Finding (Re)Purpose: The Power of a Pre-Feasibility Analysis in Coal Repurposing

Case Study

July 2024

RMI's plant repurposing analysis directly informs decision-making for coal transition stakeholders in Indonesia

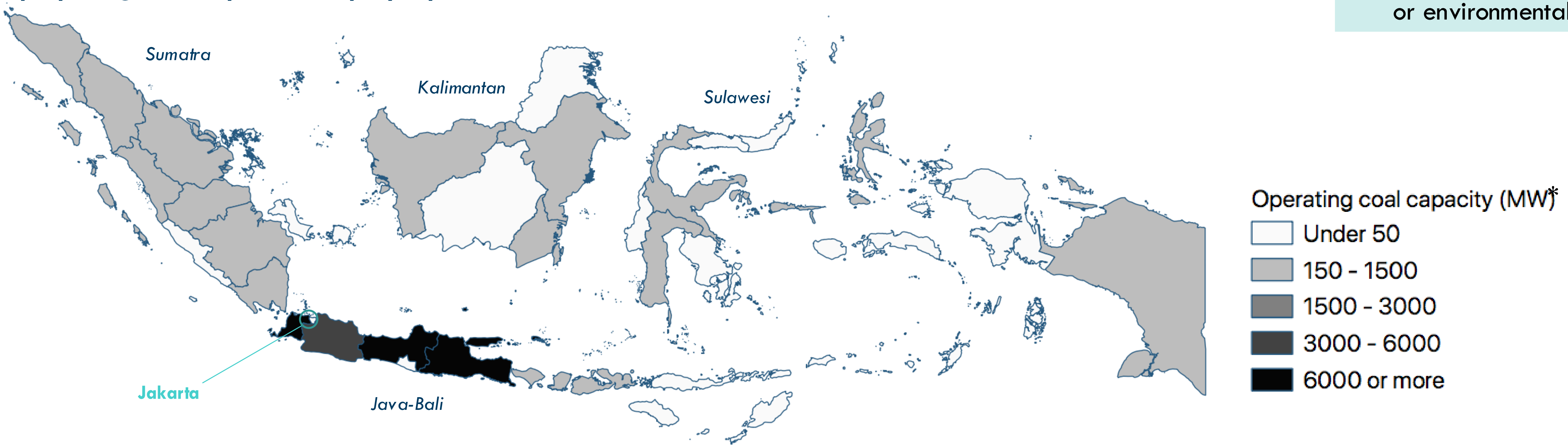
Indonesia is one of the world's major coal-exporting countries, and its electricity system is characterized by fossil-intensive assets, with consumption driven primarily by coal-fired power plants (CFPPs). Most of these assets operate in **dense-population centers,** and together encompass a **significant component of local and regional GDP.**

Under the JETP announcement in 2022, Indonesia has publicly committed to a net-zero emissions goal for the power sector by 2050, with a peak power-sector emissions target of 2030.
Transitioning these fossil-intensive assets at an expedited pace to meet publicly stated targets will require careful and considered **financial, policy, regulatory, and community-focused efforts.**

Over the course of 2023, RMI, in partnership with multiple external stakeholders, conducted an extensive repurposing analysis for a representative coal asset in Indonesia. The objective of this work was **to better understand how the repurposing of coal plants can play a pivotal role in the transition to a low-carbon future.**

Case Study Plant Characteristics

- Located in densely populated Java-Bali
- High-capacity coal power plant providing dispatchable power
- Notable plant balance still left to depreciate
- Debt and equity obligations to fulfill
- Land surrounding plant site biologically important or environmentally sensitive.



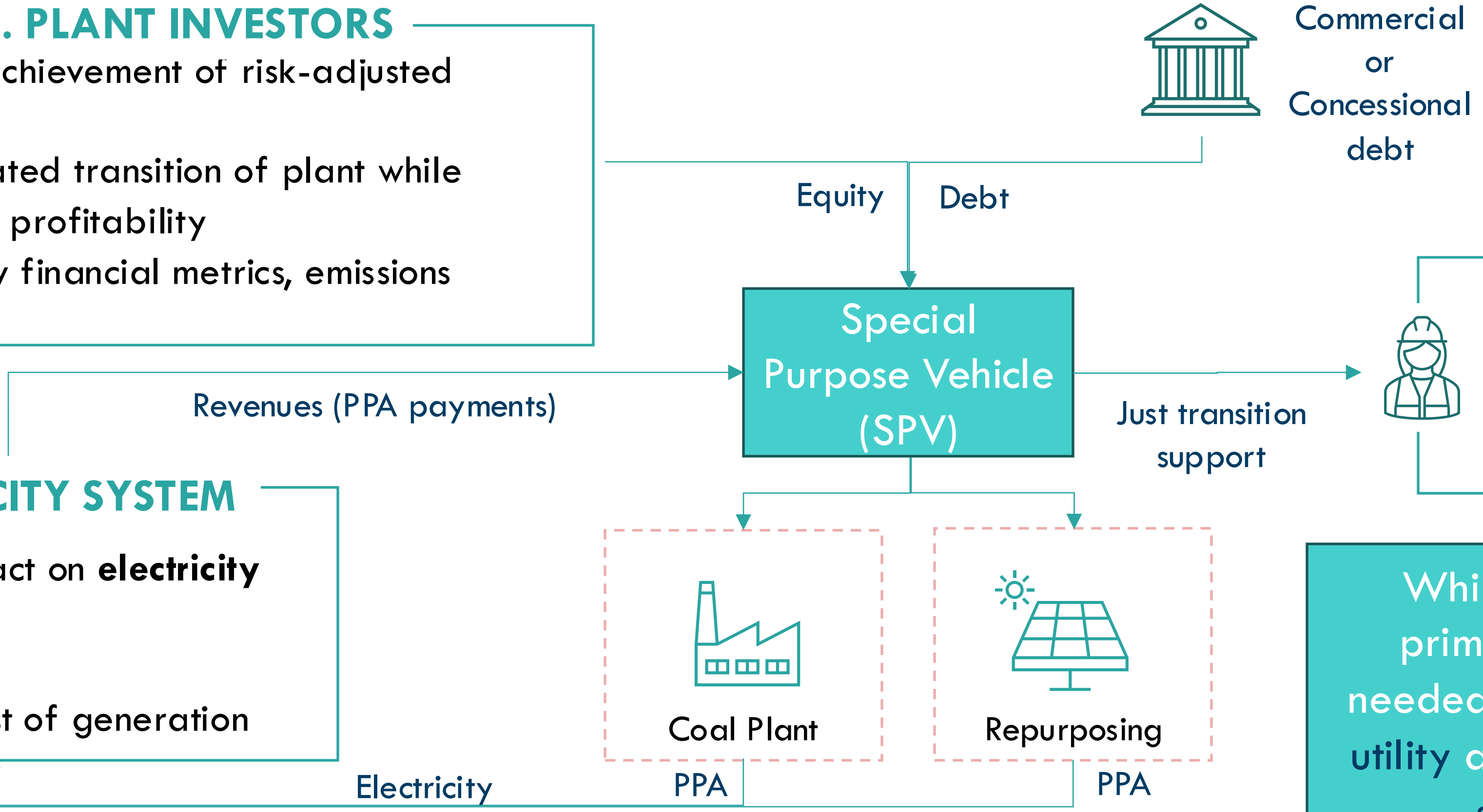
*Values as of 2022. Map data sourced from Global Energy Monitor's Global Coal Plant Tracker

To assist prospective plant investors, RMI utilized and expanded on an existing asset-level model to deliver an analysis on the financial, technical, and climate impacts of various plant repurposing options

1. PLANT INVESTORS

- Ensure achievement of risk-adjusted **returns**
- Accelerated transition of plant while ensuring profitability

Metrics: Key financial metrics, emissions reductions



3. JUST TRANSITION

- Mitigate impact of transition on **workers, communities, other stakeholders**

2. ELECTRICITY SYSTEM

- Mitigate impact on **electricity system costs**

Main metric: Cost of generation

While the SPV investors were the primary audience, the transaction needed to be financially viable for the utility and credible from a climate and social impact perspective

RMI's analysis leverages an asset-level model of the case study plant's retirement and repurposing

Inputs

Inputs

- Coal plant data and inputs
- \+
- Renewable resource techno-economics
- \+
- Cost of capital assumptions

Calculation

Scenario Modeling

- Accelerated coal transition scenarios
- Repurposing scenarios
- Financial structuring scenarios

Results

Key impact metrics

- SPV financial metrics: Projection of cash flows and asset- and SPV-level returns
- Climate metrics: Lifetime CO_{2e} emissions avoided
- Utility financial metrics: Electricity generation costs

RMI paired its asset-level model with a marginal-cost system dispatch model to find the net effect of each retirement pathway

Inputs

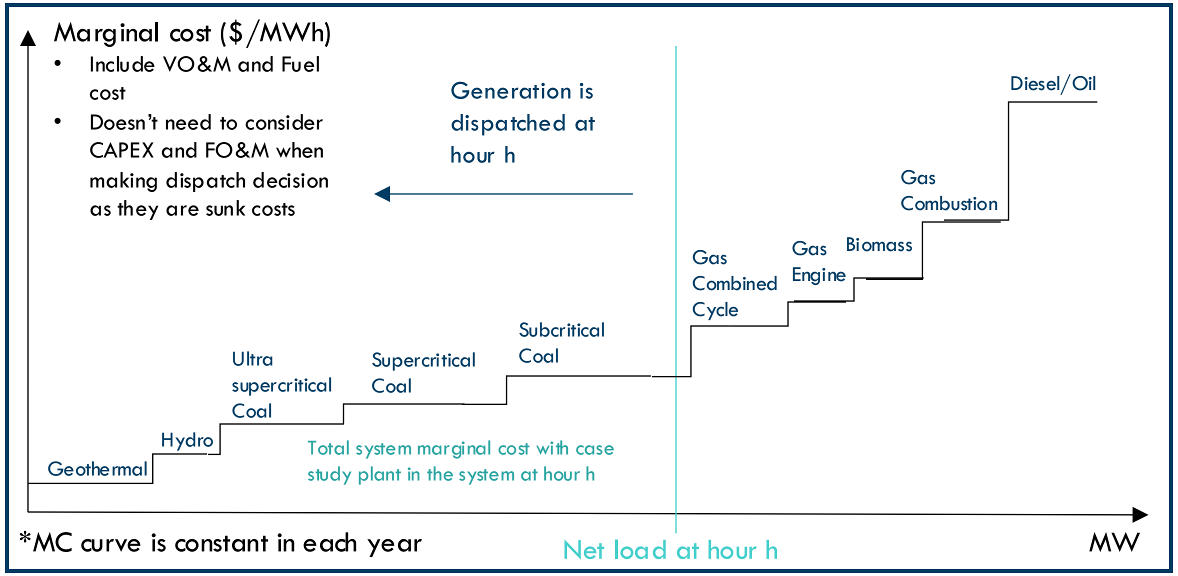
Inputs

- Hourly load (latest available year) and projected growth rate
- Approx. intermittent renewables hourly profile
- Resource mix per year in MW by resource from RUPTL for present-2030 and from other studies for 2030-2061
- Techno-economics for each generation type: min MW, total MW, max capacity factor, marginal cost, emissions intensity

Calculation

Dispatch order

Calculation for every hour of net load (Demand – Must-Run generation including contracted IPP, variable renewable generation, and other non-dispatchable generation



Outputs

- Total generation per technology
- Total variable cost of the system
- Annual CO_2 emissions
- Renewable curtailment
- Storage requirement in MW and MWh
- Average marginal cost with and without RE replacement

RMI explored, qualitatively and quantitatively, potential repurposing options to pair with the plant's retirement

Repurposing Approach	Technological Solution	Upside Possible?	Resource Potential	Space Requirement	Overall Assessment
Post-Retirement Reuse	Solar PV (+ battery storage)	Yes, under government-regulated tariffs	Fair to good	Medium to large footprint per MW, ~5 acres/MW	Explored in analysis
Post-Retirement Reuse	Wind (+ battery storage)	Yes, under government-regulated tariffs	Fair to poor	High footprint, ~30 acres/MW	Not considered due to land constraints and lower resource potential
Post-Retirement Reuse	Geothermal	Yes, under government-regulated tariffs	Requires further feasibility studies	Small footprint, comparable to coal	Could be considered if resources assessed
Post-Retirement Reuse	Floating solar	Yes, under government-regulated tariffs	Fair to poor; due to wave height and wind	High footprint, but no land use issues	Not considered due to bay-specific challenges
Lower Emissions Continuous Output	Biomass co-firing	Yes, if it can be more cost-effective than coal	Sawdust potential exists, full potential requires further assessment	Similar to coal, dependent on volume co-fired on site	Explored in analysis
Operational Flexibility	Standalone storage (battery or thermal)	None under current regulation	Battery storage mature; thermal storage more nascent technology	Small footprint	Could be considered in future if remunerated
Operational Flexibility	Flexible operation	None under current regulation	Similar to continued coal operation	Same footprint as coal	Could be considered in future if remunerated

The analysis ultimately focused on four accelerated retirement and repurposing scenarios for the case study plant

Baseline: Continued operation to end of technical life	• Plant operated under **existing ownership** • Used as the base case for comparing **electricity generation costs** in accelerated retirement scenarios
Transition Scenario 1: Early retirement with no repurposing	• Plant retired early under **new ownership** • After retirement, **grid energy** replaces plant generation • Used as base case for comparing **upside of repurposing options** for investors
Transition Scenario 2: Early retirement with clean repurposing	• Plant retired early under **new ownership,** with **repurposing of site** with clean energy • After retirement, **clean energy and grid energy** replace plant generation
Transition Scenario 3: Co-firing with sawdust and early retirement	• Plant retired early with **biomass co-firing** under **new ownership** • Requires additional **capex to retrofit** the plant, but possibly lower fuel costs and emissions
Transition Scenario 4: Co-firing with sawdust to end of technical life	• Plant operated until end of technical life with **biomass co-firing** under **new ownership** • Requires additional **capex to retrofit** the plant, but possibly lower fuel costs and emissions

RMI's analysis, supported by the findings below, indicates that early retirement and repurposing of the case study plant with clean energy is attractive, if land constraints can be addressed.

Early retirement of the plant without repurposing results in a **financially feasible** retirement scenario for stakeholders. However **blended financing** helps ensure **electricity costs do not increase** due to the transition.

Co-firing of biomass at the plant is **only profitable under the most favorable cost conditions**—and will face additional climate and sustainability scrutiny. The additional capital investments for retrofitting generally outweigh cost savings.

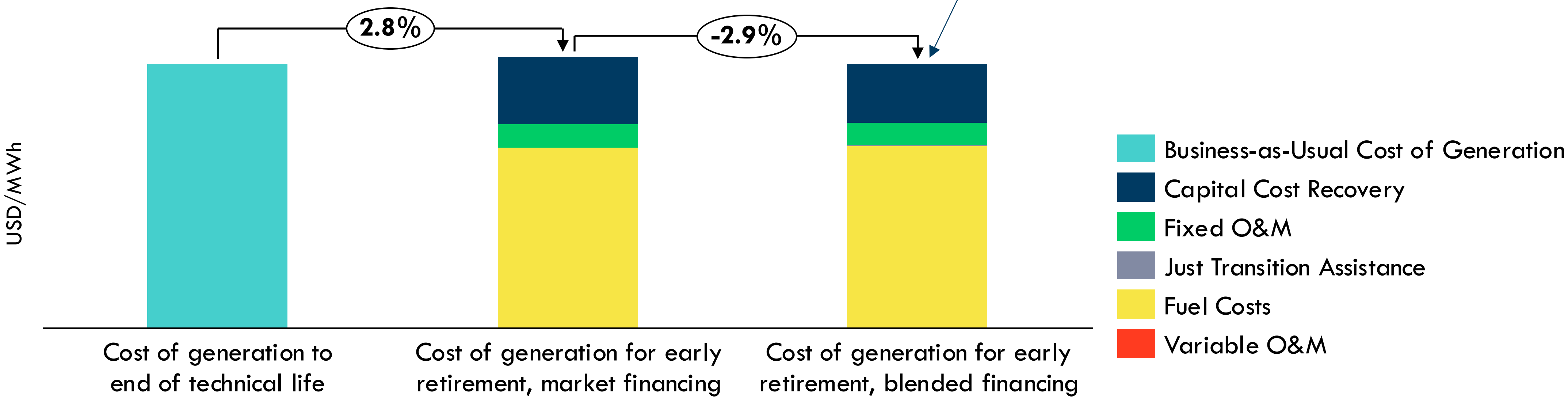
Repurposing the site with **solar PV and battery storage** can provide **additional value** to investors and emissions reductions, but is possibly constrained by **land availability**.

Additional **innovative repurposing options** could emerge if the regulatory framework recognizes alternative opportunities for generating value.

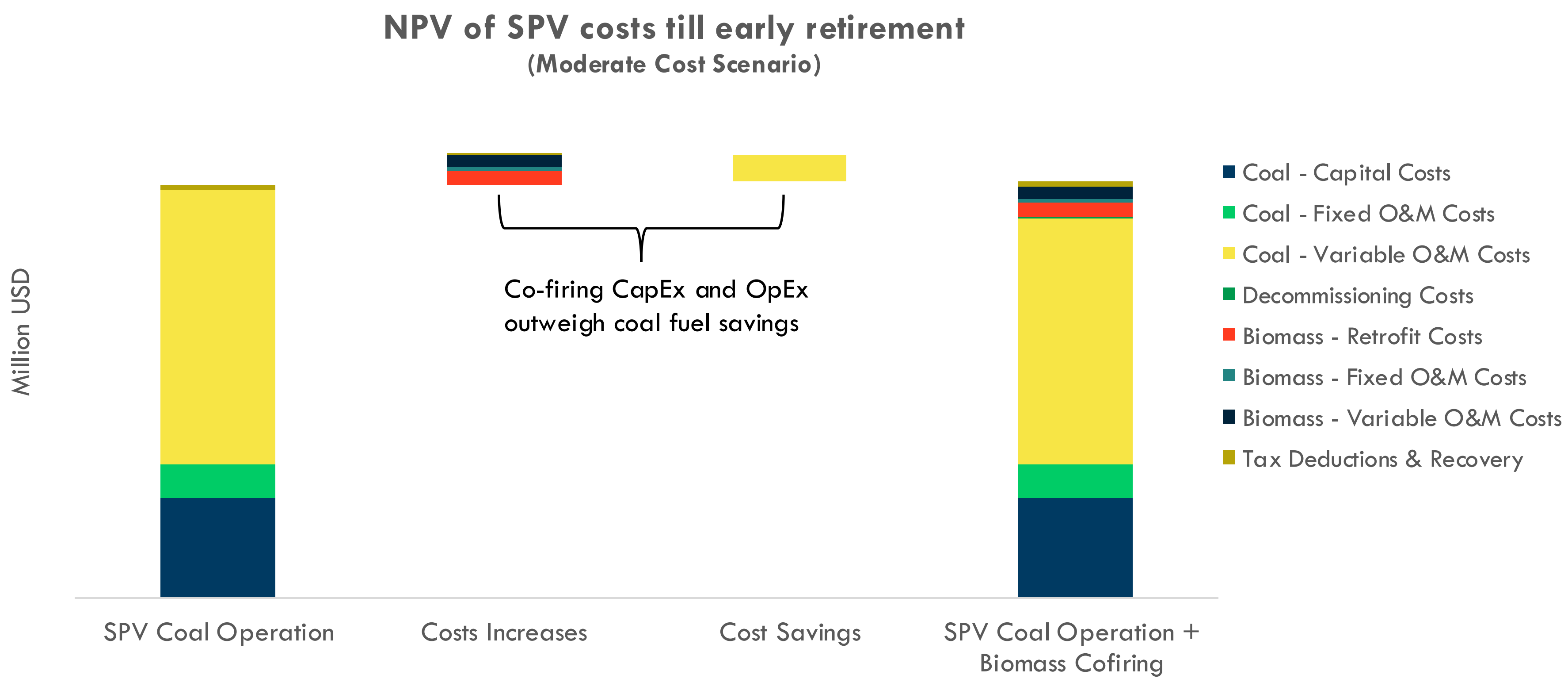
Early retirement of the plant without repurposing results in net benefits for stakeholders, particularly if blended financing can be secured

The PPA tariff required to realize SPV returns is **higher than the business-as-usual cost** of generation under the original ownership

Blended financing allows the tariff to **drop below the business-as-usual and market financing costs** of generation, supporting its financial attractiveness

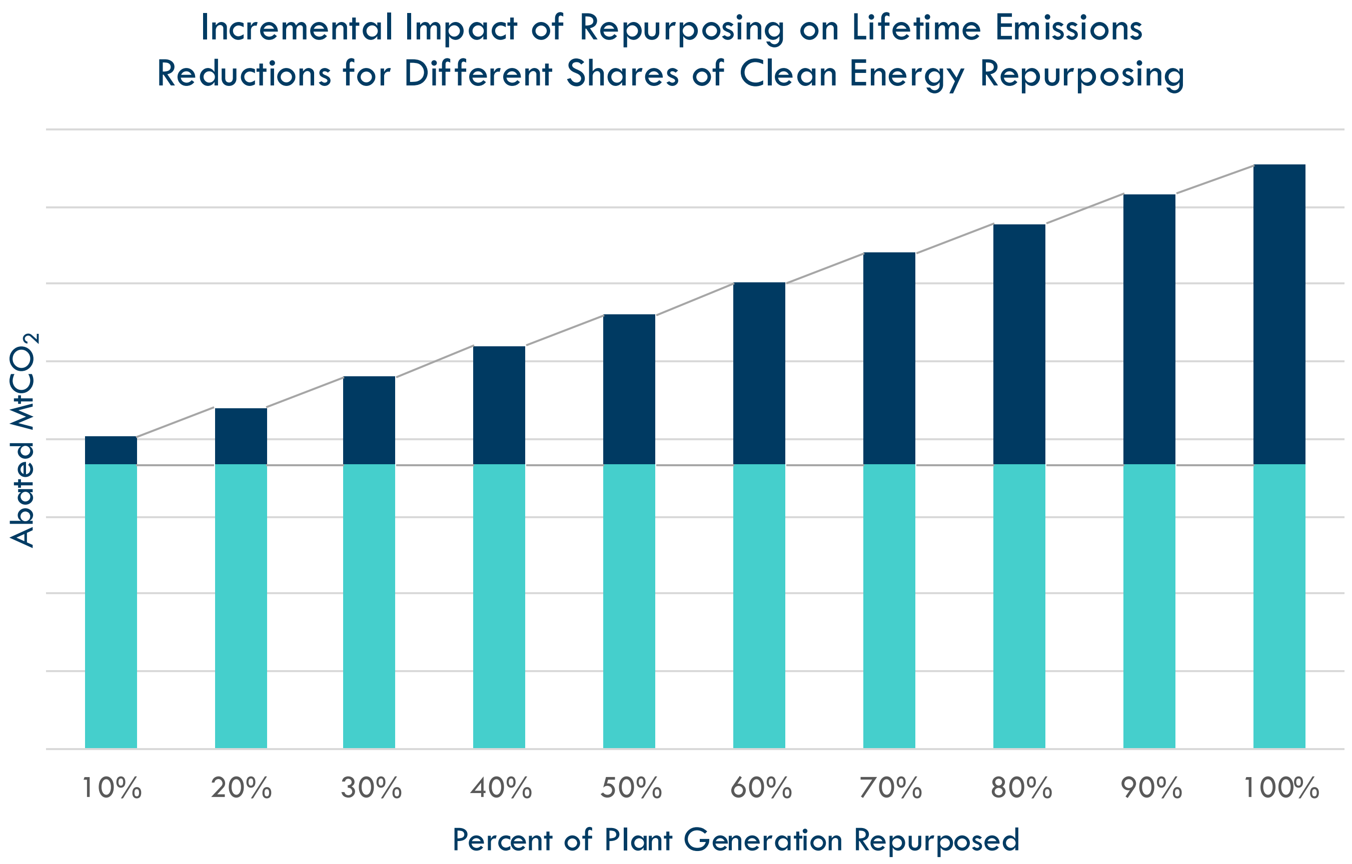


Co-firing biomass at the case study plant increases overall costs, due to the need to retrofit the system and process fuel



- Co-firing the plant to its current technical threshold is not profitable under moderate to high- cost assumptions.
- It only becomes attractive under the lowest cost estimates for retrofits, O&M, and capex
- Will likely face additional climate and sustainability scrutiny

Solar PV and battery storage offers an upside opportunity, but net profits—and emissions reductions—will depend on land availability



- Early retirement with no repurposing would require dispatch of other emitting assets across the grid post retirement
- The greater the clean generating capacity of the repurposed site, the less potential grid emissions leakage
- Building solar PV only on the existing site is constrained by the footprint of solar PV, **resulting in a small system size**
- System sizing for greater financial upside and emissions reductions would require **additional land utilization** around the plant site

Future market evolution and technology developments could warrant consideration of additional site repurposing options

Site Hybridization

- If additional land can be procured, the SPV could **invest in clean energy** at or after the point when the **levelized cost of solar is cheaper** than the **energy component of coal**
- This approach could help **increase overall site profitability,** where the coal asset would still provide capacity and some energy, but the **investors could realize greater cash flows** by **displacing some coal generation with cheaper solar generation**

Stand-Alone (Thermal) Energy Storage

- Instead of burning coal, **thermal mass** could be heated at the plant by **surplus energy from the grid to charge the storage**, which could then be **discharged to the grid on-demand**
- Storage repurposing would continue the **utilization of existing infrastructure** (steam cycle, power generation, and transmission assets)
- It could also **address curtailed electricity from variable renewable energy** and could allow the plant to **retain much of its local employment**

Flexible Operation

- If new regulations create a remuneration model for flexible operation, flexible PPA contract structures could **reduce coal utilization rates** while **maintaining baseload power to the system**