SLACC/PE/4

TOWN AND COUNTRY PLANNING ACT 1990

Application by West Cumbria Mining Ltd

Development of a new underground metallurgical coal mine and associated development at Former Marchon Site, Pow Beck Valley and area from Marchon Site to St Bees Coast

Planning Inspectorate Reference:	**APP/H0900/V/21/3271069**
Local Planning Authority Reference:	**4/17/9007**
Date of Inquiry:	**7th September 2021**

REBUTTAL PROOF OF EVIDENCE (CLIMATE CHANGE)

of

Professor Paul Ekins OBE, PhD

Professor of Resources and Environmental Policy

UCL Institute for Sustainable Resources

University College London

10 September, 2021

CONTENTS

1. INTRODUCTION

1.1. This rebuttal should be read together with my Proof of Evidence [SLACC/PE/1] ("Main Proof") and Appendices [SLACC/PE/2] and my Rebuttal Proof of Evidence in relation to the issue of the need for the coal the Applicant proposes to produce ("Need Rebuttal").

1.2. As with my Main Proof and the Need Rebuttal, save where I indicate to the contrary, the facts and matters contained in this proof of evidence are within my own knowledge. Where facts and matters are not within my own knowledge, I have identified my sources of information or understanding.

1.3. In this second rebuttal focused on the climate change impacts of the mine, I cover the following topics:

1.3.1. The emissions likely to arise from the WCM mine as compared with other mines globally (section 2)

1.3.2. The perfect substitution claim (section 3)

1.3.3. Inhibiting the transition to low-carbon steelmaking, (section 4) and

1.3.4. The claim of a "net zero" mine (section 5).

2. WCM EMISSIONS COMPARED TO OTHER COKING COAL MINES GLOBALLY

2.1. Mr Truman concludes that "development of the Woodhouse mine would lead to a global reduction in GHG emissions of between 587-770 kt CO2e per annum due to the displacement of higher GHG emitting US coking coal production." (WCM/JT/1 para. 8.5)

2.2. This figure is based on a "benchmarking" exercise described in section 3 of the Wood Mackenzie Report. They provide no information on how they estimate the emissions of mines elsewhere in the world, nor on how they estimate the transport emissions they claim are associated with these mines, aside from generalities and reliance on an

internal Wood Mackenzie "Emissions Benchmarking Tool". The "emissions assessment process" in Figure 3.1 amounts to nothing more than vague descriptions of research being undertaken, data being compiled, emissions being modelled. No information is provided on the data sources used, what "drivers of emissions" have been identified, the way that inevitable "data gaps" are filled, the formulae employed to calculate emissions, the "common factors [] used across commodities" the "reconciliation" process and what revisions are made, etc. (WCM/JT/2 Fig. 3.1).

2.3. One is simply asked to accept Wood Mackenzie's numbers at face value without any information about how they have been derived (WCM/JT/2 Fig. 3.1).

2.4. However, a few things can be said in relation to what *is* said in the Wood Mackenzie Report:

2.4.1. First, the WCM figures are <u>not</u> estimated using Wood Mackenzie's methodology. Despite noting that a function of the Emissions Benchmarking Tool is to employ "a consistent methodology in the assessment of GHG emissions to enable the comparison of assets, companies, countries and regions on a like-for-like basis," (JT/2 para 3.9) it is clear that Wood Mackenzie has not done this for the WCM mine. Instead, for WCM's mine they have input figures provided to them by WCM, which have "not been independently validated by Wood Mackenzie" (JT/2 para 3.7). These figures come from the Ecolyse Report (WCM/CL/2 page 3, "Original Ecolyse Report")). I discuss the Ecolyse Report further below, but it is important to understand that Wood Mackenzie have simply adopted figures that were provided to them and which are not derived using their standard methodology, whatever that may involve.

2.4.2. This is also partially true in relation to the transportation emissions. Despite setting out that Wood Mackenzie have calculated their own estimates of transport emissions for all seaborne metallurgical coal exports globally based on train, truck, barge and ocean freight figures (JT/2 para 3.13), Wood Mackenzie state that they have only estimated ocean freight emissions using

their own methodology, and have been provided with rail emissions for the WCM mine by WCM.

2.4.3. Second, by looking at Figure 3.4 of WCM/JT/2 one can tell that the transportation emissions (light blue) associated with WCM coal appear to be smaller than any other mine in their global dataset. (i.e. the additional height due to the light blue bar in the two WCM cases appears to be smaller than for any other mine on the graph). By way of illustration, note that despite the fact that Wood Mackenzie themselves indicate that the WCM "worst case" has scope 1 emissions higher than roughly 2/3^{rds} of global seaborne metallurgical coal exports (see WCM/JT/2 Fig. 3.2), and scope 2 emissions higher than roughly 45% of global seaborne metallurgical coal exports (WCM/JT/2 Fig. 3.3), once transportation is taken into account, WCM's worst case improves dramatically, to approximately the 5th percentile. (WCM/JT/2 Fig. 3.4)

2.4.4. This may be partly because transport emissions for all mines globally are estimated to Rotterdam, among the very closest European ports to Redcar in the UK. The numbers would likely look less favourable to WCM coal even if the analysis was for delivery to Southern European ports, let alone those in Turkey, or further afield.

2.4.5. Third, the Wood Mackenzie Report notes that "All mines' GHG emissions are shown on an unmitigated basis." (JT/2 para 3.10) It thus appears that WM's methodology is to estimate the potential unmitigated emissions from other mines globally based on its undisclosed sources. WM however then makes frequent comparisons to the "likely mitigated" emissions of WCM's operations – based on figures derived from that scenario in the Ecolyse report. The 'likely mitigated' scenario also provides the basis for one end of the range which is calculated for the purported GHG savings. It appears to be unjustified to seek to compare the WCM "likely mitigated" figure against a figure that is for unmitigated emissions from all other mines.

2.4.6. Fourth, a new "Version 2" of the Ecolyse Report ("Ecolyse Version 2") has been recently produced, (showing a significant increase in the figures which Wood Mackenzie used as inputs in their "benchmarking" analysis).

2.4.7. The benchmarking analysis uses the 2029 figures from the Original Ecolyse report for the "worst case" and "likely mitigated" scenarios. The Ecolyse Version 2 report updates both of these figures. They increase in Ecolyse Version 2 by 10%[1] and 35%[2] respectively over the figures which appeared in the Original Ecolyse Report.

2.4.8. The choice to use the 2029 figures is itself highly favourable to WCM (and no justification is given for using this year). Both versions of the Ecolyse Report project that emissions will rise significantly through 2041, after which the annual emissions will decline slightly (or stabilise, in the "worst case" scenario). It may be noted that the 2041 figures are a further 34% higher than the figure used by WM for the "likely mitigated" case[3], and a further 77% higher for the "worst case."[4]

2.4.9. Taken together, using 2041 Ecolyse Version 2 figures instead of the 2029 Original Ecolyse figures would mean using a figure 80% higher for the "likely mitigated" scenario and 94% higher for the "worst case" scenario.

2.4.10. Fifth, in order to derive its figure for greenhouse gas savings, Wood Mackenzie then compares only to US High Vol A mines (see JT/2 Fig. 3.5 and 3.6) and compares the stated WCM coal figures against what is said to be the average for US HVA producers. It can be seen from comparing Figures 3.4 and 3.5 that

---

[1] Worst Case scenario in Original Ecolyse: 228,403 tonnes CO2e versus 250,646 tonnes in Ecolyse Version 2. (See table C-4 in each document, page 40)

[2] Likely mitigated scenario in Original Ecolyse: 45,235 tonnes CO2e versus 60,971 tonnes in Ecolyse Version 2. (See table C-6 in each document, page 42)

[3] 81,649 tonnes CO2e projected by Ecolyse in 2041 versus 60,971 tonnes in 2029. Ecolyse Version 2, Table C-6, page 42.

[4] 442,429 tonnes CO2e projected by Ecolyse in 2041 versus 250,646 tonnes in 2029. Ecolyse Version 2, Table C-4, page 40.

the average is much higher for US HVA Producers than for metallurgical coal producers globally. If the coal is not equivalent to US High Vol A coal and displaces other production, the figures would likely be significantly different.

2.4.11. Sixth, of course, all of this analysis is founded on the perfect substitution assumption. It assumes that the US coal producers will not sell any of their "displaced" coal elsewhere and ignores the end use emissions of the coal. But even the range in Mr Truman's evidence of a "global reduction in GHG emissions of between 587-770 kt CO2e per annum" is significantly less than the GHG emissions of using only 10% of the coal which would be produced by this mine each year. (See the Main Proof of Michael Grubb, SLACC/MG/1 at 7.6; showing that emissions from 10% of the coal equate to 879.9 kt CO2e per annum).

3. THE PERFECT SUBSTITUTION CLAIM

3.1. West Cumbria Mining's evidence continues to rely heavily on the perfect substitution assumption for the proposition that global greenhouse gas emissions will not increase if Woodhouse Colliery produces an additional 2.78 million tonnes of coal per year.

3.2. Of course, I have already addressed the reasons why this claim is wrong in my Main Proof (at Section 3) and in my Need Rebuttal (at Section 3). Both Mr Kirkbride and Mr Truman now make further points which they say make coal and/or steel markets unusual, and which – they argue – means that the perfect substitution claim is reasonable in this context.

Price elasticity

3.3. Mr Kirkbride acknowledges that perfect substitution is "extremely unusual" (WCM/MAK/3 para 3.3) but asserts that the demand for coking coal is inelastic. (Id.)

To an economist, inelastic price elasticity means an elasticity between 0 and -1. Estimates of the price elasticity of coking coal are in the region of -0.5, i.e. inelastic in terms of the definition, but this still means that a 20% reduction in price leads to a 10% increase in demand. WCM's claim that its production (and the ensuing fall in price) will lead to zero increase in global emissions would require the price elasticity to be zero. There is no estimate that I have been able to find that this is the case. On the contrary Lorenzik and Panke (2015) (attached as Appendix PE/4/R1) find that a 'reasonable range' for the price elasticity of coking coal is -0.3 to -0.5 (p.3), and that with elasticities as low as -0.1 or -0.2 "none of the market settings is able to reproduce actual market prices" (p.13). This being the case, it is clear that if lower-priced WCM coal enters the market, it will increase demand and so global emissions.

Market structure/oligopoly

3.4. Mr Kirkbride also argues that the hard coking coal market is dominated by a few major producers and that means that the market exhibits the kind of "special and rare" circumstances that would lead to perfect substitution. (WCM/MAK/3 paras 3.5-3.8) In economic parlance, this is called an oligopolistic market. The fact that the supply of coking coal is an oligopolistic market does not lead to the perfect substitution claim being a reasonable assumption. Indeed, the Lorenczik & Panke paper (Appendix PE/4/R1) specifically models a market dominated by the Big Four players. In paragraph 3.8 Mr Kirkbride inexplicably calls these 'restricted supply sources', when they are nothing of the kind. All the suppliers he mentions have the capacity to increase their supply, and there is every prospect that they will seek to do so, with further effects on the price of coal and resulting CO2 emissions, in order to maintain their market share. The notion that the production of any of these global companies will decline by the amount of new Cumbrian coal because of the entry into the market of WCM is completely unfounded. There is nothing in the rebuttal of Mr Kirkbride, seeking to support his argument that WCM coal will cause the decline of coal production elsewhere, that can explain the expansion of the coking coal market that has occurred over the last 40 years. Indeed, he has yet to explain, using his 'substitution' argument, why it was that the opening of the world's second coal mine did not lead to the first

coal mine shutting down. In fact, it did not do so because the market expanded, and this is what will happen again if the WCM mine starts producing, with a consequent increase in global CO2 emissions.

Coal Market Dynamics

3.5. Mr Truman sets out (his Point C, JT/3 paras 3.6-3.22) why he says that the economics are "extremely more complicated" than supply and demand analysis would imply. All markets can be subject to political considerations and turbulence such as Truman describes, and commodities markets are subject to more such turbulence than most. However, in itself that does not negate the strong long-term influence of basic market forces, my presentation of which Mr Truman seems to accept (paragraph 3.7). Economic analysis is valuable precisely because it allows one to understand the hidden drivers behind complex market dynamics where many economic actors may be operating against a backdrop of natural and manmade changes - from cyclones (JT/2 para 2.39) to Chinese government bans on Australian imports (JT/3 para 3.11).

3.6. The short-term supply, demand and price movements that Truman cites in paragraphs 3.9-3.22 may be true but in themselves they do not negate the fact that the price elasticity of demand for both coking coal and steel are negative. This is why, in the estimation of such elasticities, one needs proper statistical analysis over a period of time, that looks deeper than short-term fluctuations and can identify the underlying influences on price and demand.

EU position on critical raw materials

3.7. Mr Kirkbride quotes at length to the effect that the EU would like to expand its production of critical raw materials (paragraph 3.11). The relevance of this to WCM's case is not clear. As Mr Kirkbride will doubtless be aware, the UK is now not part of the EU. To the EU, it is as much a 'third country' as Australia. There is no reason at all

why the EU would give preferential treatment to WCM coal or regard WCM coal as in any sense part of EU production.

European Emissions Trading System (EU ETS)

3.8. Mr Kirkbride uses the argument that even if EU use of coking coal did expand because of its import of lower-priced WCM coal, EU CO2 emissions would not increase because they would be capped under the EU ETS (WCM/MAK/3 para 3.13). He envisages EU steel makers buying WCM coal having also to buy emission allowances from "other heavy emitters (e.g. cement kilns, district heating plants, oil refineries, gas- and coal-fired power stations, etc)." (Similar claims are made elsewhere in WCM's evidence – see, e.g., CL/1, paras 0.8 and 4.5)

3.9. A number of points may be made in response. First, other heavy emitters may use exactly the same logic as they seek to resist decarbonisation, seeking to buy allowances from steel makers (among others). Under these circumstances the allowance price would increase dramatically and steel makers would adopt the H-DRI steel that would by then be available in Europe. WCM coal would then look for markets elsewhere (note that no-one from Javelin or WCM has given any binding assurance that if they cannot sell WCM coal in Europe to the extent now envisaged, that WCM would cease production).

Where the WCM will be sold

3.10. Second in relation to sales of WCM coal to Europe, it now appears to be accepted by a growing amount of the evidence put forward by WCM that the coal may be sold outside the UK and EU, where emissions caps are not in place. Mr Truman's evidence indicates that "Southern Europe" and Turkey are both part of the "main market" for the coal (WCM/JT/1 para 5.5; WCM/JT/2 para 2.28). Southern Europe includes Serbia, a non-EU country (WCM/JT/2, caption, figure 1.6, page 11). Bosnia and Herzegovina, a non-EU country is also listed as a "secondary target" market (WCM/JT/2, para 2.29).

3.11. Indeed, Turkey is the largest identified country in the "addressable market" identified by Wood Mackenzie. (WCM/JT/2, fig. 2.5, page 27) Bosnia and Herzegovina is also among the countries with a large enough share to be identified in the figure showing the addressable market. (Id.) To the extent that sales are now contemplated to Turkey and other non-EU countries, this would involve selling coal into a market that is not subject to similar regulatory controls and emissions targets as in the UK and EU countries.

3.12. For example, Turkey's Intended Nationally Determined Contribution (INDC), which was submitted under the UNFCCC in 2015, indicates that Turkey will seek to achieve "up to 21 percent reduction in GHG emissions from the Business as Usual level by 2030". (Appendix PE/4/R2) As can be seen on page 30[5], Turkey projects that its GHG emissions will continue to rise significantly under the INDC (increasing 55% between 2020 and 2030), but slightly slower than under the "business as usual" scenario. No mandatory emissions trading scheme exists in Turkey. Likewise, sales into countries such as Serbia and Bosnia and Herzegovina would not face emissions caps relied on in WCM's evidence.

3.13. Indeed, in relation to my claims that the coal might go to Asia or Africa, Mr Truman's rebuttal does not seek to dispute this, but argues that there would still be emissions savings, calculating what he says are figures for emissions savings if the coal is shipped to India or Japan. (JT/3 paras 3.1-3.5). I address Mr Truman's claims about emissions savings further above, in section 2. However, in this context, the key point is that the WCM evidence thus appears to accept that the coal could go anywhere in the world that a market is found.

3.14. Mr Kirkbride states (MAK/3 para 3.20) that I am "not being very careful or measured" when I say that the mine operator's incentives will be to sell the coal anywhere in the world that a market can be found, rather than shutting down if a market for the coal

[5] Internal numbering 5/5.

cannot be found in the UK or Europe. A market requires a buyer and a seller, so my language in this respect is precise, contrary to Mr Kirkbride's assertion. And there have been cases where sellers have sold below marginal cost for a period to maintain market share in the hope that markets will improve, so it is not the case that a mine operator will only ever sell where a price is above the marginal cost of production.

3.15. Mr Kirkbride also says that I seem "unwilling to allow market forces, through emissions trading, to help businesses and governments determine the most efficient way to distribute emissions across the economy." (WCM/MAK/3 para 3.19). I do not know from where this assertion arises, but much of my academic life has been spent arguing for carbon taxes and emission trading. I simply do not think that the existence of an emissions trading system in the EU and the UK is the panacea that Mr Kirkbride seems to indicate.

3.16. An emissions trading system in the EU that is calibrated to net zero by 2050, and the EU targets for dates before then, will have no room for WCM coal beyond about 2035, as the modelling in Annex 3 of my Main Proof shows. WCM coal will then seek markets elsewhere.

"Displacement"

3.17. Further, to the extent that WCM coal is sold into UK and EU markets where emissions caps exist, this will "displace" other coal that was being sold into these markets as Mr Truman recognises. (See, e.g. JT/1 para 8.5; JT/2 paras 2.1, 2.33, 3.16, 3.17, 3.18) I do not consider the frequent use of this term (as opposed to the term "substitute", which has been used elsewhere) by Mr Truman to be a mistake.

3.18. Even assuming that Mr Truman is right that the WCM coal displaces other coal (US High Vol A coal, Mr Truman says) and takes market share in the UK and EU, this does not imply that the greenhouse gas emissions of permitting the mine will be zero. As I have set out in my Main Proof and Need Rebuttal, this US coal is simply likely to be sold elsewhere, increasing total global GHG emissions.

Planned new metallurgical coal mines

3.19. In his Point G (JT/3 paras 3.48-3.57) Mr Truman provides much interesting information about present and proposed metallurgical coal mines, in the context of my evidence using the GEM database. He accepts that this is a "reasonably good resource" but states that it needs "some refinement" (para 3.49). This may well be the case, and doubtless the production of some of the proposed mines identified there will take the place of some depleted mines that stop production. But nothing in this rebuttal of Mr Truman's undermines my essential case that these mines will add to the global overall supply of coking coal, thereby increasing the demand for it as per the basic economic relationships in my main evidence (SLACC/PE/1 section 3, para 4.3).

3.20. In any case, WCM's evidence does not assert that WCM coal will take the place of depleted metallurgical coal mines, but claims it will displace currently produced U.S. coal, and it is my essential point that the mines producing this coal will not close down but will seek to sell into markets elsewhere. I repeat the point made in my Need Rebuttal (SLACC/PE/3 paras 3.4.2, 4.2) that Javelin, the company which will market WCM's coal, but which also has substantial U.S. coal interests, has not said that it envisages that with WCM coal on the market, the market for U.S. coal will decrease by the same amount.

No identification of mines that will close

3.21. Finally, in relation to the point raised by Ms Leatherdale at [CL/3 3.3] the IEA's finding that a net-zero world does not need new developments of fossil fuels means that any such new developments should identify explicitly the production that it will replace in order not to increase global emissions beyond the Paris Agreement carbon budgets. Despite this point having been made forcefully in my evidence, none of WCM's evidence, has identified which coal mines will close, when without WCM they would have remained open, so that WCM's production really does lead to no increase in global emissions. My conclusion is that WCM has no idea what such mines might be,

and that their baseless assertions of 'substitution' for other coal simply reflect their unwillingness to admit publicly that their mines will increase global carbon emissions and contribute to the climate change that is already proving so destructive in many parts of the world.

4. INHIBITING THE TRANSITION TO LOW-CARBON STEEL

4.1. I have addressed this topic at some length in both my Main Proof (paras 3.13, 3.19-3.23) and the Need Rebuttal (section 4). I do not seek to repeat those points here.

4.2. However, I note that Mr Truman now estimates that the availability of lower-cost WCM coal could save European steelmakers USD3.25 million per 1 Mtpa (WCM/JT/3 paragraph 3.27) – a potential saving for UK steelmakers, with a production of 7 Mtpa, of over USD20 million per year. The notion that this saving will not influence steelmakers when they are considering whether to refurbish their plants for continuing use of coking coal or switch to DRI runs against economic logic and common sense.

5. THE CLAIM OF A "NET ZERO" MINE

5.1. Multiple WCM witnesses repeat the claim that the mine will be "net zero" – i.e. that granting permission would lead to no new net emissions. [MAK/1 5.3, CL/1 0.6.3]

5.2. It is then said that because the mine is net zero, this means that the mine therefore:

5.2.1. Does not compromise the ability of the UK to meet the objectives of the sixth carbon budget, nor of the Government to meet its international obligations [CL/1 0.11]

5.2.2. Is consistent with the Government's Industrial Decarbonisation Strategy [CL/1 3.23]

5.2.3. Is consistent with local planning policies [CL/1 5.7]

5.2.4. Is consistent with national planning policy [ST/1 4.22-4.24]

5.2.5. Will support the transition to a low-carbon economy [CL/1 5.24]

5.3. All of these assertions rest on the faulty foundation of the net zero claim. The net zero claim is wrong for a number of reasons:

5.4. It ignores the end use emissions of the coal.

5.5. It relies on the findings of the Ecolyse Report (Version 2) that emissions are low and will be offset. I will turn briefly to offsetting below, but in relation to the estimates in the Report, these do not represent a reliable and complete assessment of the emissions arising from the mine. The problems with the Ecolyse Report are set out in detail in the Rebuttal Proof of Michael Grubb [MG/3, section 2]. In summary:

5.5.1. The methodology is unclear in many respects and leads to implausible results such as the claim that mitigation will lead to there being zero scope 1 and 2 greenhouse gas emissions during the course of the 2-year construction period. [Ecolyse 2 table 5-2, p 14] It must be remembered that WCM's evidence is that more than £200 million will be invested over this 2-year period, including more than £30 million on mine construction and more than £58 million on "site wide works". [MAK/2, Appendix 5 (Cash Flow Summary)] The idea that there will be no direct greenhouse gas emissions from any of these activities is quite remarkable. Likewise, it is claimed that emissions during the decommissioning period are negative – again, it is hard to see how all the activities that would be required to close and cap the mine, remove all the buildings and restore the site could possibly be carbon-free.

5.5.2. SLACC's legal team has advised that many of the proposed mitigation measures relied on by the Report are not legally secured. The vast majority of the claimed emission reductions due to mitigation relate to these apparently-unsecured measures.

5.5.3. Methane emission & capture levels rely on a series of assumptions for which evidence has not been provided. If any of these assumptions is wrong, the emissions could be much higher, but such assumptions do not appear to be

subject to validation once the mine is built. So, these would likely never be reflected in reports on the greenhouse gas emissions of the mine which are used to calculate the offsets required.

5.6. The net zero claim also rests on offsetting. I understand that other evidence will be given on offsetting and I do not seek to address this in detail, but I would take issue with Ms Leatherdale's statement that the mine complies with "the established mitigation hierarchy that seeks to avoid and reduce GHG emissions as far as possible, and only relies upon offsetting as a last resort to compensate for the residual emissions which cannot be avoided through any alternative means." [CL/1 5.9]

5.7. The whole notion of offsets should be applied in relation to *existing* emissions, which are difficult or impossible to reduce, and it is already unclear whether there will be enough robust offsets to perform this role. Seeking to justify new emissions, such as from this coal mine, by putative offsetting essentially guarantees that societies will not engage in sufficient emission reduction to reach the Paris targets.

5.8. The Government's Climate Change Committee has noted that "all UK emissions must be tackled, without reliance on offsets from elsewhere."[6] In discussing the role of business in delivering the Sixth Carbon Budget, the CCC recommends, among the "principles that should guide business ambition in the UK" that businesses "Minimise offsets, phase them out, and ensure only permanent emissions removals remain, in line with our recommendations around how the UK should meet its national carbon budgets."[7] Seeking to justify major new sources of emissions on the grounds that they will be offset, in an as yet completely unspecified way, runs completely counter to such principles.

Declaration

The evidence which I have prepared and provide for this appeal reference APP/H0900/V/21/3271069 in this proof of evidence is true, and I confirm that the opinions expressed are my true opinions.

[6] CD8.10, p 38

[7] CD8.10, p 393

Energy Economics 59 (2016) 179–187

APPENDIX R1

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneco

Assessing market structures in resource markets — An empirical analysis of the market for metallurgical coal using various equilibrium models☆

Stefan Lorenczik, Timo Panke*

Institute of Energy Economics, University of Cologne, Vogelsanger Str. 321a, Cologne 50827, Germany

ARTICLE INFO

Article history:
Received 12 August 2015
Received in revised form 7 July 2016
Accepted 9 July 2016
Available online 22 July 2016

JEL classification:
C61
D43
L71
Q31

Keywords:
Applied industrial organisation
Stackelberg games (MPEC)
Multi-leader–follower games (EPEC)
Cournot oligopolies (MCP)
Resource markets

ABSTRACT

The prevalent market structures found in many resource markets consist of high concentration on the supply side and low demand elasticity. Market results are therefore frequently assumed to be an outcome of strategic interaction between producers. Common models to investigate the market outcomes and underlying market structures are games representing competitive markets, strategic Cournot competition and Stackelberg structures that take into account a dominant player acting first followed by one or more players. We add to the literature by expanding the application of mathematical models and applying an Equilibrium Problem with Equilibrium Constraints (EPEC), which is used to model multi-leader–follower games, to a spatial market. Using our model, we investigate the prevalent market setting in the international market for metallurgical coal between 2008 and 2010, whose market characteristics provide arguments for a wide variety of market structures. Using different statistical measures to compare model results with actual market outcomes, we find that two previously neglected settings perform best: First, a setting in which the four largest metallurgical coal exporting firms compete against each other as Stackelberg leaders, while the remainders act as Cournot followers. Second, a setting with BHPB acting as sole Stackelberg leader.

http://dx.doi.org/10.1016/j.eneco.2016.07.007
0140-9883/

REPUBLIC OF TURKEY

INTENDED NATIONALLY DETERMINED CONTRIBUTION

In accordance with decisions 1/CP.19 and 1/CP.20, the Republic of Turkey hereby presents its Intended Nationally Determined Contribution (INDC) towards achieving the ultimate objective of the United Nations Framework Convention on Climate Change which is set out in its Article 2 and clarifying information.

National Circumstances

Turkey achieved 230 per cent increase in GDP between 1990 and 2012. Its population has increased more than 30 per cent since 1990. Turkey's energy demand increases by 6-7 percent every year.

Turkey is an upper-middle income developing country according to the World Bank classification. Turkey remains eligible to official development assistance (ODA).

Turkey is listed in Annex I to the UNFCCC. However, Decision 1/CP.16 recognized the special circumstances of Turkey and placed Turkey in a different situation than the other Parties included in Annex I.

Turkey aims to contribute to the collective efforts to combat climate change in line with its national circumstances and capabilities.

With this perspective, National Strategy on Climate Change and National Climate Change Action Plan were adopted in 2010 and 2011 respectively.

National Climate Change Action Plan consists of emission control and adaptation policies and measures which are being implemented in all relevant sectors.

The greenhouse gas inventory of the year 2012 revealed that the total emissions in 2012 expressed in CO_2 equivalent were 440 million tons in Turkey. The energy sector had the largest share with 70.2 percent. Industrial processes with 14.3 percent, waste sector with 8.2 percent and agriculture with 7.3 percent followed the energy sector. Turkey's per capita greenhouse gas (GHG) emission for the same year was 5.9 ton CO_2 equivalent, which is much lower than the EU and OECD average.

Information on INDC

INDC	**Up to 21 percent reduction in GHG emissions from the Business as Usual (BAU) level by 2030.**
Period for Implementation or Contribution	2021-2030
Scope and Coverage	Economy-wide. Energy, industrial processes and products use, agriculture, land use land-use change and forestry, and waste sectors.
GHGs	All greenhouse gases included in the national inventory: • Carbon dioxide (CO2); • Methane (CH4); • Nitrous oxide (N2O); • Hydrofluorocarbons (HFCs); • Perfluorocarbons (PFCs); • Sulfur hexafluoride (SF6); • Nitrous trifluoride (NF3).
Methodological approaches	Methodological approaches are based on using the IPCC 2006 Guidelines and IPCC 2013 KP Supplement. Global warming potential on a 100 year timescale in accordance with the IPCC's 4th Assessment Report.
Use of International Market Mechanisms	Turkey aims to use carbon credits from international market mechanisms to achieve its 2030 mitigation target in a cost effective manner and in accordance with the relevant rules and standards.
Consideration of fairness and ambition based on national conditions	Turkey has to continue its sustainable development process. Rapid industrialization and urbanization have been taking place in Turkey over the last 30 years. Turkey is responsible for only 0.7 percent of the global emissions since the industrial revolution. Energy imports have a significant share in Turkey's account deficit. Turkey has to use its limited energy resources. Turkey experiences financial and technological constraints in combating climate change. This INDC provides additional policies, plans and measures in many sectors.
How the INDC contributes to achieving the ultimate objective of the Convention (Article 2)	Up to 21 percent reduction in GHG emissions from the BAU level by 2030 will enable Turkey to step on low-carbon development pathways compatible with the long-term objective of limiting the increase in global temperature below 2°C.

Planning Process	**Turkey may revise this INDC in accordance with changing circumstances.** Turkey supports its INDC through a national climate change policy which includes; - 10th National Development Plan - National Strategy on Climate Change - National Climate Change Action Plan - National Strategy on Industry - Strategy on Energy Efficiency - National Strategy and Action Plan on Recycling - National Legislation on Monitoring, Reporting and Verification of GHG emissions - National Smart Transportation Systems Strategy Document (2014-2023) and its Action Plan (2014-2016) Turkey's INDC was prepared in a participatory approach through multiple stakeholder meetings and by analytical studies conducted for 1 year. Times-MACRO model is used for energy related modeling and other national models and studies are used for non-energy sectors.
Financial Needs	Recalling the decisions 26/CP.7, 1/CP.16, 2/CP.17, 1/CP.18 and 21/CP.20, in view of successfully implementing this INDC, Turkey will use domestic sources and receive international financial, technological, technical and capacity building support, including finance from the Green Climate Fund.

<u>Plans and policies to be implemented for this INDC</u>

Energy

- Increasing capacity of production of electricity from solar power to 10 GW until 2030
- Increasing capacity of production of electricity from wind power to 16 GW until 2030
- Tapping the full hydroelectric potential
- Commissioning of a nuclear power plant until 2030
- Reducing electricity transmission and distribution losses to 15 percent at 2030
- Rehabilitation of public electricity generation power plants
- Establishment of micro-generation, co-generation systems and production on site at electricity production

Industry

- Reducing emission intensity with the implementation of National Strategy and Action Plan on Energy Efficiency
- Increasing energy efficiency in industrial installations and providing financial support to energy efficiency projects
- Making studies to increase use of waste as an alternative fuel at the appropriate sectors

Transport

- Ensuring balanced utilization of transport modes in freight and passenger transport by reducing the share of road transport and increasing the share of maritime and rail transport
- Enhancing combined transport
- Implementing sustainable transport approaches in urban areas
- Promoting alternative fuels and clean vehicles
- Reducing fuel consumption and emissions of road transport with National Intelligent Transport Systems Strategy Document (2014-2023) and its Action Plan (2014-2016)
- Realizing high speed railway projects
- Increasing urban railway systems
- Achieving fuel savings by tunnel projects
- Scraping of old vehicles from traffic
- Implementing green port and green airport projects to ensure energy efficiency
- Implementing special consumption tax exemptions for maritime transport

Buildings and Urban Transformation

- Constructing new residential buildings and service buildings as energy efficient in accordance with the Energy Performance of Buildings Regulations
- Creating Energy Performance Certificates for new and existing buildings so as to control energy consumption and greenhouse gas emissions and to reduce energy consumption per square meter
- Reducing the consumption of primary energy sources of new and existing buildings by means of design, technological equipment, building materials, development of channels that promote the use of renewable energy sources (loans, tax reduction, etc.)
- Dissemination of Green Building, passive energy, zero-energy house design in order to minimize the energy demand and to ensure local production of energy

Agriculture

- Fuel savings by land consolidation in agricultural areas
- Rehabilitation of grazing lands
- Controlling the use of fertilizers and implementing modern agricultural practices
- Supporting the minimum tillage methods

Waste

- Sending solid wastes to managed landfill sites
- Reuse, recycle and use of other processes to recover secondary raw materials, to utilize as energy source or to remove wastes
- Recovering energy from waste by using processes such as material recycling of wastes, bio-drying, bio-methanization, composting, advanced thermal processes or incineration
- Recovery of methane gas from landfill gas from managed and unmanaged landfill sites
- Utilization of industrial wastes as an alternative raw material or alternative fuel in other industrial sectors, through industrial symbiosis approach
- Conducting relevant studies to utilize wastes generated from breeding farms and poultry farms
- Rehabilitation of unmanaged waste sites and ensuring wastes to be deposited at managed landfill sites.

Forestry

- Increasing sink areas and preventing land degradation
- Implementing Action Plan on Forestry Rehabilitation and National Afforestation Campaign

The emission reductions to be achieved by these policies and plans compared to the business-as-usual scenario are presented in the figure below.