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A CASE STUDY - RENEWABLE METHANOL FROM BIOMASS GASIFICATION AS MARINE TRANSPORT FUEL

Global Syngas Technologies Conference, 2024

San Diego, California, USA

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AGENDA

- Why Renewable Methanol?
- Renewable Methanol Market Scenario
- Biomass Availability
- Biomass to Methanol Case Study:
 - Block Flow Diagram
 - Basis and Assumptions
 - Plant Performance Summary
 - OPEX
 - Simple Payback Period versus Methanol Price
 - Simple Payback Period versus Feedstock Price
- Summary

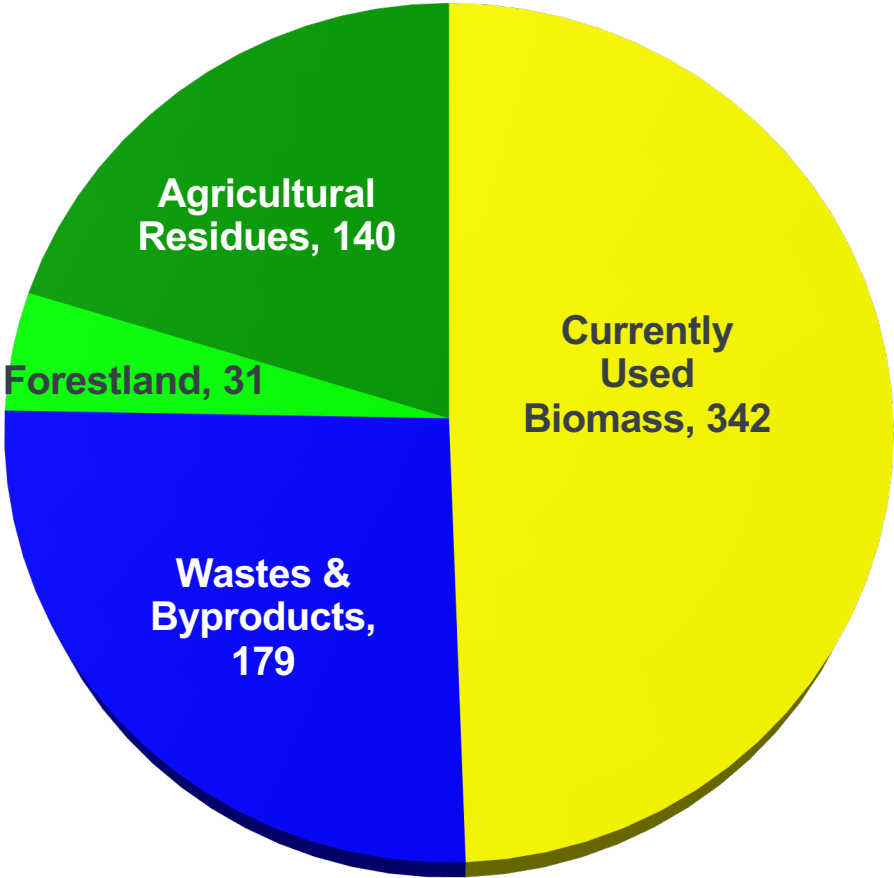
WHY RENEWABLE METHANOL

- Easy slip-in solution to decarbonize shipping industry
- No sulfur emissions
- Well-proven technologies, large scale production possible
- Liquid at ambient conditions → Easy to blend, handle, store and transport
- Versatile chemical for direct use as well as to produce various derivatives like DME, MEG, gasoline, SAF, olefins, formaldehyde etc.
- Can also serve as H₂ carrier

RENEWABLE METHANOL MARKET SCENARIO

- Global renewable methanol capacity: 0.7 MMTPA (as on 2024)
- Renewable methanol capacity expected to reach 20 MMTPA by 2028-2030
- Shipping industry alone is expected to consume ~18 MMTPA by 2030 led by industry giants like Maersk, Evergreen, COSCO, CMA CGM etc
- ~80 methanol ships have been ordered by giants of shipping industry like Maersk, Evergreen, COSCO, CMA CGM etc

BIOMASS AVAILABILITY IN USA



Millions Dry Short Tons per Annum

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CASE STUDY

BASIS AND ASSUMPTIONS

Parameter	Case 1	Case 2	Case 3	Case 4
Case Definition	Biomass Power Plant		NGCC Power Plant	
	w/o CCS	w/ CCS ⁽¹⁾	w/ Partial CCS ⁽²⁾	w/ CCS ⁽¹⁾
Feed to Gasification, sTPD (w/ 15-20 wt% moisture)	3,000	3,000	3,000	3,000
Biomass Feedstock Cost, USD / sTon	60	60	60	60
Raw Water Cost, USD / 1000 Gallon	7	7	7	7
Natural Gas Cost, USD / MMBtu	N.A.	N.A.	3	3
IRA CCS Credit, USD/MT (USD/sTon)	N.A.	85 (77)	N.A.	85 (77)
Gasifier Type	Fluidized Bed			

- Notes:
- 1) 100% capture and sequestration of by-product CO₂ from CO₂ Removal Unit.
 - 2) Partial capture and sequestration of by-product CO₂ from CO₂ Removal Unit to match the carbon intensity of Case 1.

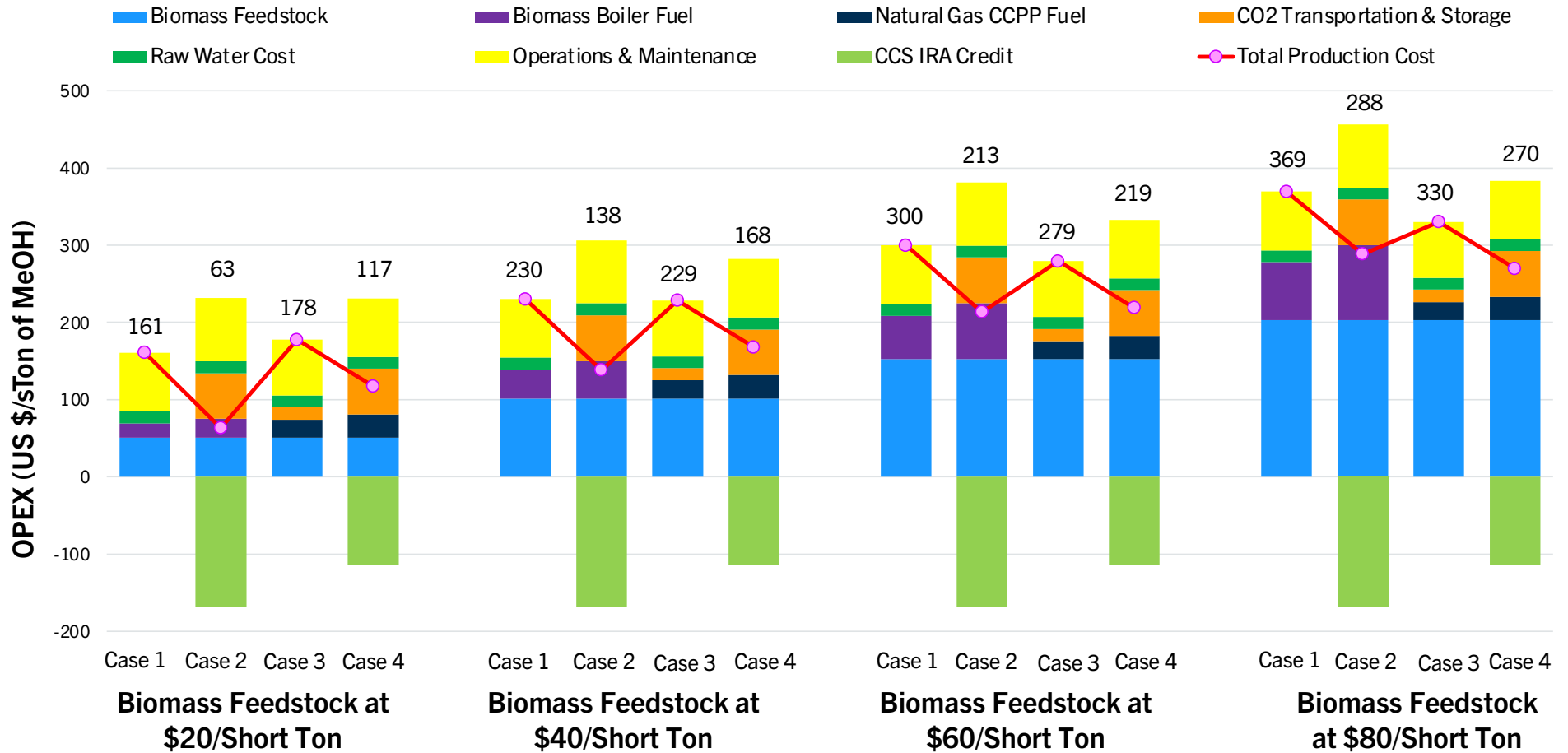
PLANT PERFORMANCE SUMMARY

Parameter	Case 1	Case 2	Case 3	Case 4
Case Definition	Biomass Power Plant		NGCC Power Plant	
	w/o CCS	w/ CCS	w/ Partial CCS	w/ CCS
Methanol Product, sTPD	1,181	1,181	1,181	1,181
CO ₂ to Sequestration, sTPD	Nil	2,574	691	2,574
Net Power Consumption, MW	47	61	50	61
Raw Water Intake, US GPM	1,739	1,739	1,739	1,739
NG Consumption, lb/h	Nil	Nil	19,524	23,576
Carbon Intensity, g CO ₂ e/MJ MeOH	2.53	-91.85	2.53 ⁽³⁾	-61.29

Notes:

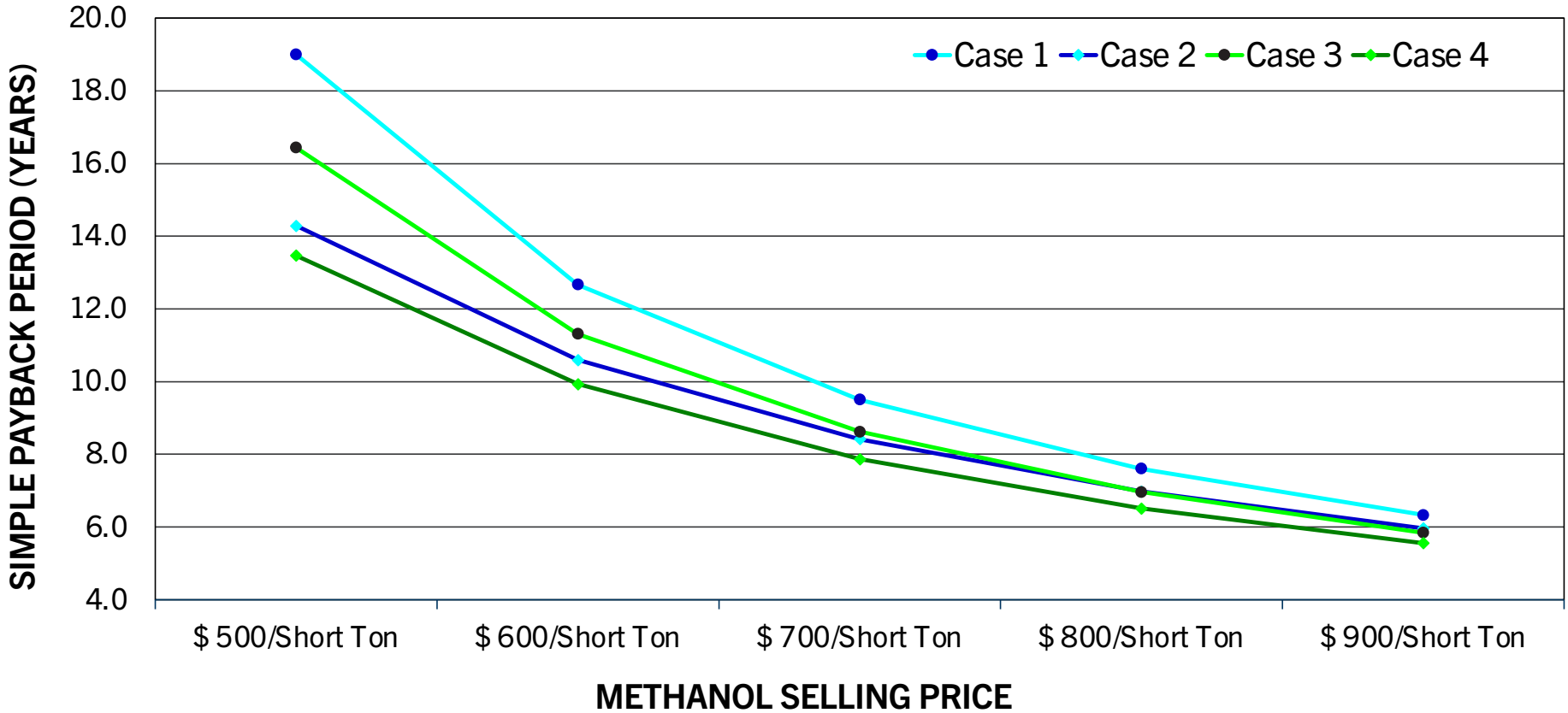
- 1) Forestry residues GHG emissions for production & 100 km transportation is considered as 1.25 g CO₂e/MJ of MeOH
- 2) NG well to tank/gate maximum GHG emissions to USA Pacific Region is considered as 13 g CO₂e/MJ of NG
- 3) Carbon Intensity (CI) for Case 3 w/o CO₂ Capture and Sequestration (CCS) is 27.94 g CO₂e/MJ

OPEX



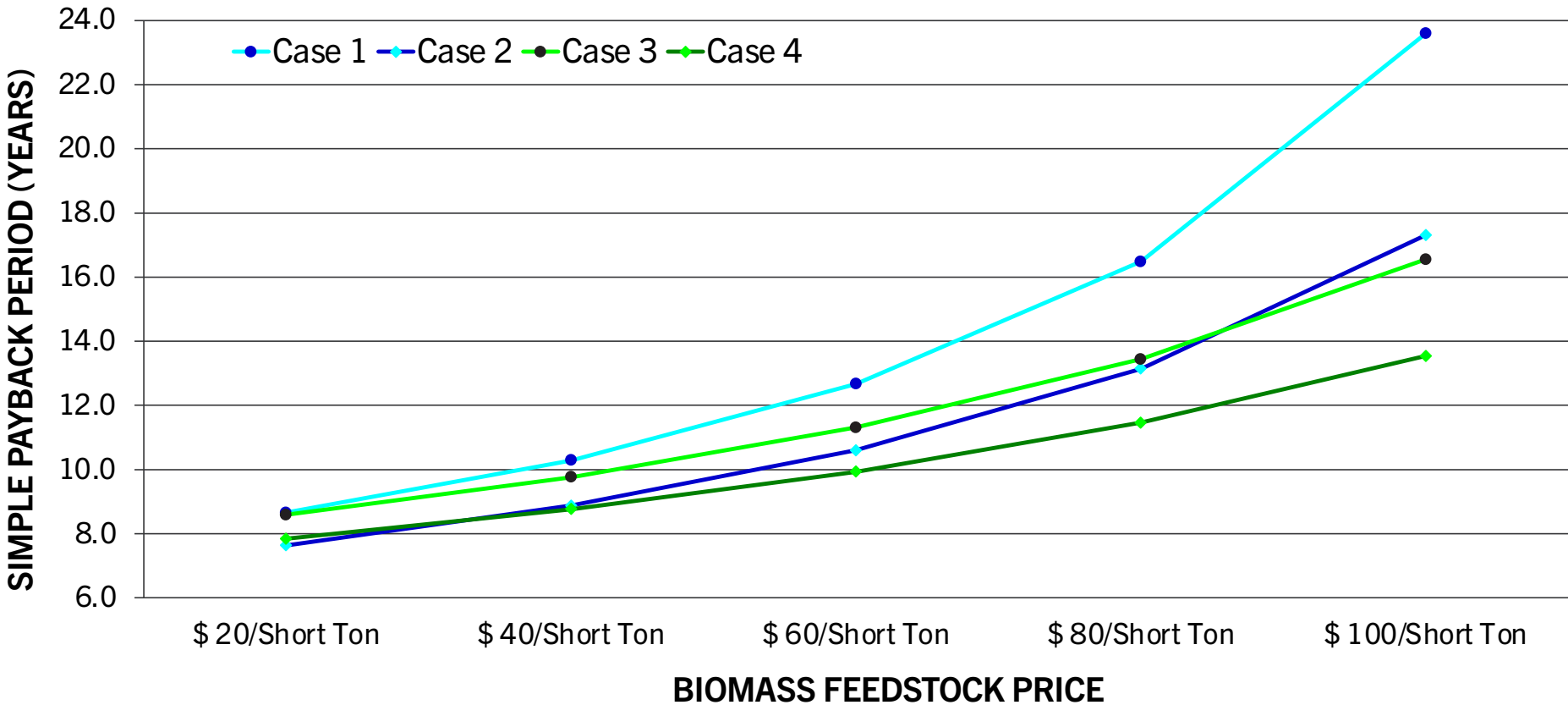
SIMPLE PAYBACK PERIOD VERSUS METHANOL PRICE

(Feedstock @ US \$ 60/sTon)



SIMPLE PAYBACK PERIOD VERSUS FEEDSTOCK PRICE

(Methanol @ US \$ 600/sTon)



SUMMARY

- Renewable methanol is a versatile chemical with a significant demand growth
- Renewable methanol from biomass gasification is a proven and cost competitive approach, allowing carbon recycle / sequestration and conversion of waste to value added product
- Biomass feedstock and O&M are the major OPEX contributors
- CO₂ Capture and Sequestration (CCS) improves the economics significantly
- If CCS is not an option, Case 1 payback period is reasonable up to feedstock price of USD 60/sTon and methanol price \geq USD 600/sTon
- If CCS is an option, Case 4 offers best payback period followed by Case 2 & 3
- Biomass gasification is a capital-intensive process → Need experienced engineering contractor with in-depth knowledge and proven track record from early stages of the project

REFERENCES

➤ Articles / Open-Source Documents

1. Methanex Methanol Price Sheet, September 2024
2. Methanex Monthly Average Regional Posted Contract Price History

➤ Webpages

1. <https://shipandbunker.com/news/world>
2. <https://about.bnef.com/blog>
3. <https://www.energy.gov/>

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