CARBON TRUST

TECHNICAL APPENDIX 2

Prioritisation Framework

August 2023

PRIORITISATION FRAMEWORK

1. Introduction
2. Security scoring
3. Cost scoring
4. Environment scoring
5. Socioeconomic scoring
6. Conclusion and next steps

PRIORITISATION FRAMEWORK

Introduction

Introduction (1/2)

This Technical Appendix provides detailed guidance on each building block of the Prioritisation Framework in terms of the scoring criteria, choice of indicators, selection of proxy data and the scoring thresholds. Each section in this document focuses on one of the four dimensions of the Prioritisation Framework:

- Security
- Cost
- Environment
- Socioeconomic

It is followed by the breakdown of all regional-level factors, plant-level factors and plant-level indicators where relevant. Specifically, the breakdown of the components cover:

Scoring rationale
An overview of (1) how a regional-level or plant-level factor affects the way the selected plant-level indicator is scored, and (2) how the selected plant-level indicator is used as an independent metric. The section also clarifies whether the scoring rule applies to all plants, or only non-captive or captive plants, and whether any proxy data is used.

Scoring rules
The combination of normalised and repurposing adjustment scores that should be applied to the plant under different scenarios. It should be noted that the thresholds selected for different scenarios* reflect the context of the CFPP fleet in Odisha and their performance distribution against the selected metric. **When replicating the Prioritisation Framework for other regions, these thresholds can be adjusted to reflect the nature of the CFPP fleet**.

The choice of indicators for Odisha are informed by the level of data availability and can be adjusted for other regions accordingly.

** E.g., Captive generation's contribution to regional power consumption is <30%; 30-60%; >60% or cost of buyout is <100 million; 100-200 million; >200 million etc.*

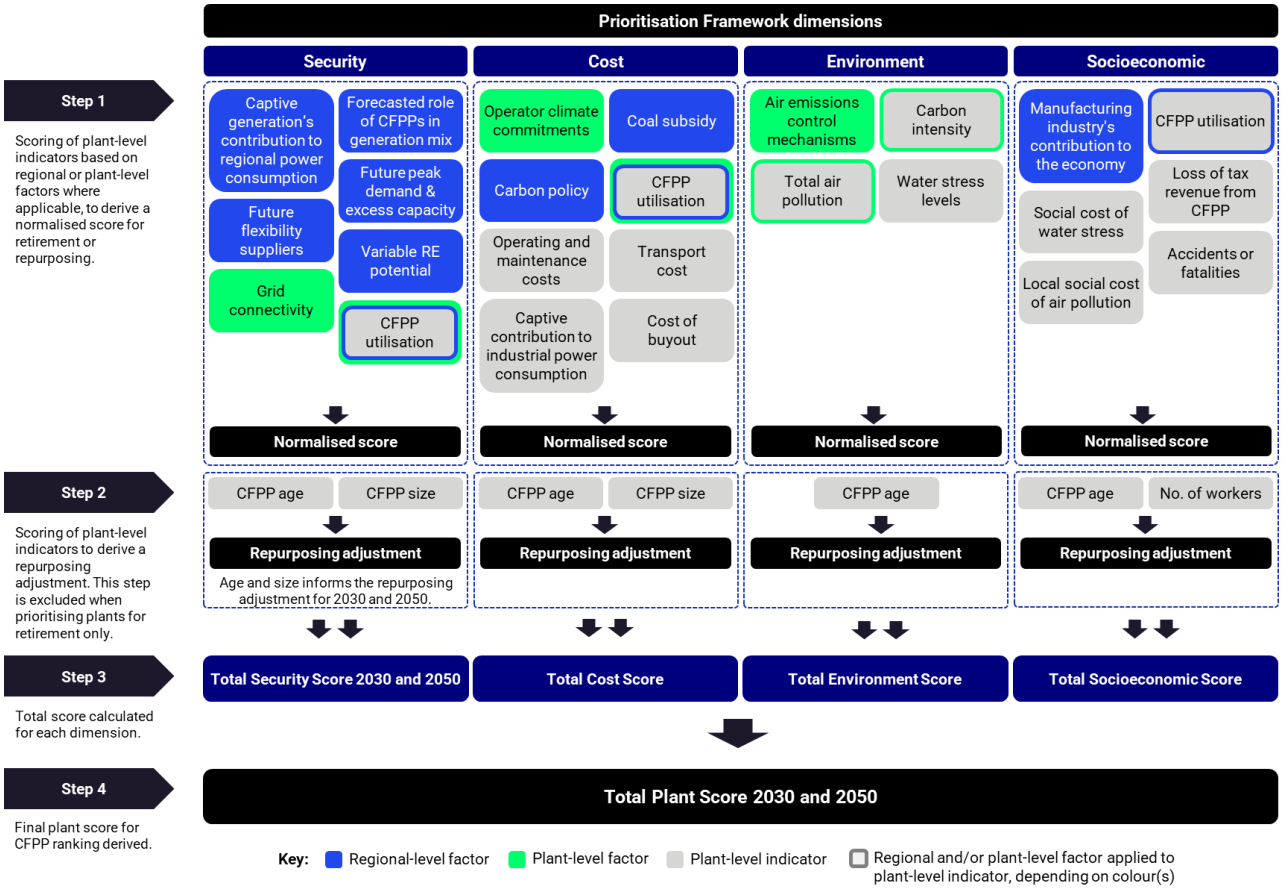
Introduction (2/2)

Please note that the criteria under the four dimensions — security, cost, environment and socioeconomic — may at times score plant-level indicators such as utilisation in conflicting ways.

The intention of applying contradicting scoring rules and multiple criteria within the Prioritisation Framework is for the final rankings of plants to reflect the competing nature of different stakeholder perspectives. However, this may result in plants having average performance across the four dimensions when prioritising for retirement or repurposing. This may be controversial for certain stakeholder groups.

In these instances, appropriate weightings can be applied to develop different CFPP ranking lists to reflect the importance attached to each dimension by stakeholders.

Prioritisation Framework overview



Scoring approach

- The indicators under each dimension are scored from 0-1.
- Scoring of indicators may be informed by regional or plant-level factors, or repurposing assumptions.
- A total score is calculated for each dimension, and a final score derived for CFPP rankings.
- The higher the score, the more eligible the plant is for repurposing or retirement.
- Weightings of scoring dimensions and indicators can be adjusted to account for stakeholder preferences and priorities.

PRIORITISATION FRAMEWORK

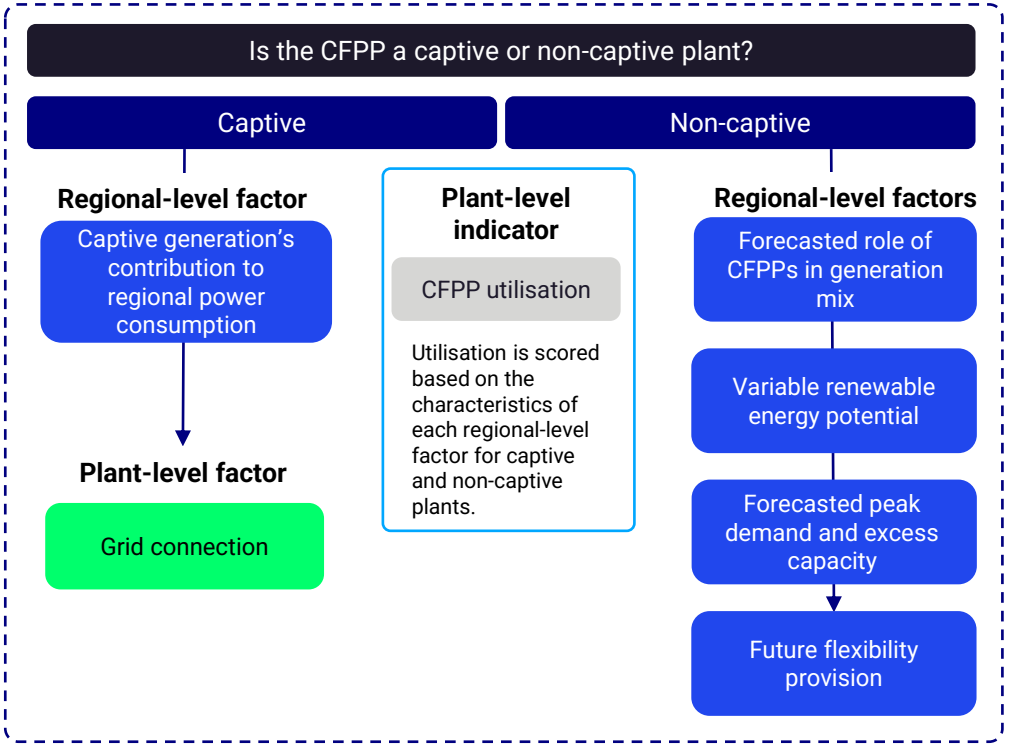
Security scoring

Security Score (1/2)

Under this score, CFPPs should be prioritised according to their role in supporting the security of supply, along with the impact that respective repurposing options will have on the energy system.

1 Normalised Security Score

Scoring is based on the CFPP's utilisation, and the factors listed below, depending on whether the plant is captive or non-captive. Under the security score, CFPPs should be prioritised according to their role in supporting the security of supply.

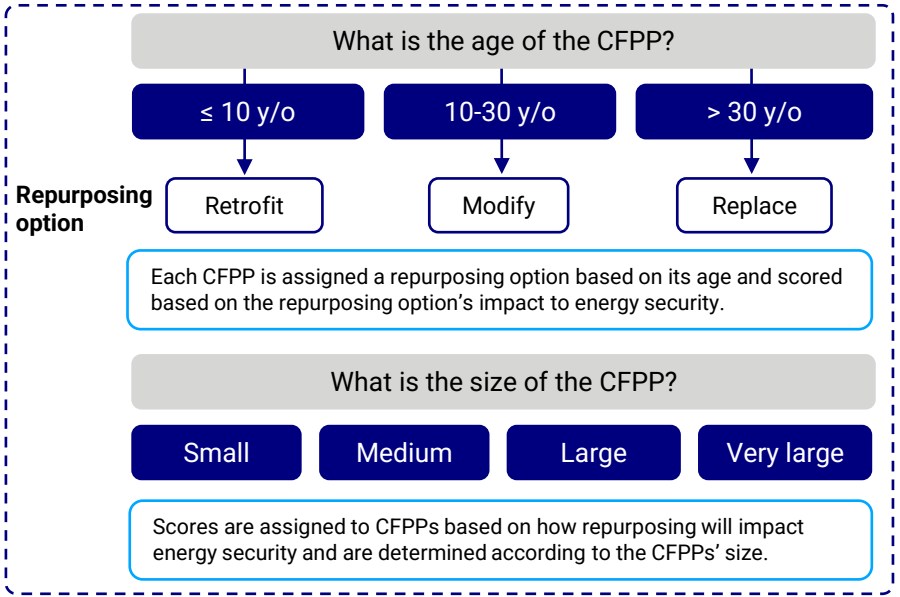


Security Score (2/2)

2 Repurposing adjustment

Repurposing options based on a CFPP's age are considered in order of least to most disruptive to security of supply in the short and long-term.

In terms of size, repurposing smaller plants will have the least impact on the security of the system. Therefore, smaller plants should be prioritised in the short-term, while medium to large sized plants should be prioritised in the long-term.



3 Total Security Score

The Total Security Score takes into account the role of the CFPP in supporting the security of supply, along with the impact that respective repurposing options will have on the energy system.

Total Security Score =
Average of [Normalised Security Score] and [Repurposing adjustment]

Normalised security scoring example

Regional-level factor: forecasted role of CFPPs in generation mix. Plant-level indicator: CFPP utilisation

Utilisation is selected as a plant-level indicator as it relates to how much of the plant's current capacity is being used to contribute to a region's energy security. If a CFPP is non-captive, then one of the regional-level factors applied to the utilisation plant-level indicator is the role of CFPPs in the region's generation mix.

Scoring rationale

Forecasted role of CFPPs in the generation mix

↓

CFPP utilisation

The importance of coal as an energy source in the future will inform the plant's score depending on its utilisation. Non-captive plants with high utilisation should not be prioritised unless the regional-level assessment shows a low level of coal in the forecasted generation mix.

CFPPs are a small % of the future generation mix ⟷ **CFPPs are a large % of the future generation mix**

Non-captive plants with high utilisation are prioritised — *Non-captive plants with low utilisation are prioritised*

Scoring rules

Plant-level indicator	Criteria	Value	Forecasted role of CFPPs in generation mix		
			Energy from CFPPs is ≥ 50%	Energy from CFPPs is > 10% but < 50%	Energy from CFPPs is ≤ 10%
CFPP utilisation	Low	0% ≤ x ≤ 20%	1	0	0
	Medium	20% < x ≤ 80%	0.5	1	0.5
	High	80% < x ≤ 100%	0	0.5	1

Normalised security scoring example

Regional-level factor: variable renewable energy potential. Plant-level indicator: CFPP utilisation

Utilisation is selected as a plant-level indicator as it relates to how much of the plant's current capacity is being used to contribute to a region's energy security. If a CFPP is non-captive, then one of the regional-level factors applied to the utilisation plant-level indicator is the level of variable renewable energy potential.

Scoring rationale

Variable renewable energy potential

↓

CFPP utilisation

The expected contribution of variable renewable energy in the region's future generation mix can be used to determine whether highly utilised CFPPs can be phased down with minimum disruptions to the energy system. Non-captive plants with high utilisation should not be prioritised unless the regional-level assessment notes a high development of variable renewable energy. This suggests that there will be sufficient alternative capacity built in time to cope with the forecasted demand.

Variable RE is a small % of the future generation mix ⟷ **Variable RE is a large % of the future generation mix**

Non-captive plants with low utilisation are prioritised — *Non-captive plants with high utilisation are prioritised*

Scoring rules

Plant-level indicator	Criteria	Value	Variable renewable energy potential		
			Energy from solar and wind is ≥ 30%	Energy from solar and wind is > 10% but < 30%	Energy from solar and wind is ≤ 10%
CFPP utilisation	Low	0% ≤ x ≤ 20%	0	0	1
	Medium	20% < x ≤ 80%	0.5	1	0.5
	High	80% < x ≤ 100%	1	0.5	0

Normalised security scoring example

Regional-level factor: forecasted peak demand and excess capacity. Plant-level indicator: CFPP utilisation

Utilisation is selected as a plant-level indicator as it relates to how much of the plant's current capacity is being used to contribute to a region's energy security. If a CFPP is non-captive, then one of the regional-level factors applied to the utilisation plant-level indicator is the expected amount of peak demand and excess capacity in the system.

Scoring rationale

Forecasted peak demand and excess capacity

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CFPP utilisation

The expected amount of future excess capacity in the energy system can be used to determine whether highly utilised CFPPs can be phased down with minimum disruptions to the energy system. Non-captive plants with high utilisation should not be prioritised unless the regional-level assessment concludes a high level of future excess capacity compared to the forecasted peak demand. A low level of future excess capacity may suggest that there will not be a sufficient availability of reserves.

Low excess capacity ⟷ **High excess capacity**

Non-captive plants with low utilisation are prioritised

Non-captive plants with high utilisation are prioritised

Scoring rules

Plant-level indicator	Criteria	Value	Forecasted peak demand and excess capacity		
			Future excess capacity ≥ 50% of peak demand	Future excess capacity > 20% and < 50% of peak demand	Future excess capacity ≤ 20% of peak demand
CFPP utilisation	Low	0% ≤ x ≤ 20%	0	0.5	1
	Medium	20% < x ≤ 80%	0.5	1	0.5
	High	80% < x ≤ 100%	1	0	0

Normalised security scoring example

Regional-level factor: future flexibility provision. Plant-level indicator: CFPP utilisation

Utilisation is selected as a plant-level indicator as it relates to how much of the plant's current capacity is being used to contribute to a region's energy security. If a CFPP is non-captive, then one of the regional-level factors applied to the utilisation plant-level indicator is the type of technologies used as flexibility suppliers in the energy system.

Scoring rationale

Future flexibility provision

CFPP utilisation

The role of different technology types in flexibility provision can be used to determine whether highly utilised CFPPs can be phased down with minimum disruptions to the energy system. Non-captive plants with high utilisation should not be prioritised if the CFPPs are forecasted as the exclusive or main supplier of flexibility to the system.

Coal plays a small role in flexibility provision ⟷ **Coal plays a large role in flexibility provision**

Non-captive plants with high utilisation are prioritised ⟷ *Non-captive plants with low utilisation are prioritised*

Scoring rules

Plant-level indicator	Criteria	Value	Future flexibility provision		
			Primarily CFPPs	A mix of CFPPs and other technologies	CFFPs are not suppliers or have a very low contribution
CFPP utilisation	Low	0% ≤ x ≤ 20%	1	0	1
	Medium	20% < x ≤ 80%	0.5	1	1
	High	80% < x ≤ 100%	0	0.5	1

Normalised security scoring example

Regional-level factor: captive generation's contribution to regional power consumption. Plant-level indicator: CFPP utilisation

If a CFPP is captive, then one of the regional-level factors applied is captive power generation's contribution to regional power consumption. Utilisation is selected as a plant-level indicator as it relates to how much of the captive plant's current capacity is being used to contribute to regional power consumption.

Scoring rationale

Captive generation's contribution to regional power consumption

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CFPP utilisation

If captive generation has a low contribution to regional power consumption, then all captive plants should be prioritised as their removal will not have significant impact on the security of supply. If captive generation has a high contribution to regional power consumption, then all captive plants should not be prioritised as they will be critical to security of supply.

Captive generation makes a limited contribution to regional power consumption ⟷ **Captive generation makes a significant contribution to regional power consumption**

All captive plants are prioritised — *All captive plants are not prioritised*

Scoring rules

Plant-level indicator	Criteria	Value	Captive generation's contribution to regional power consumption		
			Contribution is ≤ 30%	Contribution is > 30% but < 60%	Contribution is ≥ 60%
CFPP utilisation	Low	0% ≤ x ≤ 20%	1	1	0
	Medium	20% < x ≤ 80%	1	0.5	0
	High	80% < x ≤ 100%	1	0	0

Normalised security scoring example

Plant-level factor: grid connection status. Plant-level indicator: CFPP utilisation

Utilisation is selected as a plant-level indicator as it relates to how much of the plant's current capacity is being used to contribute to a region's energy security. If a CFPP is captive, then one of the plant-level factors applied to the utilisation plant-level indicator is the grid connection status of the plant.

Scoring rationale

Grid connection status

CFPP utilisation

The grid connection status of a captive plant can be used to determine whether highly utilised captive CFPPs can be phased down with minimum disruptions to the energy system. Captive plants with low utilisation should be prioritised when they are connected to the main grid to minimise the impact on the grid's security of supply. If a captive plant is not connected to the grid, then repurposing or retirement will not affect the security of supply of the power system, regardless of its utilisation.

CFPP is grid-connected → **CFPPs is off-grid**

Plants with low utilisation are prioritised — *Utilisation does not impact prioritisation*

Scoring rules

Plant-level indicator	Criteria	Value	Grid connection status	
			CFPP connected to the main grid	Off-grid
CFPP utilisation	Low	0% ≤ x ≤ 20%	1	1
	Medium	20% < x ≤ 80%	0.5	1
	High	80% < x ≤ 100%	0	1

Repurposing adjustment security scoring example

Plant-level indicator: CFPP age

Two sets of scores are produced under the repurposing adjustment for the short-term (2030) and long-term (2050) to reflect the changing nature of the energy system and its ability to handle disruptions over time. The age of the CFPP is used to inform the repurposing option most suited for the plant.

Scoring rationale

In the short-term scenario (by 2030), the three repurposing options in the order of least to most disruptive to the power system supply are (1) modify, (2) retrofit, and (3) replace. This is to account for the implementation timeframes required for each repurposing option, whereby modifying for flexibility will take the least amount of time to implement and is therefore the least disruptive to the power system. In the long-term scenario (by 2050), replacement of a plant with renewable energy is most desirable as this results in a full exit from coal, which should be the ultimate objective of the coal transition.

Scoring rules

Plant-level indicator	Criteria	Value	2030 scenario	2050 scenario
CFPP age	Retrofit	0 ≤ x ≤ 10 years	0.5	0
	Modify	10 < x ≤ 30 years	1	0
	Replace	> 30 years	0	1

Repurposing adjustment security scoring example

Plant-level indicator: CFPP size

Two sets of scores are produced under the repurposing adjustment for the short-term (2030) and long-term (2050) to reflect the changing nature of the energy system and its ability to handle disruptions over time. The size of the CFPP is used to determine whether a plant should be prioritised for repurposing in the short or long-term.

Scoring rationale

Repurposing smaller plants will have the least impact on the security of the system. Therefore, smaller plants should be prioritised in the short-term scenario (2030) as this will cause the least disruption to the grid in supplying electricity. When considering a long-term scenario (2050), medium to large sized plants should be prioritised for repurposing, with the assumption that appropriate measures have been taken to ensure that the energy system is able to tolerate the removal of greater amounts of coal from the power generation mix

Scoring rules

Plant-level indicator	Criteria	Value	2030 scenario	2050 scenario
CFPP size	Small size	0 ≤ x ≤ 50 MW	1	0
	Medium size	50 < x ≤ 200 MW	0.7	0.7
	Large size	200 < x ≤ 500 MW	0.3	1
	Very large size	> 500 MW	0	0.3

PRIORITISATION FRAMEWORK

Cost scoring

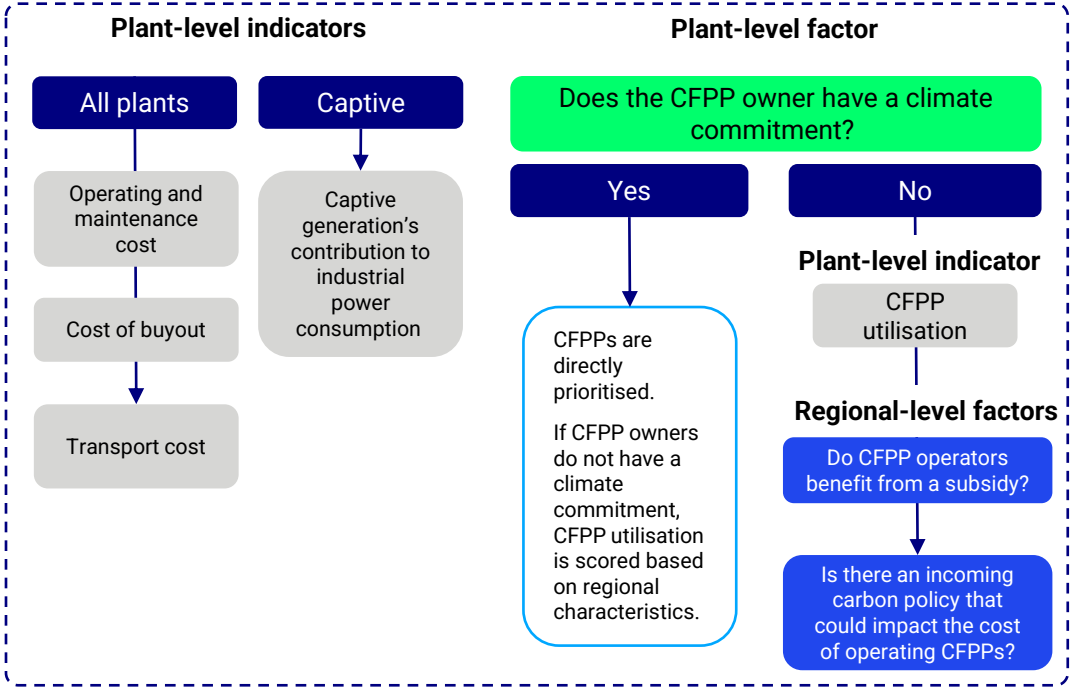
Cost Score (1/2)

Under this score, CFPPs should be prioritised according to the cost of continuing to operate them, along with how expensive it might be to repurpose the plant.

1 Normalised Cost Score

Scoring of indicators is based on whether the CFPP operator has a climate commitment. For CFPP utilisation, if the operator does not have a climate commitment, scoring is based on two additional factors: coal subsidies and carbon policy.

CFPPs should be prioritised based on the cost of continuing to operate them.

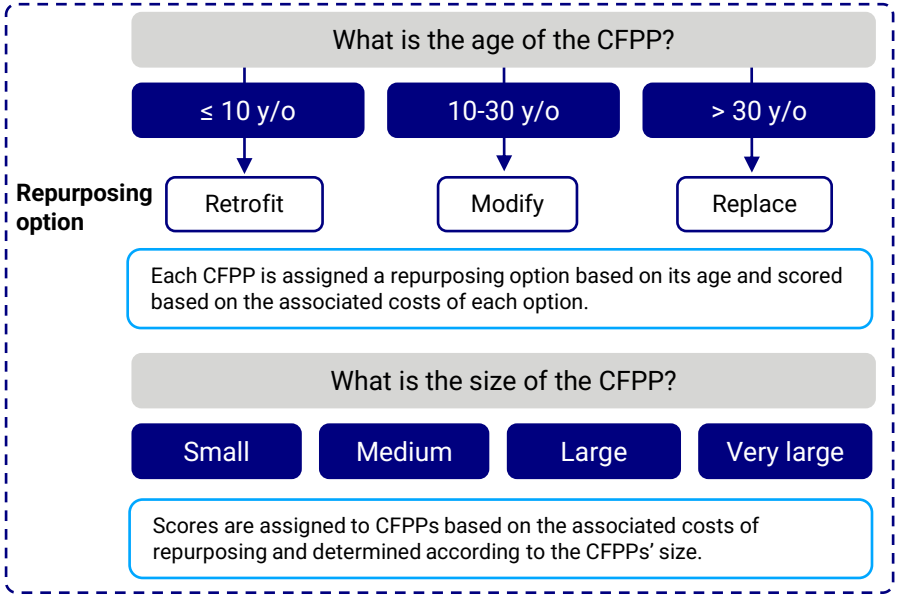


Cost Score (2/2)

2 Repurposing adjustment

Repurposing options are considered in the order of least to most expensive:

1. Modify the CFPP for flexibility;
2. Retrofitting to co-fire with alternative fuels; and
3. Replacement with renewable energy. In terms of size, it is assumed that the larger the CFPP, the more costly it is to repurpose.



3 Total Cost Score

The Total Cost Score takes into account the costs of operating CFPPs and how expensive it might be to repurpose the plant.

Total Cost Score =
Average of [Normalised Cost Score] and [Repurposing adjustment]

Normalised cost scoring example

Plant-level indicator: total operating and maintenance costs

Total operating and maintenance costs is selected as a plant-level indicator as it relates to how costly it is to continue operating CFPPs.

Scoring rationale

CFPPs with high operating and maintenance costs should be prioritised as they will be more costly to run and may limit future cashflows, compared to other equivalent plants with lower costs. Therefore, it would be in the plant owner's best interest to retire or repurpose a coal plant that is more expensive to operate.

Total operating and maintenance costs

Low O&M costs → **High O&M costs**

Plants with high O&M costs are prioritised

Scoring rules

Plant-level indicator	Criteria	Value	Score
Total operating and maintenance costs	Low costs per year	0 ≤ x ≤ 15 $/MWh	0
	Moderate costs per year	15 < x ≤ 30 $/MWh	0.5
	High costs per year	> 30 $/MWh	1

Normalised cost scoring example

Plant-level indicator: cost of buyout

Cost of buyout is selected as a plant-level indicator as it can be used to determine how challenging it might be for a third party to acquire a CFPP to enable its early retirement or repurposing.

Scoring rationale

CFPPs with lower costs of buyout should be prioritised as it will be easier for a third party to become involved and potentially acquire the asset for repurposing or retirement, compared to a CFPP with higher buyout costs. Lower buyout costs may also indicate limited revenue generation and profitability for the CFPP operator, and therefore may be more inclined to retire or repurpose the plant.

Cost of buyout

Low buyout costs → **High buyout costs**

Plants with lower buyout costs are prioritised

Scoring rules

Plant-level indicator	Criteria	Value	Score
Cost of buyout	Low costs	0 ≤ x ≤ 100 $ millions	1
	Moderate costs	100 < x ≤ 200 $ millions	0.5
	High costs	> 200 $ millions	0

Normalised cost scoring example

Plant-level indicator: transport cost

CFPPs that are located close to their coal supply source are expected to face lower transportation costs which in turn can make their operations more cost effective. As such, CFPPs that are located far away from their coal supply source should be prioritised.

Scoring rationale

Due to lack of data on transport costs for CFPPs, distance to coal source is used a proxy for this indicator. Plants that are located further away from their coal supply source should be prioritised due to higher transportation costs incurred which can make plant operations less cost effective. Plant owners may therefore be more inclined to retire or repurpose such plants due to the additional operational costs.

Transport cost

Low transport cost → **High transport cost**

Plants with higher transport costs should be prioritised

Scoring rules

Plant-level indicator	Criteria	Value	Score
Transport cost (distance to coal source)	Low costs	Domestic coal (≤ 200 km)	0
	Moderate costs	Domestic coal (> 200 km)	0.5
	High costs	Imported coal	1

Normalised cost scoring example

Plant-level factor: climate commitment. Plant-level indicator: CFPP utilisation

Utilisation is selected as a plant-level indicator as it relates to how much revenue a plant is able to generate in order to run cost-effectively. One of the plant-level factors applied to the utilisation plant-level indicator is the climate commitment status of the plant owner.

Scoring rationale

Climate commitment

↓

CFPP utilisation

For CFPPs operated by owners who have a climate commitment, they may be willing to retire or repurpose their plant regardless of its utilisation rate in order to meet their targets, and hence all plants are given a score of 1. For CFPP operators who do not have a climate commitment, two additional regional-level factors are applied to derive the scoring of the utilisation indicator as detailed in the following slides: **Coal subsidies and carbon policy**.

CFPP owner has a climate commitment ⟵ ⟶ **CFPP owner does not have a climate commitment**

All CFPPs are prioritised regardless of utilisation

Scoring not applicable (please see scoring rules for coal subsidies and carbon policy)

Scoring rules

Plant-level indicator	Criteria	Value	Climate commitment	
			CFPP operator has a climate commitment	CFPP operator has no climate commitment
CFPP utilisation	Low	0% ≤ x ≤ 20%	1	No scoring
	Medium	20% < x ≤ 80%	1	
	High	80% < x ≤ 100%	1	

Normalised cost scoring example

Regional-level factor: coal subsidy. Plant-level indicator: CFPP utilisation

Utilisation is selected as a plant-level indicator as it relates to how much revenue a plant is able to generate in order to run cost-effectively. If a plant's owner does not have a climate commitment in place, then one of the regional-level factors applied to the utilisation plant-level indicator is whether CFPP operators benefit from subsidies.

Scoring rationale

Coal subsidy

CFPP utilisation

If a CFPP's cashflows are ensured by a particular subsidy, then there will be an incentive for the plant owner to continue running the plant regardless of the utilisation level of the generation unit. If there is no subsidy, the revenues generated through operating CFPPs will be directly related to its level of utilisation. As such, plant owners may be more willing to retire or repurpose units with low utilisation given that they would generate less revenue.

With subsidy — **No subsidy**

Utilisation does not impact scoring

Plants with low utilisation should be prioritised

Scoring rules

Plant-level indicator	Criteria	Value	Coal subsidy	
			With subsidy	No subsidy
CFPP utilisation	Low	0% ≤ x ≤ 20%	0	1
	Medium	20% < x ≤ 80%	0	0.5
	High	80% < x ≤ 100%	0	0

Normalised cost scoring example

Regional-level factor: carbon policy. Plant-level indicator: CFPP utilisation

Utilisation is selected as a plant-level indicator as it relates to how much revenue a plant is able to generate in order to run cost-effectively. If a plant's owner does not have a climate commitment in place, then one of the regional-level factors applied to the utilisation plant-level indicator is whether an incoming carbon policy could impact the cost of operating CFPPs.

Scoring rationale

Carbon policy

CFPP utilisation

In cases where the financial value of a CFPP is associated with eventual transactions in a carbon market or avoidance of carbon taxes, the retiring or repurposing of a plant with higher utilisation would be favoured by the plant owner due to greater emissions generated resulting in more costs. If there is no carbon policy that could affect a plant's financial value, there is no additional incentive for plant owners to consider retiring or repurposing their plants, and therefore all the CFPPs are scored with 0.

With carbon market/taxes ⟷ **No carbon market/taxes**

Plants with high utilisation should be prioritised — *Utilisation does not impact scoring*

Scoring rules

Plant-level indicator	Criteria	Value	Carbon policy	
			Carbon market/taxes will affect financial value	Carbon market/taxes will not affect financial value
CFPP utilisation	Low	0% ≤ x ≤ 20%	0	0
	Medium	20% < x ≤ 80%	0.5	0
	High	80% < x ≤ 100%	1	0

Normalised cost scoring example

Plant-level indicator: captive generation's contribution to industrial power consumption

If a CFPP is captive, then one of the regional-level factors applied is the importance of the captive plant's power generation to the energy consumed by the local industrial sector.

Scoring rationale

If a captive plant's power generation has a small contribution to industrial power consumption, then captive CFPPs should be prioritised for retirement or repurposing as it is more likely that the industrial businesses are purchasing the majority of their electricity from the grid, which is likely to be more expensive. As such, the industrial business will not be making significant cost savings from the captive plant and may be more inclined to retire or repurpose the CFPP.

Captive generation's contribution to industrial power consumption

CFPPs are not the main source of power for industry ⟷ **CFPPs are the main source of power for industry**

Captive CFPPs are prioritised ⟷ *Captive CFPPs are not prioritised*

Scoring rules

Plant-level indicator	Criteria	Value	Scoring
Captive contribution to industrial power consumption	Low	0 ≤ x ≤ 30%	1
	Medium	30 < x ≤ 60%	0.5
	High	> 60%	0

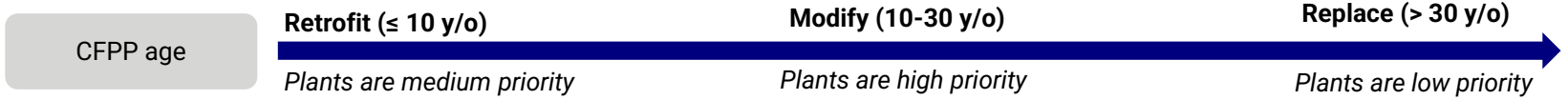
Repurposing adjustment cost scoring example

Plant-level indicator: CFPP age

The age indicator is linked to the repurposing option that is most suitable based on a plant's age, and scored based on the associated costs of each option.

Scoring rationale

Modifying a CFPP for flexibility is the least cost repurposing option, followed by retrofitting to co-fire with alternative fuels, and replacement with renewable energy. Therefore, modifying for flexibility should be prioritised first.



Scoring rules

Plant-level indicator	Criteria	Value	Scoring
CFPP age	Retrofit	0 ≤ x ≤ 10 years	0.5
	Modify	10 < x ≤ 30 years	1
	Replace	> 30 years	0

Repurposing adjustment cost scoring example

Plant-level indicator: CFPP size

The size indicator is scored based on the costs associated with repurposing the plant.

Scoring rationale

CFPPs that are smaller in size will be least expensive to repurpose relative to larger sized plants, given the level of effort required and potential costs that might be incurred. Therefore, CFPPs that are smaller in size should be prioritised first.

Scoring rules

Plant-level indicator	Criteria	Value	Scoring
CFPP size	Small size	0 ≤ x ≤ 50 MW	1
	Medium size	50 < x ≤ 200 MW	0.7
	Large size	200 < x ≤ 500 MW	0.3
	Very large size	> 500 MW	0

PRIORITISATION FRAMEWORK

Environment scoring

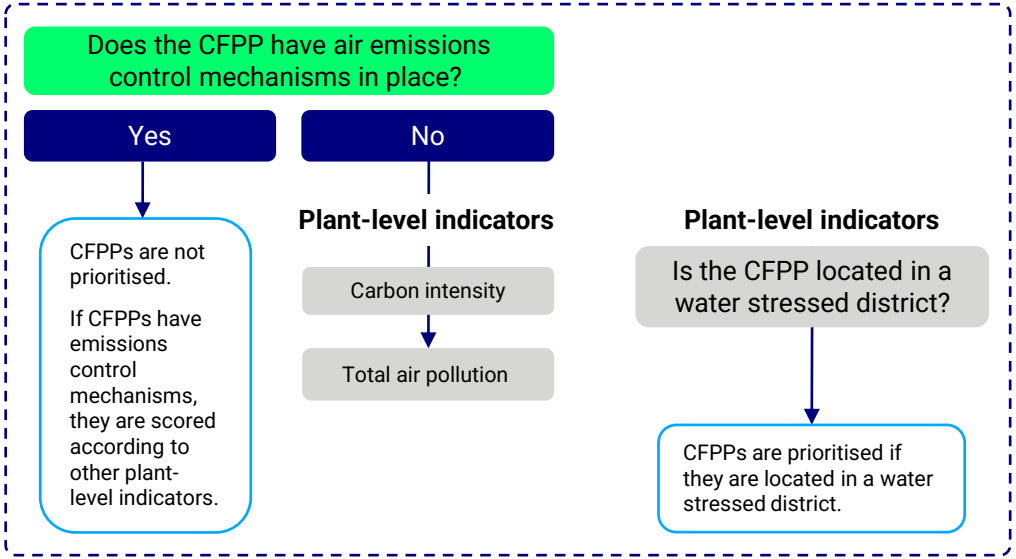
Environment Score (1/2)

Under this score, CFPPs should be prioritised in terms of how environmentally damaging they are now, along with the environmental impact of their suitable repurposing options.

1 Normalised Environment Score

Scoring of indicators is based on whether the CFPP has air emissions control mechanisms in place.

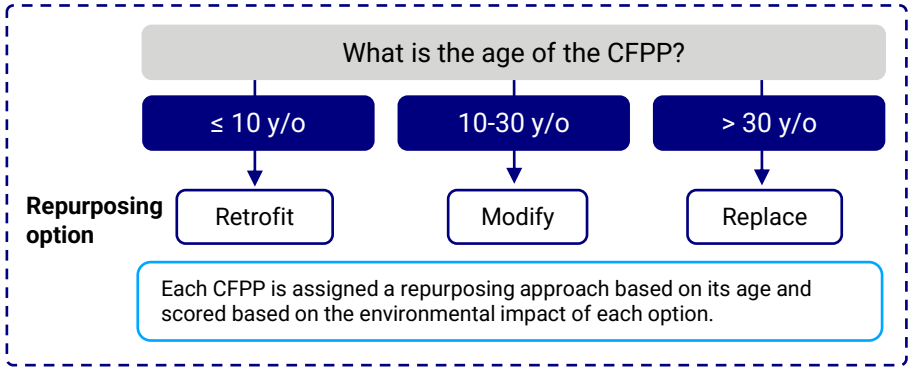
Location of the CFPP in terms of water stress is also considered as an indicator. CFPPs should be prioritised according to how environmentally damaging they are.



Environment Score (2/2)

2 Repurposing adjustment

Repurposing options are considered in the order of least to most environmentally damaging: replacement with renewable energy, followed by retrofitting to co-fire with alternative fuels and modifying for flexibility.



3 Total Environment Score

The Total Environment Score takes into account how environmentally damaging the CFPP is and the environmental impact of suitable repurposing options.

Total Environment Score =
Average of [Normalised Environment Score] and [Repurposing adjustment]

Normalised environment scoring example

Plant-level factor: air emissions control mechanisms. Plant-level indicator: carbon intensity

Carbon intensity is selected as a plant-level indicator as it relates to how environmentally damaging the plant is. This is scored based on whether plants have air emissions control mechanisms in place.

Scoring rationale

Air emissions control mechanisms

Carbon intensity

For CFPPs that have no emissions control mechanisms in place, plants with a higher level of emissions per energy generated should be prioritised first for retirement or repurposing as they are more pollutant. If CFPPs have emissions control mechanisms in place, plants should not be prioritised first as they will be less pollutant overall.

CFPPs have emissions control mechanisms → **CFPPs do not have emissions control mechanisms**

Plants are low priority → *Plants with greater carbon intensity are prioritised*

Scoring rules

Plant-level indicator	Criteria	Value	Air emissions control mechanisms	
			Presence	No presence
Carbon intensity	Low	0.00 ≤ x ≤ 0.80 tCO_2e/MWh	0	0
	Medium	0.80 < x ≤ 0.90 tCO_2e/MWh	0	0.5
	High	0.90 < x ≤ 1.00 tCO_2e/MWh	0	0.75
	Very high	> 1.00 tCO_2e/MWh	0	1

Normalised environment scoring example

Plant-level factor: air emissions control mechanisms. Plant-level indicator: total social cost of air pollution

The contribution of the plant to air pollution is estimated by using the metric total social cost of air pollution, which is selected as a plant-level indicator. This captures the social cost of air pollution without accounting for territorial restrictions (i.e., it is not adjusted for local impact within national borders). This is scored based on whether plants have air emissions control mechanisms in place.

Scoring rationale

Air emissions control mechanisms

↓

Total social cost of air pollution

For CFPPs that have no emissions control mechanisms in place, plants with a higher level of emissions per energy generated should be prioritised first for retirement or repurposing as they are more polluting. If CFPPs have emissions control mechanisms in place, plants should not be prioritised first as they will be less polluting overall.

CFPPs have emissions control mechanisms ⟵ ⟶ **CFPPs do not have emissions control mechanisms**

Plants are low priority

Plants with high social costs of air pollution are prioritised

Scoring rules

Plant-level indicator	Criteria	Value	Air emissions control mechanisms	
			Presence	No presence
Total social cost of air pollution	Low	0 ≤ x ≤ 60 $/MWh	0	0
	Medium	60 < x ≤ 120 $/MWh	0	0.5
	High	> 120 $/MWh	0	1

Normalised environment scoring example

Plant-level indicator: water stress levels

The potential water impact of a CFPP is captured by using the water stress levels of the region where the plant is located. The water stress level is the ratio of fresh water demand to supply in the region where the plant is located.

Scoring rationale

CFPPs located in water stressed districts should be prioritised first for retirement or repurposing, given the significant amount of water required for plants to operate and the additional strain they incur on already scarce water resources in local environments.

Water stress levels

Low water stress levels → **High water stress levels**

CFPPs located here are not prioritised

CFPPs located here are prioritised

Scoring rules

Plant-level indicator	Criteria	Value	Scoring
Water stress levels	Low	< 10%	0
	Low-medium	10-20%	0.25
	Medium-high	20-40%	0.5
	High	40-80%	0.75
	Extremely high	> 80%	1

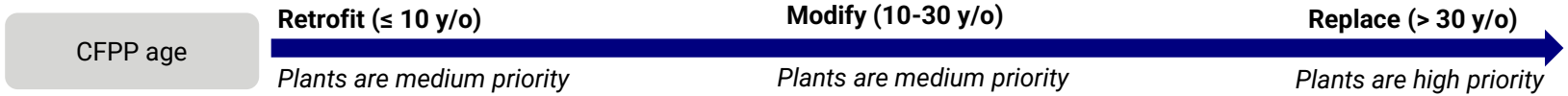
Repurposing adjustment environment scoring example

Plant-level indicator: CFPP age

The age indicator is linked to the repurposing option that is most suitable based on a plant's age and scored based on the associated environmental impact of each option.

Scoring rationale

Replacement with renewable energy is the least environmentally damaging option, and therefore should be prioritised first. It is expected that emissions reductions from retrofitting to co-fire with alternative fuels will vary depending on the type of fuels used and blending rates, and as such, may not always be less emissions-intensive than modifying the CFPP for flexibility, depending on its frequency of use. As such, both options are deemed the same in terms of emissions reduction potential for this study and are scored equally.



Scoring rules

Plant-level indicator	Criteria	Value	Scoring
CFPP age	Retrofit	0 ≤ x ≤ 10 years	0.5
	Modify	10 < x ≤ 30 years	0.5
	Replace	> 30 years	1

PRIORITISATION FRAMEWORK

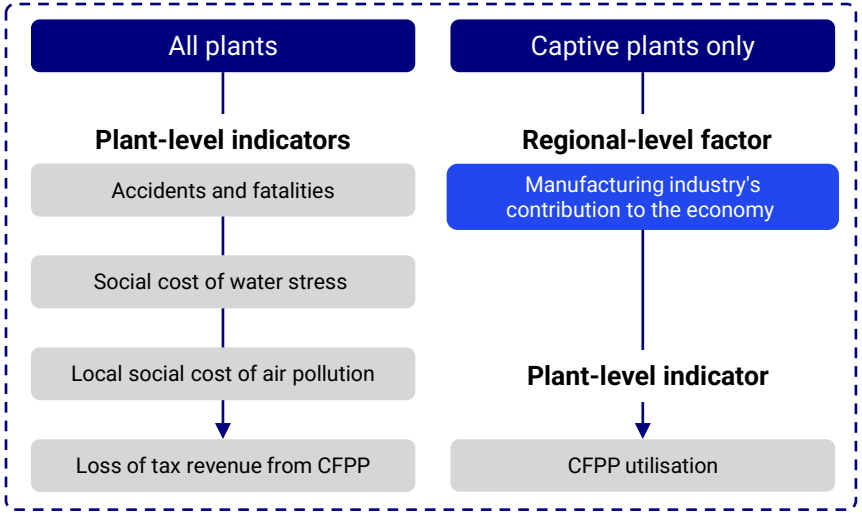
Socioeconomic scoring

Socioeconomic Score (1/2)

Under this score, CFPPs should be prioritised in terms of their impact on society today, along with the likely impact that the repurposing options will have on livelihoods in terms of continued employment and requirements for re-training/re-allocation of jobs.

1 Normalised Socioeconomic Score

CFPPs should be prioritised in terms of their impact on society today, including accident fatalities, potential loss of tax revenues in the event of repurposing, the social cost of water stress and air pollution, as well as the manufacturing industry's contribution to the economy for captive plants.



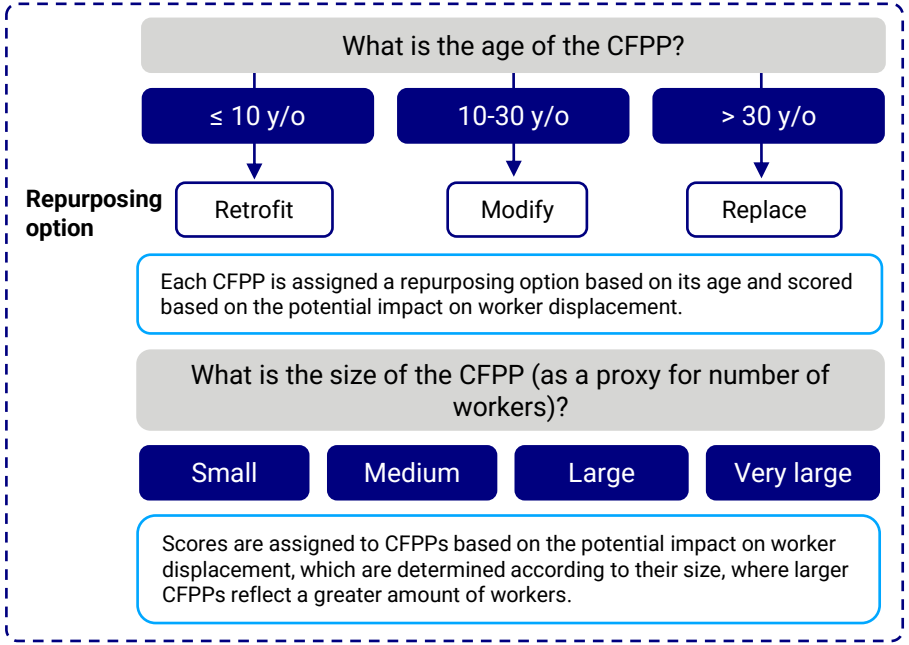
Socioeconomic Score (2/2)

2 Repurposing adjustment

Repurposing options are considered in the order of the impact on worker displacement:

1. Modify CFPP for flexibility;
2. Retrofitting to co-fire with alternative fuels; and
3. Replacement with renewable energy.

Number of workers is also a key consideration for potential displacement.



3 Total Socioeconomic Score

The Total Socioeconomic Score takes into account the impact of CFPPs on society, along with the likely impact that different repurposing options will have on livelihoods.

Total Socioeconomic Score =
Average of [Normalised Socioeconomic Score] and [Repurposing adjustment]

Normalised socioeconomic scoring example

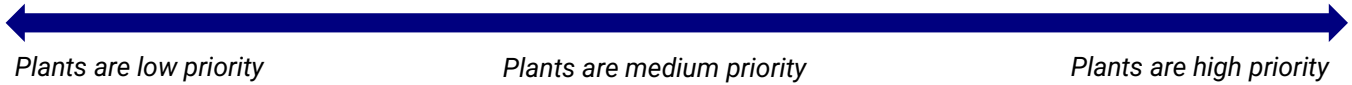
Plant-level indicator: accidents and fatalities

Accidents and fatalities are used as a proxy for safety standards enforced at plant sites. Due to lack of data, incidents reported in the media in the last five years are used for scoring this indicator. Plants that have reported fatalities are prioritised first as the loss of life is considered the most severe outcome and represents a failure in safety standards for workers. This is followed by reported accidents including worker injuries or leaks impacting local communities as this indicates violations in safety rules.

Scoring rationale

Plants that do not have a strong safety track record should be prioritised for retirement or repurposing in order to mitigate the risk of harm to workers and potential toxic leaks that can adversely impact local communities.

Accidents and fatalities



Scoring rules

Plant-level indicator	Criteria	Scoring
Accidents and fatalities (reported in the media in the last five years)	None	0
	Accidents	0.5
	Fatalities	1

Normalised socioeconomic scoring example

Plant-level indicator: loss of tax revenues

Due to lack of data, plant utilisation and size are used as proxies for this indicator as they can provide an indication of the amount of tax revenue that might be lost to the government in case of retirement.

Scoring rationale

Loss of tax revenues

CFPP utilisation

CFPP size

It is assumed that bigger plants with higher utilisation pay more taxes due to the size of their operations and greater revenue generation potential. Therefore, small plants with the low utilisation should be prioritised first to minimise losses to the government, followed by medium-sized plants with moderate utilisation, and finally, large plants with high utilisation.

Small size and low utilisation → **Large size and high utilisation**

Plants are high priority … *Plants are low priority*

Scoring rules

Plant-level indicator	Size	Utilisation		
		0% ≤ x ≤ 20%	20% < x ≤ 80%	80% < x ≤ 100%
Loss of tax revenues	0 ≤ x ≤ 50 MW	1	0.75	0.5
	50 < x ≤ 200 MW	0.85	0.6	0.35
	200 < x ≤ 500 MW	0.65	0.4	0.15
	> 500 MW	0.5	0.25	0

Normalised socioeconomic scoring example

Regional-level factor: manufacturing industry's contribution to gross value added. Plant-level indicator: CFPP utilisation

If a CFPP is captive, then one of the regional-level factors applied is the economic importance of the manufacturing industry, as measured by its contribution to the region's gross value added (GVA). Utilisation is selected as a plant-level indicator as it relates to how much of the captive plant's current capacity is being used to contribute to the manufacturing outputs.

Scoring rationale

Manufacturing industry's contribution to gross value added

↓

CFPP utilisation

Captive plants with high utilisation should only be prioritised if the region's manufacturing industry is not critical to the economy. If the manufacturing industry has a low contribution to the economy, then all captive CFPPs should be prioritised as their removal or repurposing will not have significant economic impact. If the manufacturing industry has a high contribution to the economy, then all captive CFPPs should not be prioritised as their removal or repurposing will have a major negative economic impact

Manufacturing makes a small contribution to GVA ⟵ ⟶ **Manufacturing makes a large contribution to GVA**

All captive CFPPs are prioritised — *All captive CFPPs are not prioritised*

Scoring rules

Plant-level indicator	Criteria	Value	Manufacturing industry's contribution to gross value added		
			Contribution is ≤ 30%	Contribution is > 30% but < 60%	Contribution is ≥ 60%
CFPP utilisation	Low	0% ≤ x ≤ 20%	1	1	0
	Medium	20% < x ≤ 80%	1	0.5	0
	High	80% < x ≤ 100%	1	0	0

Normalised socioeconomic scoring example

Plant-level indicator: social cost of water stress

The social cost of water stress is selected as a plant-level indicator to capture the cost of socioeconomic losses stemming from water stress as a result of the operation of CFPPs.

Scoring rationale

As CFPPs are key contributors to water scarcity, plants that operate in regions where the expected socioeconomic losses from water stress are high should be prioritised for retirement or repurposing to limit the impacts of water stress on the local community. Plants operating in regions where the social cost of water stress is medium should be prioritised next, followed by plants in regions with a low social cost of water stress.

Social cost of water stress

Low social cost of water stress → **High social cost of water stress**

Plants are high priority

Scoring rules

Plant-level indicator	Criteria	Value	Scoring
Social cost of water stress	Low	0 ≤ x ≤ 1.5 $/MWh	0
	Medium	1.5 < x ≤ 3.0 $/MWh	0.5
	High	> 3 $/MWh	1

Normalised socioeconomic scoring example

Plant-level indicator: local social cost of air pollution

The local social cost of air pollution considers only in-country impacts of air pollution as a result of a plant's operations.

Scoring rationale

As CFPPs are key contributors to air pollution, plants that contribute the most to the local air pollution and therefore result in higher health impacts to the community should be prioritised for retirement or repurposing.

Local social cost of air pollution

Low local social cost of air pollution → **High local social cost of air pollution**

Plants are high priority

Scoring rules

Plant-level indicator	Criteria	Value	Scoring
Local social cost of air pollution	Low	0 ≤ x ≤ 20 $/MWh	0
	Medium	20 < x ≤ 40 $/MWh	0.5
	High	> 40 $/MWh	1

Socioeconomic repurposing adjustment scoring example

Plant-level indicator: CFPP age

The age of the CFPP is used to inform the repurposing option most suited for the plant. The repurposing options are then scored based on their expected impact on worker displacement.

Scoring rationale

CFPPs eligible for modification for flexibility provision should be prioritised first as this form of repurposing is expected to have the least impact on workers. Retrofitting to co-fire with alternative fuels should be prioritised next as a high transferability of worker skills is expected with minimal disruption to livelihoods. Replacement with renewable energy is expected to have the biggest impact on worker displacement as it will require significant re-training over long timeframes. As such, CFPPs most eligible to be replaced with renewable energy should be prioritised least to minimise the impact on livelihoods.

CFPP age

Retrofit (≤ 10 y/o) — *Plants are medium priority*

Modify (10-30 y/o) — *Plants are high priority*

Replace (> 30 y/o) — *Plants are low priority*

Scoring rules

Plant-level indicator	Criteria	Value	Score
CFPP age	Retrofit	0 ≤ x ≤ 10 years	0.5
	Modify	10 < x ≤ 30 years	1
	Replace	> 30 years	0

Socioeconomic repurposing adjustment scoring example

Plant-level indicator: CFPP size (number of employees)

Due to lack of data on the number of employees per plant, the size indicator is used as a proxy for employment, where plants with higher installed capacities tend to have more employees. This indicator is scored based on the potential socioeconomic impact of repurposing or retirement.

Scoring rationale

Large CFPPs with a bigger workforce will likely face some extent of disruption regardless of the option selected. As such, smaller plants employing fewer workers should be prioritised first, followed by medium-sized plants with moderate to large numbers of workers. It should be noted that, according to the literature, after a certain threshold, larger plant capacities do not necessarily indicate more employees due to significant automation. Therefore, any plant greater than 200 MW is considered to be “large”*.

CFPP size (number of employees)

Small plants → **Large plants**

Prioritised → *Not prioritised*

Scoring rules

Plant-level indicator	Criteria	Value	Score
CFPP size (number of employees)	Small	0 ≤ x ≤ 100 MW	1
	Medium	101 < x ≤ 200 MW	0.5
	Large	> 201 MW	0

*Foon D. W. and Terziovski M. The impact of operations and maintenance practices on power plant performance

PRIORITISATION FRAMEWORK

Conclusion and next steps

Conclusions and next steps

The **Prioritisation Framework** is designed to account for the regional context in terms of its degree of readiness to transition to clean energy, and the CFPP's operating conditions and their impact on the environment and the community.

The framework is not designed to be a one size fits all approach to ranking CFPPs for repurposing or retirement, and offers flexibility to stakeholders in the following ways:

Additional repurposing options can be integrated into the framework based on other technologies suited to the local context.

The criteria used to assess and rank plants and the weightings applied to the indicators under each criterion can be adjusted to reflect regional priorities and stakeholder interests.

Timeframe preferences for repurposing or retirement decisions can be accounted for in the framework and adjusted based on the region's coal phase-out ambitions.

When replicated for other regions, the **Prioritisation Framework** can serve as an entry point for comprehensive discussions with policymakers and key energy sector stakeholders on how they should plan support for energy transition initiatives.

The results can provide a reference point on the potential scale of renewable energy deployment needed and corresponding investment requirements based on the size of coal capacity prioritised for repurposing.