’s carbon pricing policy is ineffective in encouraging decarbonisation in the mining sector. Deep decarbonisation is required in heavy polluting industries to avoid further temperature increases from them emission of greenhouse gas emissions that advance climate change. Carbon pricing policies need to be designed to adequately to encourage decarbonisation efforts in heavy polluting industries such as mining. Sector specific carbon mitigation policies with emission limitations are necessary to accelerate decarbonisation in the mining sector. Furthermore, the carbon price needs to be set at a level that exceed the costs of carbon emission abatement to persuade mining entities to decarbonise.

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ANNEXURE 1: NET PRESENT VALUATION SIMULATION 1

Year		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Cashflow year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Investment cost	(497,124,217)										
Maintenance costs		(4,971,242)	(5,269,517)	(5,585,688)	(5,920,829)	(6,276,079)	(6,652,643)	(7,051,802)	(7,474,910)	(7,923,405)	(8,398,809)
Electricity saving		-	-	-	-	-	-	-	-	-	-
Profit/ (Loss) before tax		**(4,971,242)**	**(5,269,517)**	**(5,585,688)**	**(5,920,829)**	**(6,276,079)**	**(6,652,643)**	**(7,051,802)**	**(7,474,910)**	**(7,923,405)**	**(8,398,809)**
Income tax benefit		68,454,005	41,689,831	28,352,843	1,598,624	1,694,541	1,796,214	1,903,987	2,018,226	2,139,319	2,267,678
Carbon tax saving		13,235,996	13,328,648	13,421,948	13,515,902	13,610,513	13,705,787	13,801,727	13,898,339	13,995,628	14,093,597
Total cashflow	**(497,124,217)**	**76,718,758**	**49,748,962**	**36,189,104**	**9,193,697**	**9,028,976**	**8,849,357**	**8,653,912**	**8,441,655**	**8,211,542**	**7,962,466**
Discount rate	**11.75%**										
NPV	**(321,905,394.70)**										
EAA	**42,422,719.29**										
Increase in carbon tax to break-even per tonne of CO_2	**509.61**										

Year	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Cashflow year	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Investment cost										
Maintenance costs	(8,902,738)	(9,436,902)	(10,003,116)	(10,603,303)	(11,239,501)	(11,913,871)	(12,628,703)	(13,386,426)	(14,189,611)	(15,040,988)
Electricity saving	-	-	-	-	-	-	-	-	-	-
Profit/ (Loss) before tax	(8,902,738)	(9,436,902)	(10,003,116)	(10,603,303)	(11,239,501)	(11,913,871)	(12,628,703)	(13,386,426)	(14,189,611)	(15,040,988)
Income tax implications	2,403,739	2,547,964	2,700,841	2,862,892	3,034,665	3,216,745	3,409,750	3,614,335	3,831,195	4,061,067
Carbon tax saving	14,192,252	14,291,598	14,391,639	14,492,381	14,593,827	14,695,984	14,798,856	14,902,448	15,006,765	15,111,812
Total cashflow	**7,693,254**	**7,402,660**	**7,089,365**	**6,751,969**	**6,388,991**	**5,998,858**	**5,579,902**	**5,130,357**	**4,648,349**	**4,131,891**

ANNEXURE 2: NET PRESENT VALAUTAION SIMULATION 2

Year		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Cashflow year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Investment cost	(497,124,217)										
Maintenance costs		(4,971,242)	(5,269,517)	(5,585,688)	(5,920,829)	(6,276,079)	(6,652,643)	(7,051,802)	(7,474,910)	(7,923,405)	(8,398,809)
Electricity saving		97,822,263	103,173,141	108,816,711	114,768,985	121,046,849	127,668,112	134,651,557	142,016,997	149,785,327	157,978,585
Profit/(Loss) before tax		**92,851,021**	**97,903,624**	**103,231,024**	**108,848,156**	**114,770,770**	**121,015,468**	**127,599,755**	**134,542,087**	**141,861,922**	**149,579,776**
Income tax implications		42,041,994	13,833,083	(1,027,669)	(29,389,002)	(30,988,108)	(32,674,176)	(34,451,934)	(36,326,364)	(38,302,719)	(40,386,539)
Carbon tax saving		-	-	-	-	-	-	-	-	-	-
Total cashflow	**(497,124,217)**	**134,893,014**	**111,736,707**	**102,203,355**	**79,459,154**	**83,782,662**	**88,341,292**	**93,147,821**	**98,215,724**	**103,559,203**	**109,193,236**
Discount rate	**11.75%**										
NPV	**352,720,743.93**										

Year	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Cashflow year	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Investment cost										
Maintenance costs	(8,902,738)	(9,436,902)	(10,003,116)	(10,603,303)	(11,239,501)	(11,913,871)	(12,628,703)	(13,386,426)	(14,189,611)	(15,040,988)
Electricity saving	166,620,013	175,734,128	185,346,785	195,485,254	206,178,297	217,456,250	229,351,107	241,896,613	255,128,357	269,083,878
Profit/(Loss) before tax	**157,717,276**	**166,297,226**	**175,343,669**	**184,881,951**	**194,938,796**	**205,542,379**	**216,722,404**	**228,510,187**	**240,938,746**	**254,042,891**
Income tax implications	(42,583,664)	(44,900,251)	(47,342,791)	(49,918,127)	(52,633,475)	(55,496,442)	(58,515,049)	(61,697,750)	(65,053,461)	(68,591,580)
Carbon tax saving	-	-	-	-	-	-	-	-	-	-
Total cashflow	**115,133,611**	**121,396,975**	**128,000,878**	**134,963,824**	**142,305,321**	**150,045,937**	**158,207,355**	**166,812,436**	**175,885,285**	**185,451,310**

ANNEXURE 3: NET PRESENT VALUATION SIMULATION 3

Year		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Cashflow year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Investment cost	(497,124,217)										
Maintenance costs		(4,971,242)	(5,269,517)	(5,585,688)	(5,920,829)	(6,276,079)	(6,652,643)	(7,051,802)	(7,474,910)	(7,923,405)	(8,398,809)
Electricity saving		97,822,263	103,173,141	108,816,711	114,768,985	121,046,849	127,668,112	134,651,557	142,016,997	149,785,327	157,978,585
Profit/ (Loss)before tax		**92,851,021**	**97,903,624**	**103,231,024**	**108,848,156**	**114,770,770**	**121,015,468**	**127,599,755**	**134,542,087**	**141,861,922**	**149,579,776**
Income tax implications		42,041,994	13,833,083	(1,027,669)	(29,389,002)	(30,988,108)	(32,674,176)	(34,451,934)	(36,326,364)	(38,302,719)	(40,386,539)
Carbon tax saving		13,235,996	14,023,140	14,857,096	15,740,648	16,676,744	17,668,510	18,719,257	19,832,491	21,011,929	22,261,508
Total cashflow	**(497,124,217)**	**148,129,010**	**125,759,847**	**117,060,451**	**95,199,802**	**100,459,407**	**106,009,802**	**111,867,078**	**118,048,215**	**124,571,132**	**131,454,745**
Discount rate	**11.75%**										
NPV	**502,299,279.73**										

Year	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Cashflow year	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Investment cost										
Maintenance costs	(8,902,738)	(9,436,902)	(10,003,116)	(10,603,303)	(11,239,501)	(11,913,871)	(12,628,703)	(13,386,426)	(14,189,611)	(15,040,988)
Electricity saving	166,620,013	175,734,128	185,346,785	195,485,254	206,178,297	217,456,250	229,351,107	241,896,613	255,128,357	269,083,878
Profit/ (Loss)before tax	**157,717,276**	**166,297,226**	**175,343,669**	**184,881,951**	**194,938,796**	**205,542,379**	**216,722,404**	**228,510,187**	**240,938,746**	**254,042,891**
Income tax implications	(42,583,664)	(44,900,251)	(47,342,791)	(49,918,127)	(52,633,475)	(55,496,442)	(58,515,049)	(61,697,750)	(65,053,461)	(68,591,580)
Carbon tax saving	23,585,400	24,988,024	26,474,062	28,048,474	29,716,517	31,483,758	33,356,097	35,339,785	37,441,442	39,668,084
Total cashflow	**138,719,012**	**146,384,999**	**154,474,940**	**163,012,299**	**172,021,838**	**181,529,695**	**191,563,452**	**202,152,221**	**213,326,726**	**225,119,394**