



# Economics of co-firing rice straw with coal in old and new coal power plants in Vietnam

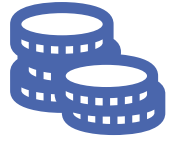
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### **Economic drivers**

Fuel cost saving  
Valorize  
agricultural wastes



### **Social drivers**

Create jobs in rural  
area  
Reduce trade  
deficit



### **Environmental drivers**

Reduce air  
pollutant emissions  
GHG emission  
mitigation

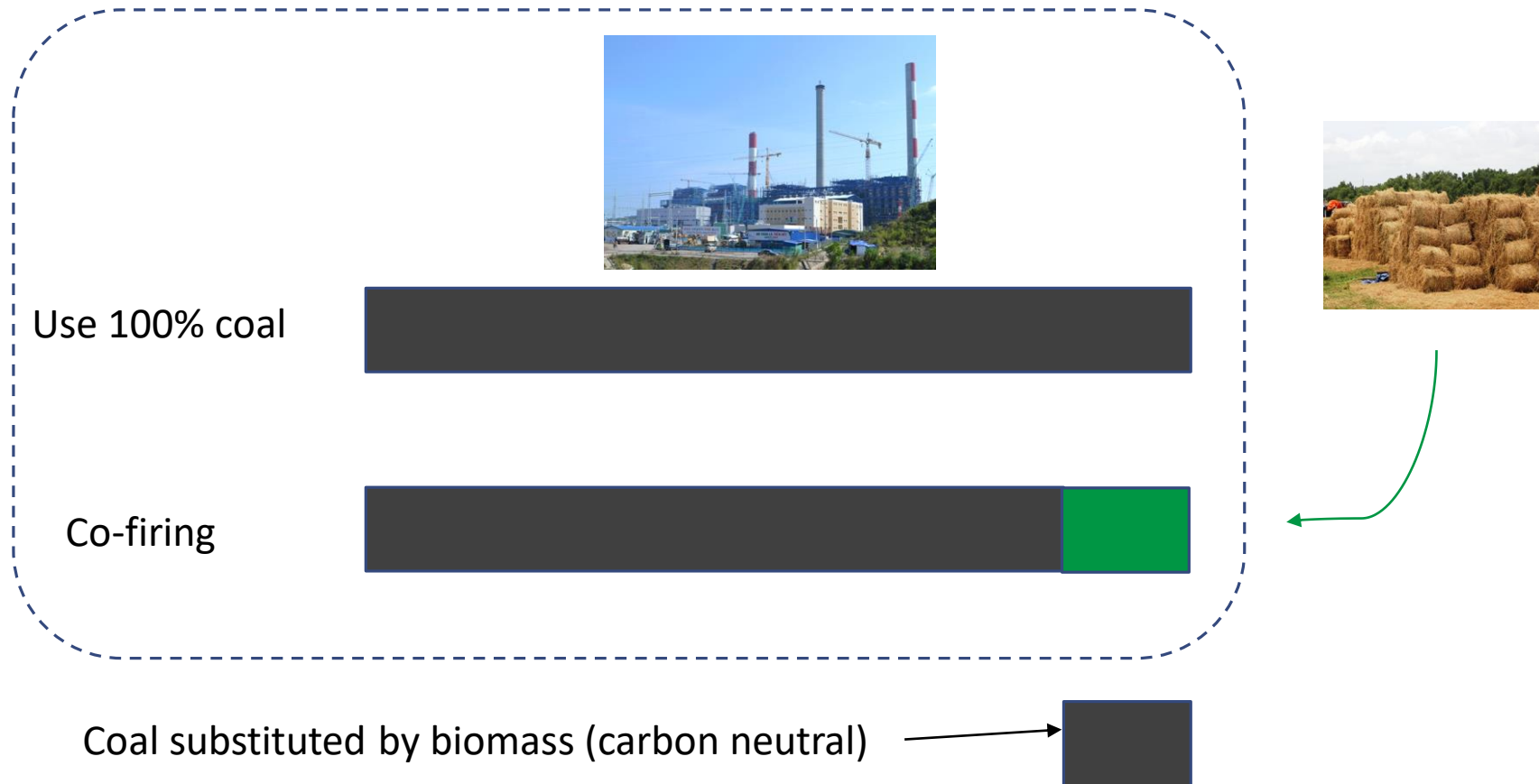


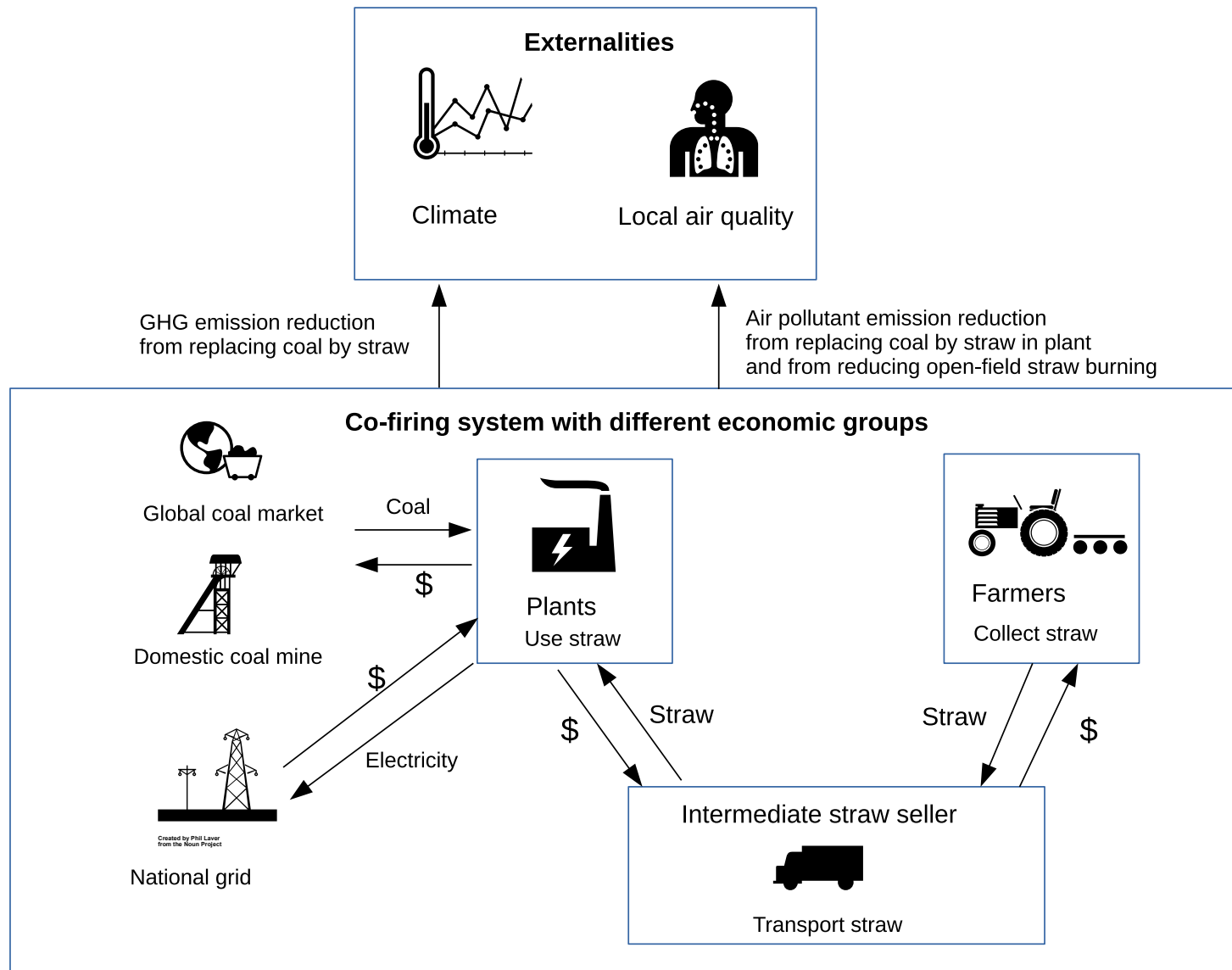
### **Policy drivers**

Renewable  
Portfolio Standards  
Climate change  
commitment

# Why consider biomass energy?

# Co-firing offset part of coal used in power plants by biomass





# Financial model of the sector

Source code available at <https://github.com/AnHaTruong/Costs-and-Benefits-Cofiring-VN>

# Three aspects evaluated



## Social aspect

Local job creation  
National trade balance



## Environmental aspect

GHG emissions  
Air pollutant emissions  
and health impact



## Economic aspect

- Willingness to Accept (WTA) of farmer
- Willingness to Pay (WTP) of plant

# Two case studies

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MONG DUONG 1

- New plant (2015)
- Typical size (1080 MW)



NINH BINH

- Old plant (1976)
- Small size (100 MW)

## Co-firing options:

- Direct co-firing with blended fuel
- 5% co-firing rate (heat basis)

# Co-firing create job mostly through supply chain

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	Mong Duong 1		Ninh Binh	
	Full time job equivalent	Total wages	Full time job equivalent	Total wages
<b>Straw collection</b>	176	304 kUSD	31	54 kUSD
<b>Straw transportation</b>	14	2 kUSD	1	1 kUSD
<b>Straw loading</b>	7	11 kUSD	1	2 kUSD
<b>Operation and Maintenance</b>	22	57 kUSD	2	6 kUSD
<b>Total</b>	219	394 kUSD	35	63 kUSD

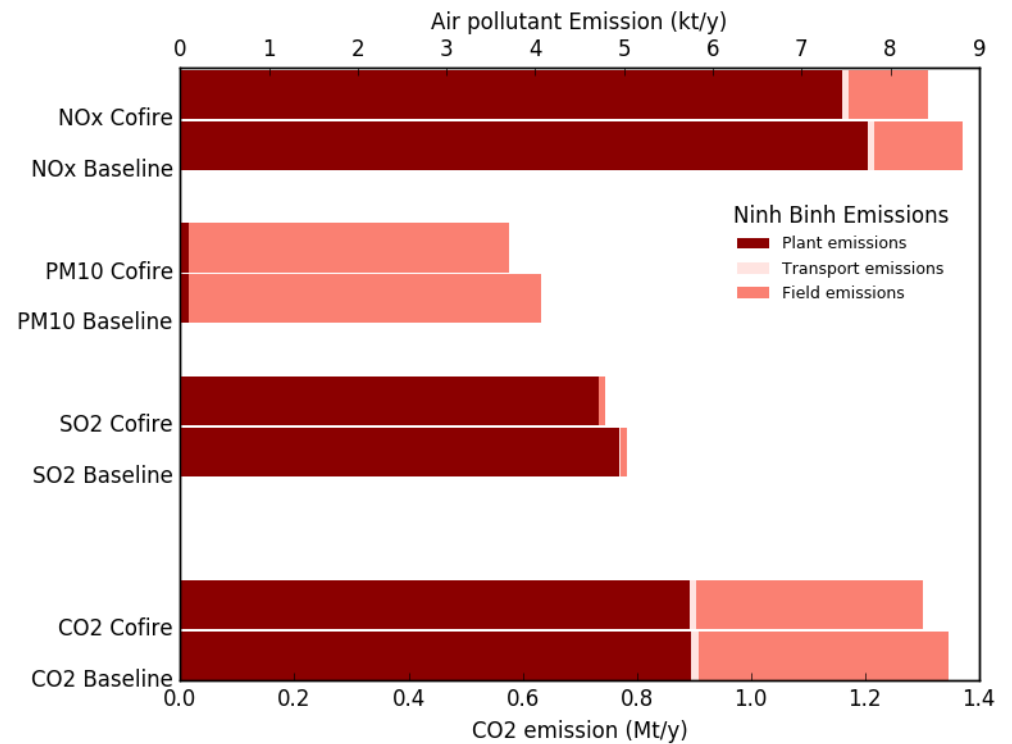
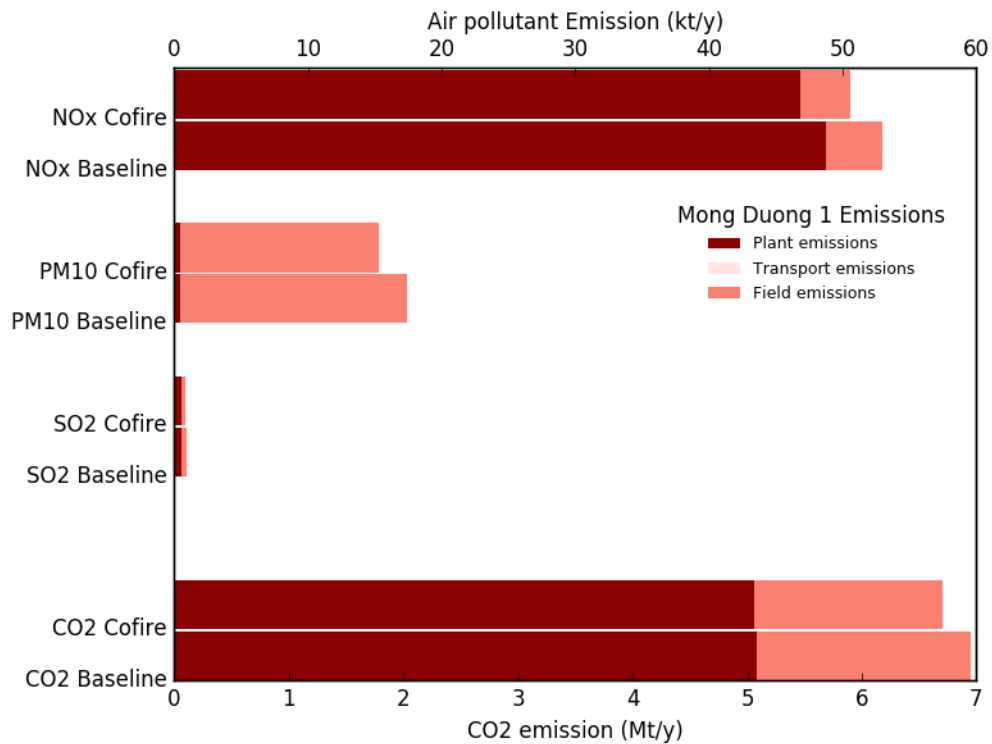
# Co-firing improves trade balance by curbing coal import

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- Coal saved by co-firing
  - In Mong Duong 1: **136 kt/y ~ 15 MUSD/y** at coal imported price of 112 USD/t (Vietnam Customs 2019)
  - In Ninh Binh: **22 kt/y ~ 2.5 MUSD/y**
- In 2018 Vietnam imported **23 Mt** of coal and paid **2.5 billion \$** (Vietnam Customs 2019)



# Co-firing reduces air pollutant and GHG emissions

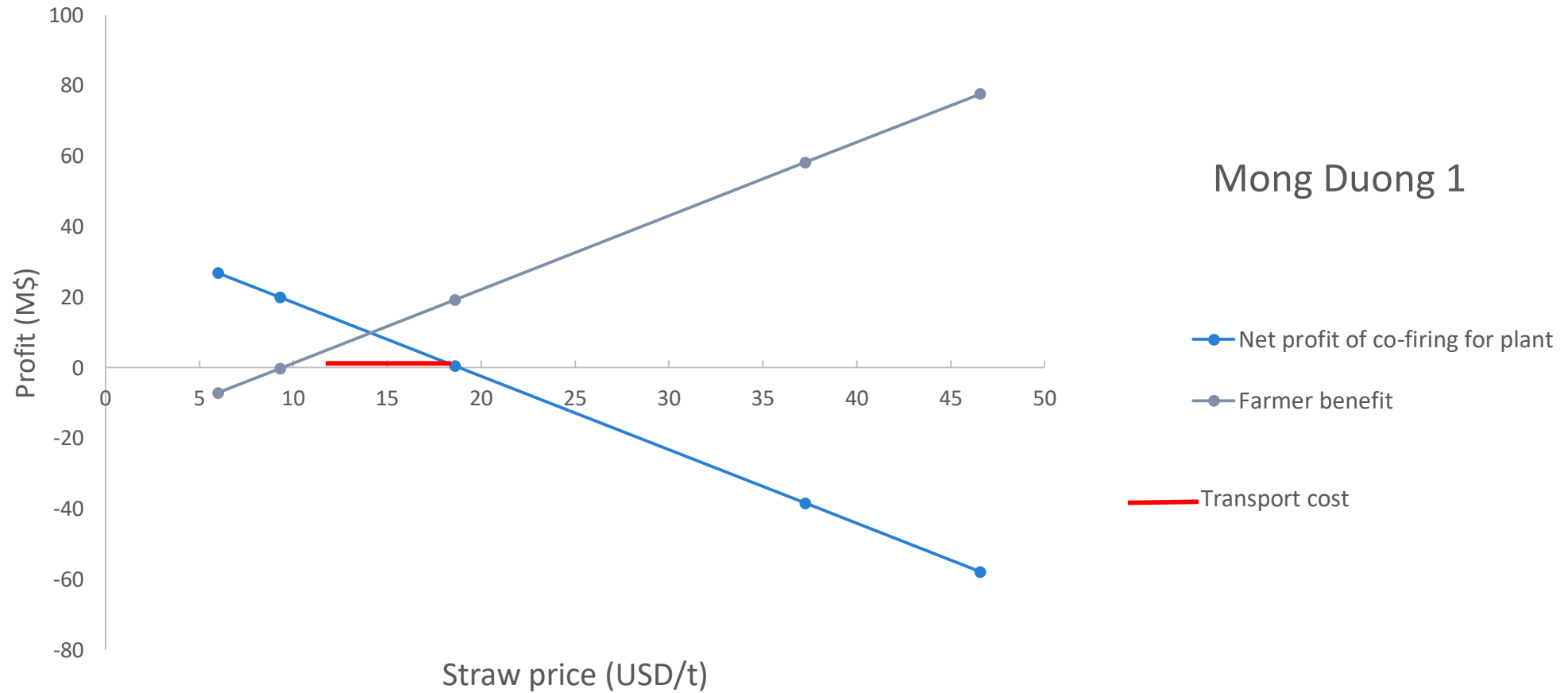


# Environmental benefits: particulate matter first, Greenhouse gas emission last

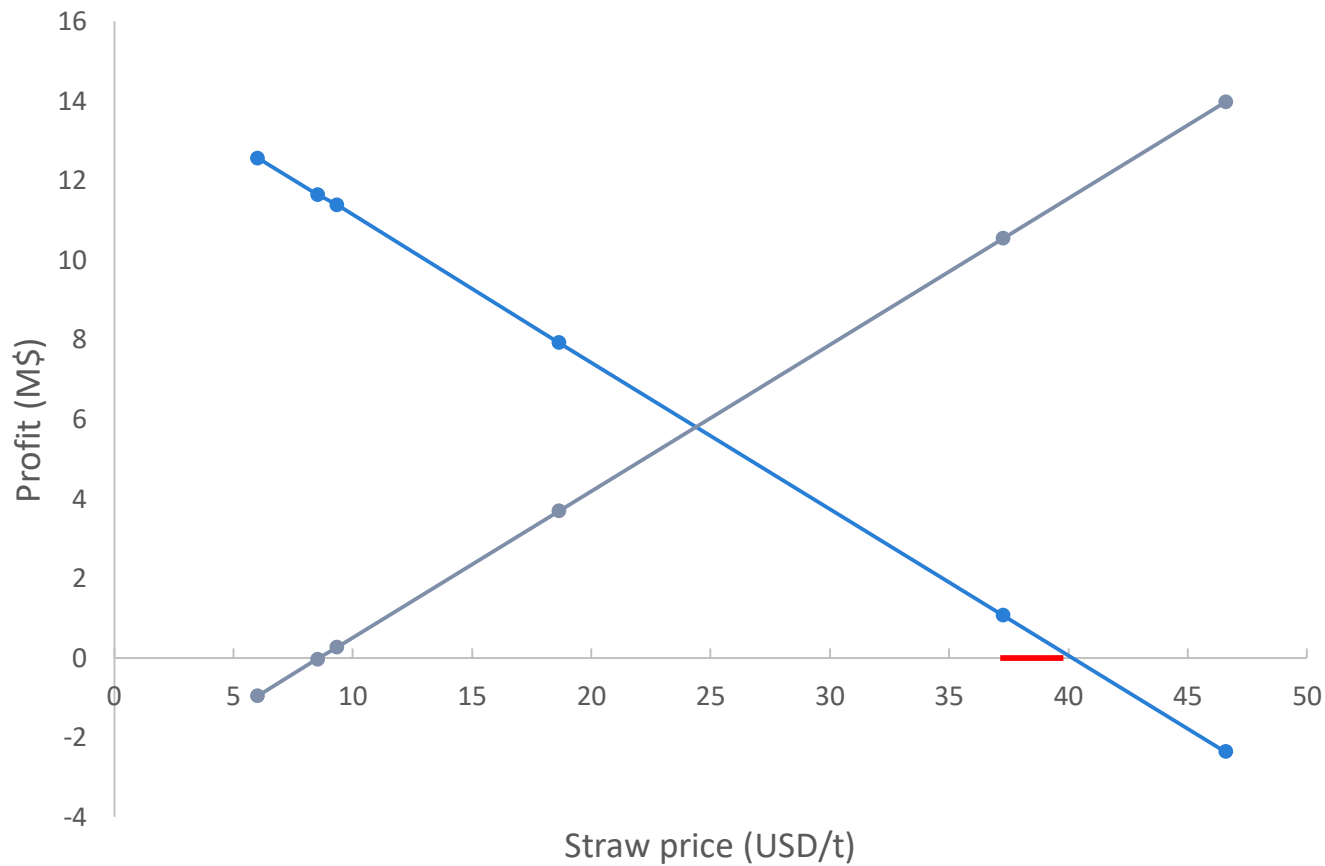
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Pollutant	External cost (USD/t)	Mong Duong 1		Ninh Binh	
		Emission reductions (t/y)	Benefit (kUSD/y)	Emission reductions (t/y)	Benefits (kUSD/t)
CO <sub>2</sub>	1	249 474	249	44 788	45
SO <sub>2</sub>	3 767	68	254	244	921
PM <sub>10</sub>	5 883	2 063	12 141	362	2 133
NO <sub>x</sub>	286	2 409	689	382	109

External costs of air pollutants are from Sakulniyomporn, Kubaha, and Chullabodhi (2011)



There is a narrow range of straw price that allow all 3 groups to benefit from co-firing in Mong Duong 1 case

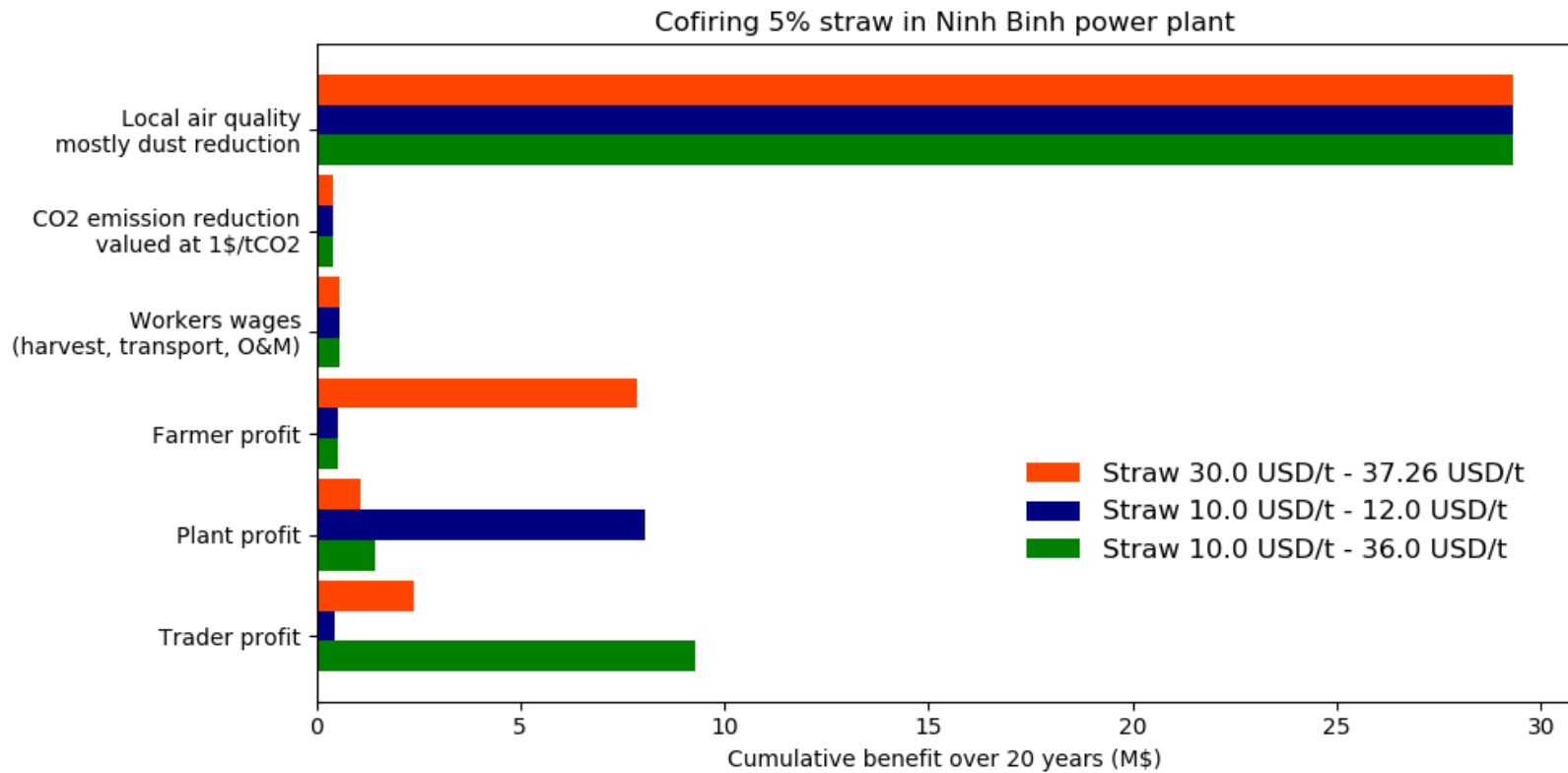


## Ninh Binh

- Net profit of co-firing for plant
- Farmer profit
- Cost of transport

There is a wide range of straw price that allow all 3 groups to benefit from co-firing in Ninh Binh case

## Example of costs-benefits of co-firing



- Largest benefit is the external benefits of local air quality improvement
- Different price structures give benefit to different actor

# Conclusions

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- The WTA + transportation cost < WTP in both cases.
- The externality of co-firing straw on local air quality improvement is significant enough to justify the technology regardless the external benefit of greenhouse gas emissions reductions.
- Co-firing rice straw is more an agricultural than an energy or environmental policy.
- It's time to implement the Renewable Portfolio Standards!



Thank you for your attention!

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