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Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Submission on the Proposed Canterbury Air Regional Plan

Form 5: Submissions on a Publicly Notified Proposed Policy Statement or Regional Plan under Clause 6 of Schedule 1 of the Resource Management Act 1991

Return your signed submission by 5.00pm, Friday 1 May 2015 to:

Freepost 1201
Proposed Canterbury Air Regional Plan.
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Trade Competition

Pursuant to Schedule 1 of the Resource Management Act 1991, a person who could gain an advantage in trade competition through the submission may make a submission only if directly affected by an effect of the proposed policy statement or plan that:

a) adversely affects the environment; and
b) does not relate to trade competition or the effects of trade competition.

Please tick the sentence that applies to you:

☑ I could not gain an advantage in trade competition through this submission; or

☐ I could gain an advantage in trade competition through this submission. ***If you have ticked this box please select one of the following:***

- ☐ I am directly affected by an effect of the subject matter of the submission
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Date:

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Please note:
(1) all information contained in a submission under the Resource Management Act 1991, including names and addresses for service, becomes public information.

B	**I do wish to be heard in support of my submission;** and if so, I would be prepared to consider presenting your submission in a joint case with others making a similar submission at any hearing

C (1) The specific provisions of the proposal that my submission relates to are: *(Specify page number and subsection numbering for each separate provision).*	(2) My submission is that: *(State concisely whether you support or oppose each separate provision being submitted on, or wish to have amendments made and the reasons for your views.)*	(3) I seek the following decisions from Environment Canterbury: *(Please give precise details for each provision. The more specific you can be the easier it will be for the Council to understand your concerns.)*
All of the proposal, as detailed in the attached document entitled "Straterra Submission".	Please see attached document entitled "Straterra Submission".	Please see attached document entitled "Straterra Submission", in particular the section entitled "Relief Sought".

Add further pages as required

SUBMISSION

STRATERRA™
NATURAL RESOURCES OF NEW ZEALAND

Submission to ENVIRONMENT CANTERBURY on

"PROPOSED CANTERBURY AIR REGIONAL PLAN" (APRIL 2015)

INTRODUCTION

1. Straterra[1] welcomes the opportunity to submit on the "proposed Canterbury Air Regional Plan" (also referred to in this submission as the pCARP or the "air plan"). The deadline of 1 May 2015 is noted.

2. In preparing this submission, Straterra has consulted extensively with industry, in particular, Bathurst Resources, Fonterra, Greenwood Roche Chisnall, Synlait, Taylor Coal, as well as diverse members of the coal sector in Canterbury, including industrial coal users, and engineering consultants.

3. Straterra commissioned a report from CRL Energy to better understand the impacts on coal-related industries of the pCARP, attached as Appendix 1.

4. Straterra supports the submissions lodged by Fonterra, Synlait and Bathurst Resources, and on the latter, supports the arguments made in relation to the management of $PM_{2.5}$ discharges.

5. Industrial coal users in Canterbury range from large dairy factories, meat processors and fertiliser manufacture, to smaller leather processing operations and the like, to heaters of commercial premises such as hospitals, education institutions, the Burnham military camp; to commercial greenhouses. Coal is so used because it is much cheaper than electricity or diesel as a source of industrial process heat. In Canterbury, coal is supplied from a range of producers in the Southland, with the value chain including blending, transport, storage, handling, and efficient use in boilers.

6. Straterra submits from the point of view that RMA plans need to be fair, reasonable and fit for purpose in providing for the sustainable management of natural resources, including air quality. The pCARP falls short of this aim. We look forward to constructive engagement with Environment Canterbury, within the planning process, to achieve desirable and workable outcomes in the final plan.

[1] Straterra is the industry body representing NZ minerals production, exploration, research, services, and support http://www.straterra.co.nz/about/

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EXECUTIVE SUMMARY

Impacts on industry

7. Industrial coal users in Canterbury are extremely concerned over the possible impacts on them of the proposed Canterbury Air Regional Plan. Billions of dollars of investment could be destroyed or not realised, and hundreds of jobs in the region could be lost or not created, as a result of the new plan provisions.

8. For the industries that survive, the costs of complying with the air plan have not been quantified adequately by ECan in its section 32 analysis. In our analysis (refer to the CRL report in Appendix 1), the costs of compliance are likely to be significant, and in many cases prohibitive, as one would expect. That could be mitigated to an extent with adequate transition times, e.g., five years.

Proposed plan is not fit for purpose

9. In some places, PM_{10} discharges may be reduced as a result of actions by industries, as part of meeting air plan objectives. An example is the Washdyke area, where industry is by far the dominant cause of PM_{10} pollution, noting that few exceedances occur, and that these are spread through the year.

10. But in most other Clean Air Zones in Canterbury, air plan Objectives will not be achieved because the regulatory focus is on industry contributions which are relatively insignificant, insofar as Canterbury's air quality is concerned. ECan's policy approach is inappropriate to addressing Canterbury's complex set of air quality issues, and the costs to society of industrial contraction and opportunities foregone will far outweigh any benefits to society, probably by orders of magnitude.

Legacy reverse sensitivity

11. It is the case that residential development (more sensitive activities) has occurred, and is occurring near established industrial sites in areas where previously there were no sensitive activities, or very few. Such industries will be required to bear the costs of extra compliance to meet these changed expectations around amenity, arising from events over which these industries have no influence or control. That is, district and city councils have approved land-use changes, or have not appropriately controlled land-use change through policy provisions in their respective planning documents. That approach is unfair and unreasonable, and does not recognise the investment made by industries to establish and operate their activity, nor the costs or practicability of having to move if they are unable to "reduce" their effects.

12. Where legacy reverse sensitivity issues occur, the relevant councils should bear the responsibility for decisions that have led to economically-inefficient and undesirable outcomes.

Section 32 report

13. We highlight concerns with the section 32 report, which in our view contains errors of omission, and errors in logic. In summary, the costs to industry, and especially those associated with moving to a new site, are underestimated, and no credible arguments have been advanced in favour of the proposed blunt-instrument approach to Policies and Rules.

Conclusion

14. In general, ECan has adopted a blunt-instrument approach to air quality Policies and Rules, despite extensive prior engagement with industry on the concerns raised in this submission.

15. Straterra contends that the logical policy response is a set of solutions tailored to the set of air quality issues that exist in Canterbury, in the wider context of the socio-economic wellbeing of the Canterbury region. We propose a list of principles (para. 56 of this submission) by which a new set of Policies and Rules should be developed.

RECOMMENDATIONS

16. Straterra recommends Environment Canterbury to:

a) Note Straterra's view that the policy approach to the proposed Canterbury Air Regional Plan (air plan) is inappropriate, and will not achieve sustainable management;

b) Note Straterra's view that the air plan will likely lead to the loss of billions of dollars of investment and hundreds of jobs, and/or investment and job opportunities foregone;

c) Note Straterra's concern that ECan has made plan proposals with little or no knowledge of the impacts on businesses in Canterbury;

d) Agree to adopt the report produced by CRL (Appendix 1), which concludes that many boiler operators in Canterbury would need to adopt new technologies or innovation to meet the new requirements of the air plan, and that the cost of doing so will likely be prohibitive in the majority of cases;

e) Agree that Canterbury presents a set of air quality issues, requiring a sophisticated approach to solutions;

f) Agree that there is no one-size-fits-all approach for resolving Canterbury's complex air quality issues;

g) Agree that a focus on industry will achieve few or no benefits for people's health and wellbeing, while likely imposing significant costs on businesses, in Clean Air Zones where home heating dominates PM_{10} discharges;

h) Note that industrial users of coal are constrained in changing to another fuel because the unit energy cost of coal is half that of diesel, and one-third that of electricity;

i) Agree that **Rule 7.3** on offensive or objectionable odour occurring beyond a property boundary should be reclassified from being a non-complying to a discretionary activity, to provide for discussion on whether or not people's health and wellbeing are affected;

j) Note Straterra's support for **Rule 7.28**, which provides for a level of odour beyond the boundary of a property subject to the exercise of discretion on a range of matters;

k) Note Straterra's support for new development proposals to be located in areas other than sensitive areas (within non-polluted airsheds);

l) Note Straterra's support, in principle, for new entrants into a Clean Air Zone having to offset others' discharges of PM_{10}, except in Washdyke where the focus should be on the efficiency of industries;

m) Agree that existing industrial operators, in situations of legacy reverse sensitivity, should not have to bear the additional costs of managing PM_{10} discharges in response to events that are beyond their control or influence;

n) Agree that city and district councils, who decide changes in land-use, should bear the responsibility for the adverse consequences to existing businesses of later encroachment by sensitive activities, by paying for additional costs incurred by those industries;

o) Agree that the air plan fails to give effect to the **Canterbury RPS** because it fails to distinguish between effects on ambient air quality and localised effects on air quality in their management, and, on that basis, note Straterra's view that ECan is in breach of **section 67 (3) (c)** of the RMA;

p) Agree to extend the period for lodging resource consents, for those businesses that currently do not need a resource consent, to five years from the air plan becoming "operative", for businesses to be able to adopt new technologies and innovation cost-effectively, noting that such relief may still fail to prevent a number of industries from closing;

q) Agree to provide clarity on the interaction between **Rules 7.14** and **7.18**, to avoid confusion or unintended consequences, and to provide more clearly for offsets where appropriate;

r) Note Straterra's qualified support for the requirements in **Rules 7.27** and **7.31 (12)** for industrial users of solid fuel to apply for a resource consent for the use of solid fuel as an input (i) everywhere for more than 1MW combined heat output, and (ii) greater than 40kW combined heat output in those CAZs where industry contributes at least 20% of total PM_{10} emissions.

s) Note Straterra's view that little or no evidence has been provided in the section 32 report as to the likely impacts of the air plan on industries in Canterbury, and its view that ECan is in breach of its legal obligations under **section 32** of the RMA;

t) Agree to withdraw the section 32 report as inadequate; and

u) Agree that principles should be developed as the first step to developing fair, reasonable and fit for purpose proposals for Policies and Rules in the air plan (para. 56 of this submission).

DISCUSSION

Problem definition

17. The proposed Canterbury Air Regional Plan states that industry "contributes a significant proportion" of contaminants into air (page 1-3). That is incorrect.

18. ECan's evidence is that the contribution of industry to PM_{10} discharges is highly variable across Canterbury. Referring to the section 32 report, pages 3-3 to 3-5 (S32: 3-3 – 3-5), the contribution of industry and home heating to PM_{10} emissions is listed for the Clean Air Zones:

- Geraldine – 2% v. 92%
- Waimate – 5% v. 92%
- Timaru - 5% v. 88%
- Kaiapoi – 7% v. 88%
- Ashburton – 9% v. 82%
- Christchurch – 23% v. 57%
- Rangiora – 27% v. 69%
- Washdyke (industrial zone of Timaru) – 89% v. 7%

19. The fact is that Canterbury faces a set of air quality problems, not a single air quality problem. This is a complex problem, requiring a sophisticated approach to solutions (refer to paras. 52-56 of this submission).

Blunt-instrument approach to a complex problem

20. ECan has opted for a blunt-instrument approach to a complex problem, despite the contention: "The main source of PM_{10} in Washdyke is industrial discharges, while for all other airsheds the main source is domestic heating" (S32: 3-1).

21. ECan's approach provides a generous time frame for reducing home heating emissions of up to 19 years (S32: 3-7). In CAZs where home heating is the dominant contribution to PM_{10} discharges, that approach will not achieve air plan Objectives, and the costs of implementing the air plan, from industry contraction and investment opportunities foregone, will greatly outweigh the benefits.

22. It is wrong to apply the same policy framework (pages 6.1 and 6.2) across Canterbury because the problem definition is not the same across Canterbury, and because the distribution within society of costs and benefits arising from the air plan will fall unevenly, inefficiently, and unfairly to industries, with a knock-on effect on residents in loss of jobs and increased costs of goods and services. Overall, air plan Objectives will not be achieved.

Costs

23. As a general comment, ECan has failed to properly quantify the costs to industries of meeting air plan requirements, and does not know which businesses will be able to meet those costs, and which will not.

Cleaner technology and innovation

24. To ensure that industrial activities can take place, within limits imposed under the National Environmental Standards for Air Quality, "the air plan must provide rules that enable them" (page 1-3, Rules 7.14 – 7.18). But the drive to "cleaner technology" and innovation (page 1-7, and S32: 4-22, 4-23, 4-39) has not been costed, and could lead to business closures. That is the opposite of enabling.

25. Going into more detail, ECan estimates that 21 boilers may need to upgrade their technology within CAZs, and ECan does not know how many boilers are situated outside of those zones (S32: 4-42).

26. ECan does not know what mitigation levels will be needed to meet the new requirements, and does not know the costs to those businesses/operations (S32: 4-42). If the $63,000 upgrade figure is a reasonable estimate for each boiler of less than 1MW, that would be prohibitive for most smaller operators, if they cannot afford diesel or electric heating.

27. ECan's broader statement "the costs of avoiding or mitigating discharges that exceed guidelines will likely increase but it is unknown by how much" is of concern. It is irresponsible to introduce a plan that could impose significant costs on business without a proper understanding of the likely actual impacts.

28. Given the inadequacy of the section 32 report, Straterra commissioned from CRL a report entitled "Assessment of Impacts of Canterbury Proposed Air Plan on Coal Users and Cost Effectiveness of Technology Options" (attached as Appendix 1). We refer, in particular, to the conclusions on page 7 of that report. To summarise:

    - Many industries may be technically able to modify their use of coal to fall within the thresholds and meet resource consent requirements, however, at a significant cost;
    - Most smaller and medium-sized industrial users of coal would not be able to afford to apply this technology to their existing boilers, and would find themselves to be non-complying or prohibited activities. That also goes for hospitals, and educational and other institutions that use coal-fired boilers for heating. It may also be the case for some very large boiler operators, e.g., dairy, meat and other food processing. Potentially, billions of dollars of investment and hundreds of jobs are at stake.

Fuel

29. Industrial users of coal do so because the cost per unit of energy produced is half that of diesel and one-third that of electricity. In almost all cases of industrial coal use, there is no commercial alternative. Changing from coal to some other fuel is not feasible or practicable (cf. S32: 4-39).

Offsets

30. The statement, "there is provision for industry to offset their effects in polluted airsheds" (S32: 3-6, 4-39, Policy 6.22), applies as long as affected operators are not non-complying or prohibited activities, and subject to cost-effectiveness criteria. In many cases, it may not be feasible or practical to carry out offsets. In Washdyke, it may not be desirable (see also para 36). The interaction between Rules 7.14 and 7.18 needs to be made clearer.

Relocation

31. "The pCARP's policies and rules relating to industrial and large-scale burners encourage large scale and industrial dischargers to locate in appropriate areas away from residential or other sensitive areas" (S32: 4-39). Existing large-scale operations in areas that become sensitive

through inappropriate land-use planning may well close down (see below, re legacy reverse sensitivity).

32. It is not always logical for new activities to be located in areas that are not sensitive or polluted. That is because Canterbury could see a spreading of industry across the region in response to the air plan, instead of having industrial activities grouped at places, delivering overall better air quality in Canterbury. A more subtle approach is necessary.

Odour

33. Rule 7.3 covers odour, where occurring beyond the boundary of a property, being classified as a non-complying activity, or basically prohibited, if it is deemed to be "offensive or objectionable". That is a very strong requirement, in light of the subjective nature of odour, and in the case of industrial operations located in a non-polluted area with no near neighbours.

34. The complementary Rule is 7.28, which provides for a level of odour beyond the boundary of a property subject to the exercise of discretion on a range of matters. That is supported.

Reverse sensitivity

New development and sensitive areas

35. On page 1-7, the pCARP is to provide a framework so that "sensitive and discharging activities are protected from each other". That is supported in the case of new development proposals. These should be located in areas other than sensitive areas.

36. New entrants into a CAZ are required to offset someone else's air discharges to be able to gain resource consent for discharges to air of PM_{10}. That is supported, in principle, noting this may not be cost-effective for many businesses.

37. That said, the above would be an inappropriate approach to managing ambient PM_{10} levels in Washdyke where the industry contribution is dominant, and where an incremental improvement in boiler technology efficiency, and management of discharges may be more effective, as well as economically efficient.

Legacy reverse sensitivity

38. Consider the case of residential subdivision occurring near a long-established and operating industrial site that had hitherto had no near-neighbour issues. To require the operator to "reduce effects or relocate" (Policy 6.7, S32: 4-9, 4-12, 4-15) may not be cost-effective in that situation, and the business could close. ECan has not considered this possibility.

39. Straterra contends the industry's existing-use rights should be safeguarded as a matter of natural justice. It is unfair and unreasonable to require the affected industry to bear costs in response to events that are beyond its control or influence. That presents investors with sovereign risk.

40. With the Regional Policy Statement 2013 providing direction to councils to "avoid encroachment of new development on existing activities discharging to air where the new development is sensitive to those discharges" (refer to Appendix 2), arguably, the legacy issue is one that

councils could have done something about but did not. That is an argument for sheeting home responsibility for legacy reverse sensitivity issues to councils. Councils, who decide changes in land-use, should pay for the adverse consequences of their own decisions.

Process

41. We are aware of extensive engagement that ECan staff have had with some industries over a considerable period of time before the plan was notified, including on the concerns raised in this submission. Those concerns have been largely ignored. Considering the potential implications for Canterbury businesses of the air plan, that is disappointing.

42. We are aware of many Canterbury businesses who do not understand what the implications to them of the air plan will be. That is a concern.

Legal matters

Regional Policy Statement 2013

43. We disagree with the statement that "the air plan gives effect to" the Canterbury RPS (page 1-6). Whereas the RPS recognises the difference between ambient air quality, and localised effects on air quality (RPS Objectives 14.2.1 and 14.2.2), the air plan fails to distinguish between these effects. It applies its approach to ambient air quality to localised effects, e.g., "the pCARP prevents industrial discharges from exceeding ambient air quality guidelines beyond property boundaries so as to avoid the creation of new polluted airsheds" (S32: 3-8). Therefore, ECan is in breach of section 67 (3) (c) of the RMA.

Entry into force of the air plan

44. In the air plan, all rules "have immediate legal effect" from 28 February 2015 (page 3-2). Where an activity will require a resource consent once the air plan becomes "operative", the activity may continue from that date if "consent has been applied for within six months after the date the rule in the plan became operative". We recommend extending that to five years to improve the chances of industries being able to comply with the air plan, and avoid closure.

Resource consents for coal users

45. The combination of Rules 7.27 and 7.31 (12) means that every industrial user of coal will need to apply for a resource consent for the use of coal as an input. It is understood that this would be administratively convenient for ECan, as well as providing certainty to operators. That is supported with qualifications. Industrial users of solid fuel should be able to apply for a resource consent for the use of solid fuel as an input (i) everywhere for more than 1MW combined heat output, and (ii) greater than 40kW combined heat output in those CAZs where industry contributes at least 20% of total PM_{10} emissions.

Section 32 report findings

46. Straterra contends that insufficient information has been provided in the section 32 report to uphold ECan's claim that "the overall rating of efficiency of the Central Polices is expected to be high" (S32: 4-24). We dispute the claim that "the central policies for managing discharges to air

are the most appropriate to achieve the objectives of the pCARP" (refer to sections above on problem definition, and blunt instrument approach to a complex problem).

47. We challenge the claim that "the policies and rules are … appropriate for managing industrial and large-scale discharges to air" (S32: 4-41). ECan cannot substantiate this claim when it does not know the cost implications for this sector (refer to section on costs), refer also to the CRL report (Appendix 1).

48. We dispute the claim that "there is no anticipated negative effect on economic growth or job opportunities as a result of these provisions in the pCARP" (S32: 4-43). ECan has provided little or no evidence in support of that claim (refer to section on costs). Straterra contends that the adverse economic effects of the pCARP could be huge in terms of businesses and jobs lost, and new and expanded business opportunities foregone.

49. Section 32 (1) (c) requires the council to have the detail in section 32 reports match the "scale and significance" of effects, in this case, on economic matters. ECan has not done this, and has produced a set of claims that ECan has not substantiated, and on that basis ECan is in breach of its obligations under section 32 (1) (c).

50. Section 32 (1) (b) (i) requires the council to identify "other reasonably practicable options for achieving the objectives". Arguably, Options 1 and 2 are not reasonably practicable. Rather, they are strawmen leaving Option 3 as the "last man standing", or the least-worst option, or the option the council preferred to begin with. That is an inappropriate approach to implementing section 32 (1) (b) (i), and we have found this to be a general issue with section 32 reports in New Zealand.

51. On the basis of the foregoing, the section 32 report should be withdrawn as inadequate.

Proposed way forward

52. Given the problem definition provided above, the appropriate policy response is to develop a set of solutions aimed at resolving a set of problems or issues.

53. The issues to address within Clean Air Zones and polluted airsheds are summarised as:

- In the Geraldine CAZ, industry contributes to 2% of PM_{10} discharges, and home heating contributes 92%. If industrial growth is to be provided and enabled in this CAZ, a careful approach must be taken to avoid industry closures. Even if industries do achieve emissions reductions, at significant cost to them, there will be little positive impact on overall air quality. The same consideration applies to most airsheds.
- The notable exception is Washdyke, near Timaru, which is industry-dominated, and has fewer particulate exceedances per year than other CAZs or airsheds.
- In the case of Rangiora and Christchurch, both industry and home heating make significant contributions and must be addressed, and continue to be addressed.

54. Outside of the CAZs and polluted airsheds, emission controls are appropriate, however, they need not be as strict as within the CAZs, and a distinction should be made between industrial

sites with no near-neighbour issues, and sites where there are near-neighbour issues, or likely to be in the future.

55. Principles should be developed against which the effectiveness of policy proposals can be measured. We propose the following for consideration by, and discussion with ECan:

- Rules to be tailored to the issues arising in each spatial category;
- Within a spatial category – three different types of CAZ, plus non-CAZ with no sensitivity issues, and non-CAZ with sensitivity issues – Rules to target the greatest gains in emissions reductions for greatest cost-effectiveness, including on the issue of odour;
- Different approaches to be taken to managing ambient air quality, and localised effects on air quality;
- Responsibility for legacy issues, e.g., legacy reverse sensitivity, is a public good (or liability); and
- Adequate transition periods to be provided to industry in cases where the cost-effectiveness of upgrading technology to meet new air plan requirements is identified as an issue, on the basis of adequate information.

56. Straterra is not in a position at this stage to propose an alternative set of Polices and Rules to enable Canterbury to achieve air plan Objectives in a way that is fair and reasonable to all parties, and fit for purpose. We would welcome engagement with ECan towards developing a workable air plan, in the context of the planning process.

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1 Executive Summary

1. The aim of this study was to survey a wide range of users to assess numbers of small, medium and large coal boilers, inside and outside current Clean Air Zones (CAZ) and what options the small and medium operators have for individual emissions reduction.

2. Several rural boiler operators contacted could not see the point of resource consents in rural areas that are unpolluted. Some took great pride in keeping their emission plumes free of visible smoke for the sake of their reputation among their neighbours. One grower said that implementation of the proposal would likely mean the loss of 20 jobs from his business and other businesses also hinted closure was a likely consequence of high compliance costs.

3. Almost all coal boiler sites in the >1MW category currently have resource consents so the main impact is that they would in future be assessed on the criterion that the PM_{10} concentration of their exhaust gas plume does not exceed 2.5 micrograms per standard cubic metre at the property boundary. Ecan has not provided any estimates of how many boilers that comply with the current flue gas criterion (for 250 mg/m³ total suspended particulate) may be non-complying according to this new measure.

4. 45 of the 85 coal boiler sites covered in this study are in the proposed CAZs. If the operators were applying for resource consents under the new Rule 7.14 and if the PM_{10} concentration of their flue gas plume likely exceeds 2.5 micrograms per standard cubic metre at the property boundary, the activity would be classified **restricted discretionary if the operator offset 100% of their emissions** by paying for emission reductions elsewhere in the airshed.

5. Under new Rule 7.15, any of those 45 coal boiler sites in the proposed CAZs that can not meet a 250mg PM_{10} per standard cubic metre flue gas concentration would be classified as **non-complying activities**. (Note this is not the key criterion but it is less stringent than the usual current 250mg total suspended particulate criterion because PM_{10} is typically only 50-80% of TSP.)

6. For applications under new Rule 7.16, any of the 40 coal boiler sites outside the proposed CAZs that cannot meet a 250mg PM_{10} per standard cubic metre flue gas concentration would be classified as **discretionary activities**.

7. For applications under new Rule 7.17, any of the 40 coal boiler sites outside the proposed CAZs established prior to 28 February 2015 that likely exceed 2.5 micrograms PM_{10} per standard cubic metre at the property boundary would be classified as **non-complying activities**. (Compliance with this criterion may be unrealistically expensive for smaller coal boilers on properties that have a boundary close to the chimney stack.)

8. The intention appears to be that for applications under new Rule 7.18 (although poorly drafted), any of the 45 coal boiler sites inside the proposed CAZs established prior to 28 February 2015 and any new boiler site (inside or outside a CAZ) that likely exceed 2.5 micrograms PM_{10} per standard cubic metre at the property boundary would be classified as a **prohibited activity**. (If this proceeds, it is likely to act as a major barrier to future investment in coal or non-pellet wood boilers even in rural Canterbury.)

9. If Ecan's estimated consenting cost of $15,000 per boiler and mitigation cost of $63,000 for an older coal boiler are realistic, the theoretical cost for 42 sites that may require consents could be over $3 million. In practice, it is likely that less than one quarter of them could afford the required compliance and upgrading costs. Some businesses would close while most of the businesses and the schools would have to shift to other heating sources if they could absorb the higher energy costs.

10. From discussions with a range of industry experts and application of overseas studies, we assess the following costs for achieving various emission levels of total suspended particulate.

11. 200-300 mg/m³ is expected to be achieved for a modern multicyclone on a typical industrial boiler. This is the simplest particulate emission control option and the least expensive at around $40,000 for a 1MW boiler. For small boilers, conventional high efficiency cyclones can provide similar performance for similar cost.

12. 100-150 mg/m³ is expected to be achieved for a wet scrubber, considered the option best capable of performing to this level but at a cost of about $75,000-$100,000 for a 1MW boiler. Collection efficiency decreases with decreasing particulate matter size and scrubber type.

13. < 20 mg/m³ can be achieved for a bag filter. However, test results are highly variable depending on the boilers' coal feed systems, the coal properties and on the operation of the boiler. 50 mg/m³ would represent more typical operation for bag filters at an approximate cost of $100,000 for a 1MW boiler.

14. An Oxygen Trim system determines the amount of oxygen and then positions the air damper or fan to maintain greater efficiency, which in turn would reduce particulate emissions. The cost would be $12,000-$15,000, which is still prohibitive for smaller boilers.

15. Tuning boilers on a regular basis saves costs and can reduce boiler emissions. On average, EECA finds that every dollar spent on tuning returns up to $30 in energy savings. A 1MW non-modulating solid fuel fired boiler will take a day to tune with the use of a flue gas analyser and particulate emissions testing costing up to $3,000. Alternatively, a 6MW modulating solid fuel fired boiler requiring a boiler tuning characterization may take up to a week and cost $8,000-$10,000.

16. Several minor boiler modifications can improve boiler efficiency and therefore can save costs as well as potentially reducing particulate emissions. These include installing a cyclone to the boiler flue, fitting a suction fan to the unit with a multicyclone grit arrestor and fitting a rotary valve to the bottom of the grit arrestor hopper so that the ash is fed back into the boiler.

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Assessment of Impacts of Canterbury Proposed Air Plan on Coal Users and Cost Effectiveness of Technology Options

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2 Introduction

Environment Canterbury has publicly notified its Proposed Air Plan and submission hearings will be held over several months. Their Cost Benefit Analysis (s32) report attempts to justify increasing the stringency of requirements for 21 smaller boilers in 6 regional towns and for an unknown number of boilers in unpolluted areas. There is no direct indication of how officials will implement Best Practicable Option for boiler technology when existing air discharge consents come up for renewal or when new installations are considered. They accept that the industrial/commercial sector is responsible for only 23% of PM_{10} emissions in Christchurch, but the precautionary approach of controlling such emissions in unpolluted areas to ensure they stay unpolluted seems unnecessarily harsh.

The prime purpose of this report is to provide an independent assessment of the impacts of the Proposed Plan on a range of coal users and the costs of measures to meet new stringent control measures on smaller boilers. This may demonstrate that those costs are unjustifiable compared with the costs that need to be borne by households to achieve major overall PM_{10} reduction in polluted airsheds. Existing consent holders are likely to be more concerned about new assessment criteria for compliance under the Proposed Plan.

A secondary purpose is to enable industrial/commercial coal users to compare the current operation of their plant with the currently accepted best practice and make an approximate assessment of the cost effectiveness to improve performance and emissions from the various retrofit technology options.

3 Survey of Coal Users

The aim of this survey is to contact Ecan officials, coal suppliers and a wide range of users to assess numbers of small, medium and large coal boilers (inside and outside current Clean Air Zones) and what options the small and medium operators have for individual emissions reduction.

Assistance was sought from Ecan staff to help identify boiler operators they know would be captured by the proposed new Air Plan rules. No reply was received so this study is inevitably limited in its scope. Based on CRL Energy's boiler database and with the help of coal suppliers, several coal users were phoned to assess numbers of small, medium and large coal boilers (inside and outside current Clean Air Zones) and what options the small and medium operators have for individual emissions reduction.

Many respondents were suspicious of how the information would be used until they were assured that information and comments would be kept confidential and only summarised information and anonymous comments would be published in this report.

Several rural boiler operators contacted could not see the point of resource consents in rural areas that are unpolluted (and some expressed anger at the ability of Ecan to demand these costs to be spent for no gain). Some took great pride in keeping their emission plumes free of visible smoke for the sake of their reputation among their neighbours.

One grower reported that because of tight margins in the market he is in, the costs of applying for a resource consent and potentially being required to reduce emissions in a rural area would almost certainly close his business with the loss of about 20 full-time jobs. Others hinted at the likelihood of closure (with the loss of all their past investment) if they had to face high compliance costs. Some growers on the outskirts of Christchurch could see that increasing pressure from air quality issues related to houses being built close to their properties would eventually drive them out of business.

A rural accommodation provider considered the new requirement would be absurd and unfair. If the Ecan estimate of $15,000 consenting costs for a small boiler are correct, that would represent more than 10 times the annual cost of the coal they use to get through the extremes of winter. Such costs (or the costs of changing the heating system to an equally secure supply) could not be justified so they would continue to operate their boiler cleanly and hope that Ecan applies common sense to rural coal users.

A few schools had been informed there is a new Proposed Plan that is likely to affect their operation of a coal boiler. A number of school caretakers did not know if they had resource consents and a few did not know what they were. An administration staff member of one small school argued they should not need one for their semi-rural coal boiler but a search of Ecan's consents showed they already had one. Another school in one of the town Clean Air Zones had costed alternatives for their coal boiler. While the Ministry of Education generally funds the capital cost of such changes separately, the much higher ongoing energy costs for electricity or wood pellets would inevitably mean less available funds for the school's direct spending on the children's education.

This limited snapshot of numbers of coal users likely to be impacted by the proposed Air Plan should be considered as the low end of an uncertain range because there are bound to be several more that have not been identified in this study.

Table 1: Numbers of sites with coal boilers likely to be impacted by the proposed Air Plan

	>1MW capacity*	**≤1MW capacity**	**Of which the following have no current consent**
Christchurch CAZ	20	14	4
Rangiora CAZ	1	2	2
Kaiapoi CAZ	0	0	0
Ashburton CAZ	1	1	1
Timaru CAZ	7	6	6
Geraldine CAZ	0	1	1
Waimate CAZ	0	2	2
Outside CAZs	19	21	26
TOTAL	48	47	42

* Almost all boilers in this category currently have resource consents so the main impact is that they would in future be assessed on the criterion that the PM_{10} concentration of their exhaust gas plume does not exceed 2.5 micrograms per standard cubic metre at the property boundary. Ecan has not provided any estimates of how many boilers that comply with the current flue gas criterion (for total suspended particulate) may be non-complying according to this new measure.

The conclusions from this part of the study are therefore:

1. 45 of the 85 coal boiler sites covered in this study are in the proposed CAZs. If the operators were applying for resource consents under the new Rule 7.14 and if the PM_{10} concentration of their flue gas plume likely exceeds 2.5 micrograms per standard cubic metre at the property boundary, the activity would be classified **restricted discretionary if the operator offset 100% of their emissions** by paying for emission reductions elsewhere in the airshed.

2. Under new Rule 7.15, any of those 45 coal boiler sites in the proposed CAZs that cannot meet a 250mg PM_{10} per standard cubic metre flue gas concentration would be classified as **non-complying activities**. (Note this is not the key criterion but it is less stringent than the usual current 250mg total suspended particulate criterion because PM_{10} is typically only 50-80% of TSP.)

3. For applications under new Rule 7.16, any of the 40 coal boiler sites outside the proposed CAZs that cannot meet a 250mg PM_{10} per standard cubic metre flue gas concentration would be classified as **discretionary activities**.

4. For applications under new Rule 7.17, any of the 40 coal boiler sites outside the proposed CAZs established prior to 28 February 2015 that likely exceed 2.5 micrograms PM_{10} per standard cubic metre at the property boundary would be classified as **non-complying activities**. (Compliance with this criterion may be unrealistically expensive for smaller coal boilers on properties that have a boundary close to the chimney stack.)

5. The intention appears to be that for applications under new Rule 7.18 (although poorly drafted), any of the 45 coal boiler sites inside the proposed CAZs established prior to 28 February 2015 and any new boiler site (inside or outside a CAZ) that likely exceed 2.5 micrograms PM_{10} per standard cubic metre at the property boundary would be classified as a **prohibited activity**. (If this proceeds, it is likely to act as a major barrier to future investment in coal or non-pellet wood boilers even in rural Canterbury.)

6. If Ecan's estimated consenting cost of $15,000 per boiler and mitigation cost of $63,000 for an older coal boiler are realistic, the theoretical cost for 42 sites that may require consents could be over $3 million. In practice, it is likely that less than one quarter of them could afford the required compliance and upgrading costs. Some businesses would close while most of the businesses and the schools would have to shift to other heating sources if they could absorb the higher energy costs.

4 Technologies for Particulate Emission Capture

Emission levels are primarily influenced by the type of firing system used to burn the fuel. Three of the most commonly encountered systems in New Zealand are spreader (or sprinkler) stokers, chain grates and Vekos boilers.

With chain grate stokers, coal is fed onto a travelling or vibrating grate and burns on the fuel bed as it travels through the furnace. Ash particles fall into an ash pit at the rear of the grate. Coal is fed onto the moving grate where the firing rate is regulated by altering the height of an adjustable gate and/or the speed at which the fuel moves along the grate. Chain grates generally have relatively low inherent emissions and can tolerate high fines content fuel without loss of combustion efficiency although most operators prefer a graded product for minimum emissions. In New Zealand chain grate stoker installation firing capacity is generally greater than 1MW as the complex construction of the plants makes them unsuited for smaller scale operation.

In the spreader systems, the coal is dropped on to a flipper mechanism, which sprinkles the fuel on top of the fire bed that sits on the grate. The purpose of the grate is to remove ash automatically from the combustion chamber, rather than to control the firing rate.

In a Vekos boiler the coal is dropped from the top of the combustion chamber onto a cone, and air is supplied from beneath this cone. Both the Vekos and spreader systems have the common feature that a large proportion of the fuel (up to 50%) burns in suspension before ever reaching the grate. Because of this, particulate carryover is usually high, but they are well suited to burning varying quality coals, with good load following capability. Vekos boilers are usually confined to smaller scale (<5MW) plant.

This section provides a review of various particulate emission reduction methods. For the industrial boilers the most common particulate removal devices are cyclones, multi-cyclones, wet scrubbers or bag filters. Each of these technologies is explored in the following sections.

4.1 Cyclones and Multicyclones

A cyclone removes particulates entrained within the flue gas based on the difference in density between the gases and particulates. Particulate laden gases enter the funnel shaped cyclone through a tangentially mounted duct in the upper portion of the vessel, (Figure 1). The velocity of the gases entering the cyclone causes the gases to spin, throwing the heavier particles to the outside wall of the vessel. The heavier particles slide down the walls and exit the cyclone through an airlock device in the base (usually a rotary valve or slide valve). The gas, separated from the particulate content, leaves the cyclone through a duct in the top centre of the vessel.

To efficiently separate the particulates, it is critical for the cyclone to ensure adequate spin velocities within the vessel. By bundling a number of small diameter cyclones together in parallel, the velocities can be kept high with improved separation efficiency being the result. This is termed a multi-cyclone. Cyclones also introduce a restriction to the flow of flue gases, which limits the degree of separation that can be achieved – higher separation is achieved with higher spin.

Cyclones are a low maintenance method of reducing particulate emissions without requiring high pressure losses through the system. Their simple all-metal construction means they can run at temperatures of up to 300°C.

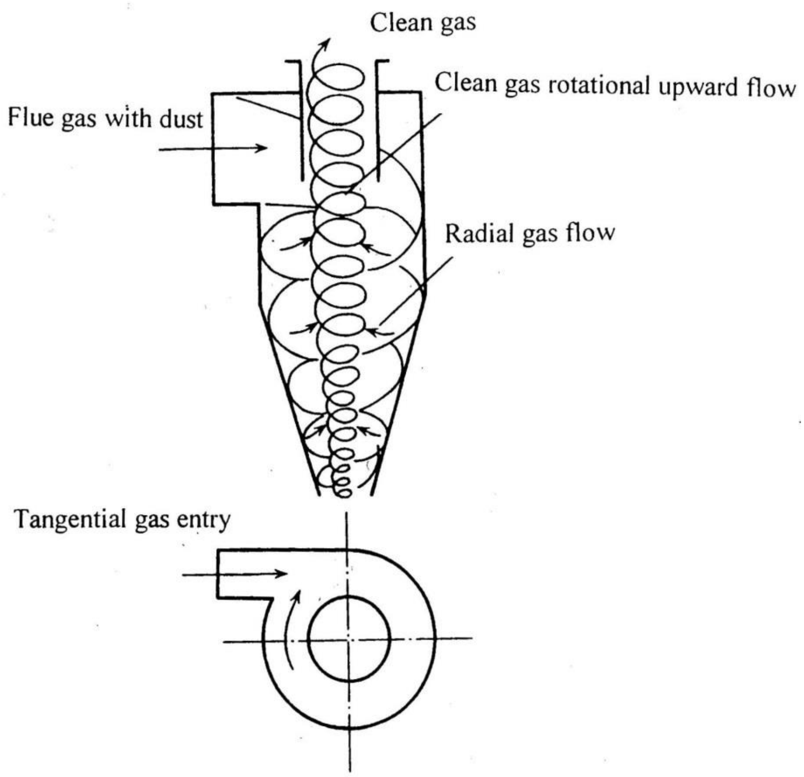

Figure 1: Schematic of the operation of a cyclone.

4.2 Wet Scrubber

Wet scrubbers remove particulates from gas streams by capturing them in liquid droplets that are sprayed across the gas stream then separating the droplets from the gas stream normally by using a cyclone separator. The range of particulate sizes that can be captured depends on the size of the liquid droplet. A smaller droplet size will capture finer particulates. Figure 2 provides a typical wet scrubber arrangement.

The capture efficiency from wet scrubbers is higher than that of a normal cyclone system – a function of the particulate possessing a higher density due to its wet state and therefore easier to separate.

Wet scrubbers can be used for all types of boiler without temperature limitation. With the addition of different chemicals to the spray water, the scrubber can capture other pollutants such as sulphur oxides in addition to the particulates. The cooling effect of the sprayed liquid can have the added benefit of reducing mercury emissions.

The particulate laden water from the wet scrubber must be treated before it can be discharged as trade waste. Normally water is recycled in the scrubber system and only a small portion (approximately 10%) is discharged. A potential problem for wet scrubber systems is the deposition of ash at the interface between the wet surface and dry surface (e.g. on the walls of the venturi and connecting pipework). This is particularly relevant when dealing with a very low unburnt carbon ash with high levels of calcium oxide - in this case the ash deposit can act like a cementing agent.

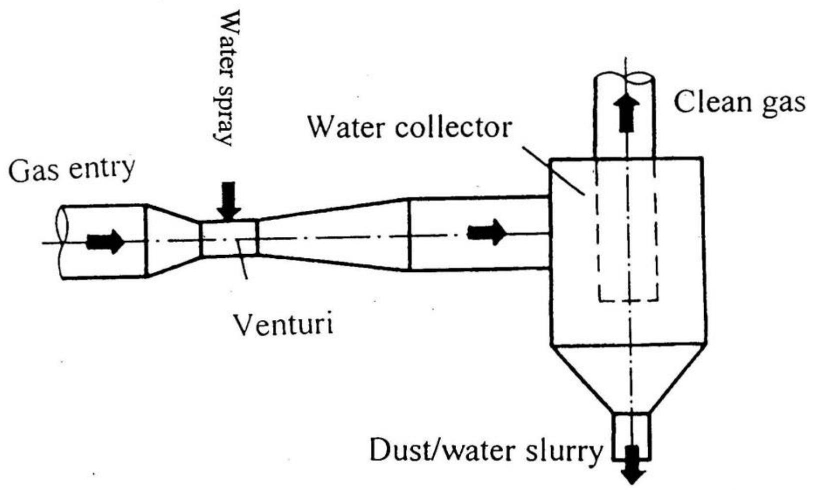

Figure 2: The Schematic of a Wet Scrubber.

Cost estimates for wet scrubbers provided in this report have been mainly based upon those of the US Environmental Protection Agency cost estimates[1].

A. Morrow of Morrow Engineering has suggested wet scrubbers may be useful for New Zealand boilers as they have been successful overseas, however there is some negative public perception on the use of the technology as it continuously generates steam emissions, often confused with smoke.

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[1] USEPA. (2002). *Air Pollution Control Cost Manual, Sixth Edition* (6th ed., Report no. EPA/452/B-02-001). Retrieved from www.epa.gov

4.3 Bag Filters Filtration

Bag filters (sometimes also referred to as baghouses) remove particulates by passing a gas stream through a porous media (normally a fabric). It is a more effective means of removing particulates from a flue gas stream than cyclones or wet scrubbers. The particulates form a "porous dust cake" on the surface of the fabric and it is this dust cake that does the actual filtration. The fabric is usually configured in the form of multiple cylindrical bags in parallel – "the baghouse". The number of bags is determined by the total flue gas volume and the bag permeability.

Particulate laden gas passes through the filter media from the outside and leaves the particulate matter behind on the outside surface of the bag. When the particulate build up has reached a design load on the filter's surface, a short pulse of air from inside the bag (causing a reverse flow across the bag filter) or mechanical shaking causes the particulate cake to fall off the filter media into a hopper at the base of the baghouse.

A schematic of one such system, the pulse-jet system, is provided in Figure 3. For this system, a blast of compressed air is suddenly injected into the interior of the filter bag, generating a sudden reverse flow through the filter media that dislodges the deposited particles of soot and dust so they fall to the base where they accumulate.

The key material in the baghouse filtration system is the filter media. The filter media has to withstand high temperature and corrosive gases. Commonly filter media for particulate control in boilers is nylon, polyethylene, polypropylene, Teflon and glass fibre. The working temperature for normal filter material is between 180º—240°C. Teflon and glass fabric can work at temperatures up to 280°C.

One of the significant downsides of the use of bag filter system is that there is an increased risk of fire via the fabric catching burning embers. This is why the presence of a cyclone upstream of the gas flow is of high importance as it substantially reduces this risk. The presence of cyclones can also reduce the caking of the fabric from particulates, allowing more efficient operation. Maintenance costs can also be high if regular replacement is necessary, although this can be reduced if suitable material is selected.

An alternative to the standard bag filters is a ceramic filter which has the added benefit of a higher collection efficiency, greater corrosion resistance and higher temperature capability. There is typically little experience with these systems in New Zealand however indicated prices from industry suggest their cost would be in the order of twice that of a standard bag filter.

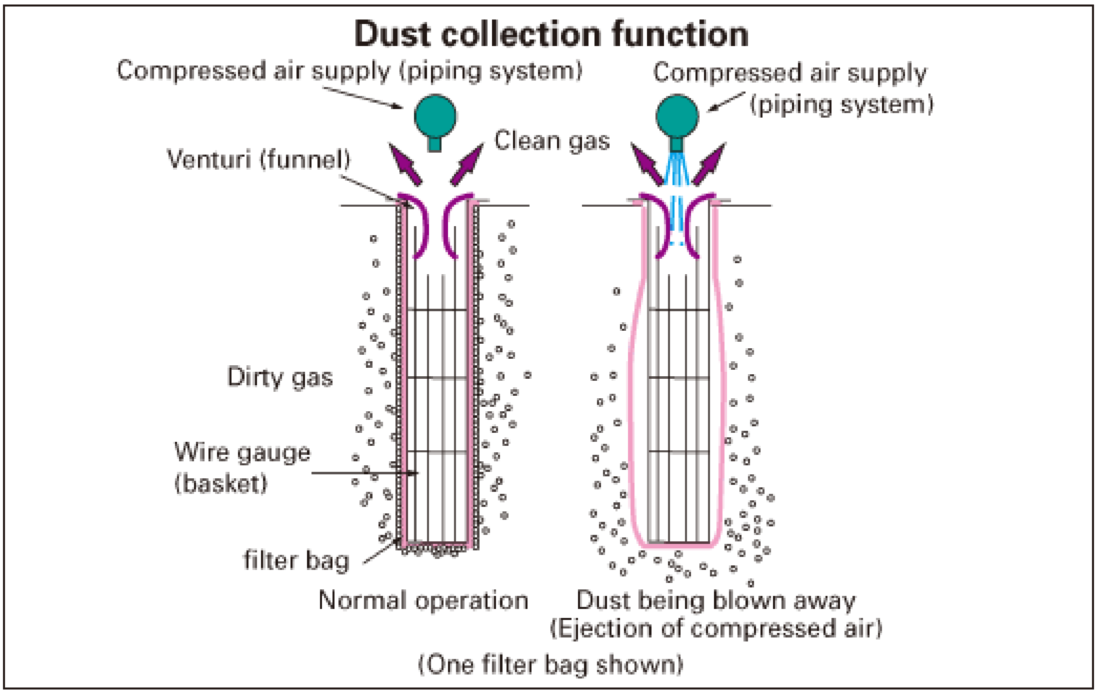

Figure 3: Schematic of a Pulse-Jet System.

4.4 Comparison of the Particulate Removal Devices

The efficiency of particulate removal for multicyclones, wet scrubbers and baghouses are listed in Table 2. The limitations on particulate sizes for these technologies are listed in Table 3.

Table 2: Particulate Collection Efficiency

	Multicyclone	Wet scrubber	Baghouse
Spreader stoker and Vekos	65—75%	80—99%	up to 99.7%
Chain grate stoker	80—85%	up to 99%	up to 99.7%
Underfeed stoker	80—85%	up to 99%	up to 99.7%

[2]

Table 3: Capture Efficiencies for Various Particulate Sizes

Emission Control Technology	**Minimum Particle Size (µm)**	**Collection Efficiency**
Separation chamber (generally used as a pre-separator)	>20	<50%
Cyclone (generally used as pre-separator)	5-25	50-90%
Multicyclone	5	80-95%[3]
Wet scrubbers		
Spray Tower	>10	<80%
Dynamic Tower	>2.5	<80%
Collision Scrubber	>2.5	<80%
Venturi Scrubber	>0.5	<99%
Bag filter	<1	95-99%+
Electrostatic precipitator	>0	>99%

In general, multicyclone systems are the simplest and have the lowest cost but also have the lowest collection efficiency. A more efficient option is a bag filter where the particulate emissions can be controlled to below 50 mg per standard cubic metre. Unfortunately the cost of installation and operation of a bag filter system is significantly higher than the cost of a multicyclone.

From the data in Table 2 it is clear that the bag filter system is the most efficient option for dust collection with a collection efficiency > 99% for some systems. However, CRL Energy has found the performance of different bag filter installations to be quite varied, especially those used on spreader stokers[4]. Of the particulate capture systems, multicyclones have the lowest efficiency ranging from 65-85%. The collection efficiency for wet scrubbers is in the range of 80-99% depending on the system configuration.

Table 4 lists these and provides further comparison between the three emissions control technologies.

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[2] Chriström, M., Jokiniemi, J., Hokkinen, J., Makkonen, P., and Tissari, J, (2006).Combating Particulate Emissions in Energy Generation and Industry, Finland, VTT Technical Research Centre of Finland.

[3] United States Environmental Protection Agency. (nd.). Air Pollution Control Technology Facts Sheet (Report no. EPA-452/F-03-005). Retrieved from www.epa.gov

[4] In spreader systems, the coal is dropped on to a flipper mechanism that spreads the fuel on top of the fire bed, which sits on the grate.

Table 4: Comparison of Cyclone, Wet Scrubber and Bag Filter Particulate Removal Systems

Advantages	Disadvantages
Cyclone or multicyclone • Low capital cost • Relative simplicity and few maintenance problems • Relatively low operating pressure drop (for the degree of particulate removal obtained) in the range of approximately 5–15cm water column • Temperature and pressure limitations imposed only by the materials of construction used • Dry collection and disposal • Relatively small space requirements	• Relatively low overall particulate collection efficiencies, especially for particulate sizes below 10µm • Inability to handle materials with high adhesive properties
Wet scrubbers • No secondary dust sources • Relatively small space requirement • Ability to collect gases, as well as particulates (especially ones with high adhesive properties) • Ability to handle high-temperature, high-humidity gas streams • Low capital cost (if wastewater treatment system is not required) • Insignificant pressure-drop concerns for processes where the gas stream is already at high pressure • High collection efficiency of fine particulates (albeit at the expense of pressure drop)	• Potential water disposal/effluent treatment problem • Corrosion problems (more severe than with dry systems) • Potentially objectionable steam plume opacity or droplet entrainment • Potentially high pressure drop—approximately 25cm water column and increased power requirements • Potential problem of solid build-up at the wet-dry interface • Relatively high maintenance costs
Filter systems (baghouses) • Very high collection efficiency (up to 99.7%for some systems) for both coarse and fine particulates • Relative insensitivity to gas stream fluctuations and large changes in inlet dust loadings (for continuously cleaned filters) • Recirculation of filter outlet air • Dry recovery of collected material for subsequent processing and disposal • No corrosion problems • Simple maintenance • Potentially flammable dust collection • High collection efficiency of submicron smoke and gaseous contaminants through the use of selected fibrous or granular filter aids • Various configurations and dimensions of filter collectors • Relatively simple operation	• Requirement of costly refractory mineral or metallic fabric at temperatures in excess of 290°C • Need for fabric treatment to remove collected dust and reduce seepage of certain dusts • Relatively high maintenance requirements • Explosion and fire hazard of certain concentrated dusts (~50 g/m^3) in the presence of accidental spark or flame, and fabric fire hazard in case of readily oxidisable dust collection • Shortened fabric life at elevated temperatures and in the presence of acid or alkaline particulate or gas constituents • Potential crusty caking or plugging of the fabric, or need for special additives due to hygroscopic materials, moisture condensation, or tarry adhesive components • Respiratory protection requirement for fabric replacement • Medium pressure drop requirements—typically in the range of 10–25cm in water column

4.5 Other Methods of Emissions Control

4.5.1 Electrostatic Precipitators

An electrostatic precipitator (ESP) is a method of particulate emission control where electric fields are used to separate particles from the gas stream, collecting these onto a plate and then removed.

The ESP has two sections, the charging and collecting areas. Firstly the particulate matter entrained within the flue gas passes by an ioniser that conveys a positive electric charge on the particulate matter. This now positively charged particulate is collected via a negatively charged plate on the collecting section. The particles are periodically removed from this plate via rapping, hammers or vibrators and collected in hoppers for removal. Typically an ESP is divided into several zones to increase removal efficiency.

Typically efficiencies of ESPs are more than 98% for PM_{10}, and almost as high for $PM_{2.5}$. Although fabric filters are the most efficient means of collecting overall particulate matter ESPs reduce the risk of fire and can cope with hot flue gases up to around 700ºC.

ESPs have some disadvantages including a high capital cost, susceptibility to fluctuations in flue gas conditions and possible explosion hazard (depending on conditions).

There is not currently an established market for ESP's in New Zealand. The few that have been installed are on larger boilers (e.g. Huntly Power Station). Note that indicated prices for these units have suggested they may be 2-3 times the capital cost of a fabric filter bag house. ESPs also require specialised servicing and maintenance due to the high voltage nature of the unit.

4.5.2 Oxygen Trim

The quantity of oxygen in the flue gas of a boiler indicates the degree of excess air present in the flue gas. The higher the boiler efficiency the lower the level of excess air present within the flue gas. An Oxygen Trim system determines the amount of oxygen and then positions the air damper or fan variable speed drive (VSD) to maintain the correct set point in this way greater efficiency is achieved, which in turn would reduce particulate emissions.

There has been a suggestion that such a system in New Zealand would cost in the order of $12,000 to $15,000, a cost which is prohibitive for smaller boilers. For similar (but cheaper) systems firing natural gas in Australia a payback period of 5.9 years has been estimated for a 0.5MW boiler, and 3 years for a 1MW boiler[5].

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[5] Sustainability Victoria. (2015). Combustion Trim for Boilers. Retrieved from www.swagelokenergy.com.

4.5.3 Boiler Tuning

Tuning boilers on a regular basis saves costs and can reduce boiler emissions. On average, every dollar spent on tuning returns up to $30 in energy savings. Many businesses have annual maintenance programmes but it is beneficial to tune boilers more often than once a year. Good boiler tuners will adjust the air to fuel ratio in the boiler to get maximum fuel efficiency, reducing particulate emissions and potentially deliver savings of up to 25% on boiler costs[6].

Typical boiler tuning costs vary depending on the boiler. For example, a 1MW non-modulating solid fuel fired boiler will take a day to tune with the use of a flue gas analyser and particulate emissions testing (generally recommended although not always required) and cost up to around $3,000. Alternatively, a 6MW modulating solid fuel fired boiler requiring a boiler tuning characterization may take up to a week and may cost around $8,000-$10,000.

4.5.4 Minor Modifications

Some minor boiler modifications have been suggested which could improve boiler efficiency, and therefore save costs as well as potentially reducing particulate emissions have been suggested. These include the following:

- Fitting a suction fan to the unit with a multicyclone grit arrestor.
- On the grit arrestor, fit a rotary valve to the bottom of the hopper and feed the ash back into the boiler.
- Fit a cyclone to the boiler flue.

4.6 Estimated Attainable Emission Reduction from Emission Control Technologies

Each particulate emission control device is estimated to achieve the following approximate particulate emission level after the use of the emission control technologies following discussions with industry:

1) 200-300 mg/m³ is expected to be achieved for a modern multicyclone on a typical industrial boiler but would struggle to achieve < 200 mg/m³. This is the simplest (and least expensive) particulate emission control option. For small boilers, conventional high efficiency cyclones can provide similar performance for similar cost.

[6] Energy Efficiency and Conservation Authority. (2015). Boiler tuning support, retrieved from www.eccabusiness.govt.nz

2) 100-150 mg/m³ is expected to be achieved for a scrubber (considered the option best capable of performing to this level). However collection efficiency decreases with decreasing particulate matter size and scrubber type.

3) < 20 mg/m³ can be achieved for a bag filter. However, test results are highly variable depending on the boilers' coal feed systems, the coal properties and on the operation of the boiler. However there is a suggestion that the figure of 10-20 mg/m³ is unusually good and 50 mg/m³ would represent more typical operation for bag filters[7].

4) < 10 mg/m³ can potentially be achieved from an ESP however costs can be prohibitive, particularly for smaller operations. Potential costs are available in Figure 5 for varying emission limits.

5) < 10 mg/m³ can also potentially be achieved from ceramic filters, but again costs may be prohibitive as they are considerably more expensive than baghouse technologies.

4.7 Typical Particulate Emission Control Equipment in New Zealand

A cyclone or multicyclone tends to be the choice for particulate separation for boilers above 1MW firing capacity in New Zealand. The operating condition of these varies considerably. As a general rule, the larger and newer the plant, the better performing its cyclone will be. Vekos boilers (in this class) use the standard, inbuilt cyclone for emissions control.

For plant below 1MW, emission control is usually not fitted and the emission level is mainly controlled by the level of excess air.

Particulate emission factors from various types of coal fired boilers using New Zealand coals have been developed from a review of monitoring tests by CRL Energy. These estimates have also taken into account factors published by overseas authorities, notably the USEPA. Where CRL Energy's review of test results differs from the theoretical potential, a compromise value has been offered, particularly for bag filters. Such compromise values are based on our experience with operating and testing boilers. Until a more extensive database of information on New Zealand emission factors is developed, it will be necessary to make such estimates in order to avoid biases introduced by using USEPA and other factors.

The resulting basic emission factors developed and used in this report are presented in Table 5.

Where monitoring data was available for some boiler sites, results (averaged over several years in some cases) were used to estimate emissions instead of general emission factors.

[7] D. Gong, personal communication, 2007.

Table 5: Total Suspended Particulate Emission Factors

Technology	kgTSP /tonne coal	mg/m³ *	PM_{10}
Chain grate with multicyclone	2.1	230	70%
Chain grate with wet scrubber #	1.4	150	80%
Chain grate with baghouse	0.4	50	90%
Spreader stoker with multicyclone	3.8	490	70%
Spreader stoker with wet scrubber #	1.2	150	80%
Spreader stoker with baghouse	0.4	50	90%
Vekos boiler - internal cyclone	6.7	750	60%
Vekos boiler with multicyclone	2.3	250	70%
Vekos boiler with wet scrubber #	1.4	150	80%
Underfeed stoker - no grit arrestor	5.0	550	50%
Underfeed stoker with multicyclone	1.9	200	70%
Underfeed stoker with wet scrubber #	1.4	150	80%

* Milligrams of TSP (total suspended particulate) per standard cubic metre (corrected to 12% CO_2)
# Wet scrubber estimates are very approximate because there are no test results to assess the performance for New Zealand coals

5 Emission Control Costs

The total installed cost (TIC) is the up-front (turn-key) cost which must be paid for installing any new system. TIC includes basic capital cost (control device plus ancillaries), installation cost, retrofitting costs, direct installation costs such as foundations, supports, electrical equipment, and indirect costs such as performance testing, contractor fees, and engineering.

New Plant

The derived equations for TIC of various particulate control systems for new plant were developed using the basic components of guidelines provided in the USEPA Air Pollution Control Cost Manual[8] adapted for the current New Zealand situation.

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[8] USEPA. (2002). *Air Pollution Control Cost Manual, Sixth Edition* (6th ed., Report no. EPA/452/B-02-001). Retrieved from www.epa.gov

Note the section on multicyclones had not been written but this work does contain the basic principles that have been used to develop the TIC equation. Cost curves from Damiano and Campbell 1997 were adjusted to be consistent with some real cost data for a multicyclone project.

The resulting curves of total installed cost against plant size are shown in Figure 4. Note there is considerable variation expected in cost and performance, the combination of which means the calculated TICs are usually expected to be within a range of ±30%. The variation may be even higher, depending on the individual site circumstances.

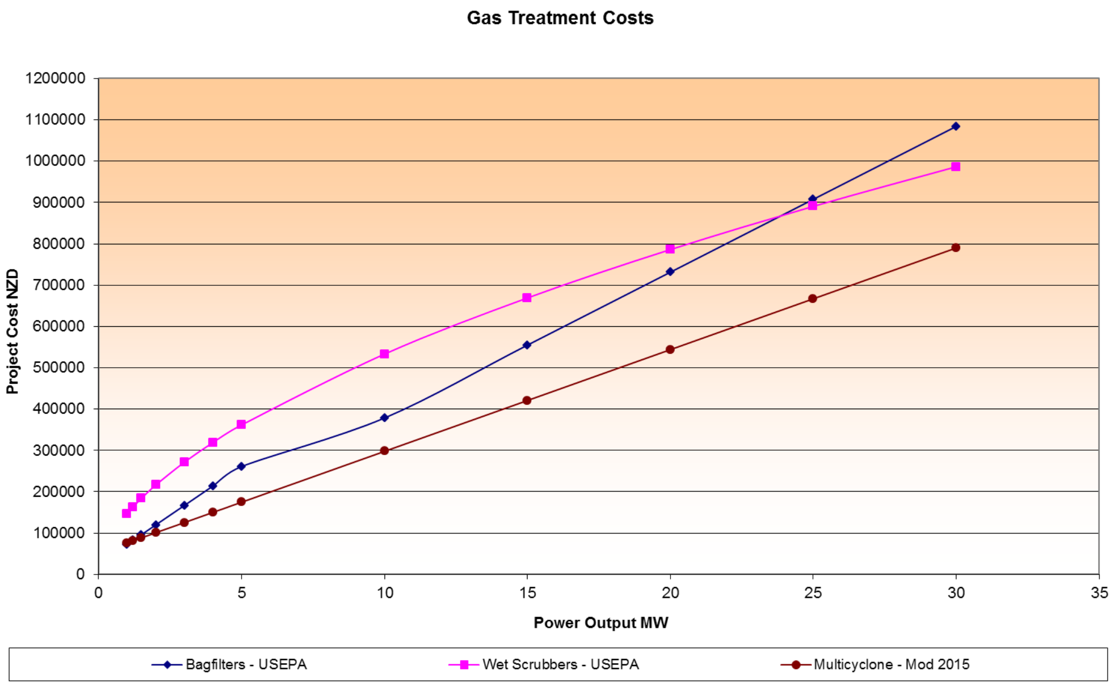

Figure 4: Total Installed Cost Curves for Particulate Emissions Control Equipment

Note – Costs for individual sites may vary by ±30%.

These curves were derived from the following equations where $\mathbf{P}_{cap}$ is the rated capacity of the installation:

Damiano, L. F., and Campbell, R. B., (1997). *Costs to Industry of Complying with Particulate Emission Standards for Solid Fuel Combustion*, (CRL Report 97-11243), Lower Hutt, New Zealand: CRL Energy Ltd.

Wet scrubber total installed cost:

$$TIC_{Wet\,Scrubber} = 120 \times \ln\left(\frac{P_{Cap}}{2}\right) + 12.5 \times P_{Cap} + \frac{38}{P_{Cap}} + 14.6 \text{ (k\$)}$$

Baghouse total installed cost:

$$\begin{array}{ll} For\ P_{Cap} \leq 5MW & TIC_{Baghouse} = 39.8 \times P_{Cap} + 21.9 \\ & \qquad\qquad\qquad\qquad\qquad\qquad \text{(k\$)} \\ For\ P_{Cap} > 5MW & TIC_{Baghouse} = 29.9 \times P_{Cap} + 21.9 \end{array}$$

Note that the total installed costs above include a retrofit factor of 1.2, and include all extra equipment such as fans, pumps, pipework, filter media, and electrical work, plus the indirect costs suggested to be used in the USEPA guide.

Multicyclone total installed cost:

$$TIC_{Multicyclone} = 20.8 \times P_{Cap} + 43.8 \text{ (k\$)}$$

Retrofit Factors:

The expressions describing the cost curves above are for new installations and do not include an allowance for retrofitting an existing installation (usually expected to be higher cost than a new installation). Specific information may be known about the site suggesting the level of difficulty likely to be encountered. The following multipliers have been used across the three emissions control systems considered:

- Straightforward conversion: multiplier = 1.20
- Moderate difficulty conversion: multiplier = 1.35
- Very difficult conversion: multiplier = 1.50

Indicated New Zealand Industry costs:

From several discussions with those in the boiler manufacturing and servicing industry in the Canterbury region an estimation of the total installed costs of the emission control technologies analysed was approximated to form the following diagram in Figure 5.

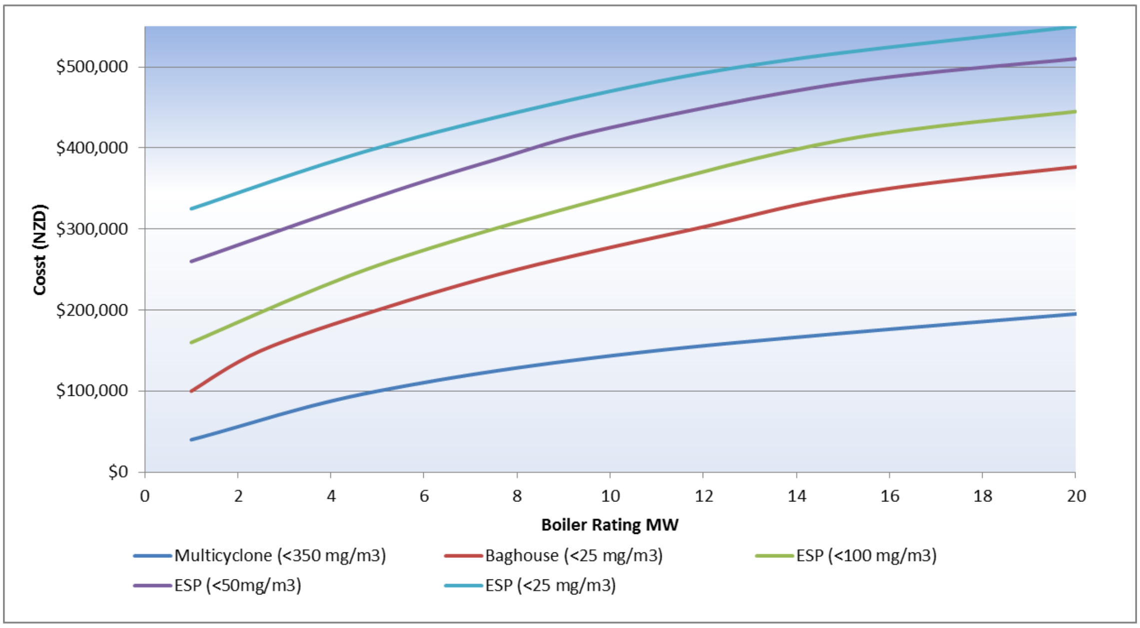

Figure 5: Estimated costs from New Zealand Industry, variation of a diagram supplied by industry.

Rough indicated costs for a 1MW solid fuel fired boiler emission control technology, provided by New Zealand industry is as follows:

- Wet Scrubber - $75,000-$100,000
- Cyclone - $30,000
- Multicyclone - $40,000
- Electrostatic Precipitator – >$250,000+, although generally not considered as too expensive
- Baghouse - $100,000
- Ceramic filters - $150,000 - $250,000

All costs are supplied as "ball park figures" only. There has been no allowance for costs such as civil, permits, testing, electrical etc.

There is some indication of possible reductions in the future cost of baghouses due to cheaper options (~$50,000) from Chinese imports however, these new systems are yet to be trialled in New Zealand so cannot be confirmed.

6 Acknowledgements

The authors are grateful to the numerous coal users who participated in the survey and to the following boiler manufacturing and servicing providers for providing information for this report.

- Morrow Engineering
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- Scotts Engineering
- Lyttelton Engineering
- Fogarty Industries
- ComMec
- Windsor Engineering

Appendix A – Conclusions from Report to Coal Association on Particulate and PM_{10} Emissions from Industrial Coal Combustion in New Zealand[9]

- The total emission levels measured by the PM_{10} cascade impactor at seventeen representative coal burning industrial sites in New Zealand are between 90 and 110% of the values obtained by the ASTM standard method. The agreement holds across a wide range of values from 100 to 600 mg/dsm^3 (dry standard cubic metres) and no bias is seen.

- The PM_{10} emission factors as measured by the PM_{10} cascade impactor at these sites ranged from 48 to 86%. The mean emission factor value for Vekos and sprinkler stoker systems was close to the 65% suggested by USEPA data. The emission factor for chain grate systems (69%) was somewhat greater than the 55% value presented in USEPA data.

- The mean particulate emission for the selected chain grate sites was 256 mg/dsm^3 with a mean PM_{10}% of 69% giving a mean PM_{10} emission level of 176 mg/dsm^3.

- The mean particulate emission for the selected sprinkler stoker sites was 245 mg/dsm^3 with a mean PM_{10}% of 70% and a mean PM_{10} emission level of 172 mg/dsm^3.

- The mean particulate emission for the selected Vekos sites was 468 mg/dsm^3 with a mean PM_{10}% of 61% and a mean PM_{10} emission level of 285 mg/dsm^3.

- The more efficient the grit arrestor, as judged by total particulate levels, the more likely that percentage PM_{10} will increase.

- The influence of increasing fines content on PM_{10} is masked by other factors such as efficiency of grit arrestor, load demand and other site specific parameters. In the one instance where the main variable was fines content an appreciable and almost corresponding variation in PM_{10} emissions was observed.

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[9] Hennessy, W. and Gong, D. (2005). *Review of particulate emissions from industrial coal combustion in New Zealand*. (Report No. 05-11025). Lower Hutt, New Zealand: CRL Energy Ltd