# Utility Sector Decarbonization Pathways for China & Indonesia

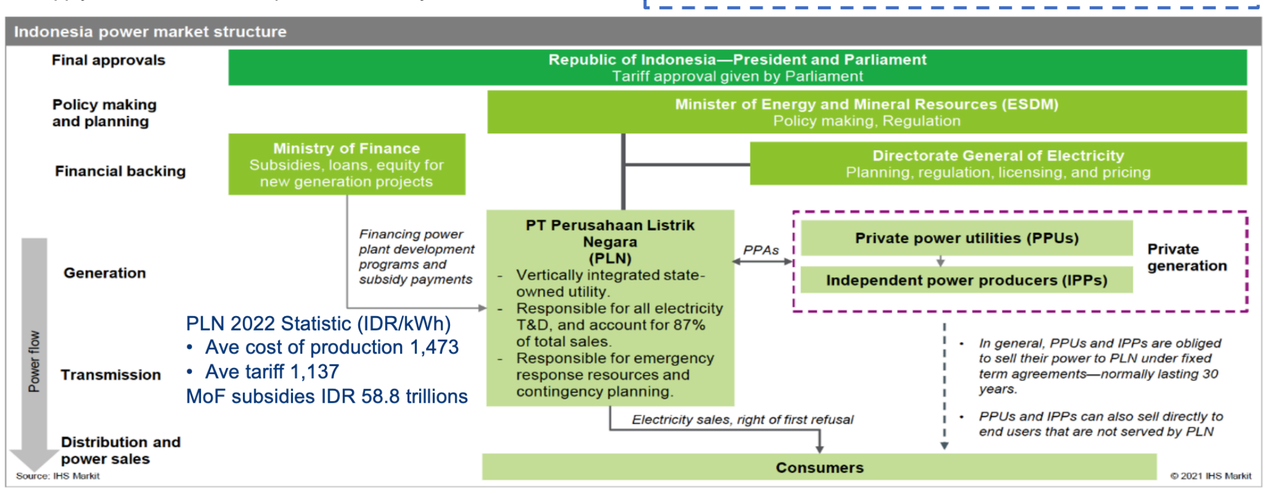
Team Members: CHEN Qinyi (Team Lead), TAN Ye Teng, WU Hao, YIN Hongru
Advisors: Johan SULAEMAN (SGFIN) and an Asset Management firm

Cost-Benefit Analysis of Indonesia Coal-Fired Power Plant Decarbonization Options: Considering the Utility Market Structure, Regulatory Landscape, Carbon Pricing Instruments, Technology Viability and Socio-Economic Context

## Indonesia Utility Market Structure

- Harga Batubara Acuan (HBA): Government's monthly reference export price for high-quality coal. Jun-2024 HBA US$123/ton but US$70/ton price cap on coal sold to state electricity utility PLN
- Domestic Market Obligation (DMO) mandates coal miners to supply 25% of their annual production locally but not enforce

**Resulted in**
- PLN **locking in on CFPPs** due to cost of electricity produced by CFPP is much lower than that of other technologies, e.g., renewable energy
- **Coal supply shortage** when HBA is much higher than price cap => impact on energy supply security and resiliency




*Source: IHS Markit. Indonesia Power Market Profile. February 2021*

## China CFPP EPO and Replace with Nuclear Energy

### SMR LCOE

- **The levelized cost of electricity (LCOE) of HTR-PM(Huaneng) is lower** than KLT-40S(Russia) and CAREM-25(Argentina).
- **HTR-PM has a high technology readiness level (TRL) value of 8,** which means that the technology has been demonstrated to function reliably in an operational environment.

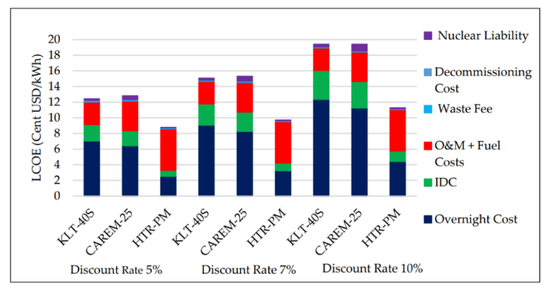
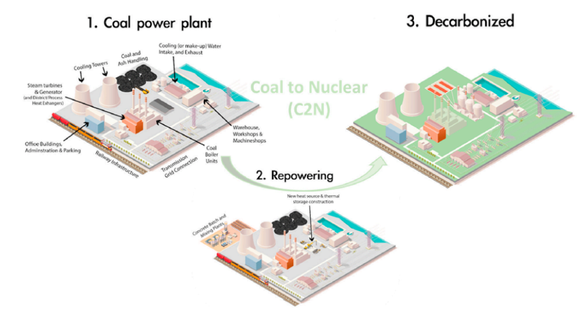



**Figure 8.** Graph of the distribution of cost components of CAREM-25, KLT-40S, and HTR-PM LCOE with various discount rates.

### Coal Fired Power Plants Retrofit (C2N)

- **Shandong Nuclear Power Plant:** replace 1800 MW of coal-fired power plant capacity.
- **Fujian Nuclear Power Plant (Huaneng):** replace 1800 MW of coal-fired power plant capacity.

*Source: Nuclear Power Plant to Support Indonesia's Net Zero Emissions, Energies 2023*




## Indonesia "Cap-Trade-And-Tax" System Accelerate Decarbonization

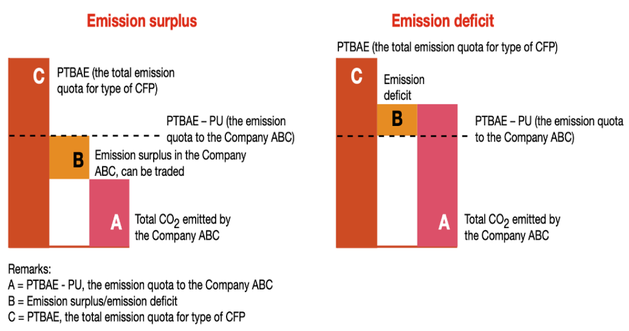
### Emissions Trading System (ETS)

**Intensity based:** Plants receive free allowance based on the intensity cap.

**A hybrid "cap-trade-and-tax" system:**
- Coal plants that have not surrendered a sufficient amount of allowances or offsets under the scheme will be subjected to a carbon tax at **a fixed price of IDR 30/kg CO2 (USD 2/tCO2)**

Emission cap: **0.9 tCO2/MWh**
Emission intensity for 1 GW Jawa-8 Ultra Supercritical (USC) CFPP: **0.873 tCO2/MWh**
Annual net energy production: **6,622 GWh**
**Assumption: carbon trading price= carbon tax**

### Indonesia ETS Mechanism




*Source: PwC 2023 "Power in Indonesia: Taxation and Investment Guide"*

### Conclusion

- BAU Scenario: annual surplus of **USD 357,588**
- EPO Scenario: annual surplus of **USD 8.3 million**
- Carbon pricing instruments (i.e., carbon tax and carbon trade) accelerate early phase out of CFPP

## CFPP Early Retirement Through Transition Carbon Credits

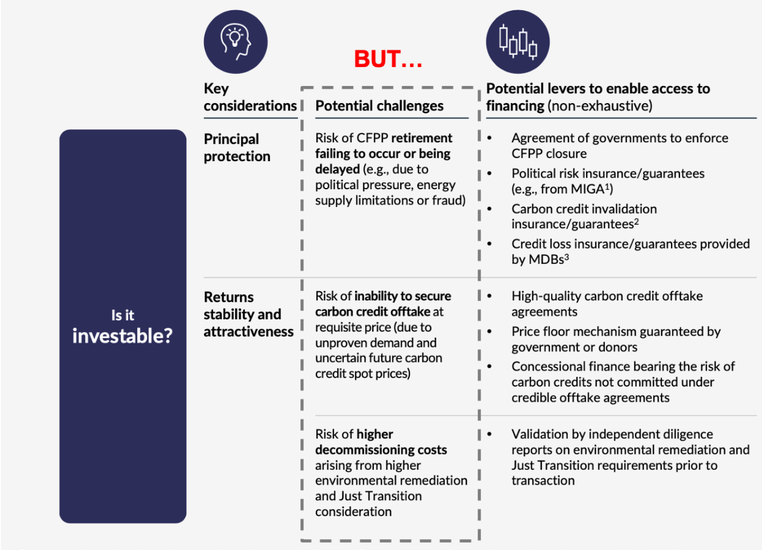
### Pain Points of Existing Carbon Credits

- Lack of additionality
- Verification and monitoring challenges
- Double counting
- Market saturation and low prices

### What is Transition Carbon Credit?

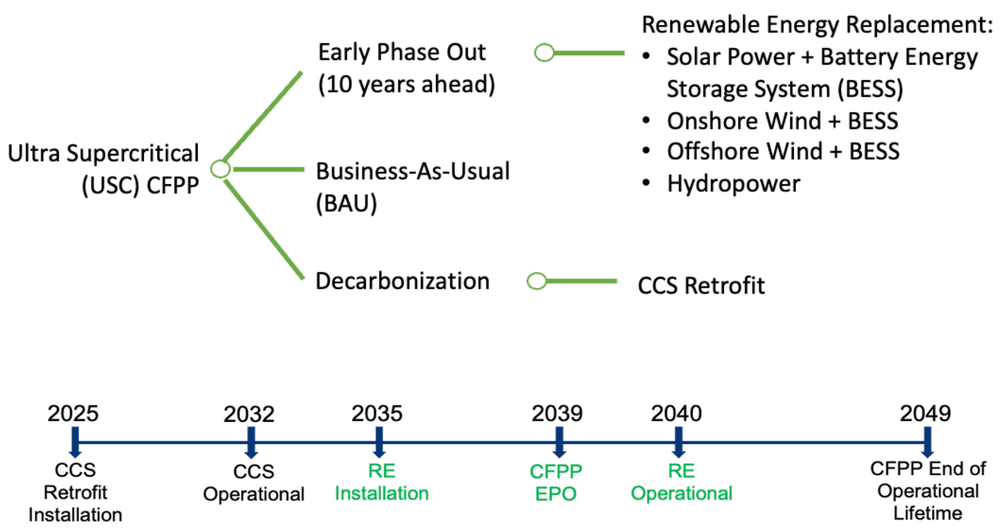
Credits generated from the **early retirement** of a CFPP and its replacement with a **cleaner energy source** demonstrates irreversible action to reduce emissions at source, and could be classified as high-quality credits and differentiated from existing avoidance credits

### Challenges to financing early retirement of CFPP with transition credits



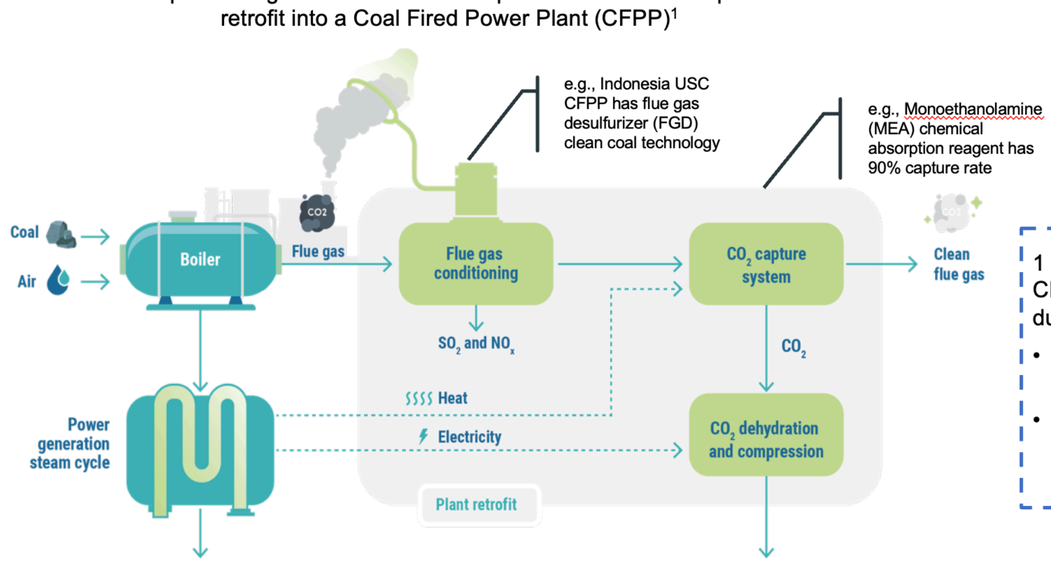

*Source: Accelerating the early retirement of coal-fired power plants through carbon credits, MAS*

## Case Study Scenarios




## Scenario: CFPP Retrofit with CCS Technology

Simplified diagram of additional components for carbon capture retrofit into a Coal Fired Power Plant (CFPP)[1]




1 GW Jawa-8 Ultra Supercritical (USC) CFPP is most suitable for CCS retrofit due to:
- USC is built with FGD system, thus minimize CCS cost
- Longest remaining lifetime in Indonesia existing USC CFPP, which maximize CCS's benefit

*Source:*
- *[1] Coal's endgame: Cost-benefit analysis (CBA) of early retirement coalfired power plant (CFPP) versus CFPP with carbon capture and storage (CCS). Clean, Affordable and Secure Energy for Southeast Asia (CASE) in Indonesia (CASE Indonesia).*
- *ERIA. (2022). Study on the Potential for Promoting Carbon Dioxide Capture, Utilization, and Storage (CCUS) in ASEAN Countries Vol. II*
- *World Bank. (2015). The Indonesia Carbon Capture Storage (CCS) Capacity Building Program CCS for Coal-fired Power Plants in Indonesia.*

## Scenario Cost Components

| Cost (year) | REF | CCS | EPO (solar) | EPO (onshore wind) | EPO (offshore wind) | EPO (Hydro Large) |
|---|---|---|---|---|---|---|
| CCS CAPEX | No | Yes | No | No | No | No |
| CCS OPEX | No | Yes (7-24) | No | No | No | No |
| Stranded asset | No | No | Yes (14) | Yes (14) | Yes (14) | Yes (14) |
| Rehiring package | No | No | Yes (14) | Yes (14) | Yes (14) | Yes (14) |
| Income losses | No | No | Yes (15-24) | Yes (15-24) | Yes (15-24) | Yes (15-24) |
| State revenue losses | No | No | Yes (15-24) | Yes (15-24) | Yes (15-24) | Yes (15-24) |
| Decommissioning cost | Yes (24) | Yes (24) | Yes (14) | Yes (14) | Yes (14) | Yes (14) |
| Solar power CAPEX | Yes (19) | Yes (19) | Yes (10) | No | No | No |
| Solar power OPEX | No | No | Yes (15-24) | No | No | No |
| BESS CAPEX | No | No | Yes (10) | Yes (10) | Yes (10) | No |
| BESS OPEX | No | No | Yes (15-24) | Yes (15-24) | Yes (15-24) | No |
| CFPP Operational cost | Yes (0-24) | Yes (0-24) | Yes (0-14) | Yes (0-14) | Yes (0-14) | Yes (0-14) |
| Electricity subsidy | Yes (0-24) | Yes (0-24) | Yes (0-14) | Yes (0-14) | Yes (0-14) | Yes (0-14) |
| Onsore Wind Power CAPEX | No | No | No | Yes (10) | No | No |
| Onsore Wind Power OPEX | No | No | No | Yes (15-24) | No | No |
| Offshore Wind Power CAPEX | No | No | No | No | Yes (10) | No |
| Offsore Wind Power OPEX | No | No | No | No | Yes (15-24) | No |
| Offsore Wind Power variable OPEX | No | No | No | No | Yes (15-24) | No |
| Hydro Power Large CAPEX | No | No | No | No | No | Yes (10) |
| Hydro Power Large OPEX | No | No | No | No | No | Yes (15-24) |
| Hydro Power Large variable OPEX | No | No | No | No | No | Yes (15-24) |

## Recommendations For CFPP Decarbonization

### Option Recommendation

**1st – EPO with Solar**
- Cost-effectiveness
- Large potential remains

**2nd – CCS Retrofit**
- Maximize the utility of CFPP
- Help to develop Indonesia's storage and utilization potential to generate benefits

**Other Less Recommended – EPO with Wind & Hydro**
- Higher costs economically and environmentally
- Relatively less potential

### Factors Need to Pay Attention to

**Technology Costs**
- All technologies are quickly developing which may gradually decrease the cost in the future. It can significantly influence the value of decarbonization projects

**Government Support and Financial Incentives**
- Financing benefits are crucial for projects to get funding to start

**Environmental and Social Impact**
- Decarbonization projects create large impacts on many stakeholders in society, should also consider environmental risks and community effects

**Energy Supply**
- Should consider the reliability and consistency of energy supply when implementing technologies