

Energy Programme, GIZ Indonesia & ASEAN

Comparative Study of Ancillary Service

as Recommendation for Ancillary Service Provision for Indonesia

2026

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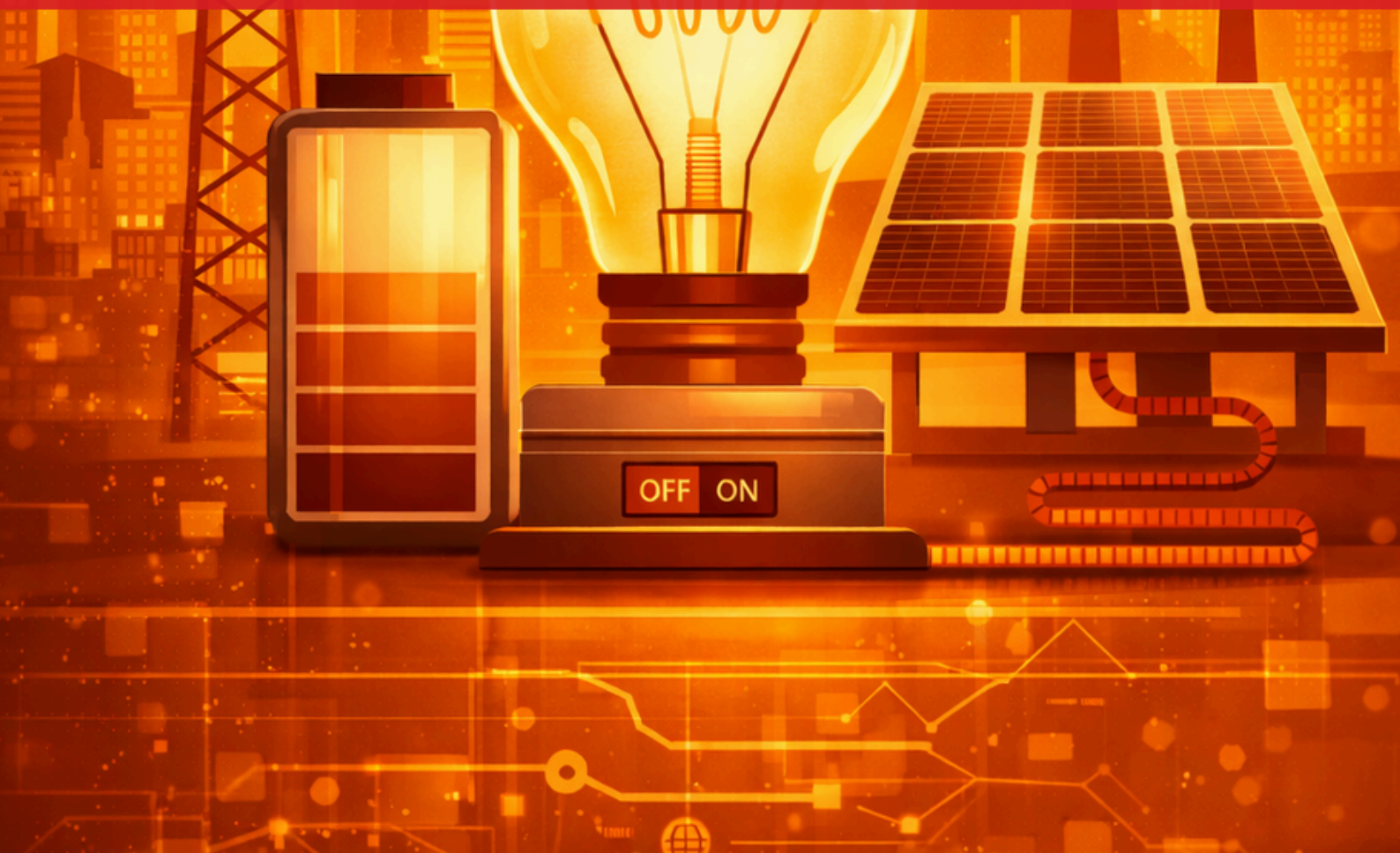
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LIST OF ABBREVIATIONS

AC	Alternating Current
ACE	Area Control Error
AEMO	Australian Energy Market Operator
aFRR	Automatic Frequency Restoration Reserve
AGC	Automatic Generation Control
AS_SO	Ancillary Services Standard Offer
ASA	Ancillary Service Agreements
ASAPP	Ancillary Service Agreement Procurement Plan
ASPA	Ancillary Service Procurement Agreement
ASRM	Ancillary Service Reserve Marke
AVR	Automatic Voltage Regulator
B2B	Business to Business
CAPEX	Capital Expenditure
CfD	Contracts for Difference
COC	Certificate of Compliance
COD	Commercial Operation Date
CPF	Custom Participation Factor
CRMPs	Cost Recovery Market Participants
CSG	China Southern Power Grid Company
CSP	Competitive Selection Process
DAM	Day-ahead Market
DC	Direct Current
DCFs	Default Contribution Factors
DOE	Department of Energy
DRA	Dispute Resolution Administrator
ECO	Enforcement and Compliance Office
EMA	Energy Market Authority
EMC	Energy Market Company
ENTSO-E	European Network of Transmission System Operators for Electricity
EPIRA	Electric Power Industry Reform Act
ERC	Energy Regulatory Commission
Eskom	South African system operator and electricity provider
FCAS	Frequency Control Ancillary Services
FCR	Frequency Control Response
FFR	Fast Frequency Reserve
FiT	Feed-in Tariff
FPP	Frequency Performance Payments
GCM	Governor Control Mode
HFO	Hydro Fuel Oil
IEMOP	Independent Electricity Market Operator of the Philippines
ISO	Independent System Operator
IUPTLU	Izin Usaha Penyediaan Tenaga Listrik untuk Kepentingan Umum (Electricity Supply Business License for Own Use)
KMAJ	Komite Manajemen Aturan Jaringan (Grid Code Management Committee)

MASA	Market Ancillary Service Arrangements
MEMR	Ministry of Energy and Mineral Resources
mFRR	Manual Frequency Restoration Reserve
MO	Market Operator
NCFs	Negative Contribution Factors
NEM	National Electricity Market
NEMDE	National Electricity Market Dispatch Engine
NEMS	National Electricity Market of Singapore
NGCP	National Grid Corporation of the Philippines
NLAS	Network Loading Ancillary Services
NLDC	National Load Despatch Centre
NPC	National Power Corporation
NSCAS	Network Support and Control Ancillary Services
NTCSA	National Transmission Company of South Africa
NYISO	New York Independent System Operator
OPEX	Operational Expenditure
PAO	Provisional Authority to Operate
PF	Power Factor
PGC	Philippines Grid Code
PJBL	Perjanjian Jual Beli Listrik (Electricity Purchase and Sale Agreements)
PJM	Pennyslvania - New Jersey - Maryland
PRAS	Primary Reserve Ancillary Service
PSO	Power System Operator
PUB	Public Utilities Board
RLDC	Regional Load Despatch Centre
RR	Replacement Reserve
RTM	Real-time Market
RTUs	Remote terminal units
RUPTL	Rencana Usaha Penyediaan Tenaga Listrik (Electricity Supply Business Plan)
SGCC	State Grid Corporation of China
SO	System Operator
SP	Singapore Power
SRAS	Secondary Reserve Ancillary Service
SRAS	System Restart Ancillary Services
STATCOM	Static Synchronous Compensator
SVC	Static var Compensator
TOSAS	Transient And Oscillatory Stability Ancillary Services
TPBAC	Third Party Bids and Awards Committee
TRAS	Tertiary Reserve Ancillary Service
TSO	Transmission System Operator
UCTE	Union for the Co-ordination of Transmission of Electricity
VCAS	Voltage Control Ancillary Services
VRE	Variable Renewable Energy
WESM	Wholesale Electricity Spot Market

Executive Summary

Ancillary services refer to the various support services and functions necessary for maintaining the reliability and stability of power system. These services are crucial for ensuring that electricity is delivered efficiently and reliably with sufficient quality to consumers.

At present, the provision of AS is regulated by the load dispatch center, with most AS is provided by generators. However, the provision of AS does not have a special commercial aspect, as the cost of AS provision by generators is already included in capacity and energy payments. While having commercial arrangement for AS will have multiple benefits such as, (i) allowing the system to procure AS from private entities to maintain system operation and enhance system's reliability, (ii) incentivise the private sector to invest in equipment that can ensure power system security and reliability in the long term, and (iii) open opportunities for non-traditional sources e.g., VRE, BESS, electric vehicles, and demand respond to provide services to the grid.

This study aims to develop recommendations for ancillary services (AS) provision in Indonesia by benchmarking AS implementation (business model incl. procurement, and contacting; pricing, payment components) in several countries. The countries examined in this study are the Philippines, India, China, Singapore, Australia, and South Africa, where the AS provision in these selected countries have been separated from energy payment. Initial analyses are conducted to identify AS practices that could be adopted in the Indonesian context. In addition, in-depth analyses are carried out for the Philippines and Singapore to derive applicable legal recommendations for AS implementation in Indonesia.

Key recommendations

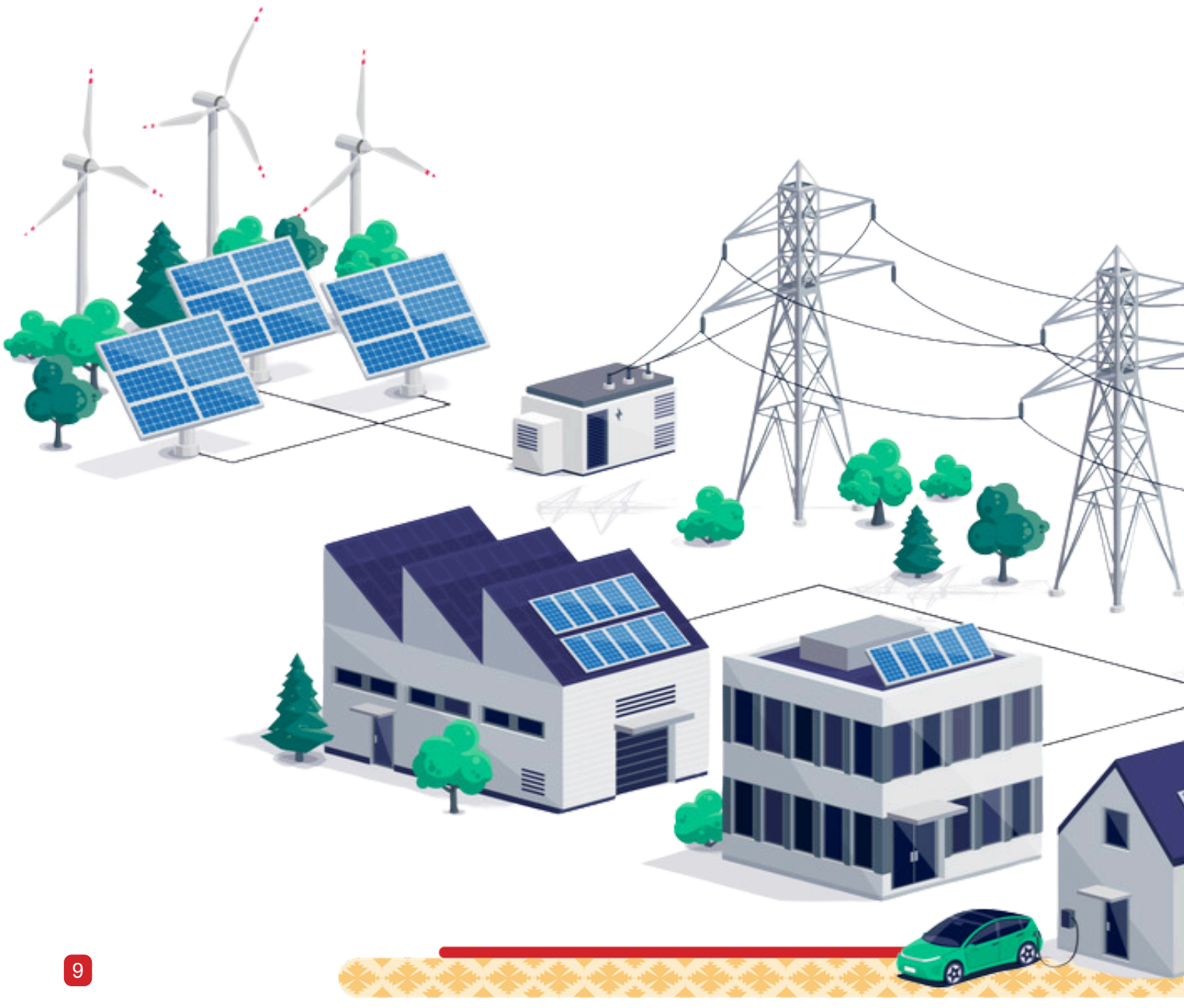
Based on international case studies, as well as considering Indonesia's electricity industry structure, suggested initial set up of ancillary service for Indonesia are:

- **Define Clear AS Products via Legislation or Regulation:** Begin by legally or regulatorily defining a suite of AS products—frequency reserves (primary, secondary, tertiary), reactive power support, and black start—modeled after frameworks like the Philippines, India, and Australia.
- **Implement Bilateral Standard Agreements (Non-market Procurement):** AS procurement can be done through standardized contracts with generators and storage providers. This mirrors the Philippines' use of Ancillary Service Purchase Agreements (ASPAs)—simple, transparent contracts awarding providers based on meeting service criteria. This avoids market complexity while ensuring reliable procurement. These ASPAs can be implemented alongside existing PPAs. Depending on the Indonesian regulatory framework, this can be done by either adding them to existing PPAs and or via separate negotiations or tendering.
- **Set Quantitative Reserve Requirements:** Specify AS volumes as fixed percentages of demand or generation capacity thresholds.
- **Mandate Grid Code Obligations with Penalties for Non-Compliance:** Similar to India's voluntary but performance-monitored AS offerings, Indonesia can require AS providers to submit availability and response data, with non-compliance resulting in financial penalties or disqualification.
- **Advance Towards a Reserve Market via long-term contracts:** Ancillary Service spot markets like in Europe or Australia are not feasible in the short term in Indonesia. However, for cost-optimized procurement of Ancillary Services market structures are essential. In the Indonesian context this could be achieved via long-term contracting as is already implemented for Black Start Services. This allows reserves to be provided by the cheapest offer, so generators can deliver with least additional cost and ensure the overall most efficient way of operation.

In terms of legal reform, AS in Indonesia could be conducted by amending Electricity Law No. 30/2009 and/or GR 14/2012. Separately, Sseveral key provisions to detailed arrangements can be regulated in the amendment to Law 30/2009 and/or GR 14/2012 are:

- Add the definition of AS;
- Include 'electricity generated from AS' in the definition of electric power and AS activities in the definition of electricity transmission (specifically for Electricity law amendment);
- Clarify that Integrated IUPTLU holders may conduct AS planning and procurement as part of its transmission activity;
- Clarify that Generation IUPTLU holders and Transmission IUPTLU holders may act as AS Provider by obtaining a statement letter or AS certificate from MEMR;
- Add a requirement to obtain MEMR's approval for AS costs paid by PLN to AS Providers;
- Clarify that AS cost is one of the components of electricity tariff paid by consumers (specifically for Law 30/2009 amendment); and
- Add procurement mechanisms for AS provision (specifically for GR 14/2012 amendment).

Seperately, several detailed arrangement can be regulated under MEMR Regulation level, e.g.: classification of AS types, detailed procedures for otbaining a statement letter or AS certificate from MEMR, detailed procurement mechanisms detailed procedure for obtaining MEMRs approval for AS costs paid by PLN, and others.



Introduction

Ancillary services refer to the various support services and functions necessary for maintaining the reliability and stability of power system. These services are crucial for ensuring that electricity is delivered efficiently and reliably with sufficient quality to consumers. Ancillary services include services such as frequency regulation, voltage control or reactive power support, black start capability, and reserves (both spinning and non-spinning).

At present, the provision of AS is regulated by the load dispatch center, with most AS is provided by generators. However, the provision of AS does not have a special commercial aspect, as the cost of AS provision by generators is already included in capacity and energy payments. Mechanism for AS provision have been regulated in the Grid Code (MEMR Regulation No. 20/2020)

With the increase in demand and the higher share of VRE in the power system, the need for AS will also increase and require specialised commercial aspects for AS provisioning. Separate payments for AS will help to ensure cost transparency, efficient resource allocation, and fair compensation for providers.

In a single buyer model, government regulation is essential for the provision of ancillary services. This is to ensure grid reliability, fair pricing, and efficient cost recovery. A study on regulation framework should be conducted for Indonesia to ensure that AS is adequately provided with fairly priced and efficiently procured goods in accordance with international standards.

This report investigates ancillary service business model and regulatory framework from international practice and its lesson learned. The findings are translated to formulate essential concepts for the implementation of efficient procurement strategies for Indonesia context, with main goal to ensure the reliable and cost-effective operation of the electricity grid.



General Overview of Ancillary Services

Ancillary services are the services necessary to support the transmission of electric power from generators to consumers. They are critical support functions required to maintain the reliability, stability, and security of a power grid. Ancillary services ensure the continuous balance between electricity supply and demand, manage grid infrastructure within safe operating limits, and enable rapid recovery from disruptions. Ancillary services are needed at all times, not only during disturbances or faults.

Ancillary services have been formulated as early as 1995 by the Federal Energy Regulatory Commission (FERC) in the US (Hirst & Kirby, 1996), long before the proliferation of variable renewable energy (VRE). Hirst & Kirby (1996) have distilled more than 40 different proposed ancillary services into 7 services in 1996, namely:

- Scheduling and dispatch (1)
- Generating reserves:
  - Load following (2)
  - Reliability (3)
  - Supplemental operating (4)
- Energy imbalance (5)
- Real-power loss replacement (6)
- Voltage control (7)

Services (1) and (6), although still essential for modern power systems, are commonly provided by the system operator. Scheduling and dispatch (1) is typically still done by the utility / system operator as it requires access to information and control of the whole system and cannot be provided competitively by individual generators or consumers. Real-power loss replacement (6) is generally calculated by the system operator, provided by the generators, and paid by the consumers (Salt River Project, 2018; Bonneville Power Administration, 2023).

Services (2)–(5) can be categorised as "Frequency control" ancillary services, although definitions and categorisations remain varied across power systems as each power system's needs are unique, as discussed further in the next subsection. As power systems evolve, additional ancillary services, such as black start and harmonic compensation, have also been formulated to solve emerging power system issues.

This report shall focus on the most urgently needed ancillary services in Indonesia – which have been defined in the Indonesian Grid Code – namely:

- Frequency control
- Voltage / reactive power control
- Black start

It is noted that many countries and regions consider frequency control/response and load following reserve as separate (Pollitt & Anaya, 2021). In this study, they are referred to as event reserves and non-event reserves (see Figure 1) – following (Gandhi, Kumar, Rodríguez-Gallegos, & Srinivasan, Review of power system impacts at high PV penetration Part I: Factors limiting PV penetration, 2020) and (Ela, Diakov, Ibanez, & Heaney, 2013), and in line with the Indonesian Grid Code – and are both considered to be within frequency control services. This is done to simplify the discussion and not to introduce too many ancillary service products when the process of ancillary service regulation is just starting.

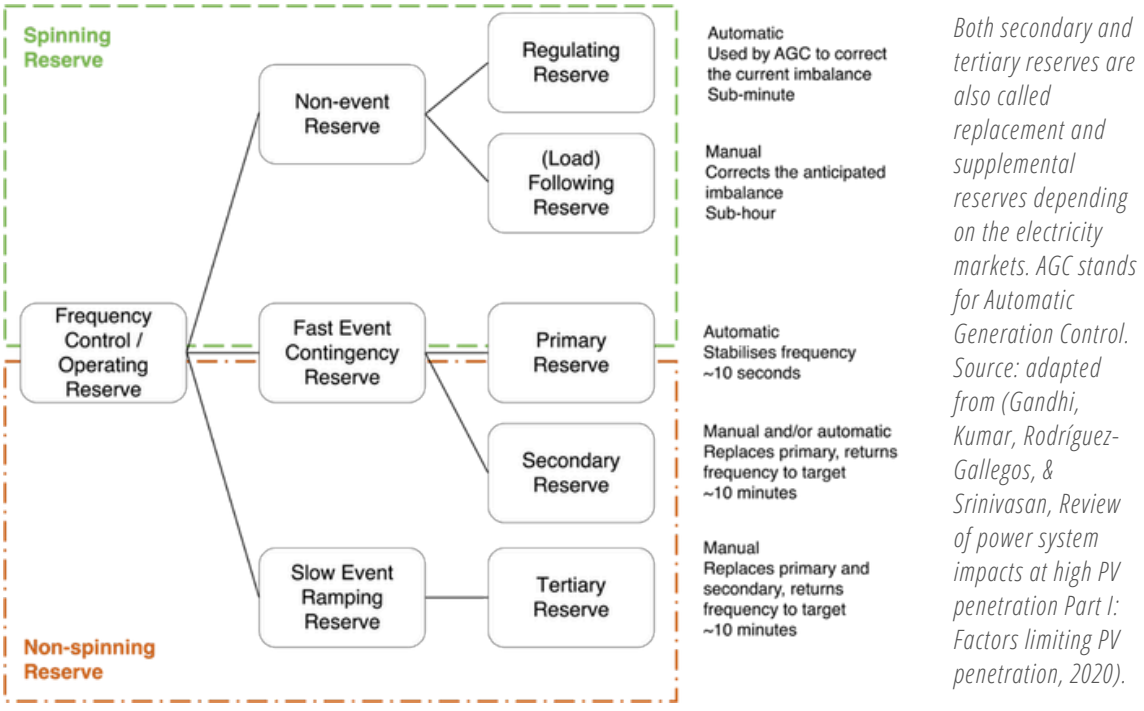
3.1. Types of Ancillary Services

3.1.1. Frequency Control

Frequency control is fundamental to grid stability. The power system operates at a predetermined nominal frequency (50 Hz in Indonesia), and maintaining this frequency is crucial for the safe operation of electrical equipment and the overall stability of the network. Change in frequency indicates an imbalance in aggregate supply and aggregate demand in a power system. Imbalance in supply and demand can arise when demand/generation deviates from forecast, unplanned disconnection of load/generators, as well as when load deviates from generation schedule. When supply exceeds demand, frequency rises; when demand exceeds supply, frequency drops. During normal operation, frequency is maintained at 50.00±0.20 Hz. Frequency control services are deployed to correct the supply-demand imbalance, both during normal operations and during contingencies.

Traditionally, frequency control is done through adjusting the supply side (generators), as they can be more easily and reliably controlled by system operator. To provide the frequency services, generators are required to be able to adjust its power output upwards and/or downwards based on the power system needs. The capacity to adjust the operating points is also called "reserve."

Frequency control services can be defined based on response time, delivery duration, and if they are deployed during normal operations or only during contingencies. Some of the services within frequency control are listed in Figure 1. The types, time scales and definitions of these services vary across power systems, even within the same country (Cochran, 2013), (NERC, 2021). For instance, systems with large inertia react slowly to changes in load or supply and therefore reserves do not need to respond as quickly as in small systems with little inertia. Further, the energy mix and distribution of loads and generators require different capacities, activation times and sustain times of reserves. there are different terminologies used in different regions, whereby many countries follow either the European or the US terminology. In the following, the three types defined by UCTE (Union for the Co-ordination of Transmission of Electricity) are briefly compared regarding their naming and time scales in the European (ENTSO-E) and US system (NERC).



Both secondary and tertiary reserves are also called replacement and supplemental reserves depending on the electricity markets. AGC stands for Automatic Generation Control. Source: adapted from (Gandhi, Kumar, Rodríguez-Gallegos, & Srinivasan, Review of power system impacts at high PV penetration Part I: Factors limiting PV penetration, 2020).

Figure 1. Classification and brief explanation of different types of frequency control services.

Primary Reserve – Frequency Containment Reserve (FCR), Frequency Response Reserve

Primary Reserve is the fastest-acting service. It kicks in automatically within seconds—within 10 to 30 seconds (Europe) or 10 to 60 seconds (US)—to arrest frequency deviations following a disturbance. This response is brief, in Europe, for instance, lasting up to 15 minutes, aiming to immediately stabilize the grid. It operates through speed governors on generators (or batteries) often in combination with droop control, responding proportionally to frequency deviations—thus damping sudden fluctuations.

Secondary Reserve – separated into:

- **Automatic Frequency Restoration Reserve (aFRR), Regulating Reserve:** Secondary Reserve is activated automatically after the FCR has stabilized the frequency. In Europe it starts within 30 seconds after an event (full delivery within around 5 minutes) and sustains the response for several minutes (up to 15 minutes). In the US the activation period lasts from 1 to 10 minutes. Its role is to restore frequency to its nominal value and relieve the load on FCR.
- **Manual Frequency Restoration Reserve (mFRR), (Contingency) Reserve/Imbalance:** This service is manually activated by system operators to support or replace aFRR when needed. As an example, its activation happens within approximately 15 minutes, and capacity is maintained for longer durations ranging from several minutes to hours.

Tertiary Reserve – Replacement Reserve (RR), Supplemental Reserve

Tertiary Reserves are active power reserves available to restore and support the required level of Secondary Reserve to be prepared for further system imbalances. Tertiary Reserve is typically activated manually (Kaushal & Hartem, 2019). Replacement Reserves in Europe are typically activated only after 15 minutes and sustain their output level up to several hours. In the US their response time ranges from 10 minutes to hours.

These reserves work together in a layered approach to ensure seamless responses to grid fluctuations, from the fastest automatic responses (FCR) to sustained manual support (mFRR) and comprehensive system recovery (RR). In systems with low inertia like the Nordics (Finland, Norway, Sweden) (Fingrid, n.d.) with high shares of renewables or island systems like Sulawesi, even shorter activation times may be required. In the European context this is referred to as Fast Frequency Reserve (FFR) or Synthetic Inertia. Similar to Primary Reserve, this reserve type is running on a static control scheme, i.e. it is activated automatically if the frequency drops below a certain threshold (Transnet BW, n.d.). A summary of the reserve type characteristics with exemplary activation and response times from Europe can be found in the following table:



Frequency reserve types with typical activation and response time in Europe

Reserve Type	Also Known As	Activation Speed (Europe)	Activation Response Time (Europe)	Purpose	Control Mode
Ultra-fast Reserve, Synthetic Inertia	Fast Frequency Reserve	<1 s	2s-10s	Very fast response to sudden frequency drops	Static automatic control
Primary Reserve	Frequency Containment Reserve, Frequency Response Reserve	15s	30s	Stabilize frequency immediately after a disturbance	Speed governor, droop control
Secondary Reserve	Automatic/ Manual Frequency Restoration Reserve, Regulation Reserve	30s	15 min/hours	Restore frequency and relieve Primary Reserve	Automatic Generation Control or manual activation
Tertiary Reserve	Replacement Reserve, Supplemental Reserve	15 min	hours	Replace Secondary Reserve and manage larger imbalances	Manual activation

In addition, a more detailed list of key reserves and requirements for low-inertia systems following the example of Finland is given in Annex I. The activation of primary, secondary, and tertiary reserves / frequency control during frequency drop contingency is illustrated in Figure 2.

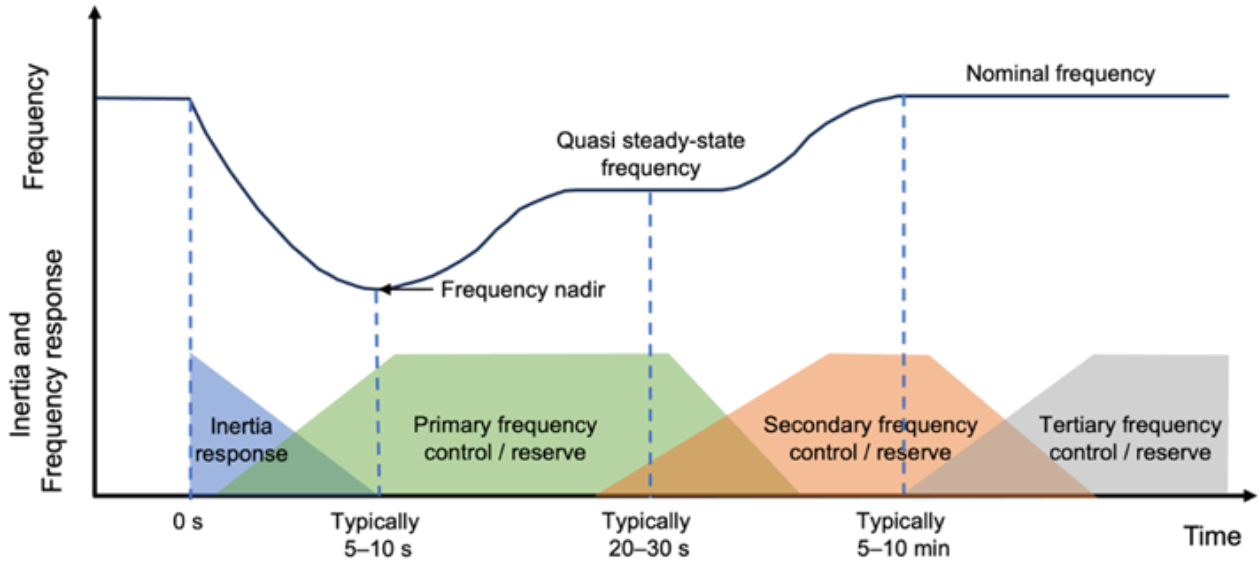


Figure 2. Illustration of frequency response during a contingency causing frequency drop.

3.1.2. Voltage Control

Like frequency, voltage levels in a system also have to be maintained within certain limits to prevent damage to electrical equipment connected to the system. Voltage that is too low may even cause Voltage Collapse and leads to a blackout. While frequency indicates a balance of active power demand and supply in a system, voltage indicates a balance of reactive power demand and supply, especially at the transmission level.[1]

Active and reactive power are properties of alternating current (AC). In an AC system, voltage and current typically have waveforms that vary sinusoidally. The waveforms of the voltage (V) and current (I) may either be in phase or out of phase with each other. Active power is then the multiplication of voltage with the current component that is in phase with the voltage waveform, while reactive power is the multiplication of voltage with the remaining current component. The vector addition of the active power (P) and reactive power (Q) is then termed the apparent power (S). In AC systems, only active power is being consumed, which is why active power is also called real power. Reactive power is just energy moving back and forth across the circuit and does no useful/real work at the load. Nevertheless, the current that accounts for this reactive power, together with the line resistance, causes energy losses (Gandhi, 2019). The term power factor (PF) is used to quantify the ratio of active power to apparent power. PF is a dimensionless number between -1 to 1; a PF of 1 means that reactive power is zero.

Voltage ancillary services are therefore necessary to keep the reactive power balance and maintain the voltage within acceptable limits. Moreover, voltage ancillary services may also include dynamic reactive power reserve to prevent abnormal voltage levels or voltage collapse during contingency.

Unlike frequency which has a uniform value throughout the power system, i.e. 50 Hz, voltage values are different at different areas within the same power system (e.g. 220 V, 66 kV, 500 kV) and even at different points within the same area. The local nature of voltage, coupled with reactive power characteristics which increases transmission losses, mean that voltage control needs to be done locally. Therefore, the reactive power resources should be distributed throughout the power system.

Sources of reactive power can be classified as static resource and dynamic resource. On the one hand, static resource is a resource which cannot or have limited ability to adjust its reactive power output, such as fixed shunt devices (reactor and capacitor), switched shunt devices, and tap-changing transformers. On the other hand, a dynamic resource is one which can change its reactive power output quickly and has continuous operating outputs. Dynamic reactive power resources include synchronous generators, synchronous condensers, inverters (VRE and battery energy storage systems (BESS)), and other reactive power devices.

For both,static and dynamic resources, the following activation procedures are classified:

1. Primary voltage control: Local automatic control which is activated within milliseconds and can last up to one minute
2. Secondary voltage control: Centralized automatic control action one minute after the voltage deviation and can be maintained for several minutes
3. Tertiary voltage control: 10–30 min after the voltage deviation occurrence, optimization of network losses considering the reactive power reserves

[1] At the distribution level, where the resistance is relatively high compared with the reactance, voltage is also strongly affected by active power.

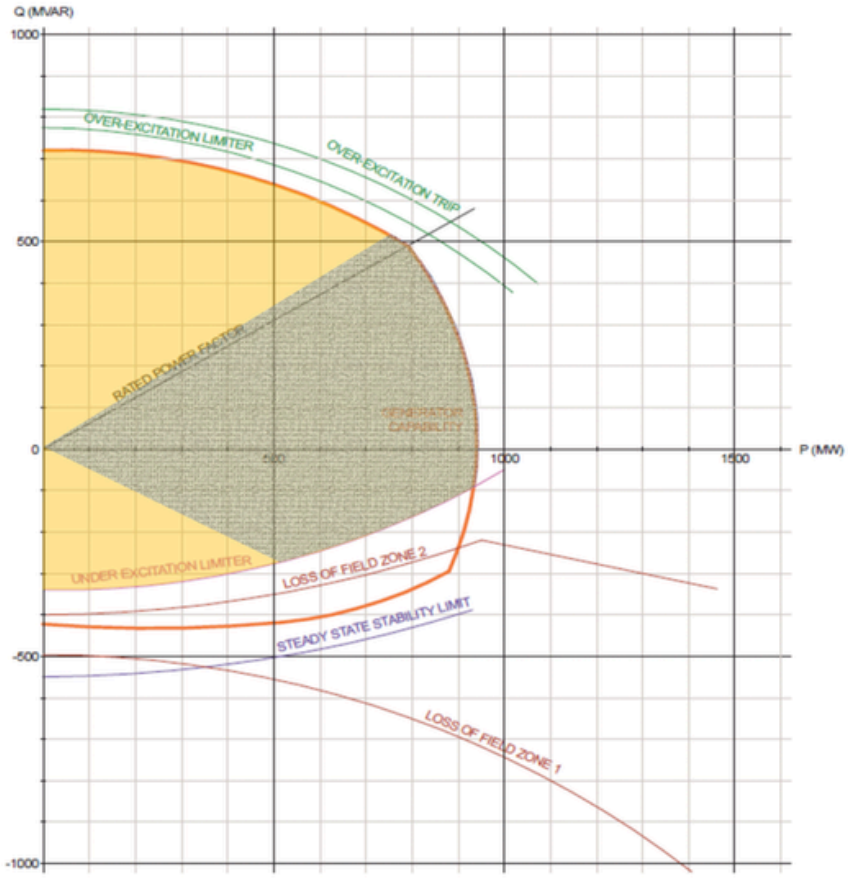


Figure 3. Synchronous generator capability curve. The blue-shaded area indicates feasible operating point for the generator, while the textured area indicates power factor from 0.85 lagging to 0.95 leading.
Source: Adapted from (NERC, 2016).

For synchronous generators, their reactive power capability is limited by their active power output and their stator winding capacity, field current, and terminal voltage. Most, if not all, synchronous generators are equipped with automatic voltage regulator (AVR) to keep voltage constant. Typical synchronous generators' reactive power capability can be illustrated using generator capability curve ("D-Curve") shown in Figure 3. The Indonesian Grid Code (CC 4.4.2.5) requires synchronous generators to be able to operate at PF within 0.85 lagging (injecting reactive power) and 0.90 leading (absorbing reactive power), and VRE at PF within 0.95 lagging and 0.95 leading. As illustrated in Figure 3, generators have reactive power capabilities beyond this range.

3.1.3. Black Start Services

Black start service is the service to restore power after a total blackout by restarting generators without external grid support. During a power plant outage, operators typically depend on the grid to power essential "house loads" (e.g. lighting, data systems, and telecommunications equipment) as well as auxiliary systems needed to start or sustain a generating unit (e.g. oil pumps, gas compressors, draft fans, pulverisers, controls, switchgear, sensors, and safety systems) (Gracia, Markel, & Rizy, 2019). However, if a widespread outage occurs, there is no external power available for the power plant. This necessitates a plant capable of starting its generator units from a completely de-energized state without relying on external grid power—a capability known as black start.

The black start units provide the initial energy required to re-energise sections of the grid, which then sequentially enable larger generation units to come online. A well-planned and regularly exercised black start strategy is essential for minimising downtime and mitigating the economic and social impacts of extended outages.

The "ideal" black start unit possesses the following characteristics (Gracia, Markel, & Rizy, 2019):

- Has rapid and resource-efficient startup
- Consistently available for black start, with sufficient fuel (at least half a day's worth)
- Has adequate real and reactive power outputs to energise transmission and restart other generators
- Has multiple units with black start capability for continuous availability
- Can energise other generators with minimum transformations (transformers in the path) and transmission switching operations
- Can operate quickly after a blackout, can maintain operation during frequency swings, and can contribute to frequency stabilisation

Hydropower plants with water storage are particularly suitable (Gracia, Markel, & Rizy, 2019) as they typically require minimum power to start (and usually already have backup power to manage spillway gates), can start quickly (usually within 10 minutes), have enough fuel (water) except in extreme droughts, tend to be tolerant of frequency swings, have high inertia that contributes to grid frequency stabilisation, and usually have sufficient power output to energise the transmission system, other generators, and loads. On the contrary, gas-fired combine-cycle plants need hours to restart and rely on active gas pipeline to supply fuel, while coal-fired plants require hours to re-heat boilers and operational cooling systems before a restart (Coleman, 2021). Thermal power plants (both fired by gas and coal) typically require 7–8% of its nameplate power rating to energise from a cold start, compared with 1.5–2% for gas turbine[2] and 0.5–1% for hydropower plants (Kurup & Ashok, 2015). Other energy storage systems such as battery can also provide black start services with sufficient power and energy capacity. The suitability of battery energy storage systems (BESS) for black start and other ancillary services are elaborated further in a separate report on BESS. VRE, because of its reliance on environmental conditions to generate power, cannot be a reliable black start generator. Only BESS-equipped VRE with sufficiently large energy storage and power rating may be able to provide black start services.

Therefore, power systems have and continue to rely on hydropower plants for black start capability. In the US, about 40% of the black start units are hydropower turbines, even though hydropower makes up only about 10% of overall US generating capacity (Gracia, Markel, & Rizy, 2019), whereas in the Philippines, black start services are fulfilled by hydropower (55%) and diesel/heavy fuel oil (HFO) power plants (45%) (Barroco, 2021). Nevertheless, it is important for black start units to be distributed throughout the grid – including within/near the city – to allow faster system restoration.

In the Indonesian Grid Code, thermal and hydropower plants that are selected by load control centre are required to have black start facility and to test their black start capability at least once a year (OC 1.6.3).

[2] Gas turbine is also known as combustion turbine. In Indonesian, it is called Pembangkit Listrik Tenaga Mesin Gas (PLTMG).

3.2. Technical Requirements

For grid-connected parties, generators, customers or prosumers technical requirements specify what their installations have to be capable of doing in order to be connected [17]. This is important not only from a perspective of maintaining reliable grid operation but also for monitoring the actual provision Ancillary Service to be procured IPPs. The technical requirements need to at least specify the following:

- Technical specification of the offered service: such as activation time and precision for reserves
- Product resolution (time): On what time resolution is the service procured (block sizes)? This can e.g. be hourly, daily, weekly.
- Product resolution (magnitude): What is the resolution in MW or MVar of the service? (Example: Minimum bid size of 1 MW for primary reserve in many markets)
- Lead time: How many hours or days ahead of delivery is the service procured?

Technical requirements are defined by country and are according to the needs with respect to system size, inertia and response time. An overview of technical requirements in the European and Nordics system is given in Annex I.

3.3. Cost and Payment of Ancillary Services

Many assume that ancillary services can be provided for free. This is false. While the costs of ancillary services tend to be much lower than the costs of energy, as illustrated in Section 3.4, they do exist and are incurred every time ancillary services are provided. These costs can be in the form of additional investment that the ancillary service provider has to make to deliver the service, as well as increase in wear and tear of the equipment because of ancillary service provision.

Sources of cost for Ancillary Service can be categorised into capital cost, opportunity cost, utilisation cost, operational cost, as well as other costs, as elaborated in Table 1. The following subsections shall explore how these costs materialise for different types of ancillary services provided by different types of resources.

Table 1. Types of costs for ancillary services

Cost type	Description
Capital cost	Upfront cost required for investment in additional equipment or retrofit required to provide ancillary services, including additional monitoring and communication equipment.
Opportunity cost	Cost of foregone opportunity that cannot be pursued because of ancillary service provision. For generators, this is usually in the form of output reduction for reserve availability. Opportunity cost depends on power purchase agreement (PPA)/feed-in tariff (FiT)/electricity price paid to the generators.
Utilisation cost	Cost incurred to provide the ancillary service when requested (not only availability), usually in the form of fuel and/or change in power output. Utilisation cost depends on generator specifications and grid operational conditions.
Operational cost	Cost that are incurred indirectly because of ancillary service provision. Examples include wear and tear, power loss, and efficiency reduction because of ancillary service provision. Operational costs depend on generator specifications and grid operational conditions
Other costs	Other costs include transaction and contract costs, as well as emission and externalities. Other costs can be a one-time cost, such as contract costs, or recurring, such as transaction costs.

The capital cost to upgrade or invest in an equipment is typically a fixed cost. So are some operational costs that have to be incurred regardless of whether the ancillary services are delivered, such as regular maintenance to ensure the ancillary service capability, personnel costs, etc. Other costs have fixed components too, such as transaction and contract costs.

Operational costs also have variable components, namely the increase in wear and tear, power loss, and efficiency reduction of the equipment, as well as additional maintenance required on top of the regular equipment maintenance. Opportunity cost and utilisation cost are variable costs as they are only incurred when the ancillary service provider is asked to make the ancillary service available or to deliver it. Other costs can be variable too, such as costs of emission and other externalities associated with providing ancillary services.

3.3.1. Frequency Control Services

Frequency control services have been traditionally provided by synchronous generators. While it is possible for other resources, such as flexible and controllable load (i.e. demand response), VRE, and energy storage to also provide the same services, their procurement face more challenges, both regulatory and technical ones. Therefore, only frequency control services provided by synchronous generators shall be elaborated here. Emerging sources of ancillary services are discussed in Chapter 7.

To provide frequency control services, it is important that the generators have sufficient room to increase or decrease their power output and are able to do so quickly (high ramp rate). Depending on the generators, capital cost may need to be incurred to retrofit the generators to make them more flexible, i.e. lowering the technical minimum load and increasing the maximum ramp rate.

Opportunity cost is incurred when generators have to reduce their output for reserve availability. Opportunity cost should be low or non-existent in a system that has generation overcapacity. System operator can also choose to procure reserve from generators which do not have to incur opportunity cost.

When the generators are called to deliver upward reserve (not only provide the availability on standby), fuel is spent on generating the energy, which is the utilisation cost. In delivering downward reserve, generators forgo payments which could have been obtained from energy generation. In this case, the utilisation cost is the profit from the foregone energy generation.

Operational cost of providing frequency ancillary services comprises the additional maintenance and reduced lifetime because of load cycling, hot start, warm start, and/or cold start that occur while providing the services. The cycling and startups that generators go through to provide the service reduces the generators' fuel efficiency, increases wear and tear as well as emissions. The added thermal and mechanical stress from cycling and startups may also increase the likelihood of unexpected equipment failure and forced outages, reducing availability and lifetime.

For frequency services, opportunity costs (if any) and utilisation costs are usually the highest, but the operational costs are not negligible either.

3.3.2. Voltage Control Services

Unlike frequency control services, voltage control services are not only provided by synchronous generators, but also by reactive power devices, such as capacitor, reactor, synchronous condenser, static synchronous compensator (STATCOM), and static var compensator (SVC). VRE and BESS inverters can also be a reliable source of reactive power.

The cost structure for generators and reactive power devices in providing voltage control is different. For a generator, if the generator's reactive power capacity needs to be increased to provide reactive power beyond what is required in the Grid Code, then capital cost is incurred. Nevertheless, generators typically have reactive power capability beyond Grid Code requirements (see Figure 3) and do not need to be upgraded.

Opportunity cost is incurred if active power output needs to be reduced for reactive power availability. If active power output needs to be reduced for reactive power utilisation, utilisation cost is incurred. Generators only need to decrease their active power output for reactive power injection/absorption when the generation capability of the generator is reached (see Figure 3). Should active power be reduced, the opportunity/utilisation cost is the foregone profits from the reduction in active power generation.

Injecting and absorbing reactive power increases a generator's output current. Higher current increases power losses across the electrical components, which means reduced power output, and therefore revenue. Moreover, increased power losses also increases the operating temperature of the electrical components, which can reduce lifetime and availability, while increasing maintenance costs. All of these comprise the generators' operational costs in providing voltage control. In the absence of any opportunity and utilisation cost (no active power reduction), operational costs are likely the highest cost component for voltage ancillary service provision using generators.

For reactive power devices, the costs are slightly different. The capital cost is the main cost component as it includes the purchase and installation of the reactive power devices solely for providing voltage ancillary service.[3] There is no opportunity cost because the reactive power devices are only used to provide reactive power and there is no utilisation cost either because fuel is not needed. Nevertheless, there are variable operational costs such as additional maintenance or labour costs involved when the reactive power devices are called upon to deliver voltage ancillary service.

In general, in providing voltage control service, the initial investment for reactive power devices is higher, but their operational cost is lower than those for synchronous generators. Both generators and reactive power devices are important to have to guarantee reactive power availability, even during disturbance.

3.3.3. Black Start Services

The cost structure in providing black start services for hydropower and thermal power plants is similar. Capital cost is the cost of upgrading the power plants to provide the black start services. This may include the costs of installing emergency backup power (e.g., diesel generators), as well as electrical upgrades necessary to power the black start unit(s) (Gracia, Markel, & Rizy, 2019).

[3] Some reactive power devices also have other uses. For example, static var compensator (SVC) can also be used to reduce harmonic distortions. Nevertheless, harmonic compensation has not been defined as ancillary service in Indonesia and the reactive power devices are not likely to generate significant revenue beyond voltage ancillary service.

Black start services can incur opportunity costs if the power plants have to limit their power output to maintain their black start capability, e.g. hydropower plants reducing their power output to maintain minimum water storage required for black start. Utilisation cost comprises the fuel cost and other costs incurred when the service is called upon. Operational costs include maintenance of the backup power (most likely diesel generators) and other equipment as well as the associated labour costs.

3.4. Payments for Ancillary Services

Cost of ancillary services discussed in the previous subsection is the cost incurred by the ancillary service provider to make the ancillary services available and to deliver them when required/requested. Meanwhile, the payments for ancillary service discussed in this section refers to the payment made by the system operator to the ancillary service providers to compensate them for their services. There are different ways of compensating ancillary services (Gracia, Markel, & Rizy, 2019):

- Cost recovery: Initial (capital) costs are capitalised and compensated at a negotiated rate of return, while all the ongoing – opportunity, utilisation, operational, and other – costs are paid as they are incurred
- Standard payment: Flat-rate regulated payments set by system operator / regulator
- Economic payment: Determined based on prices submitted to tenders.

The three compensation methods are compared in Table 2 below.

Table 2. Comparisons of different payment methods for ancillary services

Cost type	Advantages	Disadvantages	Typical applications
Cost recovery	+ Reduce investment risk and make projects bankable Make investment in necessary sources more attractive	- Verification of actual costs may be difficult - Potential for overcompensation May not promote cost efficiency or technology improvement	• Services for which factors other than cost, such as locations, are important and that costs are difficult to standardise or compare • Projects that require significant capital investment and where the market for the service is not well-established or competitive • E.g. black start, voltage control
Standard payment	+ Simple and transparent to administer + Provide predictable revenue stream to providers + Can encourage efficiency if the standard payment is set at a level that rewards cost-effective provision Simplify budgeting for system operator	- May not accurately reflect the actual costs incurred, potentially leading to over-compensation - May not incentivize innovation or the provision of services that are more costly but potentially more valuable Less flexibility to adjust cost when there are cost changes or efficiency improvements	• Common and well-understood ancillary services with relatively homogeneous cost structures • Services where ease of administration and predictability are prioritized • E.g. black start, voltage control, frequency control
Economic payment	+ Promotes competition and innovation among providers, leading to more efficient pricing and potentially lower costs for consumers More transparency	- Requires sufficient participants to be effective - Potential for market power abuse if there are few providers - The complexity of tender processes can be a barrier to entry for smaller providers Requires robust tendering process	• Ancillary services where there is a sufficient number of potential providers and a competitive market can be established • Services where price discovery through market mechanisms is desired • E.g. frequency control, voltage control in competitive areas

Price for ancillary services should be determined based on the quality of the services, with higher quality services yielding higher prices, to keep incentivising quality and enhancing system reliability. This means that in frequency control services, the faster the response time, the more expensive the reserve, i.e. spinning reserve is more expensive than non-spinning reserve. This is because the faster reserve can replace the slower reserve.

Regardless of the methods of compensation to the ancillary service providers, the pricing components can consist of the following, but not limited to:

- Capability or capacity [IDR/MW/year or IDR/Mvar/year]: Capacity component to incentivise new capacities in the system, ensuring long-term system adequacy and reliability.
- Availability [IDR/MW/h or IDR/Mvar/h]: Availability component to compensate resources for being ready to deliver the ancillary service whenever required. This payment component is especially important for black start services where blackouts are rare and unpredictable, but the black start generators have to be available at all times.
- Utilisation [IDR/MWh or IDR/Mvarh]: Utilisation component to compensate the resources when the ancillary services are delivered (not just made available) and recover their variable cost.
- Incentive and penalty based on agreed performance criteria.

The price components are different for different jurisdictions and for different ancillary services. They may also be different for different technology with different cost structures and financing, and can still change with technology, regulatory, and market conditions. Ancillary service payment components for selected countries are elaborated in Section 6.

Types of contracts and payment components have to take into account the cost structure of the resource to ensure bankability. When capital cost is involved – either for upgrade, retrofit, or to build new power plant/equipment – financing is most probably required by the potential ancillary service provider. Therefore, the ancillary service contract needs to be bankable, i.e. it may need certain revenue guarantee to pay back investors (Barroco, 2021). The longer the contract duration, the lower the required price. Different technologies have different cost structures, e.g. hydropower plant has high fixed cost and likely requires longer-term contract with higher certainty in payment terms. Ancillary service contract on its own is unlikely satisfactory to fulfil a financing need to build a new power plant, since ancillary service revenue is likely a small percentage of the power plant's total lifetime revenue. However, when coupled with PPA, ancillary service contract can enhance the power plant's bankability. Nonetheless, care should be taken to ensure that there is no double-payment for the same service (in PPA and in the ancillary service contract).

For equipment that are used solely for ancillary services, such as reactive power devices and possibly BESS, the long-term contract may involve letting the system operator full control of the equipment. The system operator can offer regulated payments over time (e.g. monthly over 20 years) to the equipment owner not based on usage. There need to be proper warranties and terms to protect both the system operator from low quality of equipment and installation works, as well as the equipment owners from improper use of equipment or breach of payments by the system operator.

3.5. Procurement of Ancillary Services

Procurement of ancillary service is the responsibility of system operator, as it tasked with ensuring grid stability and reliability, not only through managing energy production and transmission, but also by coordinating the procurement of ancillary services like frequency control, reactive power, and black start. In vertically integrated utilities, similar to how the same organisation (like PLN) may handle both system operator and generator function, the system operator may also provide ancillary services using its own resources. When ancillary services are demanded and provided within the same company, the procurement is relatively simple.

However, as the need for ancillary services increases and the system operator's resources can no longer fulfil it sufficiently or effectively, system operator may start to procure ancillary services from other generators/sources.

There are three main methods to procure ancillary services from third parties:

- Mandatory with or without payment: requiring generators (sometimes also VRE) to provide certain ancillary services as interconnection requirement
- Bilateral contracts (can be through tender/auction or direct award)
- Through real-time/spot market (usually for frequency control in jurisdictions with electricity market)

In the following a brief overview of the different procurement methods is provided.

3.5.1. Mandatory Provision

Depending on region and AS product, provision is required by the Grid Code. It is often remunerated on the basis of the actual amount of AS provided as is the case, e.g., for reactive power support in most European countries except for Denmark and Sweden (Pinson, 2018). In some cases the mandatory provision is not remunerated. An example is the former provision of Basic Ancillary Services in China or Primary Reserve in India as will be discussed in Sections 5.2 and 5.3. While such an approach is simpler to implement as no tendering or setting up a market platform is necessary, it is prone to non-compliance by the AS providers as no financial incentive is set for compliance with the imposed rules.

3.5.2. Contract-based procurement/Bilateral Agreements

Bilateral agreements or firm contracts are mechanisms or contracts through which system operators (like TSOs or ISOs) secure the availability of Ancillary Services from a pool of prequalified service providers.. This can have the advantage of reliable and long-term provision of the required service. One example are services, that require significant infrastructure (e.g., black start capability). In this case operators may enter multi-year agreements with providers. Bilateral agreements can also be the result of tendering processes, which is the case, e.g., in the Philippines as will be discussed in Sec. C.1.2.
In some situations bilateral contracts may be required where limited competition exists in the supply of a service.

3.5.3. Open Market Structure for Ancillary Services

An open market structure means that Ancillary Services are procured competitively rather than assigned or regulated. Market structures typically allow for non-discriminatory, cost-efficient and tractable procurement of required services. There's no contract or obligation to offer ancillary services. Instead, power producers can voluntarily participate in the market. In these markets, standardised ancillary services products are sold by power producers.The primary procurement mechanism is a competitive auction with uniform market clearing prices paid to selected sellers. The structure of these markets, including the ways in which schedules and prices are determined, are reviewed along with other key features of the market designs. Some key aspects of open market structures for energy and Ancillary Services are:

- Market Access: Any qualified participant (generators, storage, demand response) can offer services.
- Unbundling and Transparency: Ancillary Services are unbundled from energy supply.
- Market rules ensure transparent pricing and access to all eligible providers.
- Market-Based Procurement: Services are procured through auctions or continuous markets.
- Integration with Energy Markets: Ancillary Services are often co-optimized with energy markets to ensure efficient dispatch. This includes simultaneous clearing of energy and reserves to reflect real-time system needs.
- Actual scheduling of providers happens through bids based on price and volume.
- Final costs can depend on actual pricing, bid implementation such as pay-as-bid or pay-as-cleared (see below) and competition

Day-Ahead vs. Real-Time Markets:

- Participants submit bids for providing services like frequency regulation, reserves, or voltage support.
- The system operator clears the market based on cost and technical requirements.
- Day-Ahead Market: The Day-Ahead Market (DAM) is a voluntary, financially-binding forward energy market. The bid submission for the DAM is allowed as early as one week ahead and up to one day ahead of the Trading Day.
- Real-time Market (RTM): is a market for incremental and decremental deviations from the day ahead schedules which are traded for short term load balancing. The bid submission for a given Trading Hour in the RTM is allowed after the DAM result publication for the corresponding Trading Day.

Table 3. Comparison of different procurement methods for ancillary services

	Advantages	Disadvantages	Typical applications
Mandatory	+ Ensure a baseline level of essential ancillary services is available + Simplify procurement processes as they are tied to interconnection requirements + Transparent and equal to all generators that fulfil the conditions	-Services may be provided by generators that are not cost-effective -May lead to over-/under-procurement -Does not promote cost efficiency and innovation -Without payment, providers may be reluctant or provide low-quality service -Without payment, additional costs on generators may be included in energy price	• Primary frequency control from conventional generators • Reactive power provision within a certain power factor

	Advantages	Disadvantages	Typical applications
Bilateral contract (direct award)	+ Allow for targeted procurement of specific services from particular providers with unique capabilities or in specific locations + Can be faster and less complex than tendering processes	-Less transparent than tendering and can be susceptible to favouritism or lack of competition -May not ensure the most cost-effective providers are selected Do not promote cost efficiency and innovation	• Procurement of specialized services from providers with unique technology or locational advantages (e.g., black start capability from a specific plant, voltage control in a specific area with few participants) • Small-scale procurement where the cost and effort of a tender might not be justified • Extension or renewal of existing contracts with satisfactory performance
Bilateral contract (tender)	+ Promotes competition among potential providers, leading to more cost-effective procurement. Offers a transparent and objective selection process based on various criteria (if published by system operator)	- Requires sufficient participants to be effective - Potential for market power abuse if there are few providers - The complexity of tender processes can be a barrier to entry for smaller providers Requires robust tendering process	• Procurement of standard ancillary services where multiple providers are likely to exist, e.g. frequency control, voltage control within certain areas • Large-scale procurement of ancillary services where cost-effectiveness is a major priority
Real-time/ spot market	+ Highly responsive to the immediate needs of the system, as services are procured in real-time based on system conditions + Provides price signals that reflect the real-time value of ancillary services. + Promote competition and cost-efficiency	- Can lead to price volatility and uncertainty for providers and system operator - Requires a sophisticated electricity market design and infrastructure - Not suitable for services that require firm commitments or longer lead times - Participation might be limited to large providers with resources dedicated to real-time market	• Services which are needed regularly and continuously, can be provided by many participants • E.g. frequency control in places with well-established electricity markets with robust real-time operations

Each of the methods has its own advantages and disadvantages, as listed in Table 3. For example, mandatory provision is simple to implement but may lead to over/under procurement, which is currently the case for PLN. Meanwhile, spot market can provide ancillary services in exact quantity needed but require heavy investment in system and infrastructure that might not be suitable for Indonesia's present conditions. Therefore, suitable procurement types for each ancillary service need to be analysed based on the power system and regulatory conditions. That is why ancillary service procurement mechanism varies across countries and sometimes even among different power systems in the same country. The procurement methods can also be different for different types of ancillary services. The recommended procurement methods for ancillary services in Indonesia are discussed in Section 7.

There are misconceptions about how ancillary service procurement can only be implemented if there is already an electricity market. It is true that some ancillary services, primarily non-event frequency control services, are procured through real-time market, where real-time electricity markets already exist (Gandhi, Kumar, Rodríguez-Gallegos, & Srinivasan, 2020; Pollitt & Anaya, 2021). Nevertheless, even in jurisdictions with real-time electricity markets, voltage control and black start services are typically procured through mandatory provision, long-term contracts, and/or periodic auctions. Electricity market is certainly not a requirement for ancillary service procurement. The different types of procurement for different ancillary services in different countries will be elaborated further in Section 6.

For each of the ancillary service products, there can also more than one procurement mechanism. For instance, generators above a certain size are required to provide voltage control as long as PF is within 0.85 lagging and 0.90 leading (mandatory provision). Should the available quantity under the mandatory provision be inadequate to fulfil the power system needs, the system operator can form bilateral contracts with capable generators to provide voltage control beyond the specified PF when called upon.

3.5.4. Determining Ancillary Service Quantity

In deciding the quantity of ancillary services to procure, the system operator has to estimate the necessary quantity. The medium to long-term quantity of ancillary services (months to a few years, the basis of forming the ancillary service contracts) can be estimated during the power system planning, whose results include the required new generators to fulfil the electricity demand and amount of ancillary services to keep the grid stable and reliable. Meanwhile, the short-term quantity of ancillary services (hours to days, the basis to call upon the contracted generators to provide ancillary services), can be estimated together with generators' power output determination during unit commitment and economic dispatch. This will ensure that the delivery of ancillary service follows generators' and transmission constraints and is optimised with energy dispatch. There are many factors affecting ancillary service needs, including: grid size and interconnectivity (the larger the size and the more interconnected the grid, the lower ancillary service needed as percentage of load/generator capacity), the largest generator capacity, grid stability during contingencies, and correlation among contingencies. VRE penetration in the system may also affect the amount of ancillary services required. At high VRE penetration, VRE variability, intermittency, and forecast need to be considered to allow accurate economic dispatch.

There are many rules of thumb in estimating the necessary ancillary service quantity to maintain system reliability. For example, New York Independent System Operator (NYISO) requires the operating reserve to be twice the largest contingency (similar to N-2 contingency criterion[4], and the spinning reserve to be at least half of the largest contingency (Wärtsilä, 2021). CAISO requires the operating reserve to be at least the largest contingency (N-1 criterion) and spinning reserve to be at least half of the operating reserve (Wärtsilä, 2021). The system operator can maintain the current procedure or adopt some of these rules of thumb, and then adjust the estimation and procurement process based on power system needs.

3.5.5. Selecting Ancillary Service Provider

In evaluating ancillary service providers, there are many considerations involved, including the resources' capability and their location within the power system. The ancillary service providers selected need to be sufficiently diverse in terms of geographic distribution (especially for voltage control and black start services, which are local in nature), technology types, size, and remaining lifetime. Diversity ensures robustness of the system under any probable conditions and that there is no excessive market power from a single player.

[4] N-1 (and N-2) contingency criterion refer to a contingency where the largest (and simultaneously second largest) unit suffers from an outage. The unit can be a generator or a substation.

Market power of the participants needs to be assessed periodically to prevent monopoly or cartel behaviour. Should there be excessive market power and price gouging detected, regulated price cap may need to be imposed. Nevertheless, any price cap should not be too restrictive that it discourages participation in ancillary service provision and investment in necessary equipment. Moreover, the procurement process should be simple and transparent. Existing generators should not be allowed to bid below-cost prices or collude with others to prevent newcomers. In fact, parts of procurement should be dedicated for new technology/participant (perhaps not immediately) to increase the number of participants, system reliability, and long-term competition.

The capability and availability of the resources in providing ancillary services should also be tested as part of procurement process, and then regularly after contracts are awarded, to ensure that the resources are able to deliver the ancillary services when needed. Payments and penalties should also be tied to the providers' performance and availability.

3.6. Contribution of Ancillary Services to Total Generation Cost

The payments of ancillary service have to be recovered by system operator, either from generators, consumers, or both. The "causer pays" principle can be implemented if it is possible to identify the cause of the need for ancillary services. While this may make generators and large consumers more careful in everyday operations, this may also impose exorbitant risk on individual generator/consumer in case of contingencies (Pollitt & Anaya, 2021). For services that are required by all consumers, such as black start service can be included as part of the basic transmission charge or incorporated into the energy price.

Ancillary service costs and payments, whether they are passed on to the system operator, generators, or direct to consumers, eventually will have to be borne by the electricity consumers. Therefore, it is imperative to evaluate the impacts of ancillary service procurement and delivery to the total generation cost and electricity price being paid by the consumers.

Nevertheless, care has to be taken such that ancillary service procurement and dispatch are compatible with the existing system operation, such that it can be conducted effectively and do not introduce inefficiency in the coordination and the resulting dispatch schedule.

However, even if ancillary service does not reduce the energy generation price offered by the generator to the system operator, ancillary service prices are much lower than energy generation prices. In CAISO, total ancillary service payments average ~1.2% of total energy costs (~0.90 USD/MWh load) from 2021 to 2023 (California ISO, 2024), while in PJM, total ancillary service payments from 1999 to 2018 range from 0.4 to 1.0 USD/MWh load, as seen in Figure 4 (Pollitt & Anaya, 2021). To put the numbers into context, the total system cost[5] of PLN in 2023 was 1,599 IDR/kWh (~100 USD/MWh) (PT PLN (Persero), 2024).

[5] Biaya Pokok Penyediaan Tenaga Listrik (BPP), including generation, transmission, and administrative costs.

How Ancillary Service Contributes to Total Generation Cost?

Ancillary service has the potential to lower the total system cost, despite the additional payments made to ancillary service providers.

Firstly, price by the generators who are required to provide the ancillary service. **By unbundling the ancillary services from energy price, the ancillary service price can reflect the true cost of providing ancillary service.**

Secondly, **an ancillary service contract – whether as a separate contract or added to a PPA – can be a bargaining point to make the PPA more flexible.** This is also the case for new generators, where ancillary service provision terms can supplement (or be added to) PPA to enhance the bankability of the contract for the investors, and at the same time making the contract more flexible for the system operator. Therefore, procuring ancillary service from private sectors can enhance power system reliability by having more secure supply of ancillary service, and at the same time optimise overall system cost through having a more flexible power system.

Thirdly, **the system operator can choose to procure ancillary services from the private sector only when their prices are below the cost of the ancillary services should** be provided by the system operator. In Italy, allowing distributed energy resources to provide ancillary services has increased competition and reduced ancillary service prices (Gulotta, et al., 2020). **By allowing more suitable resources to provide the ancillary services, the variable cost on other generators that are not as effective in delivering the services can be reduced – reducing total generation costs – while system's flexibility and reliability can be enhanced** (Wärtsilä, 2021).

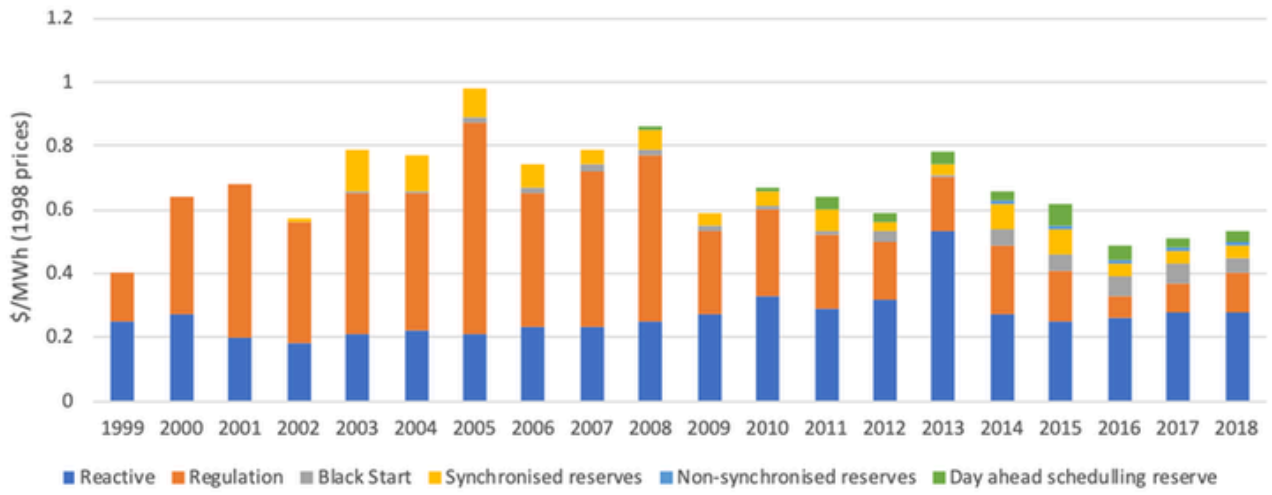


Figure 4. Total payments for each ancillary service products in [USD/MWh load] in PJM from 1999 to 2018. Source: (Pollitt & Anaya, 2021). Reactive refers to reactive power/voltage control; Regulation, Synchronised reserves, Non-synchronised reserves, and Day-ahead scheduling reserve are considered frequency control in this report.

There are many factors affecting the price of ancillary services. Chief among them are (1) ancillary service demand and supply in the system, (2) competition and market power among the ancillary service providers, and (3) fuel cost.

Ancillary service demand and supply in the system, in turn, are affected by:

- Generator composition and location[6] in the network: the more flexible the generators, the lower the ancillary service demand, and the greater the ancillary service supply
- Network infrastructure: the more redundancy and the higher network capacity, the lower the ancillary service demand
- System stability: the more stable the system, the lower the ancillary service demand
- Net demand variability: the more constant and predictable the net demand in the system, the lower the ancillary service demand

More competition tends to bring down the price of ancillary services. When the resources that are allowed to provide ancillary services are expanded further to include VRE, flexible load, and BESS, the price of ancillary services may go down further as competition increases and more efficient resources are chosen.

The higher the fuel costs, the more expensive ancillary services will be, as opportunity costs, utilisation costs, and operational costs increase.

Black start services tend to cost less than frequency and voltage services. For hydropower plants in the US, black start payments generally account for less than 1% of the plants' total revenue (Gracia, Markel, & Rizy, 2019), which mostly comprises energy and capacity payments. In PJM, black start payments were approximately 0.2% of the total system costs in 2008–2017 (approximately 500 USD/MW-peak annual demand) and were always below 0.35% of total system costs (Gracia, Markel, & Rizy, 2019).

The value of voltage control is typically lower than that of frequency control since reactive power provision does not consume fuel, but different depending on network characteristics and conditions. In Great Britain, voltage control comprises ~10% of total ancillary service payments, while in PJM it can even be more than half of total ancillary service payments (Anaya & Pollitt, 2018; Pollitt & Anaya, 2021) (see Figure 4 year 2013). As shown in Figure 4, ancillary service payments even within the same system varies from year to year depending on the system and market conditions, but should remain well below the costs of energy generation.

3.7. Monitoring Practices

Monitoring the actual provision is essential for reliable and secure system operation and to ensure compliance of AS providers with their contracted obligations. To determine whether the AS provided are sufficient, the ability of these services to maintain system reliability, stability, and the quality of power supply needs to be evaluated. This is usually known from historical data by the system operator. In the following five key aspects are listed that help to ensure that a specific service performs as expected under real or simulated conditions:

[6] Generators' location affects their ability to provide voltage control and black start services, but not that of frequency control services.

1. **Real-time performance monitoring** is essential to ensure compliance with ancillary service contracts. Key indicators include comparing the activation signal with the actual response to assess how closely the delivered MW or MVAr output matches the requested service. Response time—measuring the interval between the activation command and the unit's delivery of reserves—helps verify that providers meet required speed obligations. Accuracy, expressed as the percentage deviation from the target setpoint, further ensures that services are delivered reliably and within contracted tolerances.
2. **Availability and readiness** can be assessed through metrics that capture how reliably a resource can deliver ancillary services when needed. The availability factor indicates the percentage of time a unit is actually ready to provide the contracted service, reflecting its operational readiness and overall reliability. Complementing this, the forced outage rate measures how often a resource fails during activation attempts, highlighting unexpected technical issues or performance shortcomings. Together, these indicators provide a clear picture of a unit's dependability and its suitability for delivering high-quality ancillary services.
3. **System impact metrics** help evaluate how effectively ancillary services support overall grid stability and reliability. Frequency quality can be assessed using CPS1/CPS2 scores (or equivalent measures), which indicate how well resources contribute to maintaining stable system frequency. Voltage stability can be examined through a voltage deviation index that compares system conditions before and after reactive power activation, showing how effectively units support voltage control. For black start services, restoration time is a key metric, measuring the time required to energize the first cranking path and synchronize, thereby indicating how quickly a resource can assist in restoring the grid after a major outage.
4. **Event-based validation** ensures that ancillary service providers can perform reliably under real system conditions. Test activations—such as controlled trials for Black Start capability or reactive power delivery—allow operators to verify technical readiness and confirm that units can meet contractual requirements. Disturbance analysis complements these tests by reviewing actual performance during real system stress events, assessing how effectively resources responded when activated and identifying any gaps between expected and delivered service.
5. **Communication and control reliability** is crucial for ensuring that ancillary services can be delivered precisely when needed. Signal integrity—measured through latency and the success rate of transmitted control commands—indicates how reliably instructions reach service providers. Effective coordination is equally important, reflected in the time required to execute restoration or voltage control sequences across multiple system elements. Together, these metrics ensure that communication channels and control systems support fast, accurate, and dependable grid operations.

3.7.1. Compliance targets

To demonstrate the successful delivery of ancillary services in Indonesia, a structured set of key-performance indicators can be applied to measure both technical performance and overall system impact. These KPIs help verify that services are delivered quickly, accurately, reliably, and with tangible benefits to grid stability, while also enabling future economic optimization.

1. **Response Time:** Measures how quickly a unit reacts to activation signals, with typical targets of <30 seconds for frequency containment and <15 minutes for reserves to ensure rapid system stabilization.
2. **Accuracy of Delivery:** Assesses the difference between requested and delivered MW or MVAr output, commonly evaluated through percentage deviation (e.g., ±5%) to ensure precise service provision.
3. **Availability:** Indicates the share of time a resource is ready to provide the service, with benchmarks such as >95% availability for critical services to ensure high operational readiness.
4. **Sustainability of Response:** Evaluates a unit's ability to maintain the required output over the full service duration, for example sustaining reserve delivery for at least 15 minutes, preventing premature drop-off during contingencies.
5. **System Impact Metrics:** Assesses how effectively the service improves grid conditions, such as frequency deviation reduction before/after activation and voltage profile improvement following reactive power support.
6. **Event-Based Performance:** Measures real-world effectiveness during disturbances or test activations, typically expressed as the percentage of successful activations.
7. **Economic Efficiency:** Calculates the cost per MW of service delivered, supporting fair remuneration and informing future development of market mechanisms.

3.7.2. Black start capability monitoring

Black start capability monitoring ensures that designated units can reliably restart the grid after a blackout. Regular tests, simulations, and system checks confirm that units can self-start, energize network sections, and coordinate restoration without external power sources. Core black start tests and system checks that can be used to assess the black start capability of a unit even without a real blackout include:

No-Load Start Tests check the ability to start a generator from a dead state with no external power and the functionality of its auxiliary systems (DC supply, batteries, fuel systems). It confirms the full cold-start capability and verifies the readiness of internal support systems. This way, it establishes baseline black start readiness and identifies issues in the starting circuitry before real emergencies.

Load Energization Tests check the capability to energize a network section or dummy load right after startup and test the voltage and frequency stability during initial load pickup. It validates the controlled load pickup and confirms the ability to maintain stable operation under energized conditions. It ensures the unit can perform the first steps of system restoration. And improves the confidence in its early-stage restoration behavior.

Synchronization Tests demonstrate the ability of a unit to synchronize with the main grid after energizing a section and test the accuracy of voltage, frequency, and phase-angle matching.
This ensures a safe and compliant reconnection to the main grid and validates readiness for the transition from isolated to grid-connected mode. These tests reduce the risk of mis-synchronization and equipment damage and confirm the compatibility with system-wide restoration steps.

Simulations / Black Start Drills test the Restoration sequences using offline models or simulators and the coordination between units, substations, and control centers. They verify that the restoration plan works under various scenarios and confirm the communication and coordination pathways. The advantage of simulations is that they pose no risk to the live grid and allow for testing of rare, complex scenarios that are not feasible physically.

Battery and Auxiliary System Checks test the condition of DC systems, control logic, fuel delivery, and auxiliary components to ensure all supporting systems operate reliably during a cold start. This prevent auxiliary system failures that could undermine black start capability. This way, they enhance reliability of black start resources and help detect hidden vulnerabilities in support infrastructure.

Key performance indicators to evaluate the compliance with black start capability are:

- Start Success Rate (successful cold starts %)
- Start Time (command to minimum output)
- Load Pickup Capability (MW energized within target time)
- Voltage/Frequency Stability during energization
- Communication & Coordination (restoration sequence execution time)

The amount of black start capability needed depends on system size, network topology, and the chosen restoration strategy. Sufficient black start units must be available to energize critical transmission corridors and initiate cranking paths to larger generators, with resources geographically distributed to avoid single points of failure. While adding more black start units generally reduces restoration time, there are diminishing returns beyond a certain threshold. International standards such as NERC EOP-005 and ENTSO-E require system operators to define the precise amount and location of black start resources in their restoration plans, ensuring each designated unit can energize its auxiliaries, a transmission route, and enough load to start subsequent generators in the restoration sequence.

3.7.3. Reactive power capability testing

Physical and Operational Testing Methods

Reactive power capability and voltage control performance should be validated through a combination of physical measurements and operational response tests. **A Capability Test** measures the reactive power range (MVAr) at different voltage levels and verifies compliance with minimum and maximum limits, such as achieving the required range around a **±0.95 power factor**. **A Voltage Control Test** assesses how accurately and quickly a resource adjusts its reactive output following a setpoint change, while a **Dynamic Response Test** evaluates performance during simulated voltage dips or rises to confirm the unit's ability to stabilize voltage under disturbances.

Key Performance Indicators for Reactive Power AS

Reactive power compliance should be monitored using clearly defined KPIs:

- **Reactive Power Range:** Capability at rated voltage, e.g., corresponding to **±0.95 power factor**.
- **Response Time:** Time to reach a new reactive power setpoint after a command **(target: <30 seconds for fast control)**.
- **Accuracy:** Deviation between requested and delivered MVAr **(±5% deviation)**.
- **Voltage Stability Impact:** Measurable improvement in voltage profile following activation.
- **Availability:** Share of time the resource is ready to provide reactive support.

Testing Without Real Disturbances

Compliance can be ensured without relying on actual grid events. **Offline simulations** using load flow and dynamic models can replicate voltage excursions and validate reactive response. **On-site tests during low load periods** allow controlled voltage setpoint changes to verify device behavior with minimal operational risk. **Periodic compliance checks,** performed annually or semi-annually, help ensure that reactive capability, controller settings, and auxiliary systems remain functional over time.

Determining Required Reactive Power Resources

The required amount of reactive power support depends on system-wide voltage stability studies and planning analyses. Grid operators should use **voltage stability assessments** and **reactive power planning** to identify zonal needs, applying a general rule of maintaining reactive reserves sufficient to keep voltages within **±5% of nominal** under worst-case contingencies. International references such as **ENTSO-E** and **IEEE** recommend basing requirements on **N-1 criteria** and short-circuit strength to ensure adequate voltage regulation.

3.8. Challenges and Opportunities of Ancillary Services Procurement

Designing and procuring Ancillary Services presents an opportunity to ensure cost-effective stability while harnessing new technologies like energy storage and renewable energy sources. Without reliable and sufficient penetration of Ancillary Services, the stability of the electricity grid cannot be guaranteed. To this end, fair compensation mechanisms for the provision of Ancillary Services, ensuring compliance with the underlying rules, are essential. On the other hand, regulated competition between AS providers leads to fair prices for consumers, drives down long-term expenses and improves the quality, accuracy and timeliness of AS provision. With thoughtful design, Ancillary Service procurement enhances grid security, ensuring resilience during fluctuations or outages and supporting higher renewables integration. The examples of Europe, the USA and Australia show that competitive procurement strategies can reduce costs and leverage flexibilities more efficiently by optimizing the dispatch of resources, thus unlocking both economic and operational growth.[7]



[7] "Appendix 7.indonesia Grid Code.27 Jan 09.HAPUA SWG2 SO TOR, https://de.scribd.com/document/459912111/Appendix-7-Indonesia-Grid-Code-27-Jan-09-HAPUA-SWG2-SO-TOR?

Ancillary Service in Indonesia

4.1. Existing Regulatory and Policy Framework of Ancillary Services in Indonesia

The provision of Ancillary Services under Indonesia's prevailing laws and regulations, is primarily regulated under Ministry of Energy and Mineral Resources (MEMR) Regulation No. 20 of 2020 on National Grid Code **(MEMR Reg 20/2020)**.

(a) The National Grid Code

MEMR Reg 20/2020 defines grid code as dynamic and adaptive rules, requirements, and standards to ensure a safe, reliable, and efficient electricity grid in fulfilling the electricity demand **(Grid Code)**. MEMR Reg 20/2020 established five grid codes: (i) Jawa, Madura, and Bali Grid Code; (ii) Sumatera Grid Code; (iii) Sulawesi Grid Code; (iv) Kalimantan Grid Code; and (v) Nusa Tenggara, Maluku, and Papua Grid Code. The Grid Code **must** be adhered by: (a) power producers or electricity grid users and (b) electricity consumers.[8] Such obligation to comply with Grid Code must be included in all agreements between (a) power producers or electricity grid users and PLN, and/or (b) electricity consumers and PLN.[9]

According to Indonesian Grid Code, there are three types of operating reserve, namely "cadangan putar" or spinning reserve, "cadangan dingin" or cold reserve, and "cadangan jangka panjang" or long-term reserve.

To implement Grid Code, MEMR forms a grid code management committee (Komite Manajemen Aturan Jaringan/KMAJ). KMAJ is tasked to:

- conduct evaluation on the Grid Code and its implementation, including efforts to increase the role of new and renewable energy power plants in the electricity system grid;
- conduct assessment on changes to the Grid Code submitted by electricity generation business entities or electricity grid users and electricity consumers;
- provide recommendations as necessary on the changes to the Grid Code;
- publish the recommendations on the changes to the Grid Code; and
- conduct investigation and provide recommendations on Grid Code enforcement.
- KMAJ members are at least 15 people consisting of representatives from MEMR, PLN, private power plants or power plants owned by Wilus holders cooperating with PLN, high/medium voltage consumers, and electricity inspector.

Ancillary Services Provisions under the National Grid Code

Given that there are several types of Grid Code based on the electricity system, this Section focuses on Ancillary Services provisions under the Jawa, Madura, and Bali Grid Code. The Jawa, Madura, and Bali Grid Code provides technical provisions relating to frequency control, fast-response governor (speed governor), automatic generation control (AGC), and voltage control. For further elaboration on each Ancillary Service under the Jawa, Madura, and Bali Grid Code, please see Appendix 1.

[8] Article 4 (1) MEMR Reg 20/2020.
[9] Article 4 (2) MEMR Reg 20/2020.

4.2. Challenges of AS Implementation in Indonesia

In Indonesia, ancillary services have been provided by the system operator, PLN, to maintain the reliability, stability, and security of power systems under its jurisdiction. However, as the proportion of generation provided by third parties / private entities have increased, it is becoming increasingly more difficult to fulfil all the power systems' ancillary services using PLN-controlled equipment.

Currently there is a lack of commercial framework governing ancillary service provision in Indonesia; there is no framework for private or any entities to be compensated for the ancillary services they deliver for the grid. This is even though there are costs associated with providing ancillary services, as elaborated in Section 3.3.

The lack of commercial framework brings about short-term and long-term issues. In the short-term, when the system operator requires ancillary service beyond the mandatory provision (without payment) in the Grid Code (e.g. reactive power provision at PF beyond 0.85, operating at governor-free mode to support frequency control) and beyond what its own generators can deliver, the private generators can choose to ignore the operator's requests and the security and reliability of the power system may be compromised. As long as the private generators have no obligation or incentives to provide ancillary services beyond what have been stipulated in the Grid Code, and there are no penalty or repercussion for not abiding the system operator's request beyond the Grid Code's requirement, this issue will likely persist and even get worse as proportion of privately-controlled generators increase.

In the long-term, as there are no financial incentives to provide ancillary services, any newly built generators may not incorporate ancillary service provision in their specifications. As such there may be underinvestment in flexibility and reactive power capability of generators. This will further increase the difficulty of procuring ancillary services by the system operator and further compromise the power system's security and reliability. For example, retiring coal power plants can be converted into synchronous generators cost-effectively, which can provide voltage control services and enhance power system's inertia. However, without any commercial arrangement for the reactive power services, there is no return on investment for the synchronous generators, preventing them from being built.

Having commercial arrangement for ancillary services will have multiple benefits:

- Allow the system operator to procure ancillary service from private entities to maintain system operation and enhance system's reliability
- Free the system operator from having to invest in equipment to provide ancillary service on its own, which increases the system operators' cash flow health
- Incentivise the private sector to invest in equipment that can ensure power system security and reliability in the long term
- Open the opportunities for non-traditional sources, such as VRE, BESS, electric vehicles, and demand response, to provide services to the grid

Certain types of generators/resources at certain locations can provide needed ancillary services much more effectively and economically. When these resources are not owned by the system operator, it is much more beneficial for the system operator to procure the ancillary services from the most effective and economical resources than to build its own with long lead time and large upfront investment.

Country Case Studies

This section provides a structured overview of Ancillary Services in selected countries including Philippines, India, China, Singapore, Australia and South Africa. For each country, it outlines the structure and types of reserve services, their remuneration mechanisms, and whether a market exists—detailing procurement methods, payment responsibilities, and whether payments are made for capacity, activation, or both, and whether the market system is open market, single-buyer or vertically-integrated. Lastly, it reviews the compliance and monitoring systems in place to ensure reliable delivery of Ancillary Services.

5.1. Philippines

Country-specific abbreviations:

- NGCP – System operator
- IEMOP – Market Operator
- DOE – Department of Energy
- ERC – Electricity Regulatory Commission
- ECO – Enforcement and Compliance Office

The Philippines as an archipelago with 7641 islands in the western pacific region with a share of 59.6 % of coal in its electricity generation bear many similarities with Indonesia and thus constitute a good reference case for the integration of AS in their power system (Reuters, n.d.). Only recently an open-market Ancillary Service Reserve Market (ASRM) has been implemented in parallel to a system of bilateral Ancillary Service Purchase Agreements (ASPAs) (Department of Energy Philippines, n.d.).

5.1.1. Classification of Ancillary Services

Ancillary Services in the Philippines separate into frequency reserves, Reactive Power Support and Black Start AS. The former is divided into Regulating Reserve, Contingency Reserve and Dispatchable Reserve. In the following, the roles of the different AS types are briefly summarized:

- **Regulating Reserve**: Readily available and dispatchable generating capacity, exclusively to correct deviations
- **Contingency Reserve**: Qualified generating units and qualified interruptible loads allocated to cover the loss or failure of a synchronized generating unit
- **Dispatchable Reserve**: Generating capacity that is not scheduled for Regular Energy Supply, Regulating Reserve or Contingency Reserve, or interruptible loads not scheduled for Contingency Reserve, and that are readily available for dispatch
- **Reactive Power Support AS**: capability to supply or absorb reactive power to maintain the bus voltage (+-5%).
- **Black Start AS**: ability of a generating unit to recover from a shutdown condition to an operating condition without assistance from the grid.

It should be noted, that the Philippine classification categorizes reserves rather by the criticality of the event, i.e. the frequency deviation from the system's nominal frequency, rather than the time scale of reserve response. Yet, the same services are offered, only their classification is different.

5.1.2. Procurement

Since 2024 two parallel systems of AS procurement exist in the Philippines:

- Ancillary service purchase agreements (ASPAs): firm contracts between system operator (SO) and AS providers contracted after Competitive Selection Process (CSP) selecting the cheapest offer that meets AS requirements published in an Ancillary Service Agreement Procurement Plan (ASAPP)
- Five-minute reserve market to procure regulating, contingency and dispatchable reserve with obligation for certified generating units to submit available capacity (reserve capacity offer compliance). The SO is the single buyer of AS in the ASRM.

Reactive power and black start AS are procured through firm contracts only.

AS provision is paid by scheduled and utilized capacity for compliant hours[10]. Non-compliant hours are not paid and are subject to penalties. Ancillary service costs are then passed on to grid customers though a polluter's principle has been discussed recently. This means attributing the AS costs to parties responsible for a specific service requirement, in particular, generators that are on outage frequently and therefore require the dispatch of contingency and dispatchable reserve, would carry a higher share of AS cost.

Scheduling of AS under ASPAs takes place day-ahead by the submission of available capacity by the AS provider to the SO and submission of the Day-ahead AS schedule by the SO. Within the ASRM the SO and Market Operator (MO) are responsible for central scheduling, dispatch, spot pricing and settlement of reserve and electricity offers.

For the different Ancillary Services to be procured through ASPAs and the ASRM per trading interval and per grid (Luzon, Visayas or Mindanao), the following AS levels apply:

- Regulating Reserve: 4% total demand
- Contingency Reserve: Maximum capacity of the largest generating unit, transmission element, or power import from a circuit interconnection.
- Dispatchable Reserve: Maximum capacity of the second largest generating unit, transmission element, or power import from a circuit interconnection.
- Reactive Power Support AS: System Operator (SO) to determine day ahead through load flow simulation (depends on system voltage condition);
- Black Start AS: at least two generating units contracted per power restoration highway.

5.1.3. Compliance

AS providers are obliged to send generator mode of operations (governor control mode (GCM), Automatic Generation Control (AGC) or dispatch instruction activation) and dead band setting to SO **and Enforcement and compliance office (ECO)**. The latter is established with the operationalization of the ASRM. Unavailability of AS must be announced with supporting documents by AS provider in week-ahead horizon to ECO. With the establishment of the ASRM clear rules, the Reserve Conformance Standards (Philippines, "Ancillary Service Monitoring Manual", 2025) for timeliness and accuracy of AS response are set. In addition, each unit whether contracted under an ASPA or not must submit its available capacity to the ASRM (WESM Philippines, n.d.).
Non-compliance with these obligations or not following the dispatch instructions by the SO or AS provision is subject to financial penalties, suspension or deregistration of the respective AS provider.

[10] "TERMS OF REFERENCE Procurement of Ancillary Services through Competitive Selection Process," 2022.

5.2. India

Country – specific abbreviations:

- NLDC – National Load Despatch Centre
- RLDC – Regional Load Despatch Centre

The state-owned TSO of India is GRID-INDIA that operates and monitors the Indian Power System. It acts through the National Load Despatch Centre (NLDC) and the five Regional Load Despatch Centres (RLDCs). The responsibility for procuring and coordinating AS within their control areas lies with these entities. Despite India having multiple regional market operators, the classification and structure of AS is nationally standardized and coordinated centrally.

5.2.1. Classification of Ancillary Services

AS in India can be provided by generating units, energy storage resources and entities capable of providing demand response. The following services exist:

Primary Reserve Ancillary Service (PRAS): Capability and actual provision of primary reserves are mandatory for all units and not remunerated. It is required to immediately respond via governor action.

Secondary Reserve Ancillary Service (SRAS): Maintains or restores grid frequency within allowable band as specified in the Grid Code. Must be capable of responding within 30 seconds and providing the entire capacity within 15 minutes and sustaining it at least for the next 30 minutes. A minimum response of 1 MW and a bi-directional communication system with RLDC is required.

- Considering a region as a control area, going beyond the minimum threshold limit of ±10 MW
- The Area Control Error (ACE) for each region would be auto-calculated at the control centre of the NLDC based on telemetry data
- SRAS provider shall be selected on regional basis by the Nodal Agency to provide SRAS-Up or SRAS-Down.

Tertiary Reserve Ancillary Service (TRAS): Capability of providing up- or downwards reserve within 15 minutes and sustaining the service for at least next 60 minutes (Grid Controller of India Ltd).
Information on voltage control and black start concepts for Ancillary Services was not found for India.

5.2.2. Procurement

NLDC estimates the required levels of SRAS and TRAS at the regional level after factoring in the reserves for each state control area.

Secondary Reserve Ancillary service (SRAS)
SRAS requirements are defined day-ahead and in a real-time assessment. SRAS are procured by NLDC on a regional and voluntary basis. Actual scheduling is based on the custom participation factor (CPF) of AS units, which takes into account two criteria:

- Rate participation factor (ramping capability in in MW/min)
- Cost factor (energy charge or compensation charge)

NLDC selects the SRAS provider based on its CPF and sends dispatch signals every 4 seconds.

Tertiary Reserve Ancillary service (TRAS)

TRAS is procured in the day-ahead Ancillary Services market (AS-DAM) and real-time Ancillary Services market (AS-RTM). The prices are determined as follows:

- TRAS-UP (additional generation) – pay-as-clear: TRAS-UP selected at lowest market clearing price (MCP)
- TRAS-Down (reduced generation) – pay-as-bid: TRAS-Down selected from highest bid

TRAS is procured through a market system split into a day-ahead market procuring the base demand of TRAS and a real-time market adjusting for last-minute imbalances.

Day-Ahead Market (AS-DAM)

- Generators submit **availability bids** for each hour of the next day.
- These bids are **co-optimized** with energy bids to minimize total system cost.
- The **demand curve** for Ancillary Services is determined by NLDC/RLDCs

Real-Time Market (AS-RTM)

- Real-time bids are used to adjust for **last-minute imbalances**.
- Bids must be submitted at least 90 minutes before the time block.
- The **gate closure** mechanism ensures that once bids are locked, the system operator takes over scheduling

A more detailed explanation of the bidding process into the TRAS market can be found in Annex II.

5.3. China

Country – specific abbreviations:

- SGC – State Grid Corporation of China
- CSG – China Southern Power Grid Company

The Chinese electricity grid is separated into several subregions: The State Grid Corporation of China (SGC) controls the northern part, while the China Southern Power Grid Company (CSG) is responsible for the southern part ("China's electricity sector - Energy in China spotlight - Energy Map", n.d.). In addition, the different Chinese regions historically have very different definitions of AS and a very different implementation of AS procurement and payment figures. In particular, similar Ancillary Services can have different costs per capacity in the different Chinese regions, different units can have different costs in the same market. Therefore, general rules are difficult to define.

To better understand the current status of AS in China we give a brief summary of the historical process leading to the current state: Ancillary service procurement started in 2002 with central optimization of Ancillary Services by dispatch centers without extra compensation, which worked for weak grid infrastructure and centralized power generation and distribution but the willingness to provide Ancillary Services was low, which poses security risks for grid stability. Since 2006 China introduced compensation mechanisms for power plants according to their contribution of Ancillary Services (Kahrl & Wang, 2014). The regional AS markets in peak shifting and frequency control were merged in 2015. In April 2025 new rules for the establishment of a national AS market were announced by the Chinese government (Kahrl & Wang, 2014) allowing new AS market participants like storage devices into the market, aiming to merge the regional markets, define new AS services taking the role of non-spinning dispatchable reserve and fast ramping reserve to counter renewable variability. In addition, as causer-pays principle is planned to be implemented, which attributes costs more on the generating units or consumers requiring the AS. A more detailed description of the announced rules can be found in Annex III.

Though the implementation of AS can vary considerably between the Chinese regions in as basic things as definition of basic and paid Ancillary Services, the compensation mechanism and related methods and the cost-sharing mechanism, in the following, a very high-level classification of the existing system of Ancillary Services in China will be given.

5.3.1. Classification of Ancillary Services

The Chinese AS system basically divides into basic/mandatory services that are not compensated and paid services (S&P Global, n.d.), (China Energy Portal, n.d.).

Basic AS include:

- Generator Frequency Response which is basically equivalent to Primary Reserve
- Basic Peak Shifting/Load Following – generating units carry out output adjustments to follow load and variable generation changes within regulated output ranges. This service is meant as a reaction to predictable demand fluctuations.
- Basic Reactive-Power Control – This service requires the symmetric provision of reactive power within a regulated power factor range

Paid AS (compensated):

- Automatic Generation Control (AGC), i.e. a service that is equivalent to Secondary Reserve
- (Operating/Spare) Reserve – With this service, a margin of capacity of generators is spared. The service is separated into spinning and non-spinning reserve and back-up capacity for unpredictable changes
- Paid Peak Shifting/Load Following – generating units are dispatched if demand fluctuations are beyond the regulated peak shifting depth
- Paid Reactive-Power Control – reactive-power dispatch beyond regulated power factor range, to be dispatched by dispatch and trading agencies
- Black start capability

5.3.2. Procurement

The different definitions and implementations of AS per administrative region as well as a developing and changing AS system see basically all types of possible AS procurement strategies depending on region and service. Basic AS are mandatory for all grid-connected generating units and are not compensated. Medium- and long-term AS like interruptible loads, voltage regulation and black start capability are to be procured via bilateral negotiation/centralized bidding leading to ancillary service contract (Fund.A & Dept, 2023). Spot AS, i.e. AS to be procured the next day or short-term like (operating) reserve and frequency regulation AS are procured through bidding in a market trading platform. Since 2015, pilot markets (for frequency regulation, peak shifting and reserves) were established in the different Chinese regions (Huang' & Li, 2023), testing market-clearing and paid-as-bid concepts of remuneration (China Energy Portal, n.d.).

5.3.3. Compensation and Cost Allocation

So far, a fixed compensation has been used, the amount of which was mainly based on the production cost. The compensation factor depends on the service provided (Shang, Guo, Chen, & Lu, 2025):

- **Primary Frequency Modulation** – grid inertia requirements and unit inertia size
- **Secondary Frequency Modulation** – actual contribution to maintaining grid frequency stability
- **Peak shifting and spare reserve** – average capacity cost, the investment cost of providing paid Ancillary Services, and the loss of active power generation due to the provision of the service

- **Reactive power control** – investment costs in reactive power compensation by the system operator that are mitigated through the provision of reactive power by the service provider
- **Black Start** – Investment costs, maintenance costs, operating costs during the black start period, and annual costs for black start testing and personnel training

Historically, costs were allocated to the supply side, i.e. distributed between generating units (China Energy Portal, n.d.) and not passed to consumers as the electricity price is subject to government pricing constraints. But recent announcements propose to allow costs to be passed on partially to consumers/beneficiaries of AS (Kahrl & Wang, 2014). The updated framework shifts a portion of the costs to end-users, especially those engaged in market activities, aligning payments with who benefits from the services.

In addition, for services such as automatic generation control (AGC) and peak load control, remuneration is now tied to performance metrics such as response time, accuracy, and ramp rate. Providers are rewarded based on the quality and effectiveness of their services. Hence China's regulatory framework is evolving towards a compensation of ancillary service that is market-driven and performance-based, and where costs are fairly allocated under the principle of "beneficiary pays."

5.4. Singapore

Country-specific abbreviations

- EMA – Energy Market Authority
- EMC – Energy Market Company
- NEMS – National Electricity Market of Singapore
- PSO – Power System Operator
- SP – Singapore Power

Singapore electricity industry reform has started since the 1990s, first with corporatisation of industry assets in 1995. A day-ahead cost-based market, called Singapore Electricity Pool, began operation in 1998, while the National Electricity Market of Singapore (NEMS) was launched in 2003 and has remained in operation. Energy, regulation, and reserves are traded in half-hourly intervals in the electricity market. NEMS has evolved along the way to include demand response, intermittent generation, energy storage systems, and electricity imports.

Energy Market Authority (EMA) serves as the regulator of the Singapore electricity industry, while Power System Operator (PSO), a division within EMA ensures reliable supply of electricity and secure operation of the power system, including the dispatch of generation and ancillary services. Energy Market Company (EMC) serves as the market operator, while Singapore Power (SP) owns and is responsible for maintaining the transmission system. Market participants include generators, interruptible load (large consumers who offer to have their electricity supply interrupted), electricity retailers, and contestable consumers – who have a choice to purchase their electricity either from a retailer or indirectly from the wholesale market through SP Services.

In addition to the aforementioned stakeholders, the electricity market is governed by:

- Rules Change Panel who reviews and recommends modifications to the Singapore Electricity Market Rules (updated quarterly)
- Market Surveillance and Compliance Panel who monitors and investigate potential market breaches and enforce the market rules
- Dispute Resolution Counsellor who settles dispute among the electricity market stakeholders

5.4.1. Classification of Ancillary Services

- **Primary Reserve** (9s response): the change in MW output of the generating unit automatically by governor action in response to change in frequency, measured at 9 seconds and sustainable for an additional 9 minutes and 51 seconds. Primary Reserve arrests the initial change in system frequency and restores it to a target frequency (49.7 Hz in case of fall in frequency). Automatic by governor action
- **Contingency Reserve** (10min response onwards): reserve that is activated manually by PSO to replenish Primary Reserve in preparation for the next contingency
- **Regulation:** generation capacity that is on standby to cover second-to-second variations in load away from estimated load
- **Reactive Support and Voltage Control Services:** AS provided to allow the PSO to maintain the voltage at prescribed levels
- **Black Start Capability Services:** Capability to self-start without any off-site electrical power source during blackouts within 30 minutes
- **Fast Start Services:** service that can be activated by PSO to start delivering additional electricity supply within 10 minutes to balance the power system in the event of unexpected demand increase, forced or unplanned outages of generating units, and/or there is a projected shortfall in energy/reserve
- **Reliability Must-Run Services:** AS provided by a generator that allows the PSO to call on the generation facilities in order to maintain reliability of the system

There used to be Secondary Reserve (30s to 10min response), but the category was removed in 2017, while the Primary Reserve response of 8s to 30s was modified to 9s to 10min (Scholtz, Muluadzi, Kritzinger, & Mabaso) leaving only Primary Reserve and Contingency Reserve under the reserve category.

5.4.2. Procurement

PSO determines the quantity (and locations) needed for each type of AS. On the one hand, Regulation and Reserves are procured through the electricity market, where the energy, Reserve, and Regulation products are co-optimised in clearing their price and quantity. As a result, Reserve and Regulation prices are correlated to the energy price. Reserves can be provided by generators and interruptible load, while Regulation currently can only be provided by generators.

On the other hand, Reactive Support, Black Start, Fast Start, and Reliability Must-Run services are procured by EMC on behalf of PSO via bilateral contracts. In the period from 1 April 2024 to 31 March 2025, only Black Start is contracted/ From 1 April 2025 to 31 March 2026, Black Start and Fast Start services are contracted. Each generating station with any generating unit(s) of rated capacity 100MW and above is required to have Black Start Capability unless exempted by PSO.

For both periods, Reactive Support and Reliability Must-Run services were not contracted. This means that mandatory provision of reactive power is already sufficient in maintaining the system voltage and no additional reactive support was required. Each generating unit must have the capability of operating at a power factor from 0.95 leading to 0.85 lagging (as measured at the terminals of the generating unit prior to the step-up transformer) – the requirement for solar PV inverter is from 0.9 leading to 0.9 lagging, and the PV plant must be capable to operate in fixed power factor, Q(V), and constant Q modes.

5.4.3. Payment and Cost Recovery

Reserves and Regulation are purchased by EMC in the electricity market. The cost of Reserves are recovered from generators based on the risk they contribute to the system – a generation facility with a lower failure probability will be allocated less reserve cost compared to one with a higher failure probability – while cost of Regulation is recovered from retailers in proportion to their energy purchases and by dispatched generators up to a ceiling of five MWh for each trading period.

For the contracted AS, the payment to AS provider consists of annual CAPEX and OPEX payment with allowed 10% rate of return for CAPEX and 10% margin for OPEX. Some variable OPEX – fuel, gas pipeline usage – can be reimbursed without profit [45] The AS costs are recovered through monthly energy uplift charge, charged by EMC to the market participants.

Before the launch of NEMS, annual reserve cost was 438 million SGD, reduced to 52 million SGD in 2004because of competition. In 2004, total energy and AS costs in Singapore was 3.09 bil. SGD, consisting of energy (96.78%), Reserves (1.68%), Regulation (1.15%), and Black Start (0.4%). For the year 2024, the total costs have increased significantly to 10.64 bil. SGD, mainly due to increase in electricity demand. While the energy costs have increased to more than three times those in 2004, the ancillary service costs have remained roughly constant. Consequently, the energy costs comprise a much larger proportion (98.79%) of the total energy and AS costs, while Reserves (0.80%), Regulation (0.30%) and Black Start (0.11%) proportions have fallen considerably.

5.5. Australia

Country-specific abbreviations

- NEM – National Electricity Market
- AEMO – Australian Energy Market Operator
- MASA – Market Ancillary Service Arrangements
- ASA – Ancillary Service Agreements
- FCAS – Frequency Control Ancillary Services
- SRAS – System Restart Ancillary Services
- NSCAS – Network Support and Control Ancillary Services

5.5.1. Classification of Ancillary Services

AS in Australia are categorized into Frequency Control Ancillary Services (FCAS), System Restart Ancillary Services (SRAS) and Network Support and Control Ancillary Services (NSCAS), each being split into several subcategories as explained in the following.

Frequency control Ancillary Services (FCAS) are used to maintain system frequency within acceptable limit and are separated into two subcategories:

- **Regulation frequency control (Secondary reserves):** Regulation frequency control corrects the supply/demand balance in response to minor deviations in load or generation. The regulation frequency control services are provided by generators on Automatic Generation Control (AGC). The AGC system allows AEMO to continually monitor system frequency in case of an imbalance, the system sends control signals out to generators providing regulation services.
- **Contingency frequency control (Primary reserve):** Contingency frequency control corrects the supply/demand balance following a major contingency event, such as the loss of a generating unit, major industrial load, or large transmission element. AEMO must ensure that after a credible contingency event the frequency deviation remains within the contingency band.
  Contingency services are provided locally by technologies like governors or frequency relays that can detect the frequency deviation and respond to correct the frequency such as a generator governor response, load shedding of a specific load, rapid generation that starts a fast generator and rapid unit unloading that reduces generator output. They are subcategorized into very fast (1s), fast (6s), slow (60s) and delayed (5 min) responding units.

System Restart Ancillary Services (SRAS) are responsible for restoring power after a major blackout. SRAS can be subdivided into the following categories:

- General restart source: A generator that can start and supply energy to the transmission grid without any external source of supply.
- Trip to house load: A generator that can, on sensing a system failure, fold back onto its own internal load and continue to generate until AEMO is able to use it to restart the system.

Network Support and Control Ancillary Services (NSCAS) manage voltage and network constraints. NSCAS can be subdivided into three categories:

- Voltage Control Ancillary Services (VCAS) – Under these Ancillary Services, generators absorb or generate reactive power from or onto the electricity grid and control the local voltage accordingly. VCAS can be provided, e.g. by Synchronous condensers or static reactive power devices.
- oNetwork Loading Ancillary Services (NLAS) – To control the flow on interconnectors to within short-term limits. For instance, if the flow on an interconnector from region A to region B exceeds the short-term limit, AEMO could reduce the flow by increasing the generation levels of generators in region B, or by shedding load in region B.
- Transient And Oscillatory Stability Ancillary Services (TOSAS) – TOSAS control and fast-regulate the network voltage, increase the inertia of rotating mass connected to the power system, or rapidly increase/reduce load connected to the power system when faults such as short circuits or malfunctioning equipment occur.

5.5.2. Procurement

AEMO is responsible for procuring the required AS levels from market participants either via Market Ancillary Service Arrangements (MASA) or Ancillary Service Agreements (ASA). The former are competitive market-based services managed by the (AEMO) through which FCAS are procured. The latter contract non-market services by AEMO entering into bilateral agreements with service providers to procure long-term services like SRAS and NSCAS.

FCAS Markets

FCAS are used by AEMO to maintain or rebalance the frequency on the power system, at any point in time, close to fifty cycles per second (50 Hz) as required by the NEM frequency operating standards set by the AEMC Reliability Panel.

Participants must register with AEMO to participate in each distinct FCAS market. Once registered, a service provider can participate in an FCAS market by submitting an appropriate FCAS bid for that service, via AEMO's Market Management Systems. There are 10 FCAS markets in Australia, divided into regulation FCAS and contingency FCAS.

Table 4: FCAS markets in Australia

Market Type	Description	FCAS Types
Regulation Markets	Regulation FCAS provide frequency correction in response to minor deviations in the demand/supply balance.	• Regulation Rise: used to correct a minor drop in frequency • Regulation lower: used to correct a minor rise in frequency
Contingency Markets	Contingency FCAS correct the supply/demand balance in response to major frequency disturbances causing frequency to move outside the normal operating frequency band, which can occur after contingency events such as the loss of a generating unit or a major load.	• Very Fast Raise/Lower (1 second): Provide an immediate response to a major frequency deviation. • Fast Raise/Lower (6 seconds): Respond slightly slower than the very fast services. • Slow Raise/Lower (60 seconds): Stabilize frequency over a longer period following the event. • Delayed Raise/Lower (5 minutes): Bring the frequency back to normal following the contingency.

During every trading interval, the National Electricity Market Dispatch Engine (NEMDE) must enable a sufficient amount of each of the 10 FCAS products, from the FCAS bids submitted, to meet the FCAS megawatt requirement. The highest cost offer to be enabled will set the marginal price for the FCAS category. A more detailed description of the bidding process into the FCAS market is given in Annex IV.

Frequency performance payment (FPP)

Frequency Performance Payments (FPP) scheme, launched in June 2025, provides financial incentives to units that helps maintaining frequency closed to the nominal and penalties to units that negatively impact frequency. While not an ancillary service, FPP complements Regulation FCAS by using contribution factors to determine both payments and cost recovery; replacing the former Causer Pays methodology. Unlike the old approach, FPP rewards units that help restore system frequency, enhancing fairness and system stability.

The FPP replaces the 'causer pays' model with a more accurate framework that uses a five-minute contribution factor. This new approach is expected to ensure fairer and more transparent cost allocation for regulating Frequency Control Ancillary Services (FCAS).

Unlike most settlement functions, FPP does not require separate payment and recovery calculations. The contribution factor (CF) and residual contribution factor (RCF) have a value between 1 and -1 where positive factors result in a payment from AEMO and negative factors in a payment to AEMO.

It applies to:

- Scheduled generators
- Semi-scheduled generators
- Scheduled loads
- Bidirectional units (e.g., batteries)

This new approach is expected to ensure fairer and more transparent cost allocation for regulating Frequency Control Ancillary Services (FCAS).

5.5.3. Payment and Cost Recovery

AEMO recovers ancillary service costs from Cost Recovery Market Participants (CRMPs) which includes participants registered as Market Customer, Market Generator and Integrated Resource Provider. The costs of different types of service are recovered in different ways, in accordance with criteria set out in the Rules.

FCAS Payments

The relevant FCAS providers will receive settlement payments for each Trading Interval (TI) calculated using the relevant ancillary service price and the amount of each ancillary service dispatched for each unit.

FCAS Recovery

FCAS payments for services enabled to meet a local requirement are recovered only from specified Cost Recovery Market Participant (CRMP) in the region or regions in which the FCAS constraint was binding.
In general, FCAS costs are recovered from the parties deemed responsible for creating the need for each FCAS.

- **Lower contingency -** As contingency raise requirements are set to manage the loss of the largest generator on the system, all payments for these services are recovered from generators, pro-rated based on the energy they generate. Lower contingency FCAS costs are recovered from CRMPs with ACE values only, in the relevant requirement region(s) for each binding constraint.
- **Raise contingency -** On the other hand, as contingency lower requirements are set to manage the loss of the largest load/transmission element on the system, all payments for these services are recovered from wholesale customers, pro-rated based on the energy they consume. Raise contingency FCAS costs are recovered from CRMPs with ASOE values only, in the relevant requirement region(s) for each binding constraint.

Regulatory FCAS recovery

Regulation FCAS costs are recovered from CRMPs under separate calculations for the used and unused portions of the binding regulation FCAS constraints. The calculations utilise the negative contribution factors (NCFs) calculated under the FPP methodology for each interval, along with the default contribution factors (DCFs), which are calculated over a historic reference period.

- Used regulation FCAS recovery: For CRMPs with connection points with individual NCFs, the Regulation FCAS is recovered from each unit with a negative contribution factor.
- Unused regulation FCAS recovery: For CRMPs with connection points with individual DCFs, the regulation FCAS is recovered from each unit with a negative default contribution factor.

NSCAS and SRAS

NSCAS acquired by AEMO are typically used to control voltage at different points along the network. Generally, these services are provided by voluntary load shedding or the supply or absorption of reactive power.

SRAS enable generation to be restarted to energise the transmission system following a major supply disruption.

NSCAS Payment

AEMO procures NSCAS through contracts with registered participants on agreed terms and conditions.

Types of payments made by AEMO to NSCAS providers may include:

1. Availability payments for each trading interval that the service is available
2. Enabling payments for trading intervals when the service is specifically enabled
3. Compensation or usage payments made for the amount of the NSCAS actually provided
4. Testing payments for each successfully conducted test

NSCAS cost recovery

AEMO aggregates the relevant payments (excluding testing payments) for each trading interval and each type of NSCAS and recovers them fully from CRMPs with ACE values only from the benefiting region(s), by applying regional benefit factors.

SRAS Payment

AEMO procures SRAS through contracts with registered participants on agreed terms and conditions

Types of payments under SRAS contracts may include:

- Availability payments for each trading interval that the service is available
- Usage payments for when the service is successfully delivered in response to instructions
- from AEMO
- Testing payments for each successfully conducted test

SRAS cost recovery

AEMO aggregates the relevant payments for a SRAS event (excluding testing payments) for each trading interval and recovers the relevant costs from CRMPs on a 50/50 split basis between ACE and ASOE values from the benefiting region(s), by applying regional benefit factors. Both NSCAS and SRAS are provided to the market under long-term ancillary service contracts negotiated between AEMO and the participant providing the service.

These services are paid for through a mixture of:

- Enablement payments – made only when the service is specifically enabled.
- Availability payments – made for every trading interval that the service is available.
- Testing payments – made for costs incurred for annual testing of service.
- Usage payments – made for every trading interval when the service is used.
- NSCAS payments are recovered fully from market customers, while SRAS payments are recovered from both generators and wholesale customers on a 50/50 basis.

5.5.4. Compliance

AEMO uses SCADA systems, data logs, and continuous monitoring of the grid frequency to identify who is responsible for generating frequency deviations. If a particular generator or load causes an imbalance, it can be identified through their real-time performance data, which is compared to their forecasted output and system conditions.

5.6. South Africa

Country-specific abbreviations

- Eskom – South African system operator and electricity provider
- CfD – Contracts for Difference
- AS_SO – Ancillary Services Standard Offer

5.6.1. Classification of Ancillary Services

The South African Grid Code separates its AS into four basic categories: Reserves, System Restoration Services, Reactive Power Supply/Voltage Control and Constrained Generation [46].

Reserves are separated into three broad categories **Operating Reserve, Emergency Reserve and Supplemental Reserve**:

- **Operating Reserve** is to be dispatched within 10 min and consists of spinning- and non-spinning reserve generation and demand side resources. It is subdivided into three contributions:
  - **Instantaneous Reserve** is generating capacity or demand side managed load that is fully available 10 safter a frequency-driven event and sustained for 10 min. It thus roughly corresponds to frequency containment or primary reserve in the European classification. It directly responds to the current system frequency. It is contracted on the energy bid price.
  - **Regulating Reserve** is generating capacity or demand side managed load available to respond from 10 s after a frequency-driven event and fully activated within 10 min. A unit scheduled for Regulating Reserve must provide upward and downward capacity every hour of the day and sustain its level for 1 h. It is AGC driven and thus corresponds to Secondary Reserve in the European classification. It is contracted on the cheapest Energy Bid Price.
  - **Ten-Minute Reserve** is an offline quick start generation plant (e.g. hydro) or demand side load that has to respond within 10 min when called upon. It is responsible for restoring instantaneous and regulating reserve to the required level and must be sustained for 2 h. It is dispatched under manual generation control (MGC) and thus corresponds to tertiary reserve in the European classification. It is procured via hourly contracts based on bid price for capacity and is dispatched on energy price.

In addition to Operating Reserves, two other types of reserve secure the system in case of extraordinary events:

- **Emergency Reserve** is an interruptible load, generator emergency capacity or gas turbine capacity to be dispatched within 10 min that is under National control. It's size is defined by the average loss of coal-fired power plants. Like the Ten-Minute Reserve, Emergency Reserve is dispatched under MGC. Procurement is done via an annual contract and is dispatched on energy cost.
- **Supplemental Reserve** is generating capacity or demand side load dispatchable within 6h and available for at least 2h. It is contracted to ensure acceptable day-ahead risk and aims at restoring the operating reserve.

- **System Restoration Services** separate into three subcategories:
- **Black Start** is procured by the SO by at least two suitable facilities.
- **Unit Islanding** is the ability of units to suddenly disconnect from the transmission system and maintain its functions for at least two hours to potentially resynchronize with the system afterwards. These units are contracted and certified directly by the SO.
- **Self-Start** units can start up without external power supply, energize portion of the transmission system and supply load.

Reactive power and voltage control is a mandatory provision by generating and storage units.

Constrained Generation units restrict their power output to ensure system stability. They are procured by the SO to manage transmission system constraints and are compensated by the SO according to the market rules

5.6.2. Procurement

South Africa has a single-buyer market. That means all AS is procured directly by the SO [46]. In particular, the day-ahead demand forecast, day-ahead energy and AS schedule and execution of the energy and AS schedule are responsibility of SO. The SO further certifies AS providers and keeps a register of all certified providers. There is a clear market dominance in the transmission and generation system of Eskom and, thus, most AS provided by the utility's own units (Cliffe Dekker Hofmeyr, n.d.).
There have been several attempts to establish an market-based procurement system, to unbundle Eskom and set incentives for the private sector to invest in new generation to solve several South-African load-shedding crises and large debts of 2000s and 2010s but the effects of past attempts have been limited.
In South Africa, Ancillary Services are being systematically contracted and remunerated through formal mechanisms overseen by the National Transmission Company of South Africa (NTCSA) and Eskom, as part of a broader effort to modernize grid operations.

5.6.3. Payment and Cost Recovery

The NTCSA has launched a pilot program called the Ancillary Services Standard Offer (AS_SO) [50], covering the period through March 31, 2027 (or until funds are depleted). This initiative is designed to procure instantaneous and regulating reserves based on fixed, standard rates. Key Features:

- Instantaneous Reserve (IR):
  - Activation time: within 10 seconds
  - Sustained response: 10 minutes
  - Cap: up to 155 trigger events annually
  - Compensation: 957 ZAR/MW
- Regulating Reserve (RR):
  - Activation time: within 10 minutes
  - Sustained response: 1 hour
  - No limit on event frequency
  - Compensation: 638 ZAR/MW
- Contracting Process:
  - Private generators or facilities (≥ 50 MW) apply on a first-come, first-served basis.
  - Successful applicants sign a standard Ancillary Services Agreement (ASA), ensure vendor registration, and undergo technical testing at their own cost.

Additionally, Contracts for Difference (CfDs) via Power Purchase Agreements (PPAs) are used to remunerate reserve capacity and other Ancillary Services bundled with energy supply. Eskom's long-term contracts include fixed components for reserve capacity hedging, similar to energy hedging. They also cover services like black start, islanding, and other technical support [50]. Costs are recovered from all grid-connected generators and loads (Eskom, 2025)



Ancillary Services in the Philippines in Detail

List of abbreviations:

- NGCP – System operator
- IEMOP – Market Operator
- DOE – Department of Energy
- ERC – Electricity Regulatory Commission
- ECO – Enforcement and Compliance Office
- ASRM – Ancillary Services Reserve Market
- ASPA – Ancillary Service Purchase Agreement
- CSP – Competitive Selection Process

The Philippine reserve procurement strategy via firm contracts filed after a public tendering process referred to as competitive selection process (CSP) seems to be a reasonable option for procurement of Ancillary Services (AS) in Indonesia. For this reason, this section conducts a more in-depth analysis of the Philippine procurement strategy in the form of CSPs, also detailing its relation to the Philippine reserve market. Further, a more detailed description of monitoring, compliance and the penalty mechanism is given.

6.1. Procurement

As described in the Philippine country case Sec. 5.1 two methods of AS procurement currently exist in parallel in the Philippines: First, the required levels of AS are procured via a public tendering process leading to firm contracts between AS providers and the SO. Second, an open five-minute Ancillary Service Reserve Market (ASRM) exists for frequency reserves. Under both procurement strategies the reserve levels as introduced in Sec. 5.1 have to be procured (in case of the ASRM for each trading interval).
The detailed technical requirements for the three reserve types are shown in Table 5 in Section 6.3.
In the following, the procurement process and the relation between the two procurement strategies are described in more detail.

6.1.1. AS Procurement Prior to the Operation of the Reserve Market

The SO shall ensure compliance with its obligation to procure the required level and specifications of AS where Regulating, Contingency, Dispatchable Reserve, Reactive Power Support AS and Black Start AS shall be procured through firm contracts only. These Ancillary Service Purchase Agreements (ASPAs) are procured through a tendering process referred to as Competitive Selection Process (CSP) further described in Annex V.

The key features of the CSP are summarized in the following: After yearly publishing of Ancillary Service Agreement Procurement Plans (ASAPPs) detailing the timing, projected required levels and number of existing ASPAs per grid for the next ten years, the selection process is organized by the Third Party Bids and Awards Committee (TPBAC) selected by the SO as public tendering process announced on the web pages of the Department of Energy (DOE) or TPBAC as well as in widely-spread newspapers.

After amendments and changes to the bid documents, including among others the requirements for AS, Terms of Reference, the bidding procedure and timeline, during the pre-bid conference, the bidder with the cheapest offer meeting the requirements is selected in an open and transparent manner by the TPBAC. The signing of the contract is filed with the Energy Regulatory Commission (ERC). Details of the ASPA are shared with the Department of Energy for reasons of monitoring and compliance. The entire CSP shall not take longer than 90 days and the costs are carried by the SO. During the bidding process bidders place a bid security of 2 % of the computed capacity payment cost that is forfeited to the SO in case the bidder withdraws from the bidding process or refuses to implement the requirements after being awarded with the ASPA. ASPAs typically have a runtime of five years.

The AS scheduling takes place in a day-ahead horizon: The AS provider nominates available capacity to the SO system operations until 2 pm of the next working day or the following weekend days. The actual day-ahead AS schedule is submitted by the SO until 5 pm.

6.1.2. AS Procurement with Operation of the Reserve Market

The Philippine five-minute Reserve Market for procuring frequency reserves is active without interruptions since August 2024 and exists in parallel to the procurement of AS via ASPAs. In particular, the SO is mandated to procure Regulating, Contingency and Dispatchable Reserve through firm contracts and the Reserve Market, provided that the contracted levels per reserve region are at least as follows for the different types of frequency reserve:

- **Regulating Reserve:** Equivalent to 50% of the Regulating Reserve requirement
- **Contingency Reserve:** Equivalent to 50% of the dependable capacity of the largest generating unit
- **Dispatchable Reserve:** Equivalent to 50% of the dependable capacity of the second largest generating unit

Generating units with **contracted and uncontracted capacities,** i.e. those under firm contracts and those from AS providers not under an ASPA, must submit energy and reserve offers to wholesale electricity spot market (WESM) for each dispatch interval depending on their maximum available capacity **(reserve offer capacity compliance).** In addition, AS providers with interruptible load facilities for a specific reserve region may submit reserve offers for each dispatch interval. In contrast to frequency reserve, Reactive Power Support AS and Black Start AS are procured through firm contracts only.

The SO and Market Operator (MO) are responsible for central scheduling, dispatch, spot pricing and settlement of reserve and electricity offers and co-optimization of regular electricity and Reserve Market. The SO acts as single buyer in the ASRM.

6.2. Remuneration and Pricing

In general, remuneration for frequency reserves is based on scheduled capacity and corresponding dispatched energy for compliant hours. Capacity and energy costs for non-compliant hours are not paid and are subject to penalties. Reactive Power Support is paid per hour, provided reactive power and occurrence of the reactive power requirement, while Black Start Service is paid for provided energy and occurrence only. The costs for procurement of AS are passed on to consumers, the contribution for each electricity customer is calculated as the total amount of AS costs divided by the total metered quantity in kWh (NGCP, 2024). No pass-through charges for generators providing AS are applied by the SO (NGCP, 2024).

The detailed pricing mechanism of the Reserve Market is described in the WESM manual's Price Determination Methodology (WESM Philippines, 2024). As a reference for implementation of AS remuneration in Indonesia we briefly list the basic rates in the Philippines as described in the Terms of Reference of implementation of ASPAs (NGCP, 2024). A more detailed description can be found in Annex V

Capacity payment for scheduled capacity A (Rate in PhP/kW per hour, maximum rate. Lower rates may be proposed by the applicant in CSP):

- Regulating Reserve: PhP 2.25/kW per scheduled hour
- Contingency Reserve: PhP 1.50/kW per scheduled hour
- Dispatchable reserve: PhP 0.85/kW per scheduled hour
- Reactive Power Support: PhP 4.00/kVAR per hour, per occurrence
- Black Start Service: Incidental Energy Payment only, per occurrence

Incidental Energy Payment B = [G x (Capacity Payment Rate + Variable Costs)] – (WESM Revenue – WESM Payment)

G – for conventional plants, summation of actual energy generated or dispatched from the scheduled capacity, in kWh; for BESS, sum of the absolute value of the actual energy dispatched and absolute value of the actual energy absorbed, in kWh

Total AS cost (cost of actual provided AS):
Hourly AS Cost = [(Undispatched Capacity x A) +B] – Penalty + any billing adjustments
Penalty = 50% x (A x Scheduled Capacity) – for non-compliance with technical criteria or not following dispatch instructions of SO
Billing adjustments = applicable adjustments as a result of monthly billing reconciliation

Actual AS Prices and Levels – Comparison of Firm Contract and Market Prices

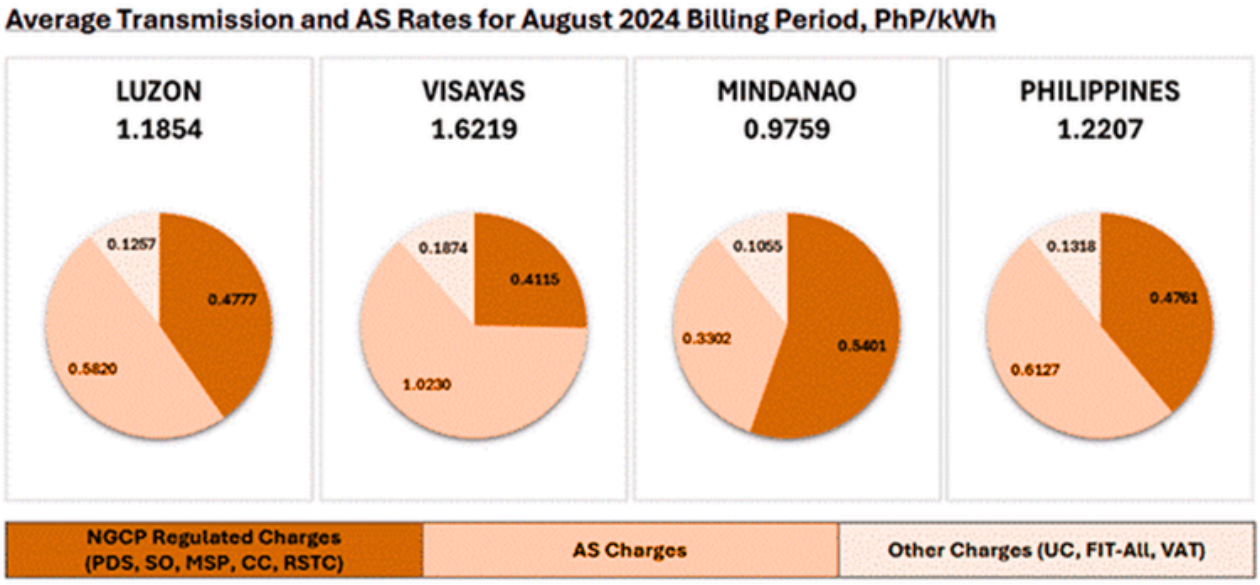


Figure 5: Average transmission and AS rates per kWh per grid and the whole of the Philippines

To compare the actual prices of AS procured through the Reserve Market and via firm contracts, the average AS Rates in August 2024 are shown in the Figure above. For comparison, the total electricity rate charged to consumers in the same period amounted to PhP11.6339/kWh. Thus, the AS Costs for the Phillippines contribute a 5.27 % of the total electricity bill. This percentage reduced to 3.98 % of the PhP 12.1552/kWh electricity bill in June 2025.[11]

To compare the costs of firm contracts compared to AS procured through the ASRM, the average ASPA and Reserve Market price are compared in the Figure below.

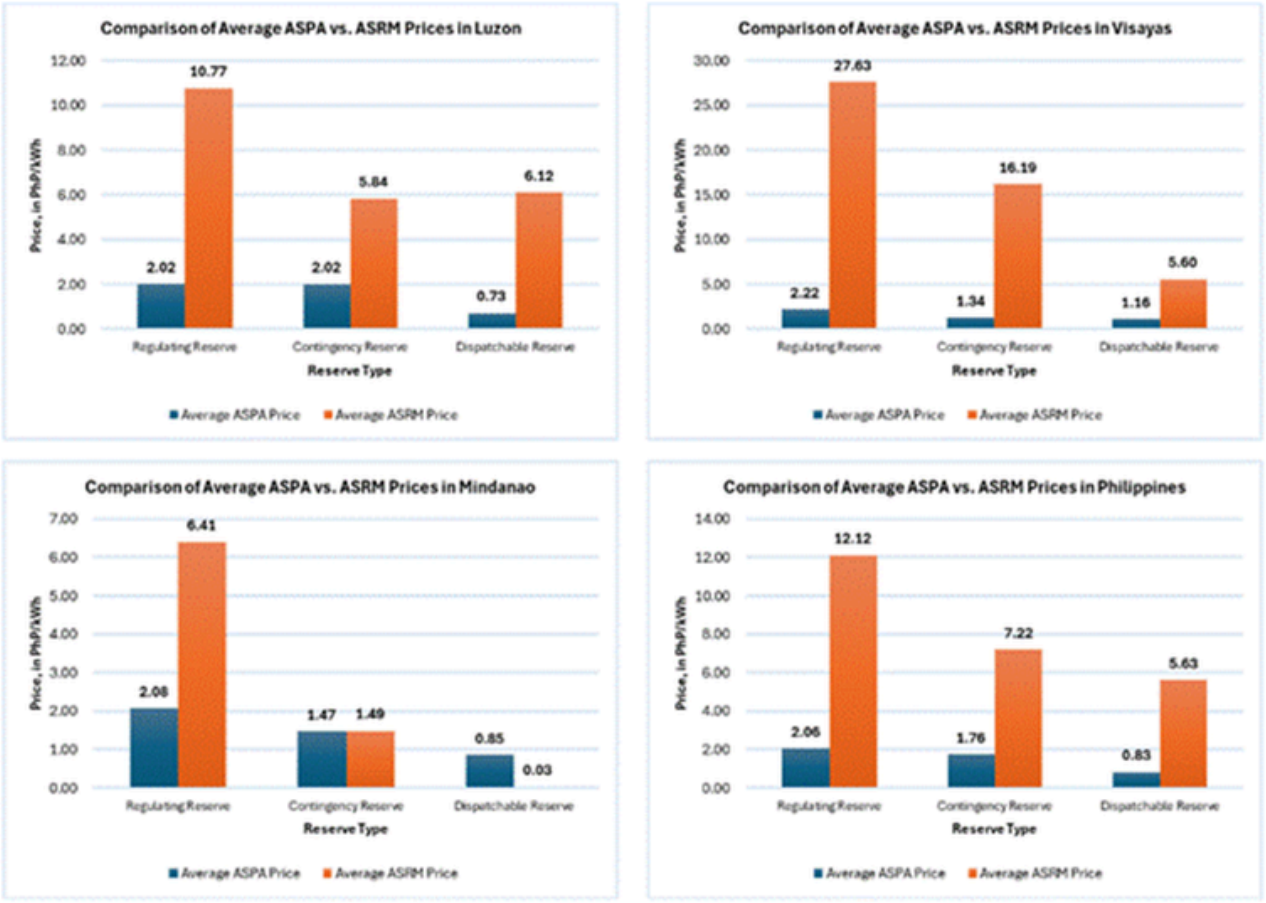


Figure 6: Comparison of computed average price of AS per kWh between ASPA and Ancillary service reserve market (ASRM)

It can be seen that typical prices per kWh reached in the ASRM market are six times as high as prices per kWh procured through ASPAs (NGCP, 2024)

As can be seen in the Table below, however, at least four times as many contracted as merchant AS providers are active in the Philippines. Potentially, market competition could further reduce market prices.

[11] "Ancillary Service and Reserve Market Briefer for Indonesia", presentation given by DOE Philippines in August 27 2025

Table 5: Certified AS plants in the Philippines per grid (August 2024)

Grid	Number of contracted AS providing units	Number of merchant AS providing units
Luzon	18	7
Visayas	16	4
Mindanao	18	2

To lower the costs of AS charges passed on to grid consumers, ideas to implement a polluter's principle are discussed in the Philippines since transmission costs have increased through AS costs (Lectura, 2025).

As an example of the required levels of reserves based on the requirements introduced in Section 5.1.2 and actual procured Ancillary services, the Table below shows the levels of Regulating, Contingency and Dispatchable Reserve as well as the number of contracted reactive power support units and contracted black start capacity.[12] The required levels, especially for the Regulating Reserve that is based on 4% of the demand, have to be compared to grid's peak demand, which in May 2025 amounted to 14,769 MW in Luzon, 3,111 MW in Visayas and 2,789 MW in Mindanao (Institute for Climate and Sustainable Cities, 2025). This is crucial for translating Philippine numbers and requirements to other systems since these depend on the actual system size and structure. Indeed, the given required levels of Regulating Reserve for Luzon and Mindanao correspond to 4 % of the peak demand. In contrast, Contingency Reserve and Dispatchable Reserve in the Philippine implementation depend on the largest dispatchable units. It is interesting to note that even under the assumption that at least 50 % of the required Reserves have to be procured via firm contracts (while the remaining capacity is procured from the ASRM), the Luzon grid fails to cover the requirements of Regulating and Dispatchable Reserve. This may be attributed to a amount of Reserve needed or a failure to procure enough Reserves.

Table 6: AS contracted by NGCP in June 2025

Grid	Luzon		Visayas		Mindanao	
	Required	**Contracted**	**Required**	**Contracted**	**Required**	**Contracted**
Regulating Reserve	591	257.78	N/A	N/A	112	68.61
Contingency Reserve	668	376.7	153	83.44	138	80.71
Dispatchable Reserve	668	191.1	153	44.27	138	129.15
Reactive power support (no. of contracted units)	6		16		18	
Black start (total MW contracted)	180		184.5		196	

[12] "Ancillary Service and Reserve Market Briefer for Indonesia", presentation given by DOE Philippines in August 27 2025

6.3. Compliance and Monitoring

This section describes the compliance rules and monitoring and control mechanisms to enforce compliance as well as applicable penalties in case of non-compliance, both for the firm contracts and the ASRM.

In general, all power with the following minimum nameplate capacities are subject to regular (two-yearly) mandatory AS capability testing by SO or certified third party:

- 10 MW for Luzon grid
- 5 MW for Visayas and Mindanao grid

Certification is a mandatory requirement to enter into a firm contract with the SO. Further, all units whether part of a firm contract with the SO or not are obliged to submit offers to the WESM (reserve offer capacity compliance).

6.3.1. Compliance and Monitoring for ASPAs

After ASPA has been contracted, the AS provider must place a performance bond amounting to 30 % of the total computed capacity payment cost for one year for the offered AS capacity per AS type. The performance bond is updated annually 30 days prior to anniversary date and is subject to withdrawal in favor of SO if contract ends by fault of AS provider. It is posted until the end of ASPA.

Required control modes for Regulating Reserve are Automatic Generation Control (AGC), but the units must be capable to run on Governor Control Mode (GCM), if required. The standard control mode for Contingency Reserve is GCM but AGC is also acceptable if it is certified.

To allow for monitoring of AS provision the following equipment must be installed at the connection point for monitoring:

- Revenue metering without connected load customer or station use load
- Remote terminal units (RTUs) for per-unit/per-sector monitoring

A penalty of 50% of the scheduled capacity times the capacity payment rate is imposed on the AS provider for non-compliance with technical criteria or not following dispatch instructions of SO.

Firm capacity must be available at the scheduled capacity level at all times. In case of unavailability the AS capacity must be replaced by the AS providers own units or, if the ASRM is operational, from other AS generating units of the same type from the ASRM.

The ASPA is subject to termination if the AS provider repeatedly fails to follow dispatch instructions, faces longer periods of unreplaced outages or service unavailability or if it fails the mandatory two-yearly certification test and subsequent reevaluations.

6.3.2. Compliance and Monitoring during Operation of the Reserve Market

The two main rules that are subject to compliance by AS providers are the **reserve offer capacity compliance** and the **reserve conformance standards** defined in the market manual and reviewed regularly jointly by market operator, system operator and **enforcement and compliance office (ECO)**.

The **reserve offer capacity compliance** obliges each generation company registered as AS provider to submit standing reserve offers up to their registered maximum reserve capability for each of its facilities in a reserve region and dispatch interval for each day of the week in accordance with timetable, whether the capacities are covered by an ASPA or not. The AS provider must provide a reason if the reserve offer is cancelled, or the reserve capacity is reduced compared to certified the capacity. A breach is constituted by failure to send an offer for each dispatch interval.

According to the **reserve conformance standards,** the accuracy and timeliness of the reserve facility response is to be monitored for each dispatch interval or billing period. Any reserve facility failing to maintain an average response accuracy or response time or not complying with dead band setting, speed droop or sustainability as set out in Table 5 will be flagged as non-compliant by the MO. A failure of meeting these criteria **in any dispatch interval** is considered **a breach of reserve conformance standards** and can lead to potential penalties.

Reserve facilities to be scheduled for regulating or contingency reserve are obliged to respond to frequency-driven events or comply with one of the following:

- Reaction through governor control mode (GCM)
- Commands via Automatic Generation Control (AGC)
- Dispatch instructions from SO

Reserve facilities scheduled for **dispatchable reserve** must be offline until receiving dispatch instructions from SO (see Table below).

Details on the compliance criteria for control modes (GCM and AGC) can be found in Annex VII.

Table 7: Reserve Conformance Standards Philippines [26]

For Regulating Reserves		
Response Accuracy	On GCM	At least 80%
	On AGC	At least 75%
Response Time	On GCM	not more than 5 seconds
	On AGC	not more than 25 seconds
Dead band Setting	0.15 Hz or lower	
Speed droop	5% or lower	
Sustainability	for the entire *dispatch interval*	

For Contingency Reserves		
Response Accuracy	On GCM	At least 80%
	On AGC	At least 75%
Response Time	On GCM	not more than 5 seconds
	On AGC	not more than 25 seconds
Dead band Setting	greater than 0.15 Hz but less than 0.30 Hz	
Speed droop	5% or lower	
Sustainability	for the entire *dispatch interval*	

For Dispatchable Reserves	
Status	must be offline unless there is a *dispatch instruction* from the *System Operator*, or it was scheduled for energy *dispatch* in the *WESM*.
Synchronization	Within 15 minutes upon advice from the *System Operator*
Sustainability	After synchronization, the *dispatchable reserve facility* shall deliver the MW capacity instructed by the *System Operator* within 15 minutes

For monitoring purposes AS providers are obliged to send the generator mode of operations and dead band settings to SO. Further, the AS provider must notify the ECO in week-ahead horizon in case it cannot provide AS providing supporting documents or records for this unavailability. To detect probable breaches of these rules, the SO regularly sends the following data to the MO:

Table 8: Data provision for Ancillary Services and timelines

Data	Timeline of provision
Generator mode of operation (e.g., automatic generation control, governor control mode, manual dispatch instruction)	Real-time
Dead band settings	Real-time
Speed droop	Real-time
Generator status	Real-time
Dispatch instructions	By 12:00 of the next day for all instructions of the current trading day
Outages	By 12:00 of the next day for all instructions of the current trading day
Power system frequency	Real-time
Control dead band	Real-time

The MO is responsible of flagging these probable breaches to ECO. The ECO monitors, evaluates, assesses and enforces compliance. Monthly reports are to be sent to the DOE and Energy Regulatory Commission (ERC). The ECO further authorizes billing and collection of penalties from AS providers. A more detailed description of the process of validation and notification of non-compliance can be found in Annex VII.

In case of confirmed non-compliance, penalties and sanctions are attributed by each of the following categories:

- **By reserve facility,** i.e. each block or unit per AS provider that is found in breach
- **By reserve type:** If a facility is registered for different reserve types, breaches are sanctioned for each reserve type separately
- **By occurrence,** i.e. the frequency or number of breaches/non-compliances per period by a specific AS provider; the counting of frequency is restored in every billing period, which corresponds to one month in the current implementation of the Philippine ASRM.

Three types of penalties can be imposed: Financial penalty, suspension and deregistration.

Table 9: Penalty levels for different frequency of breach occurrence

Frequency	Penalty Level		
	Level 1	Level 2	Level 3
1 - 864 dispatch intervals over the *Billing Period*	■		
More than 864 dispatch intervals over the *Billing Period*		■	
More than 1,440 dispatch intervals over the *Billing Period*		■	■

Depending on the frequency of breach occurrence by a specific generating facility as shown in the Table above, different penalties are defined. Note, that, with a dispatch interval length of five minutes and a billing period of one month (30 days) as currently implemented in the Philippines, one billing period consists of 8640 dispatch intervals. Thus, a penalty of level one is imposed if the frequency of breaches occurs in below 10% of the dispatch intervals. The following types of penalties can be imposed:

Financial penalty

In case of level 1 or level 2 breaches financial penalties are imposed for breaches of reserve offer capacity compliance and reserve conformance standards. The exact amounts and computations can be found in Annex VII.

Suspension

A generating facility is suspended from AS provision if level 3 is reached in reserve offer or reserve conformance compliance. The unit is not allowed to participate in the reserve market for one month after the notice of specified penalty.

If the suspension violates obligations of an AS provider under an ASPA, the suspension only applies to the reserve market, the AS provider can still submit reserve offers under the day-ahead service schedule as specified in the ASPA.

Deregistration

In case of one of the following events:

- At least level 2 breach has happened in 3 months (consecutive or non-consecutive) starting from following month
- Facility has been unavailable due to forced or unplanned outage during 90 consecutive days
- AS provider fails to pass annual AS performance evaluation takin into account the compliance monitoring results for period of one year

the AS provider responsible for the breach is deregistered permanently from the WESM but can reapply for membership provided that the registration requirements are met.


RULES
NO
YES

A Comparative Legal Analysis of Ancillary Services Regulation in the Philippines and Singapore

Note: UMBRA is qualified and licensed to provide legal analysis solely under Indonesian law. This section has been prepared at the request of GIZ for comparative and informational purposes only. Accordingly, this review does not constitute legal advice under Philippine and Singapore law, and we have not verified our understanding or interpretation with the relevant authorities or regulatory bodies in the Philippines and Singapore. Any reference to Philippine and Singapore legal or regulatory frameworks should therefore be read as non-authoritative and for reference purposes only.

7.1. Regulatory Overview of AS Provision under Philippines Law

The Philippines AS framework evolved through a sequence of sectoral reforms spanning more than five decades. Please refer to the table below:

Table 10: Philippines AS Provisions Historical Development

Year	Milestone / Instrument	Description
1971–1972	Early energy-sector consolidation	• Establishment of the National Power Corporation (NPC).[12] • Republic Act No. 6395: Designates NPC as the sole provider of electricity for the entire power system.[13] • Presidential Decree No. 40: Assigns responsibility for inter-regional electricity transmission to NPC.[14] • Republic Act No. 7638: Establishes the Department of Energy (DOE).[15]
1992	Republic Act No. 7638	Institutionalized the Department of Energy (DOE) as the central energy-policy agency.[16]
2001	Republic Act No. 9136 (Electric Power Industry Reform Act – "EPIRA")	Introduced unbundling of generation, transmission, distribution, and supply; created the Energy Regulatory Commission (ERC); and established TransCo to own transmission assets [17]
2001	Philippines Grid Code (PGC)	Included the definition of and general responsibilities related to AS.[18]
2009	Transco–NGCP Concession Agreement	A 25-year agreement granting NGCP the exclusive right to operate the national transmission system.[19]
2009	PGC 1st Revision	Included details of the reserve classifications (e.g., Regulation Reserve and Spinning Reserve).
2017	PGC 2nd Revision	Introduced a classification of reserves into primary, secondary, and tertiary categories.

[12] https://lawphil.net/statutes/comacts/ca1936/ca_120_1936.html
[13] https://lawphil.net/statutes/repacts/ra1971/ra_6395_1971.html
[14] https://lawphil.net/statutes/presdecs/pd1972/pd_40_1972.html
[15] https://lawphil.net/statutes/repacts/ra1992/ra_7638_1992.html
[16] Ibid.
[17] https://lawphil.net/statutes/repacts/ra2001/ra_9136_2001.html
[18] https://legacy.doe.gov.ph/philippine-grid-code
[19] https://www.transco.ph/about_us

Year	Milestone / Instrument	Description
2019	DOE Department Circular No. DC2019-12-0018 (DOE Cir 2019-0018)	Ancillary Service is now being procured through the WESM Reserve Market, complementing the previous bilateral (B2B) contracting scheme, and are supported by capability testing and Ancillary Service accreditation mechanisms.
2021	DOE Department Circular No. DC2021-10-0031	Adopted an open-tender regime for Ancillary Service procurement and standardized Ancillary Service Procurement Agreements (ASPA).
2021	DOE Department Circular No. 2021-03-0009	Provisions related to Ancillary Service under the WESM Reserve Market Operationalization include the submission of cost recovery applications to the ERC for approval.
2025	ERC approval of multiple ASPAs	• The ERC approved several ASPA in May 2025.[20] • The DOE requires all power plants to conduct capability testing before the end of 2025.[21]

Through EPIRA, the Philippines formally unbundled its power sector, enabling competitive markets for generation and supply while maintaining transmission as a regulated natural monopoly operated under concession.

(a) Ancillary Service Payment and Procurement Scheme under Philippines Law

Upon conducting our desktop research and review of the relevant regulations in the Philippines, we note that the payment and procurement scheme of Ancillary Services under Philippines Law are envisaged under the below structure:

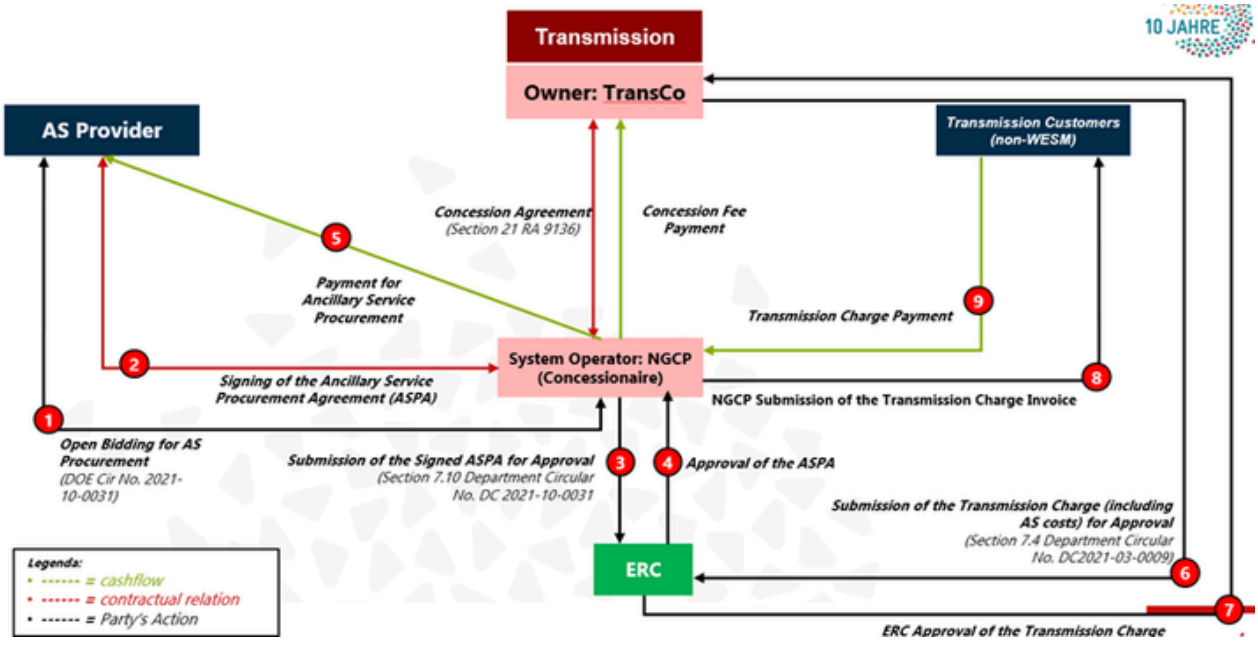


Diagram 1: Payment and Procurement Scheme of Ancillary Service under Philippine Law

[20] https://mb.com.ph/2025/05/05/erc-approves-nine-ancillary-services-agreements-for-ngcp
[21] https://dailyguardian.com.ph/doe-orders-power-plants-to-finish-grid-testing-by-2025/

(b)Comparative Analysis between Ancillary Services Provisions under Philippines Law and Indonesia

We conducted an analysis of the following Philippine regulations, compared them with Indonesia's regulatory framework, and assessed the feasibility of adapting those regulations in the Indonesian context, taking into account Indonesia's specific characteristics:

- EPIRA – as the umbrella electricity law of Philippines, EPIRA is the primary regulation that we assessed. Based on the assessment, we propose recommendations to be regulated in the amendment to Law 30/2009 or GR 14/2012 as the implementing regulation of Law 30/2009. Please see Table [*] for further elaboration.
- DOE Circular No. 2002-06-003 or the Wholesale Electricity Spot Market (WESM) Rules (DOE Cir 2002-003) - based on the discussion held with GIZ and DGE on 8 July 2025, it is understood that DOE Cir 2002-003 is the first implementing regulation of EPIRA that addressed Ancillary Services. Although the Ancillary Services regulated in DOE Cir 2002-003 are specifically for WESM, the circular could provide an illustration of the scope of regulations related to Ancillary Services that could feasibly and reasonably be regulated initially in Indonesia's regulatory framework. For contextualization with Indonesia's regulatory landscape and electricity market: (i) our recommendations based on EPIRA and DOE Cir 2002-003 are for amendment to Law 30/2009, GR 14/2012, and/or minister regulation specifically on Ancillary Services (AS MEMR Reg) and (ii) we also provide recommendations based on DOE Circular No. DC2021-00-0031 (DOE Cir 2021/0031) on Prescribing the Policy of the Transparent and Efficient Procurement of Ancillary Services by the System Operator, the content of which is more relevant for Indonesian context. Please see Table 2 for further elaboration.

  Under DOE Cir 2002-003, several provisions were introduced to establish clear requirements and procedures for AS providers. Specifically, Articles 2.2.2.3 and 2.3.5.1 set out the requirements that must be met by entities seeking to become registered AS providers. The Circular mandates that only registered AS providers are eligible to enter into Ancillary Services Agreements with the National Grid Corporation of the Philippines (NGCP), as stipulated in Article 2.3.5.2. Before registration, NGCP is tasked with determining whether a facility possesses the technical capability to deliver ancillary services, identifying the specific type of AS that can be provided, and defining the geographical area in which the facility will operate (Article 2.3.5.3). Furthermore, Article 2.3.5.4 provides that AS providers will only receive payment for services if their facility has been duly registered for the relevant AS type and designated service area.

  The Circular also provides a comprehensive definition and classification of the various types of ancillary services under Article 3.3.1.2. It further requires NGCP to establish minimum technical standards in the Grid Code and Distribution Code to ensure sufficient levels of AS provision (Article 3.3.1.3(a)). In line with this, NGCP bears additional obligations under Articles 3.3.2.1 and 3.3.2.2, including the responsibility to exert its best efforts to secure adequate Ancillary Service agreements to maintain the stability, reliability, and security of the power system.

  In terms of procurement and payment, Articles 3.3.3.1 to 3.3.3.3 detail the procedures for how NGCP should procure ancillary services, while Articles 3.3.3.4 and 3.3.3.5 describe the components and mechanisms for AS payments. Payments to AS providers are made by the Market Operator through a designated payment system, ensuring transparency and consistency in financial transactions. The Circular also establishes provisions governing the execution and administration of AS agreements (Article 3.3.3.6).

Finally, Article 3.3.3.7 provides a structured process for dispute resolution. Any disputes arising between NGCP and AS providers, particularly those concerning payments under AS agreements, are to be referred to the Dispute Resolution Administrator (DRA). This mechanism ensures that conflicts are addressed fairly, efficiently, and in accordance with the regulatory framework established under the WESM Rules.

Overall, DOE Cir 2002-003 laid the initial groundwork for regulating Ancillary Services within the restructured Philippine electricity industry. It clearly delineates the roles and responsibilities of market participants, particularly NGCP and AS providers, and establishes procedural and technical standards necessary for the reliable operation of the national power grid.

Please see Table 11 for the detailed legal comparison between the Philippine regulatory framework (namely, EPIRA and DOE Cir 2002-003) and Indonesia's electricity regulatory framework.

- DOE Cir 2021-0031 – although DOE Cir 2021-0031 was issued several years after EPIRA, some of the contents are relevant to be regulated in an AS MEMR Reg. Please see Table 3 for further elaboration.

Legal comparison between the Philippines Republic Act and DOE Cir 2002-003 and Indonesia's electricity regulatory framework

Table 11: Provisions regarding AS under DOE Cir 2021-0031 and ERC Case

Subject	Philippines	Indonesia	Notes

AS Definition	Article 4 of RA 2001-9136:
	"those services that are necessary to support the transmission of capacity and energy from resources to loads while maintaining reliable operation of the transmission system in accordance with good utility practice and the Grid code to be adopted in accordance with this Act"
		There is currently no regulatory definition of ancillary services in Indonesia.	• A Republic Act in the Philippines is enacted to implement the Constitution and holds the second-highest position in the legal hierarchy after the Constitution.[22] In the context of Indonesian law, a Republic Act is equivalent to a statute (Undang-Undang).
			• Proposed Recommendation:
			  ○ Option 1: Amend Law 30/2009 to include the definition of ancillary services.
			  ○ Option 2: If amending Law 30/2009 is not feasible, amend GR 14/2012 to define ancillary services.

Entity responsible for planning the AS procurement	Article 8 (a) of RA 2001-9136: "The TRANSCO shall assume the authority and responsibility of NPC for the planning, construction and centralized operation and maintenance of its high voltage transmission facilities, including grid interconnections and ancillary services."	Article 11(2) Law 30/2009: "A state-owned enterprise as referred to in paragraph (1) shall be given the first priority to carry out Electricity Supply Business for the public interest." Article 3 Presidential Regulation 14/2016: "The Central Government assigns PT PLN to implement the Development of Electricity Infrastructure."	Based on Article 8(a) of EPIRA, in the Philippines, transmission assets are owned by the state through TransCo, while the operation of the transmission system is carried out by NGCP. Regulation and oversight are conducted by an independent body, the Energy Regulatory Commission (ERC). In the context of ancillary service provision, TransCo is responsible for AS planning, while NGCP implements the procurement of AS, including submitting AS tariff proposals to the ERC.

[22] https://cacj-ajp.org/philippines/legal-system/sources-of-law/overview/#:~:text=The%20main%20sources%20of%20Philippine,binding%20on%20all%20other%20courts.

Subject	Philippines	Indonesia	Notes

Entity responsible for planning the AS procurement		Article 1 number 1 Presidential Regulation 14/2016:
		“Electricity Infrastructure encompasses all matters related to power generation, electricity transmission, electricity distribution, substations, and other supporting facilities.”
		Article 1 number 1 Presidential Regulation 14/2016:
		"Electricity Infrastructure is everything related to electricity generation, electricity transmission, electricity distribution, substations, and other supporting facilities."
			• In contrast, in Indonesia, PLN, as the holder of an Integrated IUPTLU (Integrated IUPTLU), owns and operates the transmission network. Consequently, PLN would be responsible for both planning and procuring ancillary services.
			• If, in the future, an Independent System Operator (ISO) is established in Indonesia to manage the transmission network, the procurement of ancillary services could be undertaken by such ISO.
			• Proposed Recommendation:
			  ○ Option 1: Amend Law 30/2009 to stipulate that the holder of an Integrated IUPTLU is responsible for planning and procuring ancillary service providers. The planning and procurement of ancillary services will be regarded as part of the transmission activities carried out by the holder of the Integrated IUPTLU.
			  ○ Option 2: If amending Law 30/2009 is not feasible, a provision stipulating that the holder of an Integrated IUPTLU is arguably responsible for planning and procuring ancillary services as part of transmission activities may be incorporated into an amendment to GR 14/2012. Option 2 is feasible because Law 30/2009 does not provide detailed provisions regarding the scope of transmission activities for the holder of an Integrated IUPTLU, allowing for the detailed regulation under GR 14/2012 to be reasonably interpreted as consistent with Law 30/2009.

Provisions on AS Pricing for Consumers	Section 4 of RA 2001-9136: (ss) “Retail Rate” refers to the total price paid by end-users consisting of the charges for generation, transmission and related ancillary services, distribution, supply and other related charges for electric service.	Article 17 and Article 21 MEMR Reg 10/2022: The electricity tariff encompasses all costs associated with electricity consumption by consumers, including: a.Demand charge (Rp/kVA) and energy charge (Rp/kWh); b.Reactive power consumption charge (Rp/kVArh); c.Maximum kVA charge based on the subscription rate (Rp/month) in accordance with the contracted capacity or other applicable forms; and/or d.Other costs related to electricity consumption as determined by the MEMR, including connection fees, security deposits, late payment penalties, and/or other charges deemed necessary for electricity supply within the business area of the Integrated IUPTLU holder.	• RA 9136 (2001) stipulates that the electricity tariff paid by consumers consists of several components, one of which is ancillary services. This indicates that the cost of ancillary services is passed on to consumers. • In Indonesia, the electricity tariff paid by consumers does not specifically include ancillary service costs. • Referring to Philippines, AS price should be included as part of the consumer electricity tariff. Accordingly, PLN needs to determine the portion of the tariff attributable to AS to be allocated for payments to ancillary service providers. A financial analysis is therefore required to assess the share of ancillary service costs within the consumer electricity tariff and to determine whether this portion is sufficient to cover payments to the ancillary service providers..

Subject	Philippines	Indonesia	Notes

Provisions on AS Pricing for Consumers			• Proposed Recommendation:
			  ○ Option 1: An amendment to Law 30/2009, GR 14/2012, and MEMR Reg 10/2022 should be undertaken to include ancillary service costs as one of the components of the electricity tariff.
			  ○ Option 2: AS costs may be incorporated as part of other costs deemed necessary for electricity supply within the business area of the Integrated IUPTLU holder. The inclusion of AS costs as part of such other costs would require determination and approval by the MEMR.
			  ▪ In addition, an amendment to MiMoF Reg 20/2025 is also required to designate ancillary service costs as part of the electricity production cost (BPP) components eligible for subsidy.

AS Provider Requirements	Article 2.2.2.3 DOE Cir 2002-003:
	Ancillary Services Providers:
	• Shall register with the Market Operator under clauses 2.3.5 or 2.4 as either a Direct WESM Member or an Indirect WESM Member; and
	• Are bound by the WESM Rules upon registration with the Market Operator.
	• Article 2.3.5.1 DOE Cir 2002-003:
	• Market Participants or Network Service Providers supplying ancillary services under Clause 3.3:
	• Are required to register with the Market Operator as AS Providers for: (1) each reserve facility they operate; (2) each category of reserve to be provided from the registered facility approved by the System Operator; and (3) the category of reserve facility corresponding to the type of reserve to be provided from that facility.
	  ○ May register as either Direct or Indirect WESM Members, in accordance with the requirements set out in Clause 2.3.
		There is currently no regulation regarding AS Provider in Indonesia.	• Essentially, Articles 2.2.2.3 and 2.3.5.1 of DOE Circular 2002-003 regulate the requirements for AS providers to supply ancillary services. However, the substance of these provisions in DOE Circular 2002-003 is not directly relevant for Indonesia, as Indonesia does not operate a wholesale electricity market.
			• Therefore, the regulatory substance concerning the requirements for AS providers can instead refer to DOE Circular 2021-0031.
			• Under DOE Circular 2021-0031, AS providers are required to hold certification from NGCP or an ERC-accredited institution.
			• Procurement of ancillary services may be participated by both existing and new generators, where: (i) existing generators must possess AS certification before participating in the procurement, and (ii) new generators must obtain AS certification within six months after COD and at least four months before commencing AS provision.
			  ○ The requirements to provide ancillary services in the Philippines are: (i) ERC approval of the ASPA; (ii) AS certification; and (iii) a Provisional Authority to Operate or Certificate of Compliance (similar to a Operational Worthiness Certificate (SLO) in Indonesia).

Subject	Philippines	Indonesia	Notes

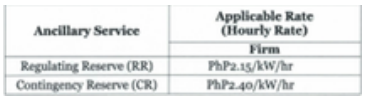
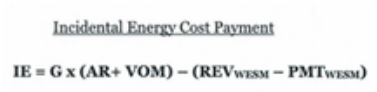
AS Provider Requirements	Article 2.3.5.3 DOE Cir 2002-003:
	Before a Market Participant or Network Service Provider is registered as an AS Provider entitled to supply reserves under Clause 2.3.5.1, the System Operator must:
	• Declare that the relevant reserve facility is capable of providing the specified reserve category in accordance with the Grid Code and Distribution Code;
	• Classify each reserve facility into the appropriate reserve facility category for each type of reserve to be supplied;
	• Determine the reserve region where the facility may be included, based on its ability to meet specific location-based reserve requirements; and
	• Provide written authorization to the Market Operator containing the determinations made under points (a), (b), and (c).
	
	Article 3.3 DOE Cir 2021-0031:
	"Ancillary Service Provider (ASP) refers to a person or entity providing or contracted to provide AS, provided that they have secured certification from the SO or ERC-accredited third-party AS capability testing entities prior to delivery of service."
	
	Article 2.3 Annex A DOE Cir 2021-0031:
	Pre-requisite for participating in CSP:
	• Existing Plant: Must hold an AS Certificate when the CSP commences.
	• New Generators: (i) Must commit to obtaining AS Certification within six months after COD and at least four months before commencing delivery; (ii) If not met, the System Operator may cancel the award and re-conduct the CSP.
	• AS Testing: Conducted by the System Operator or an ERC-accredited third party.
	• Minimum AS Unit Size: (i) Luzon: 10 MW; (ii) Visayas & Mindanao: 5 MW.
	
	Article 2.4 Annex A DOE Cir 0031:
	"Conditions Precedent to Start of Supply (please check as applicable):
	• ERC approval of the ASPA
	• Valid AS Certificate
	
	Provisional Authority to Operate (PAO) or Certificate of Compliance (COC). Indicated MW in the AS Certificate should not go above the Pmax as specified in the PAO or COC."
		-	• Proposed Recommendation:
			  ○ In the context of Indonesia, since there are business areas not owned by PLN, AS certificates for AS providers may be issued by an MEMR-accredited institution.
			  ▪ Option 1: The SLO is regulated under Law 30/2009, GR 14/2012, GR 25/2021, and MEMR Reg 12/2021. The accredited institution issuing the SLO is governed by Government Regulations 14/2012, GR 25/2021, and MEMR Reg 12/2021. Regulations regarding AS certificates and the accredited institutions issuing them can initially be incorporated into amendments to Law 30/2009 and Government Regulations 14/2012 or GR 25/2021, with a mandate to establish an AS MEMR Reg detailing AS certificates and their accredited issuers.
			  ▪ Option 2: Alternatively, by referring to DOE Circulars 2002-003 and 2021-0031, the AS certification requirement for generators providing AS can be regulated in a AS MEMR Reg. The AS certificate may specify the generation facility providing AS, the type of AS supplied, and the area where the AS will be provided (as referenced in DOE Circular 2002-003).

Subject	Philippines	Indonesia	Notes
AS Agreement	Article 2.3.5.2 DOE Cir 2002-003: Only an Ancillary Services Provider registered as a Direct WESM Member may enter into an ancillary services agreement with the System Operator under clause 3.3.3		• Proposed Recommendation: ◦ Option 1: The provision that only AS providers holding an AS certificate may enter into an AS agreement with PLN can be incorporated into an amendment to Law 30/2009 or GR 14/2012. ◦ Option 2: Referring to DOE Circular 2002-003, the provision that only AS providers holding an AS certificate may enter into an AS agreement with PLN can be regulated in a AS MEMR Reg.
AS Testing	Article 3.3.3.6 DOE Cir 2002-003: ◦ Ancillary services agreements shall contain a provision pursuant to which the capability of the relevant Ancillary Services Provider to provide ancillary services shall be demonstrated from time to time to the satisfaction of the System Operator according to the standard test procedures established under the Grid Code and Distribution Code.	There is currently no regulation regarding AS Testing in Indonesia.	• Proposed Recommendation: ◦ This provision can be regulated in a AS MEMR Reg. The standard AS testing procedures may also be established within the AS MEMR Reg.
AS Classification	Article 3.3.1.1 DOE Cir 2002-003: Ancillary services are services that are essential to the management of power system security, that facilitate orderly trading in electricity and ensure that electricity supplies are of an acceptable quality. Article 3.3.1.2 DOE Cir 2002-003: Without limitation, AS may include regulating reserve, contingency reserve, dispatchable reserve, reactive support, and black start capability.	MEMR Regulation 20/2020 provides detailed provisions regarding frequency control, voltage control, and black start.	• Proposed Recommendation ◦ Referring to DOE Circular 2002-003, the classification of AS can be further regulated in an AS MEMR Reg. A review of MEMR Regulation 20/2020 will also be necessary to ensure that the AS MEMR Reg specifically governing AS is aligned with MEMR Regulation 20/2020.
Minimum Standard Setting	Article 3.3.1.3 DOE Cir 2002-003: The requirements for ancillary services are to be met in the following ways: (a) By the System Operator, in consultation with the Market Operator and WESM Participants, setting minimum standards in relation to technical performance specified in the Grid Code and Distribution Code which requires some level of ancillary services to be provided by Ancillary Services Providers; (b) By the System Operator purchasing ancillary services in accordance with clause 3.3.3.	MEMR Regulation 20/2020 sets out detailed provisions concerning frequency control, voltage control, and black start.	• Proposed Recommendation: ◦ A review and amendment of MEMR Reg 20/2020 should be conducted to accommodate the AS provision scheme by AS providers, taking into account input from PLN and other holders of Integrated IUPTLU responsible for AS planning.

Subject	Philippines	Indonesia	Notes
SO Obligations	Article 3.3.2.1 DOE Cir 2002-003: The System Operator shall use reasonable endeavors to ensure that sufficient facilities are available and operable to provide for: (a) The maintenance or restoration of power system security under emergency conditions; (b) The restoration of all or any part of the power system to its satisfactory operating state, following an emergency, threat to system security or force majeure event; and (c) The availability, at all times, of the number of independent power sources able to provide black start-up facilities, determined in accordance with the procedures developed by the Market Operator to ascertain the quantities of ancillary services which the System Operator shall purchase Article 3.3.2.2 DOE Cir 2002-003: The System Operator shall use reasonable endeavors to enter into ancillary services agreements to provide sufficient ancillary services to meet the requirements of clause 3.3.2.1, subject to clause 3.3.3 Article 3.3.3.1 DOE Cir 2002-003: The System Operator shall arrange for the provision of adequate reserves for each region in accordance with clause 3.3.3.2.	MEMR Regulation 20/2020 regulates the roles and responsibilities of PLN's system operators. There are no provisions regarding the AS agreement signed by SO in Indonesia	• Proposed Recommendation ○ Based on discussions with GIZ's technical consultants, the SO Obligations stipulated in Article 3.3.2.1 of DOE Cir 2002-003 can be applied to PLN under the AS MEMR Reg.

Procurement Mechanism	Article 3.3.3.2. DOE Cir 2002-003
	"The System Operator shall arrange for the provision of adequate ancillary services for each region either:
	
	a)By competitive tendering process, administered by the Market Operator, whereby a number of Ancillary Services Providers can provide a particular category of ancillary services; or
	b) By negotiating contracts directly with an Ancillary Services Provider who is a Direct WESM Member, where only one Ancillary Services Provider can provide the required ancillary services; or
	c)Where applicable, by competitive spot market trading in accordance with clause 3.3.4."
		There is currently no regulation regarding procurement mechanism for AS in Indonesia.	• Proposed Recommendation:
			  ○ Referring to DOE Circular 2002-003, the AS procurement mechanism may take the form of: (i) open bidding/direct selection, and (ii) direct appointment if certain criteria are met, for example, when only a single AS provider can supply the type of AS required by PLN.
			  ▪ Option 1: Considering that the electricity procurement mechanism was first regulated in Article 25 of GR 14/2012, provisions regarding the AS procurement mechanism through open bidding, direct selection, or direct appointment can be incorporated into an amendment to GR 14/2012 and subsequently detailed in the AS MEMR Reg.
			  ▪ Option 2: Referring to DOE Circular 2002-003, the AS procurement mechanism can be regulated directly in the AS MEMR Reg.

Subject	Philippines	Indonesia	Notes
Procurement Mechanism	Article 3.3.3.3 DOE Cir 2002-003 The System Operator shall negotiate any ancillary services agreements with Ancillary Services Providers who are Direct WESM Members on commercial terms acceptable to the parties and at arms length, subject to clause 3.3.3.2		• In addition, referring to DOE Circular 2002-003, AS procurement can be conducted on a regional basis. In the context of Indonesia, this could be organized per system or subsystem, with consideration of local grid condition and technical requirements of the power system.
AS Payment Component	Article 3.3.3.4. DOE Cir 2002-003 Payments for AS procured under an agreement may include: (a) payment for the contracted capacity and the amount of service provided; (b) verifiable opportunity costs in the spot market, such as lost revenue or expenses incurred due to AS provision; (c) a reasonable return to the AS provider for additional direct costs incurred in providing the service; and (d) if applicable, AS prices determined through a competitive spot market mechanism. Article 3.3.3.5. DOE Cir 2002-003 Payments for ancillary services that are provided are to be made by the Market Operator via the settlements system in accordance with clause 3.13.14	In practice, the power purchase agreements (PPAPPA) generally do not include a separate component for ancillary services. However, PPAPPA typically imposes penalties if the independent power producer (IPP) fails to provide ancillary services such as frequency control, reactive power, and/or ramp rate.	• Proposed Recommendation: ◦ Provisions regarding the AS cost component and that AS payments are made by PLN can be regulated in the AS MEMR Reg.
AS Payment Component	Article 3.1 dan 3.2 Annex A DOE Cir 2021-0031: AS Price Offers are divided into: • Capacity Payment: Paid in Php/kW/h for the offered capacity. • Incidental Energy Payment: Gross cost for the scheduled and delivered capacity, including: (i) Fixed Energy Fee per kWh; (ii) Indexed Energy Fee; (iii) Charging costs for Energy Storage Systems (if applicable). • WESM & Other Market Charges: Includes costs for (i) transmission; (ii) distribution (if applicable); and (iii) taxes (+VAT).	For instance, SCC 2.2 Grid Code Indonesia: Ancillary services (AS) constitute a component of electricity procurement that must be paid by PLN to power plant operators under the PPA or other contracts. AS payments cover: (a) reactive power and voltage control; (b) frequency regulation (load following and ramp rate); (c) black start; (d) loading below the technical minimum load (TML); (e) house load; and (f) startup.	• Proposed Recommendation: MEMR may consider setting out AS cost components in the AS MEMR Reg .

Subject	Philippines	Indonesia	Notes
AS Procurement Price between the SO and the AS Provider	The SO will only pay the Incidental Energy based on the submitted components, such as fixed and indexed rates, other costs, and VAT. Payments to the AS provider during dispatch are primarily recovered from the energy sales to WESM. If the proceeds from WESM sales are insufficient, the shortfall is borne by the SO; conversely, any surplus is applied to reduce the payment in the next billing cycle. Example of AS Provision Price in the ASPA between NGCP and Universal Power Solutions, Inc. •Scheduled Capacity without Energy Dispatched: "NGCP shall pay UPSI the Applicable Rates (…) which should not be more than the indicated capacity of +- 50 MW for RR and 50 MW for CR (…) with the following rate:  •Scheduled Capacity with Energy Dispatched: "(…) the cost of generation shall be recovered through settlement in the WESM. Thus, the Incidental Energy Cost based on actual dispatch (…) calculated with (…): 	Please refer to Section of AS Payment Component above	• Proposed Recommendation: ◦ MEMR may consider setting out AS cost components in the AS MEMR Reg.
AS Provider Obligation	Article 3.3.6 DOE Cir 2002-003 3.3.6.1 An Ancillary Services Provider shall not unreasonably refuse to provide ancillary services. 3.3.6.2 When justifiable in terms of power system security, the System Operator may direct any Ancillary Services Provider to provide an ancillary service in accordance with the Grid Code.	There is no regulation regarding the obligation not to refuse the provision of ancillary services (AS).	• Proposed Recommendation ◦ Option 1: The provision that an AS provider must not unreasonably refuse to provide AS, and that PLN may request the AS provider to supply AS in accordance with the Grid Code, can be incorporated into an amendment to Law 30/2009 and/or GR 14/2012. ◦ Option 2: The above provision can be regulated in the AS MEMR Reg.

Ancillary Service	Applicable Rate (Hourly Rate)
	Firm
Regulating Reserve (RR)	PhP2.15/kW/hr
Contingency Reserve (CR)	PhP2.40/kW/hr

Incidental Energy Cost Payment

$$IE = G \times (AR + VOM) - (REV_{WESM} - PMT_{WESM})$$

Subject	Philippines	Indonesia	Notes

Dispute Resolution	Article 3.3.3.7. DOE Cir 2002-003
	Any dispute between the System Operator and the Ancillary Services Provider in relation to the determination of a payment under an ancillary services agreement shall be determined by the Dispute Resolution Administrator in accordance with clause 7.3.
	Article 7.3 DOE Cir 2002-003
	The Dispute Resolution Administrator selects seven individuals to form the dispute resolution group. From these seven, a dispute resolution panel consisting of three members will be appointed. The dispute resolution panel will establish the dispute resolution procedures that the parties must follow. The panel is required to resolve the dispute within 20 working days after being referred. In addition to using the dispute resolution panel, the Dispute Resolution Administrator may also facilitate resolution between the parties. Parties dissatisfied with the panel's resolution may file a formal complaint with the ERC.
		MEMR Regulation 20/2020 has established the KMAJ, which may appoint a Grid Code dispute resolution panel to address specific disputes.	• Proposed Recommendation
			  ○ Option 1: The role of the Dispute Resolution Administrator can be performed by KMAJ, while the role of the dispute resolution panel can be carried out by a dispute resolution panel specifically appointed by KMAJ to resolve AS-related disputes. In this case, an amendment to MEMR Regulation 20/2020 would be required to expand KMAJ's duties to include the resolution of AS-related disputes.
			  ○ Option 2: To provide flexibility, disputes between PLN and AS providers may be resolved by the parties themselves under the dispute resolution mechanism stipulated in the AS agreement.

Periodic Approval and Evaluation of US Services	Article 3.3.7.2 DOE Cir 2002-003
	The SO, in consultation with Market Operators and WESM participants, is required to conduct periodic evaluations and reviews of AS categories and AS provision arrangements.
	Article 3.3.7.3 DOE Cir 2002-003
	• Changes to the AS category and AS provision arrangements that impact the AS costs charged by Transco to electricity supply businesses must be approved by the ERC.
		There is no periodic approval and evaluation of AS services.	• Proposed Recommendation:
			  ○ Referring to Article 3.3.37.3 DOE Cir 2002-003 if there is a change in the AS category and AS supply arrangements that impact the portion of AS costs in consumer electricity tariffs, the approval of the MEMR will be required.
			  ▪ Provisions regarding periodic testing can be regulated through: (i) an amendment to Law 30/2009 and/or GR 14/2012 (Option 1), or (ii) a AS MEMR Reg (Option 2).
			  ▪ Provisions regarding adjustments to the AS cost component in consumer electricity tariffs resulting from changes in AS arrangements based on testing results can be regulated in MEMR Reg 10/2022 (Option 2).

In addition to EPIRA and DOE Cir 2002-003, we provide below legal recommendations on the provisions in DOE Cir 2021-0031 that can be regulated in AS MEMR Reg. The Department of Energy Circular is a document issued by the Department of Energy of Philippines, which presumably is similar to a minister regulation issued by MEMR.

Legal comparison between the DOE Cir 2021-0031 and ERC Case and Indonesia's electricity regulatory framework

Table 12: Provisions regarding AS under the Philippines Republic Act and DOE Cir 2002-003

Subject	Philippines	Indonesia	Notes
Procurement Plan	Article 4 DOE Cir 2021-0031: 4.1 The SO shall develop and submit to the DOE its annual Ancillary Service Agreement Procurement Plan (ASAPP) not later than 31 March of every year which contains the projected AS requirements for the next ten (10) years. 4.2 The ASAPP shall be posted at the SO website within three (3) days from receipt of the review by the DOE but should not be later than 30 April of every year. 4.3 The SO's ASAPP shall contain the following: • Type of AS to be procured per grid; • Timing of AS requirement per grid (month and year); • Existing ASPAs (providing the location and expiration); • Monthly levels of AS requirement per grid to account for seasonality; • Typical Hourly level for the past five years of the AS requirement per type per grid; and • Other information that the DOE may require.	There is currently no regulation regarding the procurement mechanism for AS in Indonesia. In practice, PPAs generally set technical limitations for power plant operation, such as frequency and reactive power. PPAs also stipulate penalties if the IPP fails to provide AS, such as frequency, reactive power, and/or ramp rate.	• Proposed Recommendation: ◦ Option 1: Referring to DOE Cir 0031, an AS MEMR Reg could be issued stipulating that PLN will be the party implementing AS procurement, and PLN is required to prepare an AS procurement plan, for example, annually for the next 10 years, as per DOE Cir 2021-0031. This AS Procurement Plan could be part of the Electricity Generation Business Plan (RUPTL). ◦ Option 2: However, considering that the RUPTL was first regulated in GR 14/2012, provisions related to the AS Procurement Plan as part of the RUPTL could be regulated in an amendment to GR 14/2012, and then further regulated in the AS MEMR Reg.
Procurement Committee	Article 5.1.1 DOE Cir 2021-0031: "The SO, through its Board of Directors (BOD), shall establish an independent Third Party Bids and Awards Committee (TPBAC) to spearhead and manage the CSP. The TPBAC shall comply with the policy and procedures in the conduct of CSP, as provided for in this Circular. The TPBAC shall be accountable to its decision in the conduct of the CSP; provided however, that the SO shall bear the expenses for any dispute or litigation arising from the CSP."	PLN generally has procurement implementing officers to carry out electricity purchasing procurement.	• Philippine regulations require system operator to establish an independent Third Party Bids and Awards Committee (TPBAC) to administer the AS competitive selection process (CSP). The TPBAC consists of five individuals with technical, legal, and market backgrounds, along with representatives from the Market Operator (MO) and TRANSCO. • Proposed Recommendation: The provisions for the formation of a special independent procurement committee to organize the procurement of AS provision can be regulated in the AS MEMR Reg.
Procurement Stages	DOE Cir 2021-0031: DOE Circular 2021-0031 provides detailed regulations on the AS procurement mechanism. Some of the key provisions include: • Minimum content requirements in the bid documents. • The Terms of Reference (TOR) and Instructions to Bidders must be submitted by the System Operator (SO) to the Department of Energy (DOE) for approval.	There is currently no regulation regarding procurement mechanism for AS in Indonesia.	Proposed Recommendation: AS Procurement Mechanism • Detailed procurement mechanisms for the provision of AS can be regulated in the AS MEMR Reg. AS Price Approval • MEMR may consider requiring PLN to submit ASPA to MEMR for approval, similar with Philippines. Another alternative is for MEMR to grant approval of the AS price agreedbetween PLN and the winning bidder.

Subject	Philippines	Indonesia	Notes
Procurement Stages	The procurement stages consist of: • Publication of the invitation to bid; • Pre-bid conference; • Submission and opening of bid documents (two-envelope system); • Evaluation of bid documents (price mechanism based on the lowest calculation according to predetermined criteria); • Award determination by the SO BOD based on TPBAC recommendations; • Signing of the ASPA. Cont.]		If a price approval from MEMR is required: • Option 1: considering that electricity price approval is regulated in Law 30/2009 and GR 14/2012, the AS price approval from MEMR can also be regulated in the amendment to Law 30/2009 and GR 14/2012, and then subsequently regulated further in the AS MEMR Reg. • Option 2: referring to DOE Cir 2021-0031, the requirement to obtain AS price approval from MEMR can be regulated in the AS MEMR Reg.
Procurement Duration	Article 7.11 DOE Cir 2021-0031 : Each AS CSP shall be completed within ninety (90) calendar days from the time of posting/publication of Invitation to Bid until the award and signing of the ASPA. Non-observance of this prescribed period will be subject to penalties to be imposed by the ERG.	Presidential Regulation 112 • Article 15 (1): The electricity procurement process through direct appointment must be preceded by the document submission process up to the signing of the PPA, including document evaluation, and must be completed within a maximum period of 90 (ninety) calendar days. • Article 16 (2): The electricity procurement process through direct selection must be preceded by the document submission process up to the signing of the PPA, including document evaluation and negotiation of the electricity purchase price, and must be completed within a maximum period of 180 (one hundred eighty) calendar days.	• The duration of AS procurement in the Philippines is 90 days. For comparison, PR 112/2022 stipulates that direct selection for electricity procurement may take a maximum of 180 days, while direct appointment may take up to 90 days. • Proposed Recommendation: The procurement timing for AS provision can be regulated in the AS MEMR Reg.
AS Testing	Article 7.10.2.7 PGC: "The Ancillary Service Provider acceptability test shall determine the committed services in terms of parameter quantity or volume, timeliness, and other operational requirements. Generators providing Ancillary Services shall conduct test or define the committed service. However, monitoring by the Grid Owner of Ancillary Service performance in response to System-derv."	There is currently no regulation regarding AS testing in Indonesia.	Proposed Recommendation • Option 1: AS MEMR Reg can regulate: (i) the testing procedures required to obtain an AS certificate; (ii) routine testing procedures for AS-providing power plants (if any); and (iii) dispatch instructions for AS. • Option 2: Specifically for AS dispatch instructions, these can be regulated through an amendment to MEMR Reg 20/2020.

Subject	Philippines	Indonesia	Notes
AS Testing	Article 8.2.2.3 PGC "The System Operator shall be responsible in issuing Dispatch Instructions for the Scheduled Generating Units and the Generating Units providing Ancillary Service" Article 8.5.3 PGC This article explains what should be included in the dispatch instructions for various types of AS, such as: • Frequency Regulating Reserve: Must specify whether the power plant will provide primary or secondary response to frequency changes. • Spinning & Backup Reserve: Must specify the generation capacity to be provided. • Black Start: Must provide specific instructions for the power plant to perform a black start. • Emergency Load Reduction: Must specify the load capacity to be reduced and the timing of implementation. • Voltage Control: Must determine the target voltage level or the maximum reactive power capacity to be supplied.		
AS Agreement Duration	Section 7.1 DOE Cir 2021-0031: "Within six (6) months from the effectivity of this Circular, the SO shall conduct a CSP for the procurement of ASPA for a contract period of a maximum of five (5) years."	Indonesia does not yet regulate specific contracts for the supply of AS. However, the supply of AS by IPPs is regulated by PPAPPA, and PPAPPA are generally valid for 20-30 years.	• Proposed Recommendation: Referring to DOE Cir 2021-0031, AS MEMR Reg can regulate the maximum time period for ASPA (such as MEMR Reg 5/2025 which regulates the maximum time period for PPA is 30 years and can be extended).
AS Agreement Duration	Section 11.1 DOE Cir 2021-0031: • "All non-firm ASPAs not converted to firm ASPAs upon effectivity of this Circular shall be valid and effective. However, for purposes of dispatching of AS, the firm ASPAs will be prioritized over non-firm ASPAs."	Indonesia has not yet arranged a specific contract for the supply of AS.	Article 11.1 of DOE Cir 2021-0031 indicates that ASPA contracts could initially be either firm or non-firm, with firm contracts being given priority. However, over time, all ASPA contracts were required to be firm contracts. Proposed Recommendation: • Option 1: AS MEMR Reg can specify whether AS contracts must be firm contracts or may be non-firm. Based on discussions with GIZ technical consultants, it is recommended to adopt firm contracts directly. • Option 2: The type of AS contract does not need to be regulated and can be left for PLN and the AS provider to agree upon on a business-to-business basis.

Subject	Philippines	Indonesia	Notes
AS Price Principle	Article 1.2 ERC Case No. 2006-049 "The following are the general principles used in the formulation of the AS-CRM: Revenue Neutrality. The formula should be revenue neutral to both System Operator and Market Operator. There should be no under and over recovery of the cost of service and no profit margin will be allowed. That is, the charges should be complete passed-on from the user or beneficiary of the service to the service provider.	SCC 2.2 Grid Code Indonesia: AS is one component in the purchase of electricity paid by PLN to IPP based on PPA or other contracts. Payments include: (a) reactive power and voltage control; (b) load following and ramp rate; (c) black start; (d) loading below the technical minimum load; (e) house load; and (f) start up.	• The Philippines uses the principle of revenue neutrality in determining AS prices. This means that the fees charged by the NGCP to electricity providers are solely for cost recovery, with no profit margin. • Proposed Recommendation: Referring to ERC Case No. 2006-049 RC which should be comparable to the regulations issued by MEMR or DJK, AS MEMR Reg can regulate that the portion of AS costs as part of consumer electricity tariffs uses the concept of revenue neutrality.

7.2. Regulatory Overview of AS Provision under Singaporean Law

The Singaporean Ancillary Services framework evolved through a sequence of sectoral reforms. Please refer to the table below:

Table 13: Evolution of AS Provisions under Singaporean Law

Year	Instrument / Development	Key Content / Impact
1970–1992	Public Utilities Act (and subsequent amendments)	The Public Utilities Act governed Singapore's integrated utilities under the Public Utilities Board (PUB), which managed electricity generation, transmission, distribution, and retail as a vertically integrated monopoly. Ancillary Services were handled internally as part of system operations, without market-based or regulatory separation.[23]
1995	Public Utilities (Amendment) Act / Transfer of Operational Authority	The Public Utilities Act (Amendment) transferred electricity operations from PUB to Singapore Power Ltd (SP), a corporatized government-owned entity. This shift marked the beginning of unbundling, separating ownership and operations, and laying the institutional foundation for competitive electricity and AS markets
1995–1996	Pre-Market Restructuring	Establishment of independent generation companies (gencos) and SP PowerAssets to own and manage transmission and distribution networks. These reforms created a market-oriented structure, enabling future introduction of Ancillary Services as a regulated and tradable service to maintain grid reliability.
2001	Electricity Act 2001	The Electricity Act 2001 created the legal framework for a competitive, open, and unbundled electricity market in Singapore. It established the Energy Market Authority (EMA) as an independent regulator, empowered to oversee licensing, grid operations, and market conduct. The Act also introduced the National Electricity Market of Singapore (NEMS), where tariffs and market prices are determined competitively. Crucially, this Act marked the first formal establishment and regulation of Ancillary Services as a distinct market segment under EMA's supervision—ensuring system reliability, operational security, and transparent Ancillary Services procurement mechanisms

Year	Instrument / Development	Key Content / Impact
2006	Establishment of the Energy Market Company (EMC)	The EMC was licensed as the Market Operator responsible for managing wholesale market operations, settlements, and AS payments. This institutionalized commercial arrangements for Ancillary Services provision, enhancing transparency, accountability, and efficiency in Ancillary Services transactions
2002	Revised Edition of the Electricity Act	Provided further clarification on technical, licensing, and operational provisions, reinforcing EMA's authority to set performance standards and registration requirements for Ancillary Services providers. Strengthened the legal foundation for Ancillary Services integration into the wholesale market.[28]
2003	Launch of the National Electricity Market of Singapore (NEMS)	Official launch of NEMS, enabling full transition to a competitive wholesale market. Under this framework, Ancillary Services began to be procured and dispatched through transparent market mechanisms, administered by the Power System Operator (PSO) under EMA's oversight.[29]
2006	Amendment I to the Electricity Act 2001	The first amendment to the Electricity Act further clarified the roles, functions, and powers of transmission licensees and agent licensees, and strengthened technical and safety standards for electricity transmission systems. This ensured consistent operational standards across grid participants and reinforced system security relevant to Ancillary Services performance.[30]
2018	Amendment II to the Electricity Act 2001	The second amendment introduced retail market liberalization, allowing household and small business consumers to choose their electricity retailers. While primarily focused on retail competition, it also emphasized broader market efficiency and flexibility but did not directly alter AS provisions.[31]
2018–2024	Subsequent Amendments to the Electricity Act 2001	Several amendments were made to refine regulatory, licensing, and enforcement frameworks. However, these changes were not directly related to AS provision. EMA continued to strengthen grid reliability standards and system resilience, indirectly supporting the effectiveness of AS operations.[32]
2025	Market Rules (National Electricity Market of Singapore – NEMS)	The 2025 Market Rules update established detailed technical and commercial specifications governing the operation of the wholesale electricity market, including procurement, scheduling, and use of Ancillary Services, notably outlined in Chapter 5. This codified the processes for AS participation, performance standards, cost recovery, and settlement, ensuring that AS provision remains reliable, transparent, and responsive to evolving system needs.[33]

Essentially, Singapore's wholesale electricity market operates under a dual structure comprising: (i) **the spot or real-time market for energy,** reserves, and regulation, and (ii) the **procurement market** for other ancillary services (AS). This study focuses on the procurement market, as Indonesia currently does not operate a spot market mechanism. In this procurement market, the Energy Market Company (EMC), acting as the Market Operator, conducts the selection and contracting of Ancillary Services providers on behalf of the **Power System Operator (PSO)** for Reactive Support and Voltage Control, Black Start Capability, Fast Start Services, and Reliability Must-Run Services (vide Article 8.2.2 Singapore Rules Chapter 5 (System Operation). Meanwhile, **regulation and reserve services are obtained through the electricity market,** where providers deliver frequency regulation within 60 seconds, primary reserve within 9 seconds, and contingency reserve within 10 minutes.

[28] Ibid.
[29] https://www.home.emcsg.com/about-emc/company-information/Who-We-Are#:~:text=The%20National%20Electricity%20Market%20of,trading%20on%201%20January%202003.&text=Energy%20Market%20Company%20Pte%20Ltd%20(EMC)%20operates%20Singapore's%20wholesale%20electricity,Singapore%20and%20throughout%20the%20world.
[30] https://sso.agc.gov.sg/act/ea2001
[31] https://sso.agc.gov.sg/act/ea2001
[32] https://sso.agc.gov.sg/act/ea2001
[33] https://www.home.emcsg.com/about-the-market/rules/market-rules

It is understood that the Ancillary Services procurement market has been in operation since the enactment of the **Electricity Act 2001,** which established the legal and institutional foundation for Singapore's competitive and unbundled electricity market. However, while the Electricity Act 2001 defines Ancillary Services and recognizes them as part of the wholesale market, it does not contain explicit provisions regulating Ancillary Services procurement processes. Instead, the Act delegates such operational and procedural matters to subsidiary instruments.

Based on our review, the primary regulatory framework governing AS procurement in Singapore is set out in the Singapore Electricity Market Rules (Market Rules), specifically Chapter 5 (System Operation) and related chapters. These Market Rules define the technical and commercial specifications for the procurement, scheduling, and settlement of ancillary services. We were unable to locate the version of the Market Rules that was in effect at the time of the Electricity Act 2001's issuance.

Accordingly, this study focuses on comparing the treatment of ancillary services under the Electricity Act 2001 with the relevant provisions contained in the current Singapore Market Rules, particularly Chapter 5 (System Operation) and other associated rules that govern the procurement and operation of AS within Singapore's wholesale electricity market.

- **AS Payment and Procurement Scheme under Singaporean Law:** Upon conducting our desktop research and review of the relevant regulations in Singapore, we note that the payment and procurement scheme of AS under Singaporean Law is envisaged under the below structure:

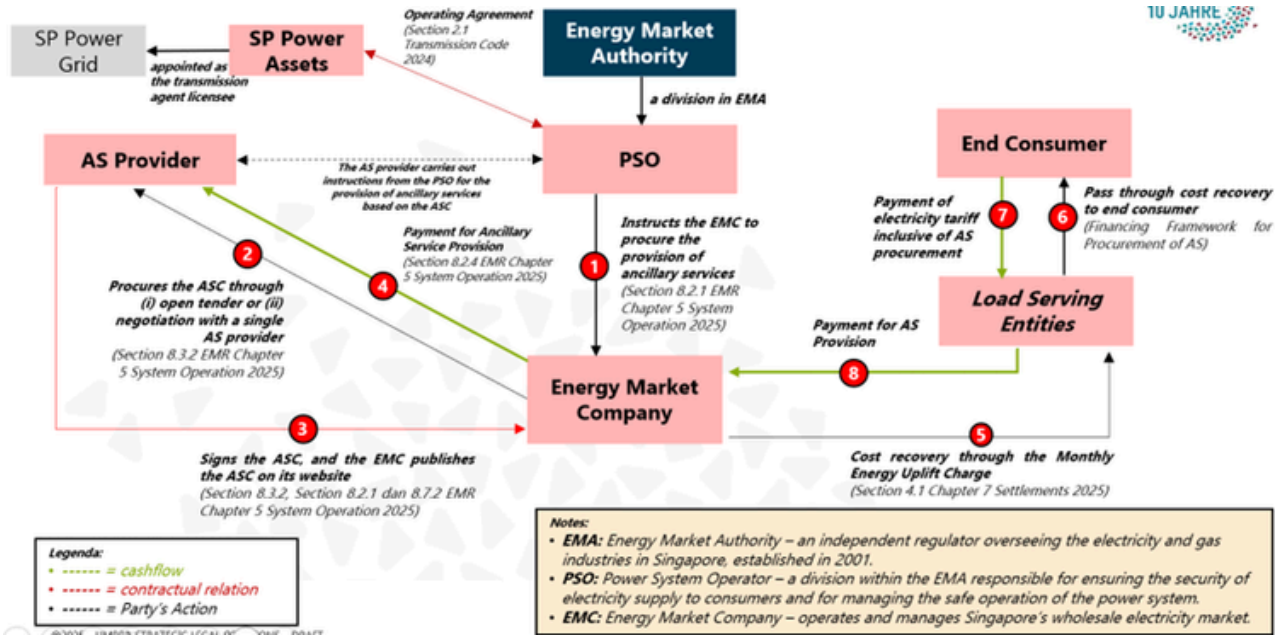


Figure 7: Payment and Procurement Scheme of Ancillary Service under Singaporean Law

- **Comparative Analysis between AS Provisions under Singaporean Law and Indonesia:** Unlike Philippines, our comparative study on Singapore Law focuses on two regulations: (i) Electricity Act 2001 and (ii) Singapore Market Rules Chapter 5 (System Operation). The majority content of Singapore Market Rules Chapter 5 (System Operation) provides a basis for items to be regulated in AS MEMR Reg, except for certain items that we view are more appropriate to be regulated in the amendment to Law 30/2009 and/or GR 14/2012, given the Indonesia's electricity regulatory framework. Please see Table 5 for further elaboration.

Table 14: Provisions regarding AS under Singapore's Electricity Act 2001 and Singapore Rules

Subject	Singapura	Indonesia	Notes
AS Definition	Article 2(1) Electricity Act 2001 "Ancillary service means a service required or provided for the security or reliability of the electricity system."	There is currently no AS definition in Indonesia.	Proposed Recommendation: • Option 1: Amendment of Law 30/2009 to regulate the definition of AS. • Option 2: If Law 30/2009 cannot be amended, GR 14/2012 can be amended to regulate the definition of AS.
AS General Requirements	Article 4.2.3 Singapore Rules Chapter 5 (System Operation) "Contracted ancillary service shall be procured by the EMC, on behalf of the PSO, in accordance with Section 8." Article 8.2.1.1 Singapore Rules Chapter 5 (System Operation) "The EMC shall procure, on behalf and at the request of the PSO, contracted ancillary services through agreements with ancillary service providers that have either: 8.2.1.1 Demonstrated to the PSO the ability to provide such contracted ancillary services from registered facilities, in accordance with the performance standards and other applicable requirements referred to in Section 4"	There is currently no regulation regarding AS procurement in Indonesia.	Since Indonesia does not have a wholesale market and PLN acts as SO, AS procurement will be carried out by PLN. Proposed Recommendation: • Option 1: Amend Law 30/2009 to regulate that the holder of an Integrated IUPTLU is responsible for planning and procuring AS to select AS providers. • Option 2: If amending Law 30/2009 is not feasible, the provision that the holder of an Integrated IUPTLU conducts planning and procurement of AS can be regulated through an amendment to GR 14/2012. Option 2 is feasible because Law 30/2009 does not currently provide provisions regarding AS.
Types of AS	Article 8.2.2 Singapore Rules Chapter 5 (System Operation) "The principal contracted ancillary services that the EMC may procure pursuant to section 8.2.1 are: 8.2.2.1 reactive support and voltage control service, 8.2.2.2 black start capability, 8.2.2.3 fast start service, and 8.2.2.4 reliability must-run service." Furthermore, there are also AS obtained through the electricity market, namely frequency regulation and reserve, the provision conditions of which are as follows: • Regulation: Achieve the provided capacity in <60 seconds. • Primary Reserve: Automatic response when a contingency occurs, reaching the provided capacity in less than 9 seconds; must be maintained for more than 10 minutes. • Contingency Reserve: Achieve the provided capacity in less than 10 minutes, must be maintained for more than 30 minutes.	MEMR Regulation 20/2020 sets out detailed provisions regarding frequency control, voltage control, and black start.	Proposed Recommendation: Because the regulations regarding AS types are quite detailed and have the potential to change in the future as needed, the regulations regarding AS types can be regulated in the AS MEMR Reg.

Subject	Singapura	Indonesia	Notes
AS Provider Requirements	**Article 4.3.1 Singapore Rules Chapter 5 (System Operation)** "Ancillary services may be provided to the PSO and the EMC only by registered facilities." **Article 4.3.2 Singapore Rules Chapter 5 (System Operation)** "The EMC shall not enter into a contract with a prospective ancillary service provider to provide a contracted ancillary service unless the facilities and procedures of such prospective ancillary service provider meet the requirements for registration as a registered facility in respect of the ancillary service to be provided and are otherwise in compliance with the requirements of this Chapter" **Article 4.3.3 Singapore Rules Chapter 5 (System Operation)** "In order to make the determination referred to in section 4.3.2, the PSO, acting on behalf of the EMC, may require each prospective ancillary service provider to demonstrate through physical tests or other appropriate means specified by the PSO that the registered facilities or equipment that will be used to provide the ancillary service meet the performance standards for the applicable ancillary service set forth in Appendix 5A." **Article 8.3.5 Singapore Rules Chapter 5 (System Operation)** "The provisions of sections 8.3.1 and 8.6.1 shall be subject to any contrary provisions contained in: 8.3.5.1 any electricity license; or 8.3.5.2 the terms of any ancillary service contract the terms of which are required by an electricity licence to be, and have been, approved by the Authority"	There is currently no regulation regarding AS procurement in Indonesia.	• The Singapore Rules do not provide further details regarding proof of registration for AS-providing facilities. • In the context of Indonesia, MEMR may consider requiring AS provider to register is registration with the MEMR and obtaining proof of registration, such as a statement letter or certificate . • Furthermore, Article 8.3.5 indicates that an AS provider must also hold an electricity business license. Therefore, in Singapore, AS providers are required to have both an electricity license and registration with the EMC • In the context of Indonesia, an AS provider is similar with holders of Generation IUPTLU licenses who own power plants and sell electricity to PLN. Accordingly, referring to Singapore's regulations, Generation IUPTLU holders may become AS Providers by obtaining proof of registration with MEMR, such as a statement letter or an AS certificate. Proposed Recommendation: • Option 1: Amend Law 30/2009 to regulate that holders of Generation IUPTLU licenses may provide AS by registering with MEMR to obtain a statement letter or AS certificate. • Option 2: If amending the law is not feasible, this provision can be regulated through an amendment to GR 14/2012. This is feasible because Law 30/2009 does not provide detailed provisions regarding the scope of electricity generation activities. **Notes:** If the holder of the Transmission IUPTLU plans to provide AS as well, a technical argument will be needed to ensure that the provision of AS by the holder of the Transmission IUPTLU is not included as a generation activity and can be considered as part of the transmission activity. Based on discussions with GIZ's technical consultant, it is understood that Transmission IUPTLU holders providing AS can be considered as part of transmission activity and will not be considered as generation activity due to the following arguments: (i) the AS is provided in the form of electricity generated from the transmission assets (e.g.: compensator), not generators; (ii) the electricity generated from those transmission assets are not in the form of energy, which is the electricity produced by generators (e.g.: in the form of VAR); and (iii) in practice, those transmission assets have been producing electricity in the form of AS for the purpose of ensuring the electricity system reliability and quality.

Subject	Singapura	Indonesia	Notes
AS Provider Obligations	**Article 8.2.3 Singapore Rules Chapter 5 (System Operation)** The EMC shall procure each contracted ancillary service: 8.2.3.1 in sufficient quantities and at the appropriate locations to enable the PSO to meet its obligations under this Chapter to ensure the reliable operation of the power system, in accordance with all applicable reliability standards; and 8.2.3.2 having regard to the applicable performance standards referred to in section 4	There are no specific obligations regarding the provision of AS for PLN.	Proposed Recommendation • Because Indonesia does not have a wholesale market and PLN also plays a role as SO, the obligations regulated in Article 8.2.3 and Article 8.2.4 can be regulated as PLN's obligations in the AS MEMR Reg as follows: • PLN must provide AS: (i) in sufficient quantity and at suitable locations to ensure reliable operation of the electricity system in accordance with the Grid Code; and (ii) in accordance with the implementation standards stipulated in the AS MEMR Reg or determined by PLN; and • PLN is obliged to pay the AS provider in accordance with the agreement of the parties in the AS agreement.
Technical requirements related to specific AS types	Singapore Rules Chapter 5 (System Operation) regulates detailed technical requirements related to regulation, reserve, reactive support, voltage control, black start, fast start and reliability of must run service.	MEMR Regulation 20/2020 sets out detailed provisions regarding frequency control, voltage control, and black start.	• Detailed technical requirements related to AS provision may be regulated in the AS MEMR Reg or amendment to MEMR Reg 20/2020.
AS Testing	**Article 4.11.1 Singapore Rules Chapter 5 (System Operation)** "4.11.1 The PSO shall develop requirements for the testing of facilities that will provide ancillary services to the PSO controlled system. The PSO shall use such tests to determine whether to register a facility as a registered facility for the provision of ancillary services and to ensure that each such registered facility continues to meet the requirements for registration to provide the applicable ancillary services. Such requirements: 4.11.1.1 shall not be inconsistent with any applicable reliability standards; and 4.11.1.2 shall be included in the system operation manual." **Article 4.11.2 Singapore Rules Chapter 5 (System Operation)** "Prior to participating in any tests referred to in section 4.11.1, the ancillary service provider or prospective ancillary service provider shall submit a detailed test procedure plan for the PSO's approval. The PSO shall evaluate the detailed test procedure plan and shall either grant its approval or reject, with reasons, the detailed test procedure plan"	There is currently no regulation regarding AS procurement in Indonesia.	Proposed Recommendation • Testing procedures and testing standards can be regulated by MEMR in the AS MEMR Reg, by receiving input from PLN and other Integrated IUPTLU holders.

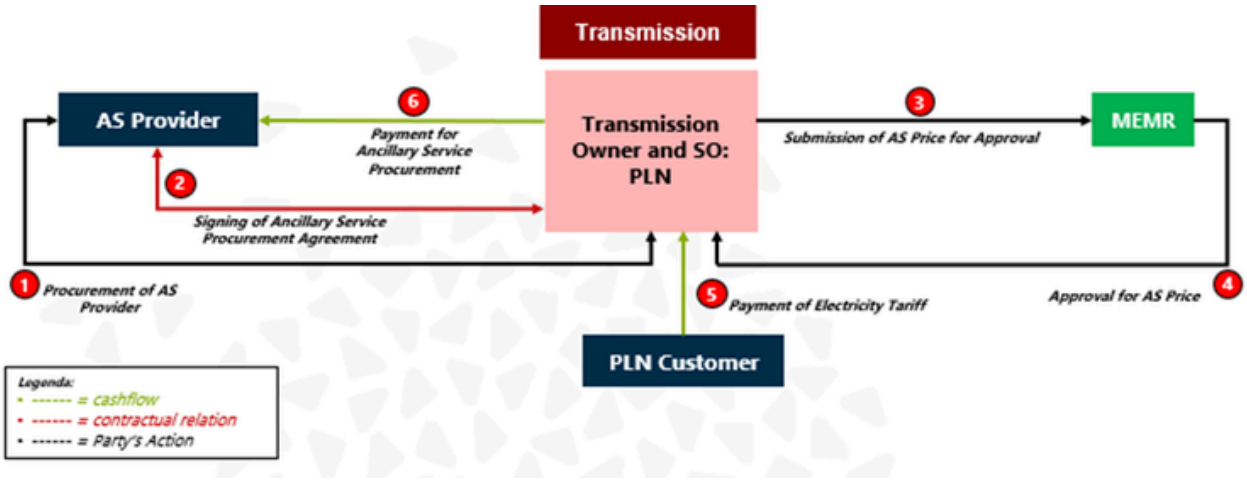
Subject	Singapura	Indonesia	Notes
AS Testing	**Article 4.12.1 Singapore Rules Chapter 5 (System Operation)** "If a registered facility providing ancillary services fails a test performed pursuant to section 4.11.1, the EMC shall not schedule, and the PSO shall not dispatch, the applicable ancillary service from the registered facility until the ancillary service provider demonstrates that the registered facility can provide the relevant ancillary service. In addition, the EMC or the PSO may require the ancillary service provider to refund any compensation it has received for the applicable ancillary service during any period prior to the date of the test to the extent that the test results and other information available to the PSO indicate that the applicable ancillary service was not provided during that period. Further, the EMC may impose such other sanctions as are permitted by the market rules or any applicable ancillary service contract."	There is currently no regulation regarding AS procurement in Indonesia.	Proposed Recommendation • This provision can be regulated in the AS MEMR Reg that if the generator does not pass the AS Testing, then PLN will not schedule and dispatch the AS, and PLN has the right to receive back the payments it has made to the AS provider.
AS Testing	**Article 4.13.1 Singapore Rules Chapter 5 (System Operation)** "Notwithstanding any other provision of the market rules the PSO may, when the PSO controlled system is in an emergency operating state, acquire ancillary services from any market participant, whether or not such market participant satisfies all of the standards and registration requirements applicable in respect of such ancillary services and whether or not the EMC has a contracted ancillary services contract with the market participant."	There is currently no regulation regarding AS procurement in Indonesia.	Proposed Recommendation • In the Indonesian context, the AS MEMR Reg may stipulate that PLN may directly appoint AS providers in emergency operating conditions.
AS Procurement	**Article 8.3.2 Singapore Rules Chapter 5 (System Operation)** "The EMC shall use one or a combination of the following processes to conclude ancillary service contracts with ancillary service providers: 8.3.2.1 where practicable, the EMC shall employ a competitive tendering or negotiation process to identify multiple potential ancillary service providers and to determine competitive prices and other terms for the ancillary service contracts; or 8.3.2.2 otherwise, the EMC may negotiate ancillary service contracts with a single potential ancillary service provider where the EMC determines that this will result in reasonable prices and other terms."	There is currently no regulation regarding AS procurement in Indonesia.	Proposed Recommendation • The AS procurement mechanism can be: (i) public auction/direct selection and (ii) direct appointment if it meets certain criteria, for example if PLN assesses that direct appointment will result in a fair price and other benefits that are not obtained from direct selection. • Option 1: Considering that the electricity procurement mechanism was first regulated in Article 25 of GR 14/2012, provisions related to the procurement mechanism for the provision of AS through public auction or direct selection and direct appointment can be regulated in an amendment to GR 14/2012, and then further regulated in the AS MEMR REg. • Option 2: referring to Singapore Rules Chapter 5, the US procurement mechanism can be regulated in the AS MEMR Reg.

Subject	Singapura	Indonesia	Notes
AS Procurement Documents	**Article 8.3.3 Singapore Rules Chapter 5 (System Operation)** When initiating the procurement process for additional services, the EMC must announce: (i) the number of services required (if any), (ii) the desired duration of the contract, (iii) the conditions under which the services will be requested, (iv) the form and time of prior notification by the PSO, (v) the time of payment for the services, (vi) the standard and level of performance of the services, (vii) the conditions under which the contract may be suspended, (viii) the process for changing the contents of the contract, and (ix) the terms of transfer of the contract to another party.	There is currently no regulation regarding AS procurement in Indonesia.	Proposed Recommendation • AS MEMR Reg may regulate the minimum content that should be included in the AS procurement document
Consultant for AS Procurement	**Article 8.3.4 Singapore Rules Chapter 5 (System Operation)** EMC may, on its own initiative or at the request of the PSO, appoint an independent consultant to conduct an audit of proposals from prospective additional service providers.	There is currently no regulation regarding AS procurement in Indonesia.	Proposed Recommendation • AS MEMR Reg may stipulate that PLN may collaborate with consultants to assist during the procurement process to select US providers.
AS Agreement	**Article 8.3.1 Singapore Rules Chapter 5 (System Operation)** Each AS contract entered into by an EMC must contain certain minimum terms and conditions, with specific additional provisions if they relate to funding of additional services, including (i) Contract Duration; (ii) Service Commencement Date; (iii) When services may be requested by the PSO; (iv) Payment Terms; (v) Contract Suspension Conditions; (vi) Contract Assignment, and others.	There is currently no regulation regarding AS procurement in Indonesia.	Proposed Recommendation • The AS MEMR Reg may regulate the minimum content to be agreed in an AS agreement. Therefore, PLN and the AS provider can regulate other matters based on the agreement between the parties in the AS agreement.
AS fees paid by the implementing party to AS Provider	**Article 8.6.1 Singapore Rules Chapter 5 (System Operation)** EMC can pay a price that includes: (a) Availability Fee: Cost for being ready to provide ancillary services when instructed by the PSO. (b) Actual and Opportunity Costs: Direct costs and lost opportunities incurred when actually providing ancillary services under PSO instruction. (c) Other Compensation: Additional compensation deemed fair and reasonable by the EMC according to the circumstances. **Section 2, Introduction Financing Framework For Procurement of Ancillary Services, 15 September 2020** For bilateral contracts, fixed CAPEX and OPEX are paid annually. 10% rate of return for CAPEX, 10% margin for OPEX. **Ancillary Price in Electricity Market** In the electricity market mechanism, the AS cost price refers to the spot price. The following AS cost components are subject to the spot price: (i) primary reserve, (ii) contingency reserve, and (iii) regulation. (Source: https://www.nems.emcsg.com/nems-prices)	SCC 2.2 Grid Code Indonesia: AS is one of the components in the purchase of electricity that must be paid by PLN to the power plant manager based on PPA or other contracts. AS payments include: (a) reactive power and voltage control; (b) frequency regulation (load following and ramp rate); (c) black start; (d) loading below the technical minimum load (TML); (e) house load; and (f) start up.	Proposed Recommendation • Provisions regarding the AS cost components paid by PLN to AS providers can be regulated in the AS MEMR Reg.

Subject	Singapura	Indonesia	Notes
US costs charged to consumers	**Article 8.2.4 Singapore Rules Chapter 5 (System Operation)** Amounts payable to a market participant under an ancillary service contract shall be paid by the EMC in accordance with the ancillary service contract and instructions to this effect given to it by the PSO, and shall be recovered by the EMC in accordance with section 4.1 of Chapter 7. **Article 4.1.1 Singapore Rules Chapter 7 (Settlement)** AS-related costs will be calculated by EMC prior to the beginning of each month and then billed to the load serving entities. Examples of AS-related costs are: (i) estimated charges from AS providers under the contract; (ii) estimated testing costs by PSOs for AS procurement; (iii) compensation and/or costs charged to EMA due to disputes or settlements of AS contracts and related agreements; (vi) estimated costs and expenses (including legal and tax) by EMC or EMA in pursuing or defending claims related to AS contracts.	MEMR Reg 10/2022 regulates the components of electricity tariffs paid by consumers, but there is nothing specific to the US.	Proposed Recommendation MEMR Reg 10/2022 does not specifically regulate AS costs as a component of consumer electricity tariffs. However, based on discussion with GIZ's technical consultants, AS costs should be included as part of consumer electricity tariffs, so PLN needs to determine the portion of these AS costs allocated to payments for AS provision to AS Providers. A financial analysis is required to determine the portion of AS costs included in consumer electricity tariffs and whether this portion is sufficient to cover the costs of providing AS to AS Providers. • Option 1: Amend Law 30/2009, GR 14/2012, and MEMR Reg 10/2022 to include AS costs as a component of electricity tariffs. • Option 2: AS costs can be incorporated as part of other costs necessary for electricity supply within the business area of the IUPTLU holder, pursuant to MEMR Reg 10/2022. The determination of AS costs as part of these other costs would require approval from MEMR. In addition, an amendment to MoF Reg 20/2025 is also needed to determine AS costs as part of the BPP components that can be subsidized.
Information Transparency	**Article 8.7.1 Singapore Rules Chapter 5 (System Operation)** "The EMC shall treat information relating to the funding of the refurbishment cost and procurement of contracted ancillary services as follows: 8.7.1.1 the EMC shall publish annually the total costs of each class of contracted ancillary services listed in section 8.2.2 subject to ancillary service contracts, together with estimates of the total costs of each class of contracted ancillary services the EMC expects to recover for the next 36 months; 8.7.1.2 the EMC shall publish annually the quantities of each class of contracted ancillary service listed in section 8.2.2 covered under ancillary service contracts, together with estimates of any additional quantities the EMC expects to acquire during the next 36 months; and 8.7.1.3 the EMC shall publish annually the total Authority funding costs for the preceding 12 months which the EMC has recovered on behalf of the Authority in accordance with section 4.1 of Chapter 7, together with estimates of the total Authority funding costs that the EMC expects to recover on behalf of the Authority for the next 36 months."	There is currently no regulation regarding AS procurement in Indonesia.	Proposed Recommendation • Such annual publication of AS-related information can be included in the RUPTL, e.g.: PLN is required to include long-term AS planning and procurement in the RUPTL. • •Option 1: Referring to the Singapore Rules Chapter 5, the AS MEMR Reg may require PLN to include long-term AS planning and procurement in its RUPTL. • •Option 2: given that RUPTL was first regulated in GR 14/2012, the obligation of PLN to include long-term AS planning and procurement in the RUPTL may be regulated in GR 14/2012, and then further regulated in the AS MEMR Reg.

7.3. Potential Adaptation of the AS Procurement Schemes of the Philippines and Singapore in Indonesia's Existing Electricity Market

i. Option 1: PLN as Transmission Owner and System Operator



ii. Option 2: PLN as Transmission Owner and ISO as System Operator

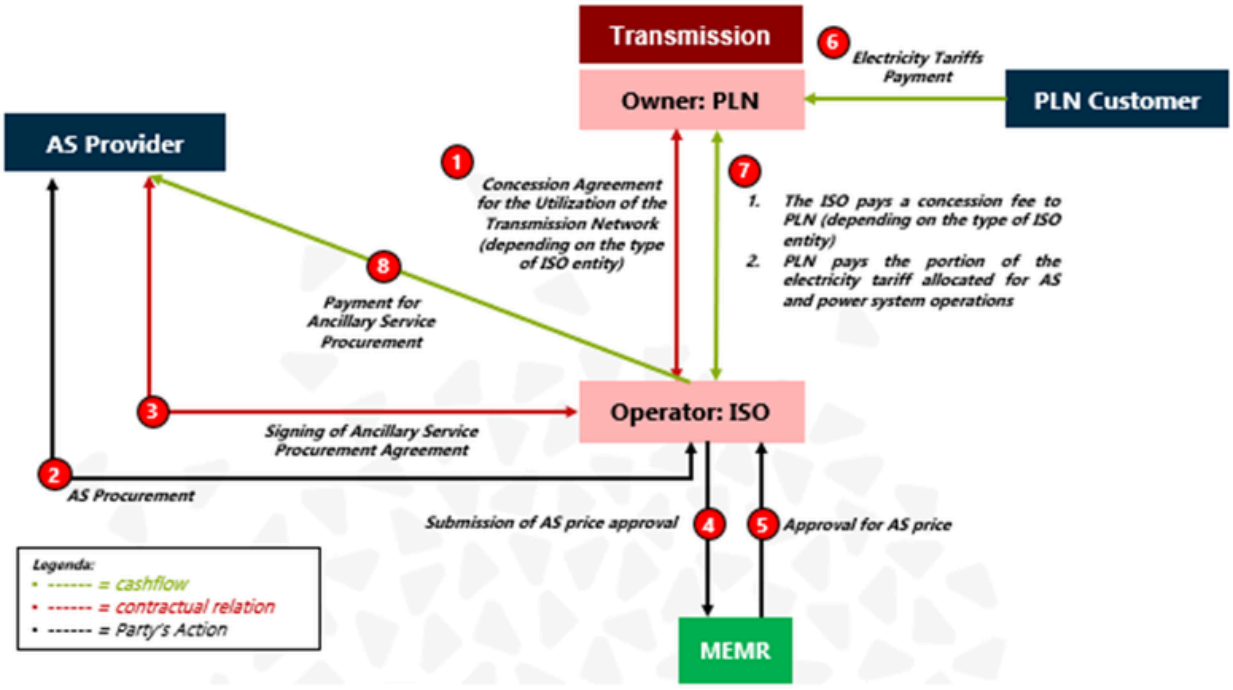


Figure 8 Potential Adaption of AS Procurement Schemes in Indonesia Electricity Market

At present, Indonesia's electricity market structure does not yet allow for the full adoption of the Ancillary Services provision framework established under the legal and institutional models of the Philippines and Singapore. This limitation arises primarily from the fact that both the Philippines and Singapore have implemented market unbundling, separating the entity responsible for system operation (System Operator or SO) from the entity that owns and operates the transmission network. In contrast, PLN currently performs both functions, serving simultaneously as the System Operator and the transmission network owner and operator.

In light of this institutional arrangement, two possible options are proposed for consideration. Option 1 involves adapting certain provisions and mechanisms drawn from the Singaporean and Philippine Ancillary Services frameworks, adjusted to fit Indonesia's current integrated structure. Option 2 represents a potential long-term model that could be implemented once an independent system operator (ISO) is formally established. This study focuses more on Option 1 as the more feasible option at the moment.
Under Option 1, specific legal and regulatory elements from the Philippines and Singapore may be adapted with appropriate modifications. For example, in the Philippines, planning and implementation of Ancillary Services are regulated as part of transmission activities. By analogy, it is proposed that the Integrated IUPTLU holder (PLN) undertake the planning and procurement of AS as part of its transmission function. Meanwhile, Singapore's framework indicates that Ancillary Services providers must be licensed electricity market participants registered with the Energy Market Company (EMC) and must hold an Ancillary Services certification for each facility providing such services. Reflecting this approach, it is proposed that Ancillary Services providers selling services to PLN can be licensed generation IUPTL holders, subject to additional requirements such as registration with the MEMR or obtaining an AS certification.

It is also noted that MEMR Reg 10/2022 does not specifically identify Ancillary Services costs as a distinct component of consumer electricity tariffs. Nevertheless, Ancillary Services costs should be included within the consumer tariff structure, with PLN determining the portion of tariff revenue allocated to AS payments under both Option 1 and Option 2. A financial assessment is therefore required to determine whether the Ancillary Services cost component embedded within consumer tariffs is adequate to cover payments due to AS providers.

In implementing Option 1, PLN would enter into cooperation arrangements for Ancillary Services provision in compliance with the grid code requirements stipulated under Indonesia's Grid Code. Non-compliance with the grid code by network users, including PLN or IPPs, may result in administrative sanctions imposed by MEMR upon recommendation from the KMAJ, as provided in MEMR Regulation 20/2020. In addition, Article 21 of GR 14/2012 requires PLN, as the integrated IUPTLU holder, to ensure the continuous supply of electricity that meets quality and reliability standards. Breaches of this obligation may result in administrative sanctions by MEMR and potential civil liability to consumers under Article 29(1) of Electricity Law for failure to meet service standards under Article 21 of GR 14/2012.

In the event that an Independent System Operator (ISO) is established, the ISO would assume responsibility for dispatch and overall coordination of power transmission, while PLN would retain responsibility for transmission network operation and maintenance (O&M) under ISO's instructions. In such a scenario, further legal assessment would be required to determine whether liability for non-compliance with the grid code or with Article 21 of GR 14/2012, particularly in the form of administrative sanctions or consumer compensation, would rest with the ISO or remain with PLN as the transmission asset owner.

Recommendations for Indonesia

Based on the country case studies the following strategy for ancillary service design in Indonesia is proposed which is taking into account the currently nonexistence of a market structure and providing a launchpad for later market development.

The comparative study and recommendations provided under this Study, particularly Sections 5 and 6, are prepared by Energynautics GmbH. UMBRA assisted GIZ and Energynautics GmbH by describing Indonesian regulatory framework related to AS provision (Section 4.1), providing comparative legal analysis of ancillary services regulation in the Philippines and Singapore (Section 7), as well as developing legal recommendations based on the recommendations provided by Energynautics GmbH and the comparative legal analysis (Sections 8.7).

8.1. Suggested Initial Setup AS for Indonesia (without Market)

Define Clear AS Products via Legislation or Regulation

Begin by legally or regulatorily defining a suite of AS products—frequency reserves (primary, secondary, tertiary), reactive power support, and black start—modeled after frameworks like the Philippines, India, and Australia. These definitions set a foundation for an effective procurement of Ancillary Services.

Implement Bilateral Standard Agreements (Non-market Procurement)

Initially, procure AS through standardized contracts with generators and storage providers. This mirrors the Philippines' use of Ancillary Service Purchase Agreements (ASPAs)—simple, transparent contracts awarding providers based on meeting service criteria. This avoids market complexity while ensuring reliable procurement. These ASPAs can be implemented alongside existing PPAs. Depending on the Indonesian regulatory framework, this can be done by either adding them to existing PPAs and or via separate negotiations or tendering. The following mechanisms are recommended to remunerate IPPs:

- Primary reserves: Capacity price (IDR/MW/h) – or mandatory & cost based (island system)
- Secondary reserves: Capacity price (IDR/MW/h) and activation price (IDR/MWh), cost-recovery e.g. via polluter's principle
- Reactive power: Cost-based, payment based on additional losses in the facility (no profit)
- Black start: Cost based, payment based on additional investment required and cost for additional fuel stocks (no profit)

To ensure compliance and reliability it is crucial to implement payments in a way that:

- Operators don't lose money when providing these services (at minimum, cost recovery).
- Operators can earn extra revenue by qualifying for and offering ancillary services.
- The grid ensures reliability by mandating minimum participation where markets alone wouldn't suffice.

For cases of non-delivery of Ancillary Services ASPAs need to include clauses of hefty fines for cases of non-compliance. This is essential for secure system operation as non-delivery of reserves can cause black-outs.

Set Quantitative Reserve Requirements

Specify AS volumes as fixed percentages of demand or generation capacity thresholds, based on experience of grid operator:

- Primary Reserves: Fixed value MW (EU), 3 – 4% of peak demand (Philippines, Central America), 10 % of peak demand (small island grid)
- Secondary Reserves: Replaces Primary Reserve, so at least double that value, 4% of peak demand or capacity of largest unit (whatever is larger)
- Tertiary Reserves: Similar range or higher, 4% of peak demand or capacity of the second largest unit

Mandate Grid Code Obligations with Penalties for Non-Compliance

Similar to India's voluntary but performance monitored AS offerings, Indonesia can require AS providers to submit availability and response data, with non-compliance resulting in financial penalties or disqualification.

Advance Towards a Reserve Market via long-term contracts

Ancillary Service spot markets like in Europe or Australia are not feasible in the short term in Indonesia. However, for cost-optimized procurement of Ancillary Services market structures are essential. In the Indonesian context this could be achieved via long-term contracting as is already implemented for Black Start Services. This allows reserves to be provided by the cheapest offer, so generators can deliver with least additional cost and ensures the overall most efficient way of operation.

8.2. Suggested AS Design for Indonesia by Phase

The suggested approach is summed within the following table, showcasing the phases and steps taken towards a robust and cost-effective ancillary service design in Indonesia.

Table 15: Ancillary service design approach by phase for Indonesia

Phase	Design Element
Phase 1: Initialization	Define AS products; procure via standardized bilateral contracts (ASPAs style)
Phase 2: Scaling	Establish volume-based reserve targets (e.g. % of demand, largest unit sizing)
Phase 3: Compliance	Add compliance monitoring, incentives, and penalties for availability & performance
With end of phase 3 effective AS framework is established Cost-optimized AS procurement can be achieved by the additional phase 4	
Phase 4: Optimization	Launch co-optimized reserve market (via long-term contracts) for more competitive pricing

8.3. Ancillary Service pricing for Indonesia

In the absence of competitive markets, it is difficult to determine the prices especially for reserves. In this case, prices have to be negotiated with the respective IPPs. A more straightforward alternative is reverse tenders, in which IPPs have to bid competitively for an ASPA.

A benchmark price calculated based on the reserves provided by **PLN's own generation units** can provide a guideline or base price (potentially for ASPA tendering). Key aspects of this approach include:

- Different prices for different technologies
- Cost of providing reserves can be calculated by determining efficiency losses during partial load operation
- Wear and tear cost of fast response needs to be estimated

Further, it can be taken into account that some technologies can **provide reserves better than others,** which can be reflected in the price:

- Option 1: Introduce premiums for **faster response** – faster units get higher remuneration
- Option 2: Introduce premiums for **flexible operation** – units with lower minimum output get higher remuneration

8.4. Monitoring and Compliance

A practical approach to implementing compliance monitoring in Indonesia can begin with pilot projects that apply these key performance indicators such as response time, accuracy of delivery, availability, sustainability of response, system impact metrics, event-based performance and economic efficiency in controlled trials involving generators, battery storage systems, or demand-response resources. Reliable data collection—using SCADA or PMU measurements for frequency and voltage, along with detailed logs of activation signals—will be essential to evaluate actual performance against requirements. Over time, Indonesia can strengthen its framework by benchmarking local results against established international standards such as ENTSO-E or NERC, ensuring alignment with global best practices as the ancillary service framework matures. The specific monitoring levels for the seven KPIs can be chosen as follows:

- **Response Time:** Primary Reserve activation within **<30 seconds**; other reserves activated within **<15 minutes.**
- **Accuracy of Delivery:** Maintain output within **±5%** of the requested MW or MVAr setpoint.
- **Availability: Ensure >95%** availability for critical ancillary services.
- **Sustainability of Response:** Maintain activated output for at least **15 minutes** for reserve products.
- **System Impact Metrics:** Demonstrate measurable improvement in **frequency deviation and voltage profile** following activation.
- **Event-Based Performance:** Achieve a high **percentage of successful activations** during real events or tests.
- **Economic Efficiency: Report cost per MW of service delivered** to support benchmarking and future market design.

8.5. Conclusion

This phased design pathway balances simplicity and reliability, starting with straightforward, contract-based procurement of essential services and gradually transitioning toward a competitive, transparent, and efficient market model when Indonesia's power sector is ready. This proactive transformation positions Ancillary Services as a strategic tool rather than just a cost center, vital for resilient, sustainable and future-ready energy systems.

8.6. Outlook

Taking the phased development of ancillary service in Indonesia as a basis and drawing a broader picture, a 10 year roadmap can be outlined aiming to evolve from status quo to an efficient and cost-effective procurement strategy. This is an indicative attempt to show how such a roadmap could look like:

Phase 1: Foundational Standard Agreements (1st – 2nd year)

- Officially define AS products in regulations or grid codes—e.g., spinning reserve, reactive support, black start.
- Draft and issue standard Ancillary Service Agreements (ASAs) mirroring the Philippines' approach (ASPAs), enabling PLN to contract providers directly on a fixed-rate basis.
- Set baseline service quantities, such as a percentage of peak demand or contingency capacity tied to the largest generating unit.
- Enforce performance metrics and availability reporting, with penalties for non-compliance.
- Assemble supporting regulation under the roadmap framework, facilitated by MEMR, backed by legal tools targeting energy transition regulation and system modernization.

Phase 2: Pilot Trials & Capacity Building (3rd – 4th year)

- Launch small-scale pilot programs in key regions (e.g., Java–Bali) using contracted AS to test dispatch, settlement, and compliance structures.
- Collect operational data to calibrate performance standards and remuneration levels.
- Facilitate capacity-building workshops for PLN, AS providers, and MEMR to operate AS contracts efficiently.

Phase 3: Establish Transitional Reserve Framework (5th – 6th year)

- Introduce centralized scheduling for core AS, similar to the Philippines' parallel market and ASPA system.
- Enable partial co-optimization of AS and energy dispatch via the RUPTL infrastructure (notably, integration of smart grid control systems specified in the 2025–2034 plan).
- Pilot tendering mechanisms for secondary reserves or reactive power through limited pilot auctions, while maintaining standard contracts for others.

Phase 4: Competitive Tendering of Ancillary Services (7th – 8th year)

- Transition to a formal, competitive AS tendering where cleared products are traded via centralized auctions settled alongside energy—modeled after Australian FCAS or China's emerging model.
- Standardize definitions and performance standards, enforce compliance via an independent office (e.g., similar to Philippines' ECO), and introduce dynamic pricing.
- Expand participation to DERs, storage, and IPPs with clearly specified eligibility and remunerable capacities.

Phase 5: Optimization & Regional Expansion (9th – 10th year)

- Integrate Indonesia's AS tendering framework into broader regional platforms, leveraging the ASEAN Power Grid and shared reliability mechanisms.
- Refine trading dynamics through co-optimization of AS and energy dispatch, incorporating variable renewables and system resilience criteria.
- Evaluate expansion of products like inertia support, fast reserves, and voltage control in line with grid modernization

8.7. Suggested Legal Reform for Ancillary Services in Indonesia

In specific, upon benchmarking as set out in Section 6 of this Report, the following details of regulatory adjustment may be considered:

Table 16: Recommendations on Proposed Amendment to Electricity Law and GR 14/2012

No.	Proposed Amendment	Remarks / Legal Notes
Proposed Amendment to Electricity Law and GR 14/2012 **Notes:** *(i) This proposed amendment to Indonesia's Electricity Law is in accordance with DGE's instruction. However, if Indonesia's Electricity Law cannot be amended to regulate AS, the AS provisions may instead be regulated through an amendment to GR 14/2012 and (ii) the legal analysis excludes the implications of an independent AS provisions to existing and future power purchase agreements.*		
1	Add the definition of Ancillary Services	The definition of AS may refer to Article 4 of EPIRA and Article 2(1) of Singapore Electricity Act 2001.
2	Add "electricity generated from Ancillary Services (AS)" in the definition of electric power.	• This aligns with the inclusion of an AS definition in the Law. • GIZ technical consultant proposed that the definition of electric power under Law 30/2009 may include 'electricity generated from Ancillary Services for the purpose of maintaining the electricity system quality and reliability'. The elucidation of the definition may further clarify that the form of electricity generated from Ancillary Services may be voltage, frequency, VAR, and/or other forms.
3	Add provisions authorizing integrated IUPTLU holders to conduct AS planning and procurement as part of transmission activities.	• Reference to Section 8(a) of Republic Act No. 9136 (Philippines) and Section 4.2.3 of Singapore Rules Chapter 5. • Under the Indonesia's current regulatory framework, Integrated IUPTLU holders (e.g.: PLN) are responsible for electricity needs in their respective business areas. Therefore, AS planning and procurement can be included as part of their transmission functions, making them AS Administers. • Although Law 30/2009 differentiates between electricity generation business and electricity supporting electricity businesses, discussions with DJK and GIZ suggest that AS provision is technically more appropriate to be considered as part of the electricity supply business. • This approach aligns with Singapore Rules Chapter 5, which indicate that AS providers are licensed electricity market participants (including generation companies). • Additionally, given that Integrated IUPLTU holders conduct AS planning as part of its transmission activity, such AS planning must also be included into the RUPTL.

No.	Proposed Amendment	Remarks / Legal Notes
4	Add AS costs as a component of consumer electricity tariffs.	• Law 30/2009 currently does not explicitly include AS costs in electricity tariffs. These costs are usually borne by PLN. • Following discussions between technical consultant, it is understood that AS costs should be recognized as part of consumer tariffs, and PLN should allocate a portion of tariff revenue to pay AS providers. Further financial assessment will be needed to determine the portion of AS costs embedded in the consumer electricity tariff that could be used to pay AS Providers and whether such portion is sufficient. • Reference: Section 4 of RA 9136 (Philippines) and Sections 8.2.4 (Ch. 5) and 4.1.1 (Ch. 7) of Singapore Market Rules, which pass AS costs through to consumers via settlement mechanisms. • Amendments to Law 30/2009, GR 14/2012, MEMR Reg 10/2022 are required to expressl include AS component in the electricity tariff paid by consumers. Those amendments are followed by amendment to MoF Reg 20/2025 expressly classify AS costs as a subsidizable component of generation cost (BPP) calculate din electricity subsidy (allowable cost). • Alternatively, if Law 30/2009 is not amended, AS costs may be categorized as "other costs according to the electricity generation needs in the Integrated IUPTLU holder's business area" pursuant to MEMR Reg 10/2022 which requires a determination from MEMR.
5	Add provisions allowing Generation IUPTLU holders to act as AS Providers, by obtaining a statement letter or AS certification from MEMR.	• Law 30/2009 does not currently allow Generation IUPTLU license holders to provide AS. • Reference: DOE Circular 2002-003 (Art. 2.2.2.3), DOE Circular 2021-0031 (Arts. 3.3 & Article 2.3–of Annex A Philippines), and Singapore Market Rules Chapter 5 (Arts. 4.3.1). • Referring to the Philippines and Singapore regulations, Law 30/2009 may be amended to impose additional requirements on Generation IUPTLU holders acting as AS providers in the form of statement letter from MEMR or AS certificat • In the Philippines, Article 3.3 and Article 2.3-2.4 of Annex A of DOE Cir 2021-0031 state that existing and new generators must obtain an AS certificate prior to participating in the competitive selection process. The capability testing is conduc • In Singapore, Articles 4.3.1-4.3.3 of Chapter 5 of Singapore Market Rules require AS to be provided by registered facilities. The registration procedure requires technical testing by PSO to ensure that the performance standard is in accordance with Appendix 5A. Furthermore, Article 8.3.5 states that the provisions in the AS agreement is subject to the requirements of electricity license and authority's approval.Although these requirements are set at ministerial level in other jurisdictions, it is recommended that Indonesia regulates them first at the Law or Government Regulation level due to its implications to the scope of activity that can be conducted by a Generation IUPTLU holder .
6	Add provisions enabling Transmission IUPTLU holders to provide AS, including: (a) amending the definition of "transmission activity" to include AS provision; and (b) requiring Transmission IUPTLU holders to register to MEMR and obtain a statement letter or AS certification for providing AS.	• The definition of transmissiona ctivity underLaw 30/2009 currently does not include AS provision. There are no specific regulations regarding Transmission IUPTLU holders acting as AS providers. • If Transmission IUPTLU holders may act as AS providers, technical justification will be required to confirm that such AS provision by Transmission IUPTLU holders does not fall under "generation" activity and can be categorized as part of transmission activity. Based on discussions with GIZ's technical consultant, it is understood that Transmission IUPTLU holders providing AS can be considered as part of transmission activity and will not be considered as generation activity due to the following arguments: (i) the AS is provided in the form of electricity generated from the transmission assets (e.g.: compensator), not generators; (ii) the electricity generated from those transmission assets are not in the form of energy, which is the electricity produced by generators (e.g.: in the form of VAR); and (iii) in practice, those transmission assets have been producing electricity in the form of AS for the purpose of ensuring the electricity system reliability and quality.
7	Add a requirement for MEMR approval of AS costs paid by PLN to AS Providers.	• Law 30/2009 requires the central government's or regional government's approval on electricity purchase price. There are no express provisions on AS costs paid by PLN to AS Providers. • Reference: DOE Circular 2021-0031 (Annex A, Art. 2.4), which requires AS Providers to obtain ERC's approval prior to providing AS. • Law 30/2009 may be amended to require MEMR's approval of AS costs paid by PLN.

No.	Proposed Amendment	Remarks / Legal Notes
Proposed Amendment to GR 14/2012		
1	Add the definition of Ancillary Services	• If Law 30/2009 cannot be amended, the AS definition may be included in GR 14/2012 amendment since Law 30/2009 does not define AS. • The definition of AS may refer to Article 4 of EPIRA and Article 2(1) of Singapore Electricity Act 2001.
2	Add provisions allowing Generation IUPTLU holders to act as AS Providers, by obtaining a statement letter or AS certification from MEMR.	• Reference to Section 8(a) of Republic Act No. 9136 (Philippines) and Section 4.2.3 of Singapore Rules Chapter 5. • Under the Indonesia's current regulatory framework, Integrated IUPTLU holders (e.g.: PLN) are responsible for electricity needs in their respective business areas. Therefore, AS planning and procurement can be included as part of their transmission functions, making them AS Administers. • If Law 30/2009 cannot be amended, this provision may arguably be regulated under GR 14/2012 amendment because based on discussions with technical consultants of GIZ and DJK, it is understood that AS aims to help stabilize the transmission grid and support electricity distribution on the transmission grid. The GR 14/2012 amendment should also mandate MEMR to further regulate AS in the AS MEMR Reg. • Although Law 30/2009 differentiates between electricity generation business and electricity supporting businesses, discussions with DJK and GIZ suggest that AS provision is technically more appropriate to be considered as part of the electricity supply business. This approach aligns with Singapore Rules Chapter 5, which indicate that AS providers are licensed electricity market participants (including generation companies). • Additionally, given that Integrated IUPTLU holders conduct AS planning as part of its transmission activity, such AS planning must also be included into the RUPTL.

3	Add provisions allowing Generation IUPTLU holders to act as AS Providers, by obtaining a statement letter or AS certification from MEMR.	• GR 14/2012 does not currently allow Generation IUPTLU license holders to provide AS.
		• Reference: DOE Circular 2002-003 (Art. 2.2.2.3), DOE Circular 2021-0031 (Arts. 3.3 & Article 2.3 of Annex A), and Singapore Market Rules Chapter 5 (Arts. 4.3.1).
		• If Law 30/2009 cannot be amended, this provision may arguably be regulated in GR 14/2012 amendment because based on discussions with GIZ's technical consultants, AS provision by Generation IUPTLU holders can be considered as producing electricity. This aligns with the definition of electricity generation under GR 14/2012, namely the activity of producing electricity.
		• Based on discussions with GIZ's technical consultants, it is understood that:
		  ◦ In providing AS, Generation IUPTLU holders technically: (i) produce electrical active power; (ii) produce electrical reactive power; and/or (iii) absorb electricity by reducing the amount of energy generated by its generators for the purpose of AS provisions.
		  ◦ The definition of electricity under GR 14/2012 is broad enough to arguably include electrical active power and electrical reactive power. Therefore, arguments can be made that Generation IUPTLU holders providing AS in the form of electrical active power and electrical reactive power is part of generation activity.
		  ◦ In relation to the reduction of electricity generated for AS provision (point (iii) above), it is understood that it may also technically be considered as generation activity because electricity is still produced although in reduced amount.
		• Therefore, it can be argued that allowing Generation IUPTLU holders to provide AS under GR 14/2012 amendment is sufficient because it can technically still be considered as conducting generation activity. The GR 14/2012 amendment should also mandate MEMR to further regulate AS in the AS MEMR Reg.

No.	Proposed Amendment	Remarks / Legal Notes
Proposed Amendment to GR 14/2012		
4	Add provisions enabling Transmission IUPTLU holders to provide AS, including: (a) amending the definition of transmission activity to include AS provision; and (b) requiring Transmission IUPTLU holders to register to MEMR and obtain a statement letter or AS certification for providing AS.	• The definition of transmission activity under GR 14/2012 currently does not include AS provision. There are no specific regulations regarding Transmission IUPTLU holders acting as AS providers. • If Transmission IUPTLU holders may act as AS providers, technical justification will be required to confirm that such AS provision by Transmission IUPTLU holders does not fall under generation activity and can be categorized as part of transmission activity. Based on discussions with GIZ's technical consultant, it is understood that Transmission IUPTLU holders providing AS can be considered as part of transmission activity and will not be considered as generation activity due to the following arguments: (i) the AS is provided in the form of electricity generated from the transmission assets (e.g.: compensator), not generators; (ii) the electricity generated from those transmission assets are not in the form of energy, which is the electricity produced by generators (e.g.: in the form of VAR); and (iii) in practice, those transmission assets have been producing electricity in the form of AS for the purpose of ensuring the electricity system reliability and quality.
5	Add provisions governing procurement mechanisms for AS through public tender, direct selection, or direct appointment (for specific criteria).	• Article 25 of GR 14/2012 currently only regulates procurement mechanisms for electricity purchase. • Reference: DOE Circular 2002-003 (Art. 3.3.3.2, Philippines) and Singapore Rules Chapter 5 (Art. 8.3.2). • Given that procurement mechanisms for electricity purchase is firstly regulated under GR 14/2012, if a separate procurement mechanism will be conducted for a provision, such procurement mechanisms may also be regulated under GR 14/2012 amendment.
6	Add a requirement for MEMR approval of AS costs paid by PLN to AS Providers.	• GR 14/2012 requires MEMR's or governor's approval on electricity purchase price. There are no express provisions on AS costs paid by PLN to AS Providers. • Reference: DOE Circular 2021-0031 (Annex A, Art. 2.4), which requires AS Providers to obtain ERC's approval prior to providing AS. • GR 14/2012 may be amended to require MEMR's approval of AS costs paid by PLN.

Additionally, set out below are proposed contents to be regulated in the AS MEMR Reg and/or other miinsterial regulations.

Table 17: Recommendations on Proposed Recommendations in Ministerial Regulation Level

No.	Proposed Recommendations	Remarks / Legal Notes
1	Define classification of AS types.	• Reference: DOE Circular 2002-003 (Art. 3.3.1.2) and Singapore Rules Chapter 5 (Art. 8.2.2). • AS MEMR Reg may set out the classifications of AS. A review of MEMR Reg. 20/2020 will also be needed to ensure alignment on AS-related provisions with the AS MEMR Reg. • The AS MEMR Reg may also regulate the types of AS that Generation IUPTLU holders must provide to PLN without profit and the types of AS that PLN will procure separately.
2	Establish detailed procedures for obtaining a statement letter or AS certification.	• Reference: DOE Circular 2002-003 (Art. 2.3.5.2). • To be included in the AS MEMR Reg.
3	Add obligations for AS Providers not to unreasonably refuse AS provision and provide AS in compliance with the Grid Code and AS agreements.	• Reference: DOE Circular 2002-003 (Arts. 3.3.6.1–3.3.6.2). • To be included in the AS MEMR Reg.

No.	Proposed Recommendations	Remarks / Legal Notes
4	Mandate periodic review of AS regulations by MEMR in consultation with PLN and other integrated IUPTLU holders.	• Reference: DOE Circular 2002-003 (Arts. 3.3.7.2–3.3.7.3). • To be included in the AS MEMR Reg.
5	Expand KMAJ's functions to include AS dispute resolution through a designated panel.	• Reference: DOE Circular 2002-003 (Art. 3.3.7.3). • To be regulated in MEMR Reg 20/2020 amendment. Alternatively, disputes between PLN and AS Providers are settled contractually according to the AS agreements.
6	Add detailed procedure for MEMR approval of AS costs paid by PLN.	• Reference: DOE Circular 2021-0031 (Annex A, Art. 2.4). • To be included in the AS MEMR Reg.
7	Add technical testing and certification standards for AS, with inputs from PLN and other Integrated IUPTLU holders.	• Reference: DOE Circular 2002-003 (Art. 3.3.3.6), PGC (Art. 7.10.2.7), and Singapore Rules Chapter 5 (Art. 4.11.1). • To be included in the AS MEMR Reg.
8	Review and amend MEMR Reg 20/2020 to adjust any AS-related minimum performance by considering the provision of AS by AS Providers separately.	• Reference: DOE Circular 2002-003 (Art. 3.3.1.3) and Singapore Rules Chapter 5. • Such review and amendment of MEMR Reg 20/2020 may consider inputs from PLN and other relevant Integrated IUPTLU holders.
9	Add provisions on AS cost components payable by PLN to AS Providers.	• Reference: DOE Circular 2002-003 (Art. 3.3.3.4), DOE Circular 2021-0031 (Annex A Arts. 3.1–3.2), Singapore Rules Chapter 5 (Art. 8.6.1), and Singapore Introduction Financing Framework for Procurement of AS (Part 2).
10	Add additional obligations of PLN as System Operator related to AS provision, for example: (a) PLN must use reasonable endeavors to ensure that sufficient facilities are available and operable to provide for (i) the maintenance/restoration of power system security under emergency conditions; (ii) the restoration of the power system to its satisfactory operating state, following an emergency, threat to system security or force majeure event; and (iii)the availability, at all times, of the number of independent power sources able to provide black start-up facilities. (b) PLN must use reasonable endeavors to enter into ancillary services agreements to provide sufficient ancillary services. (c) PLN must arrange for the provision of adequate reserves for each region. (d) PLN must procure AS in sufficient quantity and appropriate locations so that PLN may meet its obligation to ensure a reliable operating system.	• Based on discussion with GIZ's technical consultant, these obligations can be included in the AS MEMR Reg.

No.	Proposed Recommendations	Remarks / Legal Notes
11	Specify procurement procedures for AS in detail, for example: (a) PLN must submit an AS procurement plan annually to MEMR (as part of RUPTL); (b) Procurement is conducted by a procurement committee formed by PLN; (c) Competitive tender is conducted for 90 calendar days maximum; (d) PLN must announce AS procurement; and/or PLN may appoint an independent consultant to conduct audit on the bid proposals submitted by bidders.	• Reference: DOE Circular 2021-0031 and Singapore Rules Chapter 5. • If a separate procurement will be conducted for AS provision, these detailed procurement procedures may be included in the AS MEMR Reg.
12	Regulate dispatch instructions related to AS.	• This provision may be regulated in the AS MEMR Reg or MEMR Reg 20/2020 amendment.
13	Add provision on: (a) AS agreements are in the form of non-firm contract; (b) Minimum content to be included in AS agreements; and/or The AS components in the consumers electricity tariff are calculated on a revenue neutrality principle (consumers only pay AS for cost recovery).	• Reference: DOE Circular 2021-0031, ERC Case No. 2006-049, and Singapore Rules Chapter 5 (Art. 8.3.1). • To be included in the AS MEMR Reg.
14	Other provisions, for example: (a)If a power plant does not pass AS testing, PLN will not schedule and conduct AS dispatch from such facility, and PLN is entitled to recover payment that has been made to the AS providers. MEMR may also regulate other sanctions. PLN to publish annual information on the total cost and volume of contracted AS as well as the estimated total cost and volume that PLN estimates may receive or may recover (cost recovery) in a certain period in the future.	• Based on discussion with GIZ's technical consultants, these provisions may be stipulated in the AS MEMR Reg. For letter (b), according to the technical consultant, PLN must include long-term AS planning and procurement in RUPTL.

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Annex

Annex I: Reserve Structure in the Nordics

In the following Table the reserve structure in Finland [Reference] including key data for activation and endurance times as well as basic market regulations like minimum bid size and product separation are shown. Adding subproducts to the Primary Reserve (FCR-D and FCR-N) and additionally procuring Fast Frequency Reserves is a measure to stabilize systems with low inertia that have high shares of renewable energy like the Nordics or island systems like Sulawesi. Note, that the actual required time scales can depend critically on the system size, interconnections to other systems and the generation mix.

Table of Frequency control reserves according to European terminology

	Fast Reserve	Primary Reserve/Frequency Containment Reserve		Secondary/Tertiary/Frequency Restoration Reserves	
Type	Fast frequency reserve (FFR)	Disturbance (FCR-D)	Normal (FCR-N)	Automatic Frequency Restoration Reserve (aFRR)	Manual Frequency Restoration Reserve (mFRR)
Activation	Automatic, triggered by frequency drops	Automatic, linear within frequency intervals: Upward: 49.90–49.50 Hz Downward: 50.10–50.50 Hz	Automatic, linear within 49.90–50.10 Hz	Automatic, based on frequency deviation from 50.00 Hz	Manual, upon request by the TSO
Regulation	Upward	Upward & Downward (asymmetric)	Upward & Downward (symmetric)	Upward & Downward (symmetric)	Upward & Downward (symmetric)
Activation Time	0.7s at 49.50 Hz 1.0s at 49.60 Hz 1.0s at 49.60 Hz	86% rated capacity/7.5s	63% rated capacity/1min, 95% rated capacity/3min	100% within 5 minutes	100% within 15 minutes
Endurance	30 seconds (or 5 seconds in some cases)	At least 20 minutes	1 hour	1 hour	1 hour
Repeatability	Ready for reactivation within 15 minutes				
Minimum Bid Size	0.5 MW	0.1 MW	0.1 MW	1 MW	Capacity Market: 1 MW Energy Activation Market: 5 MW

Annex II: India – Bidding into the TRAS Market

BID SUBMISSION

- **Day-Ahead: Electricity is traded one day in advance for delivery in 15-minute time blocks.**
  - Process:
    - Buyers and sellers (like generators) submit bids by 12:00 PM daily.
    - Bids are matched through a double-sided closed auction.
    - The Market Clearing Price (MCP) is determined where the aggregate demand and supply curves intersect
    - Delivery occurs the next day (T+1)

- Real-Time Markets: Balances last-minute demand-supply mismatches.
  - Process:
    - Bidding happens every 30 minutes.
    - Delivery is scheduled 1 hour after market closure.
    - Like DAM, it uses a uniform market clearing price (UMCP) mechanism
- Minimum Bid size
  - Minimum bid: 0.1 MWh
  - Minimum price: Re. 1
  - Volume step: 0.1 MWh
  - Bids can be single or block bids

Annex III: China - Announced Implementation of the National AS Market (April 2025)

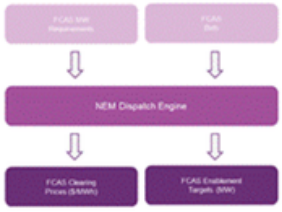
- New entities are allowed: storage, virtual power plants, smart microgrids, V2G aggregators
- Participants must register, comply with dispatch orders and share in service costs
- Dispatch agencies procure and activate services, handle security constraints, operate support systems
- Trading institutions manage registration, disclosure and settlement
- Establishment from regional markets, incorporating and testing new entities
- Full operation: continuous dispatch and real-time settlement
- AS market products:
  - Peak shaving: Responding to load variation and RES output fluctuation
  - Frequency regulation: mainly secondary regulation (Automatic generation control (AGC) or automatic power control (APC))
  - Reserve Service: Capacity held and deployed on dispatch
  - Ramping Service: Fast output changes to counter renewable variability
- Market operation:
- Participants submit bids on dispatch requirements
- Clearing and activation done per market rules
- Emergency dispatch allowed only if market is undersupplied or suspended
- Cost allocation:
- Beneficiaries pay – principle: shared between users and generators depending on spot market status
- Costs for specific services:
  - Peak shaving: by output or startup events
  - Frequency: mileage, performance score and clearing price
  - Reserve/Ramp: by capacity, time and clearing price
- Penalties in case of failure
- Settlement is done monthly while clearing is done daily
- Beneficiaries-pay principle can lead to more sustainable compensation mechanism and expansion of eligible AS providers leads to safer and more reliable grid operation

Annex IV: Australia - Bidding Process for FCAS Market

Bidding in FCAS markets

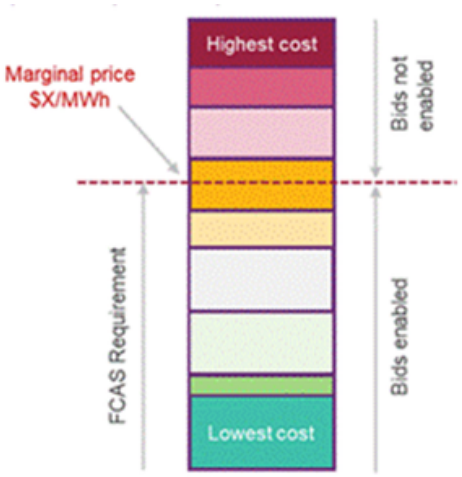
Background

During every trading interval, the National Electricity Market Dispatch Engine (NEMDE) must enable a sufficient amount of each of the 10 FCAS products, from the FCAS bids submitted, to meet the FCAS megawatt requirement.



FCAS bid submitted for a raise service	The amount of megawatts a participant can add to the system, in the given timeframe, to raise the frequency.
FCAS bid submitted for a lower service	The amount of megawatts a participant can take from the system, in the given timeframe, to lower the frequency.

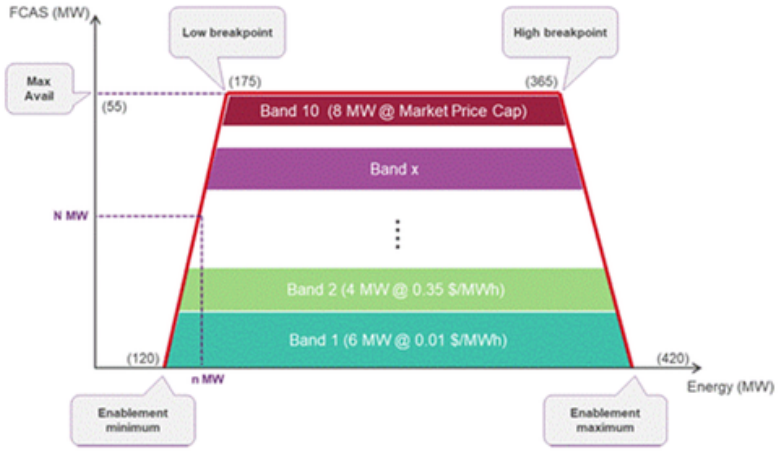
The highest cost offer to be enabled will set the marginal price for the FCAS category.



During periods of high or low demand, it may be necessary for NEMDE to move the energy target of a scheduled or semi-scheduled generating unit, wholesale demand response unit[1], or scheduled load to minimize the total cost of energy plus FCAS to the market. This process is known as co-optimization and is an intrinsic part of the dispatch algorithm.

Bidding

Bids for FCAS take the form of the generic FCAS trapezium defined by enablement limits and breakpoints. The trapezium indicates the maximum amount of FCAS that can be provided (y-axis) for a given MW in either power generation, consumption, or load reduction in the energy market (x-axis).



FCAS bids must comply with bidding rules, similar to those that apply to the energy market:

- Bids can consist of up to 10 bands with non-zero MW availabilities[3].
- Each band price must be greater than any preceding band price.
- Band prices must be set by 12:30 on the day prior to the trading day for which the bid applies.
- Band availabilities, enablement limits and breakpoints can be rebid under rules similar to those applying to the energy market.

Ancillary service plant dispatched between an enablement limit and a corresponding breakpoint can be moved in the energy market to obtain more FCAS. For example, if a generator was dispatched between the upper enablement limit and the upper breakpoint, NEMDE may "constrain" the unit in the energy market to obtain more FCAS, provided this led to the lowest overall cost. This is another way of describing "co-optimisation"

Settlements in FCAS markets

Payments
NEMDE determines a clearing price for each of the FCAS markets in each region for each trading interval. This price is then used by AEMO Settlements to determine payments to each of the FCAS providers
Payment = MWE x CP/12
where
MWE is the amount of megawatts enabled by NEMDE for the service being settled

CP is the regional clearing price for the service in that trading interval.
[1] Only for a wholesale demand response unit that has a single dispatch unit identifier (DUID) allocated for wholesale demand response and FCAS. There is no energy and FCAS co-optimisation by NEMDE if it involves two DUIDs (that is, one DUID for energy (wholesale demand response) and one DUID for FCAS).
[2] Power generation for scheduled and semi-scheduled generating units, power consumption for scheduled loads, and load reduction for wholesale demand response units. For bidirectional units it may be power generation or power consumption.
[3] Regulation FCAS bids for scheduled BDU units may consist of one bid from the generation side (all enablement limits and breakpoints are non-negative) or one bid for the load side (all enablement limits and breakpoints are non-positive) or bids for both generation and load sides which are optimised individually within NEMDE

Annex V: Philippines – Competitive Selection Process (CSP)

This Annex gives a more detailed description of the Competitive Selection Process (CSP) conducted in the Philippines with the goal of signing bilateral firm contracts (ASPAs) for AS provision between the System Operator and AS provider. This can serve as a reference for the implementation of similar tendering processes in Indonesia.

Before the bidding and selection process preparatory steps for a transparent, fair and indiscriminatory selection have to be undertaken. This includes the yearly publishing of the ten-year Ancillary Service Agreement Procurement Plan (ASAPP) by the SO (details of contents of ASAPPs below). An independent committee, the Third-Party Bids and Awards Committee (TPBAC), is established by the SO which is responsible for conducting the CSP. Further independent observers are invited to oversee the bidding and bid selection process.

The TPBAC is responsible for preparing the bid documents necessary for insuring a smooth and efficient bidding and contracting process. These include:

- Terms of Reference (TOR)
- Bid invitation (e.g. which AS is needed, time of service, etc.)
- Corporate profiles of bidders
- Technical and financial requirements
- Methods and criteria for selection
- Bidding procedure
- Awarding, signing of contract and notice of implementation
- Formal requirements for bids
- Proposed timelines and milestones
- ASPA template
- Notarized statement attesting to information submitted to bid
- Protest mechanism
- Legal documents required and mandated by government agencies

In particular, the bid documents contain detailed hourly profiles of regulating, contingency and dispatchable reserve requirements while the offer placed by the potential AS provider will contain the hourly reserve profile already taking into account scheduled outage hours. [51]

The Terms of Reference and instruction to bidders have to be approved by the Department of Energy (DOE) as additional regulating entity. The CSP is to be published on the TPBAC or DOE website with regular updates as well as in a widely circulated newspaper for two weeks.

The CSP starts with a pre-bid conference within 14 days after its publication to discuss legal, technical, and financial components of the ASPA, TOR and related topics. As a consequence, clarifications and amendments to the TOR and bidding documents are to be published on the website of SO and DOE until 14 days before the bidding process.

The selection of the lowest calculated bid meeting the AS requirements is done publicly in presence of the bidding parties. Within five days after the bid selection the TPBAC recommends to the SO to award the contract to the selected AS provider by resolution. Within 15 days the ASPA is filed with Energy Regulatory Commission (ERC) together by SO and winning party. The total CSP should not exceed 90 days from the bid invitation to signing of the ASPA. A delay is subject to penalties by the ERC. The costs are carried by the SO. Protests regarding the CSP may be filed with the TPBAC, the SO and the DOE in different levels of escalation. In case of two rounds of failed CSPs, i.e. at most one valid proposal are received per AS type, i.e. Regulating Reserve (RR), Contingency Reserve (CR), Dispatchable Reserve (DR), direct negotiations between SO and AS providers can be entered into.

For reasons of monitoring compliance of the AS provider with the offered AS levels supervised by the DOE, the key provisions of the ASPA are shared with the DOE.

Bid security to be provided by AS provider

Eligible bidders post Bid security of 2 % of total computed capacity payment cost for one year for offered AS capacity per AS type, for varying offers the maximum offered capacity and the total number of hours will be taken into account.

The bid security needs to be posted in form of security bond or irrevocable standby letter of credit from the SO's list of approved providers.It is forfeited in favor of the SO if i) the eligible bidder withdraws the bid after the bid opening, ii) the bidder fails to complete the Post-Qualification Requirements or iii) refuses to execute the ASPA after notice of award. Thebid security is valid for 120 days from starting date of bid submission.

Example values of bid securities for different types of AS:

- For RR, CR and DR: 2% of the scheduled capacity rates listed in Annex VII.
- Example for black start services (BSS): BSS capacity as certified (kW) x 12 (h) x BSS rate (PHP/kWh) x 2%. The assumption is the BSS will be utilized once a year for 12 hours.
- Example for Reactive Power Support: The maximum RPS kVAR as certified (kVAR) x 5 (h) x 5months x 4.00 PhP/kVAR/h) x 2%. The assumption is the RPS will be utilized for 5 hours a day for 5 months (dry season) per year.

Details of Ancillary Service Agreement Procurement Plan (ASAPP)

An Ancillary Service Agreement Procurement Plan (ASAPP) provides the projected requirements of AS for ten years after its publication. It is to be published yearly and must contain the following information:

- Type of AS to be procured per grid (Luzon, Mindanao, Visayas)
- Timing of AS requirement per grid (month and year)
- Existing ASPAs (location and expiration)
- Monthly levels of AS per grid to account for seasonality
- Typical hourly levels for last five years of AS requirement per AS and grid

Annex VI: Philippines – Detailed Pricing Mechanism for Firm Contracts (ASPAs)

Payment by SO is done based on scheduled capacity and corresponding dispatched energy for compliant hours. Capacity and energy costs for non-compliant hours are not paid and are subject to penalties [24].

Capacity payment for scheduled capacity A (Rate in PhP/kW per hour, maximum. lower rates may be proposed by the applicant in CSP):

- Regulating Reserve: PhP 2.25/kW per scheduled hour
- Contingency Reserve: PhP1.50/kW per scheduled hour
- Dispatchable reserve: PhP 0.85/kW per scheduled hour
- Reactive Power Support: PhP 4.00/kVAR per hour, per occurrence
- Black Start Service: Incidental Energy Payment only, per occurrence

Incidental energy payment for dispatched portion of scheduled capacity B (for RR and CR does not include energy dispatch from unit's technical Pmin, Real-time dispatch in WESM or its bilateral contract quantity, shut-down and startup outside of scheduled hour also disregarded):

Incidental Energy Payment B = [G x (Capacity Payment Rate + Variable Costs)] – (WESM Revenue – WESM Payment)

G – for conventional plants, summation of actual energy generated or dispatched from the scheduled capacity, in kWh; for BESS, sum of the absolute value of the actual energy dispatched and absolute value of the actual energy absorbed, in kWh

Variable Costs, in PhP/kWh = Fuel Cost and Variable O&M Cost, in PhP/kWh

Fuel Cost, in PhP/kWh = lower of (i) actual fuel cost; and (ii) Fuel Cost Cap

Fuel Cost Cap = Initial Fuel Cost Cap x (Fuel index which is computed as Prevailing Fuel Price ÷ Base Fuel Price)

Initial Fuel Cost Cap = fuel cost in PhP/kWh as declared during the bid submission, to be adopted in the ASPA and used as basis for AS Cost Simulation.

Prevailing Fuel Price = prevailing price of relevant fuel index based on published data
Base Fuel Price = price of relevant fuel index based on published data at the start of the ASPA implementation

Variable O&M Cost, in PhP/kWh = VOM rate x (Current CPI ÷ Base CPI); VOM rate shall be adopted in the ASPA and shall be constant throughout the duration of the ASPA

WESM Revenue = summation of WESM revenue based on market clearing price at the generator's trading node, arising from G

WESM Payment = summation of WESM purchases based on market clearing price at the generator's trading node, for generator's feedback power if applicable.

Total AS cost (cost of actual provided AS):

- Hourly AS Cost = [(Undispatched Capacity x A) +B] – Penalty + any billing adjustments
- Penalty = 50% x (A x Scheduled Capacity) – for non-compliance with technical criteria or not following dispatch instructions of SO
- Billing adjustments = applicable adjustments as a result of monthly billing reconciliation

Annex VII: Philippines – Compliance and Monitoring

Case of Firm Contracts (ASPAs)

Performance bond for winning bidders

30 % of total computed capacity payment cost for one year for offered AS capacity per AS type, i.e. Regulating Reserve (RR), Contingency Reserve (CR), Dispatchable Reserve (DR), for varying offers the maximum offered capacity and the total number of hours will be taken into account. The bid security is updated annually 30 days prior to the anniversary date of the firm contract.

The performance bond needs to be posted in form of a security bond or irrevocable standby letter of credit from the SO's list of approved providers. It is subject to withdrawal in favor of the SO if the contract ends by fault of the AS provider. I has to be posted until end of the ASPA.

In the following example calculations are given for the different types of AS:

- For RR, CR and DR: 30% of the scheduled capacity rates listed in Annex VI.
- For BSS: BSS capacity as certified (kW) x 12hrs x BSS rate (PHP/kWh) x 30%. The assumption is the BSS will be utilized once a year for 12 hours
- For RPS: RPS kVAR as certified (kVAR) x 5hrs x 5months x 4.00/kVAR per hr x 30%. The assumption is the RPS will be utilized for 5 hours a day for 5 months (dry season).

Technical and compliance reasons for termination of ASPA

1. Annual Performance evaluation indicates less than 90% compliance, even after conducting Monthly Performance evaluation with recommendations to improve performance
2. Unavailability of firm contracted capacity following a force majeure event for 15 days or less is not subject to obligation of providing replacement AS capacity nor penalties but AS provider will not be paid. Starting from day 16, replacement AS capacity have to be provided. After 90 days of unavailability, the contract will be terminated.
3. Outage of AS providing facility up to 30 days shall be replaced by replacement AS capacity by AS provider (replacement can be procured from providers own units or Reserve Market), contract will be terminated if replacement is not provided or for outages of more than 30 days
4. Power plant fails regular AS certification test (every two years) and cannot resolve technical problem for recertification within 30 days
5. Persistent occurrences of power plant tripping /non-compliance during scheduled AS time reflected in monthly and annual performance evaluation
6. Termination of Connection Agreement and Service Agreement of power plant with SO

Case if Market is operational

Glossary:

- Reserve amount adjustments – amount to be debited/credited to/from AS provider as adjustment of trading amount as result of monitoring and assessment of compliance with reserve conformance standards
- Breach – non-compliance with Reserve Conformance Standards or Reserve Offer Capacity Compliance
- Frequency-driven event (FDE) – situation that activates or triggers the need immediate response from AS providers to maintain grid stability due to power system frequency variation

Role of different entities participating in AS provision

Reserve conformance standards are defined in market manual and reviewed regularly jointly by market operator (MO), system operator (SO) and the enforcement and compliance office (ECO)

Responsibilities of system operator (SO):

- A Report about the compliance of the AS providers with the reserve schedules and dispatch instructions is regularly filed by the SO and submitted to the Department of Energy (DOE).
- The SO sends the following data to the market operator to detect a probable breach:

Data	Timeline of provision
Generator mode of operation (e.g., automatic generation control, governor control mode, manual dispatch instruction)	Real-time
Dead band settings	Real-time
Speed droop	Real-time
Generator status	Real-time
Dispatch instructions	By 12:00 of the next day for all instructions of the current trading day
Outages	By 12:00 of the next day for all instructions of the current trading day
Power system frequency	Real-time
Control dead band	Real-time

- SO informs MO and ECO about technical reason for disqualification or failed (re-)certification test passed every two years
- Reports about compliance of the SO to ensure adequate AS provision for each trading interval are filed by the SO and must be submitted to the DOE.

Responsibilities of market operator (MO):

- The MO is responsible for automatic flagging of possible breaches of the reserve conformance standards by Ancillary service providers and submission of the data to ECO.
- MO informs ECO and SO quarterly about status of suspension and reapplication of AS provider
- MO is responsible for procedures for monitoring and flagging of breaches.

Responsibilities of Enforcement and Compliance Office:

- The ECO monitors, evaluates, assesses and enforces compliance. Monthly reports have to be sent to the DOE and Energy regulatory commission (ERC), which authorizes the billing and collection of penalties from the AS providers.
- Obligations of AS providers/generating facilities:
- AS providers must submit capacity to market in every dispatch interval (reserve offer capacity compliance, more details below)
- AS must comply with the Reserve Conformance Standards described below, defining the required accuracy and timeliness of generator response
- AS providers are obliged to send generator mode of operations and dead band settings to SO for monitoring compliance
- AS provider must notify ECO in week-ahead horizon in case it cannot provide AS providing supporting documents or records

Measuring reserve response compliance of generators on governor control mode (GCM)
Required response accuracy and average response time shown in Table 5.
Response accuracy via GCM is calculated as follows:
Response Accuracy =(Actual MW Response Capacity)/(Expected MW Response Capacity)×100%

Where
Actual MW Response Capacity = Highest Actual MW Output – MW Output prior to FDE
Expected MW Response Capacity = Static gain×Δf
Δf = Worst Frequency "Highest\/Lowest" – Frequency prior to FDE
Frequency prior to FDE = f_nom+Dead band Setting
Δf : Frequency Change
f_nom : Nominal Frequency
Static gain =(Scheduled MW Capacity)/(Droop Setting ×f_nom)×100%

Measuring reserve response compliance of generators on automatic generation control (AGC)

Response accuracy: reserve facility must comply to at least 75 % of the dispatch instructions by the SO's AGC instructions for entire monitoring period

Compliance achieved if

- Actual MW Generation >= (Desired MW Generation – Control Dead band) and
- Actual MW Generation <= (Desired MW Generation + Control Dead band)
- Response time calculated from AGC command until actual generation reaches control dead band

Monitoring of compliance

- Breaches or non-compliance with reserve capacity offer compliance or reserve conformance standards are flagged or submitted to ECO by MO or responsible monitoring facility
- Validation performed by enforcement and compliance office (ECO)
- Monthly consolidated report on compliance of each AS provider to be sent to ERC and DOE by ECO

Reserve capacity offer non-compliance

- ECO sends (non-final) non-compliance notice to AS provider on a weekly basis or an appropriate time frame regarding the frequency of issuing the relevant data
- AS provider must reply and provide documents to explain the situation within five business days
- Issue of non-compliance, reply by AS provider and consultation with MO, SO and metering service provider must be resolved until 15 business days in the calendar month following the probable breach dispatch interval
- Monthly compliance monitoring and assessment report issued by ECO to every AS provider within five business days after validation assessment with non-compliance notice containing the final finding whether the AS provider was compliant with the market rules and the computed penalty.

Breach of reserve conformance standards

- MO consolidates the finding of breaches until end of month of billing period, confirmation of results until five business days after billing period with SO and ECO
- If performance of AS providing facility affects both Ancillary Services Procurement Agreement (ASPA) and reserve market rules, MO and SO together determine degree of non-compliance and necessary reserve amount adjustments as well as penalty
- Notice of probable breach is sent by MO to ECO containing the specific intervals, resource unit(s), the type of reserve for which the breach occurred and the amount that is not paid to the AS provider as consequence of the breach
- AS provider can object by filing a Request for Reassessment with Notice of Claim with ECO until ten days after receiving the preliminary settlement statement from MO containing, among other things, the reasons and data for the reassessment and the potential breach
- Reevaluation of data and determination and final settlement following the request must be finished by ECO until end of billing month following the potential breach
- Until end of month following the monitoring period, ECO files a compliance monitoring and assessment report to AS provider, SO and MO and notice of specified penalty to the AS provider, MO and SO with respect to each reserve facility containing
    - The final finding whether a breach has occurred
    - The amount of payment that is to be adjusted in the respective billing period

Financial penalties to be imposed for breaches

Breach of reserve offer capacity compliance:

- Level 1: 1000 PhP for each count of breach
- Level 2: 2000 PhP for each count of breach

Breach of reserve conformance standards:

Level 1: Penalty amount P_(p,r,a):

$P_(p,r,a) = 0.5 \times 1/n \times (SC_(p,i) \times AR_(c,r,a))$

n: number of dispatch intervals per within settlement intervals (n =12 for five-minute market)

SC_(p,i): scheduled capacity (to be translated from MW to kWh) of AS provider p for dispatch interval i

AR_(c,r,a): applicable rate for type of contract c for reserve category r in reserve region a

Table: Applicable rate for financial penalties

Applicable Rate:

Reserve Category	Applicable Rate
Regulating Reserve	PHP 3.00/kWh
Contingency Reserve	PHP 2.25/kWh
Dispatchable Reserve	PHP 1.25/kWh

Level 2: two times the amount calculated for Level

Annex VIIII: Summary Table of Country Cases

Data	Indonesia	Philippines	India	China	Singapore	Australia	South Africa
Basic description	Country with Single buyer for electricity with no separate AS procurement/payment Regulated ancillary services procurement, mainly through PLN under government rules; no real-time market yet.	Country with energy market and regulated AS procurement, coexistence of bilateral agreement-based procurement and single-buyer market	Country with regulated AS procurement/payment moving towards (real-time) market	Country with differentiation into basic and paid Ancillary services with different rules and procurement strategies per region	Country with real-time energy and AS frequency market and tendered non-frequency AS	Country with real-time energy and AS market	Country with Single buyer for electricity with separate AS procurement/payment
Regulatory framework	Law No. 30/2009 on Electricity, Government Regulation No. 14/2012, MEMR regulations No. 20/2020 on Grid Code.	Philippine Grid Code, additional Department of Energy Circulars and market rules	National Electricity Policy (2005), Tariff Policy (2016), and CERC Ancillary Services Regulations, 2022.	Regular Publication of Regulations by the National Energy Administration	Electricity Act 2001	National Electricity Law (NEL) and National Electricity Rules (NER) AEMO guidelines and Market Ancillary Services Specification	Electricity Regulation Act (ERA) Amendment Bill
Highest body that sets the law/regulation	National Parliament (DPR) and President; MEMR issues implementing regulations.	Department of Energy	Ministry of Power, Government of India.	Communist Party Decisions implemented by National Energy Administration	Ministry of Trade and Industry	Council of Australian Governments (COAG) Energy Council	National Parliament, Department of Mineral Resources and Energy (DMRE)
Who regulates (ministry, a body under ministry, a separate body, etc.)	Ministry of Energy and Mineral Resources (MEMR), Directorate General of Electricity.	Energy Regulatory Commission (ERC)	Central Electricity Regulatory Commission (CERC) sets regulations	National Energy Administration and regional electricity regulatory commissions	Energy Market Authority (EMA), a statutory board under the Ministry of Trade and Industry	Australian Energy Market Commission (AEMC) sets rules; Australian Energy Regulator (AER) enforces compliance; Australian Energy Market Operator (AEMO) operates the market.	National Energy Regulator of South Africa (NERSA)

Data	Indonesia	Philippines	India	China	Singapore	Australia	South Africa
Who enforces the regulation	Grid Code enforcement, and compliance monitoring by Grid Code Management Committee (Komite Manejemen Aturan Jaringan (KMAJ) PLN (state-owned utility) implements and enforces technical compliance.	Enforcement and compliance office (ECO)	Grid Controller of India Ltd. (Grid-India) and National Load Dispatch Centre (NLDC) implement them	Regional regulatory commissions	EMA enforces licensing and technical compliance. Market Surveillance and Compliance Panel (MSCP) within Energy Market Company (EMC) enforces Market Rules compliance and operates the market.	AER monitors and enforces compliance; AEMO ensures operational compliance and performance.	NERSA and System and Market Operator (TSMO)
Defined ancillary services	-Frequency control -Reactive power and voltage control Black start	Frequency control: regulating, contingency, and dispatchable reserves Voltage control System restoration	- Primary Reserve Ancillary Service (PRAS) - Secondary Reserve Ancillary Service (SRAS) - Tertiary Reserve Ancillary Service (TRAS) - Reactive power support - Black start capability	Basic: Frequency Response, Peak shifting/load following, Reactive power control Paid: Automatic Generation Control, Operating Reserve, Peak shifting/load following, Reactive power control, black-start capability	-Frequency control: regulation, primary reserve, contingency reserve -Reactive power/ voltage control -Black start -Fast start -Reliable must-run services	FCAS(10 markets): fast/slow raise/lower, regulating raise/lower, delayed raise/lower, very fast raise/lower NSCAS SRAS	Reserves (Operating, Emergency and Supplemental Reserve) System Restoration Services Reactive Power supply Constrained Generation
Documents where ancillary services are defined and governed	MEMR Reg No. 20/2020 on Grid code	Department of Energy Circulars No. 2019-12-0018, 2021-03-009,2021-10-0031, 2023-09-0026, 2025-08-0010	- CERC Ancillary Services Regulations, 2022 - Indian Electricity Grid Code (IEGC), 2023 - Tariff Policy (2016) - National Electricity Policy (2005)	The 'two rules' implemented in the Regulation: Measures for the Management of Power Auxiliary Services	Electricity Act 2001, Singapore Electricity Market Rules (Chapter 5 System Operation; Appendix 5A, Performance Standards for Ancillary Services)	National Electricity Rules (NER) AEMO's Market Ancillary Services Specification (MASS) AEMO's Guide to Ancillary Services in the NEM	South African Grid Code – System Operation Code

Data	Indonesia	Philippines	India	China	Singapore	Australia	South Africa
Procurement and contracting	No separated procurement for AS yet	Yearly publishing of AS requirements, 50 % of requirements are covered by ASPAs, the remaining capacities through the reserve market	- SRAS: Administered via AGC signals - TRAS: Market-based procurement	Basic Ancillary Services are mandatory and not paid for. Interruptible loads, voltage regulation and black start procured via bilateral negotiation or centralized bidding Regional pilot day-ahead markets for frequency response, peak shifting, and reserves	FCAS: procured via half-hourly market bidding Other types of AS: contracted via tenders or bilateral agreements	FCAS: procured via spot market bidding NSCAS & SRAS: contracted via tenders or bilateral agreements	Operating Reserve: procured via an hourly market. Emergency Reserve: procured via annual contracts. System Restoration Services: procured by SO via long-term contracts Reactive power control: mandatory.
Power plant requirements (e.g. minimum size, technology type)	Grid-connected, comply with PLN Grid Code; typically >10 MW for major services.	Mandatory testing and submission of AS offers by power plants larger than 5 MW (Visayas, MIndanao) or 10 MW (Luzon) Response times on GCM max. 5s, on AGC max. 25s	- Must be technically capable of providing reserves - Includes thermal, hydro, renewable, and storage units - Must comply with AGC and grid code standards	Depend on the specific implementation in each Chinese region	Must be a registered Market Participant (can be load or generation). Be able to meet performance standards for each of the ancillary service	Must meet MASS technical standards No strict minimum size; includes batteries, aggregators, hybrid systems Must be registered as a Market Participant	Minimum generator size 50 MW Instantaneous Reserve: Fully dispatchable within 10 s Regulating Reserve: Fully dispatchable within 10 min, must remain active for 1h Ten minute reserve: Responds within 10 min, must remain active for 2h
Procurement type	No separated procurement for AS yet	Public tendering with resulting bilateral agreements, intraday market	SRAS TRAS via Day-Ahead and Real-Time Markets	Mandatory provision, long-term contracting or market bidding depending on service	Market-based for FCAS Contract-based for other types of AS	Market-based for FCAS Contract-based for NSCAS and SRAS	Hourly markets, annual contracts and long-term agreements

Data	Indonesia	Philippines	India	China	Singapore	Australia	South Africa
If contracts, typical duration of contracts	No separated contract for AS yet	ASPA typically have runtimes of five years	- SRAS: Real-time dispatch - TRAS: Typically short-term (daily/hourly)	-	For contract-based AS, the contract duration depends on whether new equipment needs to be built or refurbished for the purpose of providing AS. If yes, the AS contract duration is typically the lifetime of the equipment to recover the investment (e.g. 25 years). Otherwise, the AS contract is awarded on annual basis.	- FCAS: real-time spot market (5-minute intervals) - NSCAS/SRAS: typically 1–3 years depending on service need	Depends on type of service
Payment components	Included in total energy cost	Capacity reservation and activation payment for reserves Reactive power payment per occurrence and kVAR Energy payment per occurrence for black start	Incentives for fast response and reliability	Fixed prices based on production cost, capital expenditures and operational expenditures depending on the service	FCAS: Market Clearing Price ($/MWh) determined by the marginal bid. For the contracted AS, the payment to AS provider consists of annual CAPEX and OPEX payment, with allowed 10% rate of return for CAPEX and 10% margin for OPEX. Some variable OPEX can be reimbursed without profit.	Frequency Performance Payments (FPP) for incentivizing good frequency control	Capacity and activation price for reserves

Data	Indonesia	Philippines	India	China	Singapore	Australia	South Africa
Range of prices for the different ancillary services (nominal and as % of total system costs if available)	Specific ancillary service pricing not publicly available yet	Regulating reserve: 4.50–6.00 US cents/kW/h Contingency reserve: 3.00–4.50 US cents/kW/h Dispatchable reserve: 1.7–2.50 US cents/kW/h Voltage control: 8.00 US cents/kvarh System restoration: 3.90 US cents/kWh[1] [1] (Barroco, 2021)	TRAS: ~₹5/kVArh, escalating annually by ₹0.5/kVArh Ancillary services cost estimated at ~5–10% of total system operation costs	Depends on the Chinese region	Average for 2024: Primary reserve: 2.86 SGD/MWh (highest monthly average 6.87 SGD/MWh, lowest 0.29 SGD/MWh) Contingency reserve: 19.70 SGD/MWh (highest monthly average 42.05 SGD/MWh, lowest 4.71 SGD/MWh) Regulation: 25.72 SGD/MWh (highest monthly average 41.96 SGD/MWh, lowest 11.65 SGD/MWh) Total for 2024: Reserves: 85,040,000 SGD Regulation: 31,890,000 SGD Black start: 12,057,536.64 SGD for 103 MW (0.117 SGD/W/y) Fast start: 87,643,451.28 SGD for 782 MW (0.112 SGD/W/y).	FCAS prices highly volatile; can spike to market cap ($15,500/MWh) during contingencies; annual FCAS costs typically $150–$250 million nationally	Standard offer pilot prices: Instantaneous Reserve: 957 ZAR/MW Regulating Reserve: 638 ZAR/MW

Data	Indonesia	Philippines	India	China	Singapore	Australia	South Africa
Incentives and penalties	Tax incentives for grid-support technologies; penalties for non-compliance with grid code or failure to deliver contracted services enforced by PLN and MEMR	Penalties are based on number of breaches of conformance rules, the scheduled capacity and the payment rates per reserve type. Suspension and deregistration for repeated non-compliance.	- Incentives for reliable and fast response - Penalties for non-performance or deviation from AGC signals	Some services like Automatic control and peak shifting base their remuneration on quality and accuracy of the provided service	Financial penalty for deviating from dispatch (both load facilities and generation facilities that are registered as Market Participant)	Incentives: FPP rewards for good frequency control The recovery of Payments is based on the FPP process which is a double-sided system of incentive payments and penalties based on units	Remuneration of capacity reservation and activation service
Value of AS(especially as % of total energy costs)	Has not been identified yet AS value is bundled in total energy cost	3.98% of energy bill (June 2025)		Depends on the region	1.21% of total energy and AS cost: reserves 0.8%, regulation 0.3%, black start 0.11% (2024)	FCAS costs typically <2% of total system costs, but can spike during system stress	0.4 ZARct/kWh compared to a standard active energy charge of 130-180ZARct/kWh (Megaflex tariff)
Cost/payment recovery	Costs recovered through PLN tariffs and regulated remuneration mechanisms; components include capital, operational, opportunity, and utilization costs	Passed to electricity customers	Costs recovered via regulated tariffs	Traditionally distributed among generation units. For some services the costs are shared by 50 % each by electricity consumers and generators.	The cost of Reserves is recovered from generators based on the risk they contribute to the system. Cost of Regulation is recovered from retailers in proportion to their energy purchases and by dispatched generators up to a ceiling of 5 MWh for each trading period. For the contracted AS, the AS costs are recovered through monthly energy uplift charge, charged by EMC to the market participants	FCAS via FPP allocation mechanisms NSCAS/SRAS: recovered via regulated cost allocation among market participants	Recovered from grid-connected generators and loads



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