Feasibility and sustainability of co-firing biomass in coal power plants in Vietnam

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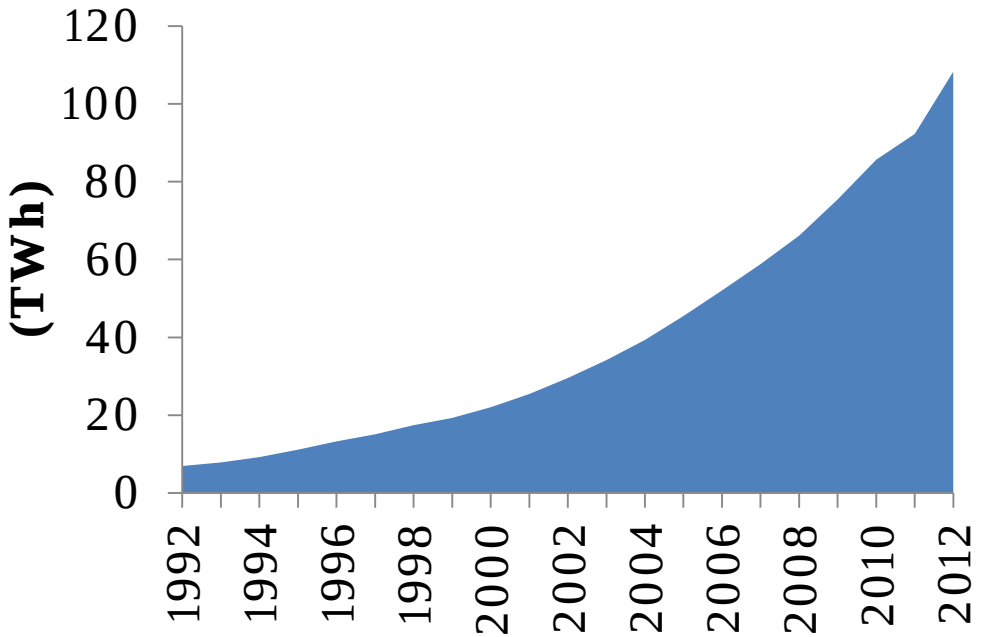
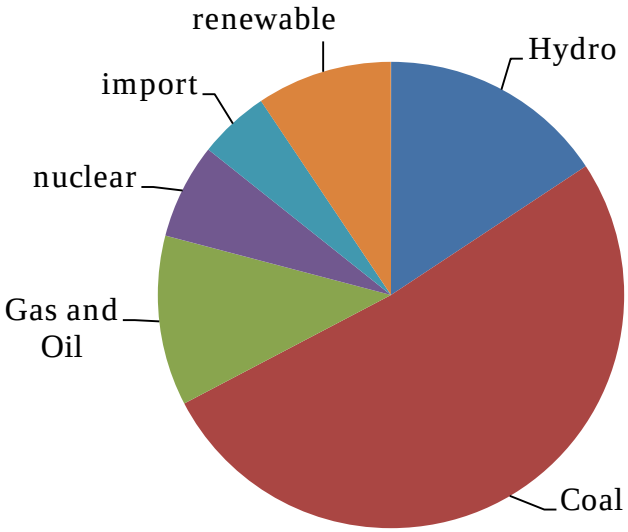
Introduction

- Co-firing is new concept in Vietnam
- Big gap in study/research on co-firing in Vietnam
- Thus, this study aims to
  - Reviewing biomass potential in Vietnam for co-firing
  - Building a set of indicators to evaluate the feasibility and sustainability of co-firing in Vietnam
  - Applying these indicators in two real cases in Vietnam

Vietnam will depend more on coal for electricity



Electricity consumption in Vietnam

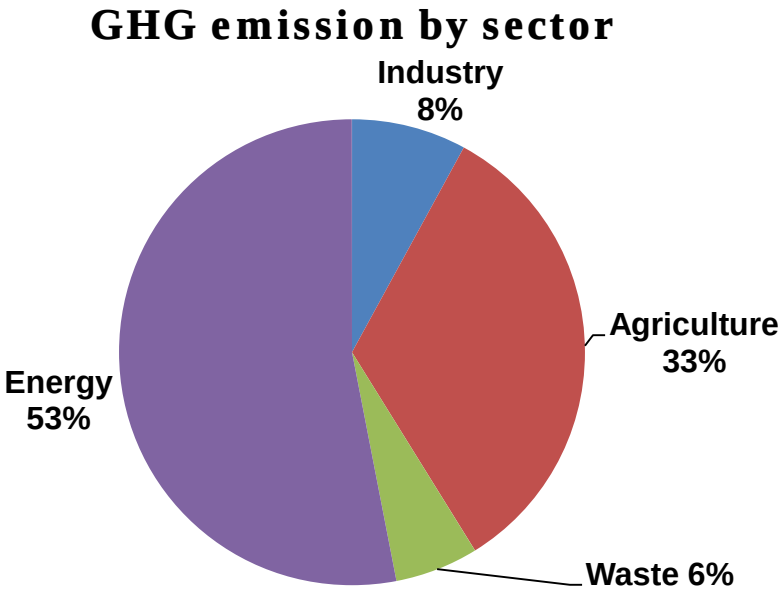


Electricity supply by sources by 2030

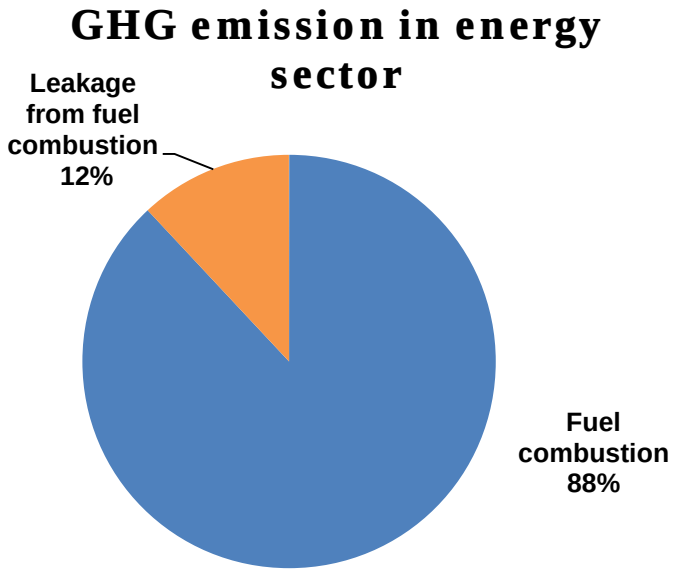
- By 2030: **57%** electricity from coal
  80 Mton coal imported per year

Source: "National Power Development Plan 7." 2011.

Energy contribute ½ total GHG emission in Vietnam



266 Mton CO_2e



141 Mton CO_2e

GHG emission reduction target : reduce **20-30%** compare to BAU

Source: MONRE. 2014. “Greenhouse Gas Inventory of Vietnam 2010.”

Vietnam has significant potential of biomass for power generation

Source: Tran, Q.C. 2011. “Review of Biomass Energy Sector in Vietnam.”

Electricity generated from biomass is much lower than its potential

- 40 bagasse cogeneration systems, 5 selling surplus electricity to the grid
  - Total installed capacity: 150 MW
  - Range of capacity: 1-25 MW
- One rice husk CHP plant, no electricity generation yet

Barriers for electricity from biomass:

- Fossil fuel subsidized
- Low electricity tariff
- High investment cost
- Continuously biomass supply required

How biomass in Vietnam is being used?

Cattle fodder

Cooking fuel

Small facilities

Make briquettes

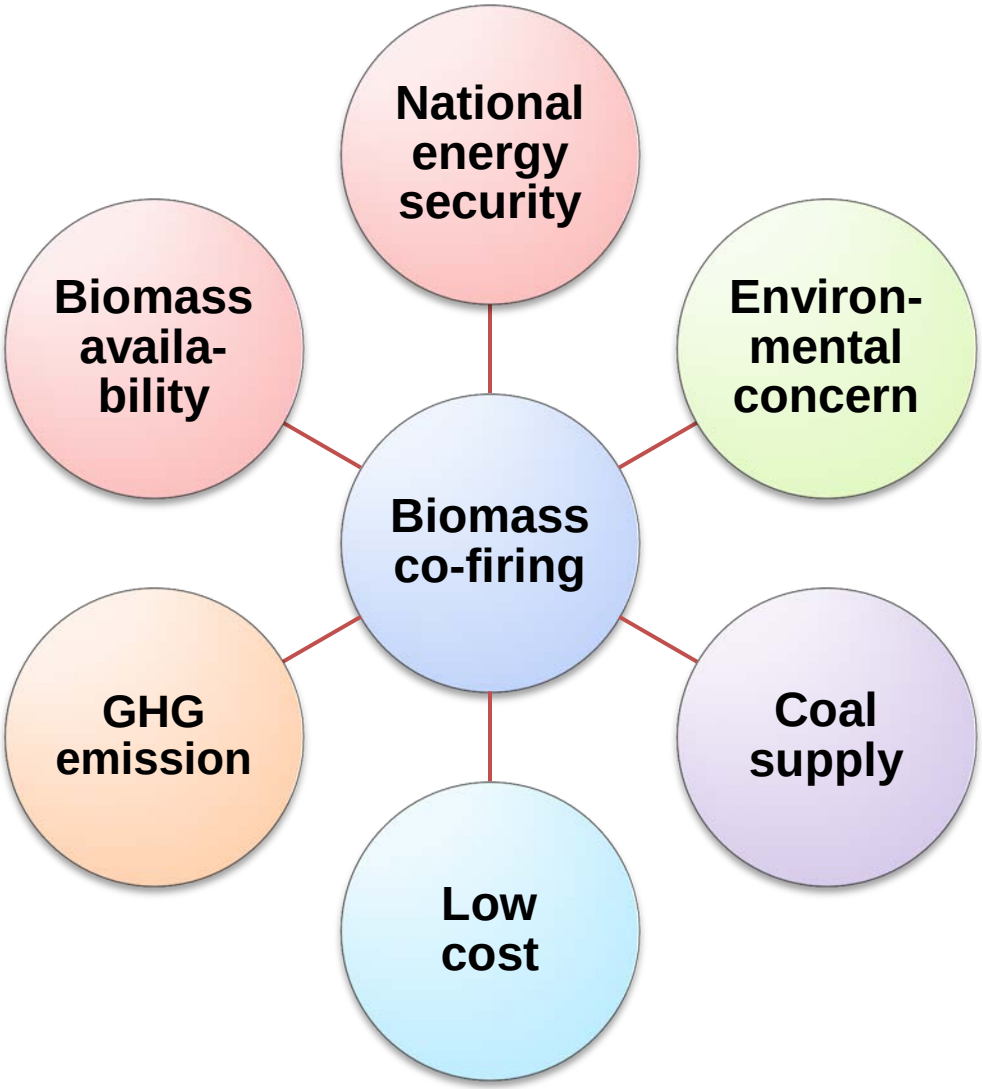
Crop residues	Total biomass produced (Mton)	Biomass utilized (Mton)	% biomass utilized
Rice straw	37.57	7.8	21%
Rice husk	7.52	3	40%
Bagasse	7.20	4.3	60%
Other crop residue	20.4	8.5	42%

Environmental concern

Open burning

Source: Tran, Q.C. 2011. “Review of Biomass Energy Sector in Vietnam.”

Why considering biomass co-firing in Vietnam?



Selected indicators

	Indicator	Unit
Technical aspect	Overal efficiency with cofiring	%
	Biomass needed	ton/year
	Biomass available density	ton/km^2·yr
	Collection radius	km
Economical aspect	Biomass unit cost as delivered at the plant	USD/ton
	Biomass cost per GJ	USD/GJ
	Effect to national trade balance (Extra revenue for coal export)	USD/year
	Levelized cost of electricity	USD/kWh
	Net Present Value	USD
	Fuel cost saved	USD/year
Environmental aspect	GHG emission reduction	ton CO_2e/yr
	Local air quality (NO_x, SO_2, $PM_{2.5}$, PM_{10})	mg/MJ
	Resource conservation	ton of coal/year
Social aspect	Extra income for farmer	USD/ha
	Number of jobs created per year	FTE jobs/ year

Case study: two coal power plants was selected

Mong Duong 1 Coal Power Plant

- 1080 MW (2 units)
- 6.5 TWh/year
- Fluidized Bed
- 2,752 Mton coal/year
- 38.8 % overall efficiency
- Located next to coal mine

Ninh Binh Coal Power Plant

- 100 MW (4 units)
- 0.75 TWh/year
- Pulverized Coal
- 420 Mton coal/year
- 21.8% overall efficiency
- Located 200 km from coal mines
- Coal transported by barges

Case study: biomass option selected for the cases

- Direct co-firing with biomass blended with coal
- 5% of rice straw co-fired in term of heat

Results

Category	Indicator	Value		Unit
		Mong Duong 1 CPP	Ninh Binh CPP	
Technical aspect	Overall efficiency with co-firing	38.59	21.62	%
	Efficiency loss	0.25	0.15	%
	Biomass needed	259,107	53,362	ton/year
	Biomass available density	52.79	68.67	ton/km^2·year
	Collection radius	71	16	km

Local rice straw supply is adequate for biomass co-firing in both case

Results

Category	Indicator	Value		Unit
		Mong Duong 1 CPP	Ninh Binh CPP	
Economical aspect	Biomass unit cost	41.31	38.15	USD/ton
	Levelized cost of electricity	4.52	6.6	UScent
	Net Present Value	1,848,558	- 6,450,985	USD
	Fuel cost saved	-2,485,162	31,533	USD/year
	Extra revenue for coal export	1,403,882	345,302	USD/year

Coal price:
Case 1: 52.7 USD/ton
Case 2: 83.83 USD/ton

Electricity selling tariff:
5.4 Uscent/kWh

How fuel cost saving for case 1 is negative

Coal is subsidized → low price

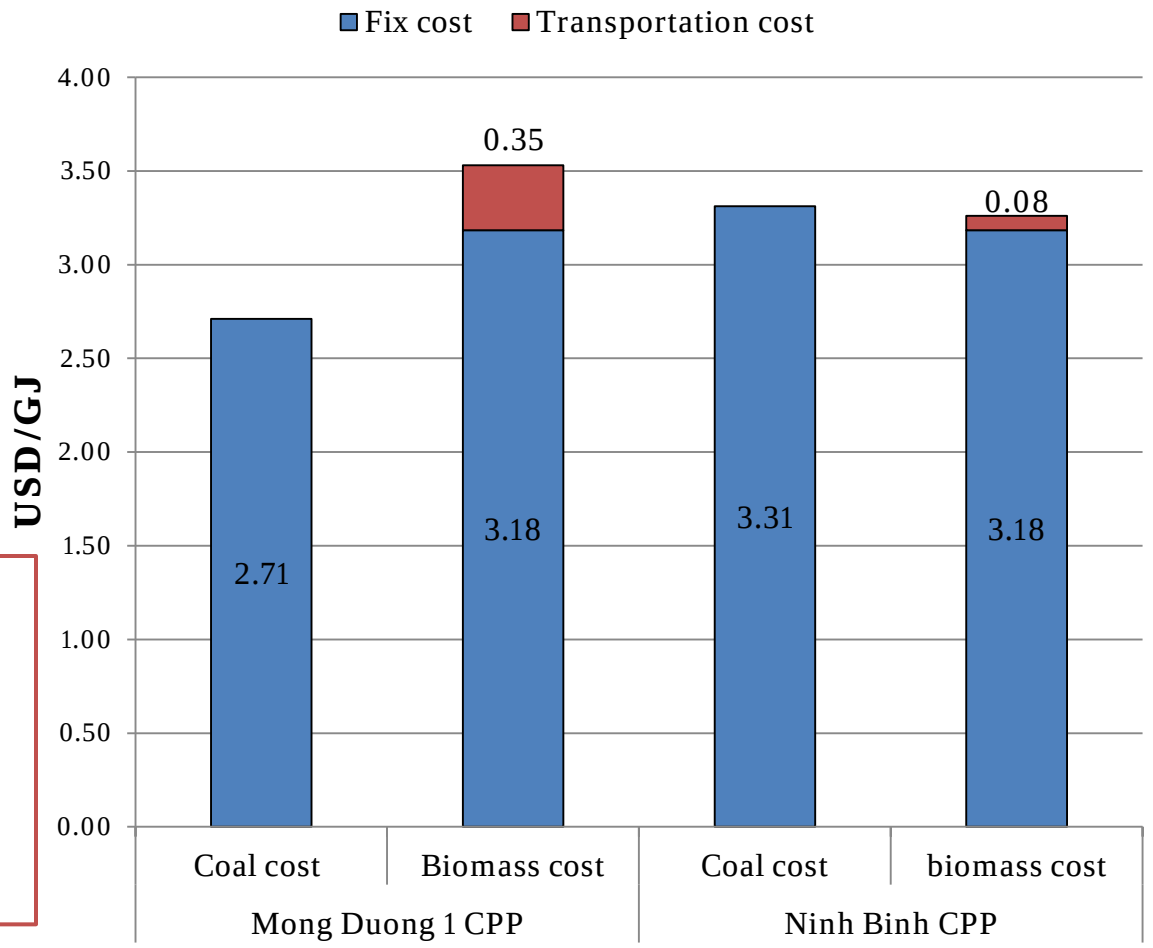
Cost per GJ of biomass is higher than coal

Coal price vs fuel cost saving:

53 USD/ton→ -2.5 mil.USD

69 USD/ton →zeroUSD

> 69 USD/ton → positive value



Fuel cost (per GJ) breakdown for two cases

How LCOE is high in case 2

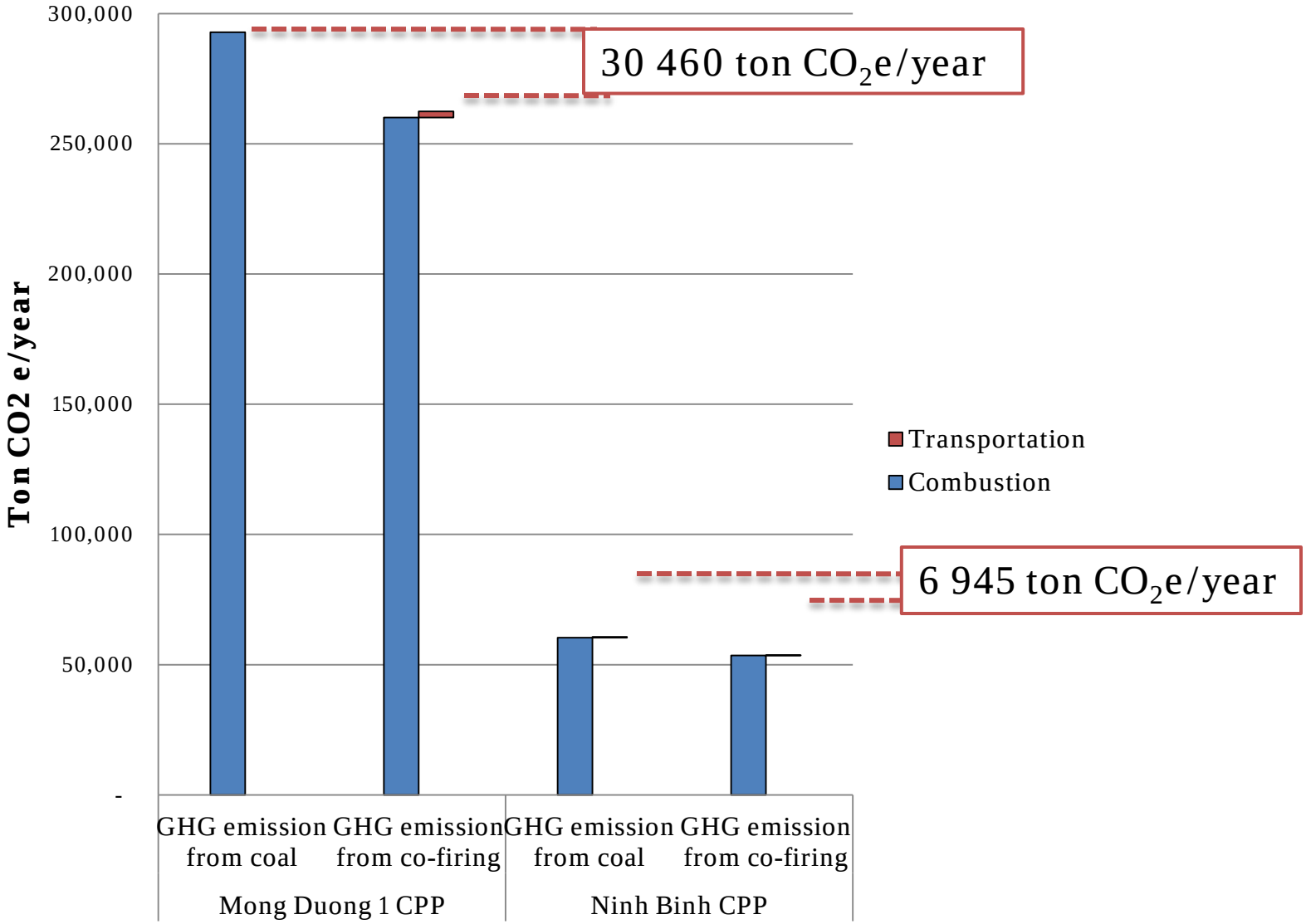
$$LCOE = \frac{capital\ cost \times CRF + OM_{fix}}{8760 \times capacity\ factor} + fuel\ cost \times Heat\ rate + OM_{var}$$

- High heat rate 16.7 MJ/kWh (for case 1 is 9.3 MJ/kWh)
- Higher electricity tariff could make NPV positive
- Co-firing is not yet subjected to supporting mechanisms

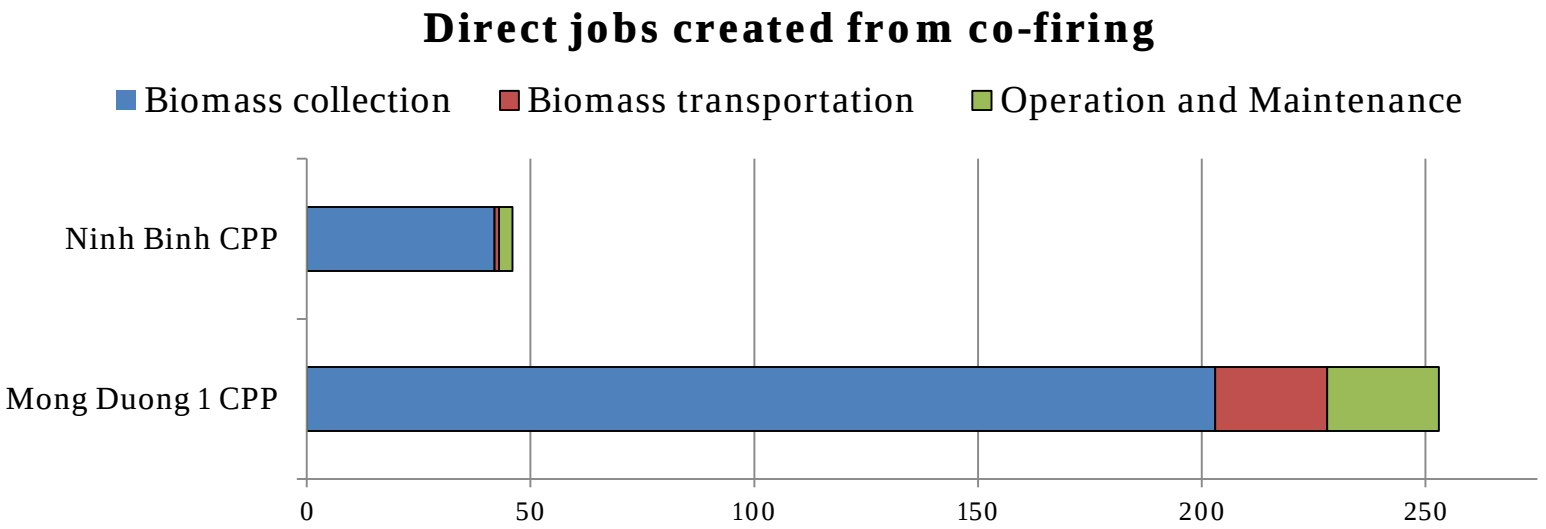
Results

Category	Indicator	Value		Unit
		Mong Duong 1 CPP	Ninh Binh CPP	
Environmental aspect	GHG emission reduction	30,460	6,945	ton CO_2e/year
	% emission reduced	10.4	11.5	%
	Resource conservation	155,987	24,664	ton of coal/year
Social aspect	Extra income for farmer	143 - 194	172	USD/ha
	Number of direct job created per year	253	46	FTE jobs/ year

GHG emission reduction from co-firing in two cases



Direct jobs from biomass collection is high because farmers using small straw winders



Straw bale size: 12-15kg
Winder capacity: 400-500 rolls/day

Rice straw co-firing could improve local air quality

- 60-90% rice straw is burned in-field
- Gases/pollutants emitted include CO_2, CH_4, No_x, N_2O, SO_x and particulates
- Co-firing rice straw
  - → less in-field burning
  - → pollutant emission more concentrated but filtered

Conclusion

- In Vietnam, major factors that drive attention to co-firing are
  - National energy security
  - Climate change
  - Environmental concerns
- Co-firing in Vietnam is not yet feasible in term of economic due to
  - Coal subsidies
  - Low electricity tariff
- Co-firing in Vietnam offers various environmental and social benefits
  - GHG emission reduction
  - Local air quality improvement
  - Extra income for local farmers
  - Jobs creation
- Supporting mechanisms could be driving forces for co-firing development in Vietnam
  - Incentive taxes
  - Biomass subsidies
  - Carbon credit

Thank you for your attention!

Questions/Comments