Lignite versus Wood-Fired Industrial Air Contaminant Emissions

Commercial and Industrial Biomass Energy Symposium

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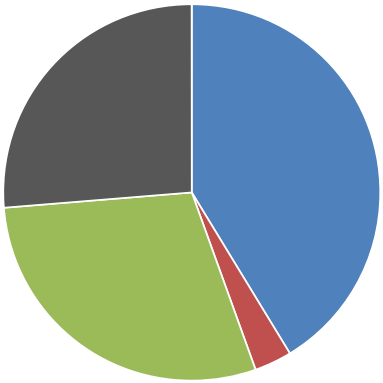
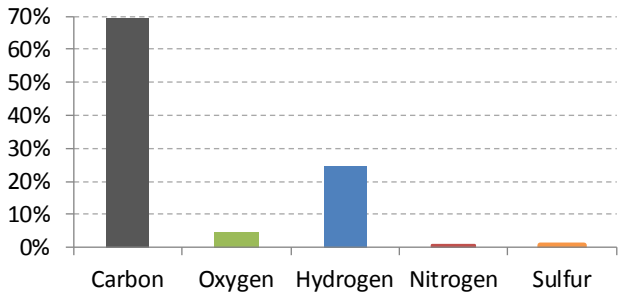
Golder Associates

Coal vs Wood composition

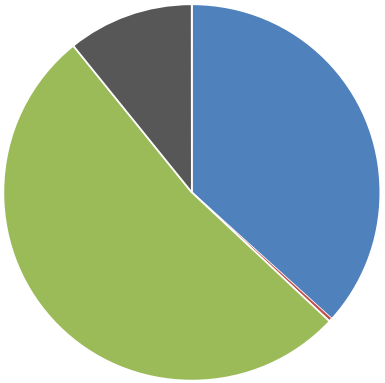
Lignite

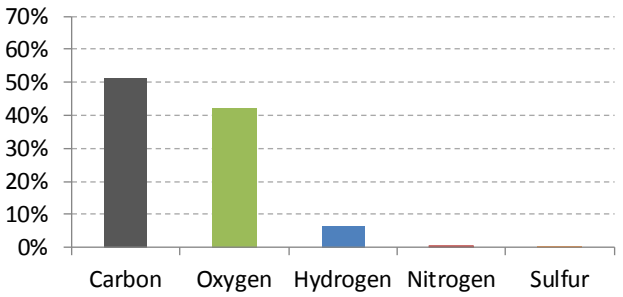




Total moisture
Ash
Volatile matter
Fixed carbon

Wood offcuts/ chips





Evolving Environmental Drivers

Status Quo

Future

?

Let's consider the following:

- Climate Change – CO_2 / CH_4
- Mercury Convention
- $PM_{2.5}$ Health Effects
- Other pollutants - SO_2, NO_x, Dioxins

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Minamata Convention on Mercury (Hg)

- NZ signed in 2013 and looks set to ratify
- Could require new (5 years from enactment) **Hg** emissions using

  "best available techniques & environmental practices"
- Threshold MW criteria to be set to capture 75% of national **Hg** emission from NZ coal-fired boilers and power plants.
- Standard techniques include flue-gas injection of activated carbon & bag-house filter systems ($5 to >$10 million for medium to large coal-fired plant)
- National Interest Analysis concluded there would be a low risk to existing NZ coal-fired plant, but the Conventional articles don't make that clear.

Minamata Convention on Mercury (Hg)

Lignite has about **9** x 10^{-3} mg Hg/MJ

Pine has about **1.5** x 10^{-3} mg Hg/MJ

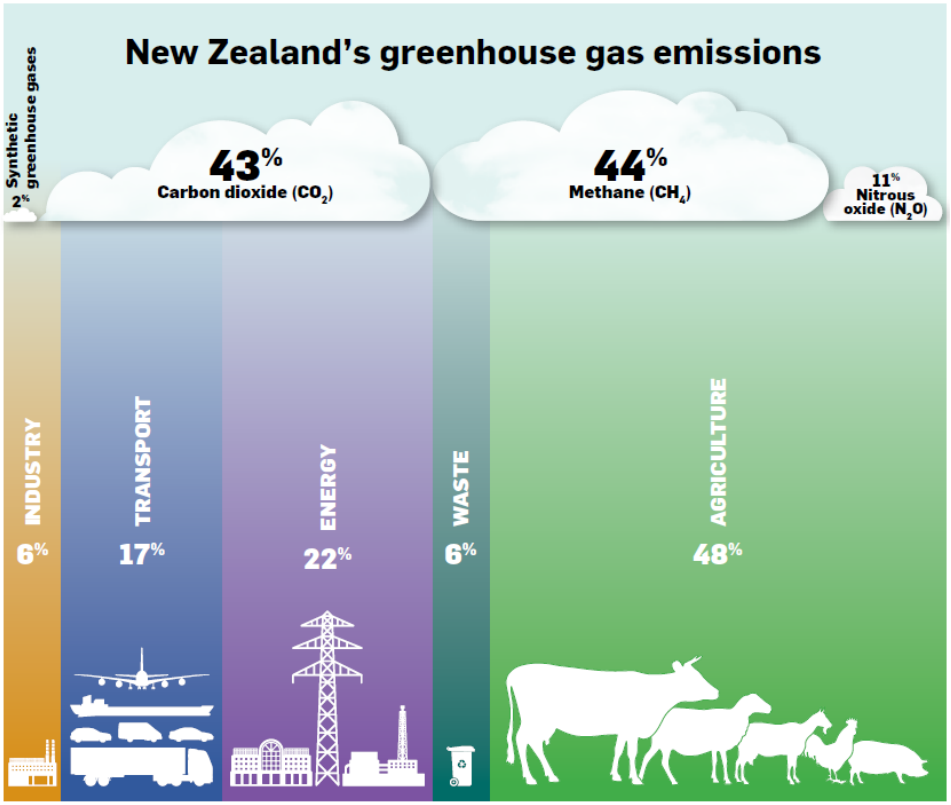
Climate Change

- Currently there are no strong economic or regulatory drivers to convert from coal to wood in large scale energy plant
- UN Conference in Paris later this year – last attempt to set legally binding agreements
- MfE released a discussion document in May 2015 to seek views on New Zealand's post-2020 contribution.
- G7 making strong noises

  And gestures:


press.co.nz
World
Lifetime alone
Coming out of solitary after 40 years
WORLD B3
Off to Leicester
Mauger in final countdown at Crusaders
SPORT B20
THE PRESS, Wednesday, June 10, 2015
B1
GERMANY
says farewell to carbon fuels

Sector Contributions to NZ's GHGs



Source: New Zealand's Greenhouse Gas Inventory for the year 2013. Emissions from forestry are not included in the estimate of total emissions. Percentages may not add up to 100 due to rounding.

Some potential issues with green wood:

Use of fossil fuels to low energy intensity fuel

Poor combustion conditions – **methane production**

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Fine Respirable Particulate ($PM_{2.5}$)

- **Significant drivers for new regulations on ambient $PM_{2.5}$ and emissions**

  Parliamentary Commissioner for the Environment Report (March, 2015). Compelling health effects science (World Health Organisation, 2013). Australia and other countries developing $PM_{2.5}$ standards. Auckland and Canterbury regions proposing guidelines/standards.

- **$PM_{2.5}$ and sub-micron PM are the most significant cause of short and long term mortality and morbidity in people**

- **Implications for industrial energy plant**

  Need for **Specialty Bag-House Filters** and/or **Electrostatic Precipitators** etc. or other **EOP** treatment systems **(\$\$\$ expensive**) to install and operate.

Changing from Coal to Wood

- **Changing to wood "potentially" provides an alternative to installing EOP**
  - Not according to published emission factors (US EPA AP-42)
  - However these data are very unreliable and mainly relate to **filterable PM**
  - New stack test **EPA Method 201(a)** http://www.epa.gov/ttnemc01/methods/comments201a202.pdf measures **filterable** and **condensable** PM fractions.

- **Potential benefits of converting to wood**
  - Consistent chipped wood size and associated VOCs can produce a relatively clean exhaust that is amenable to heat recovery
  - This indicates lower exhaust levels of **condensables** and therefore **$PM_{2.5}$**

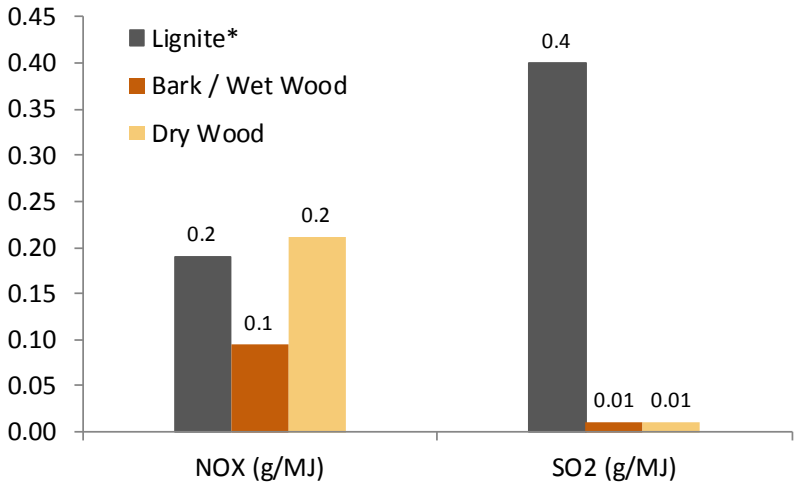
- **Generation of emission data sets using EPA Method 201(a) is necessary to confirm true benefits of wood in terms of reduced $PM_{2.5}$.**

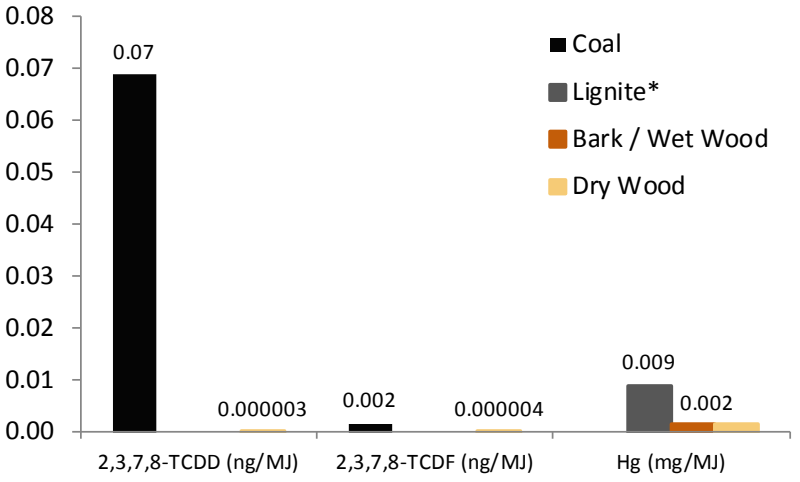
US EPA Emission Factors
Lignite vs Wood Fired Plant

Pollutant	Control	Emission Factors ($g_{pollutant}/MJ_{fuel}$)			
		Lignite coal*	Bark/Bark and Wet Wood	Dry Wood	Wet Wood
PM_{10}	No control	0.15 - **0.22**	**0.21**	0.15	**0.12**
	Multiclone	**0.06 - 0.09**	**0.14**	0.12	**0.09**
$PM_{2.5}$	No control	**0.05 - 0.06**	**0.18**	0.13	0.11
	Multiclone	**0.03 - 0.04**	**0.08**	0.07	0.05
Condensable PM (<1 micron)	All PM controls	0.01 - 0.02	**0.01**	**0.01**	**0.01**

* Considering lignite coal with average heating value of 14.5 MJ/kg and ash content of 3.6 % wt (as received basis).
† Boilers constructed before 1971.
‡ Boilers constructed after 1978.

US EPA Emission Factors
Lignite vs Wood Fired Plant





*Note: Considering lignite coal with average heating value of 14.5 MJ/kg and sulfur content of 0.5 %wt (as received basis).

Concluding comments

- Current environmental/regulatory drivers don't appear to off-set high costs of biomass supply/conversions for large energy plants
- A combination of future environmental drivers including international commitments could change the balance significantly over the next 10 to 20 years (a lot depends on the 2015 UNFCCC meeting in Paris)
- Improved economics of supply and realisation of significant heat recovery opportunities is likely to be necessary to see a significant shift from coal to wood use in large industrial plants in the medium term
- Mixed lignite/wood firing options could become a viable option for meeting any new GHG emission reduction targets along with new energy efficiency initiatives.

References

- http://www.coalassociation.org/publications/miscellaneous/Analysis%20Update%202010.pdf
- Ralph E. H. Sims, 2002. *The Brilliance of Bioenergy: In Business and in Practice*, p. 43.
- http://www.mercuryconvention.org/
- http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s07.pdf (Lignite)
- http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s06.pdf (Wood)
- http://www.epa.gov/ttnchie1/le/dioxin.pdf (Dioxins and Furans)
- http://www.mfe.govt.nz/publications/climate-change/new-zealands-climate-change-target-our-contribution-new-international
- https://www.climatechange.govt.nz/emissions-trading-scheme/
- http://www.pce.parliament.nz/assets/Uploads/The-state-of-air-quality-in-New-Zealand-web5.pdf
- http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/2013/review-of-evidence-on-health-aspects-of-air-pollution-revihaap-project-final-technical-report

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