NSW GOVERNMENT | Department of Primary Industries

NSW Primary Industries

Climate Change Research Strategy

Energy

Carbon Opportunities

Climate Resilience

Is it feasible to use biomass in NSW for grid-scale electricity generation?

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Outline

- Background
- Feedstocks
- Feasibility –Bayswater
- Feasibility – Mt Piper
- Conclusions

Bioenergy – climate role

> "*Bioenergy use is substantial in 1.5°C pathways […] due to its multiple roles in decarbonizing energy use*
>
> IPCC, 2018 Special Report on Global Warming of 1.5 ºC - Chapter 2

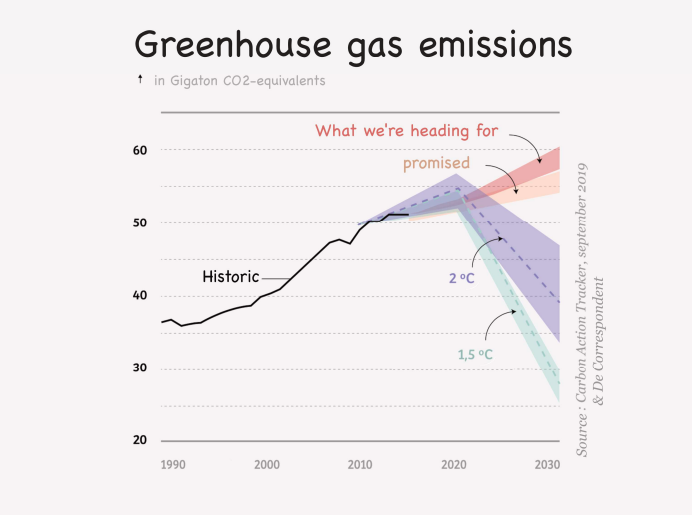
IPCC global primary energy supply of 1.5°C pathways from the scenario

database (combined values for the two key pathways):

Biomass as share of total primary energy: 26.4%

Biomass as share of total renewables: 43.4%

NSW - 0% net emissions target by 2050



Biomass for Bioenergy

Use of existing residues and new energy crops for medium / large scale electricity generation in NSW

Objectives

- Testing of energy crops (productivity – tonnes/ha)
- Techno-economic assessment potential of biomass for electricity generation ($/kWh)
- Techno-economic assessment of hybrid solar-biomass concepts (Regional hot spots)
- Contribution to emissions reduction (tCO_2-e/kWh)
- Social perceptions towards bioenergy

Rationale

- Gradual transition from coal - need for cost-effective, reliable, dispatchable power
- Existing coal-fired power stations – co-generation with biomass, no new capital investment
- Opportunity to produce pellets locally
- Biomass processing facility near where power is generated - unique in the world. Circular economy opportunities; extraction of green chemicals.
- Job creation in the establishment and running of biomass processing plant and related industries

Approach for techno-economic assessments

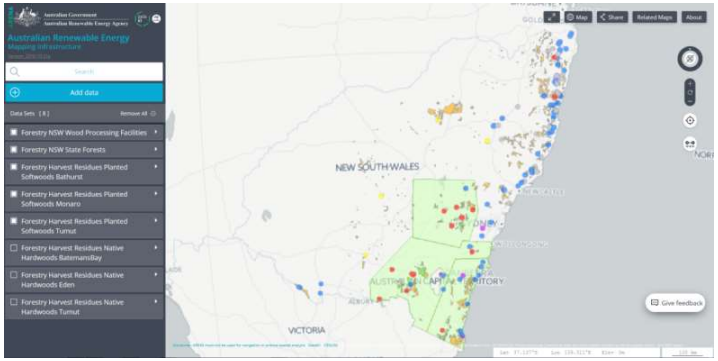
- Available feedstock (existing forestry residues)
- Distance to processing facilities
- Collection and transport costs
- Processing (2 options):
    - Network of pellet factories close to the resource
    - Centralised biomass processing facility close to the power station
- Biomass handling
- Biomass processing (pelletising or wood flour)
- Electricity output; CO_2 savings; cost of generation

Feedstocks

ABBA (Australian Biomass for Bioenergy Assessment)

https://nationalmap.gov.au/renewables/

* Biomass availability from all organic sources

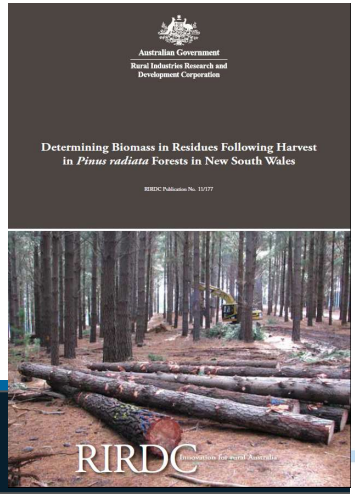


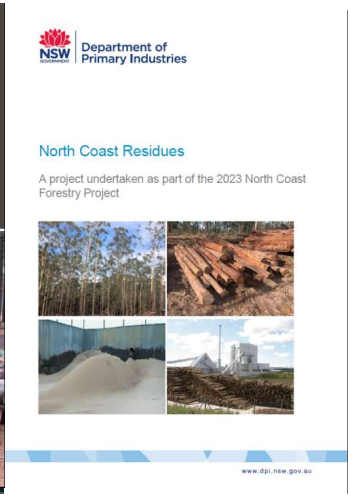
North Coast Residues project

https://www.dpi.nsw.gov.au/forestry/north-coast-residues-project

DPI RIRDC Report

Biomass from pine harvest residues





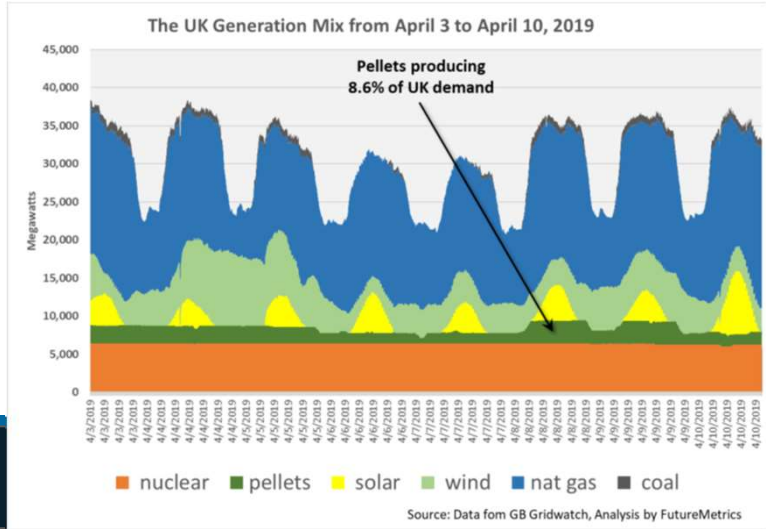
Pellets – white versus torrefied

Table 7: Overview of properties of torrefied pellets in relation to other fuels

	Wood chips	Wood pellets	Torrefied wood pellets	Charcoal	Coal
Moisture content (wt%)	30 – 55	7 – 10	**1 – 5**	1 – 5	10 – 15
Calorific value (LHV, MJ/kg)	7 – 12	15 – 17	**18 – 22**	30 – 32	23 – 28
Volatile matter (wt% db)	75 – 84	75 – 84	**55 – 80**	10 – 12	15 – 30
Fixed carbon (wt% db)	16 – 25	16 – 25	**22 – 35**	85 – 87	50 – 55
Bulk density (kg/l)	0.20 – 0.30	0.55 – 0.65	**0.65 – 0.80**	0.18 – 0.24	0.80 – 0.85
Vol. energy density (GJ/m^3)	1.4 – 3.6	8 – 11	**12 – 19**	5.4 – 7.7	18 – 24
Hygroscopic properties	Hydrophilic	Hydrophilic	**(Moderately) Hydrophobic**	Hydrophobic	Hydrophobic
Biological degradation	Fast	Moderate	**Slow**	None	None
Milling requirements	Special	Special	**Standard**	Standard	Standard
Product consistency	Limited	High	**High**	High	High
Transport cost	High	Medium	**Low**	Medium	Low
					

Abbreviations:
db = dry basis
LVH =Lower Heating Value

sources: ECN (table, fig.1, 3), Pixelio (fig. 2, 5), OFI (fig. 4)



Processing – wood flour

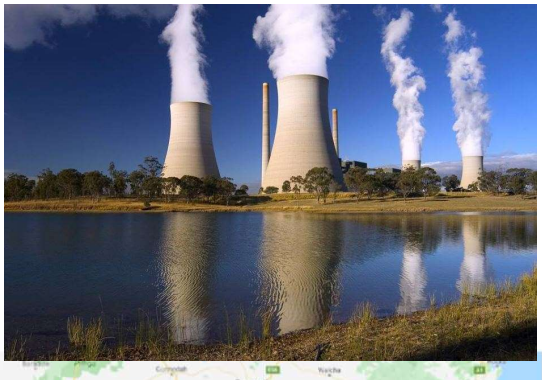
- If centralised facility next to the power generation unit – no need for pelletising
- Use of waste heat from power station to dry biomass
- Ability to be upsized if more feedstock available

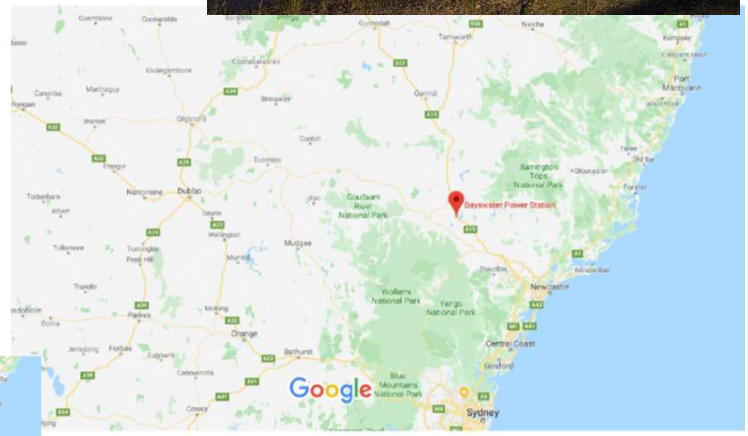
Power station specs

Both have pulverised coal burners

Bayswater: 4x660 MW units; planned closure 2035

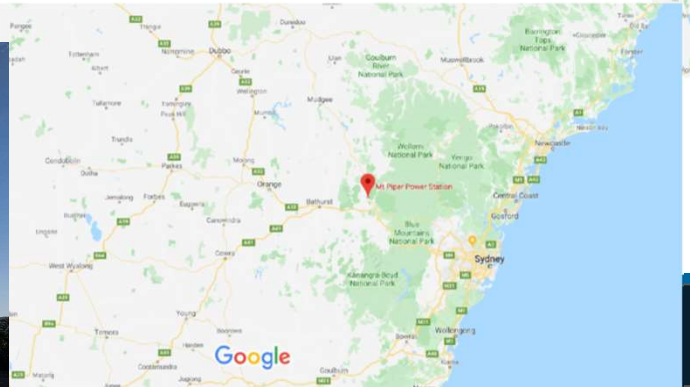
Mt Piper: 2x 700 MW units; commissioned in 92/93





Bayswater

Mt. Piper



Siting of biomass processing facility

Scenarios

Bayswater:

Network of pelletising units close to feedstock (NC)

Centralised facility next to the power generation unit (including SE plant)

Mt Piper:

Network of pelletising units close to feedstock (NC)

Dried wood flour facility

Feedstock availability

Bayswater

Sawmill residues: 330,000 tonnes

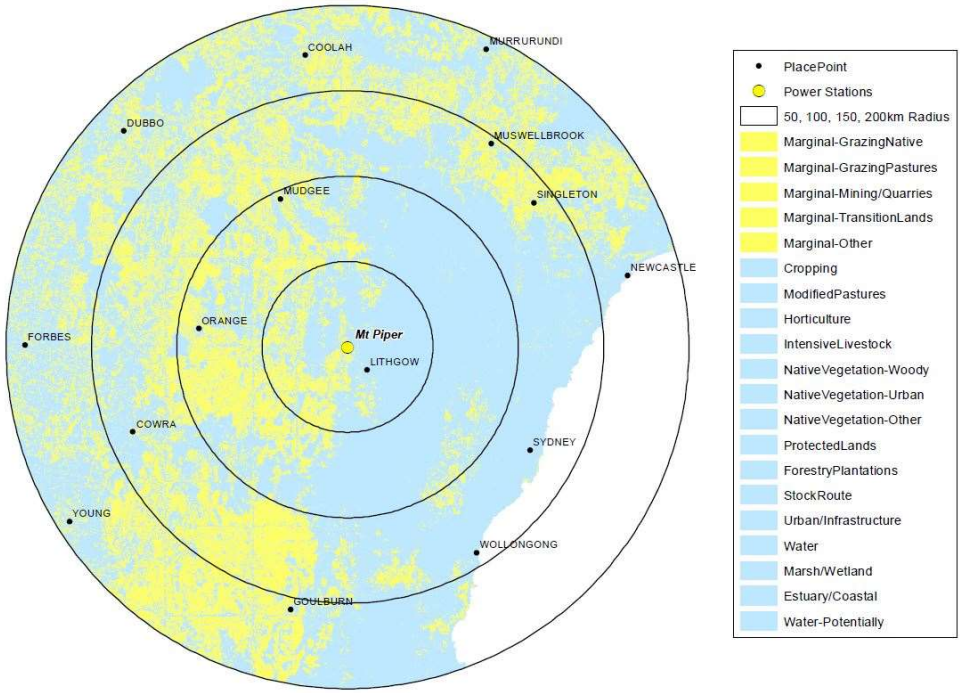
Forestry harvest residues: 1.2 Mt

Mt Piper

Pellets from NC: 900,000 tonnes

90,000 ha of radiata pine plantations; no sawmill residues available:200,000 tonnes

Potential – more feedstock



Land use type	Area (ha)	Cover (%)
Marginal-GrazingNative	1,383,166	12.5
Marginal-GrazingPastures	2,112,634	19.2
Marginal-Mining/Quarries	36,513	0.3
Marginal-TransitionLands	192	0.0
Marginal-Other	90,199	0.8
Total area within 200km of Mt Piper	**11,021,251**	**100.0**

Feedstock costs

Costs ($/GMT)	Muswellbrook	Mt Piper
Stumpage	10	10
Harvest	25-32	25
Chipping	-	16
Haulage	$12.9/GMT for <50 km to $26.50/GMT for 100-150 km	
Sawmill residues	15.6	-
Sawmill residues haulage	10+0.14/km/GMT	-
Pellet (delivered cost)	190	206-224
Delivery of pine harvest residues	-	61.30

Mt Piper feedstock (Portland)

Optimal solution: fuel prep plant next to power station (5% co-firing)

Use of waste heat from power station to dry biomass

No need to pelletise

Capital cost – 63% lower than for pellet facility

Ability to be upsized if more feedstock available

What works best?

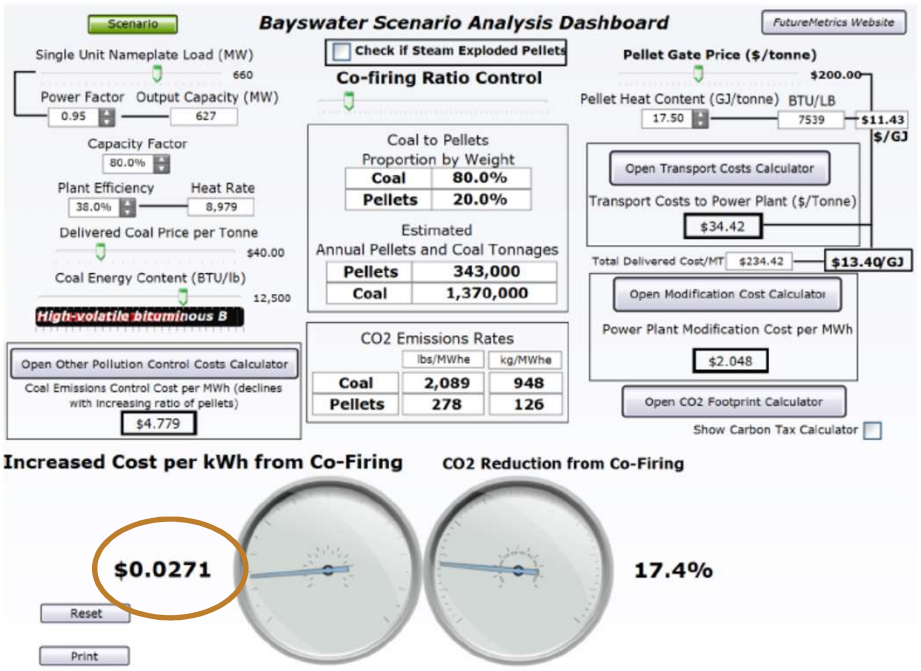
Scenarios	Strengths	Weaknesses
Decentralised white pellets	De-risking (outages); proven track record; storable in silos	Must be kept dry; need for silos can double capital costs; need for robust dust and fire control systems
Decentralised torrefied pellets	Waterproof fuel – no silos needed, can be stored in coal yard; less power in pulverising mills; minimal dust created	Higher capital investment; only one at commercial scale; biochemical recovery process not demonstrated at scale
Centralised facility	Much lower capital costs per tonne of fuel produced	Though technically viable, not yet built anywhere. Risk of one centralised facility; high number of truck loads required

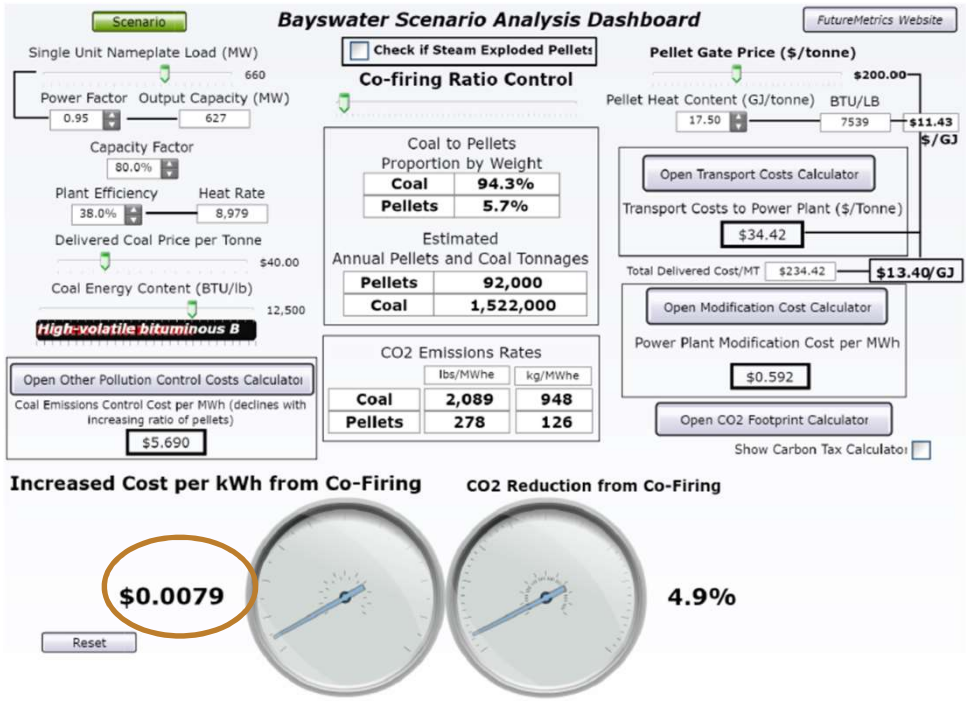
Bayswater - dashboard

1 tonne of pellets = 5 MWh
1 tonne of coal = 7.3 MWh

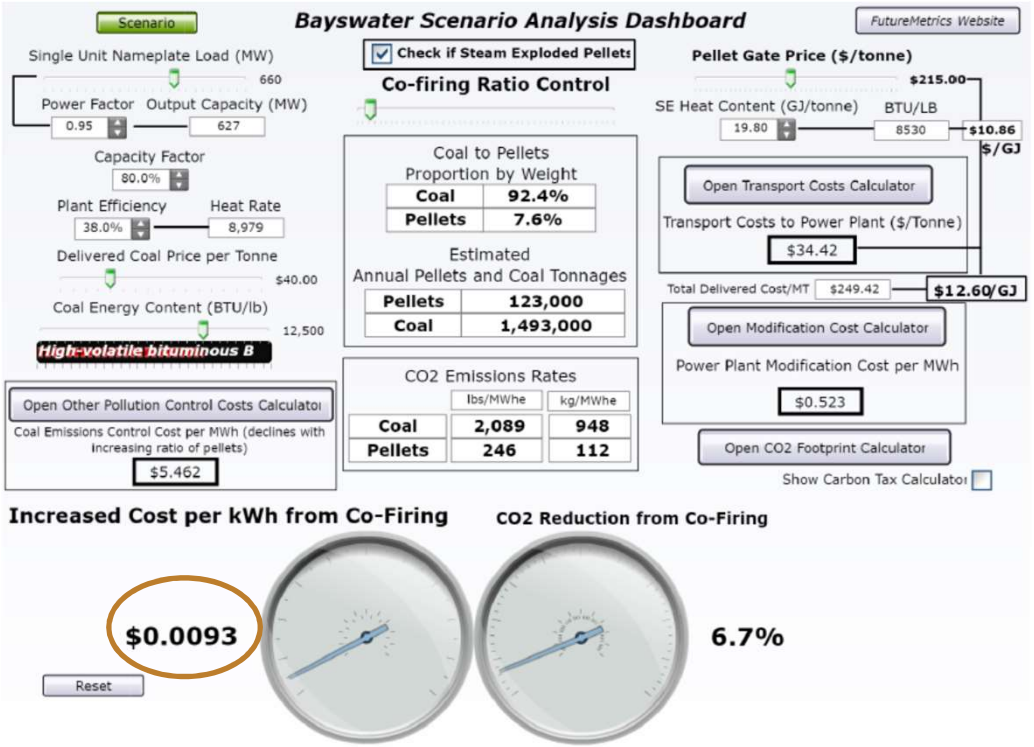
CO_2 saving of 1.41 Mt

CO_2 saving of 378,000 t



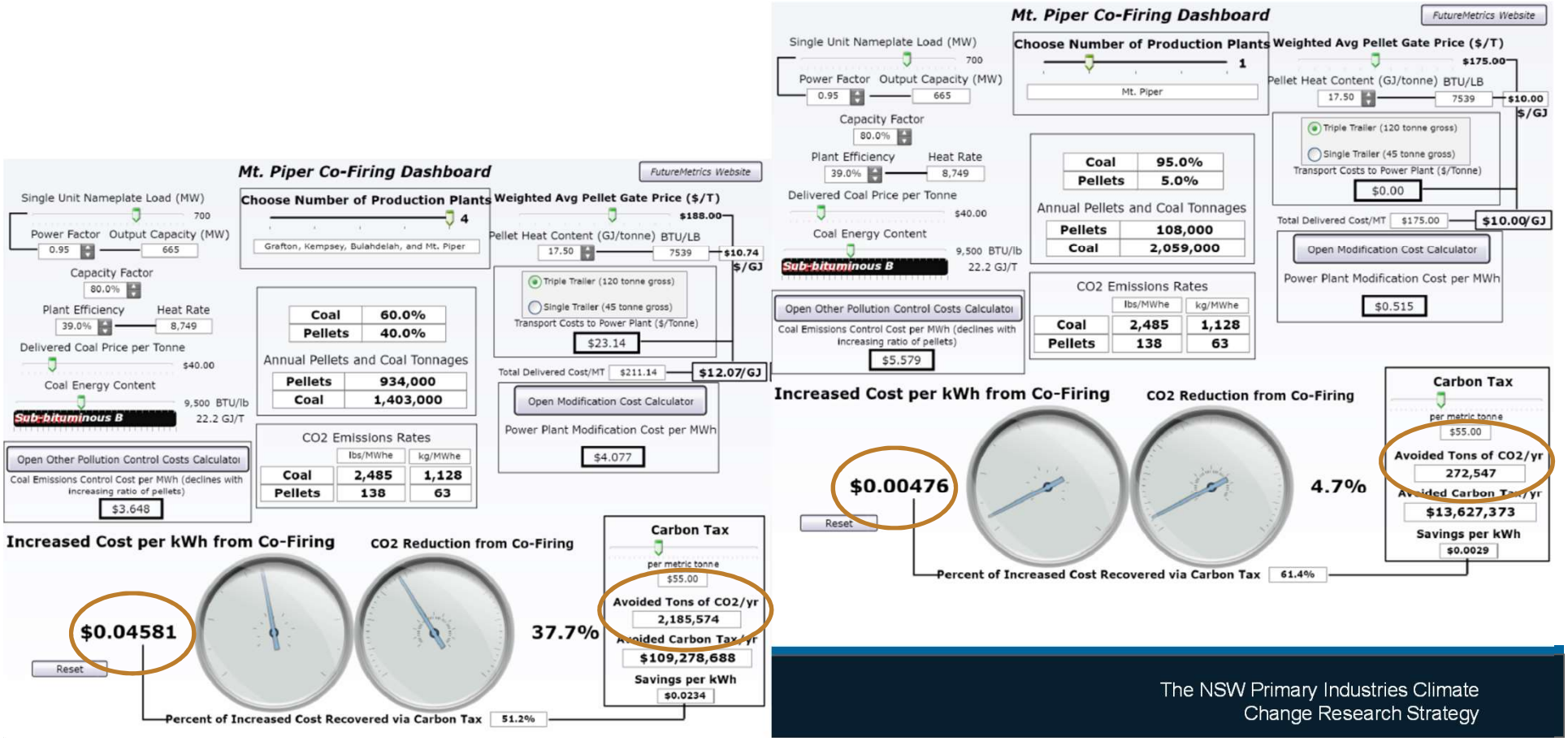


Bayswater - dashboard



CO_2 saving of 514, 000 t

Mt Piper - dashboard



Conclusions

- There are no technical hurdles to significant levels of co-firing at both power stations
- Sufficient biomass available for co-firing rates of 40-50% in one of the generation units – lower rates more realistic
- Scope for additional biomass – dedicated biomass crops
- Cost of delivered fuel comparable to the cost of fuel delivered to UK, western Europe and Japan
- Additional cost of generated electricity variable

Thank you

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More information at: https://www.dpi.nsw.gov.au/climate-and-emergencies/climate-change-research-strategy/biomass-for-bioenergy