SCHOOL OF PUBLIC POLICY
CENTER FOR GLOBAL SUSTAINABILITY

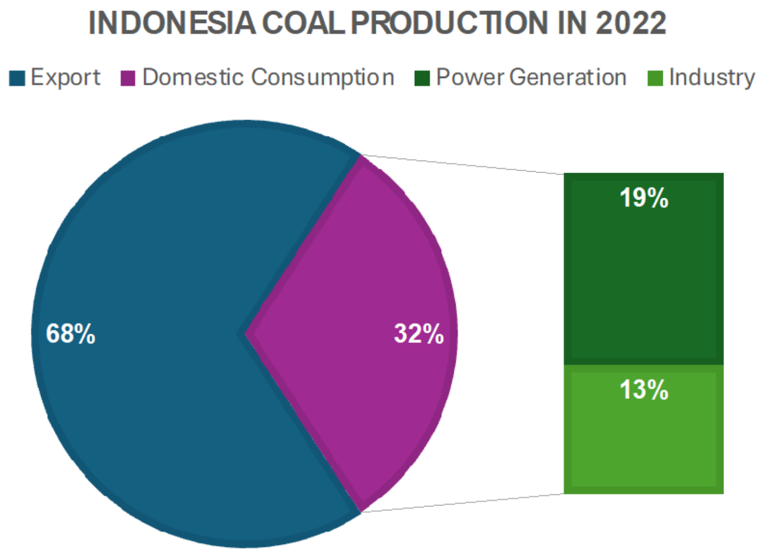
Center for Global Sustainability
Analytics for Ambition | Collective Action

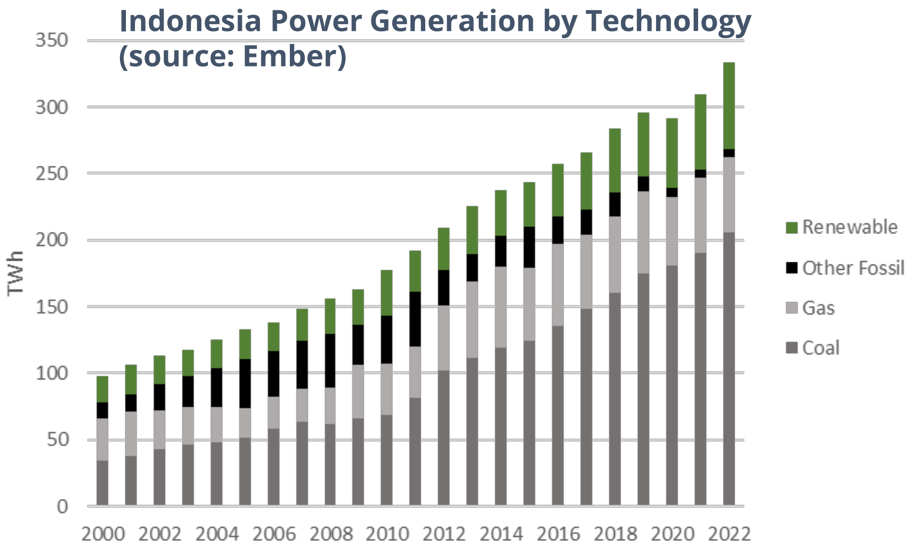
Opportunities and Challenges for Indonesia's Coal Transition

Coal Joint Technical Session: Transforming Energy Sector Infrastructure
2024 Global Methane Forum
18-21 March 2024 • Geneva, Switzerland

International financial mechanisms were set up to help Indonesia deliver an ambitious and just power system transition

- Indonesia is one of world's largest coal producers, with rapidly growing domestic demand.
- Indonesia has indicated its desire to move away from coal towards renewable energy and to achieve net-zero emissions by 2060.
- Indonesia's Just Energy Transition Partnership (JETP) was launched with G7 in 2022, including power sector targets and a finance deal:
    - Peak power sector emissions at 290 $MtCO_2$ in 2030,
    - 34% RE in total generation in 2030,
    - net zero power sector emissions by 2050,
    - an initial $20 billion in public and private financing (3-5 years).
- The Government of Indonesia published the draft Comprehensive Investment and Policy Plan (CIPP) in late 2023, outlining the roadmap for power sector decarbonization to support JETP implementation.





We conducted a series of analysis, assessing emerging policy questions and the transition opportunities and challenges for Indonesia

- Detailed plant-by-plant retirement pathways and financing needs and allocation (Cui et al., 2022)
- Implication to international developers' overseas coal assets (Cui et al., 2023)
- Rapidly growing captive coal power capacity (Zhu et al., 2023)
- Biomass supply for co-firing and impacts on land-use emissions (Squire et al., 2024)
- 1.5C-alighed transition plan beyond the CIPP (Borrero et al., forthcoming)
- Comprehensive database of Indonesia's industrial park (Lou et al., forthcoming)

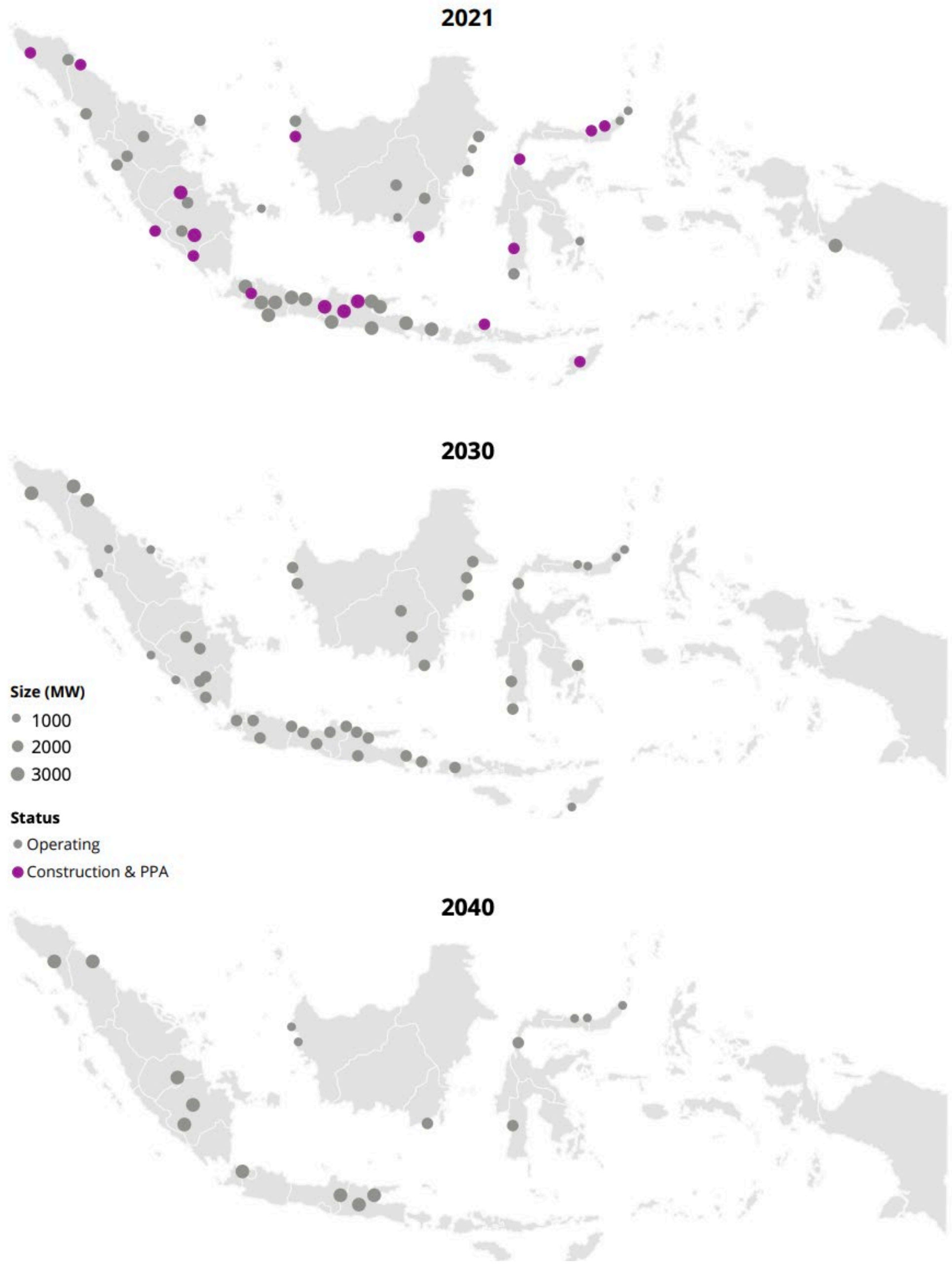
Retirement schedule for individual CFPPs based on national 1.5°C coal power pathway from IAM and plant ranking

- The national coal power generation constraint from GCAM is met by retiring coal plants one by one starting from the lowest to highest combined score at today's utilization levels.
- We then apply a minimum guaranteed lifetime (20 years) to plants that are retired before that age, except for the LHF plants. Retirement schedule for PLN and IPP plants are as follow:

Table 2. PLN and IPP coal plants retirement schedule

# of Plants, GW	PLN Retirement	IPP Retirement	Total Retirement
2022-2030	8 plants, 5.0 GW	10 plants, 4.2 GW	18 plants, 9.2 GW
2031-2040	18 plants, 7.6 GW	21 plants, 14.1 GW	39 plants, 21.7 GW
2041-2045	5 plants, 3.1 GW	10 plants, 9.4 GW	15 plants, 12.5 GW

- With minimum lifetime, some plants are now retired later than needed to meet the national coal generation constraints from GCAM, average utilization will decline from 5,935 hours today to 4,807 hours by 2030, and 1,090 hours by 2040.



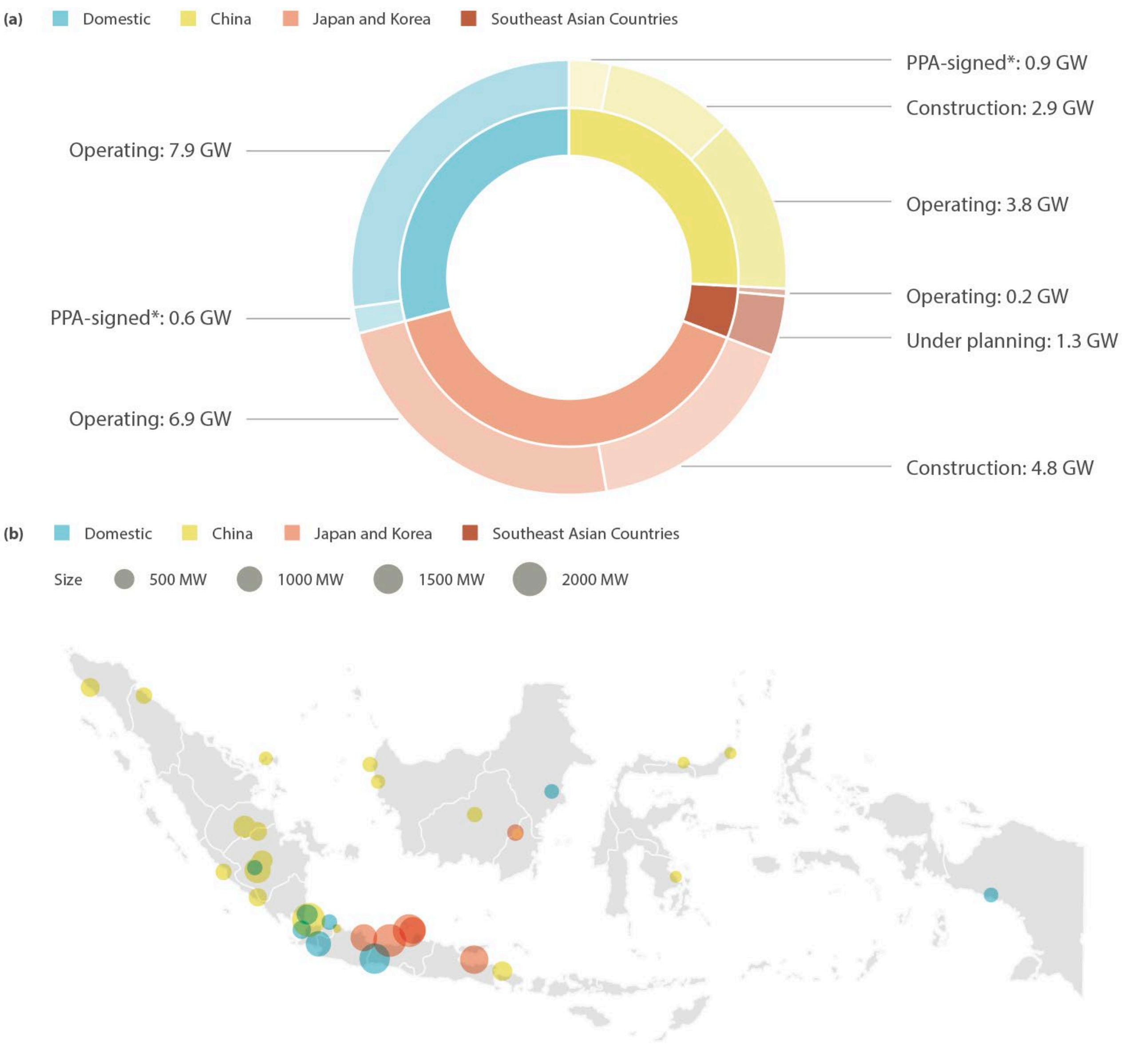
R. Cui, et. al. (August 2022). "Financing Indonesia's coal phase-out: A just and accelerated retirement pathway to net-zero." CGS, UMD, , College Park, USA; IESR, Jakarta, Indonesia.

How Indonesia's JETP may affect international coal developers' overseas assets

- Over 70% of the existing and new IPP projects in Indonesia involve one or more international developers
- 94% of the new IPP projects (under-construction, PPA-signed, or under-planning) are sponsored by international companies (9.9 GW), while only 0.6 GW is solely developed by domestic IPPs.
- Increasingly international developers' overseas coal power assets will be affected by the host country's climate and energy transition ambition.
- Provide a possible early retirement schedule to better understand the potential implications of JET-P on overseas assets

R. Cui, et al. (March 2023). "How an accelerated coal transition in Indonesia may affect Chinese developers." CGS, UMD and IESR. 21pp.

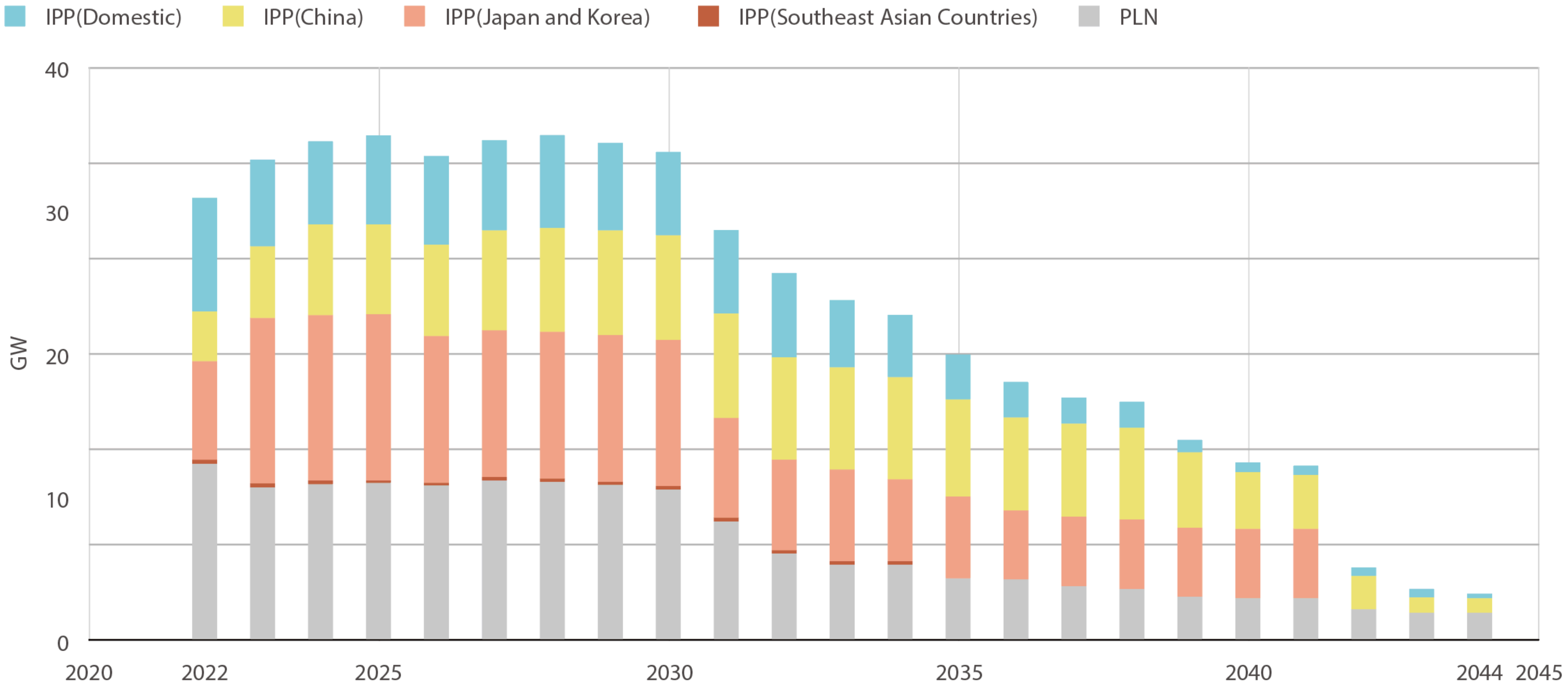
Figure 2. Indonesia's coal power plants owned by independent power producers: (a) Capacity by developers' country and project status (pie chart); and (b) plant location (map).*



*Note: plant data based on GCPT (July 2022) and authors' verification as of October 2022

According the scenario, 4.2 GW of IPP plants retire by 2030, of which 2.7 GW is developed by domestic IPPs, 1.5 GW by Japanese and South Korean companies, and only 50 MW involves Chinese developers.

Figure 3. Total grid-connected operating coal power capacity in Indonesia by developer group, 2022–2045*



*Note: based on analysis in Cui et al. (2022), which includes capacity additions and retirements in 2022 that are part of the scenario, not historical data.

R. Cui, et al. (March 2023). "How an accelerated coal transition in Indonesia may affect Chinese developers." CGS, UMD and IESR. 21 pp.

- With new projects under construction, the total operating capacity of the Chinese-involved IPP plants will continue to grow and reach 7.6 GW, double from today, within the next few years.
- Over 92% of the Chinese-involved capacity does not retire until after 2035, and over 50% not until after 2040.
- None of the Chinese IPP plants operate for more than 20 years, compared to a typical coal lifetime of 30-40 years; and those in operation after 2040 will run less than 900 hours per year, shifting from baseload to peaking service by gradually lowering the utilization levels.

We develop a framework to assess the financing need for implementing the proposed retirement pathway through a just transition

Economic

- Stranded assets for PLN
- Decommissioning cost
- Avoided coal electricity subsidies
- Early retirement compensation for IPP
- State coal revenue losses
- Tax income losses
- Policy incentives for RE deployment
- Energy access

Social

- Fiscal support for job losses (CFPP and supply chain)
- Job losses compensation (CFPP and supply chain)
- Public health benefits
- Human development
- Green job growth
- CFPP support to surrounding community
- Job and income losses (CFPP and supply chain)

Environmental

- Avoided air pollution control retrofit cost
- Reclamation cost
- Air quality improvement
- Water savings and water quality
- GHG emission reductions

KEY Coal-related Industry | Government | Public | Benefit | Cost | Uncertain Outcomes

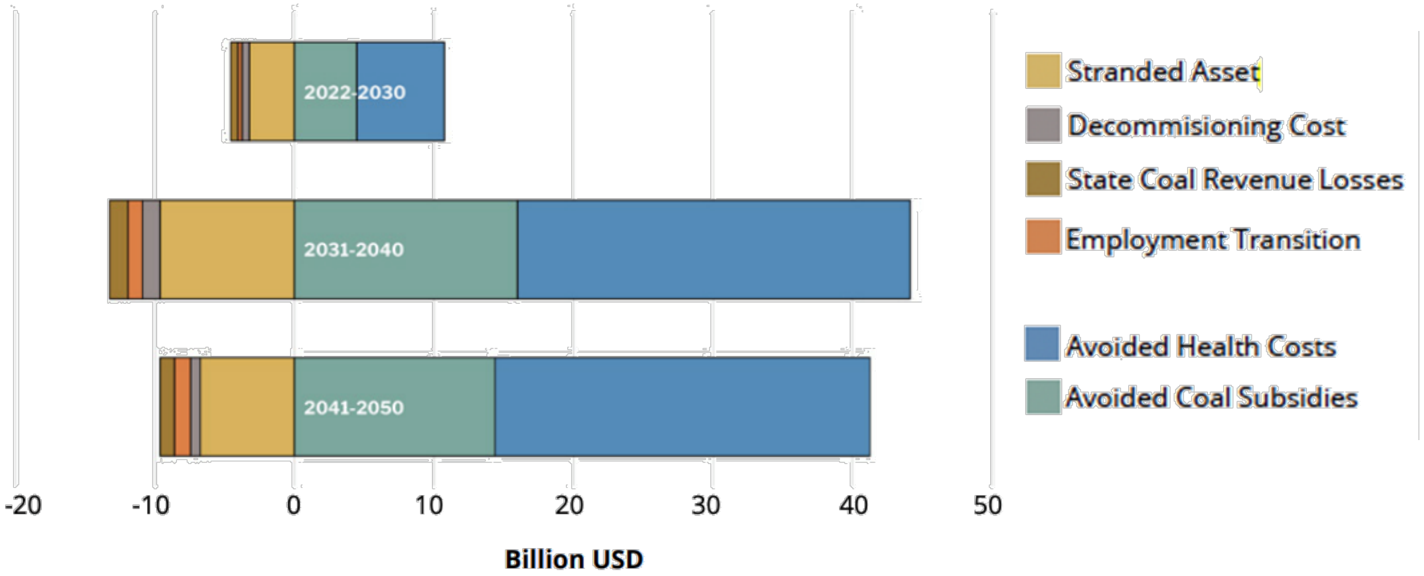
The framework covers the economic, social, and environmental benefits (blue) and costs (green) or uncertain outcomes (yellow) that are either directly or indirectly from CFPP retirements for different stakeholders – the coal-related industry, government, and the public.

R. Cui, et. al. (August 2022). "Financing Indonesia's coal phase-out: A just and accelerated retirement pathway to net-zero." CGS, UMD, , College Park, USA; IESR, Jakarta, Indonesia.

The accelerated coal phaseout is feasible and beneficial from the economic and social perspectives

- Using the best data available, we estimate the retirement costs at $4.6 billion through 2030 and $27.5 billion through 2050.
- The total savings from avoided coal power subsidies and avoided public health costs amount to $34.8 and $61.3 billion, respectively.
- The quantified benefits are 2–4 times as large as the quantified costs in each decade.
- The large upfront costs of retirement necessitate substantial international support, despite the larger benefits gained in the long run.

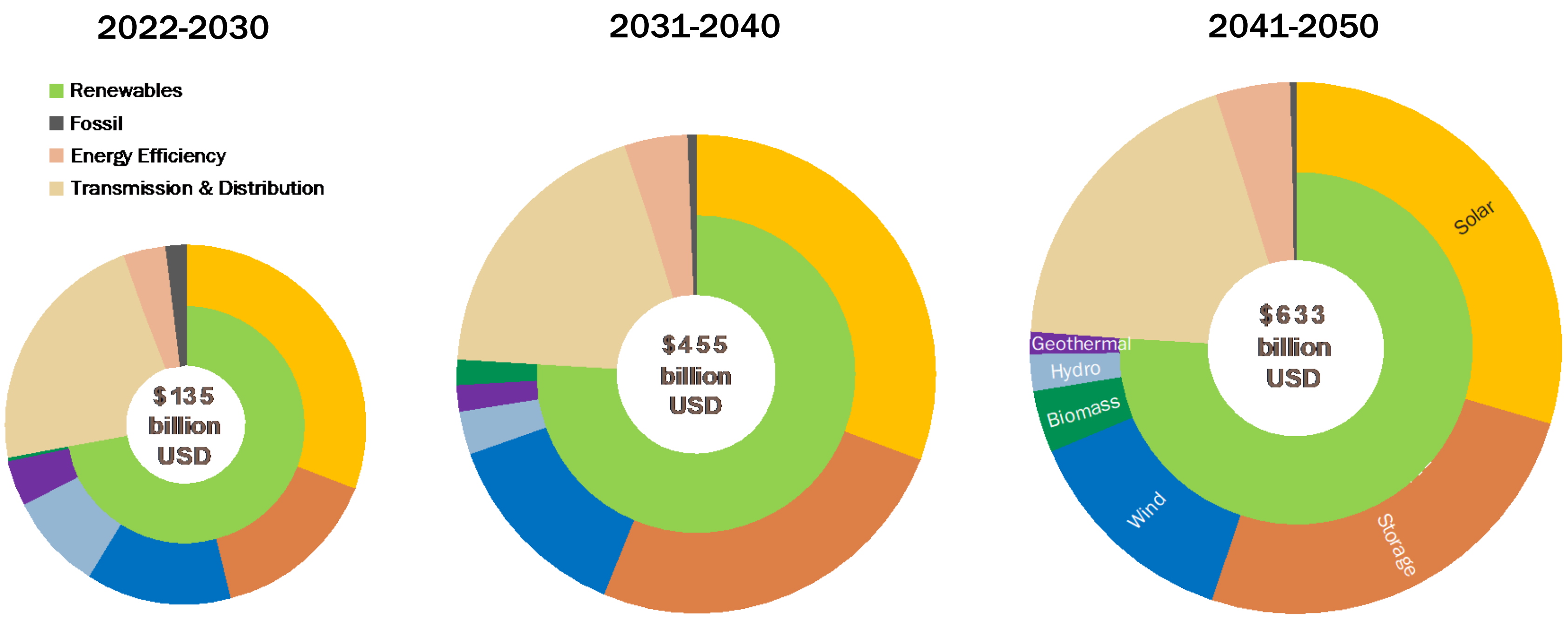
R. Cui, et. al. (August 2022). "Financing Indonesia's coal phase-out: A just and accelerated retirement pathway to net-zero." CGS, UMD, , College Park, USA; IESR, Jakarta, Indonesia.



Metric (million USD)	2022-2030	2031-2040	2041-2050
Stranded Asset	3,233	9,628	6,740
Decommisioning Cost	533	1,259	729
Employment Transition (CFPP & Mining)	272	1,041	1,161
State Coal Revenue Losses	542	1,363	1,012
Avoided Coal Subsidies	4,442	15,998	14,396
Avoided Health Costs	6,292	28,121	26,843

Figure 7. Benefits and costs for implementing the accelerated coal retirement plan in a just way. Benefits are shown as positive numbers and costs as negative numbers on the top bar chart; Benefits are shown in blue and costs in purple in the bottom table.

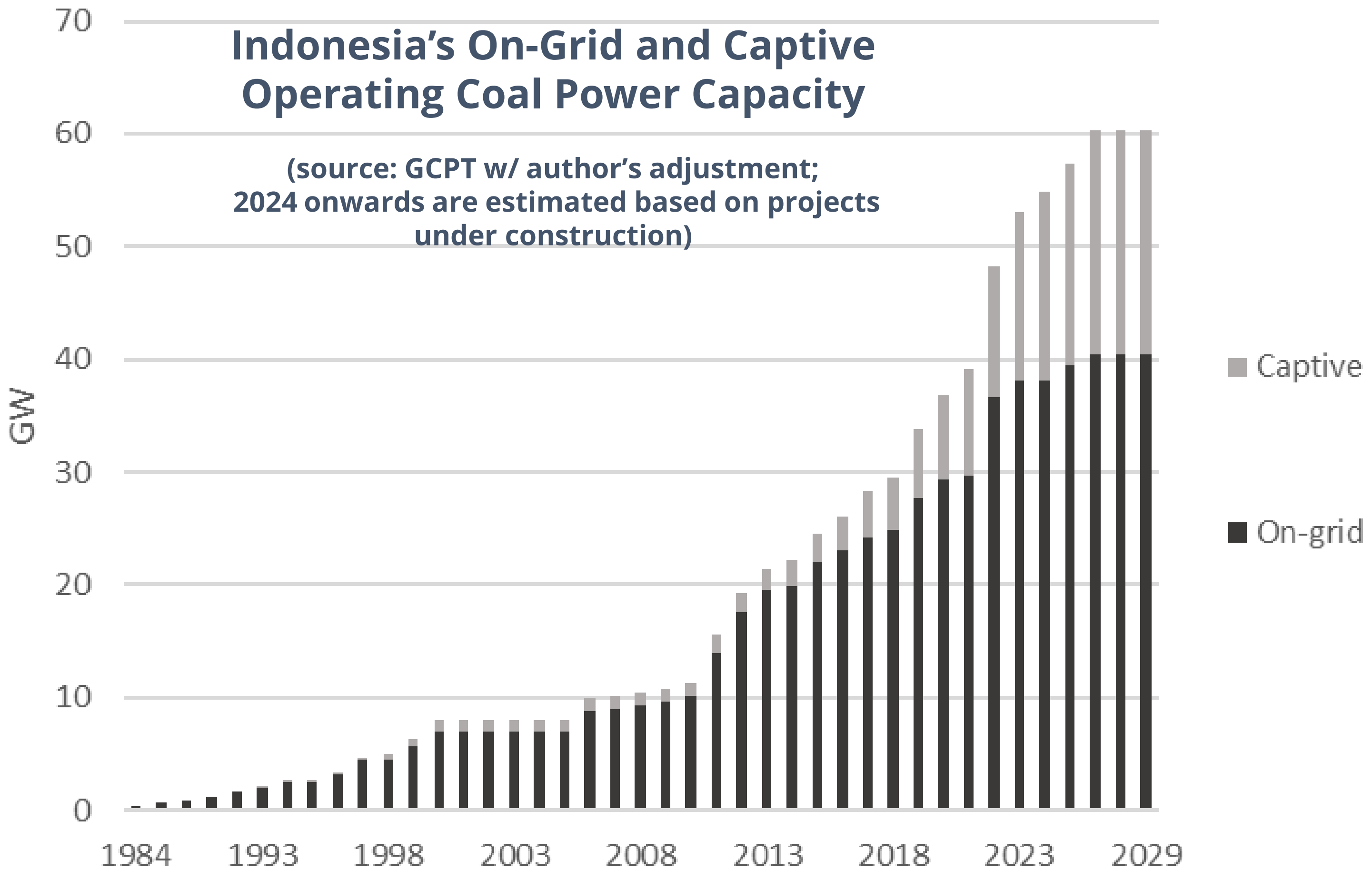
To replace coal and meet increasing demand, energy investments must scale up and shift rapidly to renewables, storage, transmission, and energy efficiency.



- We estimate over 1.2 trillion USD investment on renewables, storage, transmission & distribution, and energy efficiency for 2022-2050.
- The investment must scale up to 135 billion$ between 2022 and 2030. In comparison, the total energy investment (including fossil fuels) has surpassed 35 billion$ for the last five years, where RE investment is about 1.5-2 billion$ annually.
- Most of the investments are expected to come from the private sectors, while the public sector is critical in creating an attractive investment environment through regulations, policy supports, and/or market-based mechanisms.

R. Cui, et. al. (August 2022). "Financing Indonesia's coal phase-out: A just and accelerated retirement pathway to net-zero." CGS, UMD, , College Park, USA; IESR, Jakarta, Indonesia.

Rapid growth of captive coal has caught policy attention only recently and become a key challenge for Indonesia's coal transition



- While Indonesia has banned the development of new coal power plants (Presidential Regulation No. 112 of 2022), captive plants are exempt from this provision.
- As of 2023, Indonesia has 15 GW operating captive coal power plants, representing 28% of the total installed coal capacity.
- After 2025, with the 6 GW under construction projects coming online, captive coal will account for 34% of total installed coal capacity.
- Majority of captive coal capacity was built after 2016.

M. Borrero, et al. (forthcoming). "1.5 °C-aligned coal power transition pathways in Indonesia: additional strategies beyond the Comprehensive Investment and Policy Plan (CIPP)." CGS, UMD and IESR.

Preliminary results, please do not cite

Rapid growth of captive coal power plants are driven by strong economic and industrial demands

Figure 3. Captive power plants's end-use sectors/industries (MW)

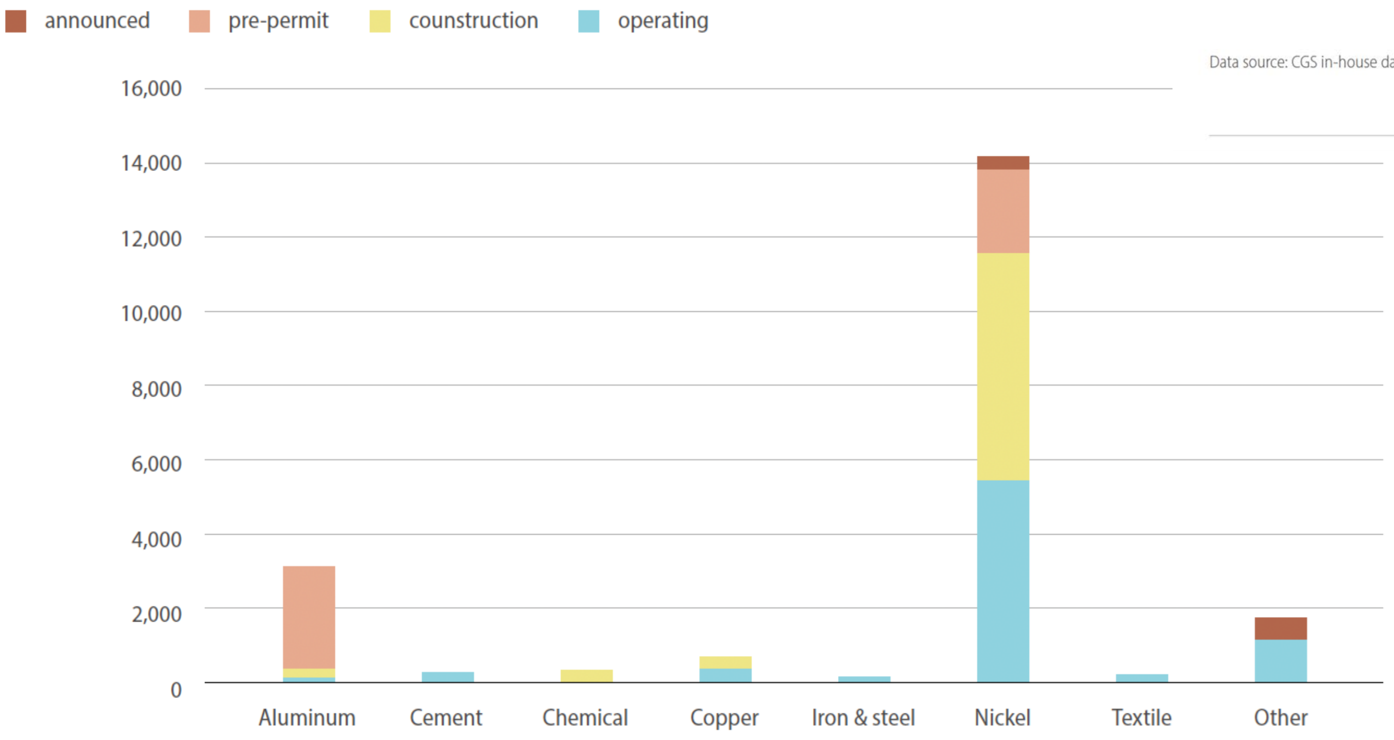
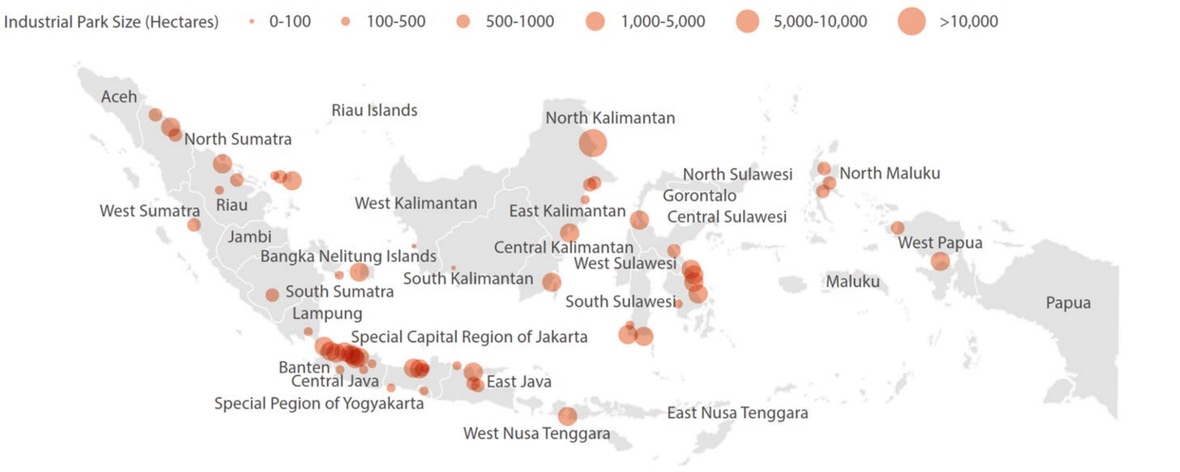


Figure 4. Industrial Parks in Indonesia by area



Data source: CGS in-house data

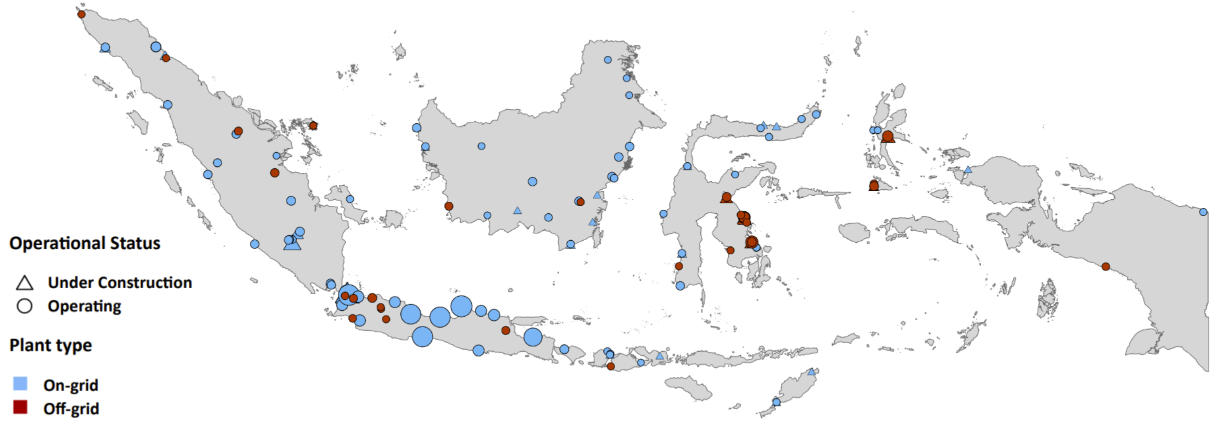
Comprehensive industrial park database to be released soon (Lou et al., forthcoming)

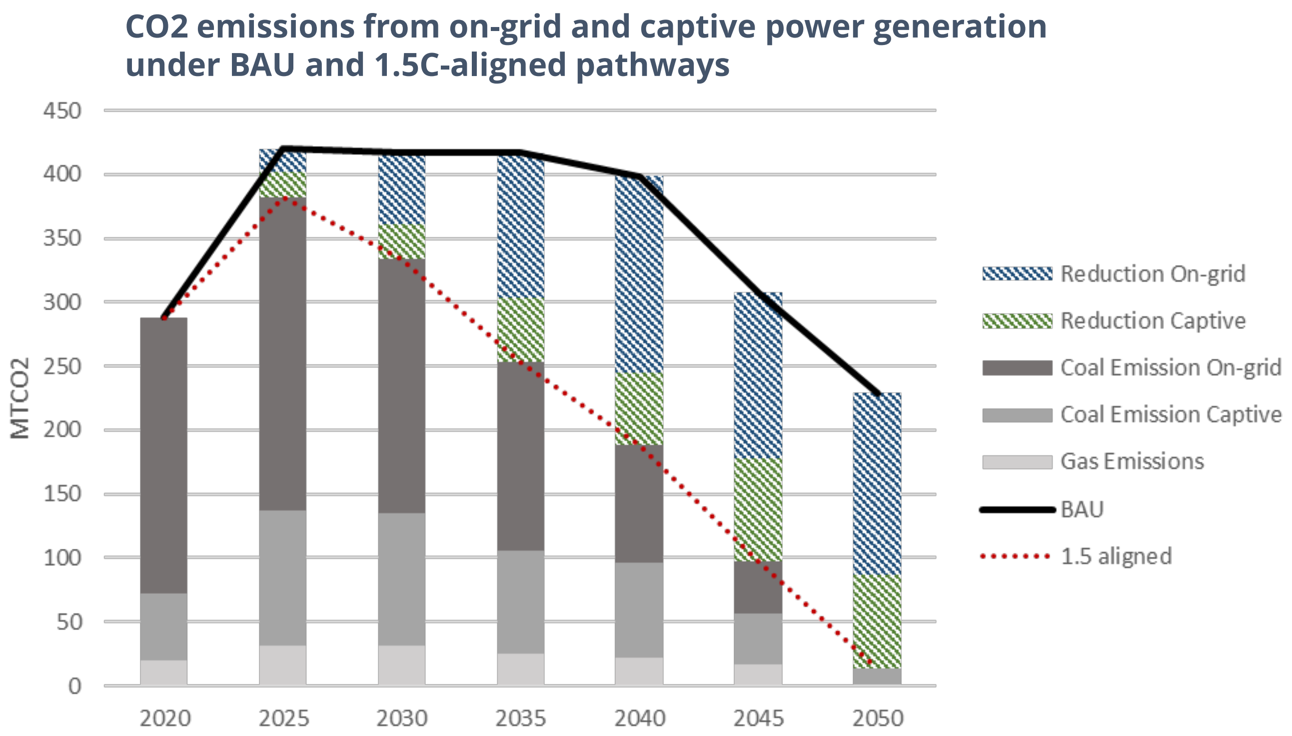
- The mining industry of climate-saving minerals as an engine of economic growth.
- Industrial estates/parks as a policy tool for industrial growth.
- Urbanization and expanding investment in infrastructure.
- Majority projects involve Chinese companies.

M. Zhu, et al. (October 2023). "Decarbonizing captive coal power plants in Indonesia and implications for Chinese stakeholders: Trends, challenges and opportunities." CGS, UMD and IESR. 40pp

A comprehensive plan for 1.5C-aligned power sector transition beyond the CIPP

- A combined pathway covering both on-grid and captive plants, emissions peak at 380 $MtCO_2$ by 2025, decrease by 13% by 2030, 51% by 2040, and ~100% by 2050.
- On-grid plants contribute to two thirds to three quarters of emissions reduction.
- A larger set of transition strategies for individual coal plants:
    - cancellation
    - early retirement (before 30 years)
    - biomass co-firing
    - lower utilization for dispatch
    - CCUS
    - onsite RE substitution (captive)
    - grid connection (captive)



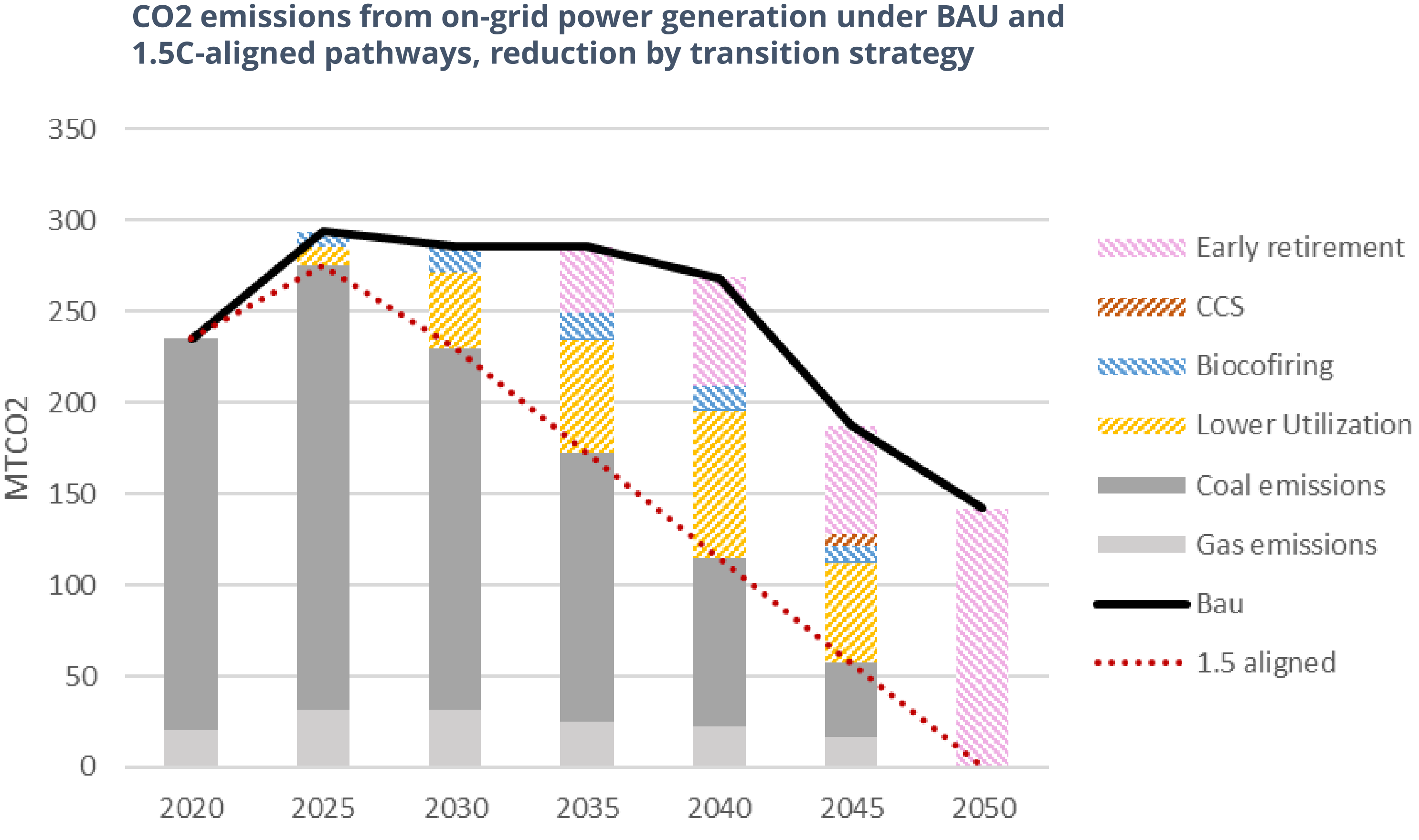


M. Borrero, et al. (forthcoming). "1.5°C-aligned coal power transition pathways in Indonesia: additional strategies beyond the Comprehensive Investment and Policy Plan (CIPP)." CGS, UMD and IESR.

Preliminary results, please do not cite

Emissions reduction pathway for on-grid coal plants by transition strategy

- On-grid plants tend to have more transition options compared to captive plants and thus deliver more reductions in the near term.
- Emissions peak at 275 $MtCO_2$ in 2025 and follow roughly a linear pathway to zero emissions by 2050.
- By 2030, 75% of the reduction is attributed to lower utilization, and 25% to biomass cofiring. Post-2030, early retirement comes in as a main strategy.
- **Flexible plants:** 53 units (8 GW) to reduce utilization to 40% in 2030 and to 30% from 2035 onward.
- **Biomass co-firing:** 103 units (5 GW) with blending ratio of 5% in 2024 to 57% by 2030; 374 MW stroker plants to 100% by 2035.



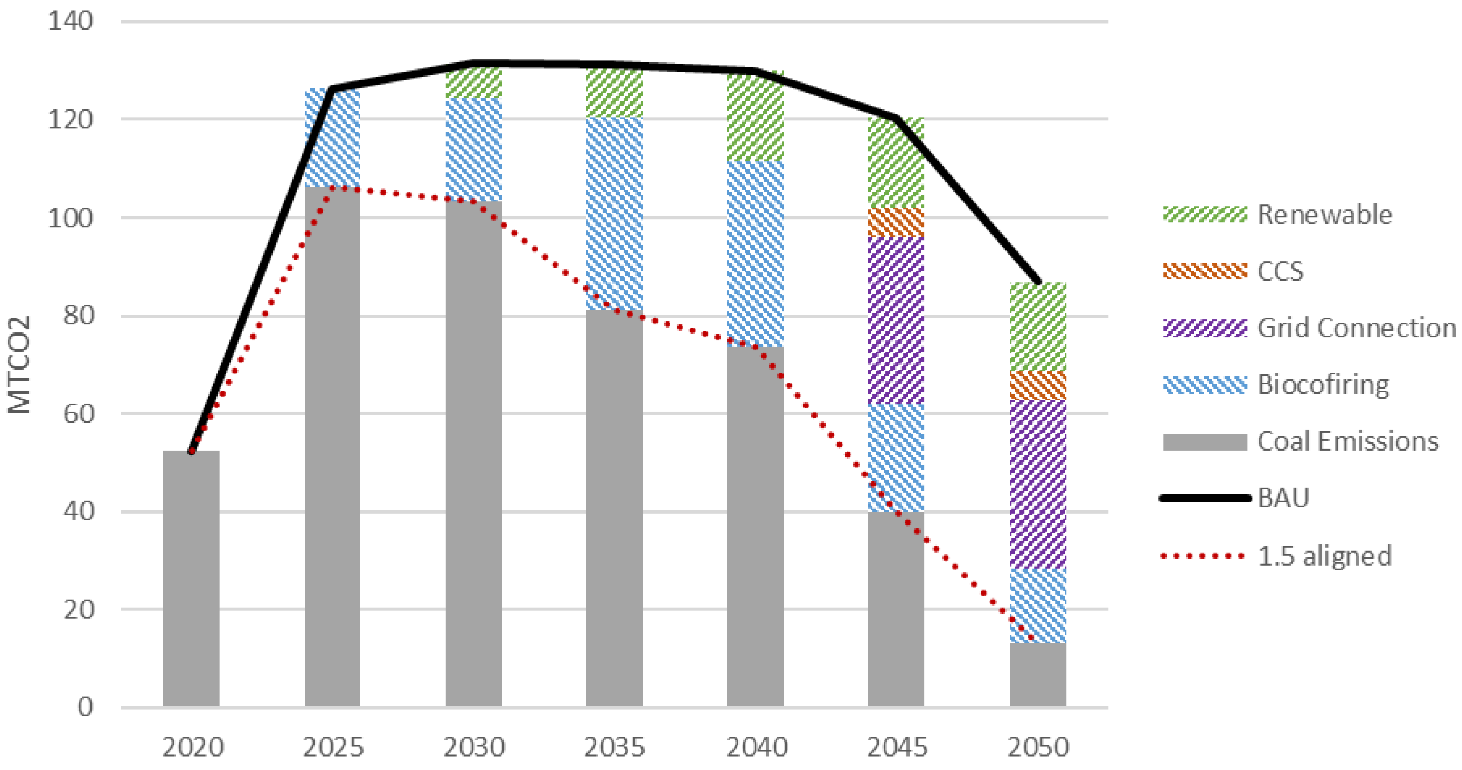
M. Borrero, et al. (forthcoming). "1.5°C-aligned coal power transition pathways in Indonesia: additional strategies beyond the Comprehensive Investment and Policy Plan (CIPP)." CGS, UMD and IESR.

Preliminary results, please do not cite

Emissions reduction pathway for captive coal plants by transition strategy

- Captive plants have less transition options with a substantial growth 2020-2025 and achieve limited emissions reduction through 2030.
- Emissions peak in 2025, to cancel 2.6 GW at pre-construction.
- By 2030, 75% reduction comes from biomass co-firing and 25% from onsite renewable substitution.
- **Biomass co-firing**: 80 units (13 GW) half of overall emissions reduction, and one unit (1.1 GW) is converted to BECCS after 2040.
- **RE substitution**: gradual replacement of 2.5 GW of coal capacity with 11.2 GW of solar capacity by 2040.
- **Grid connection** in Sulawesi becomes critical post-2040.

CO2 emissions from captive power generation under BAU and 1.5C-aligned pathways, reduction by transition strategy



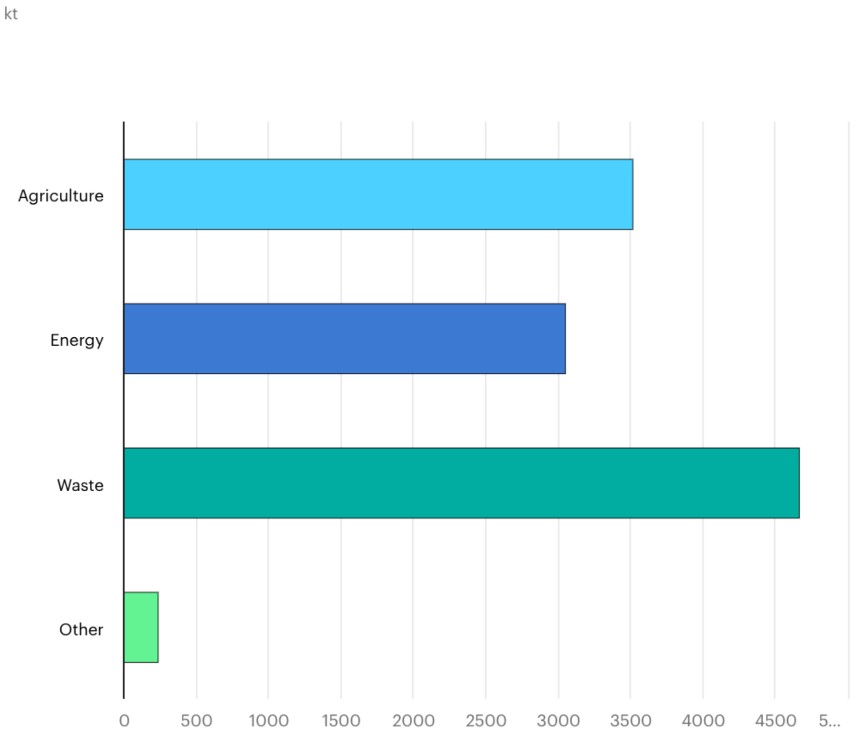
M. Borrero, et al. (forthcoming). "1.5°C-aligned coal power transition pathways in Indonesia: additional strategies beyond the Comprehensive Investment and Policy Plan (CIPP)." CGS, UMD and IESR.

Preliminary results, please do not cite

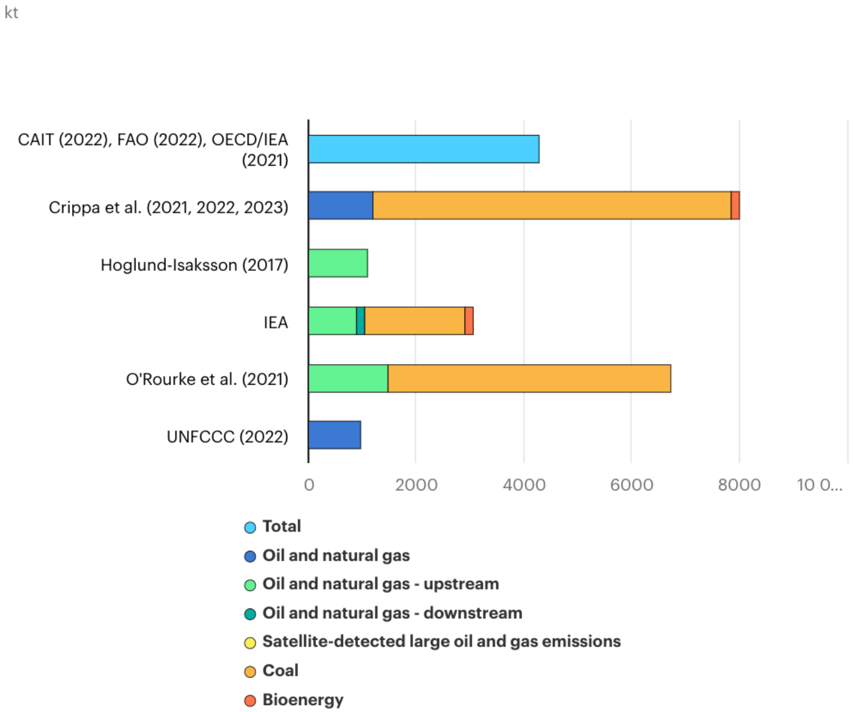
What are the potential implications of Indonesia's coal transition on its methane emissions?

- Indonesia ranks 6th globally in terms of total methane emissions (IEA 2024).
- Waste sector contributes to over 40% of Indonesia's methane emissions, followed by agriculture of 31%, and energy of 27%.
- Nearly 70% of coal production is for export, largely affected by coal transition internationally.
- Indonesia signed the Global Methane Pledge but has few domestic policies to tackle methane.

Indonesia methane emissions from all sources, IEA estimate from available datasets



Indonesia methane emissions from energy sources, comparison with UNFCCC and other estimates



Importance of complementary methane and carbon dioxide abatement for climate goal

- CO2 abatement decisive for long-term limits to warming, but initially SO2 effect dominates
- CH4 abatement thus is largest (only!) lever for near-term warming deceleration
- Complementary actions from both targeted methane mitigation and energy transition are needed to limit temperature overshoot and return to 1.5C.

C. Bertram, et al. (2023). "Ramping up methane emissions reductions in this decade: Implications of methane emissions for near- and medium-term warming." CGS, UMD.

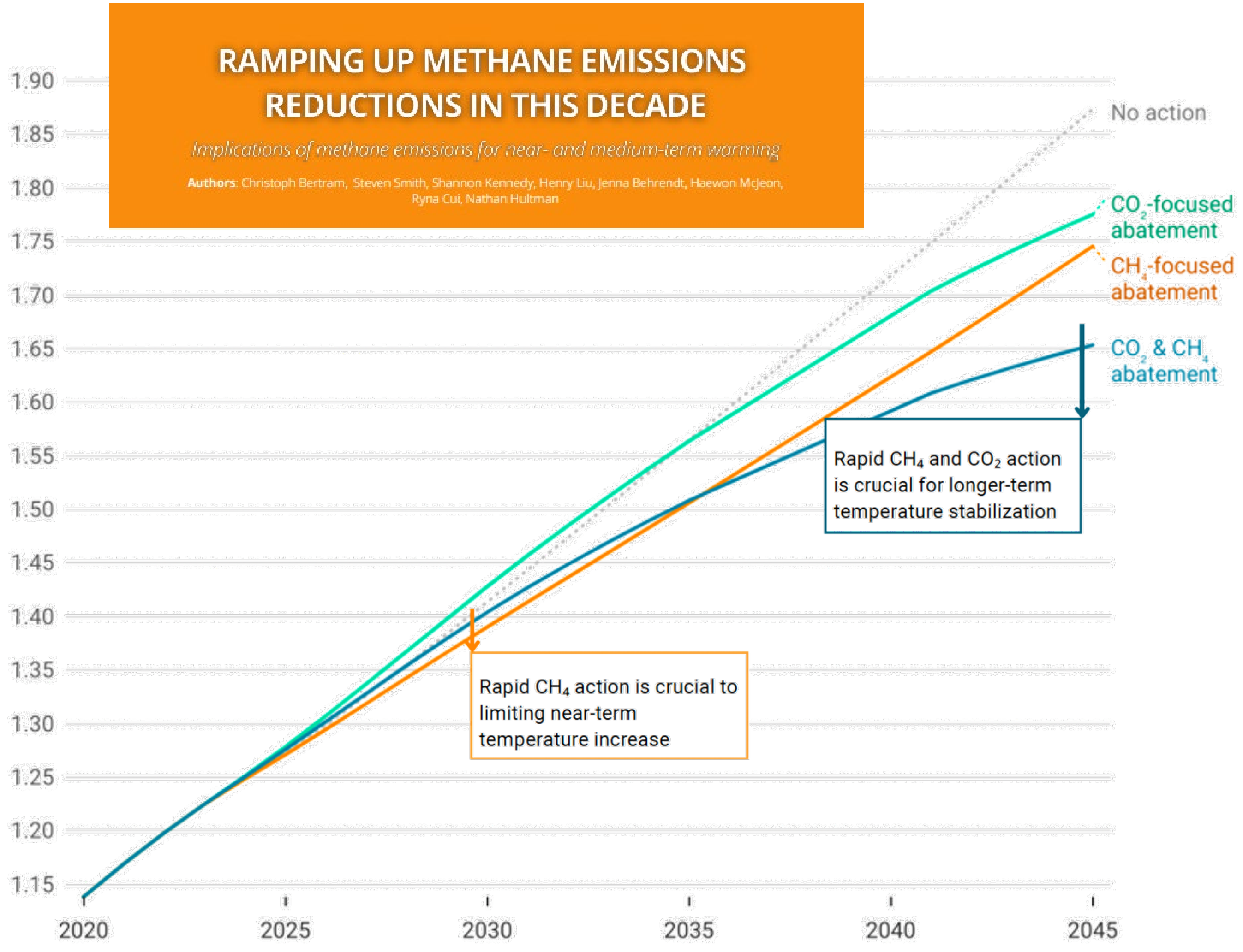


Figure 2. Carbon & methane global warming from 2020-2045. Global temperature projections in degrees Celsius under varying prioritization levels of methane abatement.

Thank you!

Ryna Yiyun Cui, PhD
Research Director, China Program Co-Director, Associate Research Professor, Center for Global Sustainability, University of Maryland
Research Scientist, Joint Global Change Research Institute, Pacific Northwest National Laboratory
ycui10@umd.edu