CHUBU Electric Power

NIPPON KOEI

Capacity Market in Japan

September, 2020

JICA Expert Team

Outline of Capacity Market

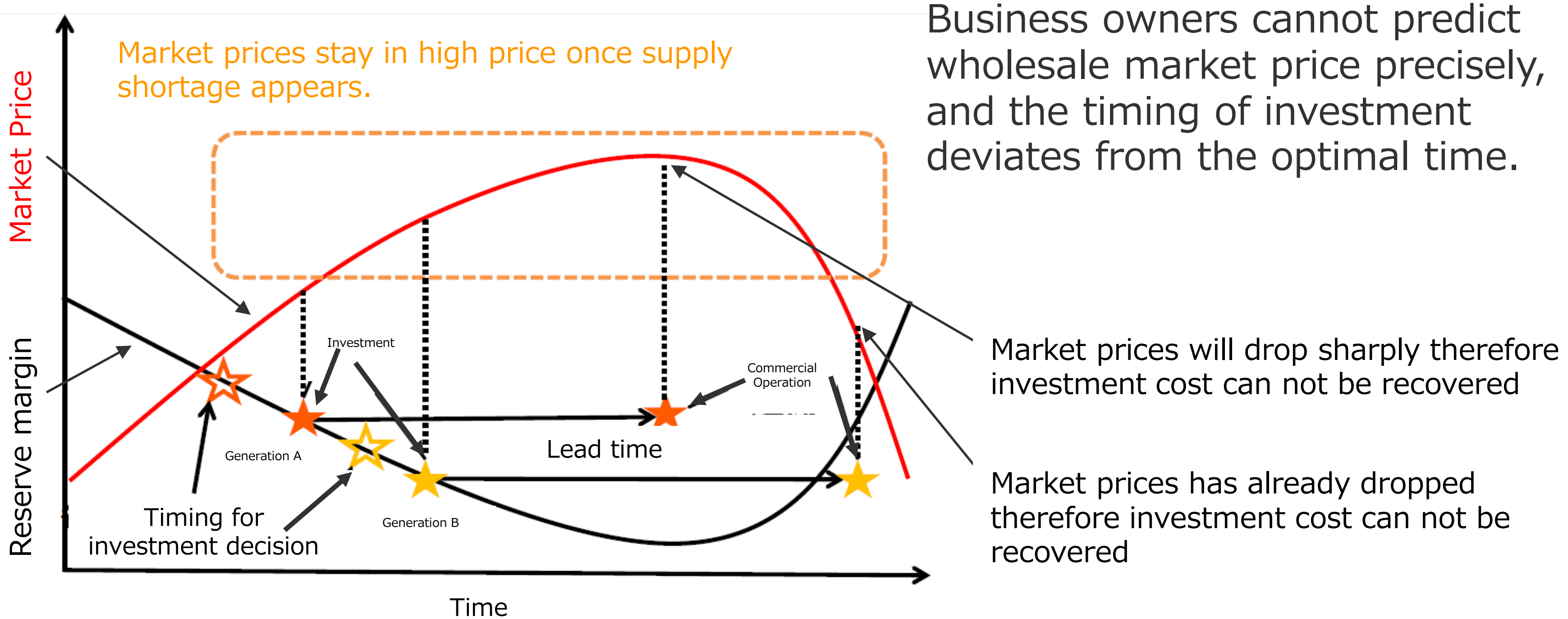
- "Capacity Market (CM)" is a market where future supply capacity (kW) is traded, not electricity now (kWh)
- A mechanism to monetize the supply capacity of power plants, etc., and efficiently secure the overall supply capacity for the future.

Market	Roles	Main Trading Entities
CM	Transaction of supply capacity (kW value) required for the whole country	OCCTO※
Wholesale Market	Trading electricity (kWh value) to supply to customers	Electricity retailers
Balancing Market	➢ Filling the gap between the supply and the demand after the gate close ➢ Response to fluctuations in supply and demand for the short term within 30 minutes ➢ Trading of adjustment power (ΔkW value + kWh value) for maintaining frequency	General transmission and distribution business owners

※Source: OCCTO (Organization for Cross-regional Coordination of Transmission Operators)

Background of CM Introduction

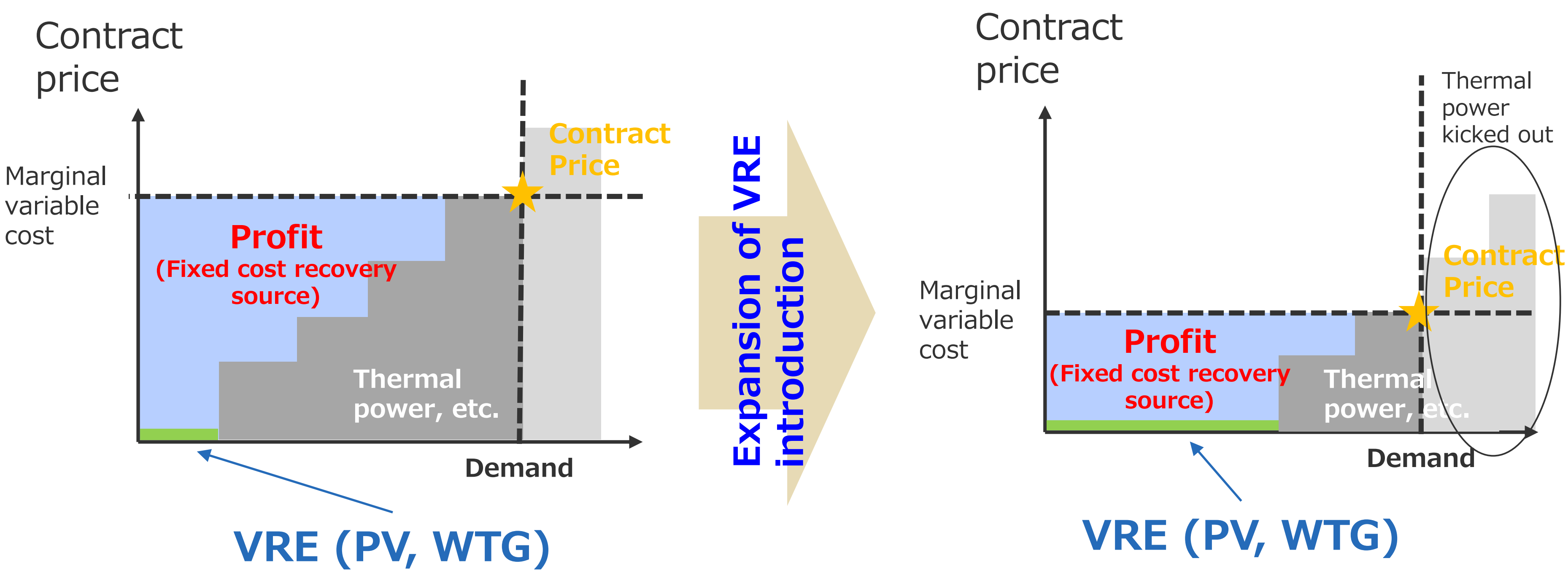
- Power generation investment decisions are difficult due to two reasons, firstly, the expansion of transactions in the wholesale electricity market and secondary the decline in market prices. Full deregulation of retail market and the expansion of renewable energy caused them.
- There is a risk that power generation investment is not carried out at the right time, and it might cause a short-term supply shortage. As a result, supply and demand may be tight and electricity prices may remain high.



Business owners cannot predict wholesale market price precisely, and the timing of investment deviates from the optimal time.

Background of CM Introduction cont'd

- As renewable power sources with zero variable cost expand, power sources with high variable cost such as thermal power will be kicked out of the market.
- In addition, it is not possible to recover fixed costs sufficiently because the contract price decreases

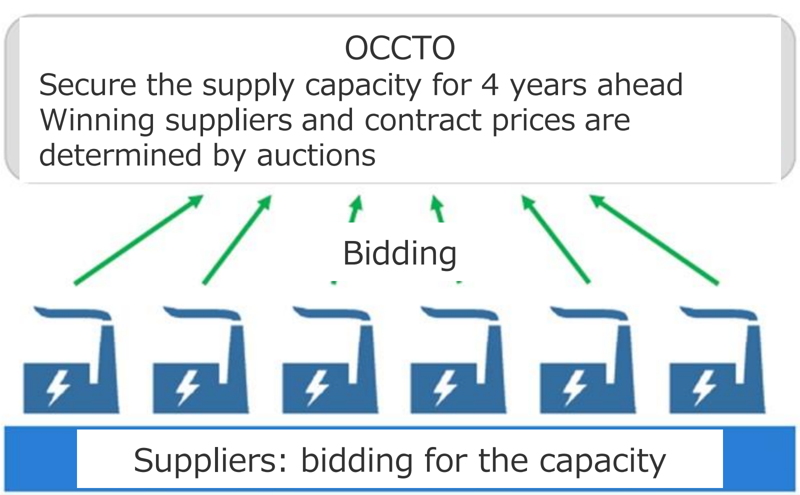


Incentive for the investment doesn't work

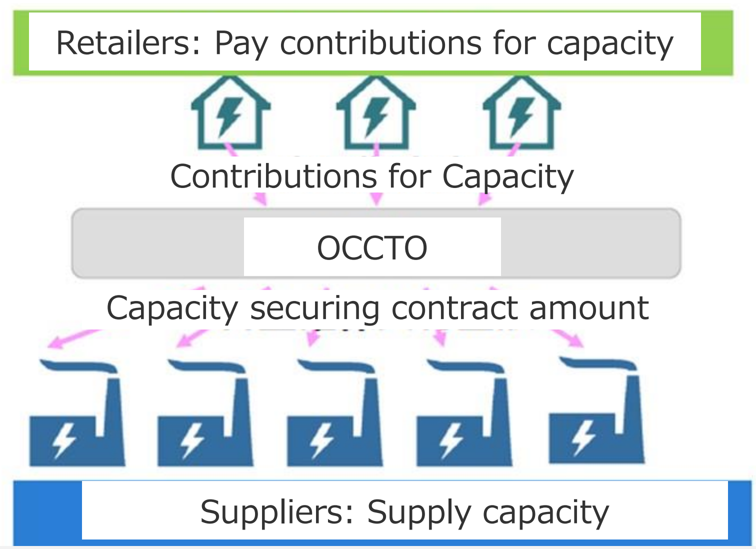
Outline of CM

- OCCTO secures the necessary supply capacity in a nationwide in the capacity market four years before the actual trade.
  - OCCTO: Holds an auction and decides the winning supplier and contract price
    During the actual trade period, contributions for capacity securement are collected from all retail power companies, and the capacity securing contract amount is paid to the power generation companies (winning suppliers).
  - Power generation companies: Provide supply capacity if you make a successful bidding at the auction
  - Retail power companies: Pay contributions for capacity to OCCTO

<u>Auction held (every year from 2020)</u>



<u>Actual trade (4 years later from Auction)</u>

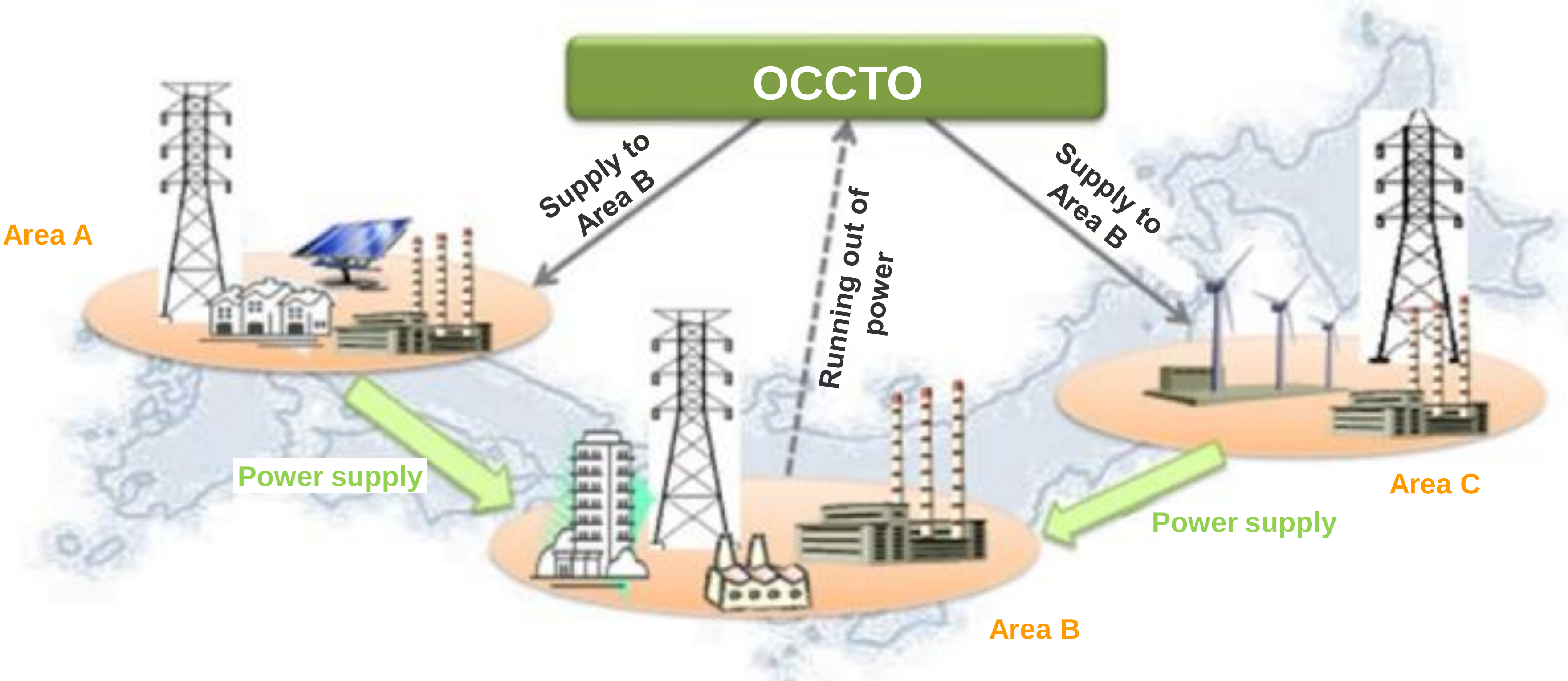


Source: OCCTO

Roll of OCCTO

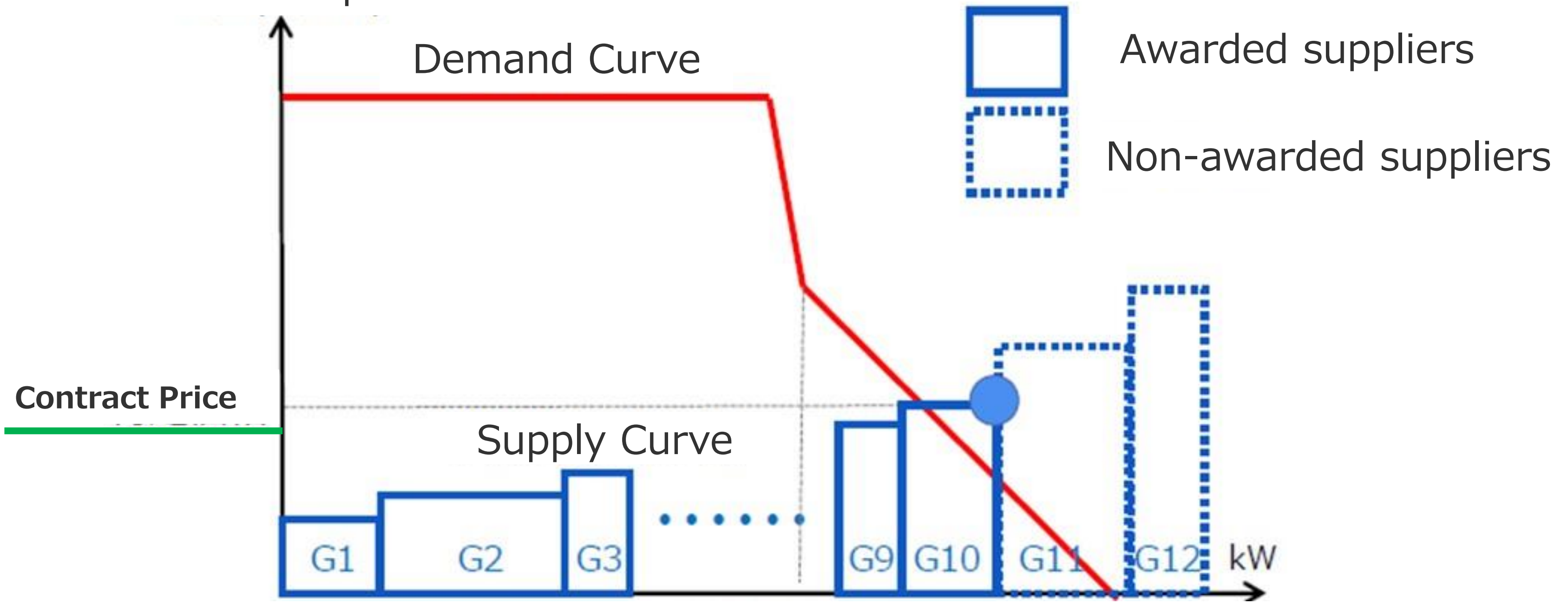
(OCCTO: The Organization for Cross-regional Coordination of Transmission Operators)

- Efficiently manages demand & supply balancing beyond supply areas.
- Monitors demand-supply balance in both ordinary and emergency situation
- Aggregates supply-demand plans & grid plans, and examines whether interconnection reinforcement is necessary or not.



Contract Price (Auction Style)

- Single price auction method. Buyer: OCCTO, Seller: Power generation companies
- The contract price is set at the intersection of the supply curve and the demand curve when bidding prices are arranged in ascending order.
- Suppliers of which bidding price below contract price can supply power



Source: OCCTO

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Wholesale Market in Japan
JEPX(Japan Electric Power Exchange)

Ceylon Electricity Board
JICA Expert Team

Jan. 20, 2022

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

Background of JEPX Establishment

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- Before the deregulation, the electric suppliers all over Japan were limited to 10 general electric power companies such as Tokyo Electric Power Company and Kansai Electric Power Company. This rule was gradually revised so that new electric power companies could enter the market and also supply electricity, and liberalization progressed.
- Under these circumstances, in 2003, Report from the Electricity Business Subcommittee of METI (Ministry of Economy, Trade and Industry) was released and JEPX established with the investment of conventional general electric power companies and new electric power companies, and started trading in 2005.
- JEPX is the only electricity trading market in Japan established in response to the trend of electricity liberalization.

Now it has been completely liberalized and all consumers are free to choose their electric power company.

Many new electric power companies do not have power generation, and it is necessary to procure power to send electricity. Therefore, JEPX was developed as an electricity market that can be accessed by all electric power companies.

JEPX Members

- To trade electricity with JEPX, you need to be a trading member of the Japan Electric Power Exchange.
- It is a wholesale market where only members (company) can trade in the market, and individual household cannot buy electricity directly.
- Initially, the market had 27 members, but as of January 2020, JEPX has 222 member companies. Most of the newly joined companies are new electric power companies.
- Ex. of new electric power company, many type of companies such as telecommunications, trading companies, house makers, and restaurants have entered the market.

New comers (Mother business)

- SB Power (Telecommunications)
- Watami Energy (Restaurant)
- KDDI (Telecommunications)
- Diamond Power Cooperation (Electric Power)
- ENEOS (Energy)
- Marubeni Power Retail Corporation. (Trading company), etc.

Conditions to become members

- To have connection and supply contract with TSO
- To meet financial requirement
  - Net assets of 10 million yen or more
  - Admission fee 100,000 yen
  - Deposit 1 million yen

1 LKR = 0.56 yen (Jan. 19, 2022)

Source: JEPX

Markets handled by JEPX

JEPX deals only with actual electricity (kWh). Trading is taking place in two markets.

- One day before market (Spot Market)
- Same-day market (Pre-market)

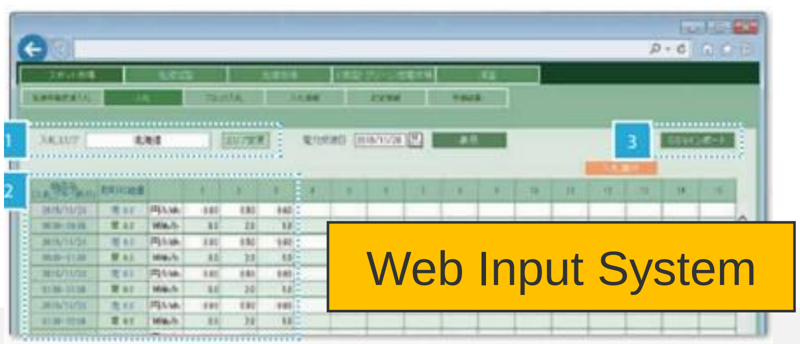
One day before market (Spot Market)

All bids of power generation companies and retailers are put together, matched, and balanced by price and quantity.

- Divide a day into 48 individual products (0 to 30 minutes, 30 to 60 minutes every hour) and trade.
- Unit is a day, you can buy and sell only the required time slots
- The unit of transaction power is 0.1MW (30 minutes, so the amount of energy is 50kWh)
- Bid through the trading system
- Blind single price auction method*

Same-day market (Pre-market)

- A place for adjustment after 1 day before planning.
- Used to adjust for fluctuations in demand due to unpredictable weather changes and the inability to generate due to generator failure.



Source: JEPX

* It is traded at the contract price regardless of the bid price. For example, even if you bid for ¥10 / kWh, if the contract price is ¥15 / kWh, it will be traded at ¥15 / kWh. Blind means that the bidding status of other participants cannot be disclosed at the time of bidding.

Actual Transaction Status

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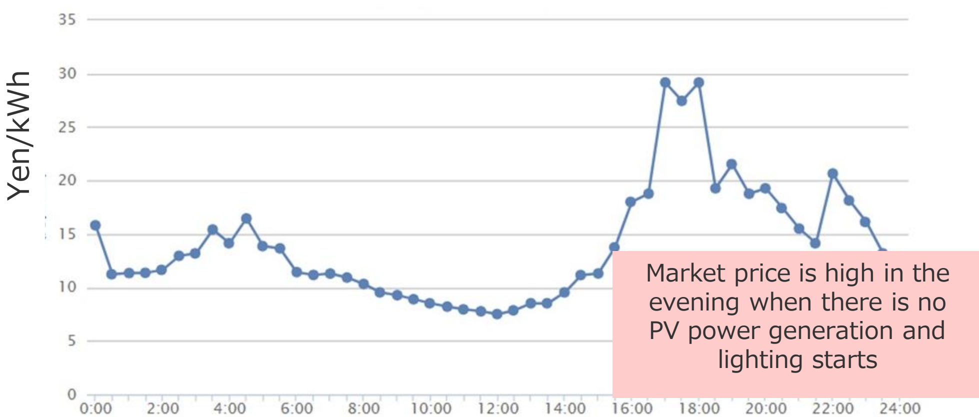
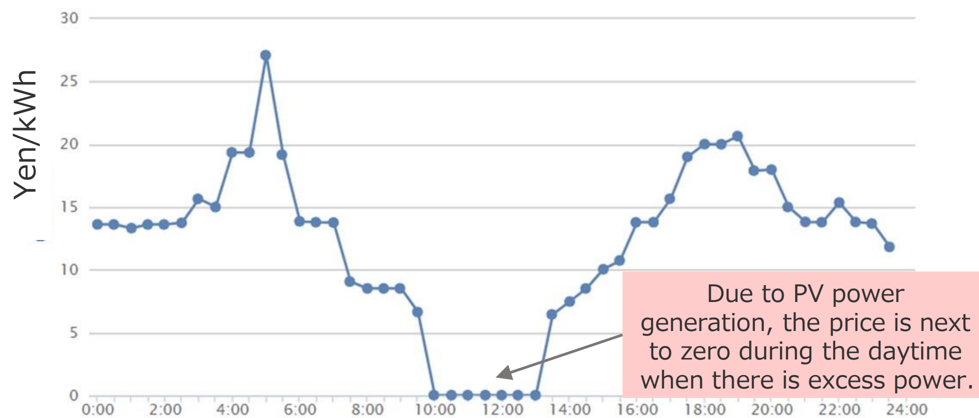
- Market prices fluctuate according to the balance between supply and demand
- Prices often peak in the evening when PV power generation decreases and lighting demand rises, which means power supply is tight.



Ex. Sunny weekday (2021/11/3, Wed.)



Ex. Sunny weekend (2021/11/7, Sun.)

Source: JEPX

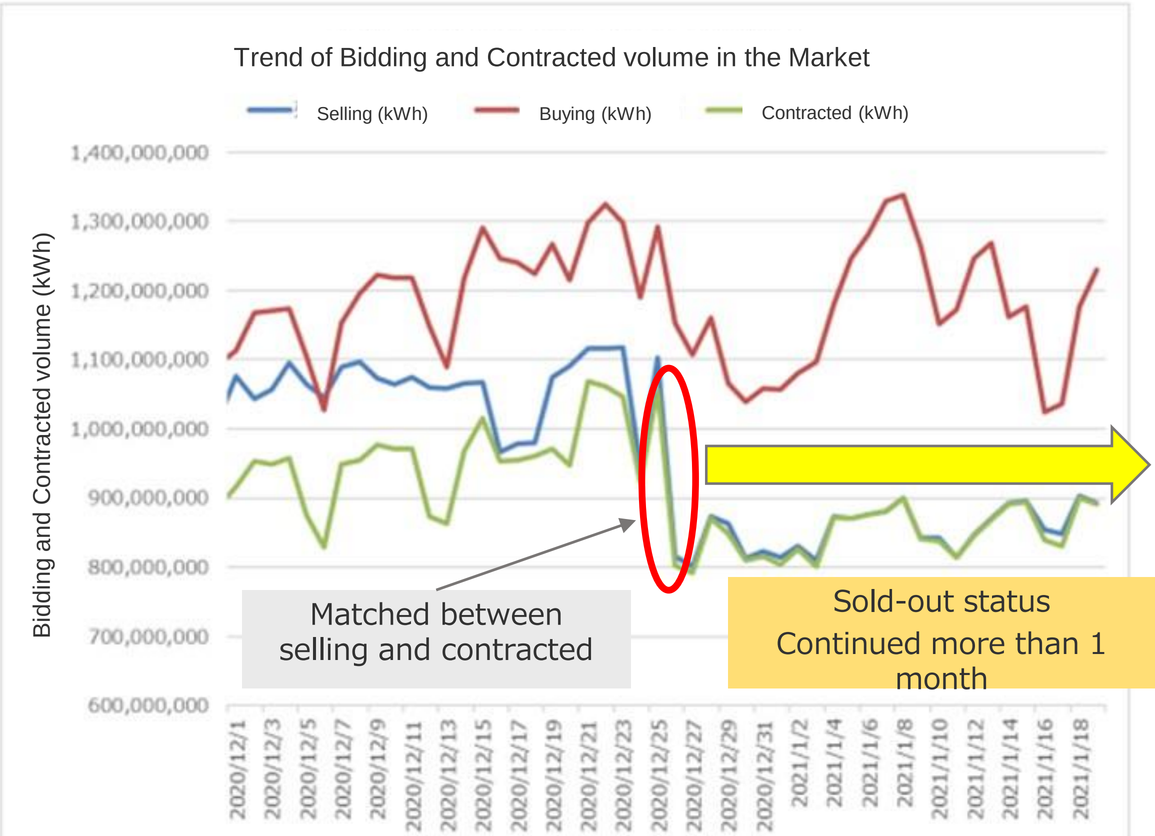
<Ref.> Tariff Menu B (Typical House Case)

Electricity Usage Charges	First 120 kWh	Per 1 kWh	21.04yen
	Over 120 kWh up to 300 kWh		25.51yen
	Over 300 kWh		28.46yen
Minimum Monthly Charge		Per Contract Per Month	258.24yen

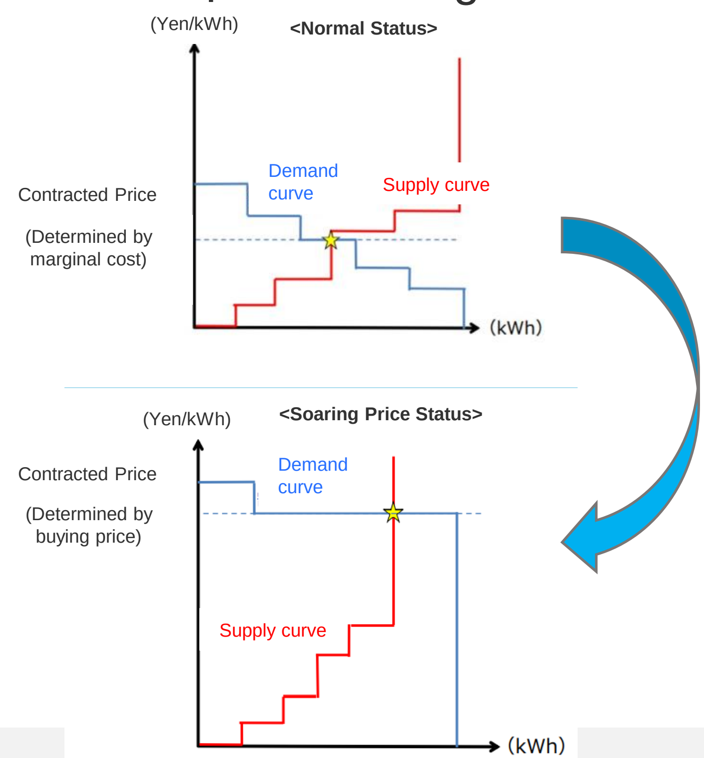
Source: CHUBU HP

Soaring Market Price and their Causes

- Remarkable power shortage occurred due to an demand increase caused by the big cold wave during the year-end and New Year holidays, a decrease in PV power generation caused by bad weather and midwinter, and a global shortage of LNG supply.
- From around December 24th, there was a sold-out condition where the volume of sales and volume of contracts matched, and it continued for a month until January 22nd.



Demand is too much larger than supply, which induced market price soaring



Source: METI

Situation of Soaring Trading Market Price and its Problem

- The market price of JEPX began to soar from mid-December 2020, and reached the highest record of 251 yen/kWh in mid-January.
- Along with this, the electricity bill of some consumers who have contracts with new electric power companies has soared.
- METI sets price cap.

NPC can procure from the Market

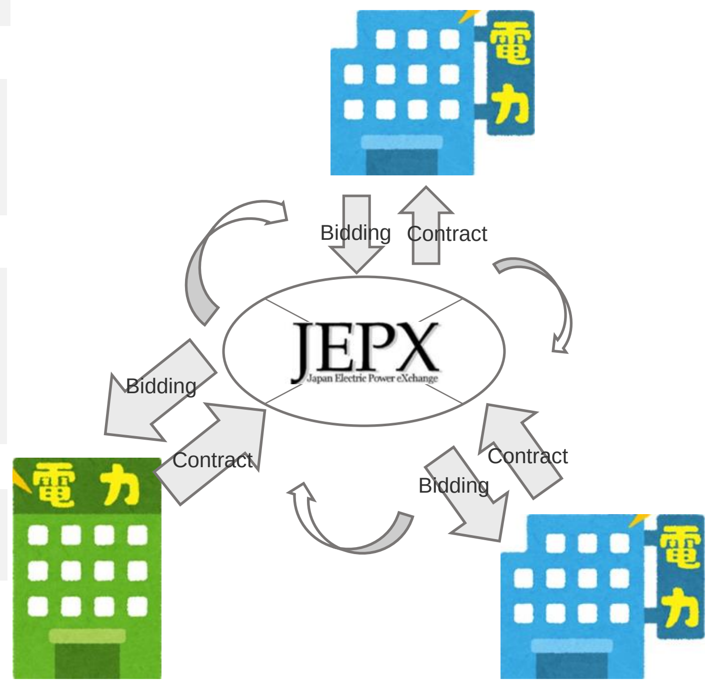
If they cannot procure, they must pay the imbalance fee (penalty)

Bid at a price higher than the market price (better than paying a penalty)
Market price < Penalty

Repeats

Contract price gets into rising spiral

Price Rising Spiral



Source: Reuters

Source: METI

Damage caused by Soaring Market Price

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- In response to the sharp rise in market prices, new electric power companies, whose financial position had deteriorated rapidly due to Negative spread, went bankrupt.
- The cash was absorbed by JEPX (finally by the TSO as an imbalance charge) in the market procurement.
- General customers who had market-linked electricity contracts were directly affected by soaring prices.

Family Energy (FE)

- Established in 2016 as a Japanese subsidiary of Family Energy, American electric power sales company
- Expanded business by aggressive door-to-door sales to general households and small businesses

Total debt of 800 million yen or more

When acquiring new customers, FE received the business suspension order because FE only told that the electricity price would be cheaper than that of general electric power company and did not tell the risk of price fluctuations.

Phoenix Energy

- Established in 2017 with an investment from JPG Energy Management LLC, American electric power sales company
- Acquired new customers using network business methods, etc.

Total debt of 300 million yen or more

- The number of businesses that received the special support of installment payment of imbalance fee is 177 (as of 2021/3/25).
- There is concern about other bankruptcy of new electric power companies in the future.

Source: Energy Shift Source: Green People's Power

Summary

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- It is necessary to design a system based on the lesson from precedent cases
- Deregulation is required before the wholesale electricity market opens
- After the deregulation, it is expected that many new players will enter the market as retailers. It is necessary to convey correct information and rules for them, who have little knowledge.
  - ➢ Retailers have a responsibility to enter the business with a thorough understanding of market risks.
  - ➢ It is desirable that the tariff scheme introduced by retailers should be open and fair.

    (General costumers can also be victims of immature market design)
- General consumers also need to understand the rules of the market before concluding a contract. (It is necessary to understand hidden risks, not just electricity tariff comparison)

Source: JEPX

Reference case in the UK

Measures to avoid tight supply at System Peak

Source: JEPX

Tariff Setting to Suppress System Peak (Triad)

What are Triads?

The Triads are the three half-hour settlement periods of highest demand on the GB (Great Britain) electricity transmission system between November and February each year. National Grid uses the "Triads" to determine TNUoS (Transmission Network Use of System Charge) demand charges for customers with half hourly (HH) meters (smart meters).

Who pays?

The Triads are used to calculate charges for those who are HH metered. This tends to be industrial and commercial customers. If they don't consume electricity in the three Triad periods, they don't need to pay Triads Charge for the entire financial year.

What might signal a Triad?

National Grid does not forecast the Triads in advance - they are only known post-February after the winter period has concluded. This is designed to encourage demand customers to avoid taking energy off the system during peak times if possible, thereby reducing the need to build expensive infrastructure that all customers would need to pay for. Some suppliers and consultancies provide a Triad forecasting service to notify their customers when they believe a Triad is likely to occur.

Source: National Grid, UK

Tariff Setting to Suppress System Peak (Triad) cont'd

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How are Triads calculated?

The Triads for each financial year are calculated at the end of March using system demand data for the half hourly settlement periods between November and February.

Demand charges for the year are based on the HH (Half Hourly) demand tariff* which ranges depending on which geographical demand zone customers are located in. Tariff is multiplied by average demand in kW during the three Triad half-hours.

Example Triad Calculation (London Area)

*: Thanks to the SM, electricity consumption is metered and sent to the supplier

Maximum Demand 1	375 kW
Maximum Demand 2	215 kW
Maximum Demand 3	558 kW
Total Demand Figure:	**1,148 kW**
Loss Adjustment Factor	1.082
Adjusted Demand Figure:	**1,242 kW**
HH Zonal Tariff	£51.87/kW
Total Annual Triad Cost:	**£64,429.88**
Number of Maximum Demand Readings	3
Annual Triad Figure:	**£21,476.63**

Very Expensive

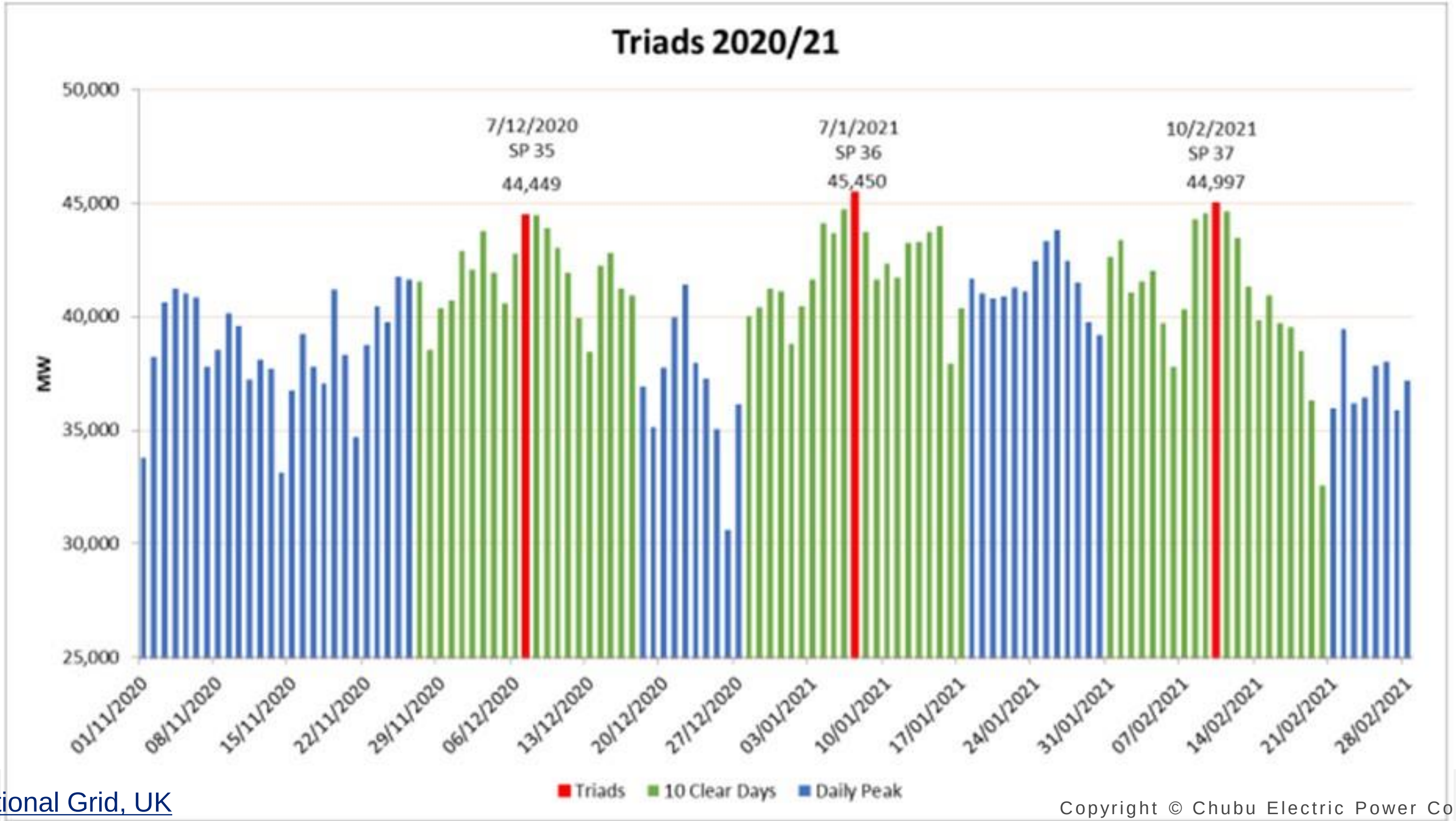
Incentive of demand restraint at the system peak works strongly to avoid Triad.

Source: National Grid, UK   Source: Energy News

When the Triad occurred in 2020/21

At the end of March, which is the end of the fiscal year, the grid operator National Grid will notify about when Triad occurred.

Date	Settlement Period	Net System Demand (MW)
7th December 2020	35	44,449
7th January 2021	36	45,450
10th February 2021	37	44,997



Source: National Grid, UK

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Balancing Market in Japan

September, 2020

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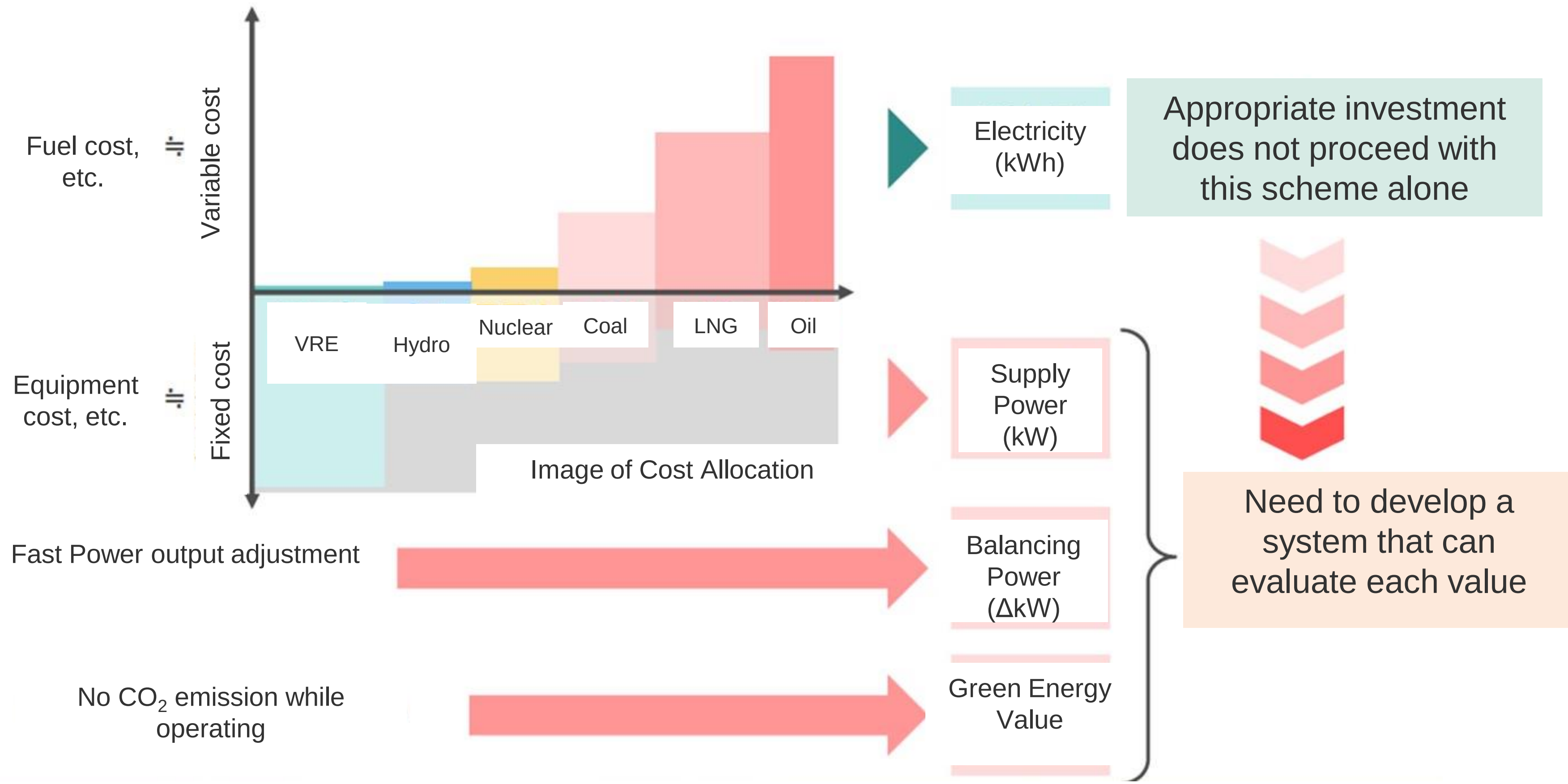
Various Value in Generation

- Electricity (kWh) is not the only value provided by power generation facilities.
- In order to invite investment on power generation, it is necessary to establish a system to evaluate the value apart from electricity (kWh)

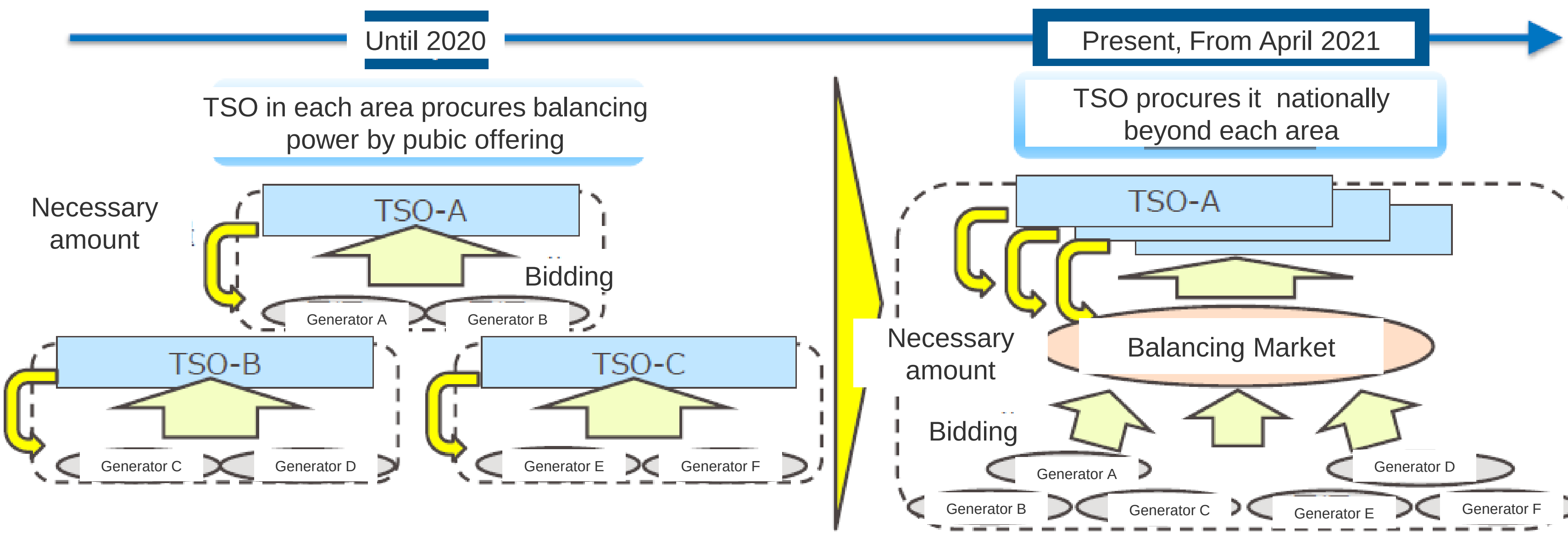


Value traded in each Market

Type of Value by power sources	Traded Value	Markets	Procurers
Electricity 【kWh Value】	Generated Energy	➢ Wholesale electricity market (1 hour before, spot, future) ➢ Baseload trading market	Retailers
Supply Power 【kW Value】	Ability to supply power (Value of existence)	Capacity Market	Retailers General electric utilities (TSOs) ※Actually, it is procured by OCCTO that is the market manager, but the cost is borne by the above
Balancing Power 【ΔkW＋kWh Value】	Balancing Ability in short term	・Public offering (at present) →Balancing Market (After 2021)	General electric utilities (TSOs)
Others 【Green Energy Value, etc.】	Environmental value associated with electricity generated by non-fossil power sources	Green energy trading market	Retailers

Purpose of the Balancing Market Launch

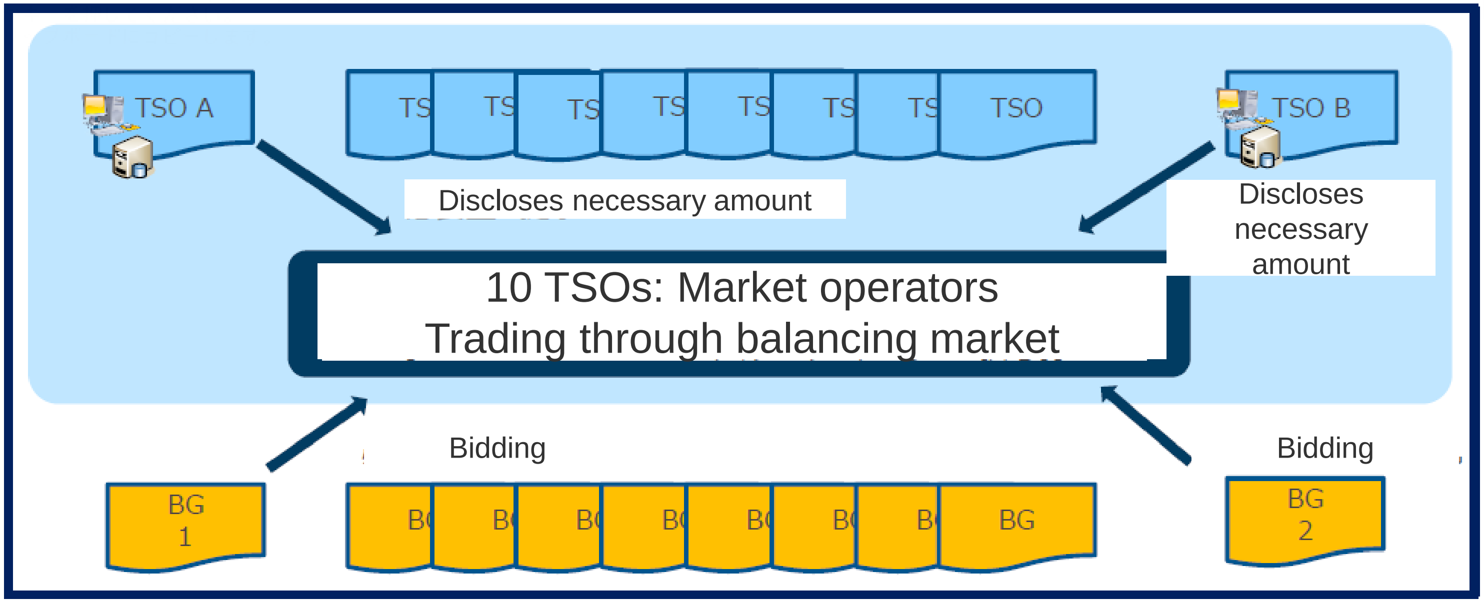
- From April 2021, Balancing market will be established in order to procure and operate balancing power nationwide and more efficiently with more transparency and fairness.



Source: Agency for Natural Resources and Energy

Outline of the Balancing Market

- Buyers of balancing power are general electric utilities (TSOs), and sellers are power generation and retailers.
- Market operators are 10 TSOs



BG: Balancing Group※

※When there is a difference between the planned and actual demand, there is an obligation to pay a penalty cost called an "imbalance fee.“ By forming a group, balancing can be achieved more easily for the entire group, which reduces risk.

TSO		Balancing power suppliers
10 TSOs	Each TSO	BG
Market Operator	Buyer	Seller

Source: Agency for Natural Resources and Energy

What is Balancing Power

- Since electricity has the characteristic of immediate consumption of generated power, TSOs instantly match the supply (power generation) with the demand (consumption) that changes from moment to moment.
- Power generators, retailers, and TSOs share roles to match the supply and the demand. Each role is below:
  - Power generation companies and the retailers match the plan with the actual result every 30 minutes under this balancing scheme.
  - TSOs find the differences, first one is error between the plans provided by the power generation companies and the actuals provided by the retailers, which remain after GC, second one is error of the generation forecast from VRE, third one is fluctuation of demand and supply that occurs within less than 30 minutes. Next TSOs consider everything the above and eventually matches the demand and the supply instantaneously utilizing balancing power.

Balancing power is the supply power used by TSOs to match the difference between the supply and the demand that cannot be grasped in advance, which has an important role in maintaining the frequency and ensuring a stable supply.

Balancing Power used for what? (Ref., Detailed Explanation)

Balancing power needs to address the following four events

1. Prediction Error of Demand

Retailers prepare a demand plan by predicting demand, but it is not possible to formulate a plan that exactly matches the actual demand, so there is a difference between the forecast and the actual result after the GC. This is called "prediction error of demand".

2. Prediction Error of VRE

Difference between predicted generation of VRE and the actual

3. Fluctuation (Error) in short range

Actual demand is constantly changing, and the output of VRE is also changing momentarily. Even if the predicted value and the actual value match in terms of the 30-minute average value, error between them occurs in terms of time shorter than 30 minutes. This is called "Fluctuation (Error) in short range"

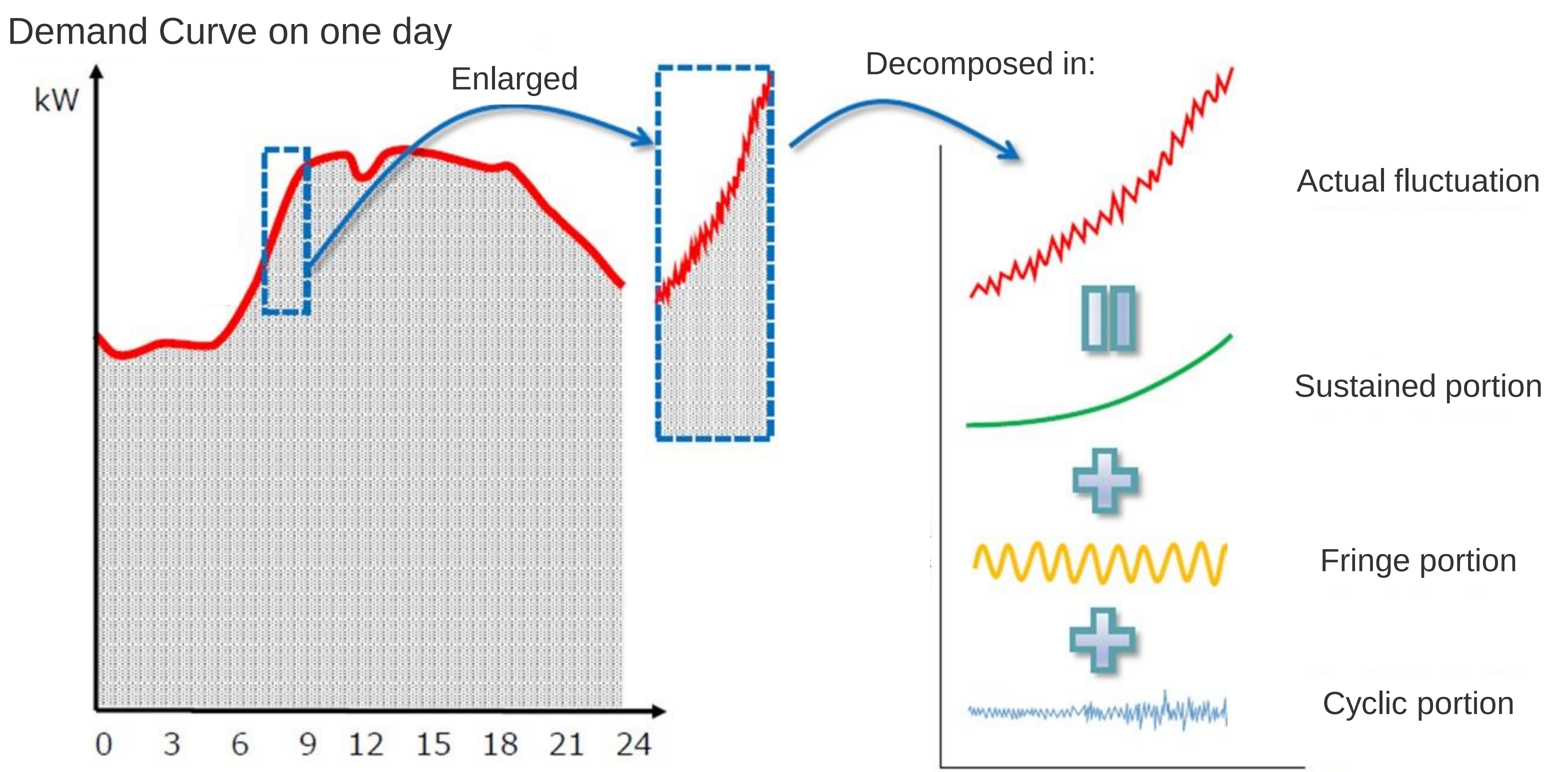
4. Generation Drop

Power supply stops due to unexpected trouble.

Source: OCCTO

Components of Demand

Electricity demand changes every moment depending on electricity usage conditions such as factory operation and household lighting, it can be decomposed into sensitive short-cycle fluctuation components and long-cycle fluctuation components.



Frequency Control Function of Generators

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- Generators have a frequency control function corresponding to each fluctuation component
- In balancing market, values are classified based on the frequency control function

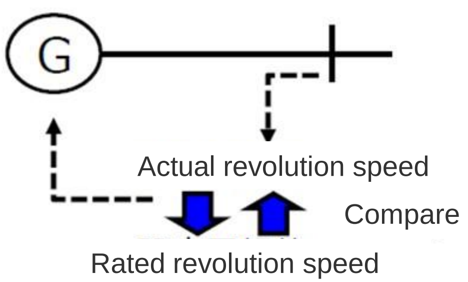
Ultra-short-term cycle portion
(Cyclic)

Short-term cycle portion
(Fringe)

Long-term cycle portion
(Sustained)

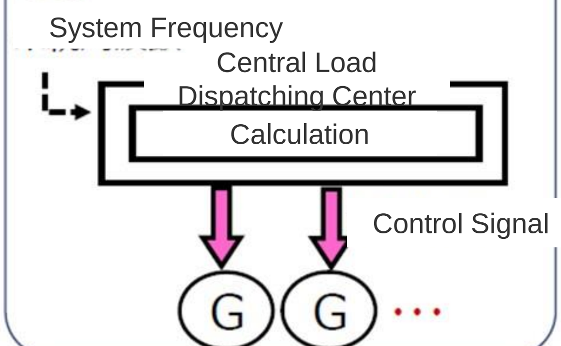
(Governor Free : GF)

The generator detects revolution speed by itself and controls it by comparing with the rated value



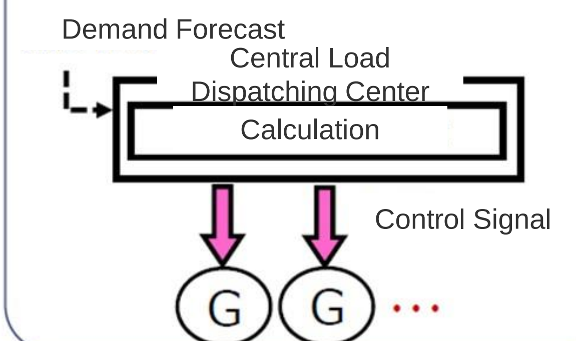
(Lord Frequency Control : LFC)

The central load dispatching center automatically controls the generator output by sending signal to make system frequency return to the rated frequency.



(Economic Dispatch Control : EDC)

The central load dispatching center calculates the optimum output to meet demand forecast and automatically sends the signal to each generator individually.



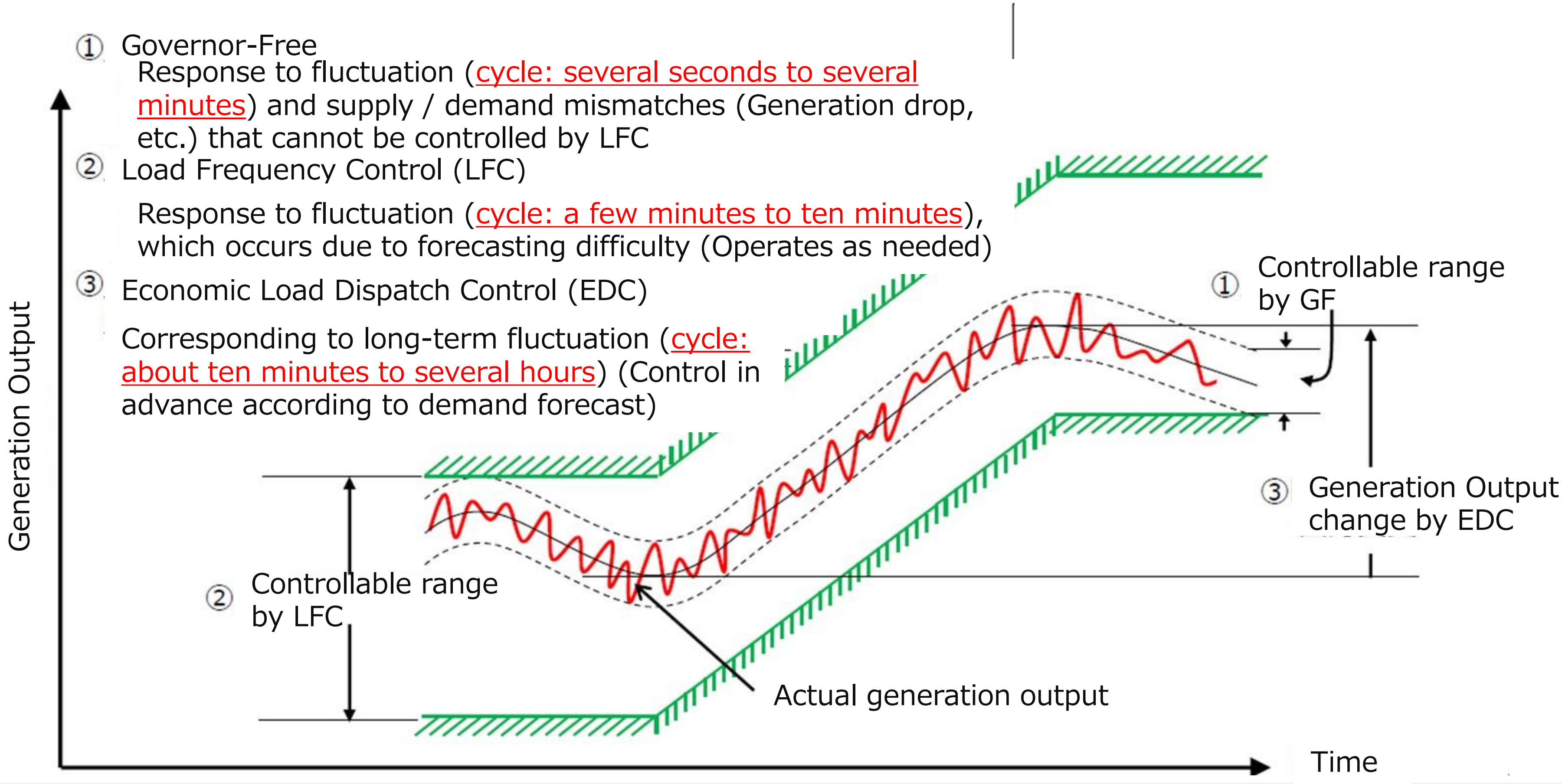
Products (Values) for sale

Primary	Secondary I	Secondary II, Tertiary I

Control Image corresponding to each Component

Depending on the fluctuation cycle of supply and demand,

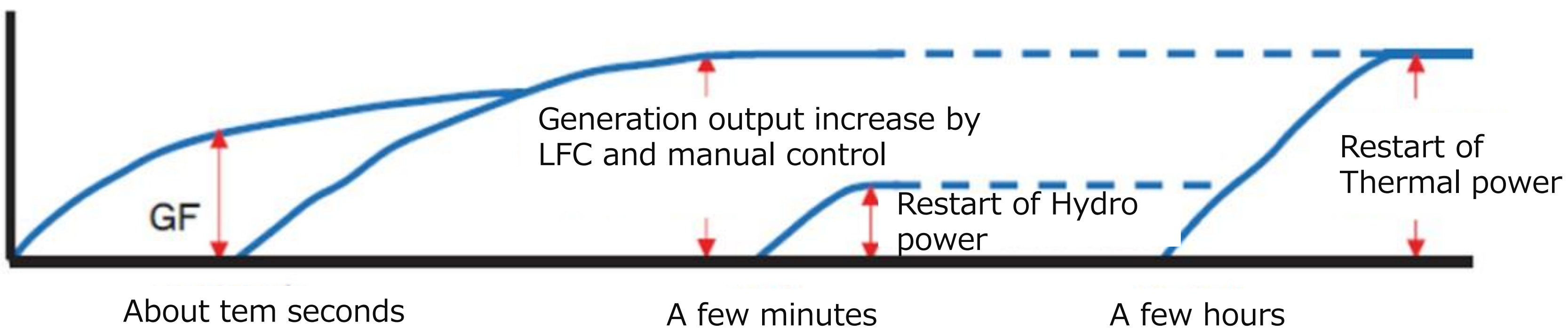
1) Function of governor-free (GF), 2) Load Frequency Control (LFC), and 3) Economic Load Dispatch Control (EDC), which are generator output control functions, are used to maintain the reference frequency of power system.



Source: OCCTO

Product Design for Balancing Market

From the viewpoint of utilizing various power source types as balancing power, they are classified into primary, secondary or tertiary according to the reaction speed, service offer period, etc.



1. Primary balancing power

   Is instantly used to suppress frequency fluctuations, such as GF function, emergency power pool control function by DC equipment, function to control demand instantaneously

2. Secondary balancing power

   Is incorporated and utilized in the LFC function

3. Tertiary balancing power

   Is utilized in response to orders from TSOs, other than the above.

Source: Agency for Natural Resources and Energy

Products in Balancing Market

Products	Outline	Response time	Duration
Primary	used to suppress frequency fluctuations, equivalent to GF	With in 10 sec	More than 5 min
Secondary ①	Used to recover the system frequency to reference frequency by LFC	With in 5 min	More than 30 min
Secondary ②	Used to recover the system frequency to reference frequency by EDC	With in 5 min	More than 30 min
Tertiary ①	Used to operate economically (Quick response)	With in 15 min	3 hrs
Tertiary ②	Used to operate economically (Slow response)	With in 45 min	3 hrs

	Primary	Secondary ①	Secondary ②	Tertiary ①	Tertiary ②
Naming in UK	Frequency Containment Reserve (FCR)	Synchronized Frequency Restoration Reserve (S-FRR)	Frequency Restoration Reserve (FRR)	Replacement Reserve (RR)	Replacement Reserve-for FIT (RR-FIT)
Control	On-line (Self Control)	On-line (LFC Signal)	Online (EDC Signal)	Online (EDC Signal)	Online
Order Cycle	- (Self Control)	0.5 – 30 sec	1 – a few min	1 – a few min	30 min
Minimum bidding	5MW	5MW	5MW	5MW	5MW: dedicated line 1MW: Command system
Unit size for bidding (Increment step)	1kW	1kW	1kW	1kW	1kW

Source: Agency for Natural Resources and Energy

Balancing Control Mechanism by T&D Sector (Transition)

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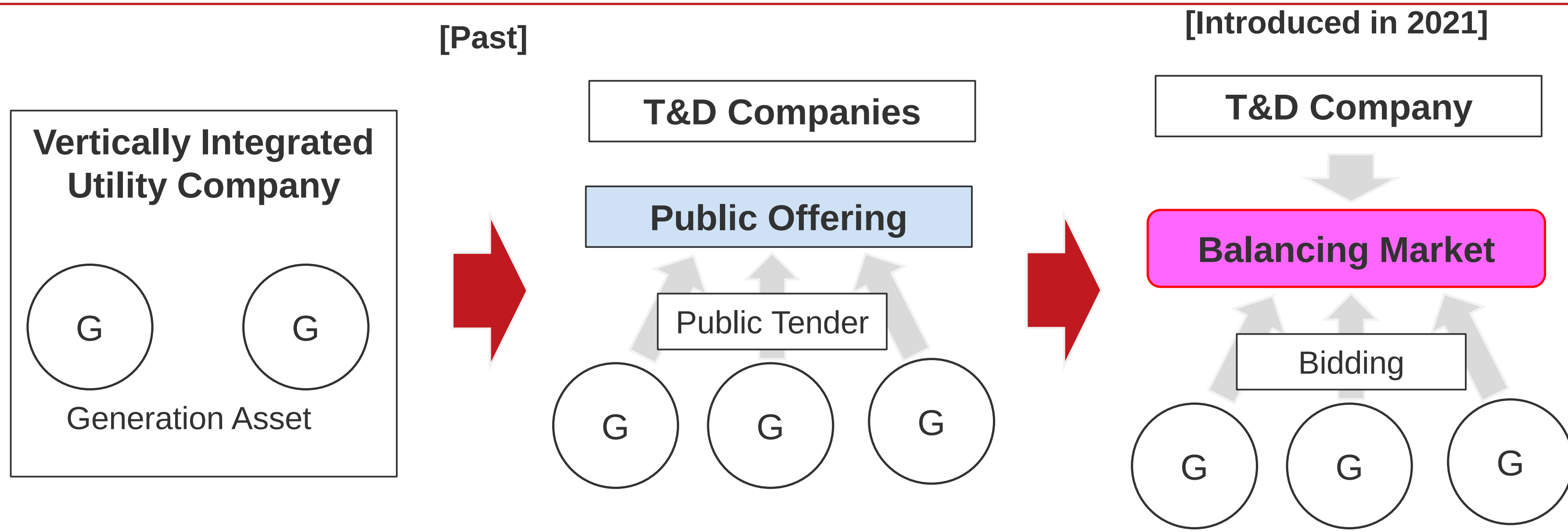
- T&D Companies (TSOs) control frequency and supply-demand balance in their each area on the basis of license. When procuring the balancing control power, both transparency and efficiency are important factors.
- In this viewpoint, TSOs began to operate power system using balancing control power procured by "public offering" in April 2017.
- "Balancing market" was introduced in 2021. Through this market, we expect that procuring balancing control power will be more efficient.



Vertically Integrated Utility has its own Generation Asset, and its own balancing control power.

Through Public Offering, T&D companies procure its balancing control power.

Through Balancing Market, unbundled T&D Companies procure its balancing control power.

Balancing Market Introduction Schedule

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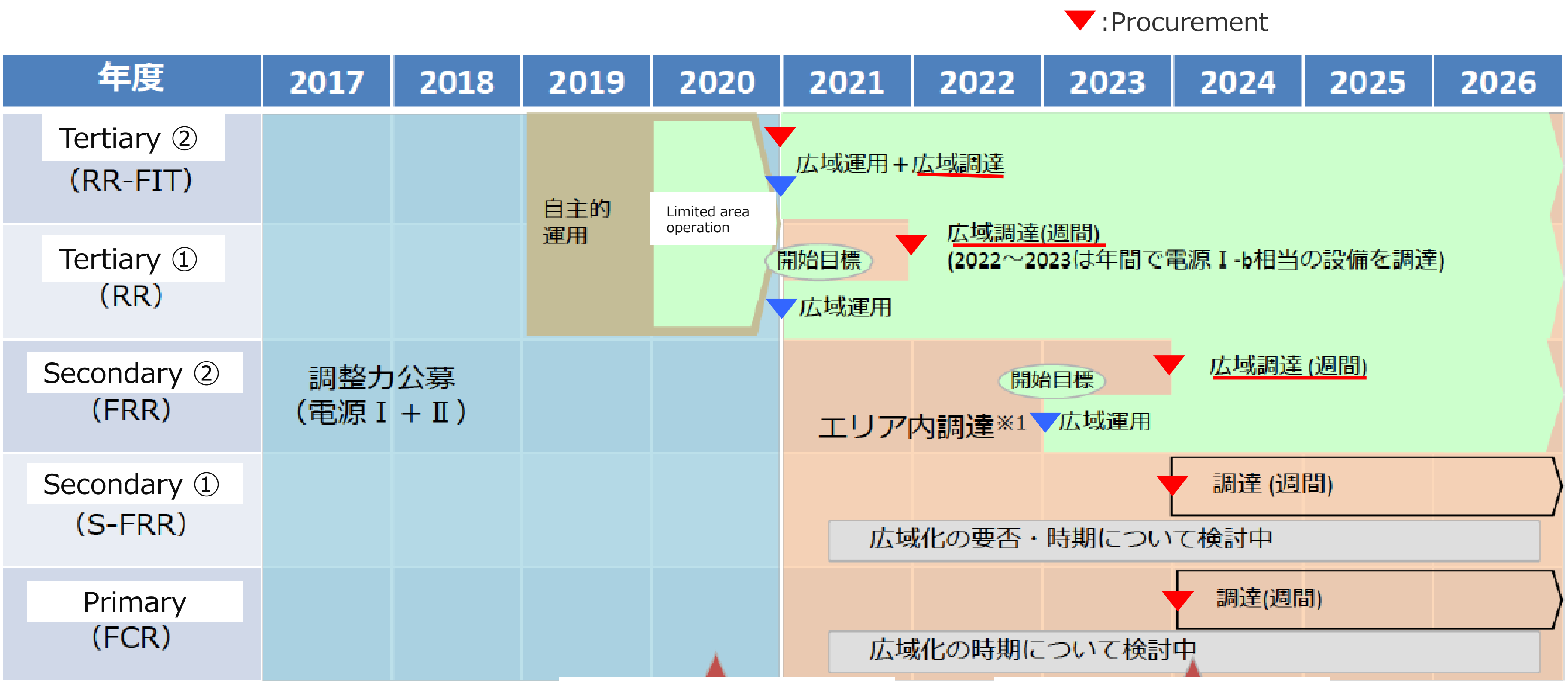
- Regarding primary and secondary, Balancing Market (procurement) will start from 2024
- Regarding tertiary ①, Balancing Market (procurement) will start in 2022, on the contrary tertiary ②, it will start in 2021.
- With respect to tertiary ②, limited area based Balancing Market will start in 2020 (Central Japan; Chubu, Hokuriku and Kansai region)



Source: Agency for Natural Resources and Energy

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Imbalance Charge
Under designing in Japan

Ceylon Electricity Board
JICA Expert Team

Oct. 27, 2022

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

Supply and Demand Balancing Scheme

CHUBU Electric Power
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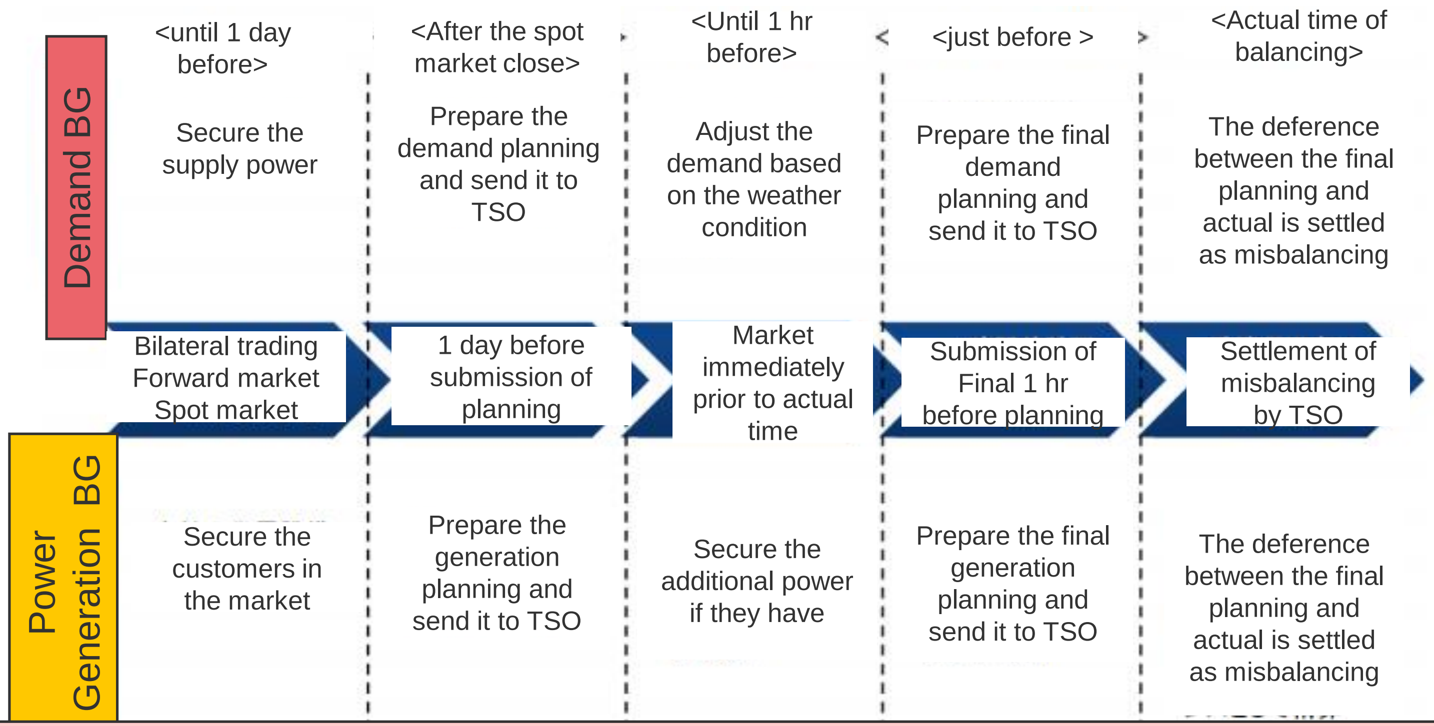
Demand BG (retailers, etc.) reasonably forecasts demand and procures supply capacity according to the forecast. Power generation BG (power generation companies, etc.) accurately generates the planned amount of supply and demand.

They were designed as the players of maintaining balance.

- Image of the balancing timeline is shown below:
- After proposing the final planning one hour before, the unbalance is taken care of by TSO



Not only TSO but also power generation companies and retail electric power companies are required to take responsibility for system stability.

Source: METI (2019)

Imbalance Scheme

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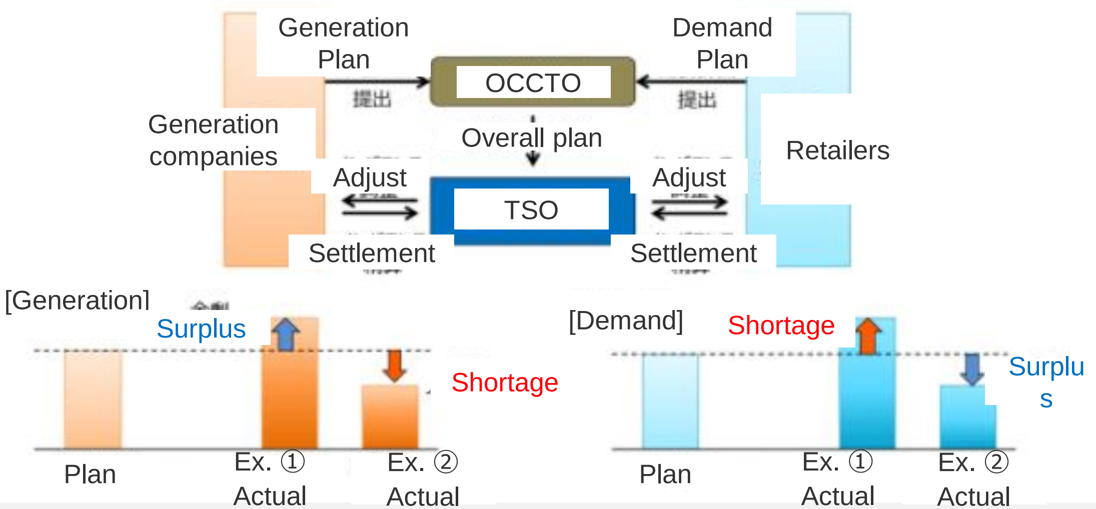
What happens if the planned value is not secured

Imbalance scheme

- The imbalance charge is billed or paid by TSO for the difference (imbalance) between the "Plan" and the "Actual performance".
  - ✓ "Plan": A planned value that the power generation company / retail company submits to TSO in advance, assuming the amount of power demand and the amount of power generation.
  - ✓ "Actual Performance": Actual demand and power generation at the target time
- There are two types of imbalance charges: demand imbalance and power generation imbalance.



Power generation companies
- In case of shortage, pay higher unit price than the market
- In case of surplus, receive cheaper unit price than the market

Retailers (Opposite view of power generation companies)
- In case that actual performance exceeds the plan (Shortage), pay higher unit price than the market
- In case that actual performance is lower than the plan (Surplus), receive lower unit price than the market

Source: Eco style denki (June, 2021)

Price Setting of Imbalance Charge (Case of Generation Raising Demand from TSO)

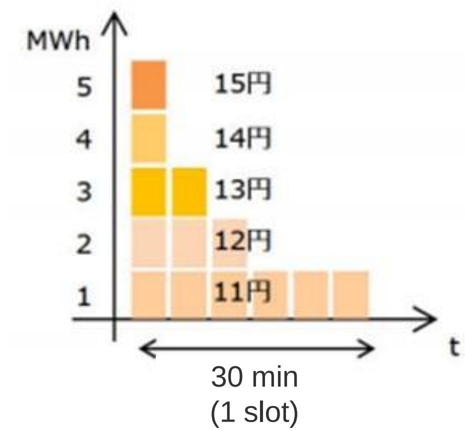
- The unit price is settled between TSO and players (power generation companies / retailers) that has offered imbalanced power or demand
- The target time slot reflects the cost required by TSO to adjust the marginal 1kWh.

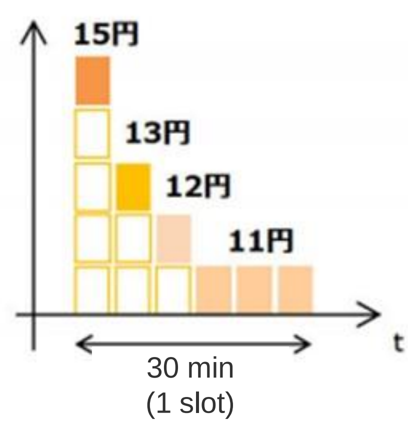
Imbalance volume and cost

Marginal cost for each 5 min

Weighted Average

Offer of increasing of generation





$$13.2 \text{ JPY} \quad \left(\frac{15円\times5+13円\times3+12円\times2+11円\times3}{5+3+2+3} \right)$$

5 min short period marginal cost should be reflected to 30 min (1 slot) imbalance charge

Source: METIi (June, 2019)

Price Setting of Imbalance Charge
(Combined Case of Generation Raising / Lowering Demand from TSO)

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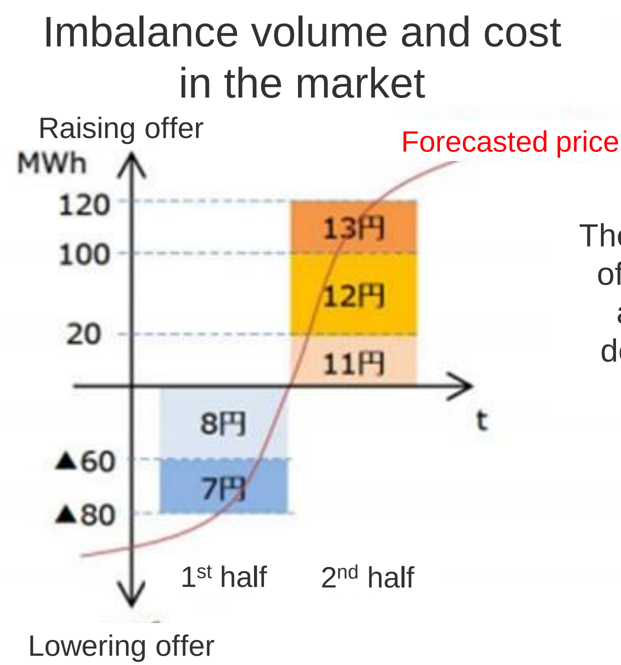
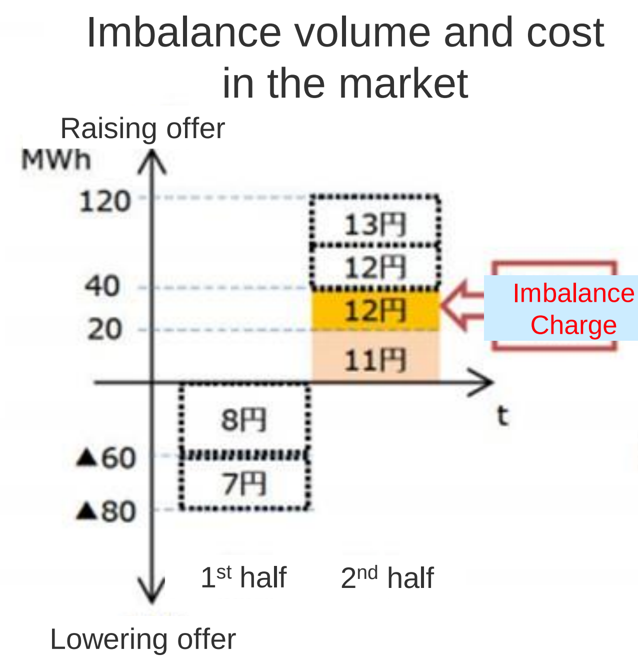
- The imbalance charge is applied based on the idea of reflecting the kWh price of the adjustment power that was actually operated for the time slot.
- The same amount is offset from the one with the higher price of the generation raising command and the one with the bigger price of the lowering command. And the remaining unit cost should be the imbalance charge.



The same amount is offset from raising and lowering in descending order



Marginal cost of remaining portion should be the imbalance charge

Source: METIi (June, 2019)

Imbalance Charge Calculation method

- A market price-linked calculation method has been introduced for imbalance charges borne by power generation companies and retailers. The principal of the imbalance charge is the "weighted average value of the spot market (1 day ago)※1 and spot market (1 hour ago)※2 " on the Japan Electric Power Exchange (JEPX).
- The incentive constant is determined by the Minister of Economy, Trade and Industry, and is added when there is deficit in the power system and subtracted when there is a surplus.

(Deficit) Imbalance charge = [Weighted average spot market (1 day ago and 1 hr ago)] x α+ β +K

(Surplus) Imbalance charge = [Weighted average spot market (1 day ago and 1 hr ago)] x α+ β -L

Incentive

α: Adjusting term reflecting power system supply and demand balance
β: Adjusting term reflecting area spot price difference
K/L: Incentive constant (Minister of METI defines)

Incentive

	Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Chugoku	Shikoku	Kyusyu	Okinawa
K	2.98	1.46	0.49	0.48	0.48	0.48	0.49	0.54	0.00
L	1.18	0.43	0.74	0.71	0.71	0.71	0.72	0.70	0.01

https://www.meti.go.jp/press/2019/03/20200331007/20200331007.html

- **※1: Spot market (1 day ago)**

The market that trades for 24 hours the next day, which consists 48 time slot products

- **※2: Spot market (1 hr ago)**

The market where you can trade from 17:00 every day to the next day, and you can trade each product up to 1 hour before delivery. Each slot product, 30 min, can be traded. It has a role as a coordination place when there is an surplus or deficit of supply and demand due to factors such as sudden climate change and power generation trouble.

https://www.ecostylepower.com/denki_column31/#i

Ancillary Service

The final imbalance is managed by TSO. Therefore, the service (compensation) for it is required.

- When customers connect to the power system, the power system adjusts the instantaneous supply-demand balance according to the fluctuation of the load and output of the power generation. This quality management function provided by the TSO is called ancillary service.
- This service will be applied from the time customers start the interconnection. In other words, customers have obligation to pay for interconnection.

Kansai Electric Power		
Ancillary Service Charge (yen/kWh)	**System interconnection in HV (6.6kV)**	**99.0**
	System interconnection in Extra HV (More than 6.6kV)	77.0

Source: Source: Guideline of System Interconnection (2019, Kansai Electric Power)

Ancillary service is a last resort service, and it is basic that each player (power generation company / retailer) shall make efforts to balance supply and demand.

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Status of Balancing Market in Japan

-Status and issues from the opening of the balancing market (April 2021) to the present-

December, 2021

JICA Expert Team

Value traded in each Market

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Type of Value by power sources	Traded Value	Markets	Procurers
Electricity 【kWh Value】	Generated Energy	➢ Wholesale electricity market (1 hour before, spot, future) ➢ Baseload trading market	Retailers
Supply Power 【kW Value】	Ability to supply power (Value of existence)	Capacity Market	Retailers General electric utilities (TSOs) ※Actually, it is procured by OCCTO that is the market manager, but the cost is borne by the above
Balancing Power 【ΔkW＋kWh Value】	Balancing Ability in short term	・Public offering（at present） →Balancing Market (After 2021)	General electric utilities (TSOs)
Others 【Green Energy Value, etc.】	Environmental value associated with electricity generated by non-fossil power sources	Green energy trading market	Retailers

Products in Balancing Market

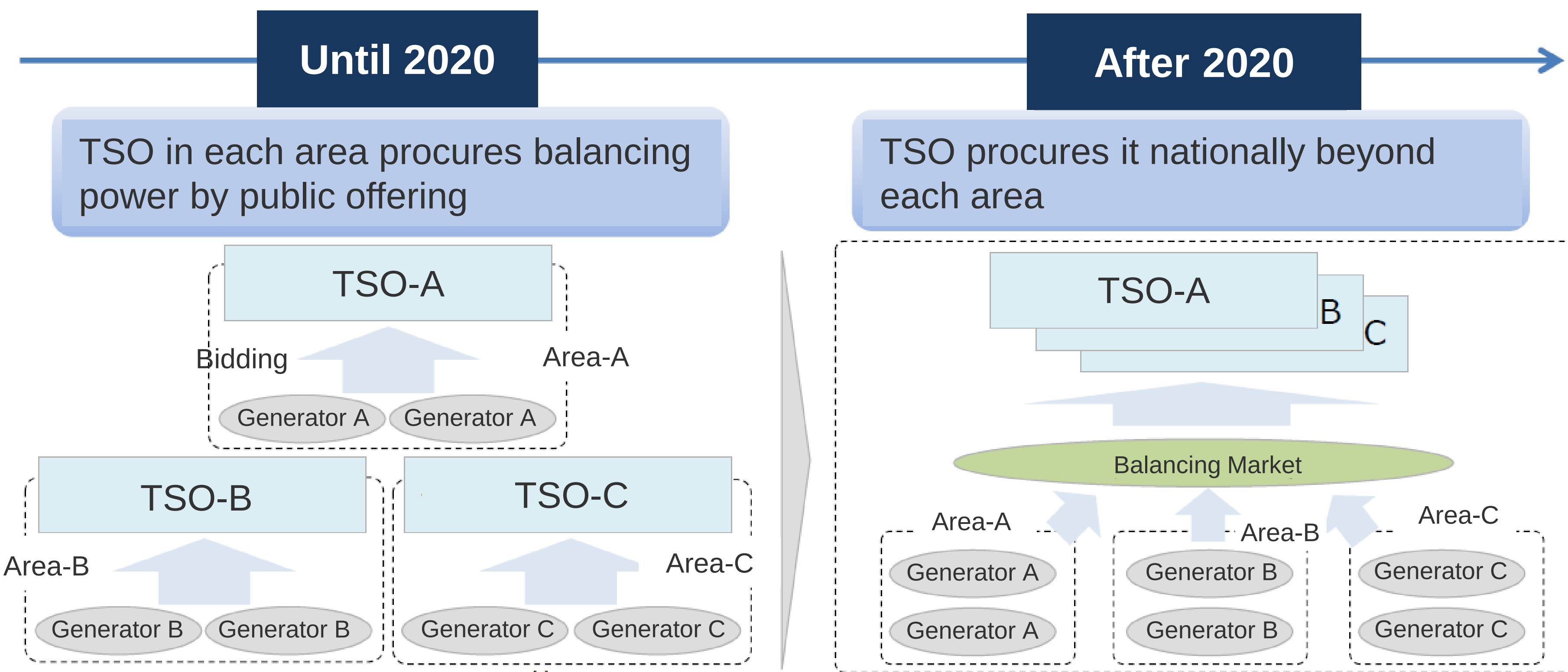
Products	Outline	Response time	Duration
Primary	used to suppress frequency fluctuations, equivalent to GF	With in 10 sec	More than 5 min
Secondary ①	Used to recover the system frequency to reference frequency by LFC	With in 5 min	More than 30 min
Secondary ②	Used to recover the system frequency to reference frequency by EDC	With in 5 min	More than 30 min
Tertiary ①	Used to operate economically (Quick response)	With in 15 min	3 hrs
Tertiary ②	Used to operate economically (Slow response)	With in 45 min	3 hrs

	Primary	Secondary ①	Secondary ②	Tertiary ①	Tertiary ②
Naming in UK	Frequency Containment Reserve (FCR)	Synchronized Frequency Restoration Reserve (S-FRR)	Frequency Restoration Reserve (FRR)	Replacement Reserve (RR)	Replacement Reserve-for FIT (RR-FIT)
Control	On-line (Self Control)	On-line (LFC Signal)	Online (EDC Signal)	Online (EDC Signal)	Online
Order Cycle	- (Self Control)	0.5 – 30 sec	1 – a few min	1 – a few min	30 min
Minimum bidding	5MW	5MW	5MW	5MW	5MW: dedicated line 1MW: Command system
Unit size for bidding (Increment step)	1kW	1kW	1kW	1kW	1kW

Source: Agency for Natural Resources and Energy

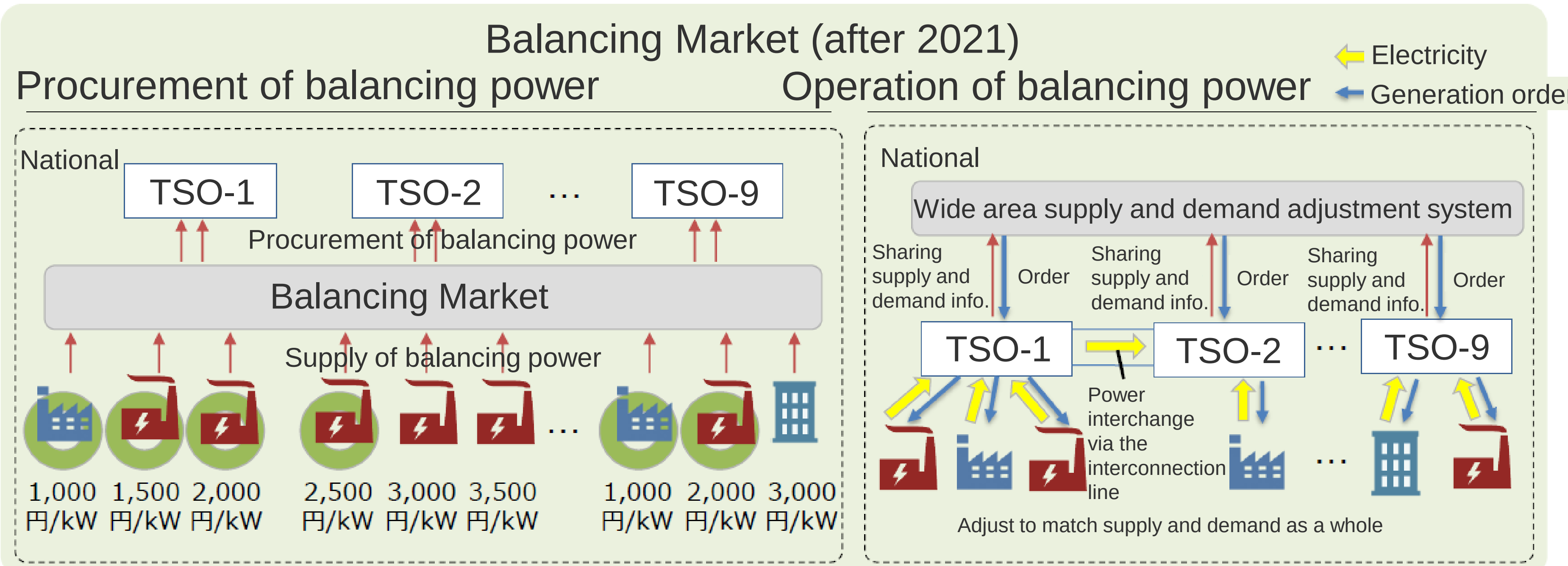
Outline of the Balancing Market (1/2)

- The balancing market was established in 2021 in order to more efficiently procure and operate the balancing power for TSO to adjust the frequency and supply and demand through the market.
- Aim for more efficient supply and demand management by procuring and operating balancing capacities over a wide area beyond the each local area.
- The market is operated by 9 TSOs.



Outline of Balancing Market (2/2)

- In the Balancing Market, then TSOs (1) secure (procure) the necessary balancing power from the cheapest one regardless of the area, and (2) it is possible for TSOs to utilized (operate) balancing power sources nationwide by instantly power interchange each other via the interconnection T/L based on the order from the wide area supply and demand adjustment system. This enables the overall optimal procurement and operation of balancing power.
- This market has started market transactions in April 2021, and is proceeding with system design in the direction that all balancing power will gradually shift to market transactions by 2024.



Balancing market introduction schedule

CHUBU Electric Power
NIPPON KOEI

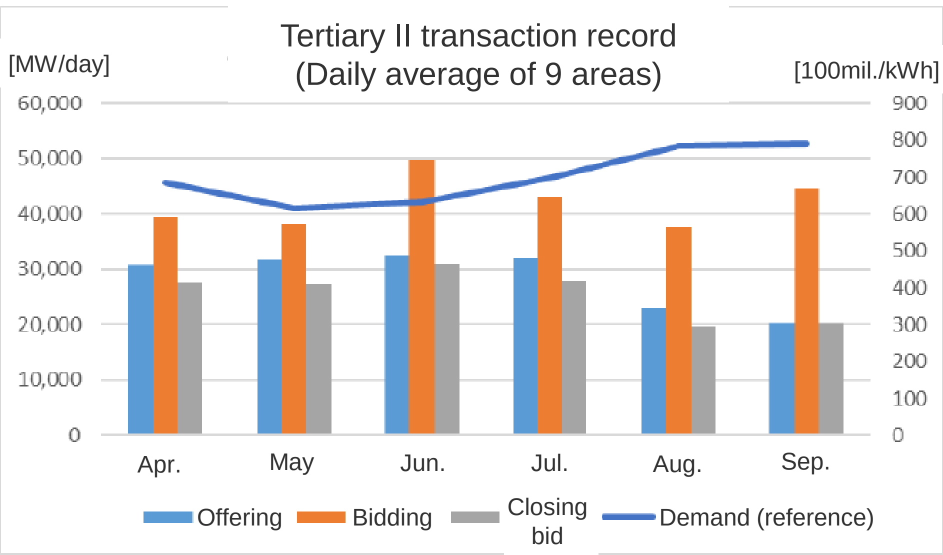
- Tertiary III started wide-area procurement in 2021.
- Market procurement is scheduled to start from 2022 for tertiary I and from 2024 for the primary and secondary.

year / Products	2019	2020	2021	2022	2023	2024～ (容量市場開設)
Products of balancing market			Tertiary II: Wide area procurement →	Tertiary I: Wide area procurement →		Secondary II: Wide area procurement → Secondary I: 24-26 procurement in the area, After 2027 wide area procurement → Primary: Wide area procurement →
Power I-a (kW)	Bidding in the area (annual) →					Capacity market →
Power I-b (kW)	Bidding in the area (annual) →					Capacity market →
Power I’ (kW)	Bidding in the area (annual) →					Capacity market →
Power II	Bidding in the area (as needed) →					Capacity market →
Power II’	Bidding in the area (as needed) →					Capacity market →
Black start	Bidding at the time of bidding for primary →					bidding →

Transaction status of Tertiary II

- For April 1st to September 14th, 2021, The bid amount ratio to the offering amount was 143.8%. However, the procurement amount insufficient at 89.4% of the closing bid amount.
- In September, the offering amount declined, and the procurement shortage was largely resolved with 99.7% of closing bid amount.

Monthly tertiary II transaction volume

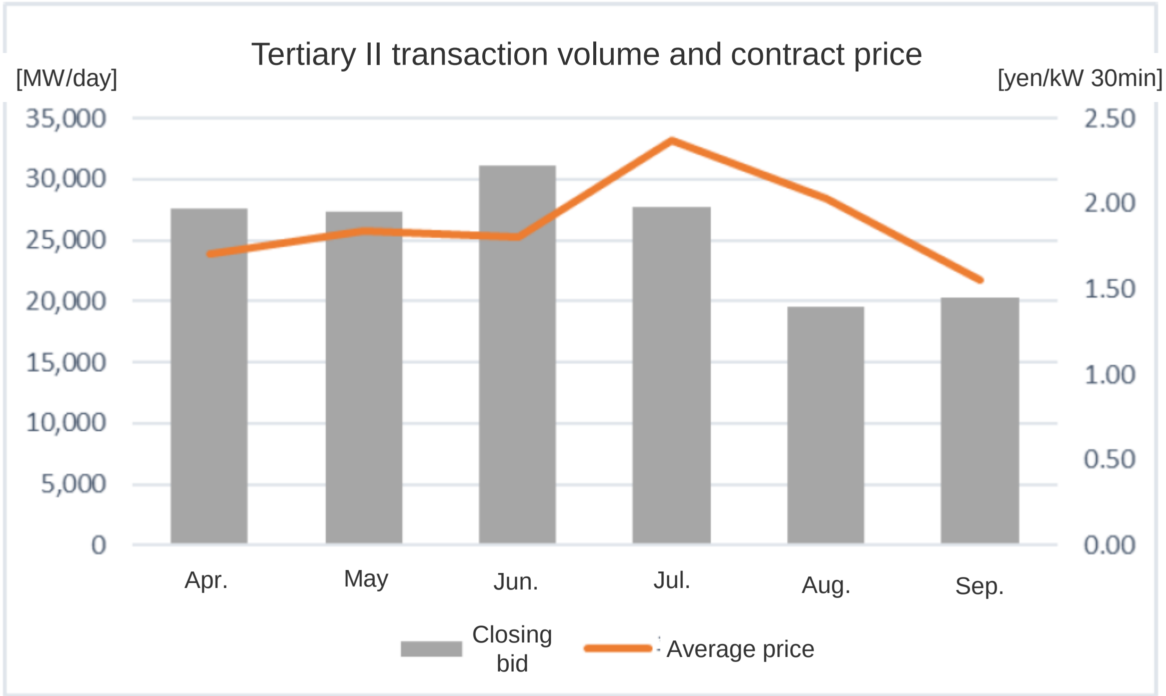


	Transaction volume (daily ave.)[MW]			Bidding /Offering	Closing bid /Offering
	Offering	Bidding	Closing bid		
Apr.	30,916	39,518	27,529	127.8%	89.0%
May	31,726	38,155	27,297	120.3%	86.0%
Jun.	32,603	49,658	31,093	152.3%	95.4%
Jul.	31,829	43,161	27,670	135.6%	86.9%
Aug.	22,841	37,656	19,526	164.9%	85.5%
Sep.	**20,298**	**44,704**	**20,239**	**220.2%**	**99.7%**
Apr. 1st- Sep. 14, 2021	**29,123**	**41,888**	**26,039**	**143.8%**	**89.4%**

Source: METI

Contract price of Tertiary II

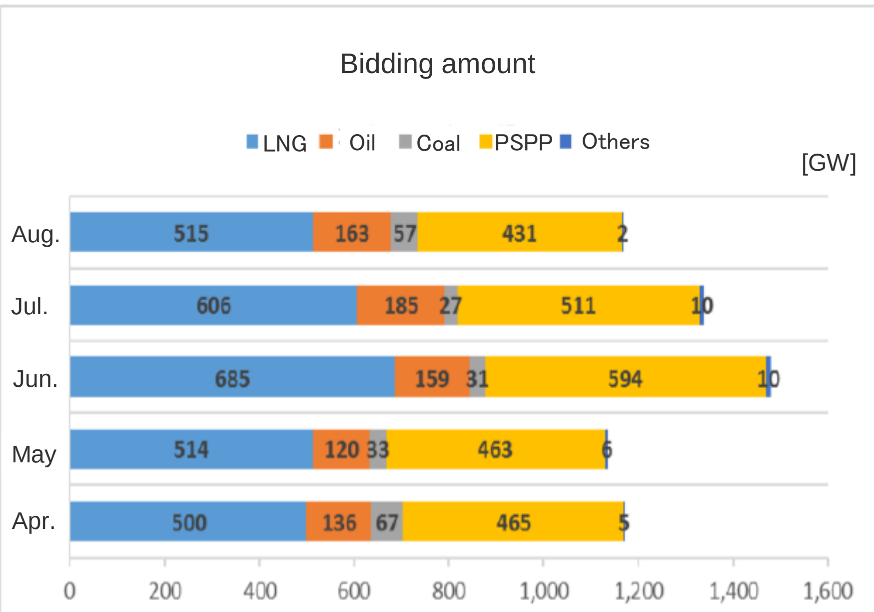
- Since April 2021, the average closing bid price was around 1.8 yen/kW 30min.
- Due to the high demand period from July, closing bid price was 2.37 yen/kW 30min in July and 2.03 yen/kW 30min in August, which were higher than the first quarter.
- The average closing bid price in September was 1.55 yen/kW 30min, which was lower than before August.

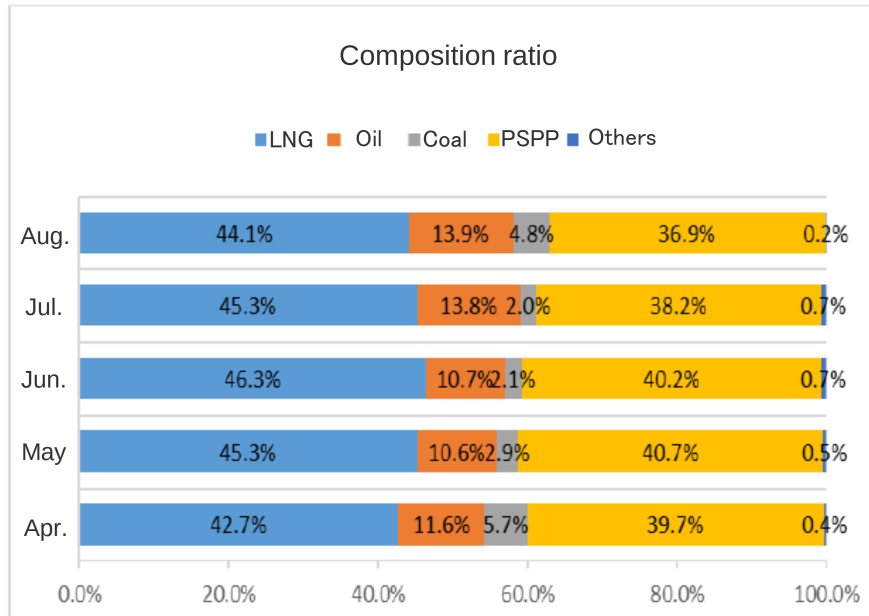


Transaction status by power supply type

- LNG thermal power and pumped storage hydropower account for about 80% of the bid amount and composition ratio for each source type of tertiary II from April to August 2021.

Tertiary II bidding configuration(Apr.-Aug. 2021)

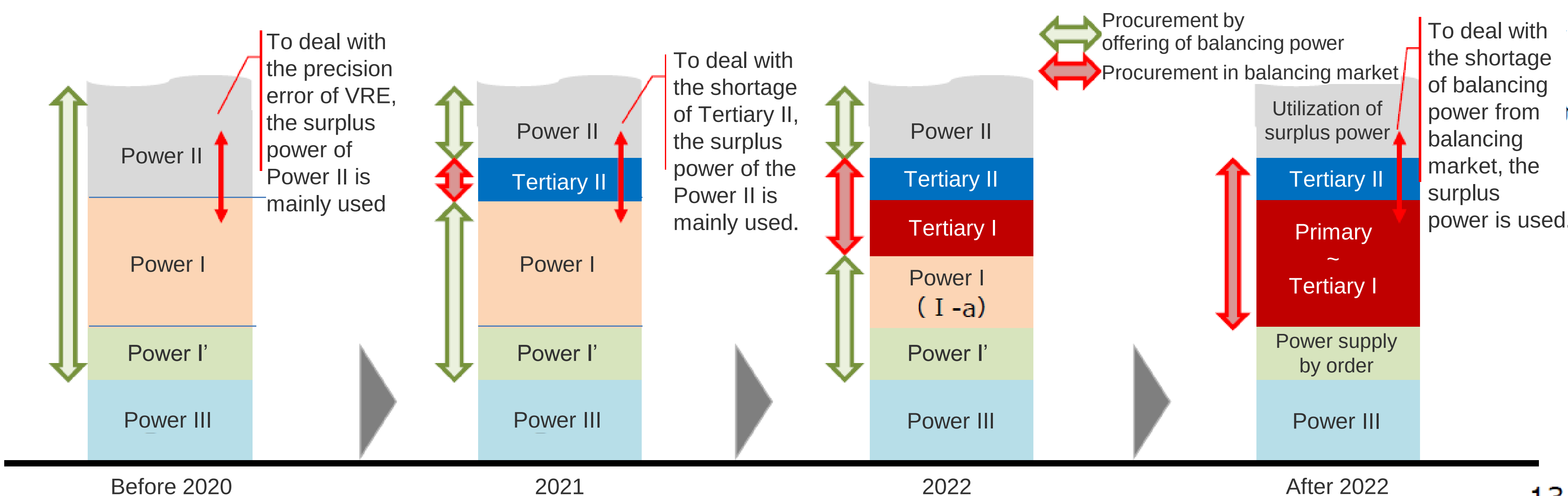




Others include DR, VPP, battery storage and general hydropower

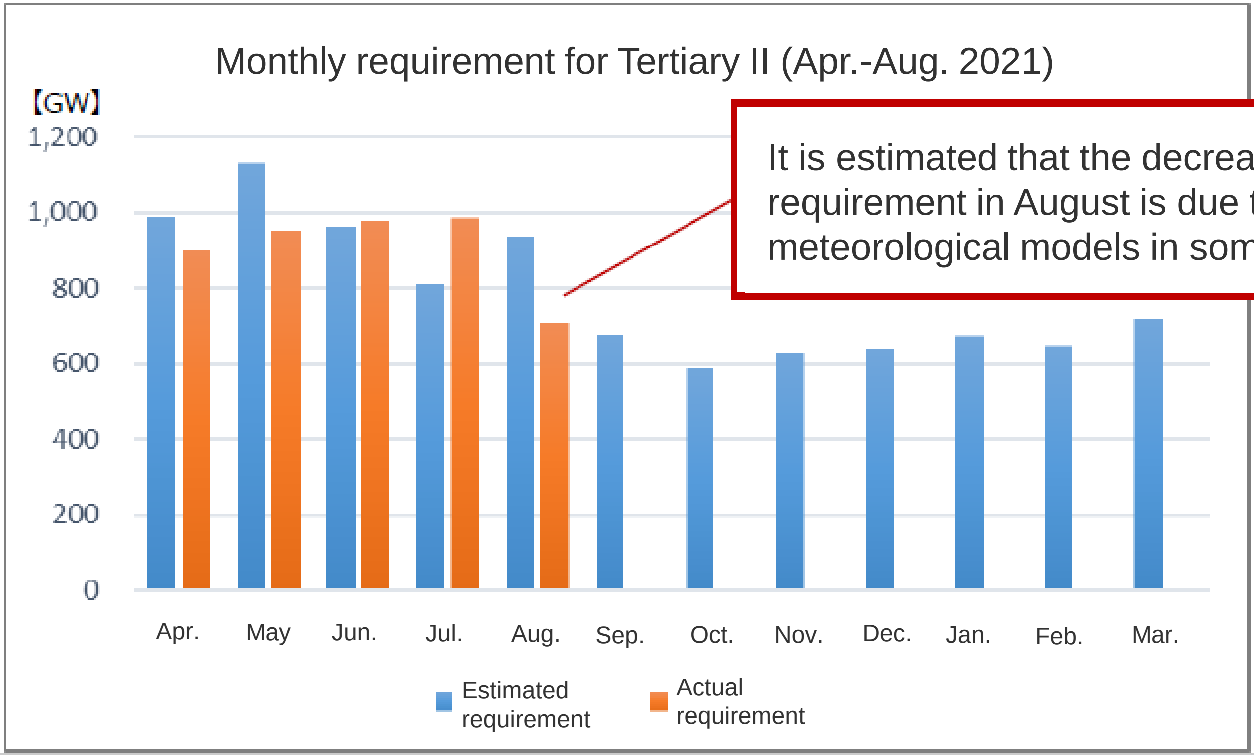
Concerns 1
Reliable procurement of balancing power only in balancing market

- Since the stat of transaction in April 2021, the procurement shortage of Tertiary II has continued.
- In the future, as the amount of VRE such as solar PV increases, it is estimated that the required amount of balancing power corresponding to the prediction error will increase, and it is important to procure sufficient balancing power.
- It is necessary to consider the full-scale operation from 2024.



Concerns 2
Offering of balancing power in an appropriate amount for stable supply

- There is a possibility that the amount of balancing power offered is excessive, and one of the improvement measures is to improve the accuracy of VRE prediction. "Utilization of multiple meteorological models" has been shown to be effective in improving forecasts, and its application is currently underway at TSO.



It is estimated that the decrease in the actual requirement in August is due to the use of multiple meteorological models in some TSOs.

Source: METI

Concerns 3
Expanding market participants to stimulate competition

- In order to increase the bid volume, it is necessary to participate in the market from a wide range of business such as DR and VPP businesses.
- As of the end of August 2021, the number of members in the balancing market is 29(27 companies), which is an increase from 24 members (22 companies) at the start of the market.

Concerns 3
Further activation of wide-area procurement

- Wide-area procurement is effective in reducing the cost of procuring balancing power. Therefore, it is important to optimize the free capacity of the interconnection line.

Disconnecting rate of interconnection capacity for Tertiary II (Apr.-Aug. 2021)

[凡例]
青字：4月～5月と比較して広域調達の向上
赤字：4月～5月とと比較して広域調達の悪化

北陸・関西間（越嶺）

	4～5月	6～8月
北陸→関西	23%	5%
関西→北陸	14%	6%

中部・北陸間（BTB）

	4～5月	6～8月
中部→北陸	14%	21%
北陸→中部	18%	41%

北海道・本州間（北本）

	4～5月	6～8月
北海道→東北	71%	58%
東北→北海道	88%	29%

関西・中国間（関中）

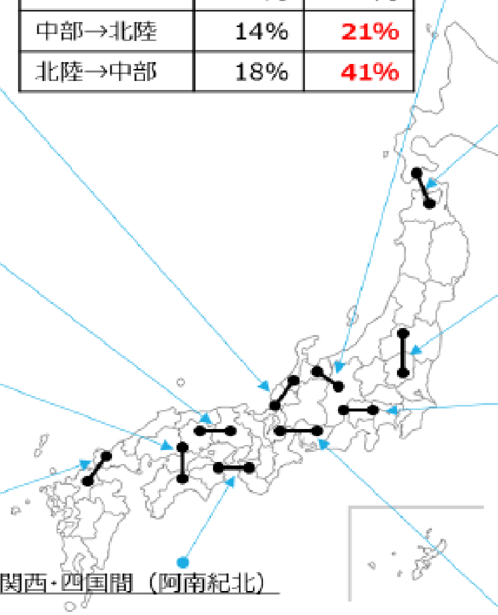
	4～5月	6～8月
関西→中国	5%	0%
中国→関西	17%	3%

東北・東京間（相双）

	4～5月	6～8月
東北→東京	50%	8%
東京→東北	2%	1%

中国・四国間（本四）

	4～5月	6～8月
中国→四国	6%	3%
四国→中国	39%	2%



東京・中部間（FC）

	4～5月	6～8月
東京→中部	41%	61%
中部→東京	63%	17%

中国・九州間（関門）

	4～5月	6～8月
中国→九州	78%	23%
九州→中国	99%	46%

関西・四国間（阿南紀北）

	4～5月	6～8月
関西→四国	6%	39%
四国→関西	39%	52%

中部・関西間（三重東近江）

	4～5月	6～8月
中部→関西	65%	23%
関西→中部	61%	36%

※ 分断率＝三次調整力②向け連系線容量が0のコマ数÷月のコマ数×100

出所）送配電網協議会提供の情報をもとに事務局にて作成

Balancing Market in Europe

Ceylon Electricity Board
JICA Expert Team

October 27, 2022

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

Positioning of the Balancing Market

After the unbundling legally, which is the final form of liberalization, it is necessary for TSOs who do not have any power generation to procure the control rights of power generation in order to perform proper grid operation. In this way, "Balancing market" has a role of procuring it economically.

Procurement options

① Command to system users to provide as an obligation
② Procurement by bilateral contract with the balancing power providers
③ Procurement utilizing market mechanism

① Designated as a grid connection condition. Mandatory service for a fee or free
② Procurement method when it is difficult to standardize services or the market competition won't work because there are few providers.
③ Procurement method when service can be designed as a standardized product and there are many providers so that market competition works

This is the last resort, and it is necessary to pursue how much economic efficiency can be improved within the range that does not influence the system operating function.

Source: MRI report (2018)

Obligation to bid on the Balancing Market

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NIPPON KOEI

- After the service products procured by the Balancing market is determined, it is necessary to confirm whether the balancing power required for stable supply can be surely secured in this market.
- It is necessary to design whether the Balancing market should be voluntary or mandatory participation. If it is mandatory, it is necessary to design what extent should be obligatory as well.

Bidding scheme to the Balancing market

① Imposing a bidding obligation on the Balancing market for players who have the ability to supply balancing power

② While bidding on Balancing market is voluntary, alternative measure to secure balancing power will be established in preparation for a shortage of bidding on the market.

① Ex., Deployed to PJM in US, etc. Full pool scheduled model

② Ex., STOR（Short Term Operating Reserve）in UK, etc. (See for the detail later)

In Germany, if the Balancing market cannot secure a sufficient volume, an additional market will be held, and if the necessary volume is still not be secured, TSO directly procures without going through the market. In this way, it is necessary to secure back-up scheme.

Source: MRI report (2018)

Economic rationality by introducing Balancing Market

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NIPPON KOEI

- The main purpose of introducing the Balancing market is to reduce the procurement cost
- It is necessary to form the market price from three aspects: market range, trading system, and competitive environment.

Transaction design

①Product design, ②Winning bidder determination, and ③Settlement have a great influence on price formation.

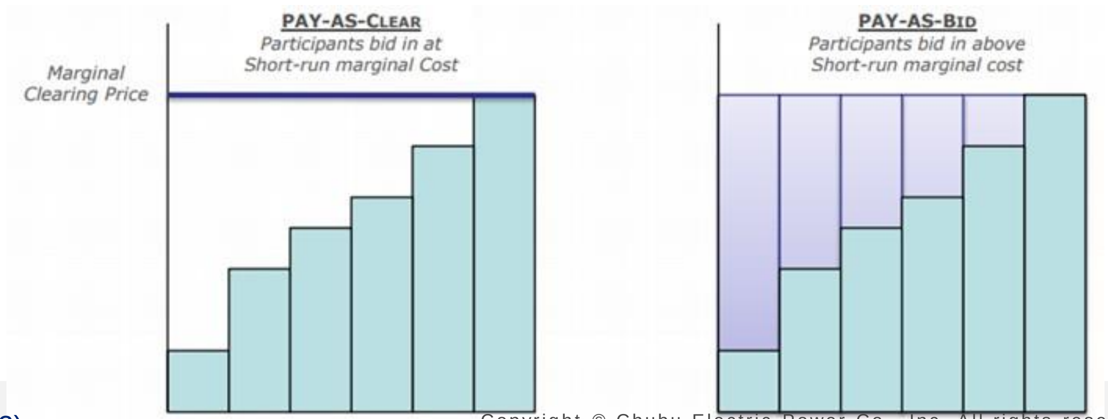
① Product design is made from the viewpoint of the technical specifications required by TSO. It is also an important factor that there are enough bidders and competition can be expected.

② Simply choosing a cheap option is not a minimization. It is necessary to consider the sum, “ΔkW value + kWh value” (See for the detail later).

③ There are mainly two methods, "Pay as Clear"*1 and "Pay as Bid"*2. It is necessary to scrutinize the competitive environment to determine which one will be minimized.

※1 : Payment at uniform market price
Participants are automatically awarded the price of the most expensive offer accepted

※2 : Payment at the price offered by players
Participants have the incentive to bid at the price of the most expensive offer accepted



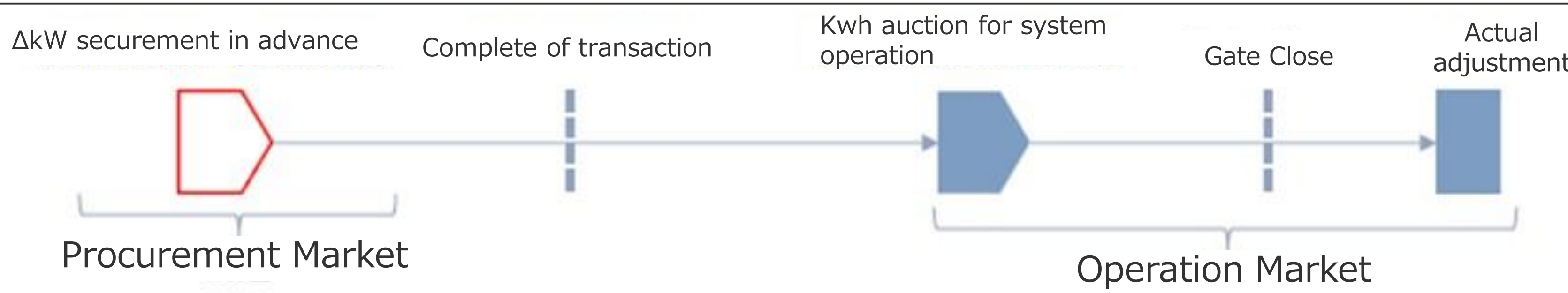
Source: MRI report (2018) Source: ofgem Report (2012)

Two-stage Structure of Balancing Market

- In the liberalized market, the principle is to entrust the balancing power procurement to the free contractual relationship between power generation companies and retailers through the wholesale electricity market.
- TSO needs to procure the necessary volume before the wholesale power transaction is completed. On the other hand, due to generation dropouts and temperature fluctuations, balancing power required for system operation will not be finalized until the actual time.

Two-stage Structure of Transaction

- In the “Procurement market“, "(ΔkW)“ is procured in advance that enables TSO to freely control the raising and lowering
- In the “Operation market”, After that, the necessary adjustment amount (kWh) in the actual time is procured.



Source: MRI report (2018)

Two-stage Structure of Balancing Market cont'd

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Procurement Market

- Held not regularly such as annually, monthly, weekly, daily, etc., depending on the design, which is not the real-time market

Operation Market

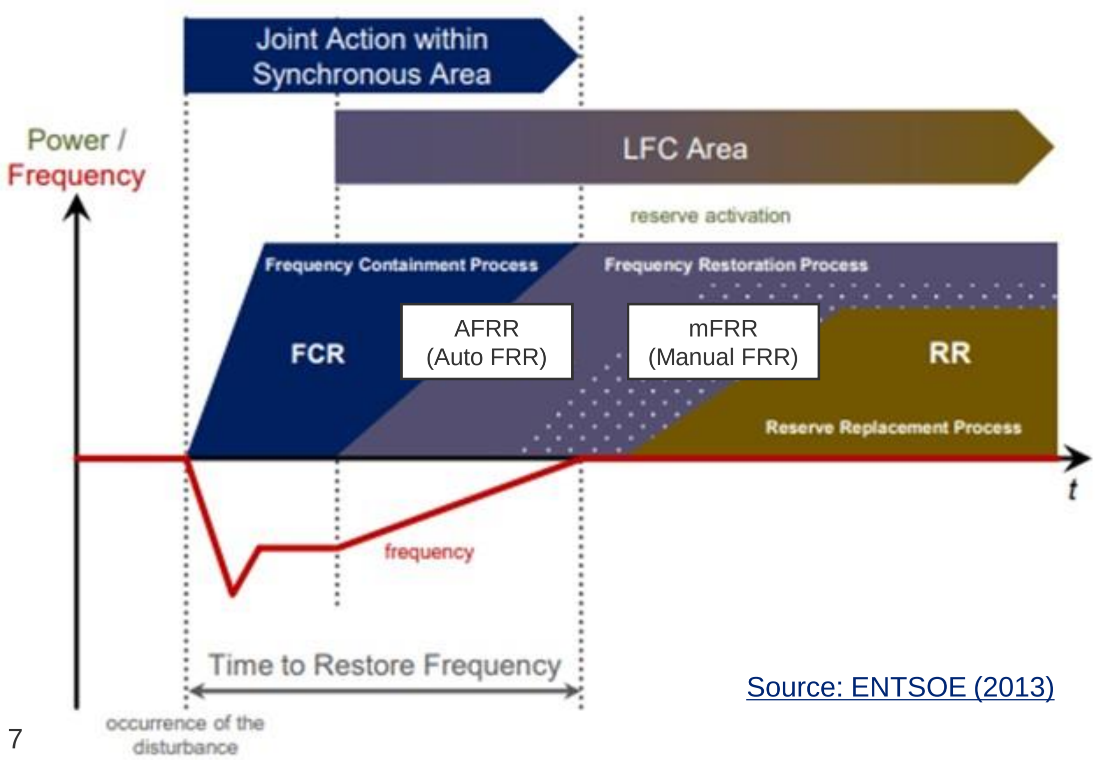
- TSO monitors supply and demand balance and frequency fluctuations, and activates the required amount of balancing power to eliminate the imbalance.
- If there are no technical restrictions on the target equipment or system congestion, the Balancing power will be deployed in ascending order of the bidding price.
- Payment will be transacted via the "Pay as bid method" or the "Pay as clear method".
  - ➢ In the raising direction (increasing power generation), TSO pays to the Balancing power provider.
  - ➢ In the lowering direction (reducing power generation), the profits from the Balancing power provider that did not incur the power generation cost are returned to the TSO.

Source: MRI report (2018)

Products of Balancing Power

European Grid Code

- It is classified into the following three types based on "the respond speed to reach the specified output level" and "the continuous duration at the specified output".
  - FCR (Frequency Control Reserve)
  - FRR (Frequency Restoration Reserve)
  - RR (Replacement Reserve)



Source: ENTSOE (2013)

	UK
FCR	Frequency Response
FRR	Fast Reserve BM Start-up Fast Start
RR	STOR STOR Runway

See for the detail later

Source: MRI report (2018)

How to procure the Balancing Power

CHUBU Electric Power
NIPPON KOEI

- In Germany, it is procured from the national market (Regelleistung) jointly operated by four TSOs
- In the UK, in addition to bidding, services are subdivided according to TSO's technical and policy needs. Then it is procured by combining mandatory and bilateral contract.
- In Northern Europe (Norway), it is procured through a market operated by TSO. However, if there is a shortage, additional procurement will be conducted through a bilateral contract with BSP (Balance Service Producer).
- In France, aFRR is mandatory procurement, others are market procurement

	Mandatory contract	Bilateral Contract	Procurement from Market
FCR	✓ UK (Mandatory Frequency Response)	✓ UK (Frequency Control by Demand Management, FFR Bridging Contract)	✓ Germany (Primary control reserve) ✓ UK (Firm Frequency Response, Enhance Frequency Response) ✓ North Europe (FCR-N, FCR-D) ✓ France (Primary Control)
FRR	✓ France (Secondary Control)	✓ UK (Fast Reserve) ✓ North Europe (mFRR)	✓ Germany (Secondary Control Reserve) ✓ UK (Fast Reserve, BM, Start-up Fast Start) ✓ North Europe (aFRR, mFRR) ✓ France(Fast reserve)
RR	N/A	N/A	✓ Germany (Tertiary Control Reserve) ✓ UK (Short Term Operating Reserve, STOR Runway) ✓ France (Complementary Reserve, Demand Response call for tender)

Source: MRI report (2018)

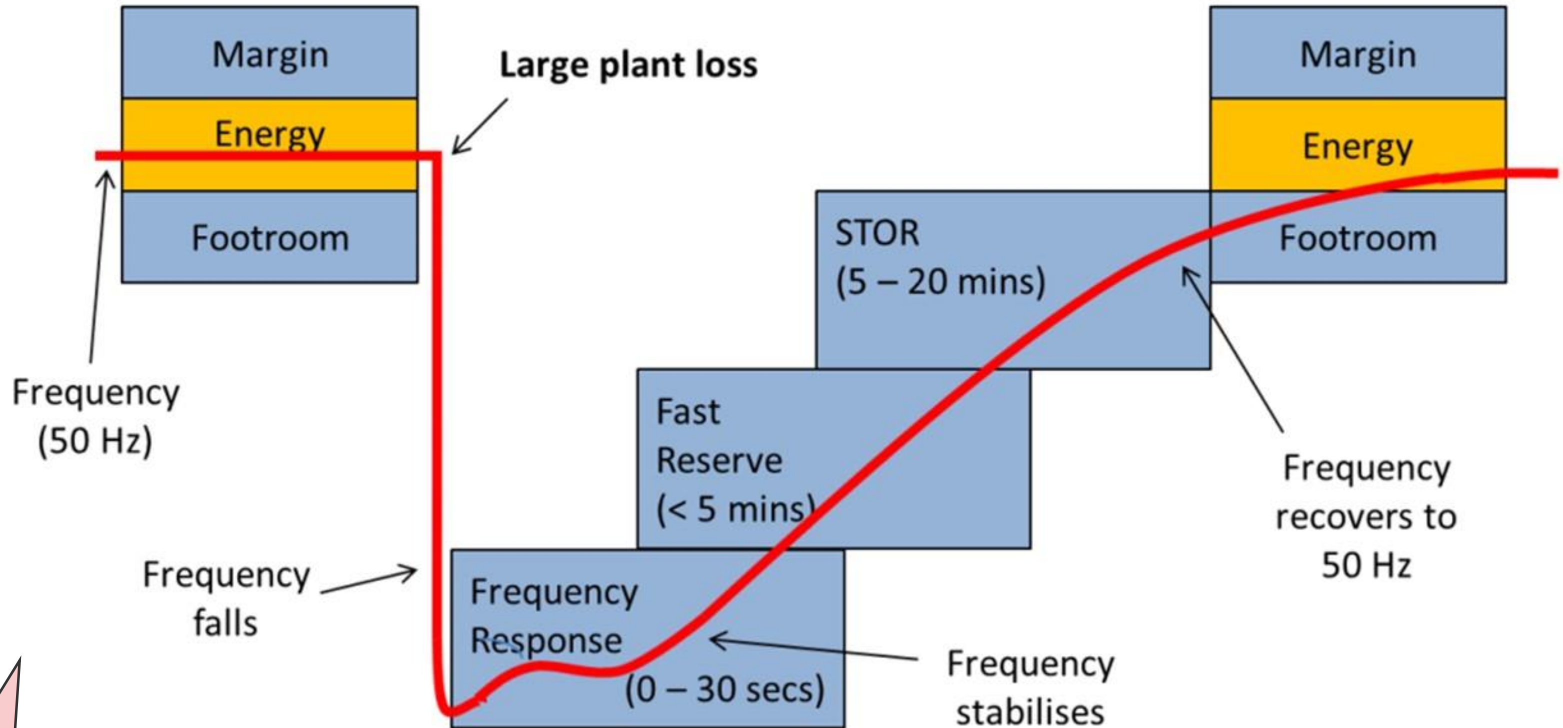
Products of Balancing Power (UK)

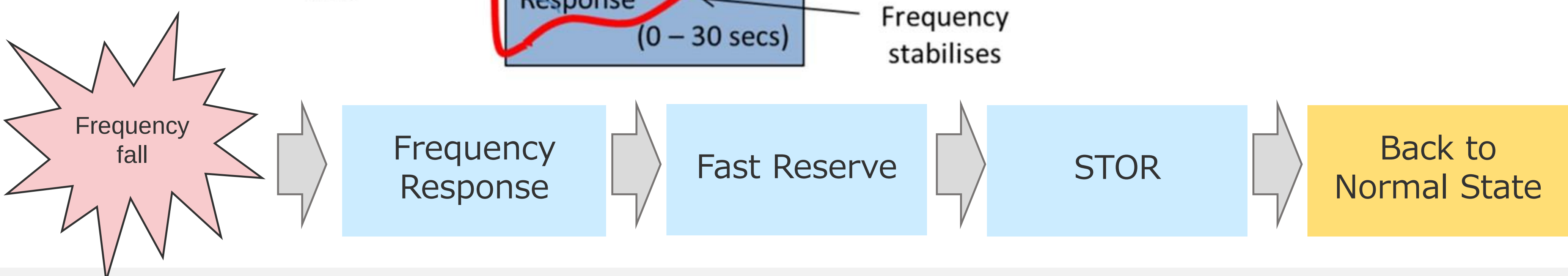
Type	Products	Characteristics	Time to reach the designated output	Procurement type
FCR	Mandatory Frequency Response	✓ Mandatory for all power sources connected to the grid ✓ Three types: Primary, Secondary, High	Less than 10 sec～Less than 30sec	Mandatory
	Firm Frequency Response (FFR)	✓ Procurement by bidding ✓ The role of complementing the frequency response obligation ✓ Three types: Primary, Secondary, High	Less than 10 sec～Less than 30sec	Bidding Bilateral
	Frequency Control by Demand Management	✓ Shedding consumers when the frequency drop relay operates	2sec～10sec	Bilateral
	Enhanced Frequency Response	✓ Target resources (mainly batteries) with a response speed of 1 sec or less	Less than 1sec	Bidding
	FFR Bridging Contract	✓ FFR produced by consumers (under design)	10sec or 30sec	Bilateral
FRR	Fast Reserve	✓ Generation output increase and restrained demand	4min	Bidding Bilateral
	BM(Balancing Mechanism) Start-up	✓ Start the BM Unit (BMU) that is not operating on the day	89min	Bilateral
	Fast Start	✓ Start from a stopped status in an emergency	5min (Auto), 7min (Manual)	Bilateral
RR	STOR(Short Term Operating Reserve)	✓ Supplying additional active power	20min (4h at maximum)	Bidding
	STOR Runway	✓ Supplement of STOR	20min (4h at maximum)	Bidding
Others	Demand Turn up	✓ Increased demand when there is a risk of Renewable power exceeding when the load is low	-	Bilateral

Source: MRI report (2018)

Function of Balancing Power (UK)

After a large-scale power generation drops and the frequency drops sharply, National Grid returns to a steady state by properly utilizing the service products.





Source: MRI report (2018)

Products of Balancing Power (Germany)

Type	Products	Characteristics	Time to reach the designated output	Procurement type
FCR	PCR (Primary Control Reserve)	✓ Automatic frequency adjustment capability that can adjust the output within 30 seconds	Less than 30sec	Bidding
FRR	SCR (Secondary Control Reserve)	✓ Output adjustment capability provided by a power generation with AFC (Automatic Frequency Control) function that can adjust the output within 15 minutes in response to the TSO's command.	Less than 5min	Bidding
RR	TCR (Tertiary Control Reserve) or MR (Minute Reserve)	✓ Adjustment capability to follow the load within 5 minutes from the TSO's command when a power supply deficit occurs.	Less than 15min	Bidding

Source: MRI report (2018)

Products of Balancing Power (Norway)

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Type	Products	Characteristics	Time to reach the designated output	Procurement type
FCR	FCR-N (Frequency Containment Reserve in Normal condition)	✓ Automatic frequency adjustment capability for frequency fluctuations (Automatically adjusted within a frequency deviation of 50Hz ± 0.1Hz)	Less than 2～3min	Bidding
	FCR-D (Frequency Containment Reserve in Distributed condition)	✓ Activated in a 200 MW loss accident （Automatically activated when the frequency falls below 49.9Hz so that system frequency can maintain ≥49.5Hz）	Less than 30sec	Bidding
FRR	aFRR (Automatic Frequency Restoration Reserve)	✓ After FCR (FCR-N, FCR-D) is activated, or when they do not exist, it is activated automatically and the frequency is restored to 50Hz.	Less than 15min	Bidding
	mFRR (Manual Frequency Restoration Reserve)	✓ Activated by TSO after FCR/aFRR is activated or if they do not exist ✓ Activated to reduce predictive imbalance ✓ Elimination of power flow congestion in Scandinavian area ✓ Activated manually from the control center of TSO in each Scandinavian country	Less than 15min (Manual)	Bidding
RR	N/A	N/A	N/A	N/A

Source: MRI report (2018)

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Electric Power

NIPPON KOEI

Introduction of Balancing Market in UK

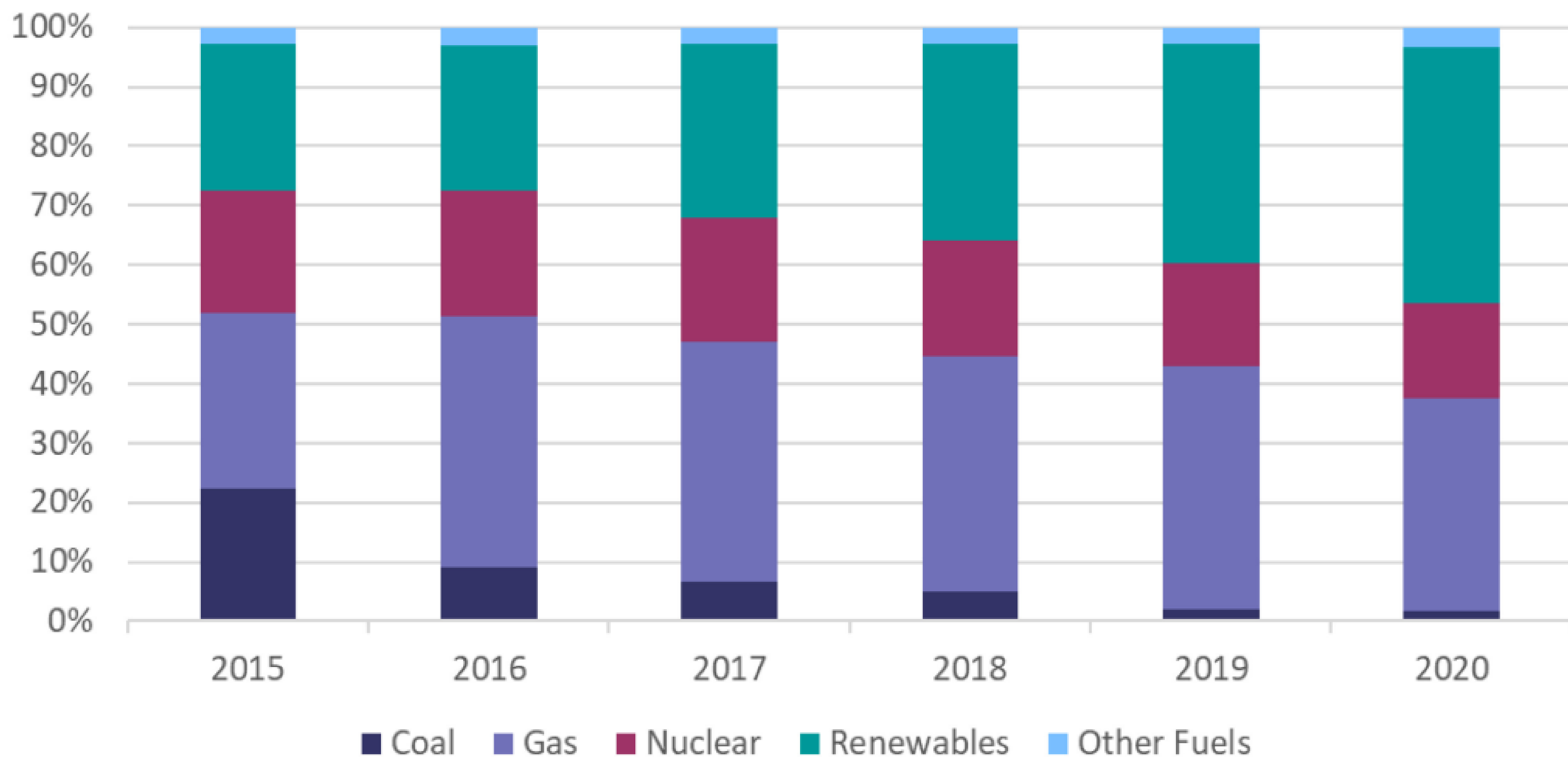
Ceylon Electricity Board
JICA Expert Team

December, 2021

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

1 UK Energy Sector Overview

UK Energy Sector Overview

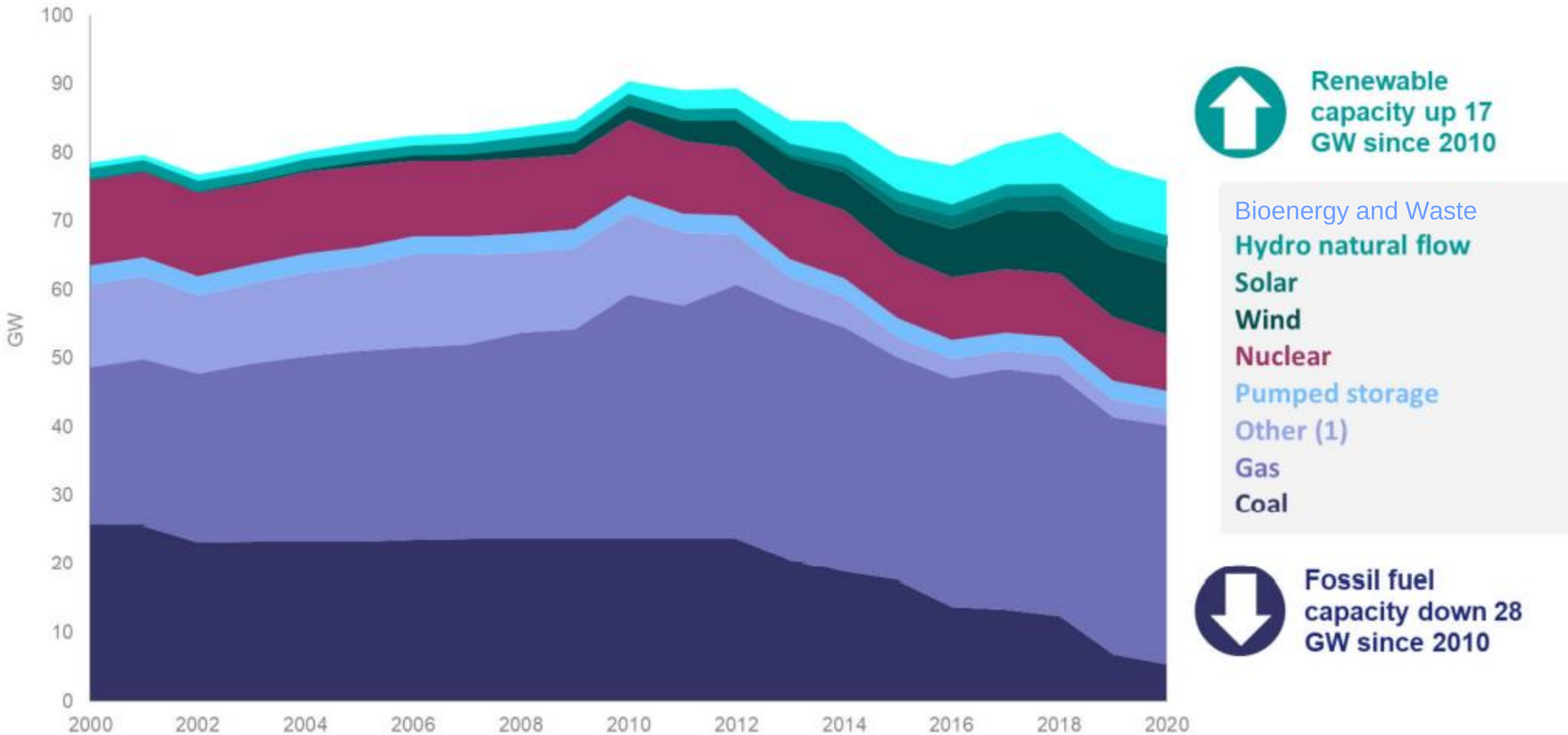


(Source) Digest of UK Energy Statistics 2021

Fig.1 Shares of Electricity Generation by Fuel, 2015-2020

https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2021

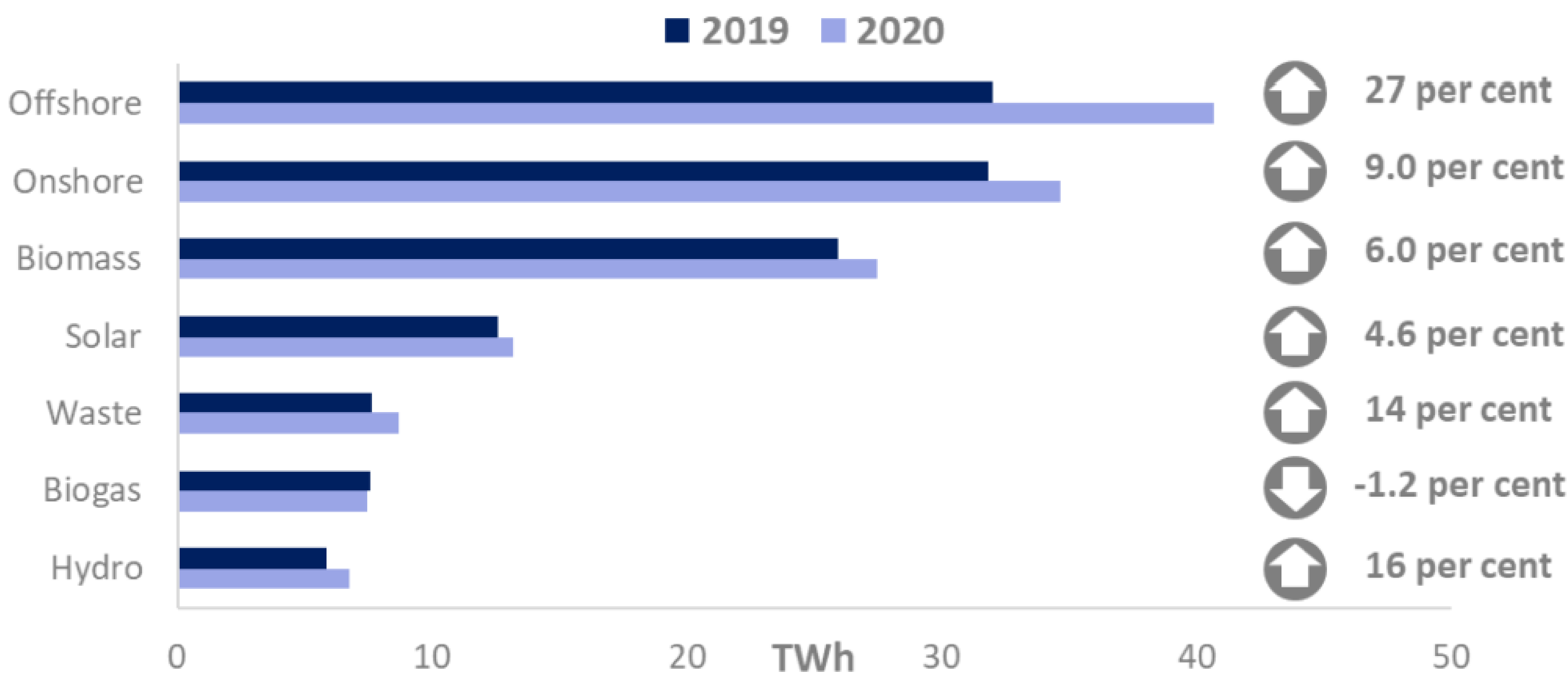
UK Energy Sector Overview



(Source) Digest of UK Energy Statistics 2021

Fig.2 Installed Capacity of UK Electricity Generation Assets by Fuel, 2000 to 2020

UK Energy Sector Overview



(Source) Digest of UK Energy Statistics 2021

Fig.3 Growth in Generation by Fuel 2019-2020

UK Energy Sector Overview

Market Roadmap to 2050

	2020	2025	Description
Supply side			These new low-carbon sources should provide cost effective power. But they will also change the characteristics of how the system behaves in terms of greater unpredictability. This means that markets will need to attribute more value to speed of service response, and enable decisions for market outcomes closer to real time operation
Renewable generation (%)	38%	75%	
Offshore wind	9.5GW	24.7GW	
Solar	13GW	19GW	
Interconnector capacity	4.75GW	17.9GW	
Demand side			Vast amounts of new potential flexibility will connect to the system, from a variety of sources including EVs and batteries. Markets across both transmission and distribution need to be co-ordinated and co-optimise to recognise the whole electricity system value that these assets can deliver.
BEVs of total cars	0.3%	9%	
Battery storage	1GW	>4GW	
Residential heat pumps	162k	1.86m	
Transmission demand summer Sunday pm	18.8GW	14.5GW	
Transmission peak demand	46.2 GW	38.7GW	

(Source) National Grid ESO “Market Roadmap to 2025”

Recent Situation of RE development in UK

UK is top runner of RE developing country among EU they have high proceeding in decarbonization.

In 2020, UK had experienced some special records under decarbonizing policy such as below.
Energy share of wind power generation to total energy of UK was 24.8% in 2020.
>The maximum power of wind turbine plant had recorded 17.2 GW on December 8 2020 between 13:00 and 13:30.
>And on 26 August 2020, **Wind Power had momentarily covered 59.9% of whole UK powe**r.

(Source) Japan Electric Power Information Center report

2 Development of Renewable Energy in UK

UK: Current Situation and Expectation of Development of RE

Power Market in UK has been changing due to Government policy and due to technical developments same as Europe goes on.

- Power Demand
  >In middle term, not so much increase is expected in power demand, however, large increase is expected in long term because of heat use and electrification of traffic infrastructures.

- Thermal Power Plant
  >**Coal Power Plant (PP) would be closed and Gas PP will be substituted with part of the Coal PP**.
  >**Old Gas PP would be substituted with new Gas PP**.

- Variable Renewable Energy
  >Increasing off-shore Wind PP.
  >Huge amount of new Solar PP will be connected to distribution line.
  >Large amount of new Solar PP will be connected to transmission line.

(Source) Website information

UK: Current Situation and Expectation of Development of RE

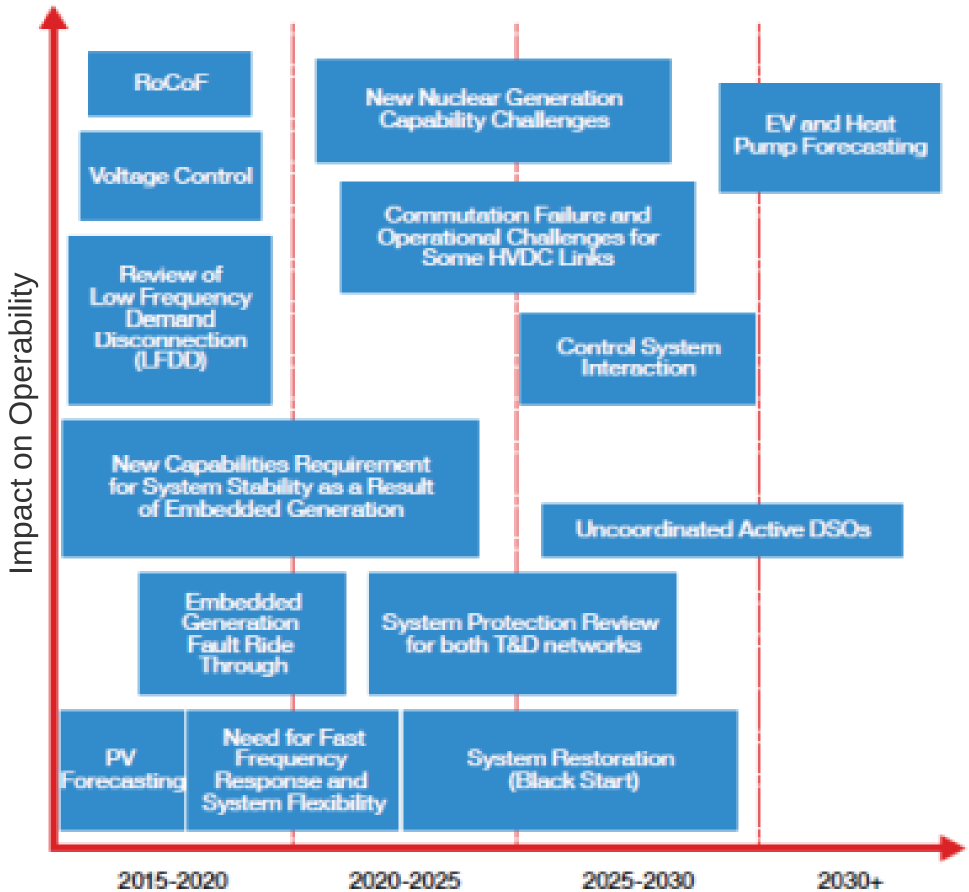
Power Market in UK has been changing due to Government policy and due to technical developments same as Europe goes on.

- Nuclear Power
  >Closing existing Nuclear PP
  >At least one (1) Nuclear PP will be operated
- Connection to the Power System
  >Large amount of RE will be connected to the Power System
  >Changing power flow direction owing to increase of the RE generation power
- Technology Development
  >Development of demand management and improvement of Efficiency
  >Increasing EV
  >Rising up of power storage for power system solution

(Source) Website information

UK: Treatment to Expansion of Renewable Energy

Changing of power source mixture requires new development of assistance tools for power system among National Grid operation scheme.



- ✓Further Instability
- ✓Decreasing of synchronous generator
- ✓Rising new type flexible providers
- ✓Increasing distributed power supply system
- ✓Changing demand curve
- ✓Necessity of new flexible power and ancillary service
- ✓Uncertainly of policy for important factor

*RoCoF: Rate of Change of Frequency

(Source) Mitsubishi Research Institute Inc. Report with Del Norske Veritas information

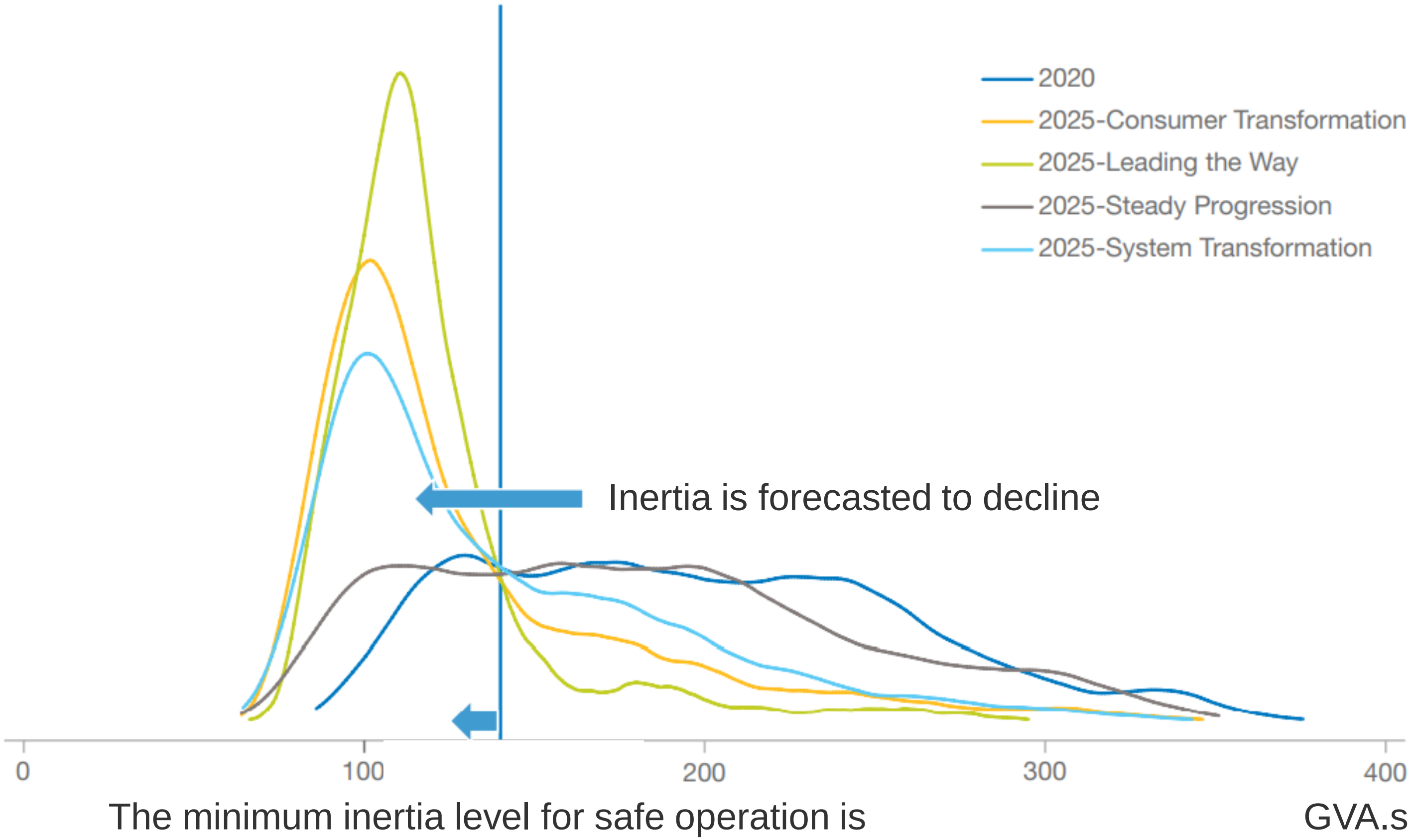
*Embedded Generation refers to energy assets embedded on customers' sites or into the distribution grid. Most commonly, it refers to combined heat and power (CHP), solar PV, wind and energy from waste technologies.

UK: Influence by Spreading Renewable Energy

The figure shows the distribution of inertia values provided by the market (before NGESO take actions to manage the system), estimated in 2020 and forecast for 2025 based on NGESO's Future Energy Scenarios. In 2020, a minimum inertia level of 140GVA.s is operated. Going forward, the minimum inertia level will be determined by the Frequency Risk and Control Report (FRCR), it is expected to be lower in 2025.

(Source) National Grid ESO "Market Roadmap to 2025"

Annual Distribution of System Inertia



The minimum inertia level for safe operation is expected to be lower than 140GVA.s

The annual forecasted average inertia provided by the market will decline in 2025, based on FES scenario to 131GVA.s (Consumer Transformation) - 119GVA.s (Leading the Way) - 180GVA.s (Steady Progression) - 140GVA.s (System Transformation). Short circuit level and dynamic voltage support are also expected to drop overall

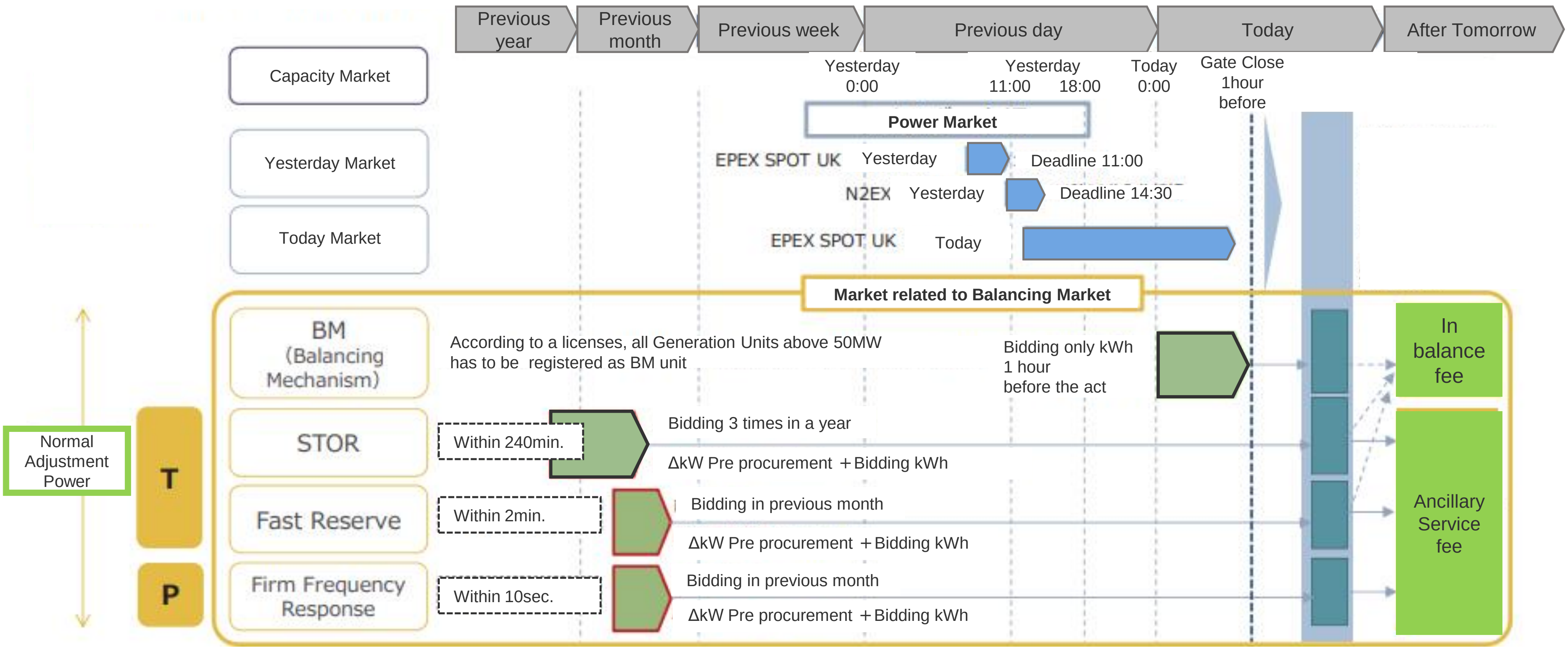
3 Outline of Balancing Market in UK

Abbreviations related to UK Balancing Power Market

BM:	Balancing Mechanism
BMU:	Balancing Mechanism Unit
DM:	Demand Management
EFR:	Enhanced Frequency Response
EPXE:	European Power Exchange
ERPS:	Enhanced Reactive Power Service
FFR:	Firm Frequency Response
FPN:	Final Physical Notification
FR:	Fast Reserve
FRR:	Frequency Restoration
IPN:	Initial Physical Notification
MFR:	Mandatory Frequency Response
NGESO:	National Grid Electricity System Operator
N2EX:	Day-Ahead Auction Market
ORPS:	Obligatory Reactive Power Service
RoCoF:	Rate of Change of Frequency
SEL:	Stable Export Limit
STOR:	Short Term Operation Reserve

UK: Process related to Balancing Market

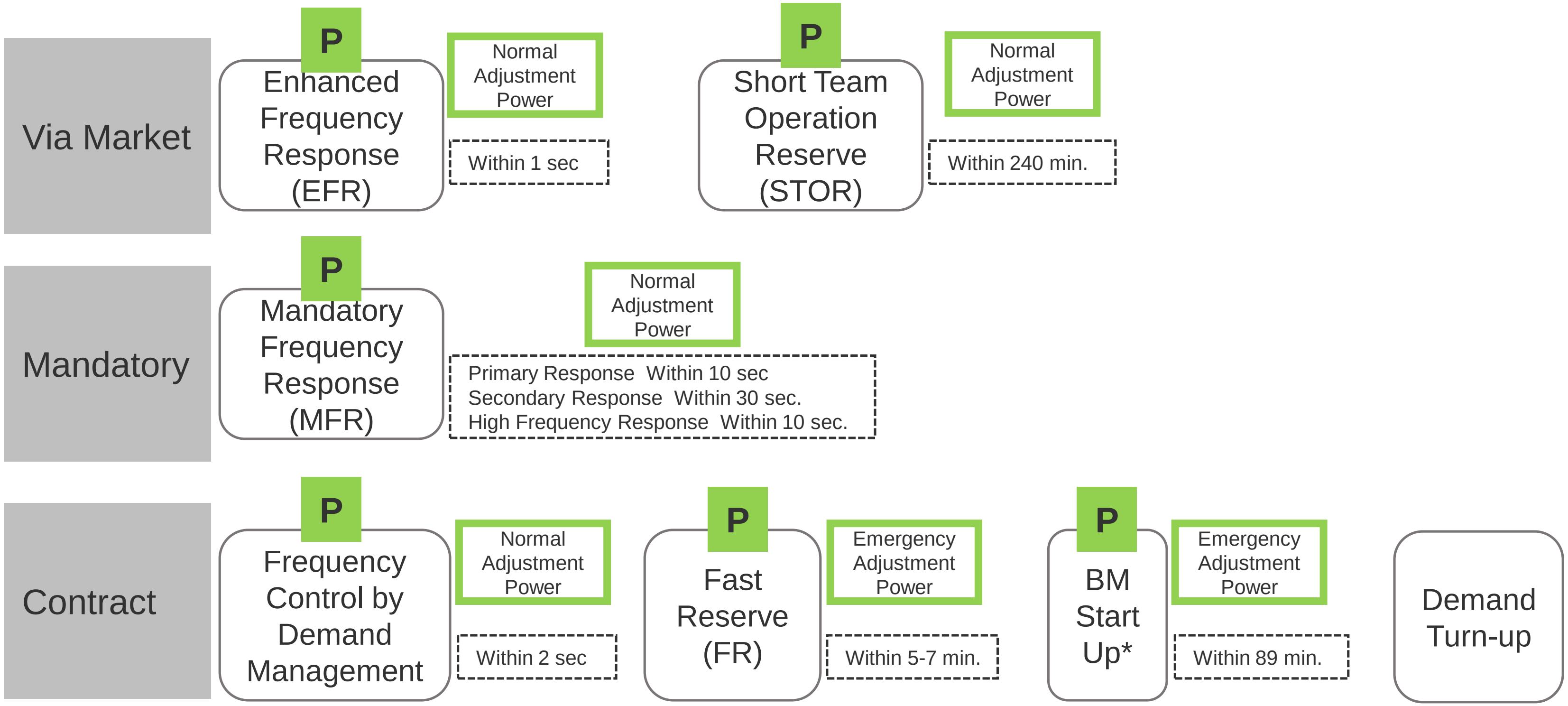
- Balancing between supply and demand is totally adjusted through the Balancing Market



(Source) Mitsubishi Research Institute Inc. Report

UK: Process related to Balancing Market

- Balancing between supply and demand is totally adjusted through the Balancing Market



Various ways are considered and mixed in the Balancing Power Market.

* Start up: The BM start up service gives us on-the-day access to additional generation. The service is open to any Balancing Mechanism (BM) participants who expect to be unavailable within BM timescales of 89 minutes.

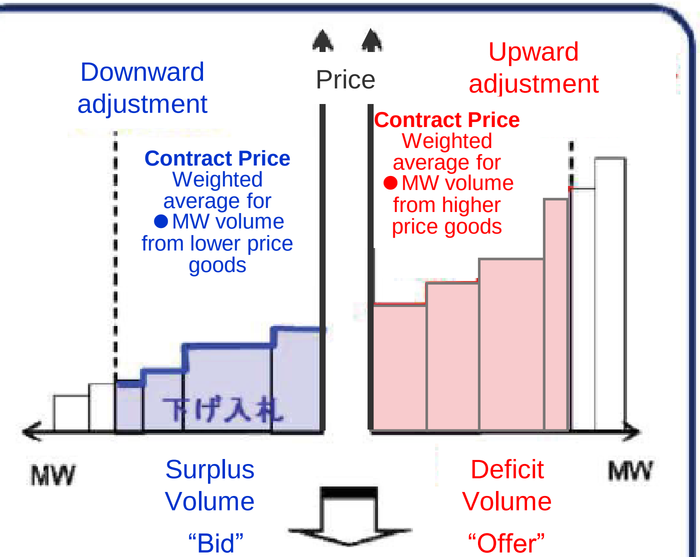
(Source) Mitsubishi Research Institute Inc. Report

3-1 Balancing Mechanism

UK : Balancing Mechanism

- Balancing Mechanism is the bidding market working after Gate Close for Balancing Mechanism Unit (who participated in Balancing Mechanism (BMU)) to procure adjustment power by NG.
- Licensed power producers (more than 50MW in capacity) and power retailers (more than 50MW in treatment volume) are required to be registered as BMU.
- Each BMU has to submit their intention of bidding on power increase or demand decrease (as "Offer") and on decrease power or demand increase (as "Bid") . Possible volume of MW (power or demand) and its selling price in each settlement period for "Offer" and "Bid" are notified to NG.
- NG receives large volume of Offers and Bids for real time manage on unbalance between supply and demand. NG decides the Offers and the Bids to deal with actually based on a lot of information such as location, response speed, variable capacity, price, etc. Adjustment of fee is decided by Pay-as-Bid method.

Adjustment of fee on Balancing Mechanism

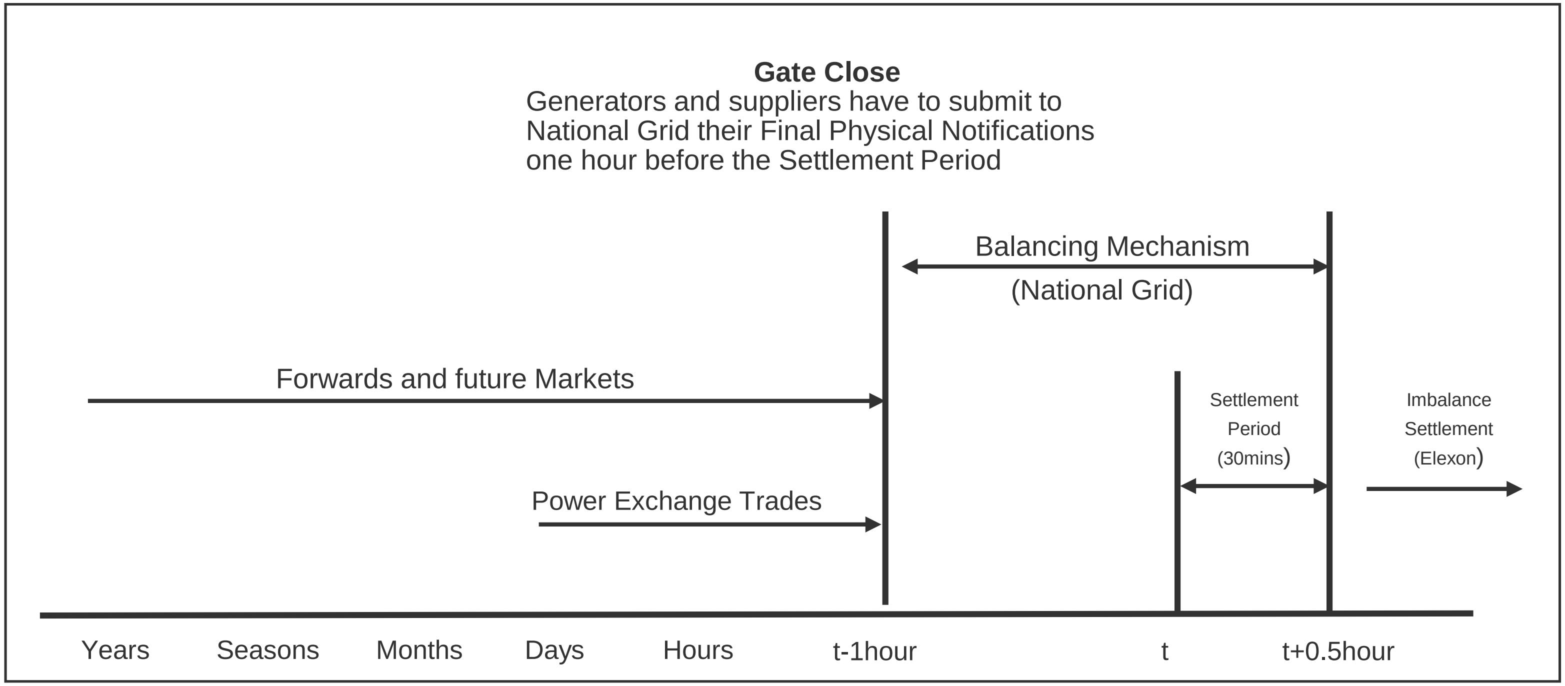


Fee adjustment by Pay-as-Bid method

(Source) Mitsubishi Research Institute Co., Inc. Report

UK：Balancing Mechanism

- All participator to the market have to submit the Initial Physical Notification (IPN), which describes expected generation or demand volumes on the operation day, by 11:00 AM on one day before the operation day. National Grid is able to grasp the power and demand situation on the operation day from the information and it makes possible to consider countermeasures to resolve the power transmission congestions.
- Power Producers and Suppliers have to submit the Final Physical Notifications (FPN), which describes final generation or demand plan, to National Grid by the Gate Close time.



(Source) Mitsubishi Research Institute Co., Inc. Report using Ofgem

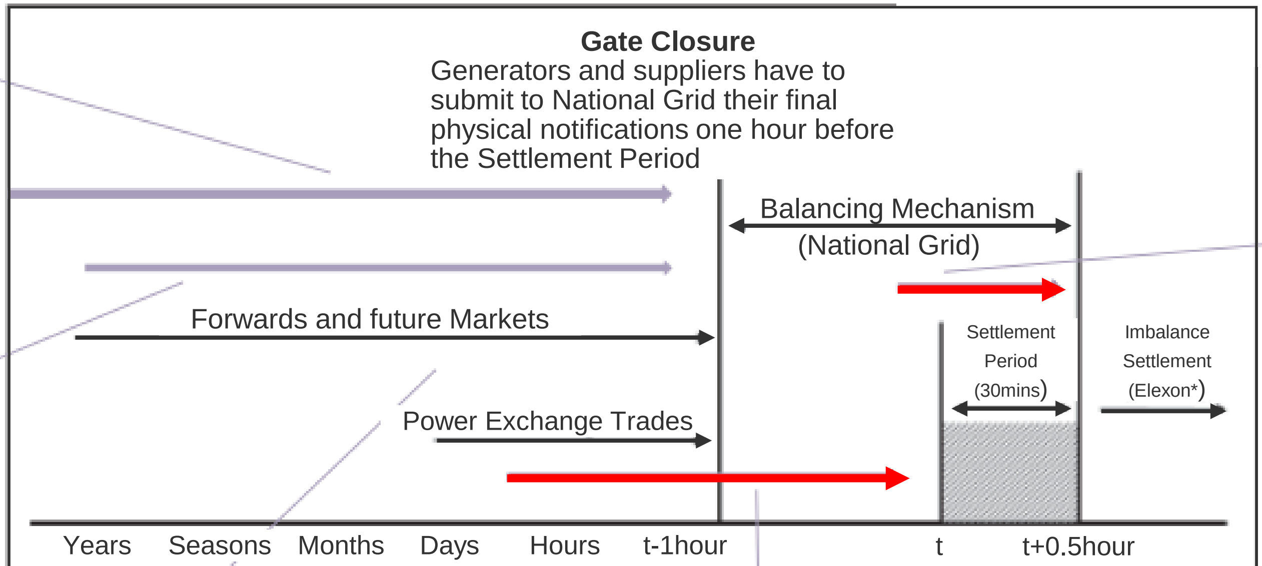
UK: Outline of Procurement of Adjusted Power

- The adjusted power deems to be included in the power market and contributes to stability of the power system.

Capacity Market
Procure & contract "MW" 4 years in advance

National Grid contracts System Support & Adjustment Power via MW or MWh

Person who is related to power markets makes motivate to treading in the Balancing Market



(Source) Mitsubishi Research Institute Co., Inc. Report using Ofgem

National Grid has to keep condition of power system by mandatory power and adjustment power

National Grid supports difference between actual condition and BM procurement such as Short Term Operation Reserve (STOR)

* Elexon was established on 1 August 2000 to manage the Balancing and Settlement Code (BSC) ahead of the New Electricity Trading Arrangements (NETA) that went live on 27 March 2001. Since then other changes have taken place that have transformed Elexon's role within the electricity market.

UK: Procurement of Balancing Power

- Adjustment Power is designed and procured in parallel with Balancing Mechanism (BM) to support the Power Market.

1. Power producers and suppliers have to belong to BM or belong to the party who participated in BM.
2. Notification of supply and demand is closed on the Gate Close (one hour before the settlement period)
3. NG adjusts the power system based on Final Physical Notification and analyzing possibility of deviation to actual power condition.
   >**Before Gate Close:** NG has a chance to procure additional adjustment power by relative deal for supplementary adjustment of power system.
   >**After Gate Close:** NG keeps power system balance by adjusting supply and demand which proposed or bidding from BM.
4. In addition, NG makes contracts on ancillary services for effective adjustment of power system.
5. NG do not disclose the adjustment power which NG can control in order to avoid influencing to price of dealing power and competition in power market.

(Source) Mitsubishi Research Institute Inc. Report

UK: Balancing Mechanism : Start up

Balancing Mechanism Start up

The BM start up service gives us on-the-day access to additional generation. The service is open to any Balancing Mechanism (BM) participants who expect to be unavailable within BM timescales of 89 minutes.

This service is made up of two elements:

Elements	Description
Start up	Process of bringing the generating unit to a state where it is capable of synchronising with the system within BM timescales.
Hot Standby	Hot standby holds the generating unit in this state of readiness. The unit will then either remain in hot standby until the end of its capability or be instructed to run via an offer in the BM.

https://www.nationalgrideso.com/industry-information/balancing-services/reserve-services/bm-start

(Source) National Grid ESO web site

UK: Balancing Mechanism Wider Access

Current Situation of Power System and National Grid's intention

NGESO's vision is to meet the future needs of the electricity system by making the most of all resources available on the system in a flexible and economic way.

It is the job to operate GB's electricity network to ensure that supply and demand are balanced and power flows across the network safely and reliably. NGESO is seeing a transformation in GB's energy mix as GB move towards a decarbonized energy system. With this change, NGESO is facing new challenges in balancing the GB electricity system while also delivering value to energy consumers.

To overcome these challenges, NGESO needs to maximize the resources NGESO have available on the system today and in the future. Service providers are key to helping NGESO manage these challenges, which is why NGESO want to better help them to help balance the GB system in the most cost effective way.

https://www.nationalgrideso.com/industry-information/balancing-services/balancing-mechanism-wider-access

(Source) National Grid ESO web site

3-2 Frequency Response Services

UK: Frequency Response Services of National Grid

Frequency Response Services

Frequency Response Services for keep frequency between 49.5Hz and 50.2Hz

Mandatory Frequency Response (MFR)	Demand Management (DM)	Enhanced Frequency Response (EFR)	Firm Frequency Response (FFR)
Grid Code It's mandatory for large capacity power producers	Demand reduction when frequency goes up by Contract	Target is Battery Frequency response within one second Via Market	Bidding more than 10MW Frequency response By Contract

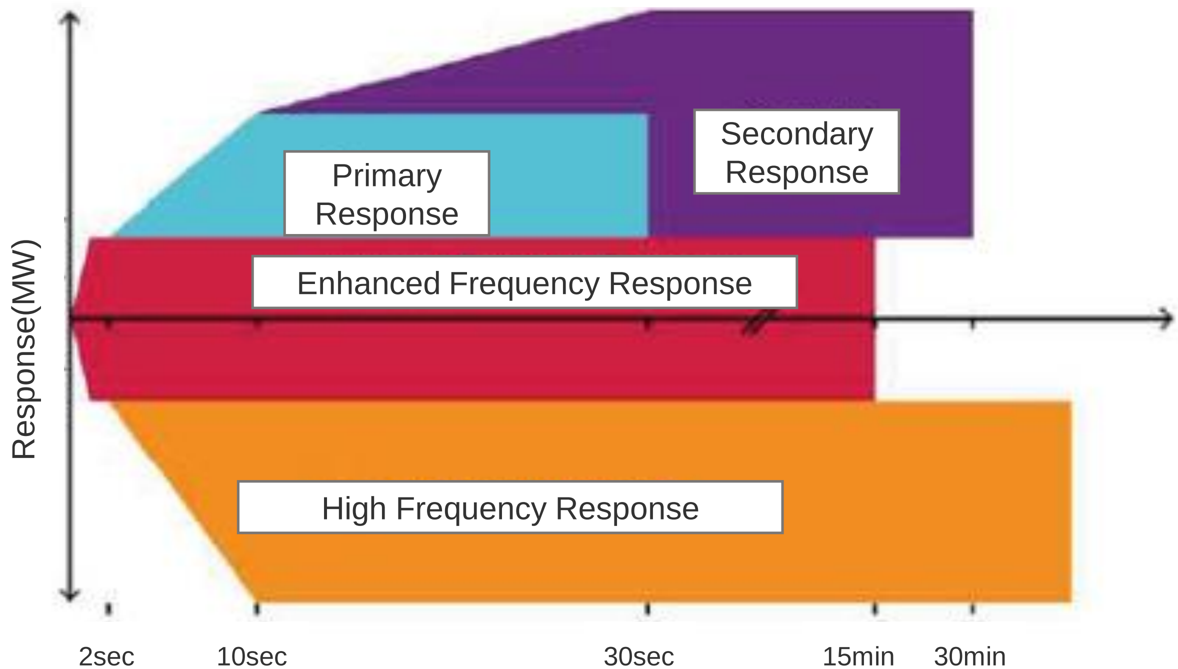
(Source) Mitsubishi Research Institute Co., Inc. Report using Det Norske Veritas information

UK: Frequency Response Services of National Grid

Enhanced Frequency Response (EFR)

- Enhanced Frequency Response (EFR) has introduced by National Grid in 2015 for quick response to frequency fluctuation. EFR should be responded within one second, i.e. targeted on mainly battery.

Image of Frequency Response Services



(Source) Mitsubishi Research Institute Co., Inc. Report

UK: Frequency Response Services of National Grid

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Frequency Response Services in National Grid

Service	Outline	Technical Matter
Mandatory Frequency Response	✓ Frequency have to be kept between 49.5Hz and 50.2Hz automatically ✓ All of power producers have a obligation ✓ There are three types of response, Primary Response, Secondary response and High Frequency Response	i) Primary Response (for high freq.) Response time: less than 10 sec. Duration time: more than 20 sec. ii) Secondary Response (for high freq.) Response time: less than 30 sec. Duration time: more than 30 min. iii) High Frequency Response (for low freq.) Response time: less than 10 sec. Duration time: No limit
Firm Frequency Response	✓ Supporting for frequency response obligation ✓ Procurement by bidding once in every month ✓ There are three types of response same as MFR	At least 10MW
Demand Management	✓ Cutting supply more than 30min. ✓ Automatically shut down in case frequency goes down below threshold value ✓ Relative contract	✓ Response time less than 2 sec. ✓ Duration time: over 30 min. ✓ Minimum load: 3MW
Enhanced Frequency Response	✓ Targeted battery for rapid response within 1 sec. ✓ By competitive bidding and four years contract ✓ Established in 2015	✓ Response time less than 1 sec. ✓ Duration time: over 15 min.

(Source) Mitsubishi Research Institute Co., Inc. Report

UK: Frequency Response Services of National Grid

Frequency Response Services

NGESO have a licence of obligation to control system frequency between 49.5Hz and 50.5Hz under law

(under regulation, NG have to keep frequency between 49.5Hz and 50.2Hz)

Power System has sufficient generation and demand held in readiness to manage all credible circumstances that might result in frequency variations.

There are two categories of frequency response.

Category	Description
Dynamic frequency response	a continuously provided service used to manage the normal second by second changes on the system
Non-dynamic response	usually a discrete service triggered at a defined frequency deviation

(Source) National Grid ESO web site

UK: Frequency Response Services of National Grid

Mandatory Response Services

Mandatory Frequency Response (MFR) is an automatic change in active power output in response to a frequency change. The service helps to keep frequency within statutory and operational limits.

Providers can offer one of these **or** a combination of different response times.

Service	Description
Primary response	Response provided **within 10 seconds** of an event, which can be sustained for **a further 20 seconds**.
Secondary response	Response provided **within 30 seconds** of an event, which can be sustained for **a further 30 minutes**.
High frequency response	Response provided **within 10 seconds** of an event, which can be **sustained indefinitely**.

(Source) National Grid ESO web site

Providing MFR (reference)

Depending on their size and location, a power station may be obliged to have the capability to provide MFR. This requirement will be set out in their connection agreement and is summarised in the table below.

Summary of connection agreement capability for MFR

	National Grid	Scottish Power	Scottish Hydro Electricity Transmission
Small	< 50 MW	< 30 MW	< 10 MW
Medium	50 MW =< 100 MW	N/A	N/A
Large	=> 100 MW	=> 30 MW	=> 10 MW

(Source) National Grid ESO web site

UK: Frequency Response Services of National Grid

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Dynamic Containment

Dynamic Containment (DC) is for deployment after a significant frequency deviation in order to meet most immediate need for faster-acting frequency response.

DC was launched in October 2020. DC requires a response time from providers within one second of a deviation in frequency outside dead-band limits. It is currently procured through a pay-as-bid day ahead auction for 24-hour long contracts.

This response is made possible through agreements NGESO make with generators for them to be available and respond when needed. Batteries' speed and flexibility make them particularly well-suited to the task, but any technology type can take part and we anticipate a wider range of providers participating in the future.

Dynamic Containment: what is it, and why do we need it? | National Grid ESO

(Source) National Grid ESO web site

UK: Frequency Response Services of National Grid

Weekly Auction Trial

The auction trial is an innovation project which is procuring Low Frequency Static (LFS) and Dynamic Low High (DLH) frequency products through the EPEX SPOT Auction Platform on a weekly basis.
https://www.nationalgrideso.com/industry-information/balancing-services/frequency-response-services/frequency-auction-trial

LFS (Low Frequency Static) - This is a static service that is triggered at 49.6Hz. Minimum requirement is 1MW and must be able to deliver full output in 1 second.

DLH (Dynamic Low High) - This is a dynamic service that delivers equal volumes of Primary, Secondary and High frequency response.

The Auction Trial, which is hosted on an EPEX SPOT built and owned bespoke auction platform, is trialling closer to real time procurement and exploring price formation in pay-as-clear auctions. It is funded through an Network Innovation Allowance (NIA) innovation project which will end in December 2021.

(Source) National Grid ESO web site

3-3 Reserve Services

UK: Reserve Services of National Grid

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Fast Reserve

Fast Reserve provides the rapid and reliable delivery of active power through an increased output from generation or a reduction in consumption from demand sources, following receipt of an electronic dispatch instruction.

There are currently three categories of Fast Reserve: Firm Fast Reserve, Optional Fast Reserve and Optional Spin Gen.

National Grid use fast reserve, in addition to other energy balancing services, to control frequency changes that might arise from sudden, and sometimes unpredictable, changes in generation or demand.

The fast reserve service is open to both Balancing Mechanism (BM) and non-BM providers who can meet the technical requirements.

This might include generators connected to the transmission and distribution networks, storage providers and aggregated demand side response.

https://www.nationalgrideso.com/industry-information/balancing-services/reserve-services/fast-reserve

(Source) National Grid ESO web site

UK: Reserve Services of National Grid

Service Dispatch

National Grid notifies successful providers of the times that the service may be required on the 12th business day of each month. These are called the nomination windows.

The fast reserve service is required 24 hours a day, 7 days a week. However, there is a greater requirement for the service during the daytime, typically between 06:00-23:00.

The fast reserve service is dispatched electronically. Units providing fast reserve must be ready to receive instructions at the start of each fast reserve window to allow them to be automatically dispatched.

For fast reserve, utilization can vary depending on system conditions, the demand profile and the generating plant on the system. However on average, providers are utilized for approximately five minutes at a time, ten times a day. The providers are still but are expected to have the capability to sustain reserve for 15 minutes.

(Source) National Grid ESO web site

UK: Reserve Services of National Grid : STOR

Short Term Operating Reserve (STOR)
STOR is a well-established service providing extra power to meet extra demand at certain times of day or if there's an unexpected drop in generation. NGESO aim to procure 1700MW of STOR to cover the largest loss.

Where it is economic to do so, NGESO will procure sources of extra power ahead of time through the STOR service. Providers of the service help to meet the reserve requirement either by providing additional generation or demand reduction.
The requirement for STOR varies depending on time of year, week and day.

https://www.nationalgrideso.com/industry-information/balancing-services/reserve-services/short-term-operating-reserve

(Source) National Grid ESO web site

UK: Reserve Services of National Grid : STOR

CHUBU Electric Power
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Providing STOR

Both Balancing Mechanism (BM) and non-BM participants with a connection to either the electricity transmission or distribution network are able to provide STOR.

The service is open to any technology with the ability to increase generation or reduce demand by at least 3 MW.

There are particular times of the day when the STOR service is more likely to be required. These are known as ‘committed windows’.

Providers are required to be available to operate at their contracted volume during these windows.

(Source) National Grid ESO web site

UK: Reserve Services of National Grid : Super SEL

CHUBU Electric Power
NIPPON KOEI

Super SEL

Super SEL is utilized to directly decrease the sum of the minimum MW level or Stable Export Limit (SEL) of generators synchronized to the system by lowering the minimum generating level at a generator synchronized.

The service is open to Balancing Mechanism participants who can meet the minimum technical requirement. Super SEL service does not require a change in the energy output of the generation, it is to give access to a reduced minimum active power level. Super SEL contract enactment will be through a trading instruction. Live data file is refreshed every ten minutes

https://www.nationalgrideso.com/industry-information/balancing-services/reserve-services/super-sel

(Source) National Grid ESO web site

3-4 Reactive Power Services

UK: Reactive Power Services of National Grid : ORPS/ERPS

Obligatory Reactive Power Service (ORPS)

The obligatory reactive power service (ORPS) is the provision of varying reactive power output. At any given output generators may be requested to produce or absorb reactive power to help manage system voltages close to its point of connection. All generators covered by the requirements of the Grid Code are required to have the capability to provide reactive power.

https://www.nationalgrideso.com/industry-information/balancing-services/reactive-power-services/obligatory-reactive-power-service

ORPS can be provided alongside other balancing services.
Reactive power is provided locally to meet the constantly varying needs of the system, and that there are sufficient reactive power reserves available to meet contingencies.
Generally, all power stations connected to the transmission network with a generation capacity of over 50MW are required to have the capability to provide this service, as set out in the Grid Code.

(Source) National Grid ESO web site

UK: Reactive Power Services of National Grid : ERPS

Enhanced Reactive Power Service (ERPS)

Generators who can provide reactive power over and above the Grid Code requirements may also choose to participate in ERPS.

The enhanced service may also be of interest to owners or operators of plant or apparatus that can generate or absorb reactive power but isn't required to provide the ORPS.

(Source) National Grid ESO web site

Related Institutions

Department of Energy & Climate Change

>Decision of reliability policy in UK with information from National Grid and Ofgem
>Capacity is procured through Capacity Market held once in a year
>Keeping reserve margin in case of emergency
https://www.gov.uk/government/organisations/department-of-energy-climate-change

ofgem

>Keeping power market stable
>Monitoring National Grid
>Approval of introduction of adjustment services to power sector
>Approval of procurement of adjustment power by National Grid
https://www.ofgem.gov.uk/

nationalgrid

>Licensed for mandatory on stable power supply
>Analysis of power system
>Decision of necessary volume of ancillary & adjustment services
>Making contracts on adjustment services
https://www.nationalgrideso.com/

(Source) Mitsubishi Research Institution Co., Inc. Report

CHUBU
Electric Power

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Balancing Market in UK
Review & additional Study

Ceylon Electricity Board
JICA Expert Team

June, 2022

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

Institutions Related to UK Power Market

>Decision of reliability policy in UK with information from National Grid and Ofgem
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(Source) Mitsubishi Research Institution Co., Inc. Report

Institutions Related to UK Power Market

View from ELEXON

ELEXON

ELEXON is a company to the successful running of the electricity industry.
ELEXON is a not-for-profit entity, funded by electricity market participants. ELEXON is a trusted, independent and reliable market expert and they continuously look to evolve and innovate so that customers and consumers can feel the benefit.

With the continued commitment to net zero emission targets, it is clear that the management of central market rules will have to change. ELEXON will continue to advocate that changes across code governance arrangements are necessary to ensure the GB energy system is more flexible and responsive. It will need to support new business models as well as existing participants to deliver net zero.

By 2025, ELEXON will create the leading provider of essential market services to the GB energy sector, for the benefit of market participants and their customers.

(Source) ELEXON Web Site

Studying Power Market in UK from view point of ELEXON

ELEXON

[Elexon and BSC seminar: Introduction to the energy market - Elexon BSC](https://www.elexon.co.uk/about/elexon-training/introducing-elexon-seminars/)

https://www.elexon.co.uk/about/elexon-training/introducing-elexon-seminars/

Click “Imbalance Settlement” (46 minutes lecture)

(Source) ELEXON Web Site

Elexon : Introduction to the energy market

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nationalgridESO	ELEXON
Grid Code (GC)	Balancing and Settlement Code (BSC)
Physical **Balancing**	Imbalance **Settlement**
Balancing physical Generation and Demand on the Network	Calculates imbalances and charges/pays Parties accordingly

(Source) ELEXON Web Site

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NIPPON KOEI

Concept of Imbalance

Elexon accounts and settles mismatches between BSC Parties **contracted** and **metered** positions

National Grid Balancing Mechanism

Parties notify Contract Volumes to Elexon

Settlement Period (SP)*

Metered Volumes Collected and Sent to ELEXON

Difference Between Metered and Contracted Volume is Party's imbalance

Imbalance volumes settled at Imbalance Price

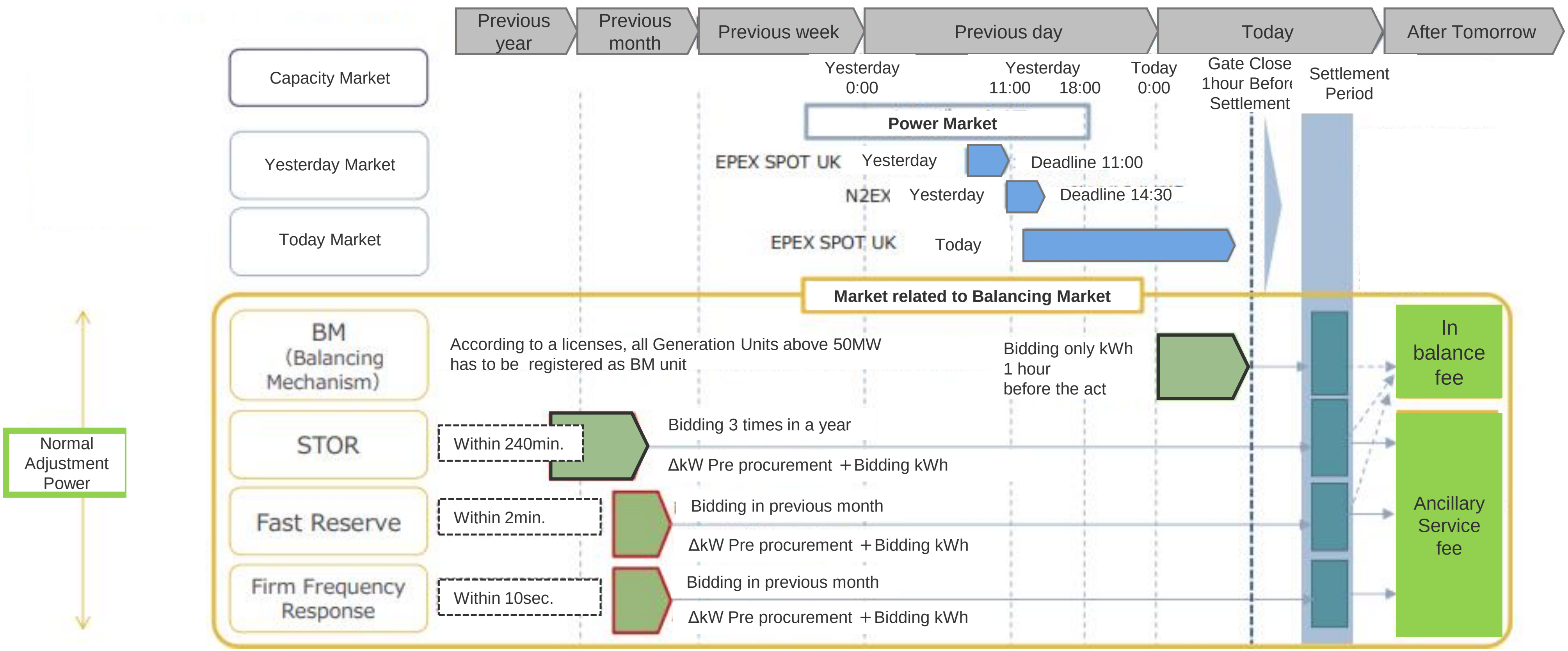
* Settlement Period is 30 minute period, 48 Settlement Periods in a day.

(Source) ELEXON Web Site

Elexon : Introduction to the energy market (review)

UK: Process related to Balancing Market (Shown in previous lecture)

- Balancing between supply and demand is totally adjusted through the Balancing Market



Power Market outline in UK

(Source) Mitsubishi Research Institute Inc. Report

Elexon : Introduction to the energy market (review)

- Balancing between supply and demand is totally adjusted through the Balancing Market

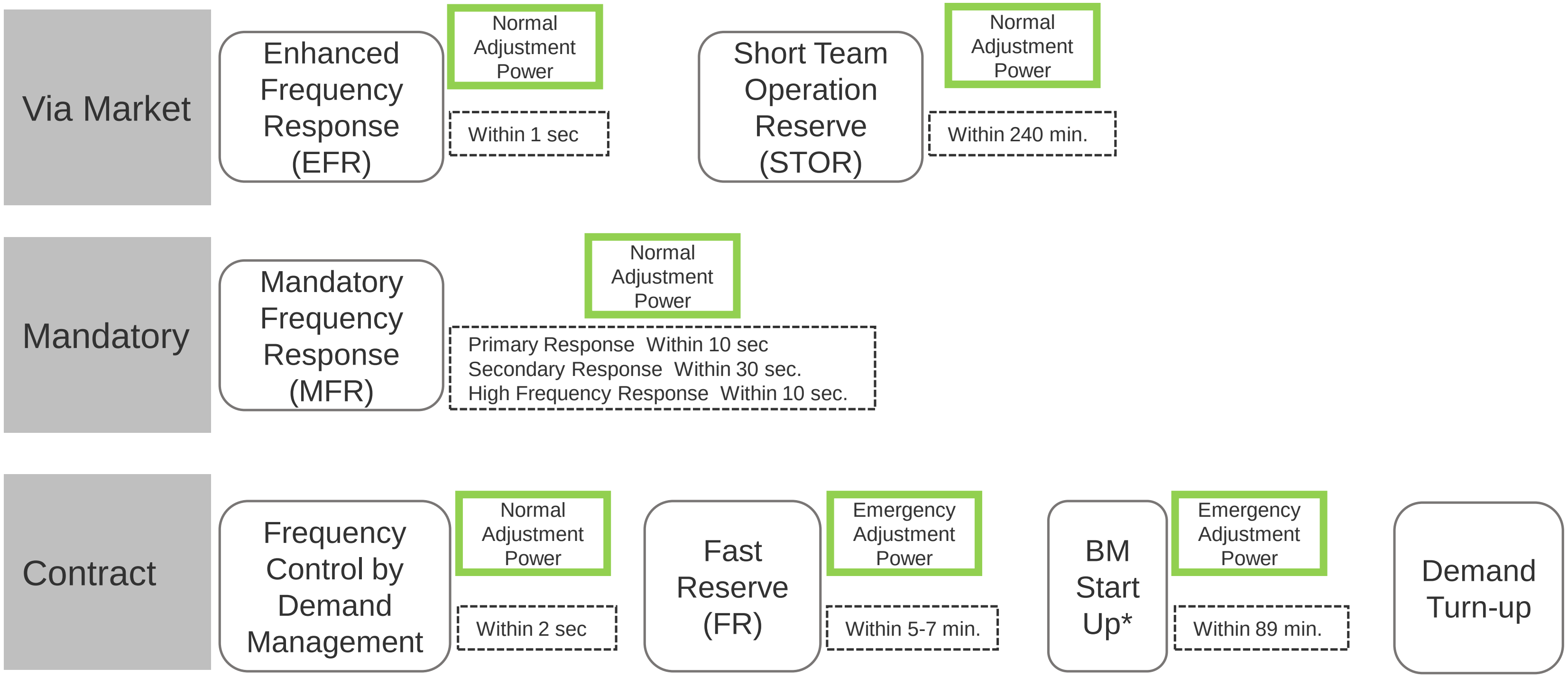


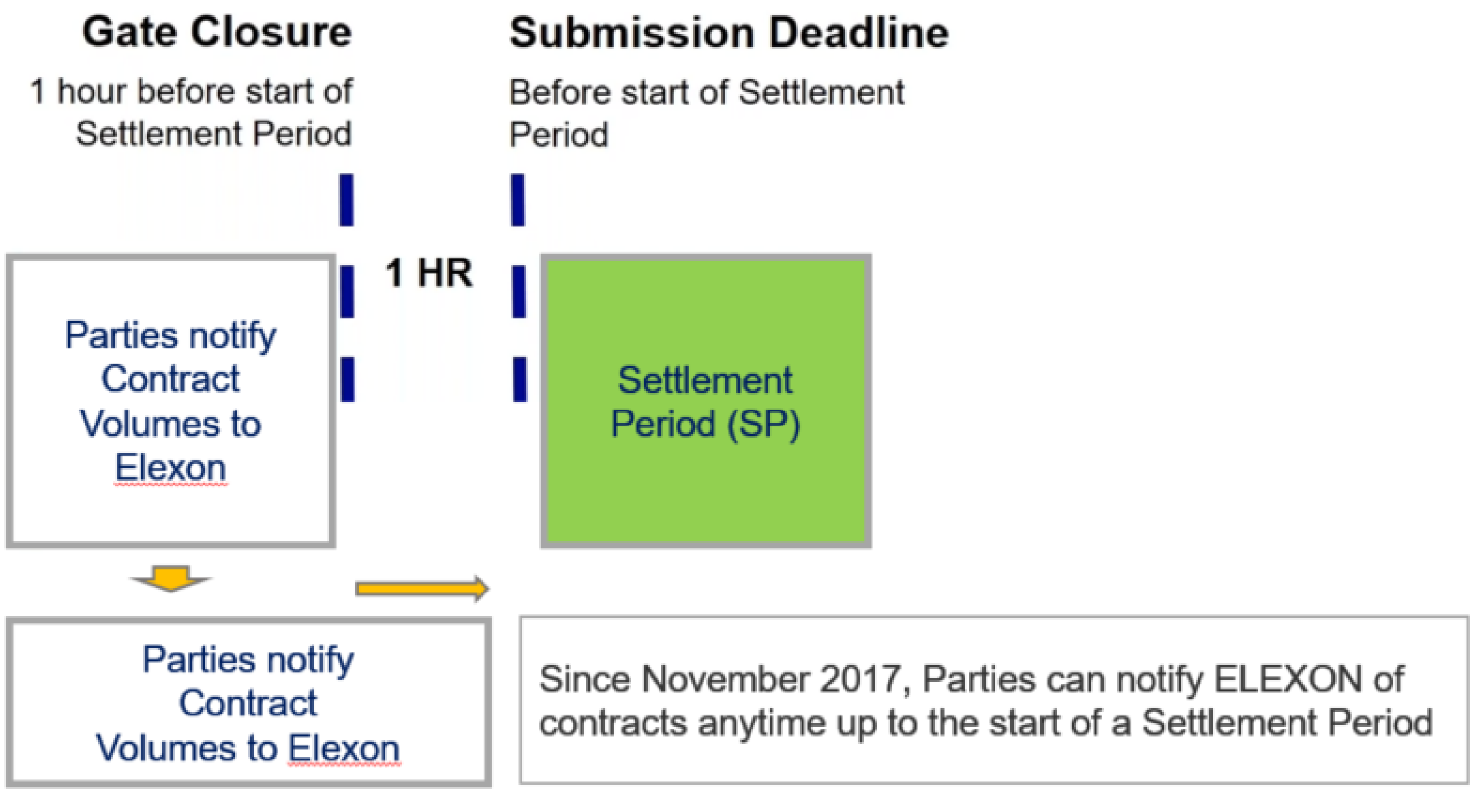
Fig. 4 Various ways are considered and mixed in the Balancing Power Market.

* Start up: The BM start up service gives us on-the-day access to additional generation. The service is open to any Balancing Mechanism (BM) participants who expect to be unavailable within BM timescales of 89 minutes.

(Source) Mitsubishi Research Institute Inc. Report

Elexon : Introduction to the energy market

Elexon capture the contracted volumes from Generators and Suppliers to see what they have bought or sold to try and balance their position



(Source) ELEXON Web Site

Elexon : Introduction to the energy market

Forward Contract Report

▪Released 4 times per day

Provides forward view of Settlement Period contract position for all acknowledged energy contracts

Covers seven Settlement Days following the Settlement Day on which the report is provided

End of Day Report

▪Released ~2am D+1

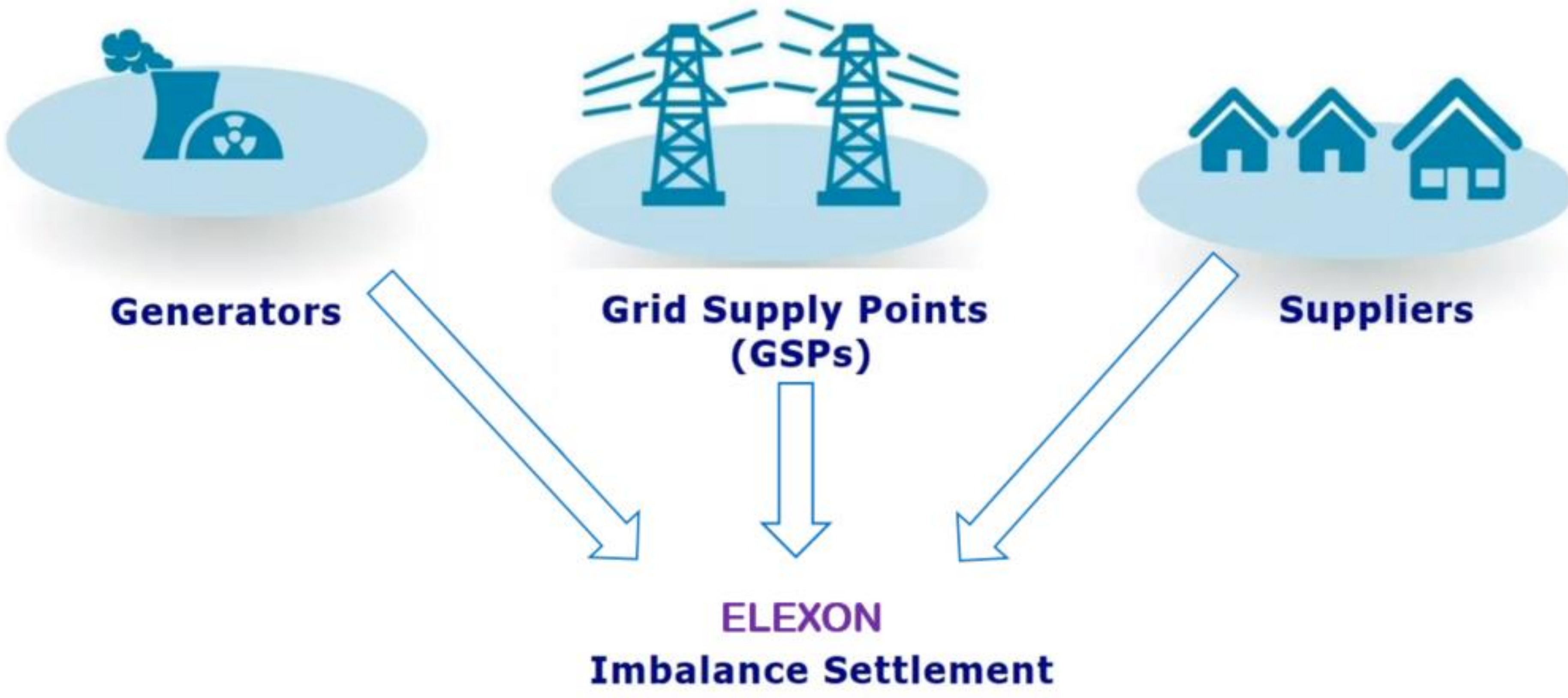
Summarises the energy contract volumes (ECVNs) and metered volume reallocations (MVRNs) for the last Settlement Day

Provides period and cumulative indebtedness data and identifies Parties in Credit Default

(Source) ELEXON Web Site

Elexon : Introduction to the energy market

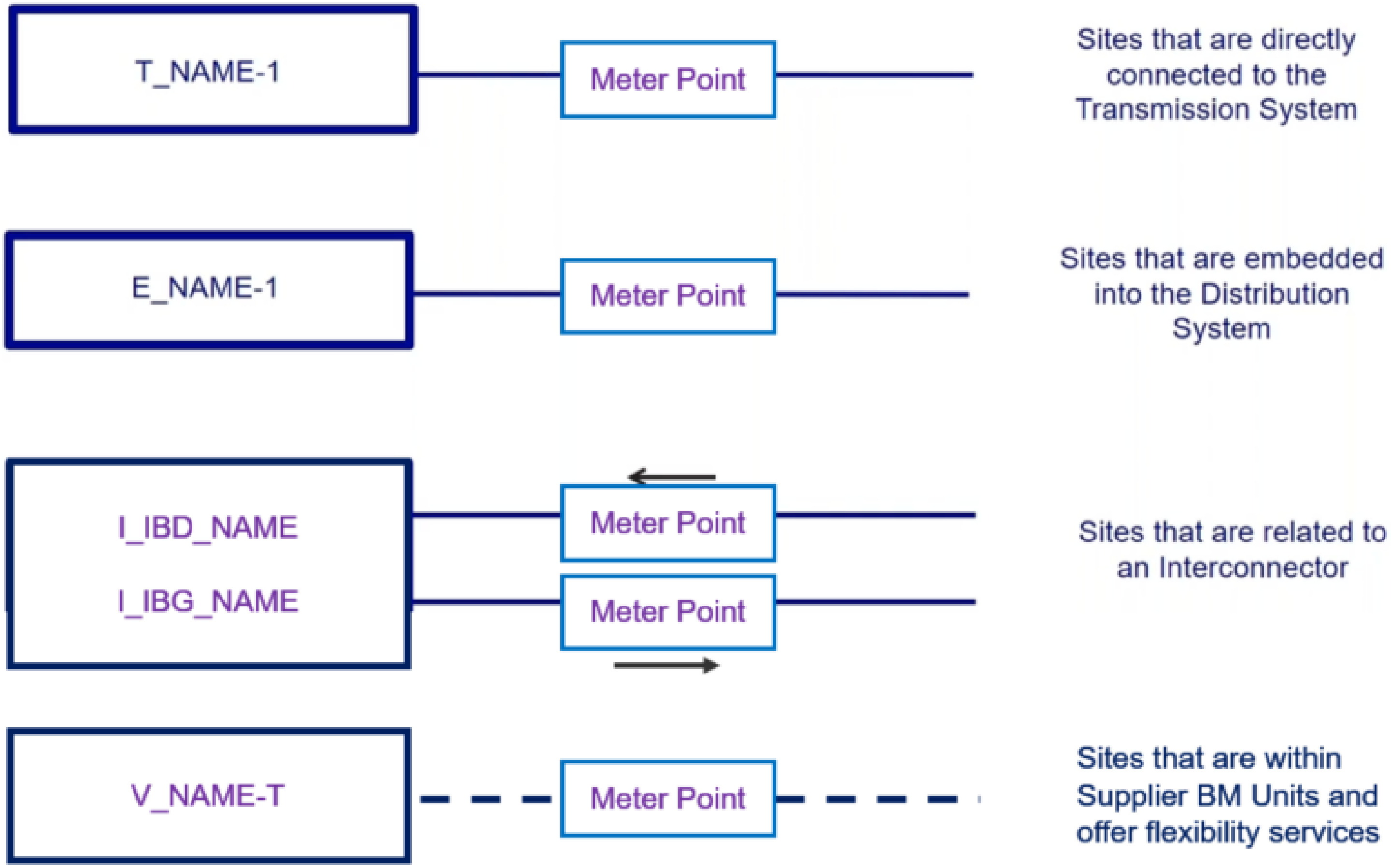
Elexon systems capture metered data to understand who consumed or generated energy during the Settlement Period



(Source) ELEXON Web Site

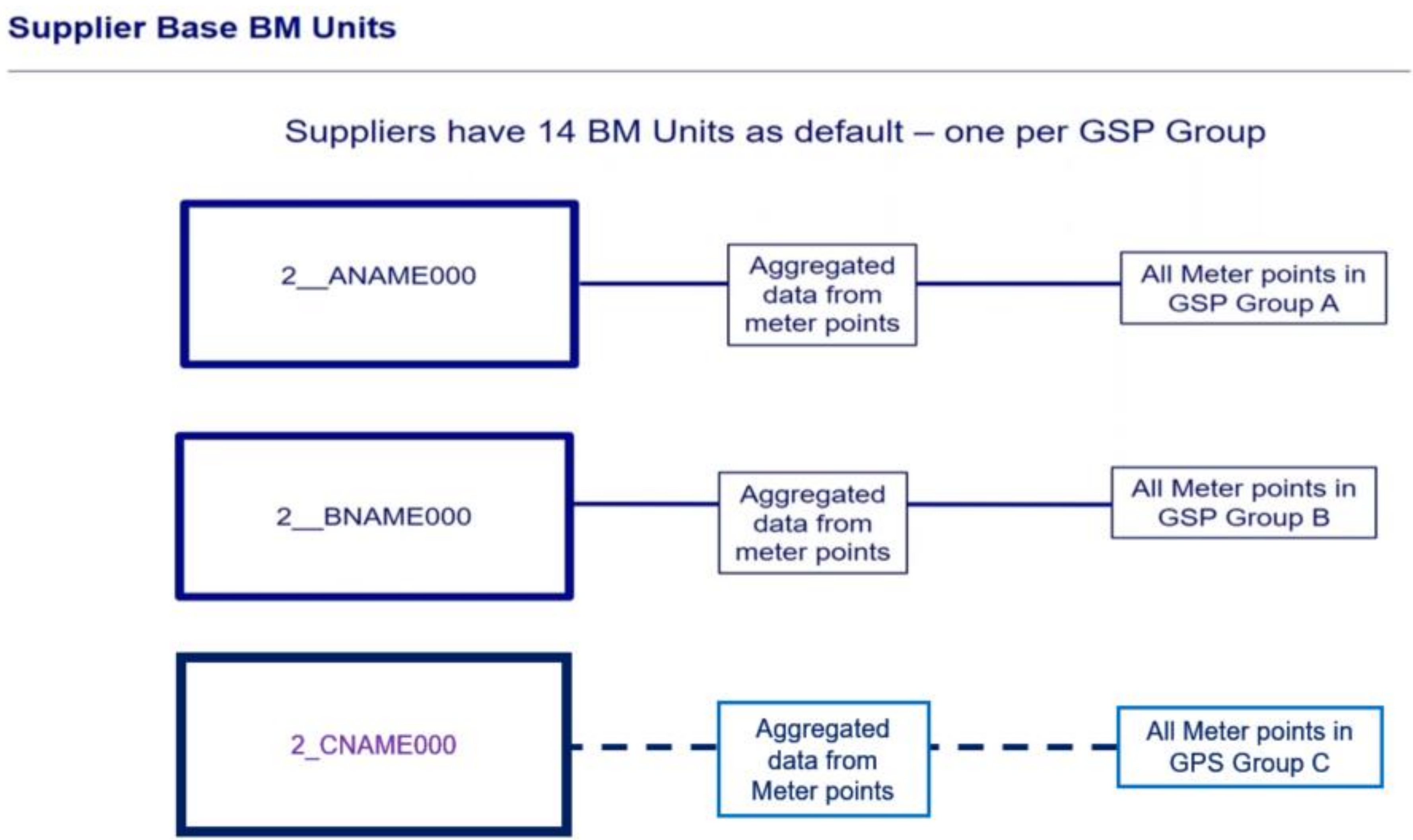
Elexon : Introduction to the energy market

Balancing Mechanism Units (BMUs)



(Source) ELEXON Web Site

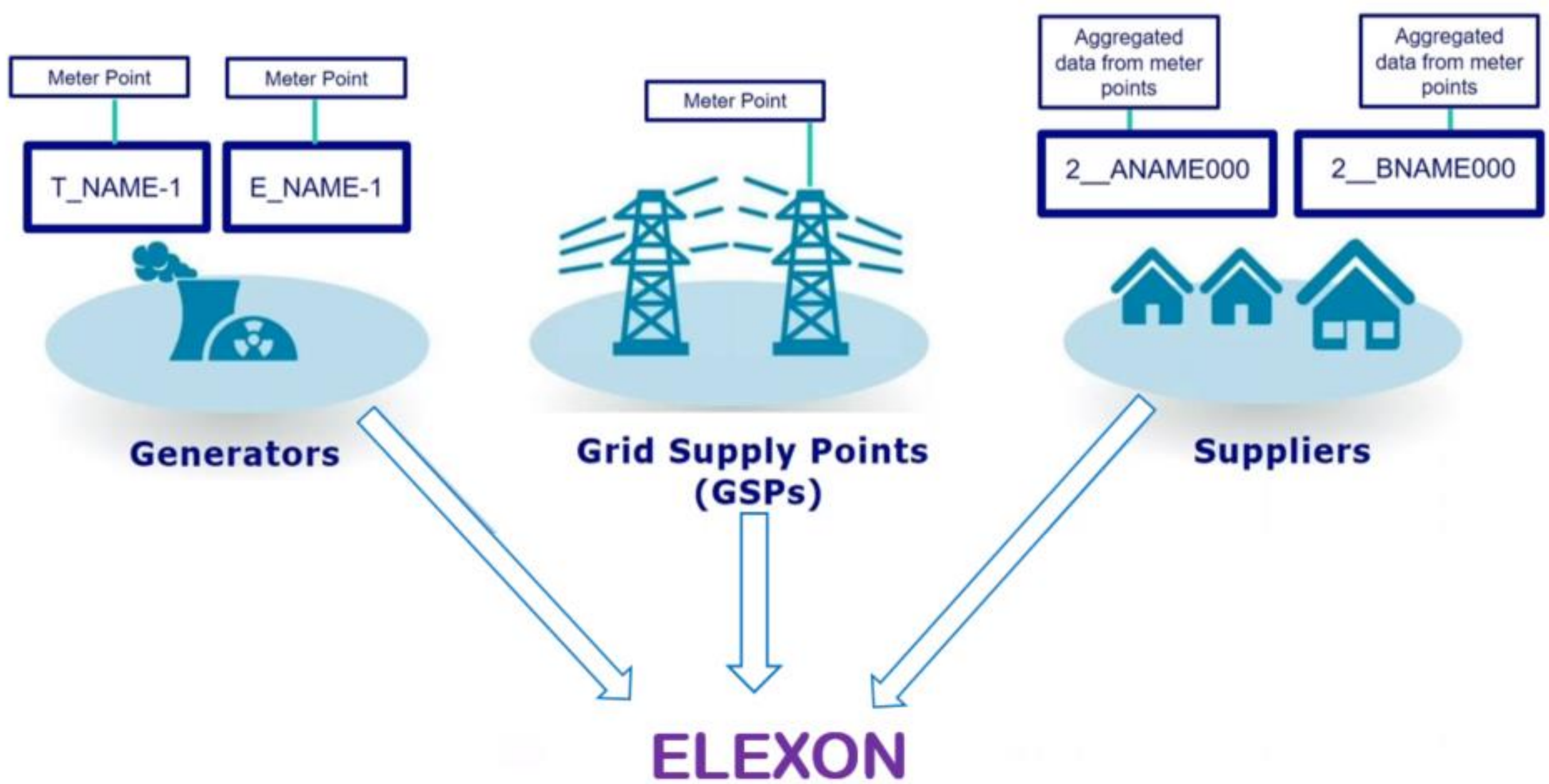
Elexon : Introduction to the energy market



(Source) ELEXON Web Site

Elexon : Introduction to the energy market

Metered Energy Volumes



(Source) ELEXON Web Site

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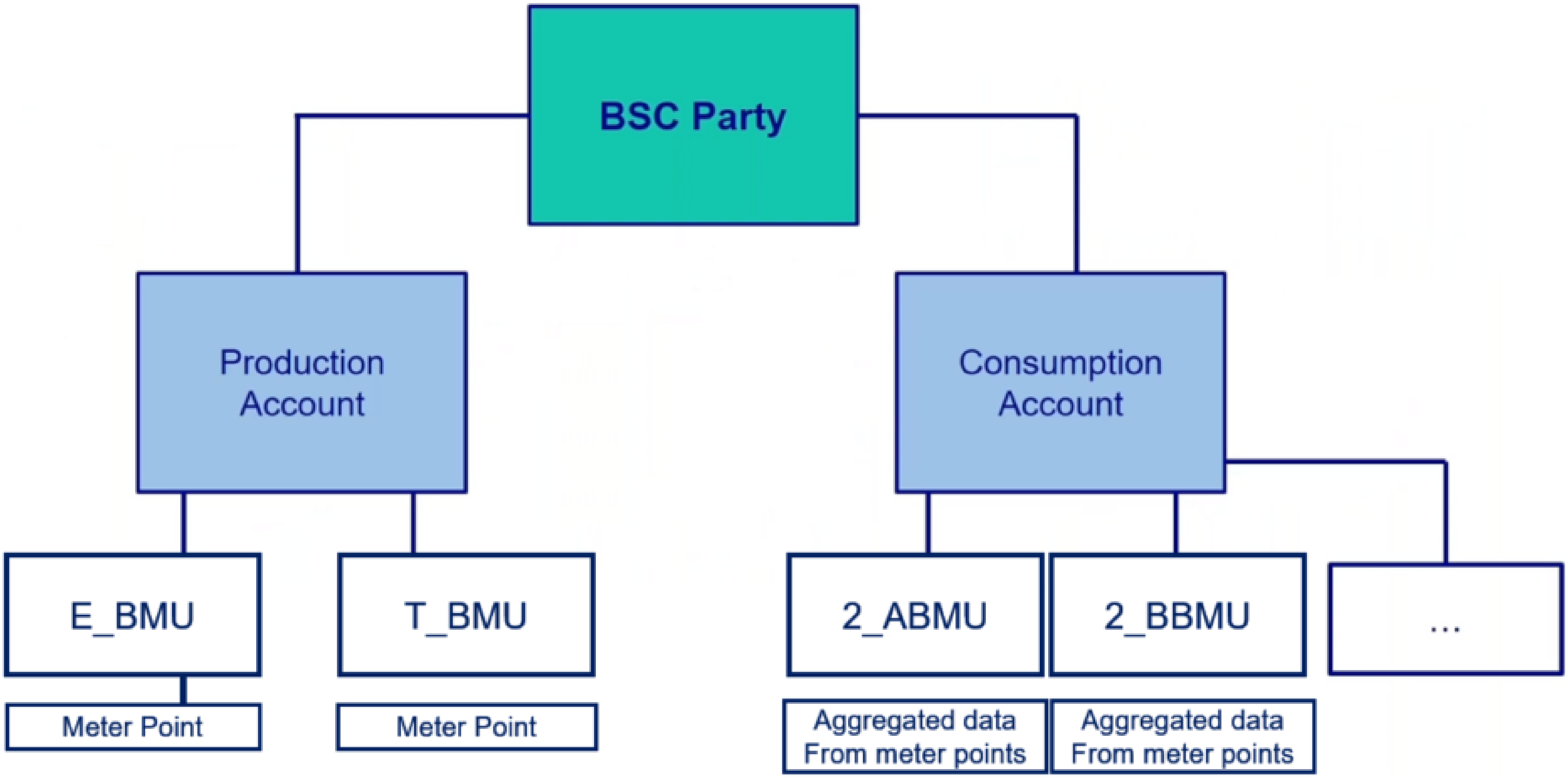
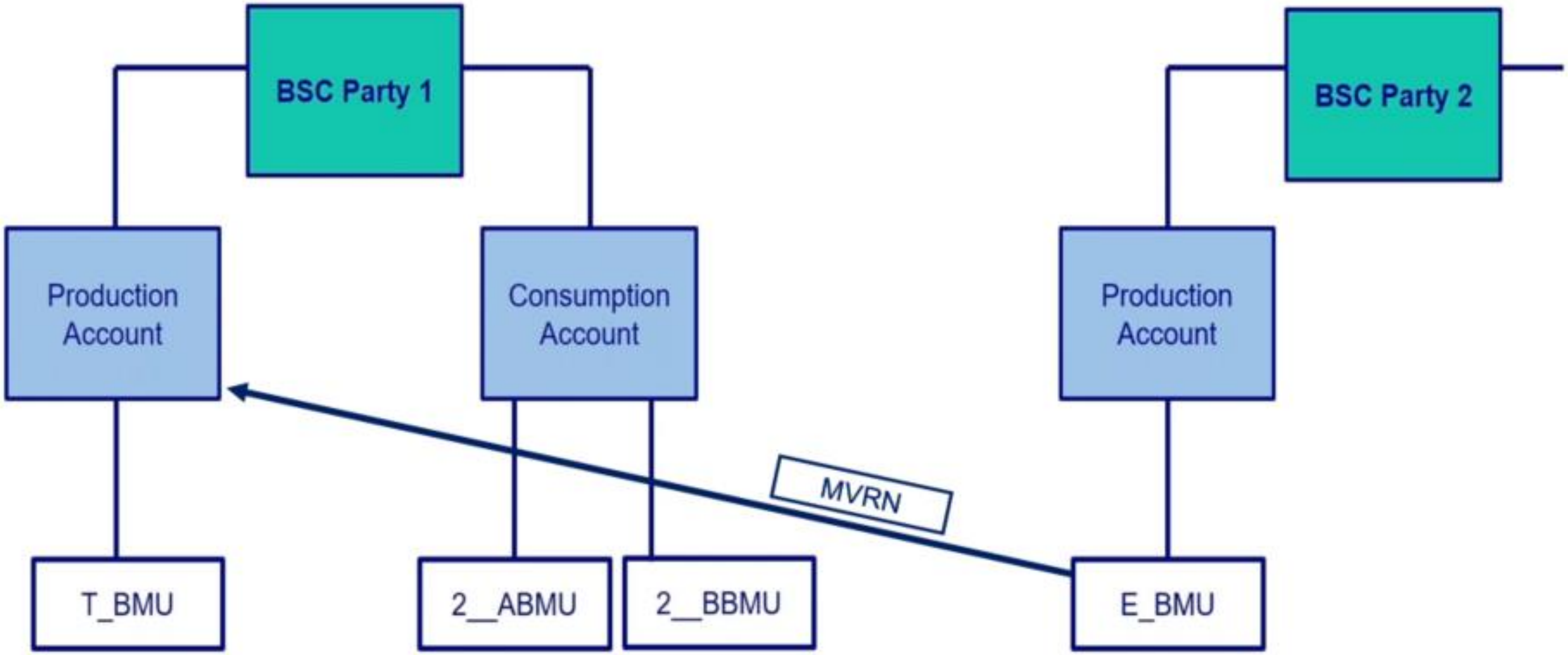
Party Accounts



(Source) ELEXON Web Site

Elexon : Introduction to the energy market

Metered Volume Reallocation Notification (MVRN)



・Move a fixed MWh volume or % of volume, to 1 or more Parties

(Source) ELEXON Web Site

Elexon : Introduction to the energy market

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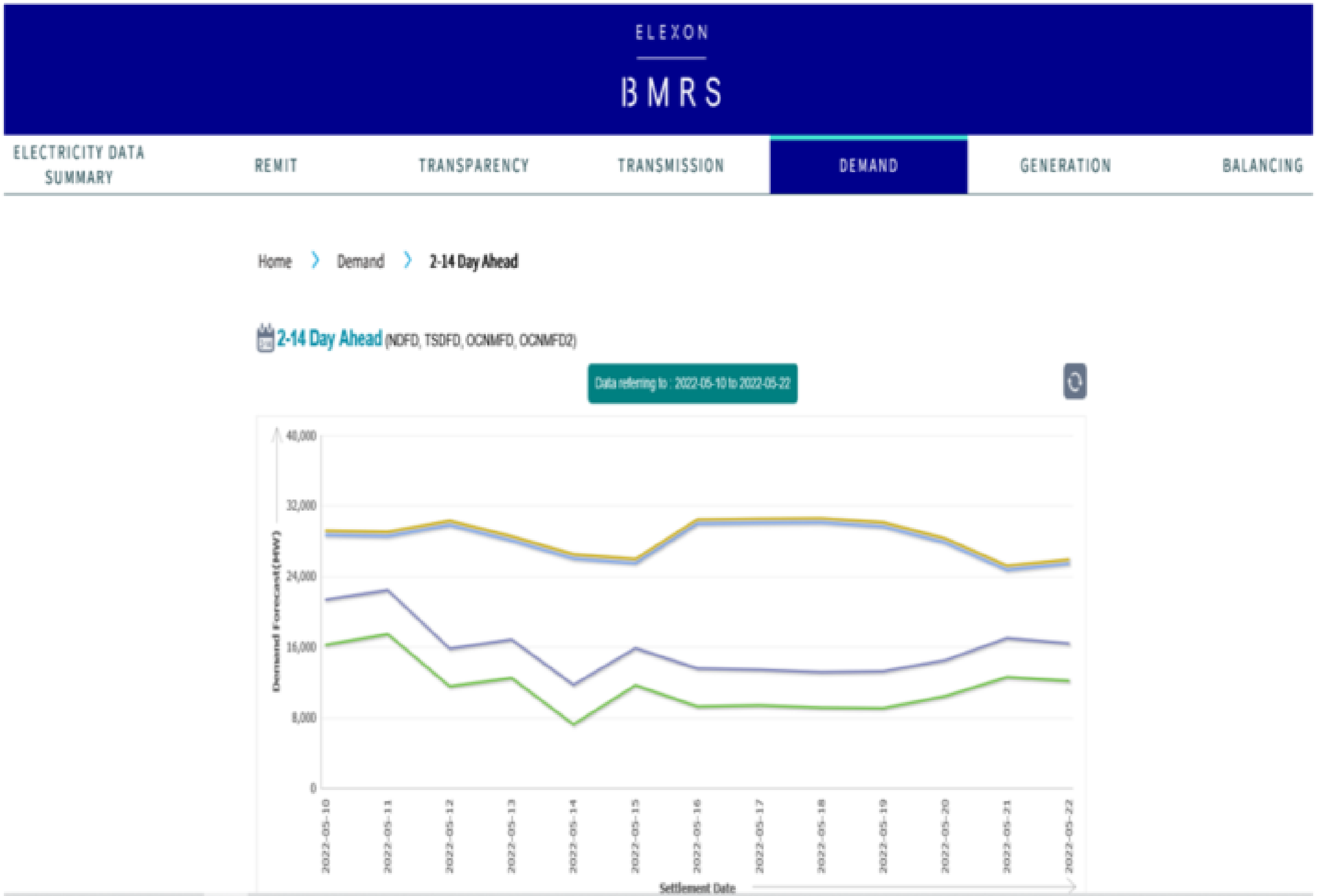
Forecast National Demand



- National Grid's demand forecast indicates how much energy will be needed for each HH
- They can then compare this to the generation planned to be dispatched

(Source) ELEXON Web Site

Elexon : Introduction to the energy market

Physical Notifications (PN)

Initial Physical Notification (IPN)

- Expected operating levels throughout the whole day for each BM Unit
  - Submitted by 11.00 day ahead

Final Physical Notification (FPN)

- Expected operation level for Settlement Period for each Balancing Mechanism Unit
- Submitted by Gate Closure

(Source) ELEXON Web Site

Elexon : Introduction to the energy market

Bids and Offers

Bids and Offers are a BSC Party's willingness to operate the BM Unit differently to their FPN.

Offer	Bid
▪ Offer to **increase energy** to the system ▪ Increase generation or decrease demand	▪ Bid to **remove energy** from the system ▪ Decrease generation or increase demand

(Source) ELEXON Web Site

Elexon : Introduction to the energy market

Bid/Offer Submission

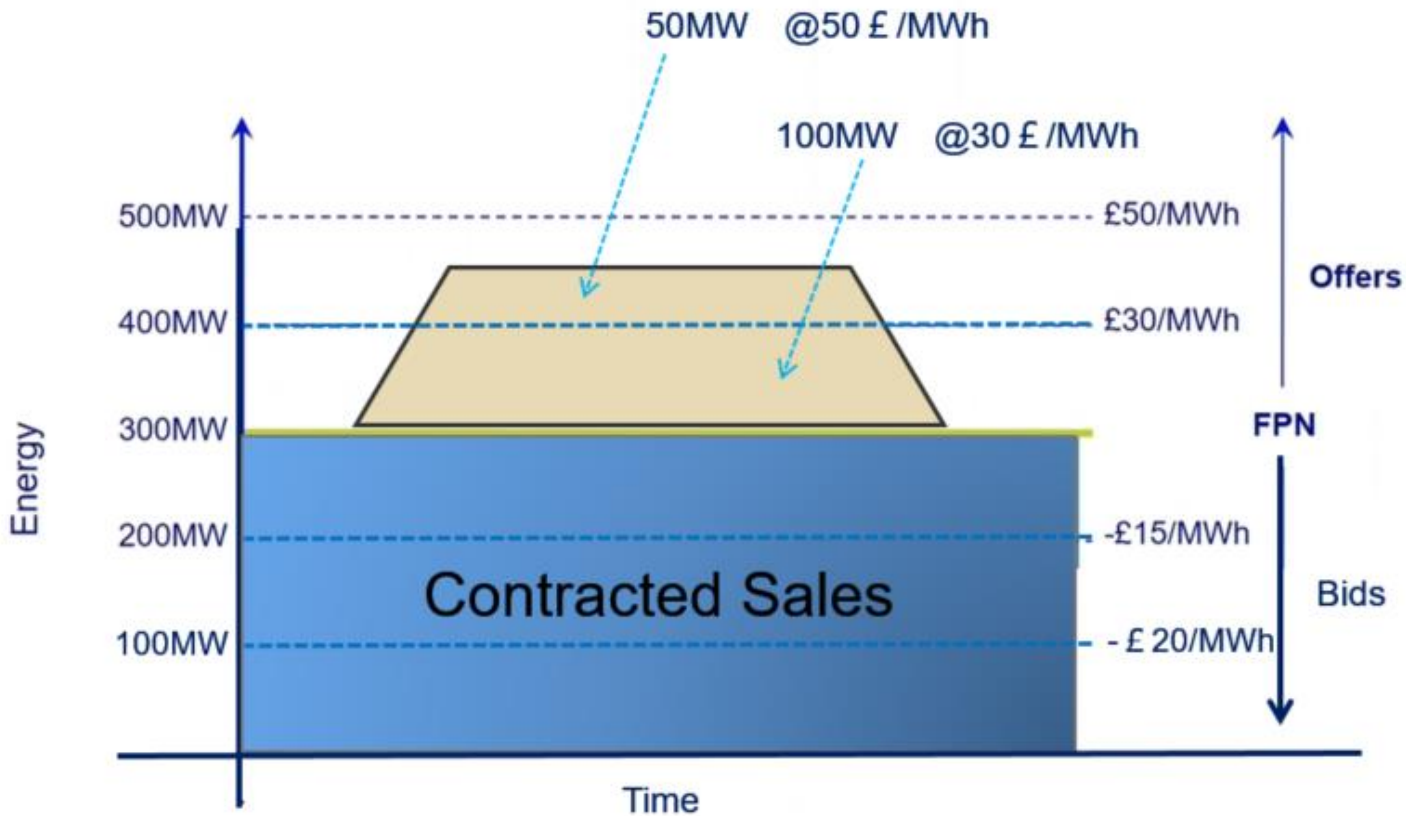
A Bid/Offer submission from a Generator with an FPN of 300MW would look like this…

(Source) ELEXON Web Site

Elexon : Introduction to the energy market

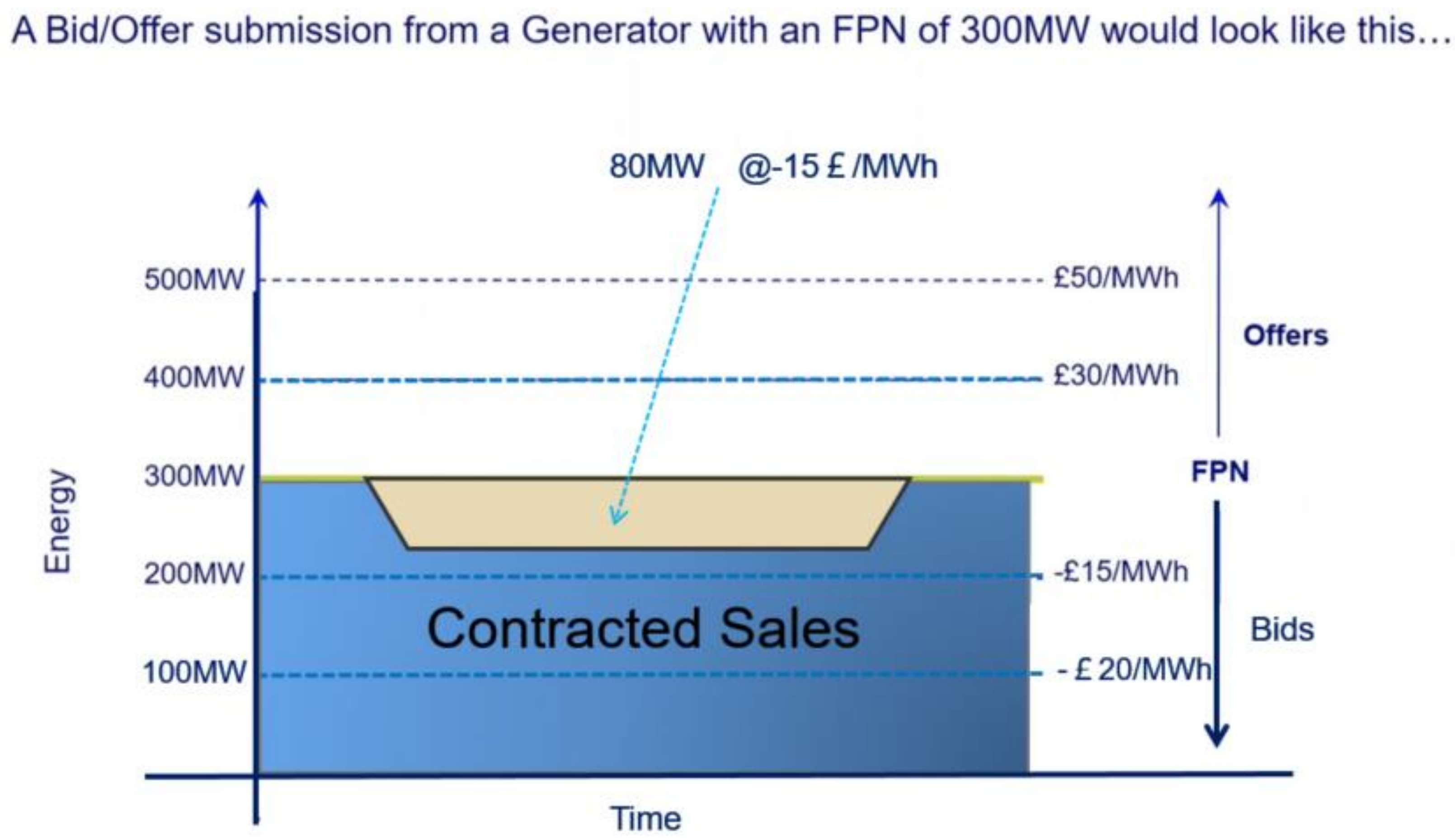
Bid/Offer Submission

A Bid/Offer submission from a Generator with an FPN of 300MW would look like this…



(Source) ELEXON Web Site

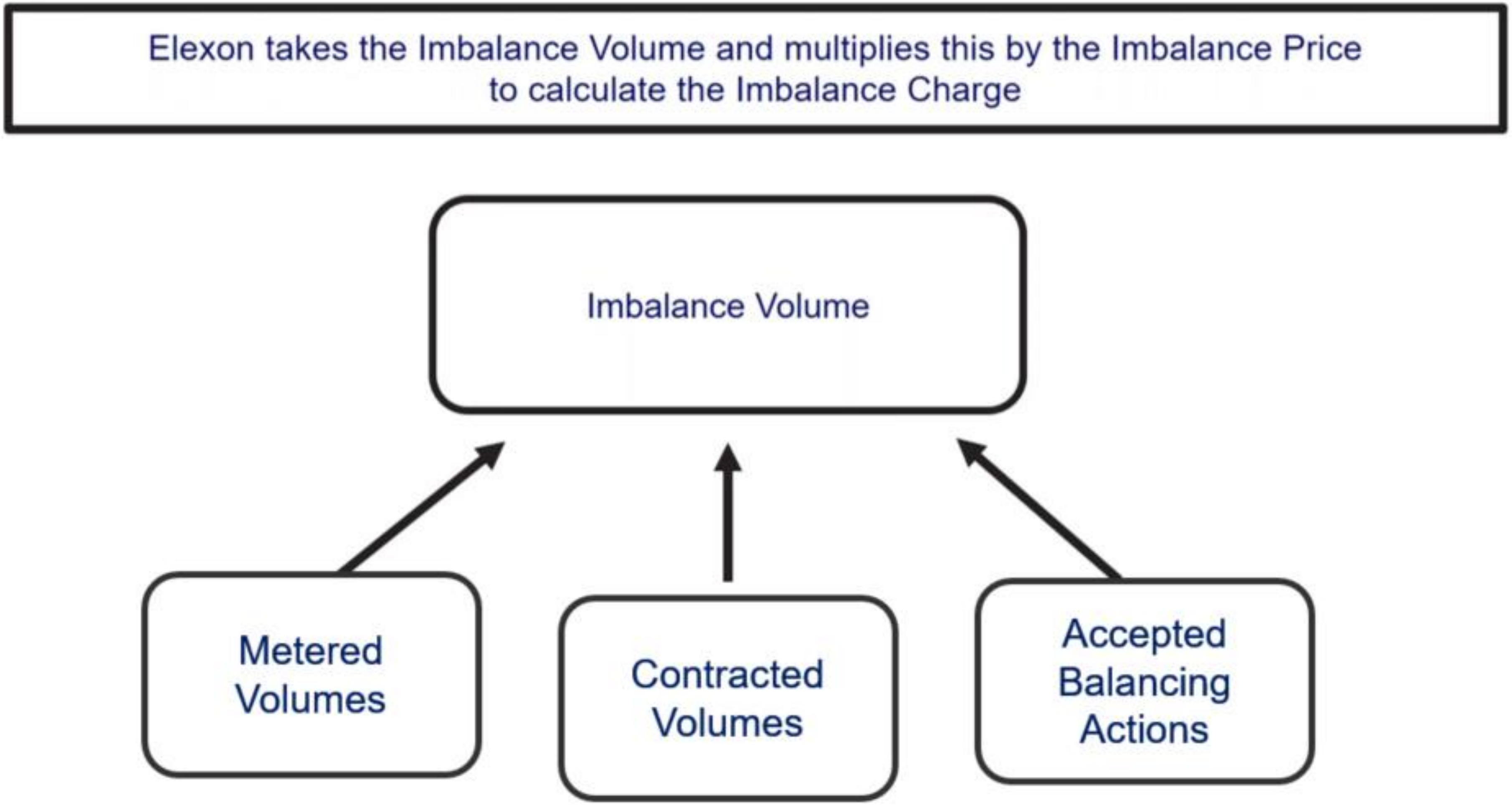
Bid/Offer Submission



(Source) ELEXON Web Site

Elexon : Introduction to the energy market

Imbalance Volume



(Source) ELEXON Web Site

Imbalance Position

PARTY IS LONG

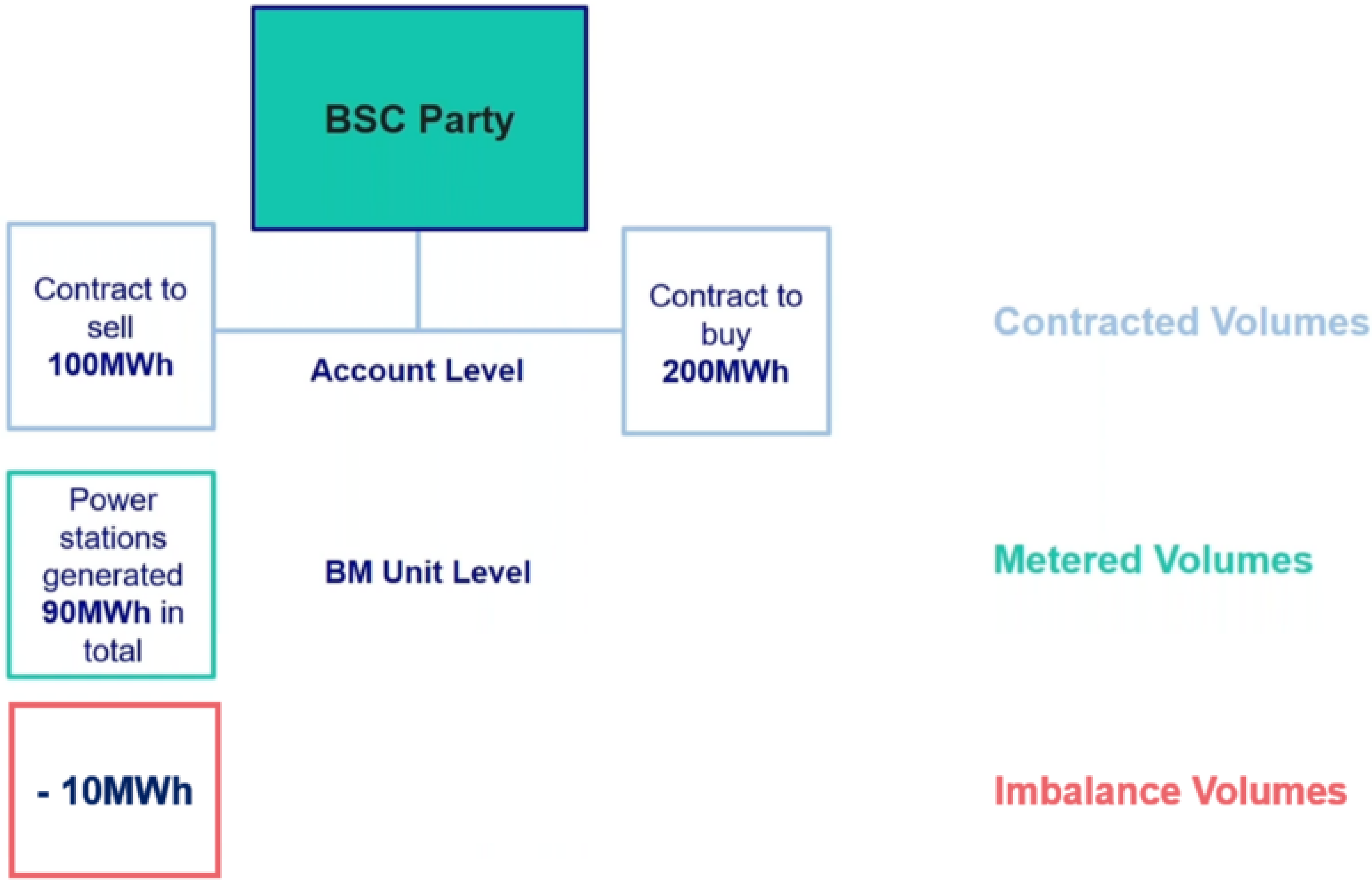
- **Is paid** for the 'surplus' imbalance at System Price
- For a Generator: Volume generated > Volume sold
- For a Supplier: Volume consumed < Volume bought

Party IS SHORT

- **Pays** for the "deficit" imbalance at System Price
- For a Generator: Volume generated < Volume sold
- For a Supplier: Volume consumed > Volume bought

(Source) ELEXON Web Site

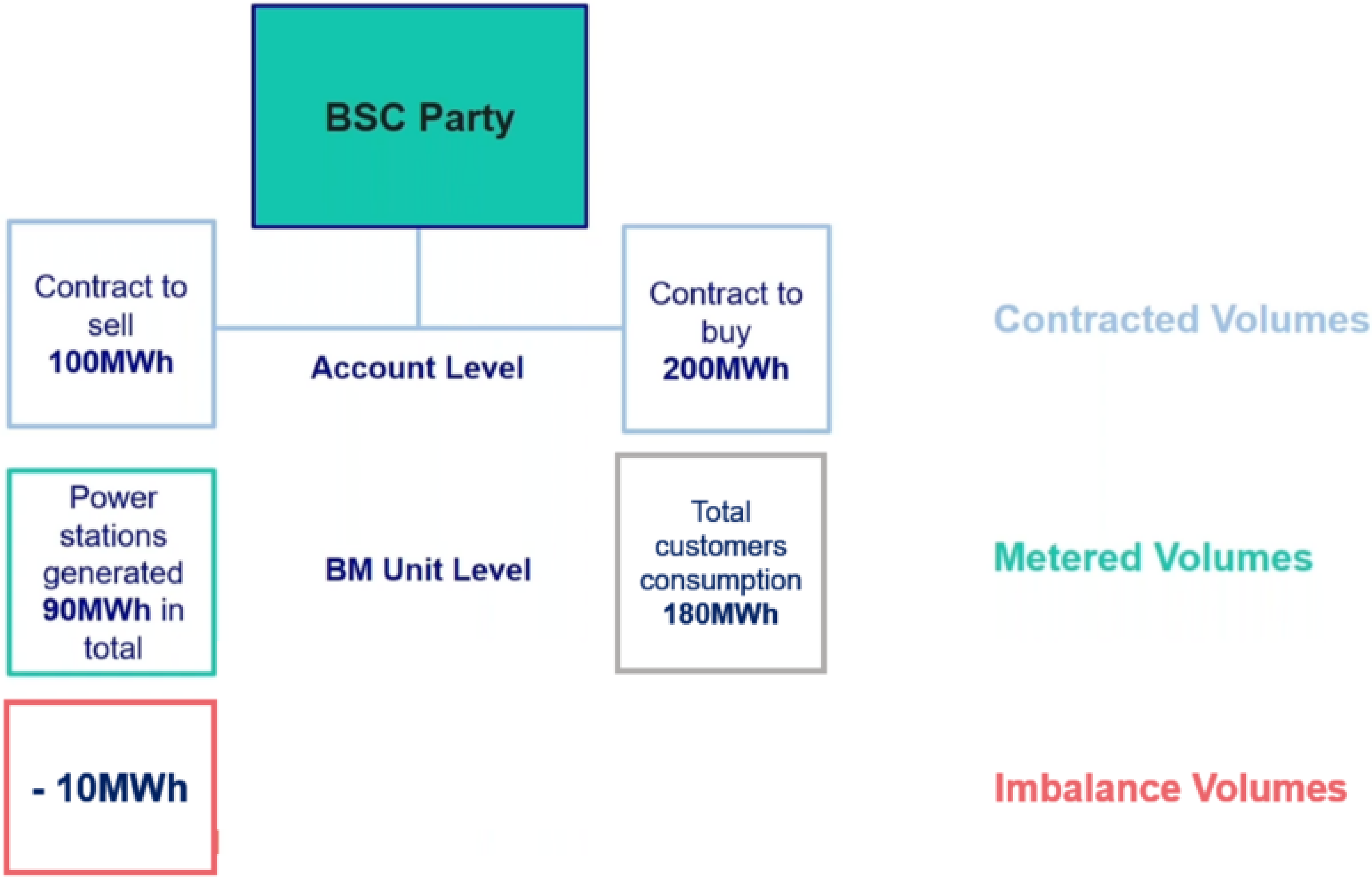
Imbalance Position Example



(Source) ELEXON Web Site

Elexon : Introduction to the energy market

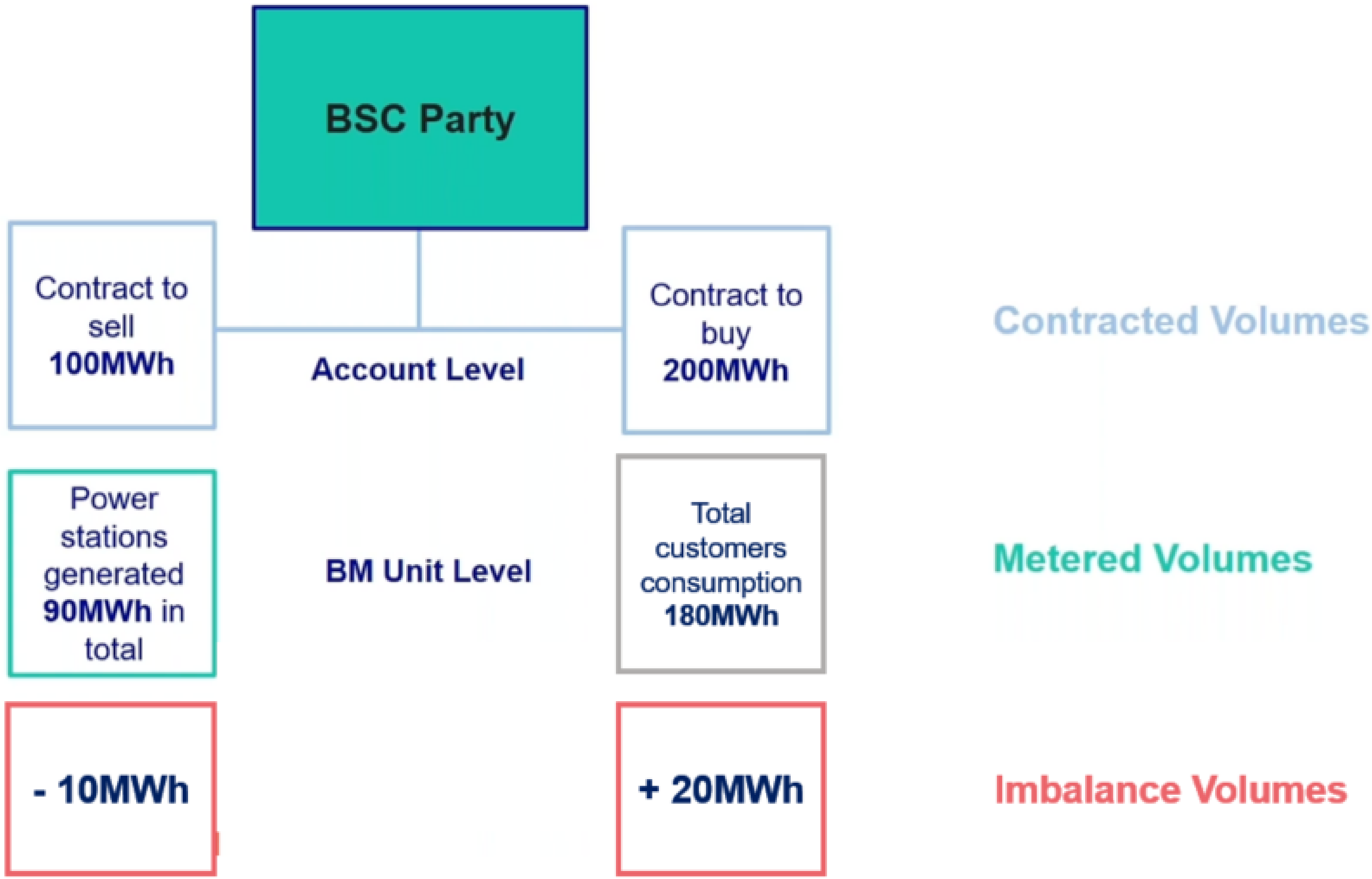
Imbalance Position Example



(Source) ELEXON Web Site

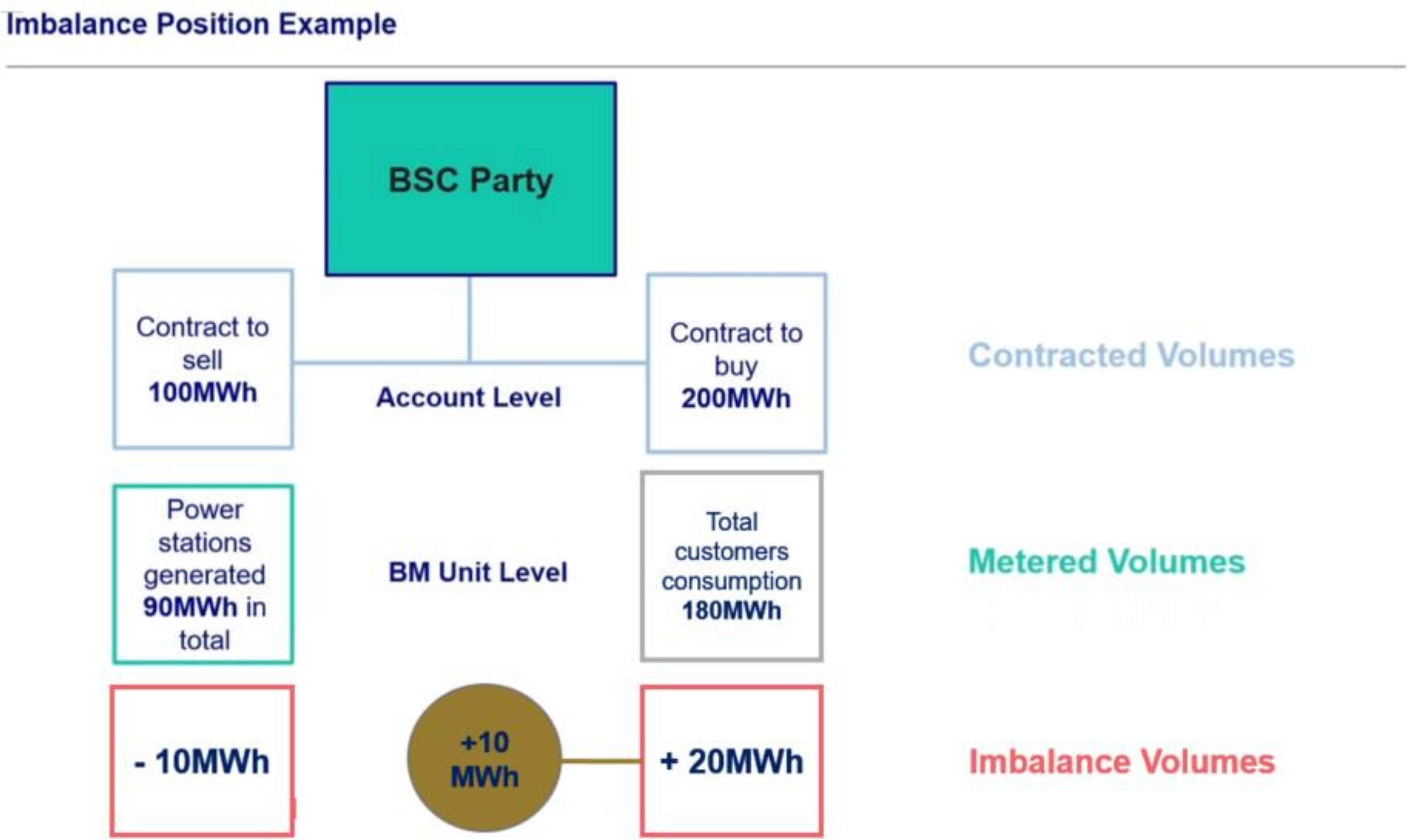
Elexon : Introduction to the energy market

Imbalance Position Example



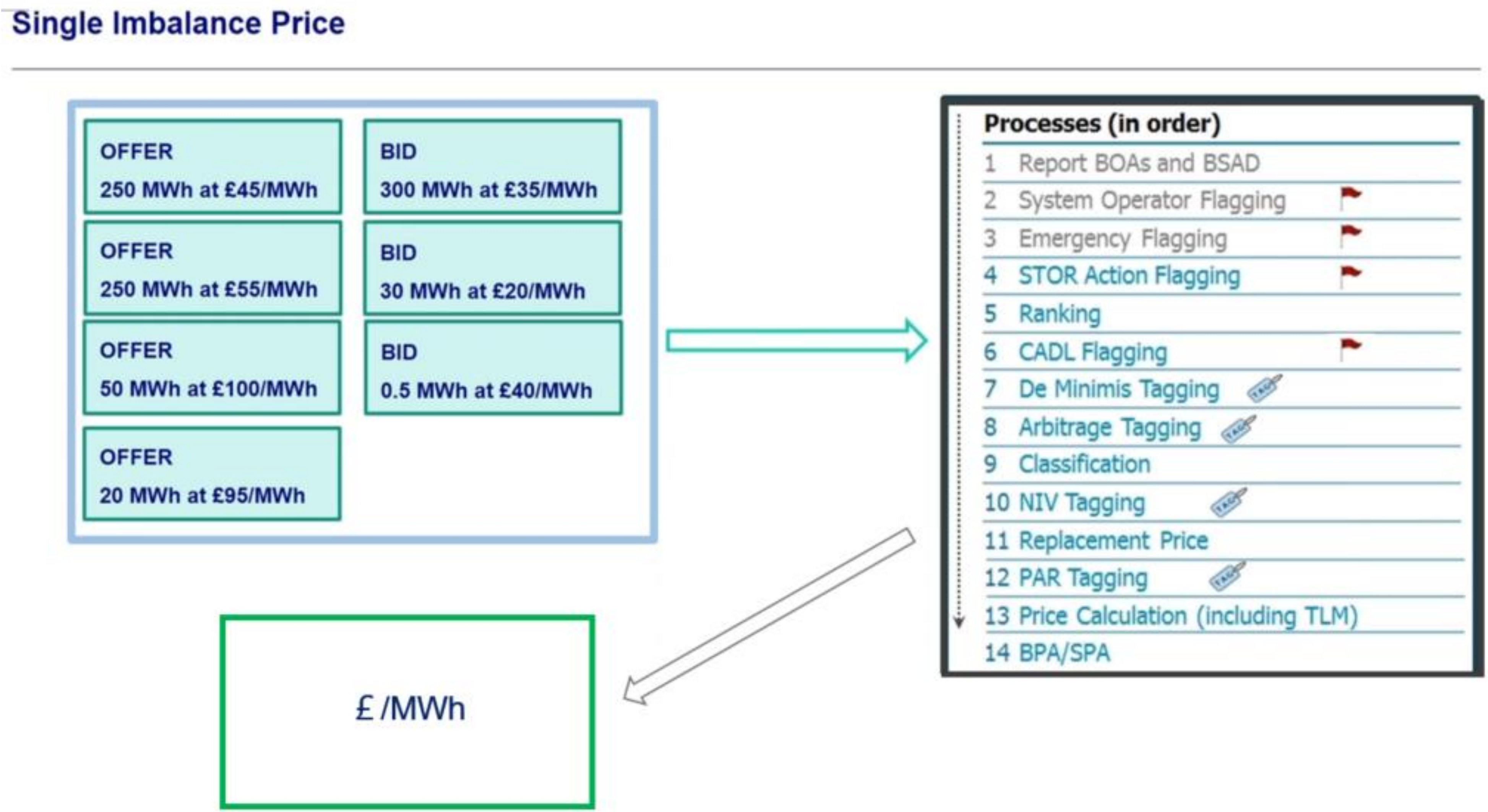
(Source) ELEXON Web Site

Elexon : Introduction to the energy market



(Source) ELEXON Web Site

Elexon : Introduction to the energy market



(Source) ELEXON Web Site

Imbalance Charge

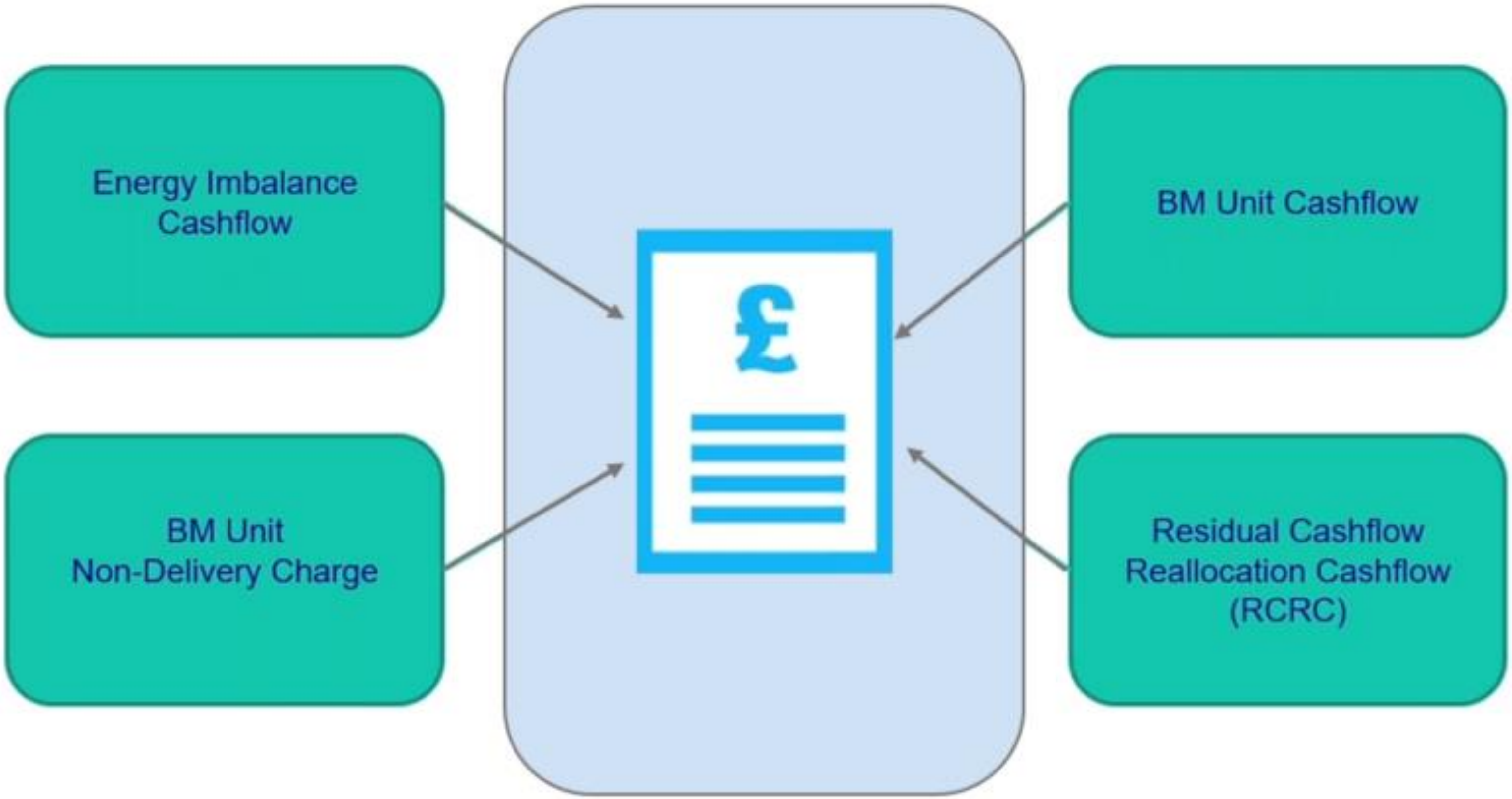
Elexon calculate a single imbalance price for a given half hour

Balancing Actions taken by National Grid are included in the calculation of the imbalance price

(Source) ELEXON Web Site

Elexon : Introduction to the energy market

Your Invoice – Trading Charges



(Source) ELEXON Web Site

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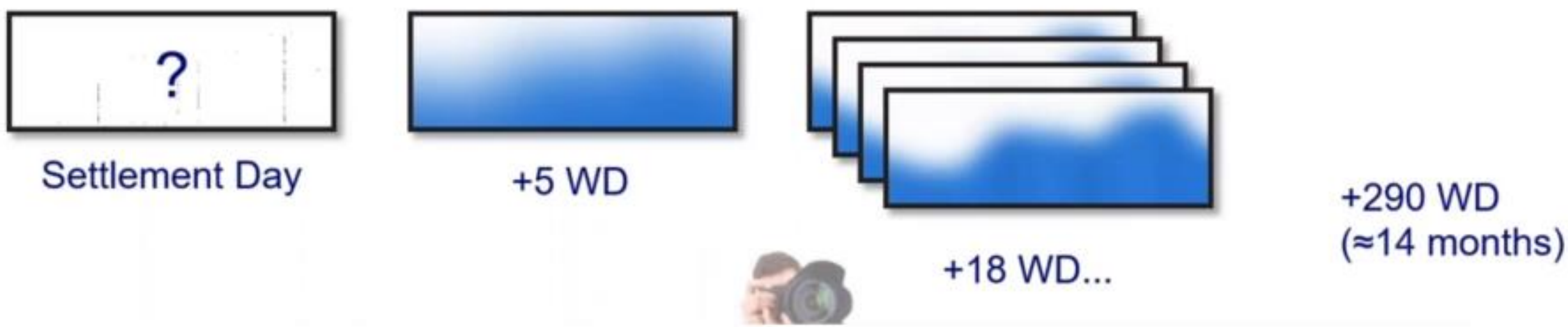
Data Reconciliation

What's a Settlement Run?

- A 'snapshot' of available data for a day after the event
- With each Settlement Run, the accuracy of the data should improve



(Source) ELEXON Web Site

Elexon : Introduction to the energy market

Concept of Imbalance

Elexon capture the contracted volumes from Generators and Suppliers so we can see what they have bought or sold to try and balance their position

Settlement Period takes place

Elexon systems capture metered data to understand who consumed or generated energy during the Settlement Period

National Grid provides data on actions taken to balance the System

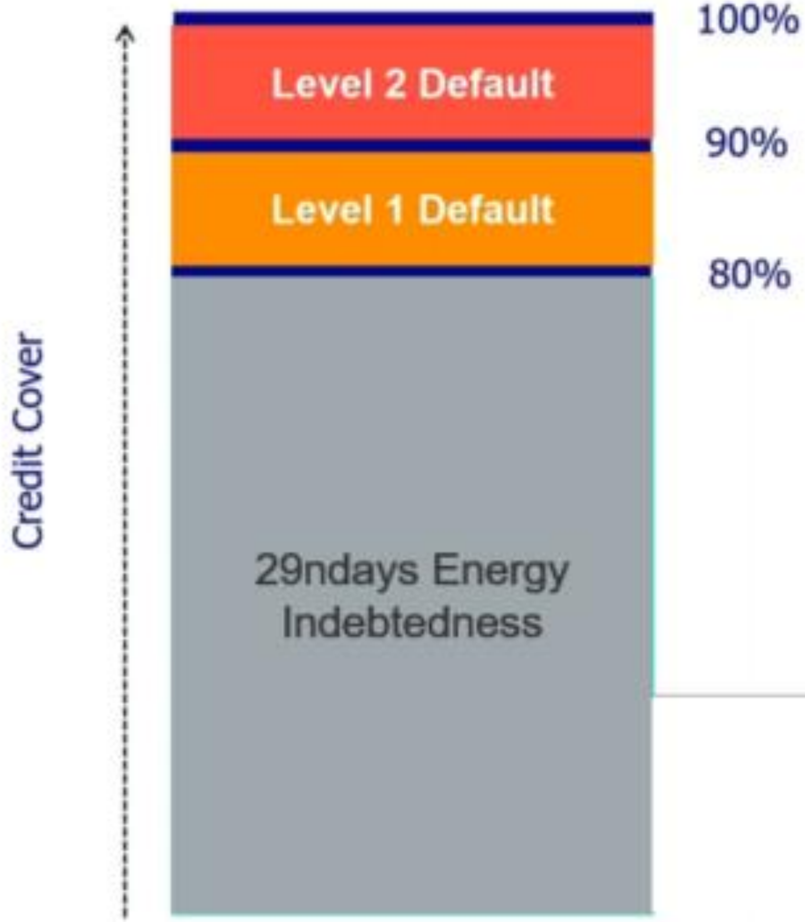
Elexon calculates the Imbalance Volume, multiplies this by the Imbalance Price, to calculate the imbalance Charge

BSC Parties will receive invoices for their Trading Charges

(Source) ELEXON Web Site

Elexon : Introduction to the energy market

BSC Credit Cover



- Due to the settlement run timetable, an invoice for a settlement day is paid, on average, 29 calendar days after it occurs
- Elexon therefore ask parties to lodge collateral to cover **29 calendar days of indebtedness**

(Source) ELEXON Web Site

Recent Topics in UK Power Sector

(Topic) Recent Topics in UK Power Sector (1)

UK Government has announced on obligation of installation of EV charger to new constructed house: Gasoline fueled vehicles will be prohibit to sell by 2030.

November 21 2021

The British government announced on the 21st November 2021 that it will require the installation of electric vehicle (EV) charging equipment in newly built houses and office buildings from 2022. In the UK, the policy is to ban the sale of gasoline-powered vehicles by 2018, with the aim of expanding charging facilities and accelerating the spread of EVs. Submit related bills to Congress by the end of 2021.
In addition to newly built houses and business establishments, it will be obligatory to install it even when a building that can hold 10 or more cars undergoes a large-scale renovation. The UK government expects that new charging facilities will be installed in up to 145,000 locations a year in England, including London, due to mandatory installation. There are about 26,000 public charging facilities in the UK, but the government believes that it is not enough to spread EVs.
Prime Minister Johnson will announce this policy in a lecture scheduled to be held on the 22nd November 2021, saying that "the British economy must be adapted to the green industrial revolution."

Photo from the article taken at London city

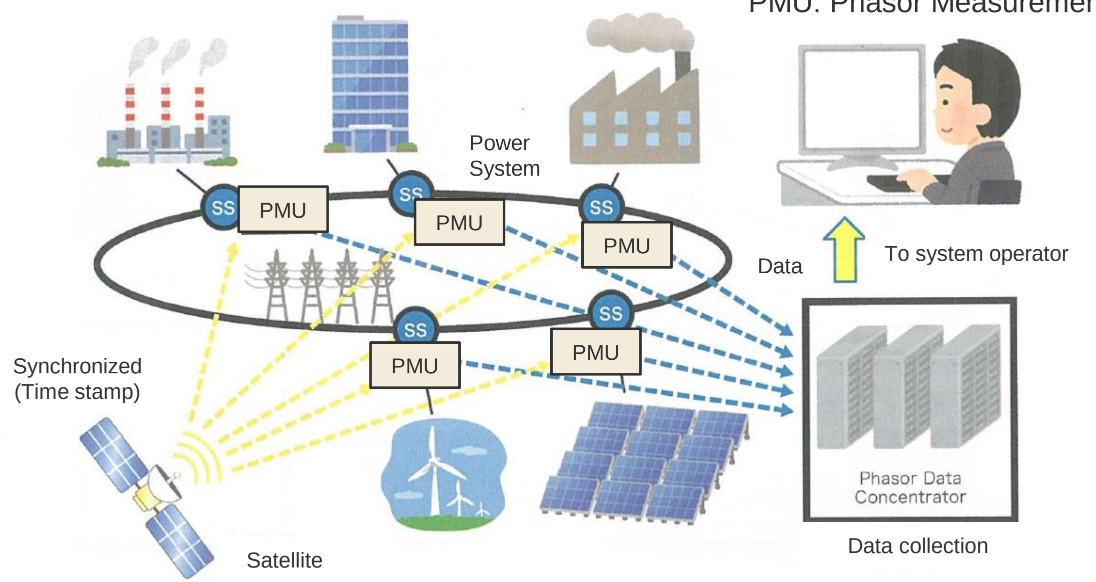
(Source) Web site information

Action by National Grid ESO for measuring Inertia in Power System

In recent years, there is a concern that the Inertial will decrease due to the increase in asynchronous distributed power sources using inverters such as wind power and solar power.
National Grid ESO is implementing various efforts to secure and manage the Inertial in order to achieve both the introduction of renewable energy and the stability of the system.
Due to the increase in distributed power sources, the number of power sources that ESO cannot fully grasp is increasing.
By accurately measuring the inertial force, it is possible to generate maximum renewable energy while ensuring supply stability, which is effective for decarbonization. In addition, it is possible to optimize the cost required to secure the inertial force.

Image of measuring Inertia (GE Digital Co.)

PMU: Phasor Measurement Unit



(Source) Japan Electric Power Information Center report

(Topic) Recent Topics in UK Power Sector (3)

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National Grid ESO and Octopus Energy launch trial to unleash demand flexibility this winter

8th February 2022

Trial to determine if moving home energy demand out of peak times can support electricity system this winter
Participating homes could reduce power demand by 150MW during each two-hour trial event
Findings to help unlock domestic flexibility to better balance the grid and reduce costs to consumers
National Grid Electricity System Operator (ESO) and Octopus Energy are launching a pioneering real-time project to determine if flexibility in household electricity can help better match supply and demand on the electricity grid.
The trial will be available to Octopus Energy's 1.4 million smart meter customers.
Customers who take part will receive a financial incentive if they reduce their power consumption below their usual levels for pre-defined two-hour windows across several key periods during this winter, allowing them to save money on their electricity bills by utilising smart energy technologies in a flexible manner.

(Source) National Grid ESO Web Site

(Topic) Recent Topics in UK Power Sector (3)

National Grid ESO and Octopus Energy launch trial to unleash demand flexibility this winter

8th February 2022

The real-time trial will help to find out if moving home energy demand out of peak times can support balancing the power grid and reduce costs, particularly at a time of the year when heating and lighting causes overall power demand to be higher.

The pilot scheme will help inform the ESO's plans to run a zero-carbon grid for certain periods by 2025 and a fully decarbonised grid by 2035 – and build understanding how households can support this goal.
It will also provide insight into how domestic customers could play a role in reducing the costs of balancing supply and demand and ultimately save consumers money on their electricity bills.

(Source) National Grid ESO Web Site

(Topic) Recent Topics in UK Power Sector (4)

CHUBU Electric Power
NIPPON KOEI

'Green inertia' projects and world-first tech tell British energy success story

World-first technology and pioneering green engineering projects are set to make this a breakthrough year for the transition to clean energy and improved stability on GB's electricity system.

7th March 2022

2022 a breakthrough year for "green" inertia
World-first deployment of inertia measuring tools onto the grid

Three new fossil free turbines that provide system inertia to launch by summer, with five new green inertia providers now connected to the system.
Three green inertia services, which mimic the effect of a power station but without using fossil fuels, will go live by summer.

Previously inertia has been provided by coal or gas power plants but the ESO is now procuring inertia from carbon free sources, which is not only significantly cheaper for consumers, but allows for greener system operation and more renewable energy to run.

(Source) National Grid ESO Web Site

(Topic) Recent Topics in UK Power Sector (4)

‘Green inertia’ projects and world-first tech tell British energy success story
World-first technology and pioneering green engineering projects are set to make this a breakthrough year for the transition to clean energy and improved stability on GB’s electricity system.

It’s also using technology to map and monitor the amount inertia on the system more accurately, which means the ESO can run a higher penetration of renewable generation, rather than bringing on coal or gas plant when inertia levels are estimated to be low.

Built by Reactive Technologies, but owned by the ESO, the ultracapacitor will enable Reactive's tool to accurately measure inertia by sending pulses of power through the grid, in a similar manner to sonar technology, accurately mapping any deviations in levels of inertia and frequency.

(Source) National Grid ESO Web Site

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Review of Previous Lecture

UK Energy Sector Overview

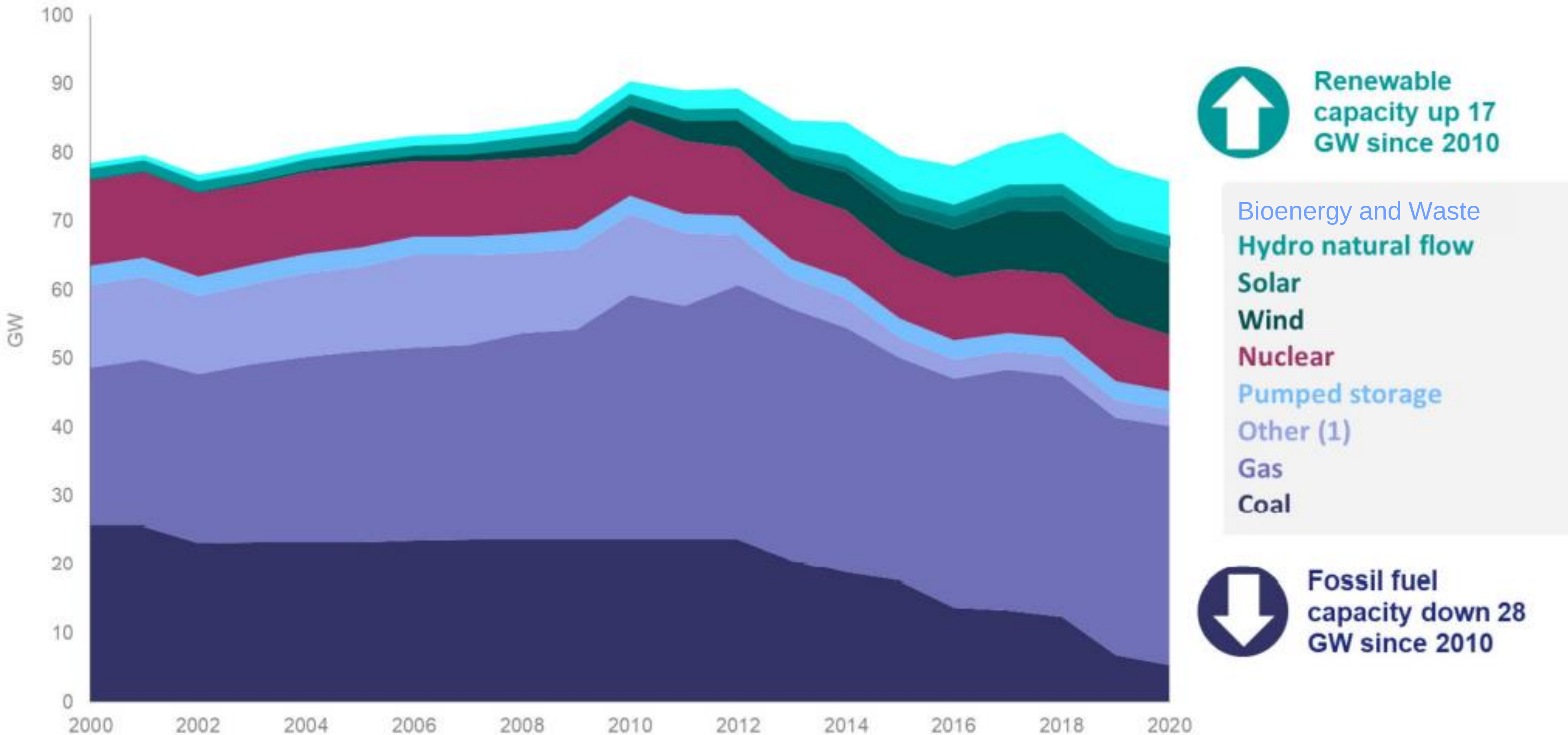


Fig.1 Installed Capacity of UK Electricity Generation Assets by Fuel, 2000 to 2020

(Source) Digest of UK Energy Statistics 2021

UK Energy Sector Overview (Future Scenarios)

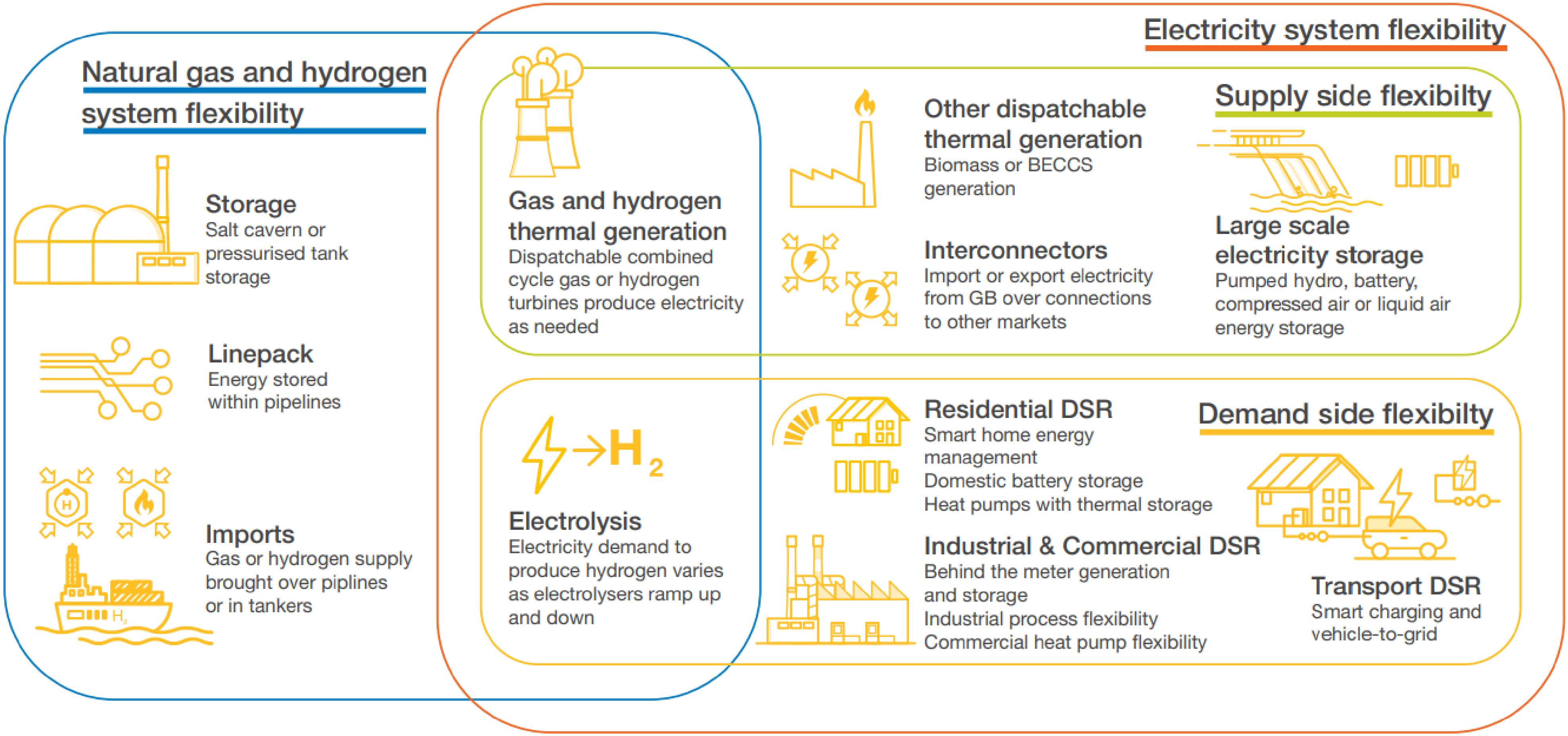


Fig.2 Flexibility in future in Power Sector

(Source) National Grid ESO "Future Energy Scenarios"
https://www.nationalgrideso.com/document/202851/download

Power Market Scheme in Ireland

Ceylon Electricity Board
JICA Expert Team

June, 2022

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

General Information

CHUBU Electric Power
NIPPON KOEI

General things

Items	Contents	Sri Lanka (Ref.)
Population	5.01 mil. (2021)	21.92 mil. (2020)
GDP	476.7 billion USD	80.7 billion USD
GDP/Capita	94,600 USD	3,700 USD
Area	70,300km2	65,600km2

Source: Ministry of Foreign Affair

System Demand (Whole Ireland)

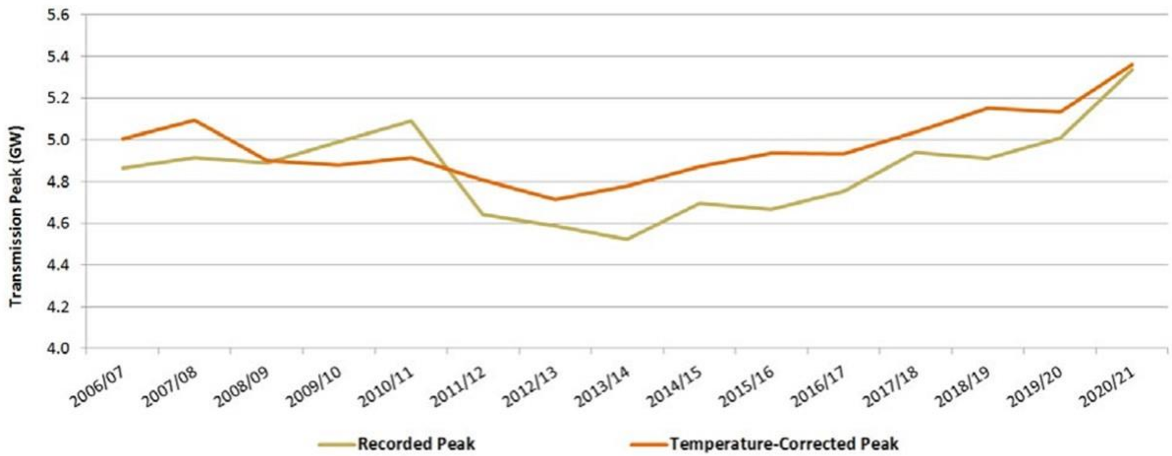


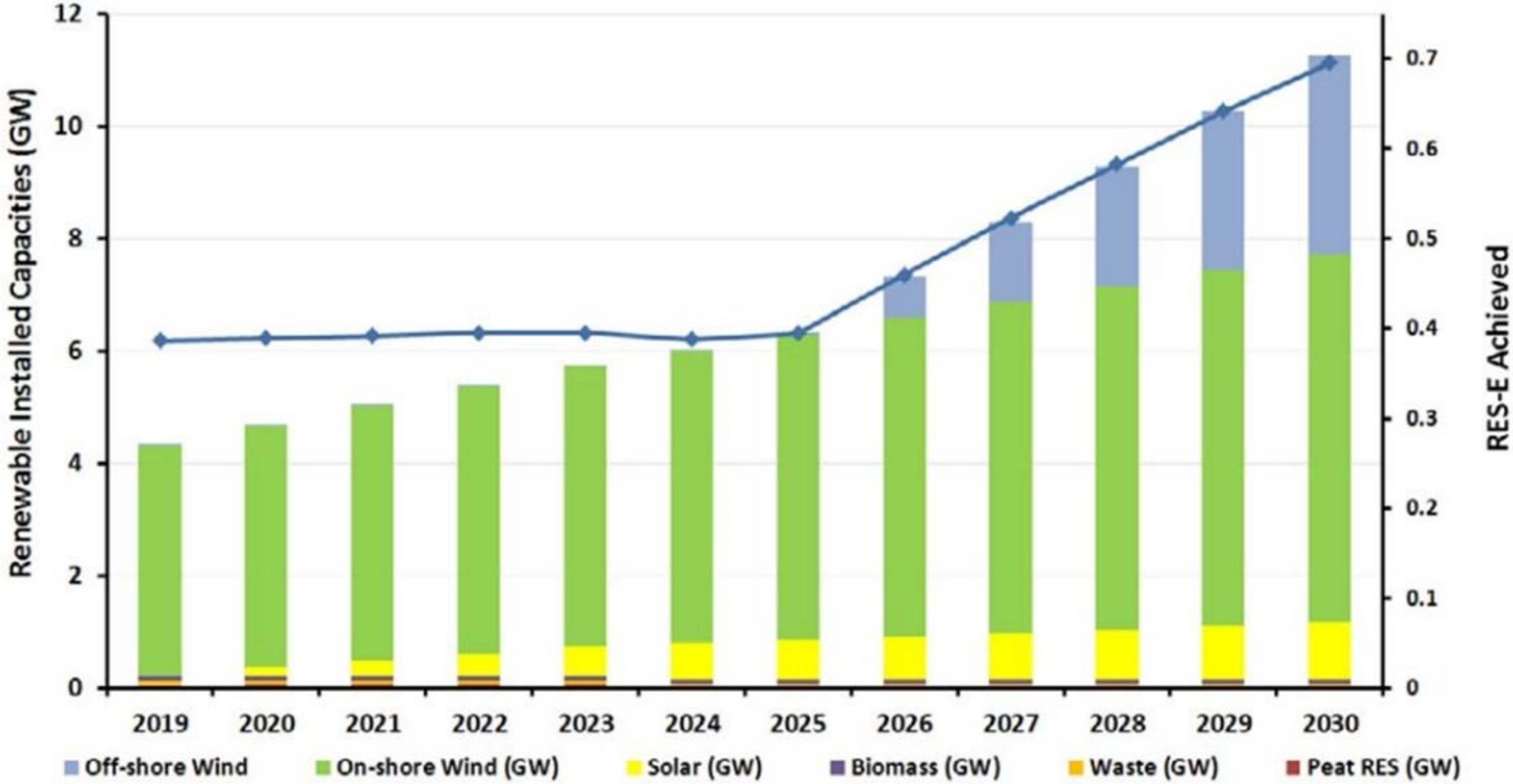
Figure 11 - Past values of recorded maximum demand in Ireland, and the ACS temperature-corrected values

2020: 5.3～5.4GW

Source: All-Island Generation Capacity Statement 2021-2030, EIRGRID & SONI

General Information cont'd

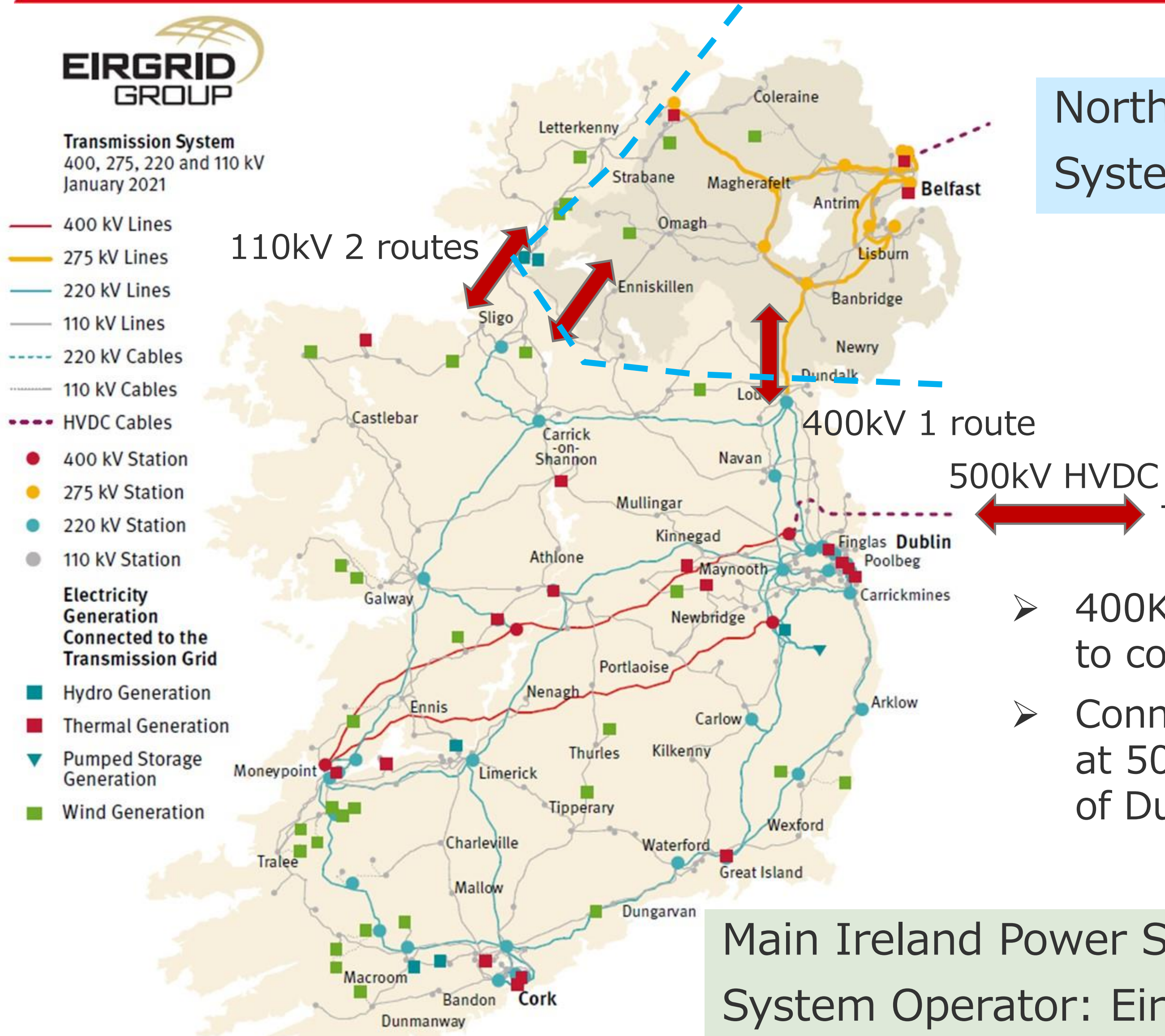
Renewable Energy Generation Portfolio



Target: 70% Achievement by 2030

Source: All-Island Generation Capacity Statement 2021-2030, EIRGRID & SONI

Power System Configuration of Whole Ireland



Northern Ireland Power System

System operator: SONI

- 400KW 1 route, 110kV 2 routes to connect with the north
- Connected to the UK main island at 500kV HVDC from the suburbs of Dublin

Main Ireland Power System

System Operator: EirGrid

Source: EirGrid Annual Report 2020

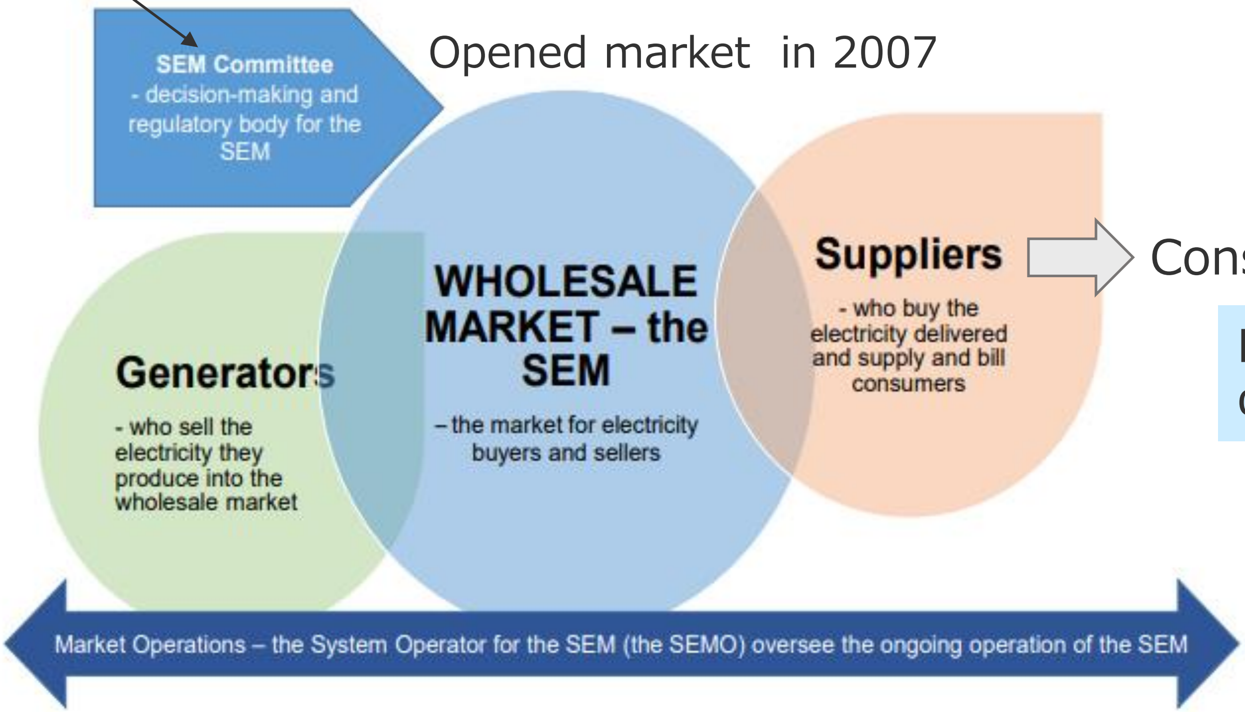
Market Condition

- Opened in 2007 as a joint Single Electricity Market (SEM) in Ireland including Northern part, which are part of the United Kingdom
- SEM is operated by a Single Electricity Market Operator (SEMO*), a joint venture between two grid operators, EirGrid and SONI.

※ Market is operated by Nominated Electricity Market Operators (NEMOs) in each bidding zone or geographical region. In Ireland, two NEMOs are integrated into SEMO

Regulator

Opened market in 2007



Consumers

Electricity cannot be sold directly to consumers from Whole sale market

This is distinct from the retail market where suppliers are responsible for the selling, metering, billing and collection of payments to customers.

Source: Quick Guide to the I-SEM

Activities in SEM

- Generators submit bids (for capacity and selling price) to the SEMO to generate electricity for each half-hour of the following day
- These bids are stacked in order with the least expensive generators called on to provide power until demand is met
- The bids and demand set the energy price for each half-hour period, called the system marginal price (SMP), and this price is paid to all those generators who are scheduled to produce power
- Generators also receive capacity payments if they are available to generate and also constraints payments if the power delivered by generators is different from that scheduled, due to the technical realities of operating a complex power system

Source: Quick Guide to the I-SEM

The Appearance Background of I-SEM

- Much has changed since the SEM was introduced in 2007. In particular, there is now a more generation from renewable sources across the island.
- As the introduction of renewable energy power sources progresses, it is believed that integration into the European market will be best practice in terms of effective use of existing power sources and grid equipment, efficient operation of interconnection lines for the supply and demand balance, and sending the appropriate price signals for capital investment.

In October 2018, the single wholesale electricity market (I-SEM) started with the idea of integration into the single market in Europe.

Source: Quick Guide to the I-SEM

Main difference of I-SEM and SEM

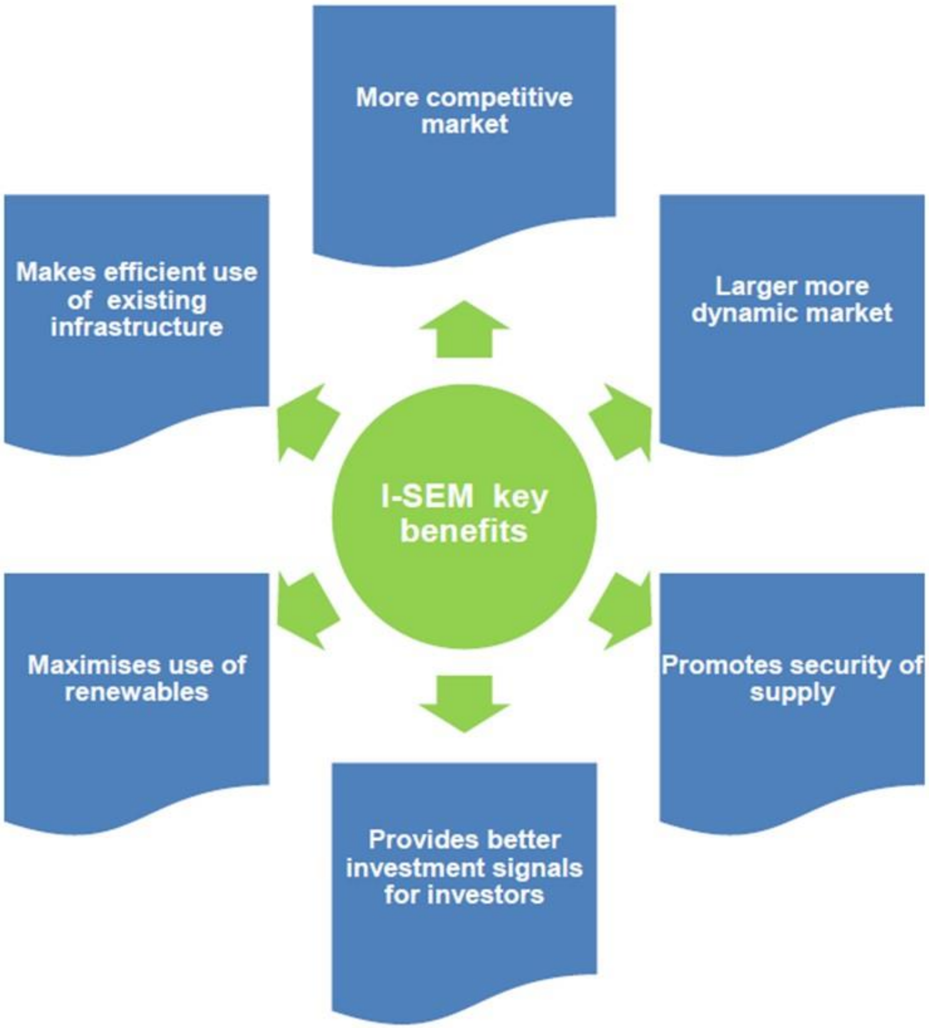
	SEM	I-SEM
Market structure	One pool and timeframe	Different markets with different timeframes
Trading opportunities	A single opportunity for generators to submit their bids each day.	Generators and suppliers will have multiple opportunities to trade (at Day Ahead and Intra Day).
Setting the market price	All generator bids stacked up in order of merit. The last generator (the most expensive) sets the price that suppliers pay. Suppliers are price takers.	Suppliers are price makers – they set limits on what they are willing to pay in each market and, this sets the market price.
Balancing supply and demand	Supply and demand are matched using an algorithm.	Generators and suppliers have to match their actual with their traded generation and usage. If their generation or usage differs, suppliers or generators are liable for these costs in the balancing market.
Capacity payments (CP) to generators	To cover generators' fixed costs and CPs are paid so long as the generator declares that it is available to run.	Generators are paid only when their output is required to meet demand and only if they can.
Trading across interconnectors with Great Britain	Capacity on interconnectors can be reserved to flow power in line with their trading approach. This may not deliver a cost-efficient flow.	Interconnection capacity allocated based on prices with electricity always flowing from the cheapest to the most expensive market.

Source: Quick Guide to the I-SEM

How changes after the installation of I-SEM

CHUBU Electric Power
NIPPON KOEI

1. Security of supply is improved because the I-SEM facilitates trading across borders and making best use of the power available from all sources on the island of Ireland
2. More competitive market because consumers should benefit from a more competitive process
3. Downward pressure on prices because power flow more efficiently via interconnectors with GB

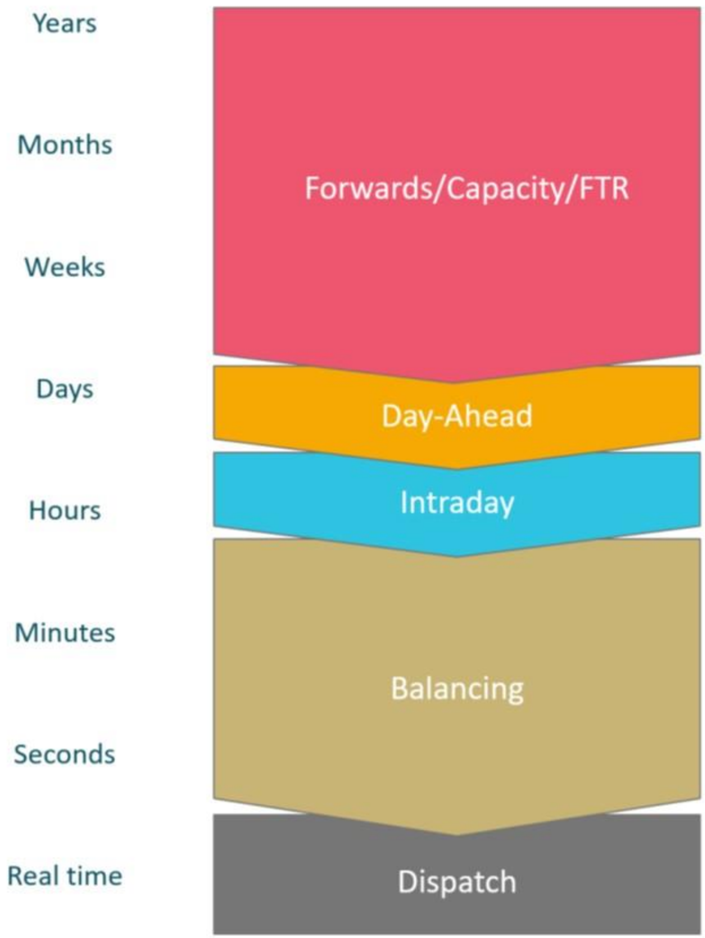


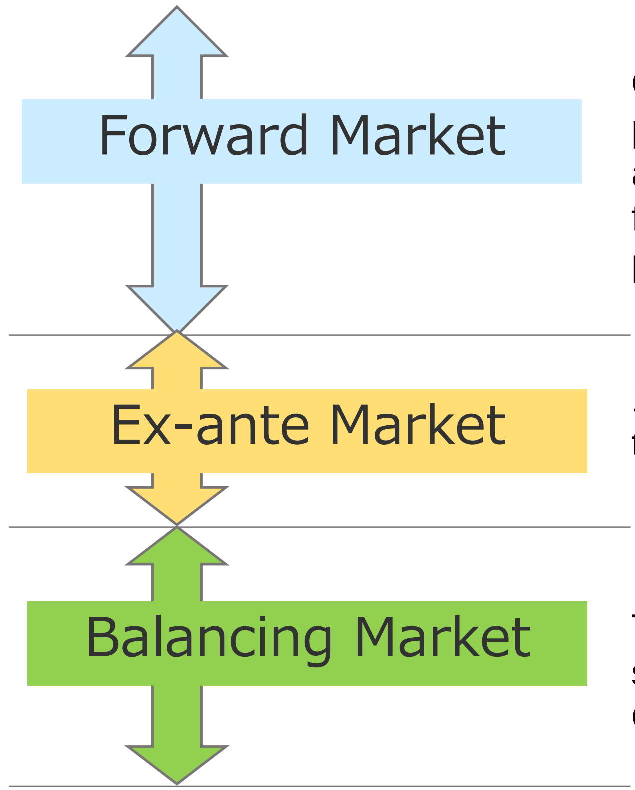
Source: Quick Guide to the I-SEM

Here in after the detailed market condition as reference

Source: Quick Guide to the I-SEM

Market Time Frame





Opportunity to hedge their positions in the DAM※1, IDM※2 and BM by purchasing contracts-for-difference (CfDs) at a strike price

19 days before to one hour trading

TSO takes actions to keep the system balanced.
Only Generator can enter the bid.

※1: Day Ahead Market
※2: Intra Day Market

Source: Quick Guide to the I-SEM

Day Ahead Market (DAM)

CHUBU Electric Power
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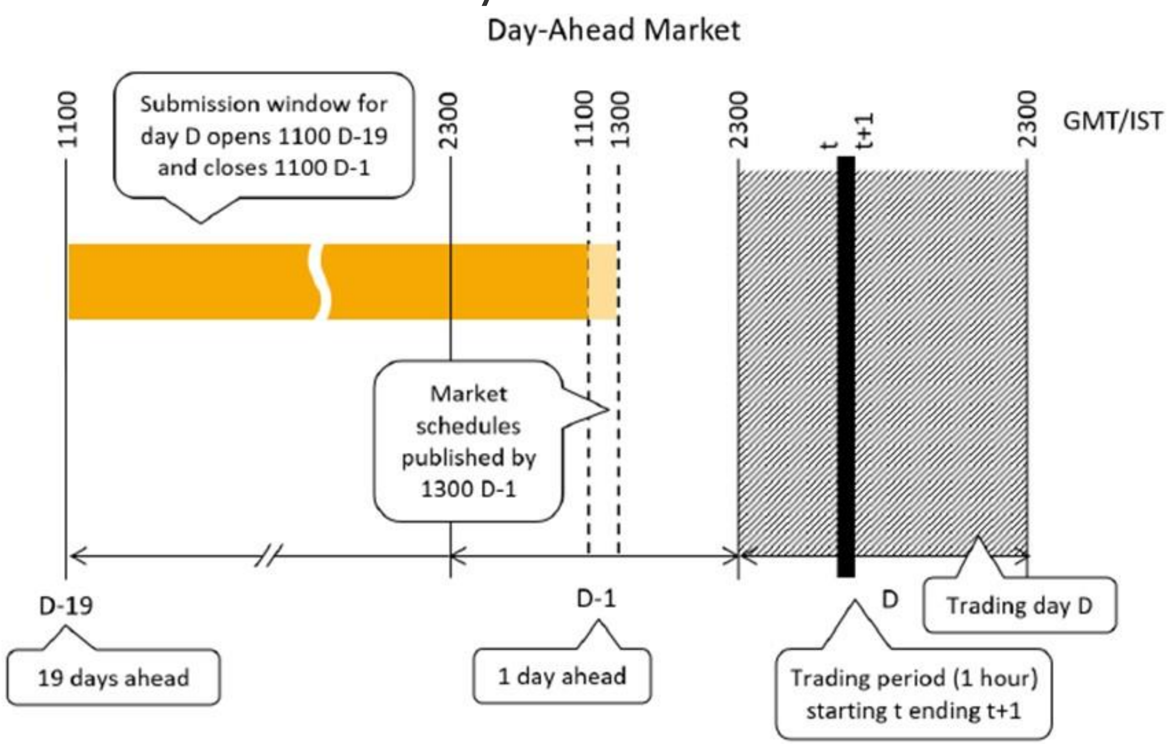
- DAM is a single pan-European energy trading platform in the ex ante time frame for scheduling bids and offers and interconnector flows across participating regions of Europe
- DAM allows for early bids and can be made from 19 days out up a day before trading
- An algorithm, called Euphemia (Pan-European Hybrid Electricity Market Integration Algorithm), is used to set the market price and the best way of distributing the power available (including across interconnectors).
- Participation in the DAM is not mandatory, but it is the only way of achieving a day-ahead position in the SEM, which is the primary mechanism through which participants establish a physical position to minimize their exposure in the Balancing Market. Because BM is mandatory for all dispachable generators, which means if they do not meet their position, they have to pay the imbalance charge.

Source: Quick Guide to the I-SEM
Source: Industry Guide to the I SEM

Market Timeline of DAM

- Trading participants submit orders in the DAM to support their desired physical position for each 1-hour trading period※1
- Submission of orders opens at 11:00 D-19 (19 days before trading day D) and closes at 11:00 D-1
- Participants submit physical notifications※2 reflecting the agreed trades to the TSOs by 13:30 D-1.



※1: Market operates on a 30-minute trading period. The DAM MWh quantities are split into two equal half-hour quantities for participants' initial nomination

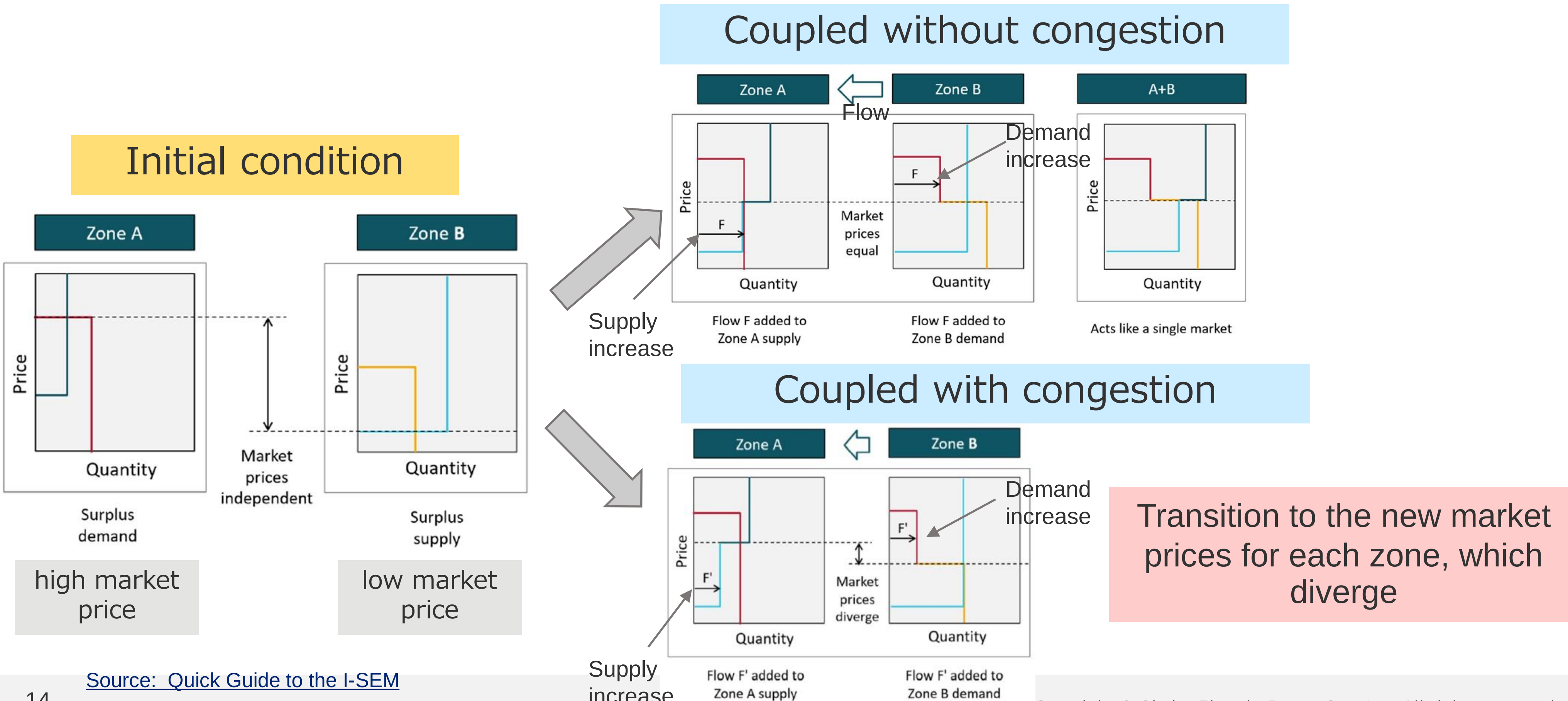
※2: It defines the expected output of generator units. A PN should reflect the participant's best estimate of its intended level of generation

Source: Quick Guide to the I-SEM

Source: Industry Guide to the I SEM

Market Integration

- Nominated Electricity Market Operators (NEMO) operates the electricity market in each area.
- If markets are separated, each market has it's own market price. Once they are connected and there is no congestion, EUPHEMIA solves the problem and set a single price as if it was a single Europe-wide market. If there is congestion, it adjusts the market price by managing trades between bidding zones



[Source: Quick Guide to the I-SEM]

[Source: Industry Guide to the I SEM]

Intraday Market (IDM)

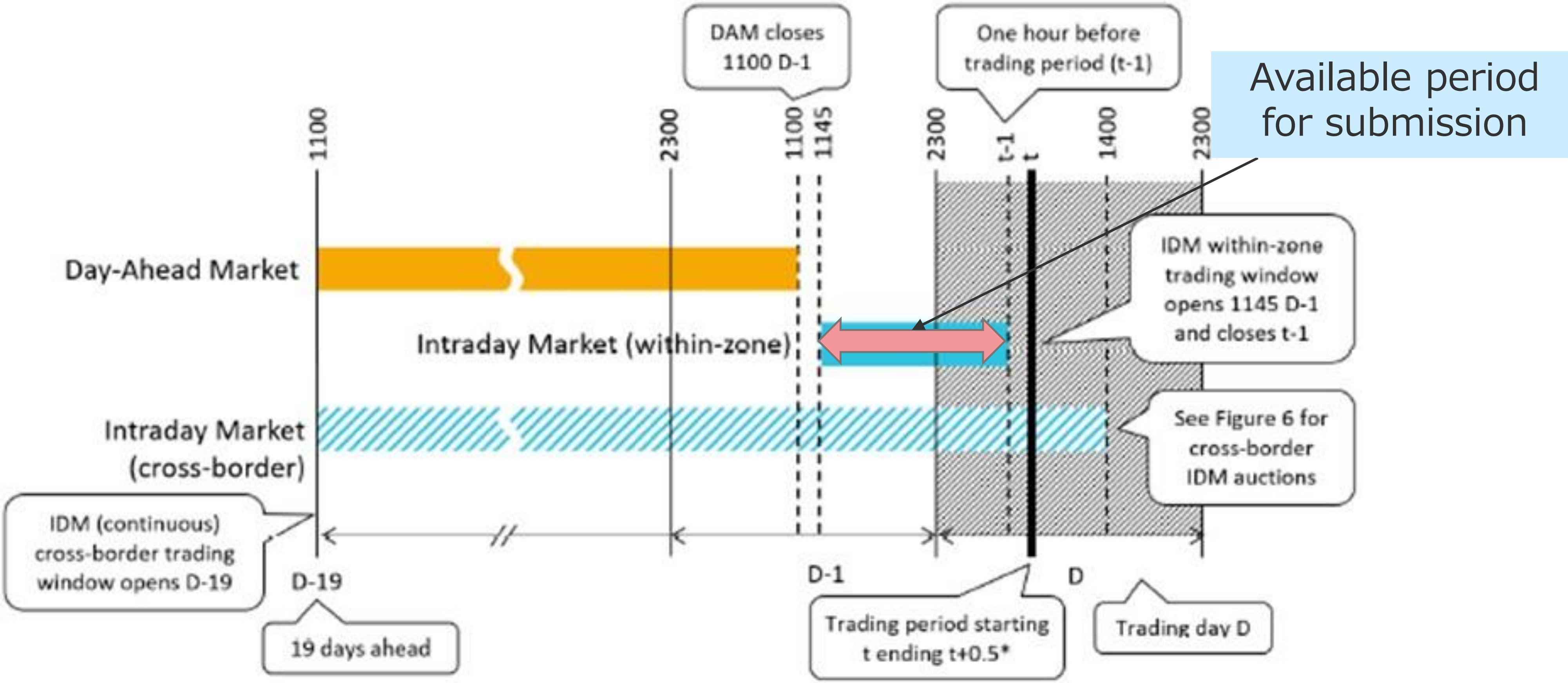
- IDM allows participants to adjust their physical positions closer to real time.
- The reasons for the adjustment are orders failing to clear in the DAM, new information becoming available (e.g. plant shutdowns and changes to forecasts), congestion on interconnectors, and assetless traders wishing to exit their positions
- IDM runs right up to one hour before trading

Source: Quick Guide to the I-SEM

Market Timeline of IDM (Within-zone Trades)

CHUBU Electric Power
NIPPON KOEI

- The IDM trading day is divided into 48 (30-minute) trading periods.
- The submission window for within-zone trades opens at 11:45 D-1 and closes one hour before real time (t-1).



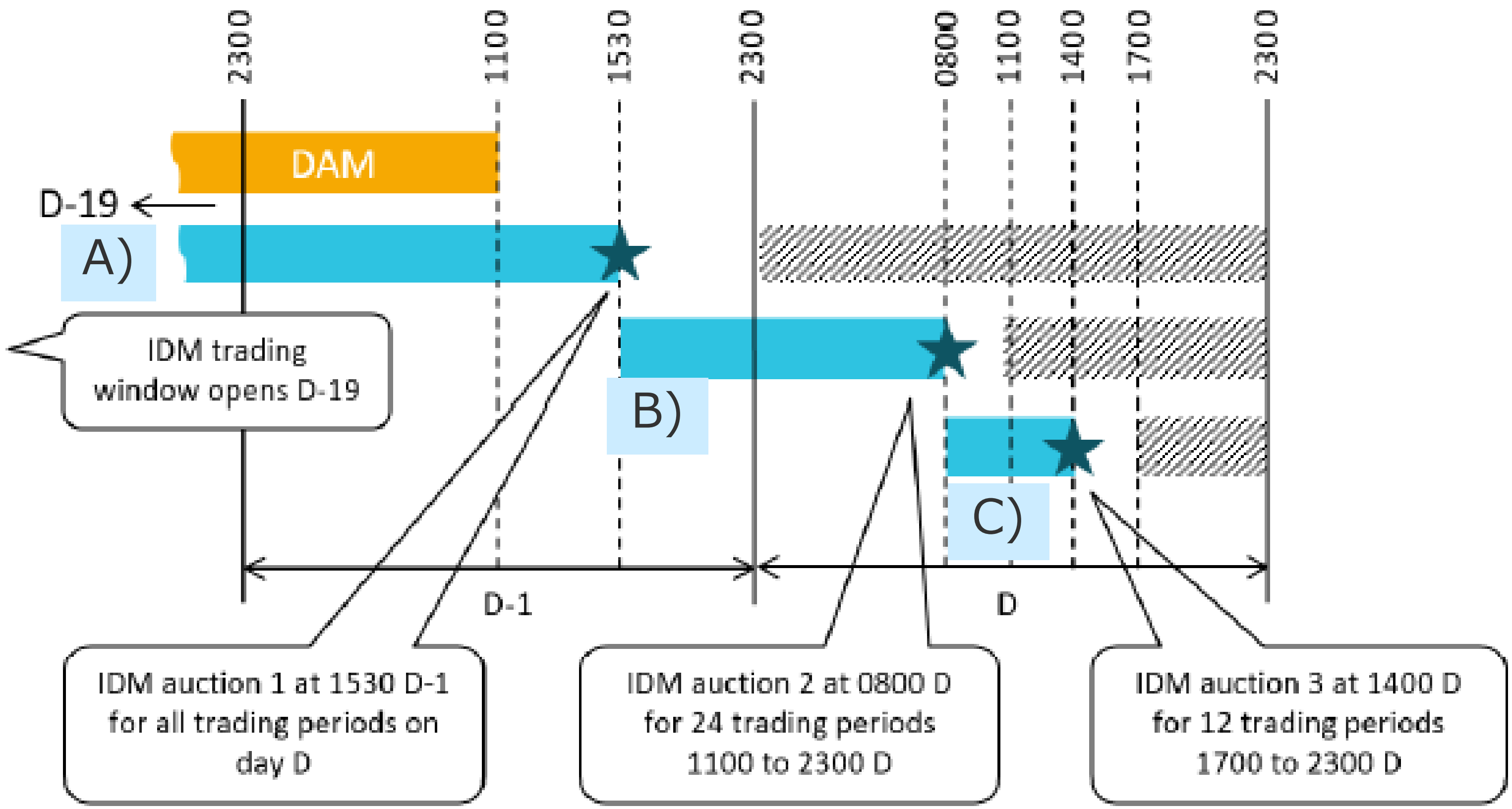
Source: Quick Guide to the I-SEM

Source: Industry Guide to the I SEM

Market Timeline of IDM (Cross-border Trades)

- Three auctions are open until:

A) (Auction 1) At 15:30 D-1 for all 48 trading periods on day D.
B) (Auction 2) At 8:00 on day D for the 24 trading periods from 11:00 to 23:00 D.
C) (Auction 3) At 14:00 on day D for the 12 trading periods from 17:00 to 23:00 D.



Source: Quick Guide to the I-SEM

Source: Industry Guide to the I SEM

Balancing Market (BM)

CHUBU Electric Power
NIPPON KOEI

Market Function

- The BM ensures that energy supply equals energy demand.
- The BM determines the imbalance settlement price for settlement of the TSO's balancing actions
- Unlike the other ex-ante markets, only generators bid in this market, suppliers take the price that is set. In this market the TSOs decide how demand is met by calling on generators to deliver power as needed.
- Market is operated by two parties, TSOs and SEMO

Responsibilities of TSOs

- Market systems operation and access to market data.
- System balancing and dispatch

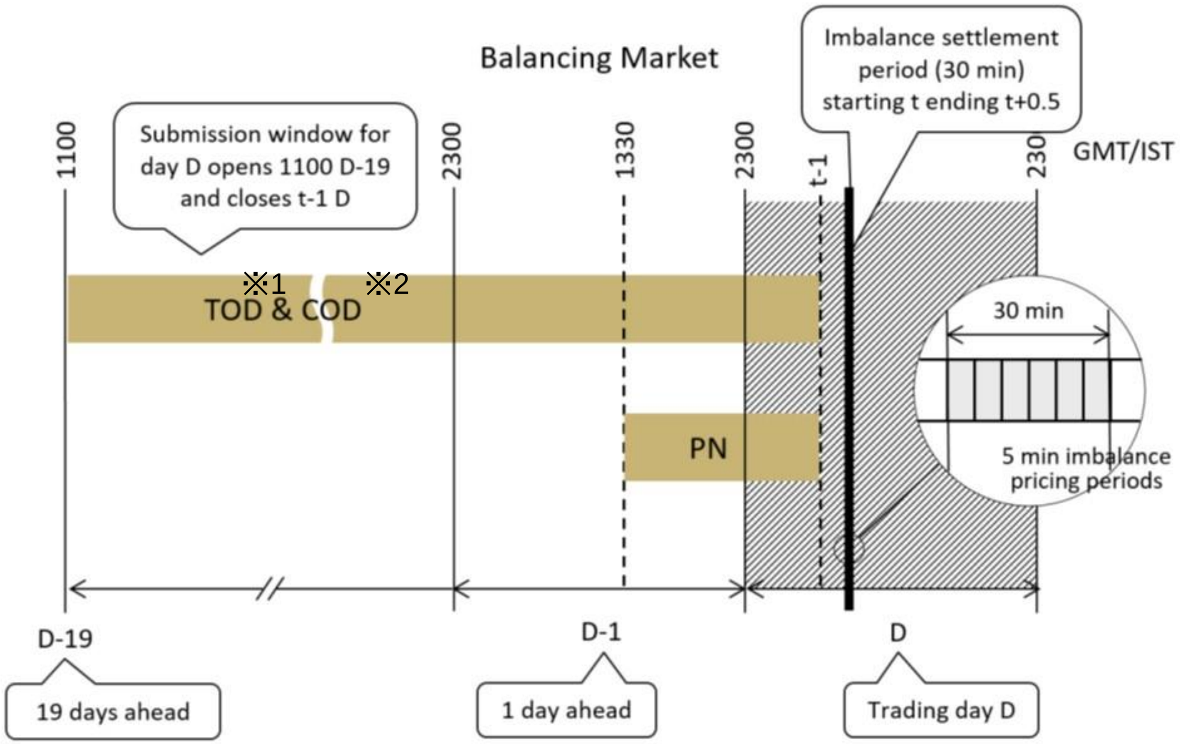
Responsibilities of SEMO

- Registration of participants
- Administration of the market rules for the settlement of imbalances and the capacity market in the Trading and Settlement Code
- Receiving submissions from participants
- Determining prices used in settlement
- Settlement and billing

Source: Quick Guide to the I-SEM
Source: Industry Guide to the I SEM

Market Timeline of BM

- The BM trading day is divided into 48 (30-minute) imbalance settlement periods
- Within each imbalance settlement period there are six (5-minute) imbalance pricing periods
- The submission window for market data(TOD ※1, COD※2, PN※3) opens 19 days ahead of the trading day (D-19) and closes 1 hour before the start of each 30-minute imbalance settlement period (t-1).



※1: Technical Offer Data, describes the physical characteristics of generator units such as capacity, minimum running levels, start-up and shut-down characteristics

※2: Commercial Offer Data, defines costs at which generators are prepared to increase or decrease their output

PN refers to Physical Notification

Source: Quick Guide to the I-SEM

Source: Industry Guide to the I SEM

Bid/Offer Acceptances of BM

TSO uses the Security Constrained Economic Dispatch (SCED) tool to produce balancing and security actions

Area hatched in red,

Dispatch profile is bigger than FPN※1

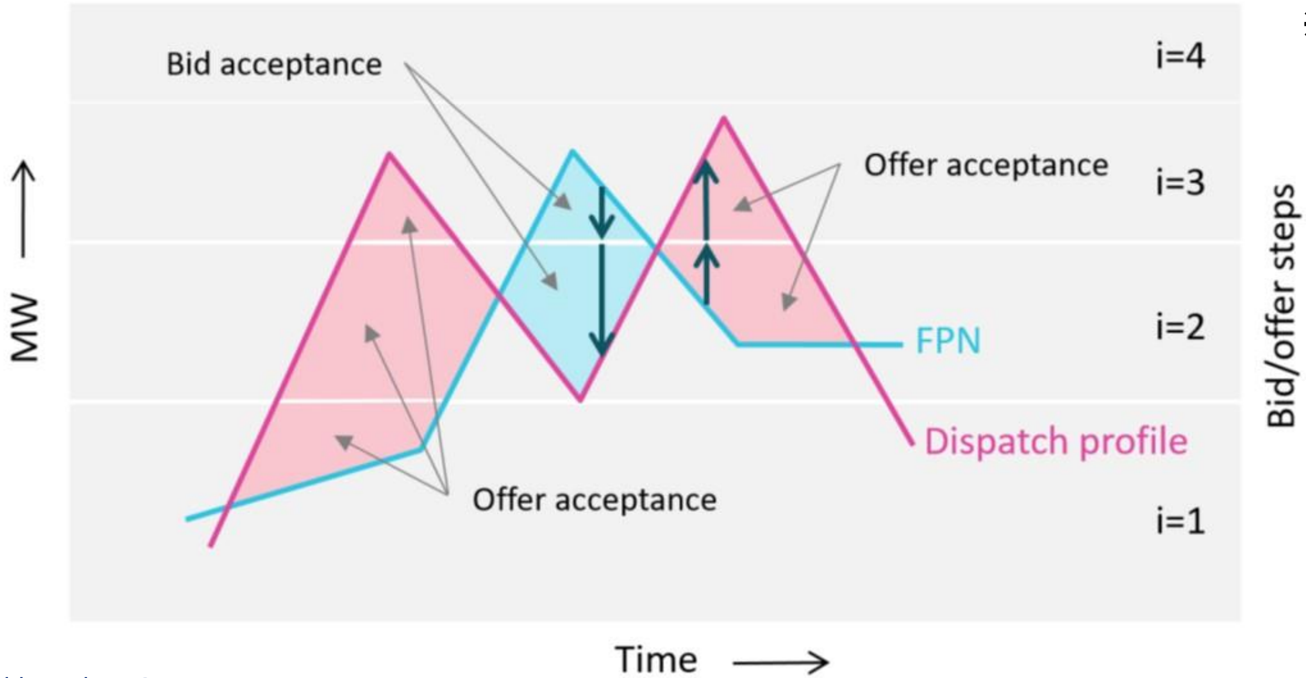
Request from the market to raise (increase power generation output / suppress demand, which is called "Offer")

Area hatched in blue,

FPN is bigger than Dispatch profile

Request from the market to lower (suppression of power generation output / increase demand, which is called "Bid")

※1: Final Physical Notification

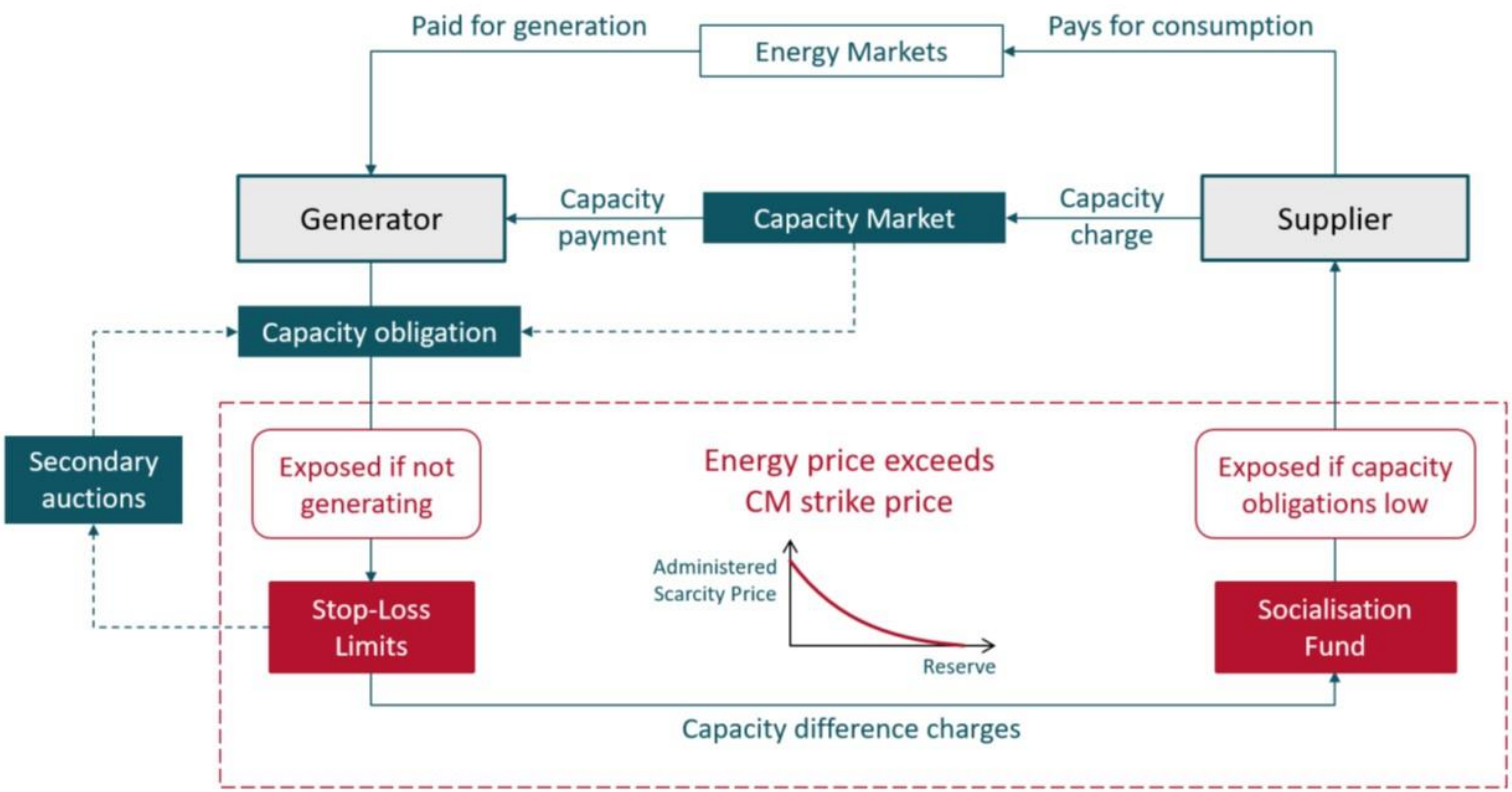


Source: Quick Guide to the I-SEM

Source: Industry Guide to the I SEM

Capacity Market (CM)

- Capacity providers sell qualified capacity to the market based on the generation capacity required in a future capacity year.
- Capacity providers who are successful in the CM receive a regular capacity payment, which recovers fixed costs of power stations, and, in return, they have an obligation to generate when the system is stressed

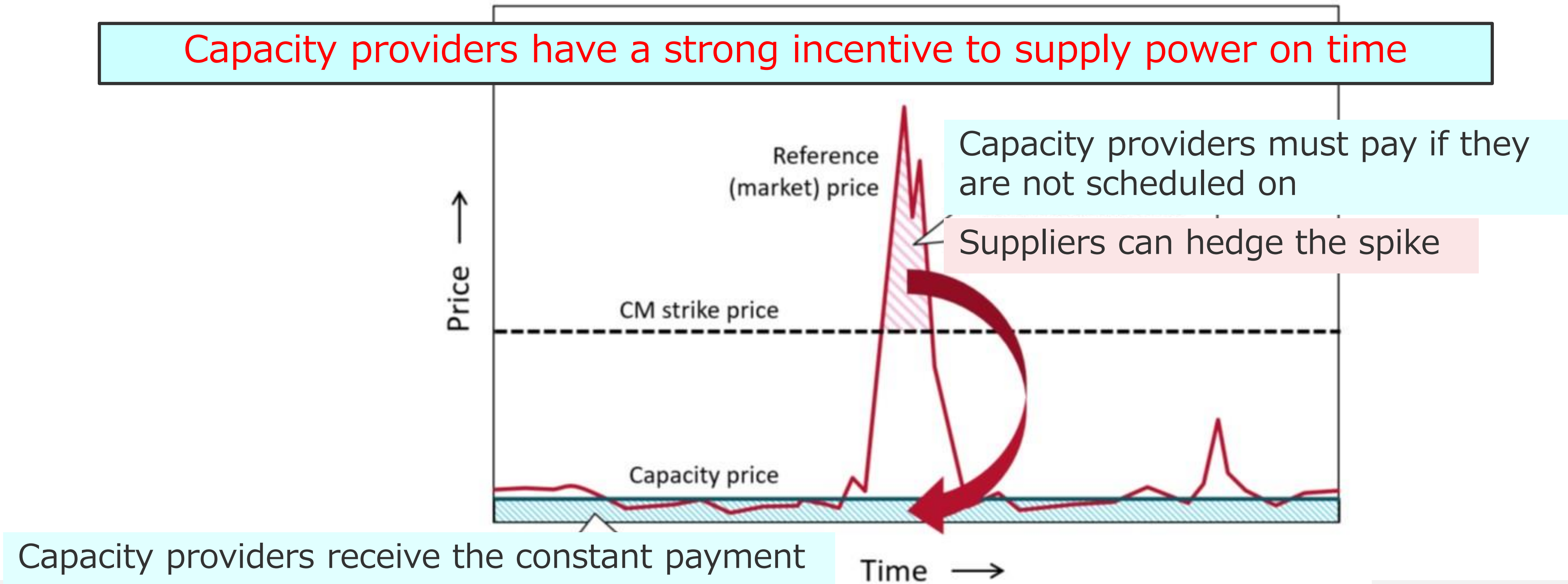


Source: Quick Guide to the I-SEM
Source: Industry Guide to the I SEM

Capacity Difference Charge

- The cost of the CM is funded by suppliers. In return, suppliers are protected against high energy prices.
- When energy prices exceed the strike price, the market pays the suppliers the difference between the energy price and the strike price.
- To fund this arrangement, generators must pay difference charges for capacity not delivered based on the difference between the strike price and a reference price.

Capacity providers have a strong incentive to supply power on time



Source: Quick Guide to the I-SEM
Source: Industry Guide to the I SEM

Market Timeline of CM

Capacity market auctions are run for a specified capacity year. The timelines for each auction are developed by the System Operators and approved by the Regulatory Authorities (RAs).

Enduring arrangement

- Primary capacity auctions will be run four years ahead (T-4) of each capacity year
- T-1 auctions will be held just before the start of the capacity year as transitional arrangement
- The first T-4 auction ran in 2018 for the capacity year ending 30 September 2022

Capacity year

- The capacity year commences at the start of the trading day on 30 September and ends at the end of the trading day on 30 September in the following year.

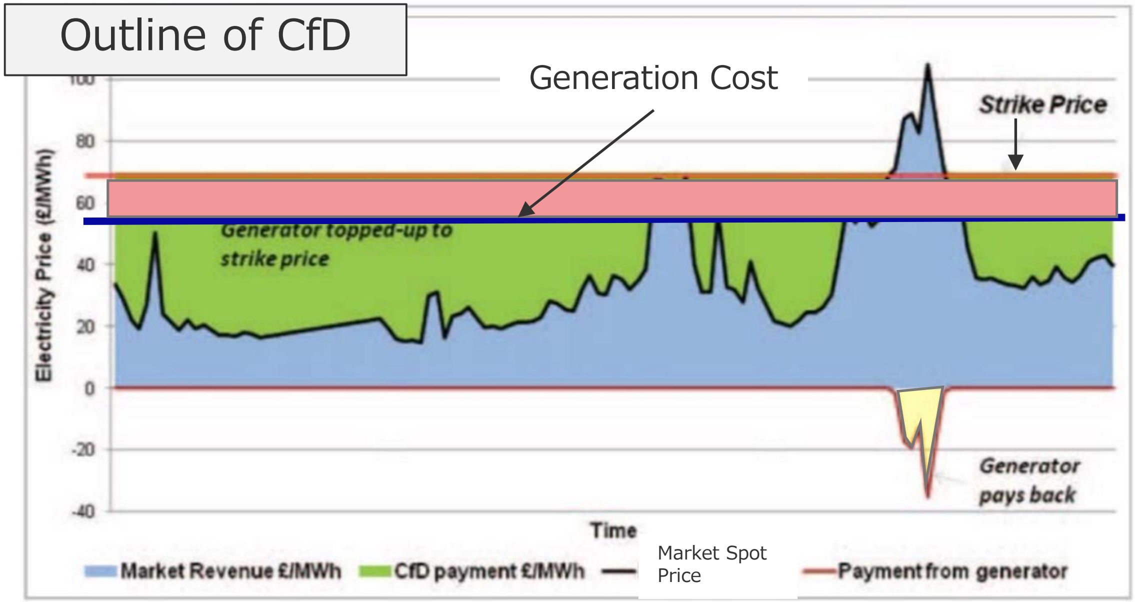
Source: Quick Guide to the I-SEM

Source: Industry Guide to the I SEM

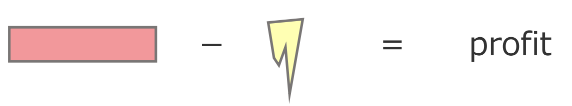
(Reference) Advantage of Forward Market (FWM)

- Transactions are conducted under the Contracts-for-Difference (CfDs)
- FWM provides participants with the opportunity to hedge their positions in the DAM, and IDM by CfDs at a strike price.

Outline of CfD



- The difference between CfD Strike price and cost is profit
- Pay the difference to the market when the Market spot price exceeds the CfD Strike price



Ex. of hedging

Energy Cost: 35 €/MWh

Production: 10MWh

Strike price: 40 €/MWh

Case 1 Market spot price: 45 €/MWh

Profit:

(45-35) x 10 = 100

(45-40) x 10 = 50

100 – 50 = 50

Case 2 Market spot price: 35 €/MWh

Profit:

(35-35) x 10 = 0

(40-35) x 10 = 50

50 – 0 = 50

Profit is constant regardless of the market spot price

Source: Quick Guide to the I-SEM

Source: Industry Guide to the I SEM

Balancing Market Scheme in Germany

Ceylon Electricity Board
JICA Expert Team

August 30, 2022

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

Agenda

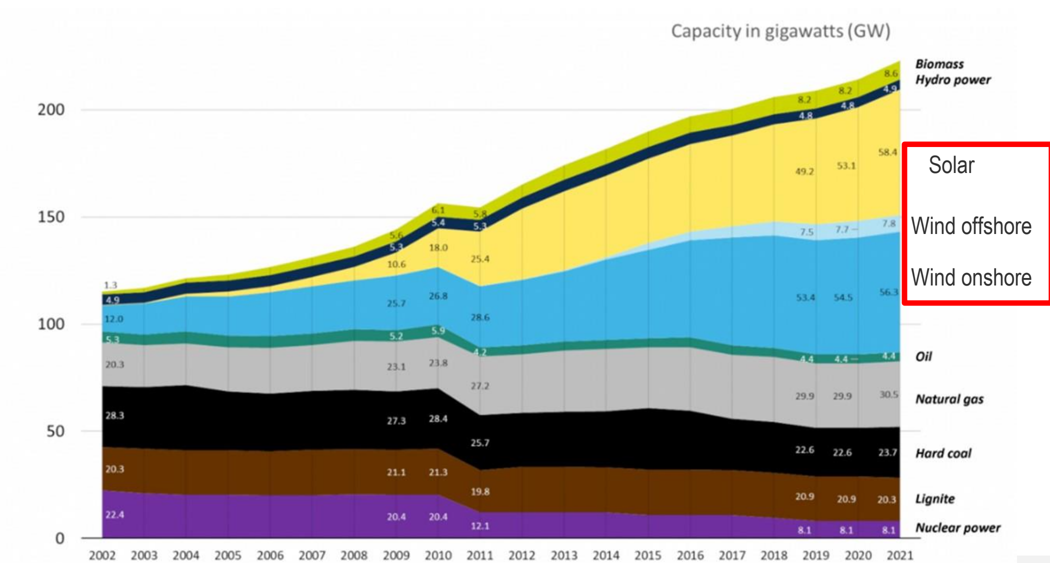
1. General Information of Germany
2. Products of Balancing Market
3. Integration of Balancing Markets (Market Expansion)
4. (Ref.) Products Details of Balancing Market

01 General Information

Item	Germany	Sri Lanka (Ref.)
Population	83 million (2020)	22million (2020)
GDP	3,862 billion USD (2019)	80.7 billion USD
GDP/Capita	46,500 USD (2019)	3,700 USD
Area	357,00km2	65,600km2

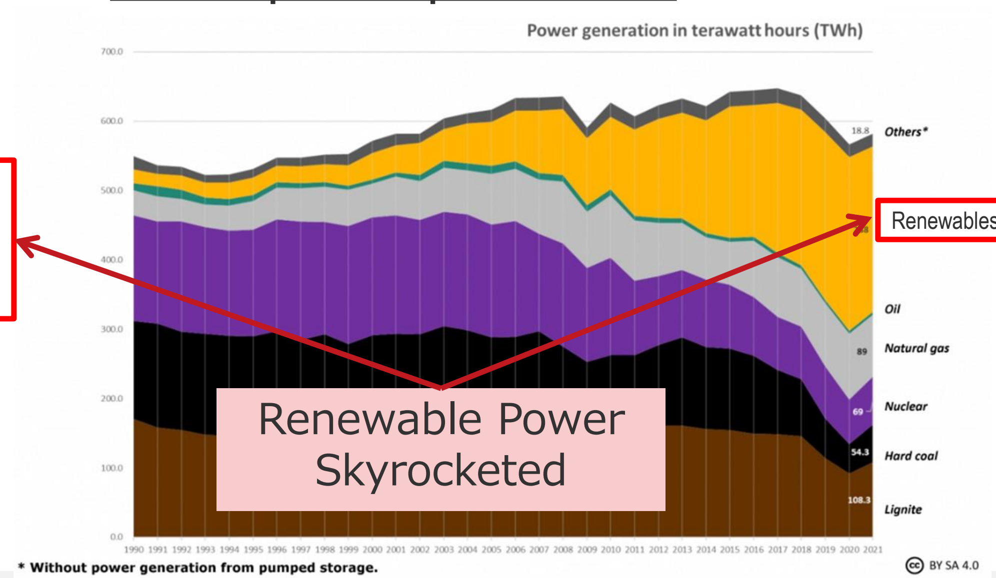
Source: Ministry of Foreign Affair

Installed net power generation capacity

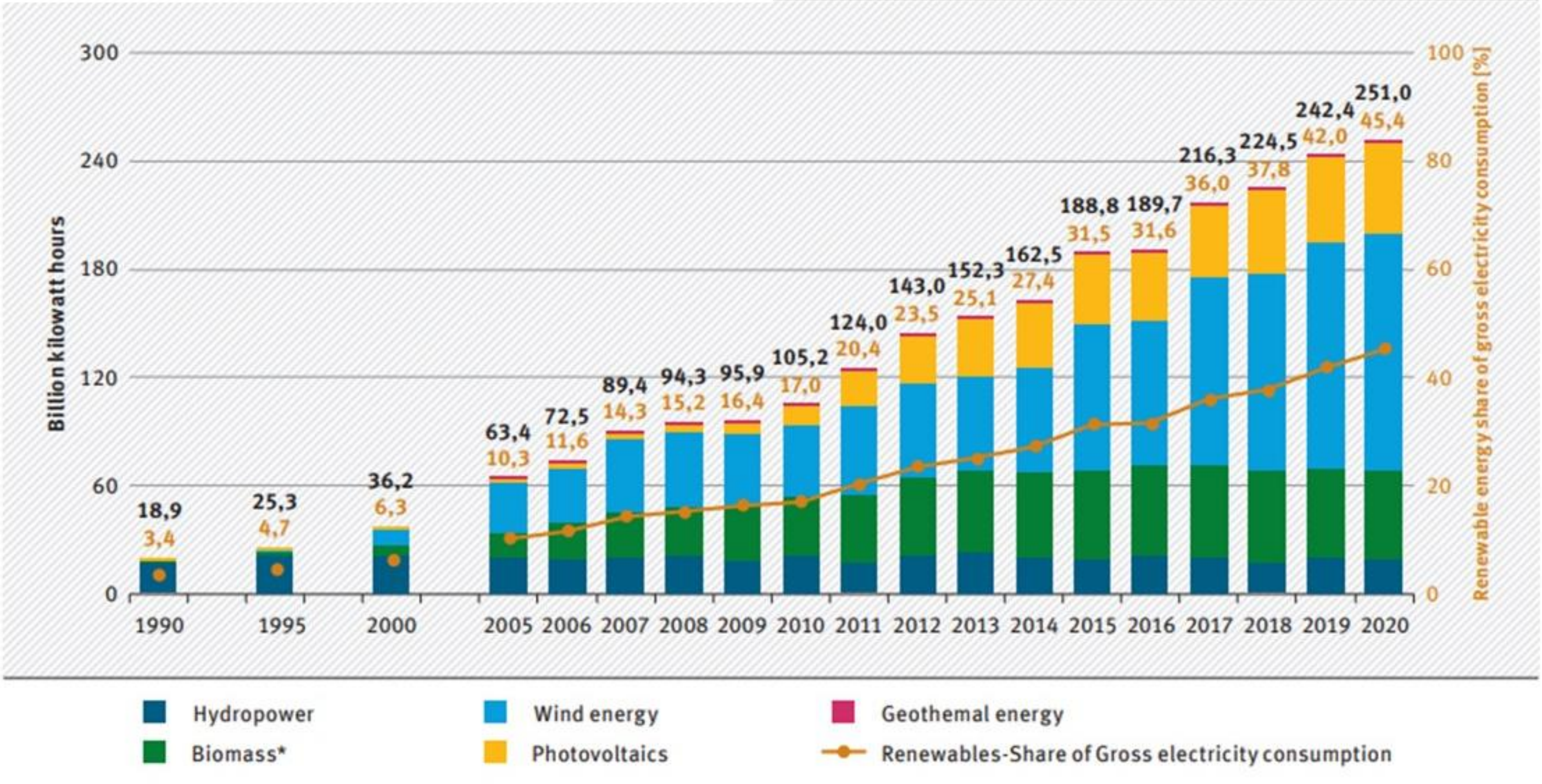


Source: Clean Energy Wire

Gross power production



Renewable Energy Generation Portfolio



Target: 65% Achievement by 2030

Source: Renewable Energies in Germany Data on the development in 2020
Source: Sechster Monitoring – Bericht zur Energiewende, Die Engie der Zukunft, 2018.06

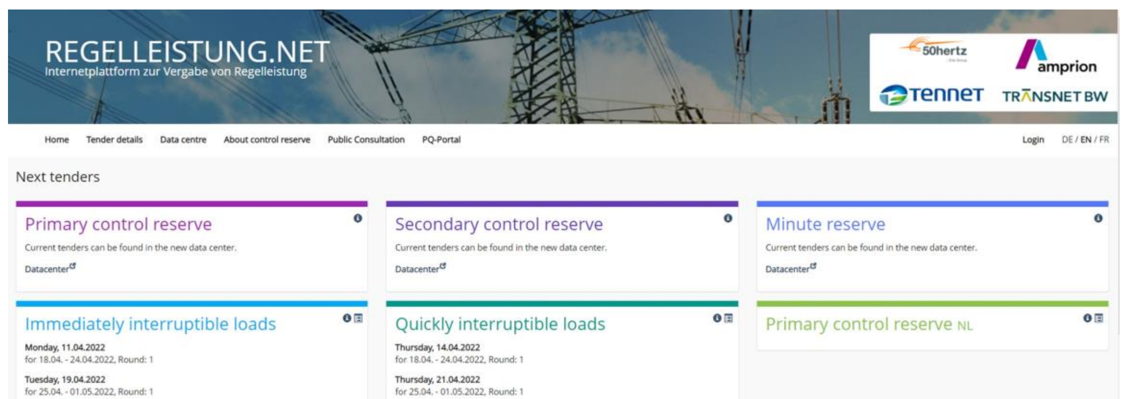
01 Configuration of Power System Operation

CHUBU Electric Power
NIPPON KOEI

Four TSOs

Jointly operate the power market

Regelleistung.NET



Source: Regelleistung.NET

Function Outline of Balancing Market 1/2

- The German transmission system operators (TSOs) need different types of control reserve
  - Frequency Containment Reserve (FCR)
  - Frequency Restoration Reserve with automatic activation (aFRR)
  - Frequency Restoration Reserve with manual activation (mFRR)

Type	Main Function	Time to activate
FCR	◆ Control by the governor of each generator ◆ Corresponds to frequency deviation due to small fluctuations in supply and demand balance ◆ Operating time per single event is up to 15 minutes	Within 30 seconds
aFRR	◆ Automatic control by load frequency control (LFC) ◆ Used to eliminate the frequency deviation that remains after adjustment by the primary control reserve (FCR)	Within 5 minutes
mFRR	◆ Manual control ◆ Used to cover power loss and demand forecast errors If, for example a consumer uses more than expected or a generation unit feeds in less than forecasted, the TSOs use balancing energy to compensate the imbalances and stabilize the grid. ◆ Operating time per single event is 15 minutes to 1 hour (15 minutes x 4 slots)	within 15 minutes (manually)

Source: Description of the Balancing Process and the Balancing Markets in Germany, Regelleistung.NET

Function Outline of Balancing Market (Main Roles) 2/2

FCR

- The main task of FCR is to stabilize the system frequency as quickly as possible after a disturbance and move to quasi-stationary level.
- To ensure this fast response and also keep contributions to be provided by every single unit involved as low as possible, FCR is activated on a non-selective (pro rata) basis and according to the principle of solidarity across the entire synchronous area.
- In case of major system imbalances, FCR is replaced by other types of balancing services as quickly as possible

aFRR

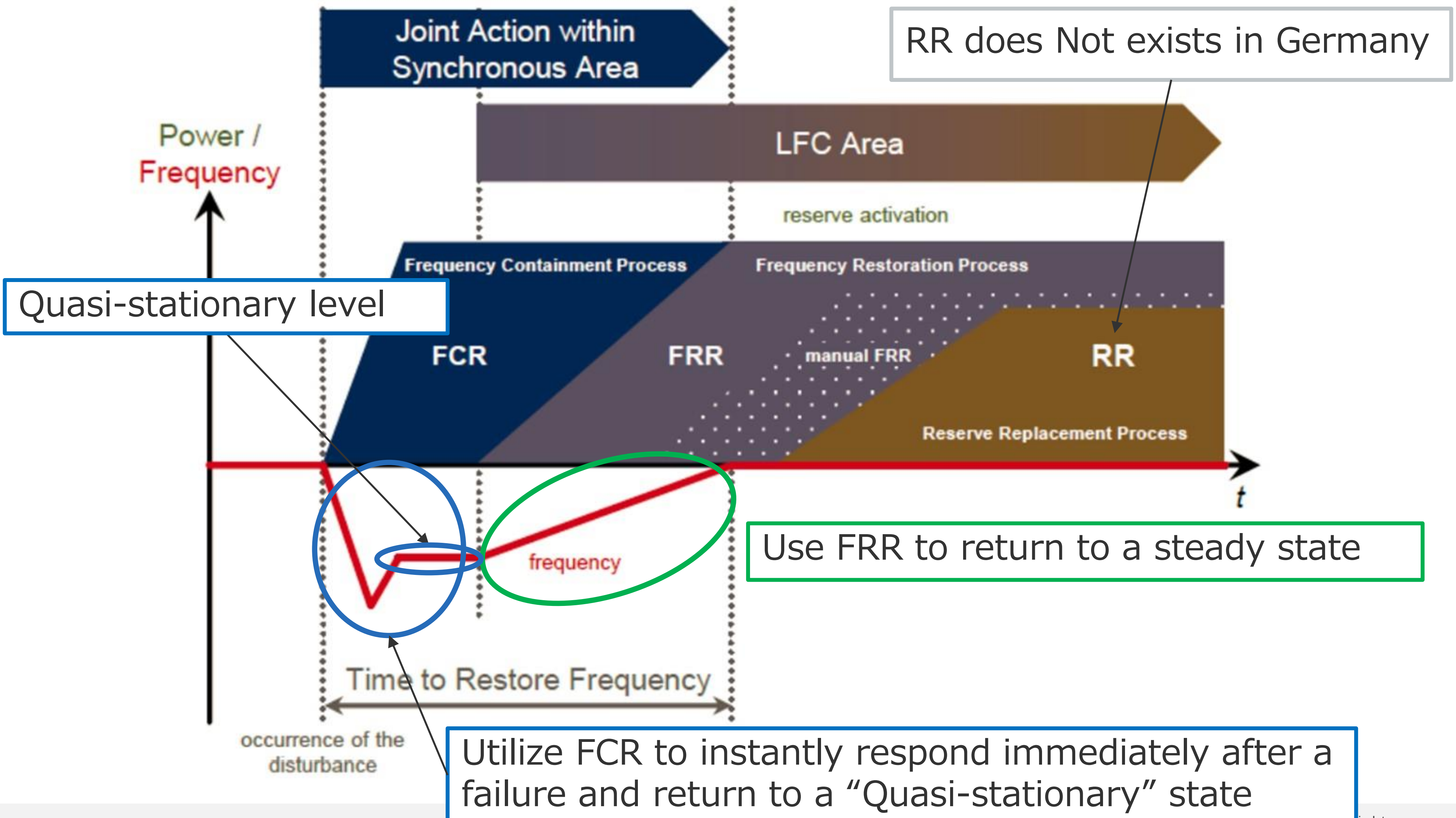
- After returning to quasi-stationary level and deviation of the frequency from its target value remains, the return to the target value is the task of aFRR.
- In contrast to the FCR, it is not activated on a non-selective basis across the entire synchronous area, but only on the polluter principle in the LFC areas which cause the system imbalance.

mFRR

- TSOs decide to activate mFRR on a case-by-case basis
- In specific cases, a preventive activation of mFRR can also take place in order to compensate expected major imbalances.

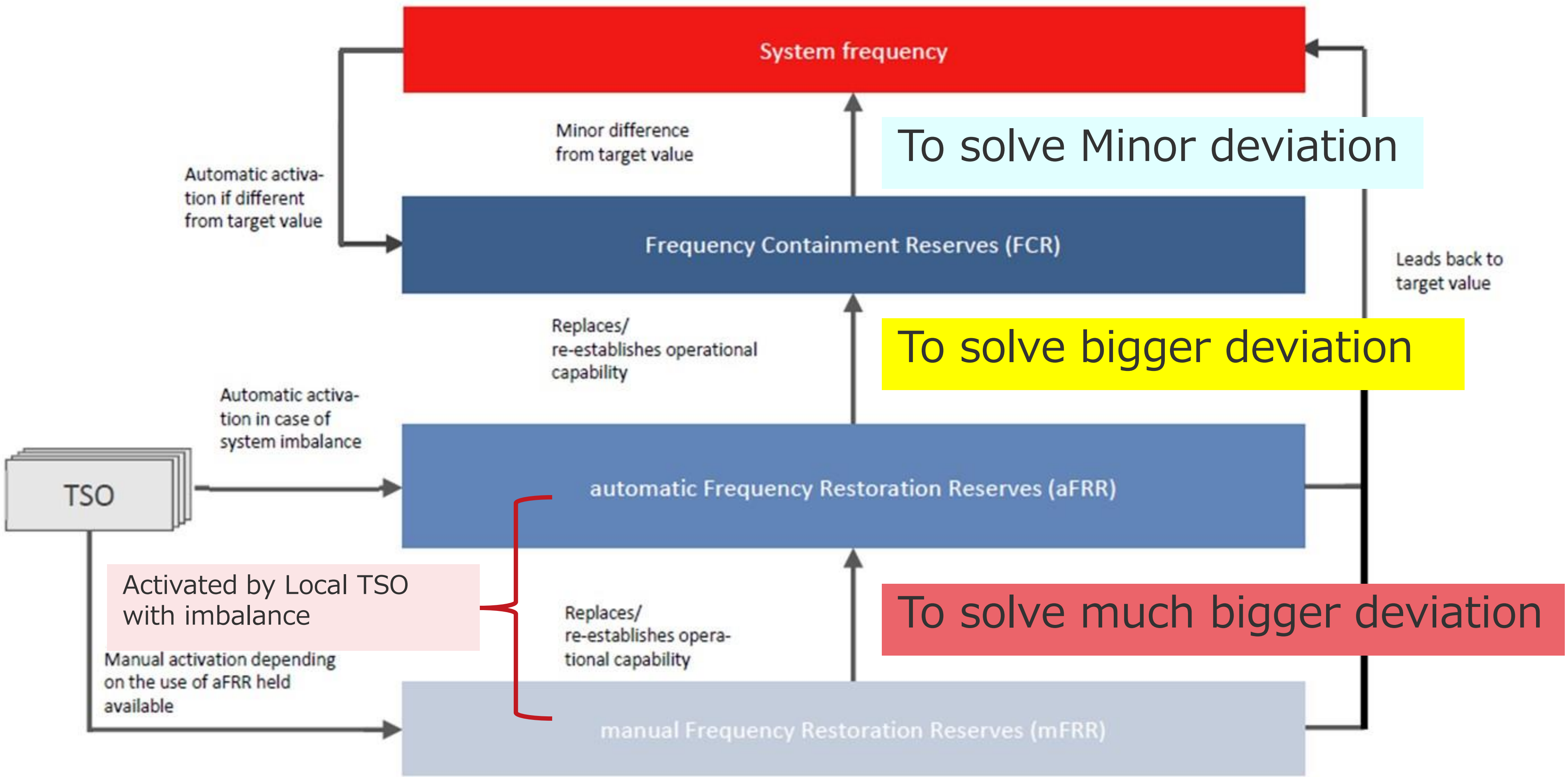
Source: Description of the Balancing Process and the Balancing Markets in Germany, Regelleistung.NET

02 Time-series Input Image of Balancing Services Function



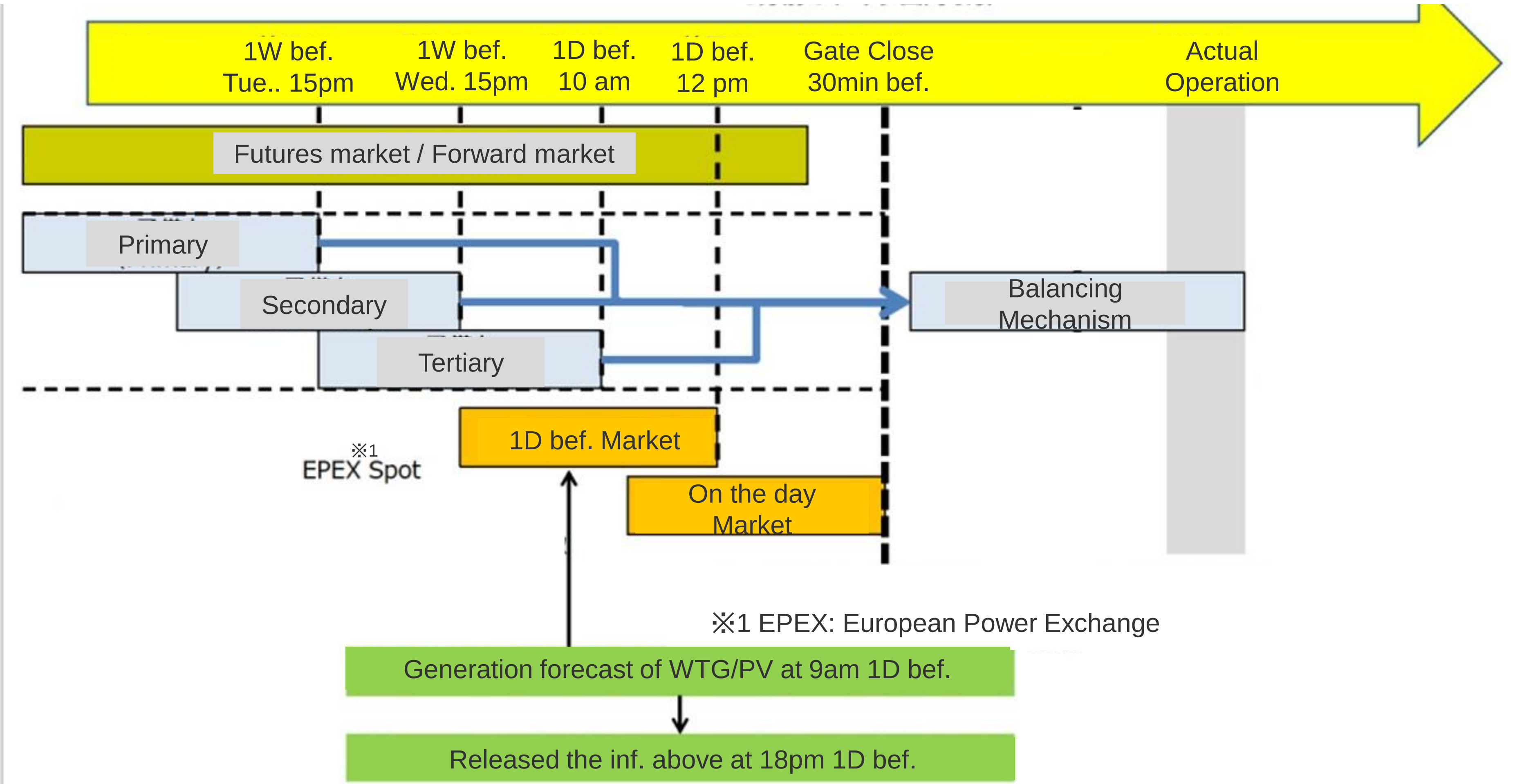
Source: Potential cross-border balancing cooperation between the Belgian, Dutch and German electricity Transmission System Operators:, Regelleistung.NET

Relationship among Balancing Services Function



Source: Potential cross-border balancing cooperation between the Belgian, Dutch and German electricity Transmission System Operators:, Regelleistung.NET

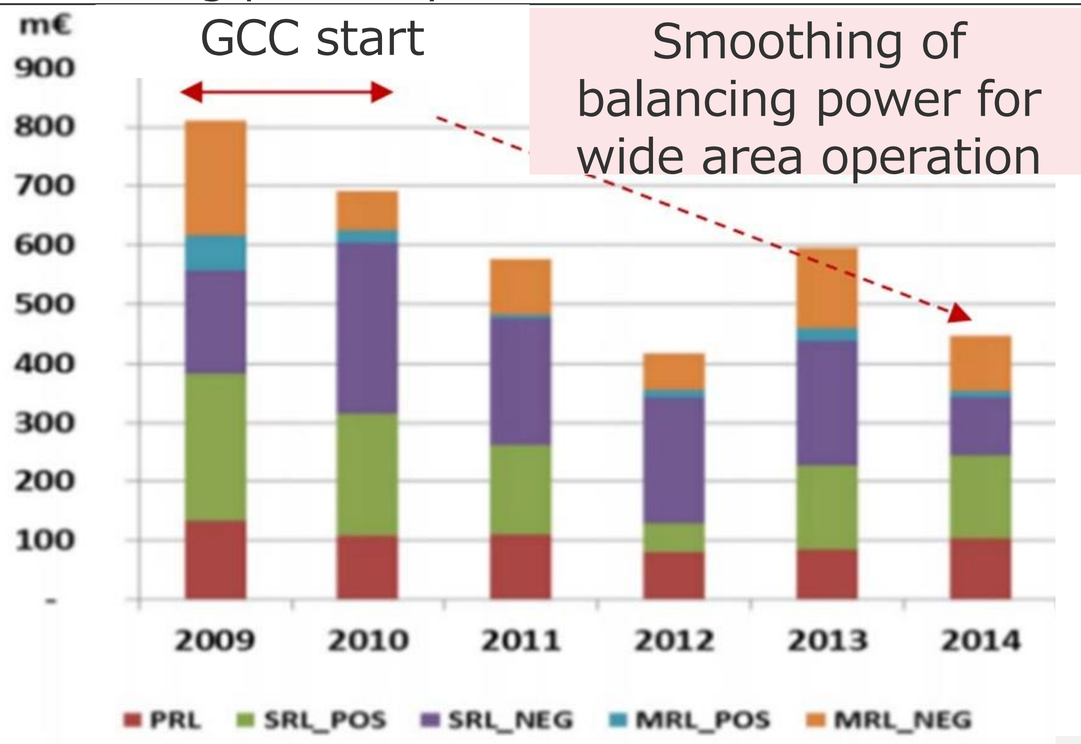
02 Time schedule



Source: IEE Japan

Wide Area Interconnection in Germany

- The four German TSOs have built a wide-area integrated system called Grid Control Cooperation (GCC).
- GCC gradually penetrated from 2008 to 2010, and the supply and balancing market was finally fully integrated (4 Modules described in the table below were gradually integrated).
- The installed capacity of PV and WTG has tripled since 2008, but the procurement cost has decreased since 2010. It is assumed to be the effect of wide-area utilization of balancing power by GCC.



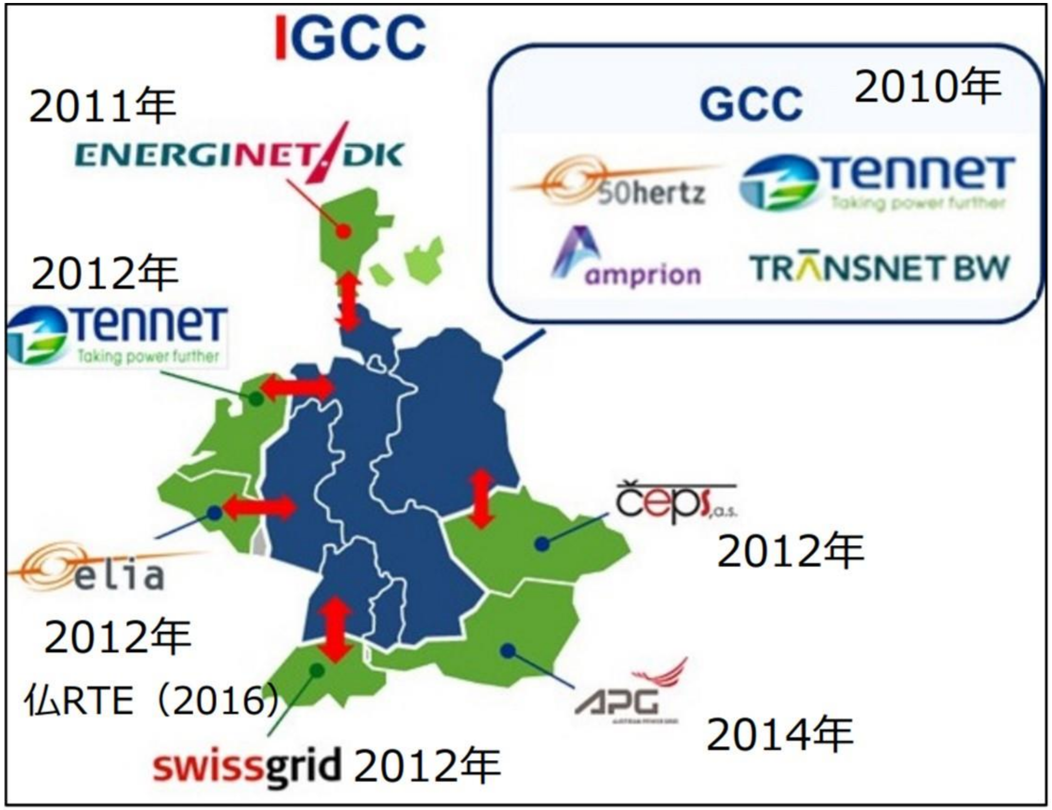
Four Modules
Offsetting imbalance
Optimization of the amount of balancing power
Joint procurement of balancing power
Joint operation of balancing power

Operation command by merit order based on energy unit price at the time of bidding

Source: MRI Report, 2017

Source: Mitsubishi UFJ Report, 2018

- Following the success of GCC in Germany, expanded to International GCC (IGCC)
- A cross-border merit order list was created.



Participants of IGCC
Germany, Austria, Belgium, Denmark, France, Switzerland, Netherlands and Czechoslovakia

	IN※	FCR	aFRR	mFRR
GCC	○	○	○	○
IGCC	○	△		△

△: Under preparation

※: Imbalance Netting

Source: MRI Report, 2017
Source: Mitsubishi UFJ Report, 2018

04	Ref. Detailed information about Balancing Services

Technical Characteristics for FCR in detail

Item	Note
Capacity product	● Symmetrical 200mHz product: FCR shall be activated as a linear function of frequency deviation between -200mHz (+100%) and +200mHz (-100%)
Response time	● 100% within 30s ● 50-100% within 15-30s ● ≤50% within 15s
Available for	● 15 minutes
Deadband	● -10mHz to +10mHz (around 50Hz)

Source: Potential cross-border balancing cooperation between the Belgian, Dutch and German electricity Transmission System Operators:, Regelleistung.NET

FCR Procurement in detail

Item	Note
Participation of BSPs※1 requires	● Valid FCR framework contract
Procurement period	● Weekly auction, every Tuesday at 15:00 for the next week starting with Monday (common procurement with NL and CH TSOs)
Product resolution in time	● One week
Minimum bid size	● 1MW
Maximum bid Size	● Prequalified volume
Bid increment	● 1MW
Bid selection	● Lowest possible total costs for procuring FCR: CMO starting with the lowest bid price
Pooling allowed	● Yes
Remuneration	● Pay-as-bid
Penalty in case of non-availability	● 10 times bid price (corresponding to the time and capacity of non-availability)
Nomination	● Day ahead (before 17:00) nomination of units and MW per unit per TSO ● Additionally possibility to add/delete units to/from pool for every 15 minutes and switching within the pool anytime possible within one control area
Yearly average price	● 17.65 €/MWh (2013)
Cost recovery	● 100% Grid Users

※1_Balance Service Providers

Source: Potential cross-border balancing cooperation between the Belgian, Dutch and German electricity Transmission System Operators:, Regelleistung.NET

Prequalification for FCR

Item	Note
Required prequalification tests	● TSO reserves the right to perform tests. ● The BSP※1 has to prequalify each unit at his connecting TSO. A successful prequalification is recognized by the other German TSOs.
Prequalification	● Per unit, for specified capacity upward and downward ● Units that cannot deliver the minimum capacity can be pooled for prequalification (only within a control area).
Minimum balancing capacity per unit	● ±2% of nominal power of unit
Tests/monitoring after prequalification?	● No periodical tests ● Response being monitored
Required real time Measurements	● Yes

※1_Balance Service Providers

Source: Potential cross-border balancing cooperation between the Belgian, Dutch and German electricity Transmission System Operators:, Regelleistung.NET

Technical Characteristics for aFRR in detail

Item	Note
Basic product	● 1 product, separate for upward/downward (procured for two different time resolutions, see next slide)
Response time	● 30s
Ramp rate	● Full provision after 5 min
Quantity contracted	● -1,969MW/+2,042MW (Q1/2014) ● -1,919MW/+1,998MW (Q2/2014) ● -1,906MW/+1,992MW (Q3/2014)

Source: Potential cross-border balancing cooperation between the Belgian, Dutch and German electricity Transmission System Operators:, Regelleistung.NET

aFRR Balancing Capacity Procurement in detail

Item	Note
Procurement period	● Weekly auction, every Wednesday at 15:00 for the next week starting with Monday
Product resolution in time	● Week peak product (08:00 - 20:00 on Monday - Friday) ● Week off-peak product (20:00 - 08:00 + weekends + federal holidays)
Penalty	● 10 times bid price (corresponding to the time and capacity of non-availability)
Minimum bid size	● 5MW
Maximum bid size	● Prequalified volume
Partial bid acceptance	● TSOs may accept partial bids in steps of 1MW
Bid selection	● Lowest possible total costs for procuring aFRR capacity
Remuneration	● Pay-as-bid
Cost Recovery	● 100% Grid Users

Source: Potential cross-border balancing cooperation between the Belgian, Dutch and German electricity Transmission System Operators:, Regelleistung.NET

aFRR Balancing Energy Procurement in detail

Item	Note
Procurement mechanism	● Weekly, every Wednesday 15:00 for the next week starting with Monday ● Energy price is provided together with capacity price, bids are selected per capacity price
Product resolution in time	● One week
Minimum bid size	● 5MW
Maximum bid size	● Prequalified volume
Remuneration energy	● Pay-as-bid ● Metered is paid
Bid selection	● Bids were selected by the capacity price CMO※1
Bid divisibility – step size for activation	● Partial activation in 1MW steps possible
Activation cycle time※2	● 4s
Cost recovery	● 100% Grid Users

※1_Common Merit Order
※2_Time between two activations of aFRR, i.e. cycle time of the TSO's load frequency controller

Source: Potential cross-border balancing cooperation between the Belgian, Dutch and German electricity Transmission System Operators:, Regelleistung.NET

Prequalification for aFRR

Item	Note
Required prequalification tests	● Technical capability of each unit to be tested and certified
Prequalification	● The prequalification procedure comprises: ✓ Technical requirements for every single technical unit ✓ Technical requirements for the aFRR pool of the BSP ✓ Requirements for the control system connection ✓ Organizational requirements ● Units that cannot deliver the minimum capacity can be pooled for prequalification
Tests/monitoring after prequalification?	● TSO can request tests in case of reasonable doubt to the proper functioning of the control connections
Required real time Measurements	● Yes, ≤4s measurements

Source: Potential cross-border balancing cooperation between the Belgian, Dutch and German electricity Transmission System Operators:, Regelleistung.NET

Technical Characteristics for mFRR in detail

Item	Note
Basic product	● 1 product, separate for upward/downward can be provided by generation and load ● Scheduled activation per ISP※1
Activation	● Semi-automatic activation (MOLS)
Activation time	● Next ISP: 22.5 – 7.5min (between 15-7.5min compulsive)
What is activated?	● Power BSP※2 is requested to ramp before ISP, keep the requested position within the ISP (and for subsequent ISPs if requested by TSO), ramp back to initial position afterwards.

※1_Imbalance Settlement Period
※2_Balance Service Providers

Source: Potential cross-border balancing cooperation between the Belgian, Dutch and German electricity Transmission System Operators:, Regelleistung.NET

mFRR Balancing Capacity Procurement in detail

Item	Note
Procurement period	● D-1 auction at 10:00 for delivery on Tuesday-Saturday ● D-2 auction at 10:00 for delivery on Sunday ● D-3 auction for delivery on Monday
Product resolution in time	● Six daily 4h-products: 00:00-04:00, 04:00-08:00, 08:00-12:00, 12:00-16:00, 16:00-20:00 and 20:00-24:00
Penalty	● Three times D-1 EPEX※1-Spot price of the relevant hour(s) multiplied by the not-available capacity and the respective time slice (i.e. 4h)
Minimum bid size	● 5MW
Maximum bid size	● Prequalified volume
Partial bid acceptance	● TSOs may accept partial bids in steps of 1MW
Bid selection	● Lowest possible total costs for procuring mFRR capacity
Remuneration	● Pay-as-bid
Cost Recovery	● 100% Grid Users

※1_European Power Exchange

Source: Potential cross-border balancing cooperation between the Belgian, Dutch and German electricity Transmission System Operators:, Regelleistung.NET

mFRR Balancing Energy Procurement in detail

Item	Note
Procurement mechanism	● D-1 auction at 10:00 for delivery on Tuesday-Saturday ● D-2 auction at 10:00 for delivery on Sunday ● D-3 auction for delivery on Monday
Product resolution in time	● Six daily 4h-products: 00:00-04:00, 04:00-08:00, 08:00-12:00, 12:00-16:00, 16:00-20:00 and 20:00-24:00
Minimum bid size	● 5MW
Maximum bid size	● Prequalified volume
Remuneration energy	● Pay-as-bid
Bidding	● Explicit bidding: bids contain price and volume information
Bid selection	● Contracted bids initially chosen by capacity price CMO※1 sequentially activated according to a energy price CMO
Bid divisibility – step size for activation	● Partial activation in 1MW steps possible
Remuneration energy	● Pay-as-bid
Cost recovery	● 100% Grid Users

※1_Common Merit Order

Source: Potential cross-border balancing cooperation between the Belgian, Dutch and German electricity Transmission System Operators:, Regelleistung.NET

Prequalification for mFRR

Item	Note
Required prequalification tests	● For the to be prequalified mFRR volume, an operational test with two provision cycles is required. ● The proof has to be provided by the BSP※1.
Prequalification	● The prequalification procedure comprises: ✓ Technical requirements for every single technical unit ✓ Organizational requirements
Tests/monitoring after prequalification?	● If requested by TSO, BSP has to provide within 10 working days operations log per technical unit.
Required real time Measurements	● No

※1_Balance Service Providers

Source: Potential cross-border balancing cooperation between the Belgian, Dutch and German electricity Transmission System Operators:, Regelleistung.NET

Imbalance Settlement

Balancing philosophy is Reactive, arrangements aim at providing clear and effective incentives for self-balancing.
→BRP※2 should be always in balance within a ISP※1

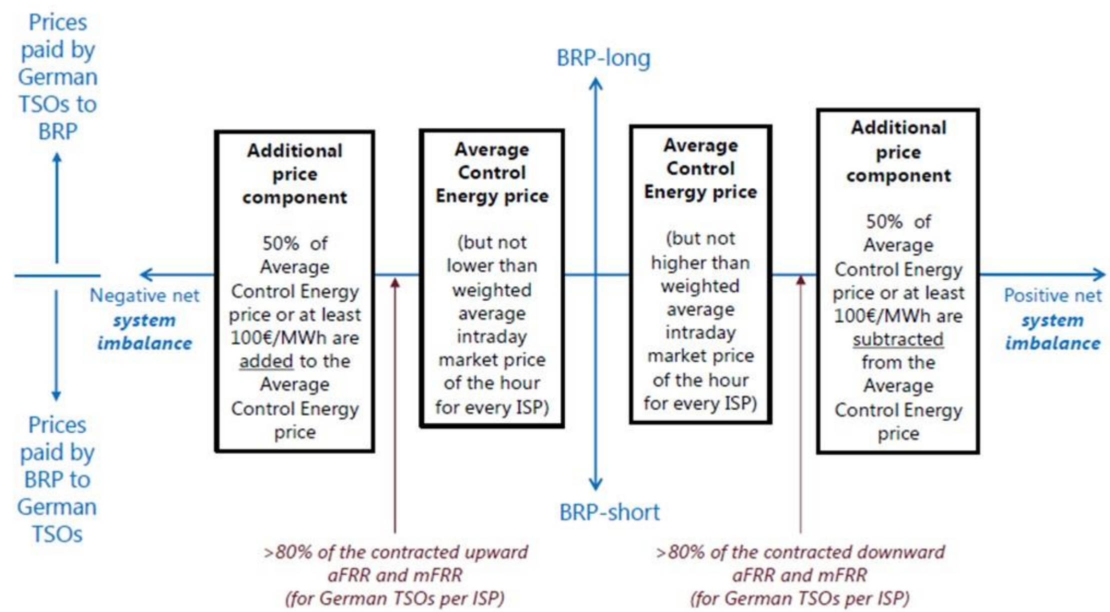
Item	Note
Settlement per	● ISP※1 of 15min
Legal context balance responsibility	● Contractual obligation on BRP to be in balance for every ISP ● In case of unplanned loss of production legal obligation on BRP to be in balance latest at the end of the following third ISP (after 45-60min).
Horizon of balancing (TSO perspective)	● In principle current and next three consecutive ISPs
Exemption for	● In principle current and next three consecutive ISPs
Basic scheme	● Single price, with additional incentives

※1_Imbalance Settlement Period
※2_Balance Responsible Party

Source: Potential cross-border balancing cooperation between the Belgian, Dutch and German electricity Transmission System Operators:, Regelleistung.NET

Imbalance Settlement cont'd

Item	Note
Imbalance pricing for imbalances that aggravate system imbalance	● Average control energy price (AEP)※1 ● In cases where more than 80% of the contracted positive/negative FRR were activated, the AEP is increased/reduced by 50%, in any case no less than by 100€.
Imbalance pricing for imbalances that reduce system imbalance	● Average control energy price
Additional or minimum incentives	● Imbalance price is coupled to the average volume weighted EPEX※2 Spot intraday market price of the respective hour (EPEX ID): ● Control area long: AEP≤EPEX ID ● Control area short: AEP≥EPEX ID



※1_Calculated as: (costs-revenues)/activated net volume
※2_European Power Exchange

Source: Potential cross-border balancing cooperation between the Belgian, Dutch and German electricity Transmission System Operators:, Regelleistung.NET

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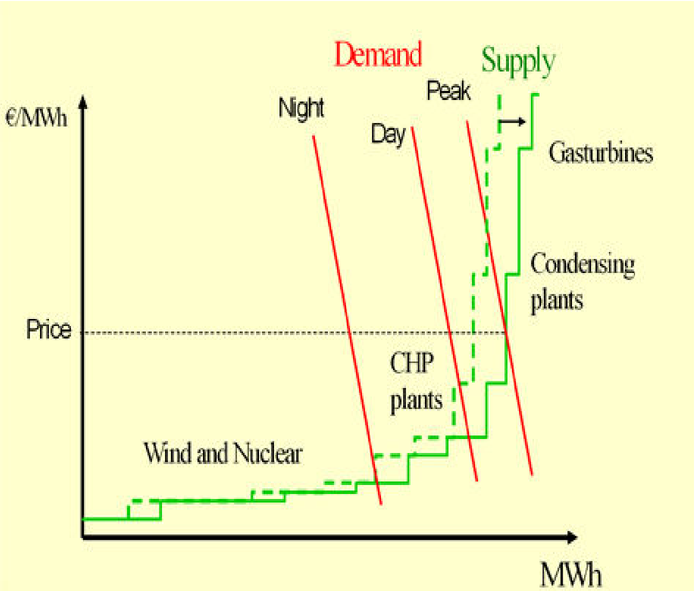
Power market in Philippines



K.M.C.P Kulasekara
M.D.R.K Karunarathne
National System Control Centre
13th June 2022

CEYLON ELECTRICITY BOARD

Country Overview

Population – 109.6 million(2020)

Three Main Regions- Luzon , Visayas and Mindanao

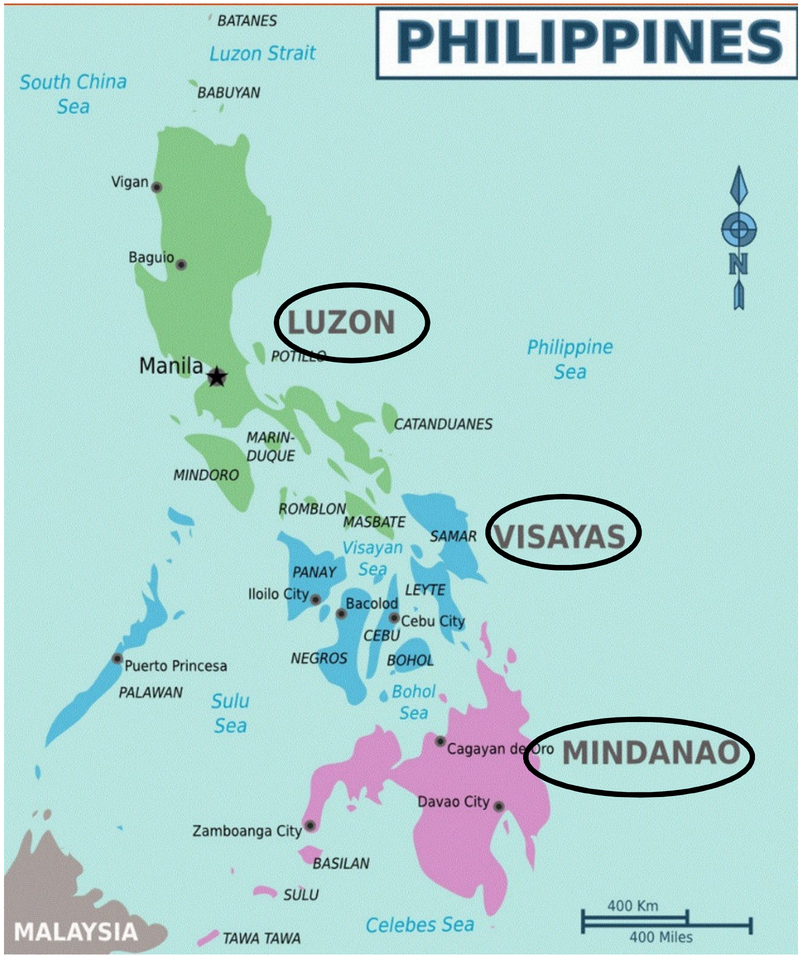
Electricity Sales- 78TWh(2017)

Annual Electricity sales growth-4.6 %

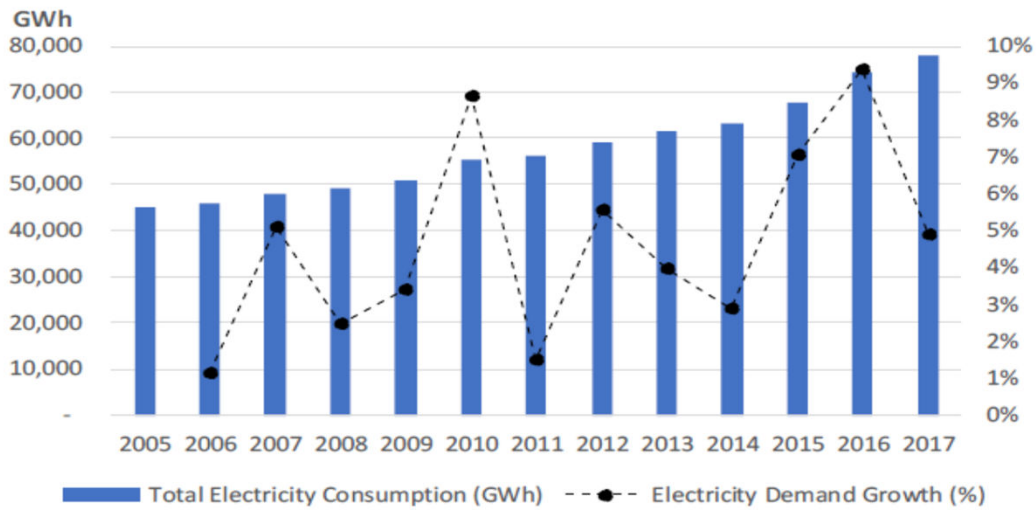
Major generation technologies

Coal 47%
Natural Gas 22%
Renewable 24%
Oil – 6.6 %

Generation capacity – 23 GW

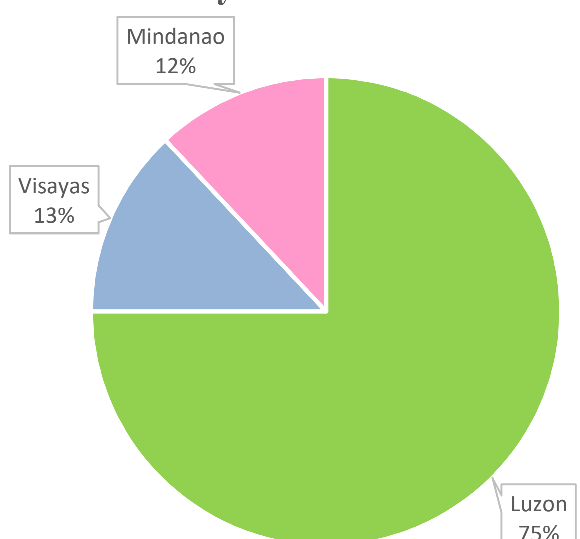


Energy Sector of Philippines

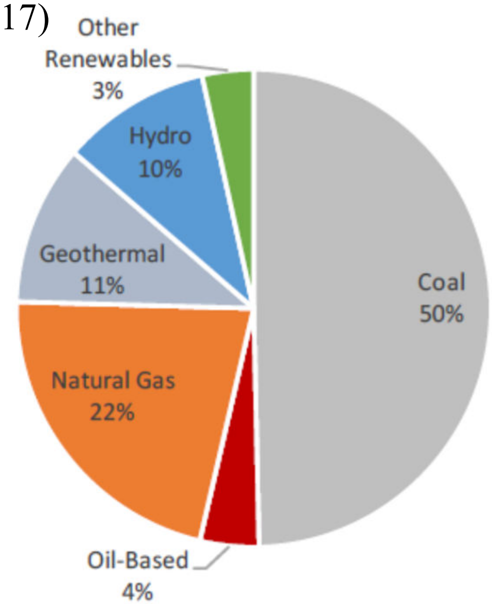


Electricity Consumption(2005-2017)

Electricity Demand Distribution



Technology wise generation share (2017)



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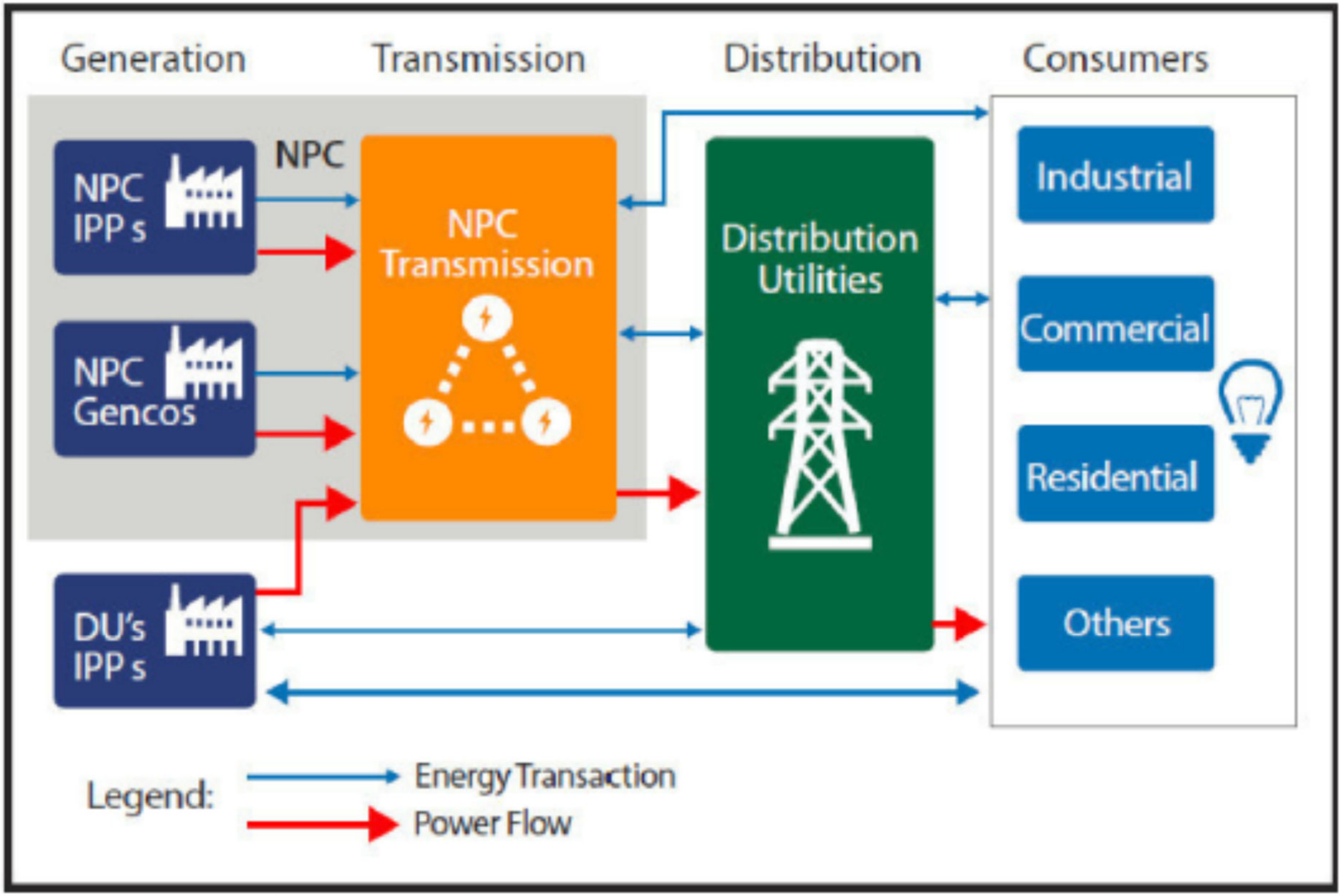
Power sector prior to Market reforms



DUs – distribution utilities and electricity cooperatives, Gencos – generation company, IPP – independent power producer, NPC = National Power Corporation,

Market Design

- The Philippine power market is composed of **bilateral contracts**, and **an energy-only bid-based power pool** (the Wholesale Electricity Spot Market, or WESM).

- The **market operator** (PEMC) develops a least-cost generation schedule and determines the market clearing spot price considering all power injections and withdrawals from the grid, based on generation offers.

- The **spot price** is used to settle trade quantities which are not covered by contracts.

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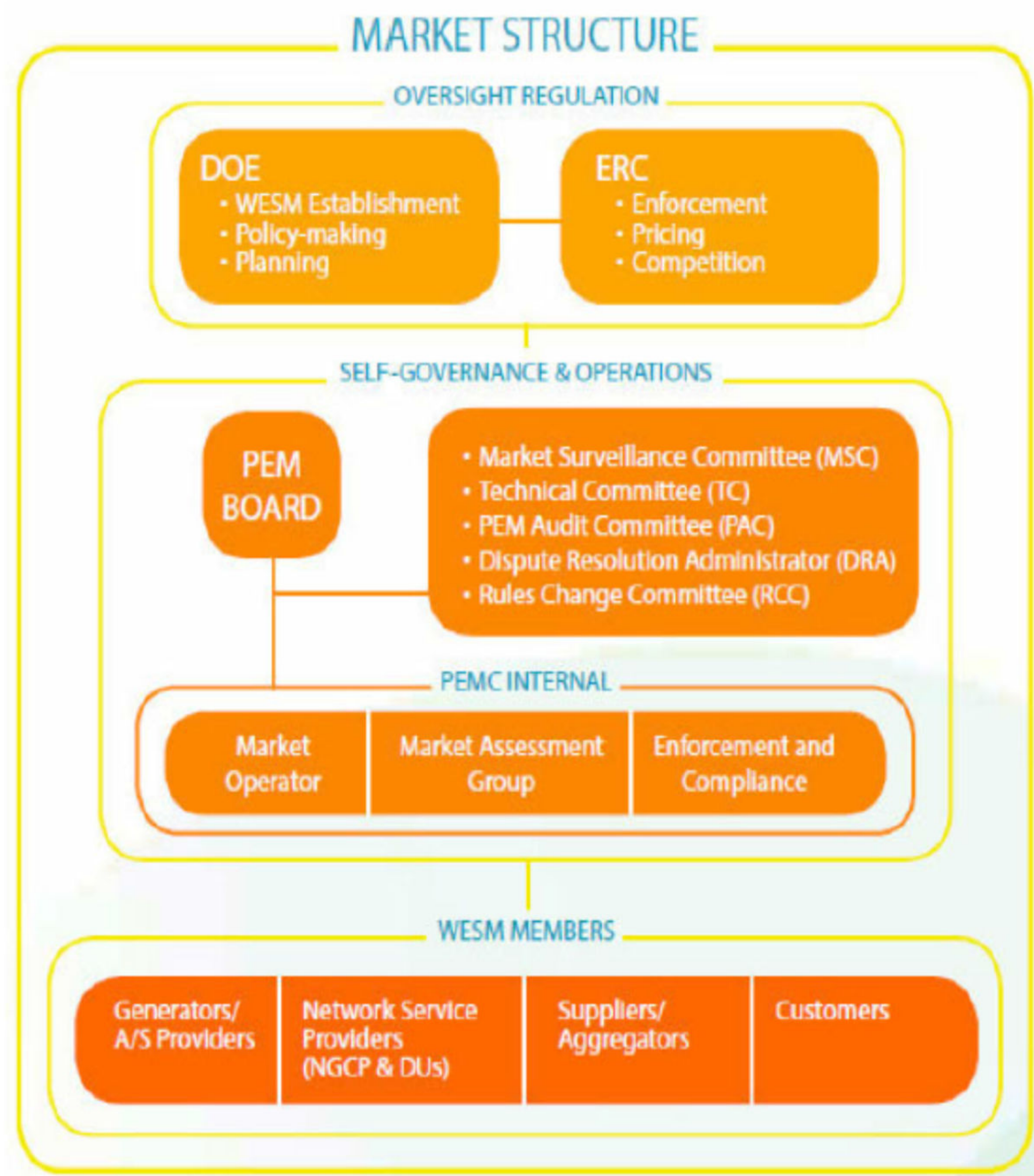
Electricity Market Structure



Hybrid Market

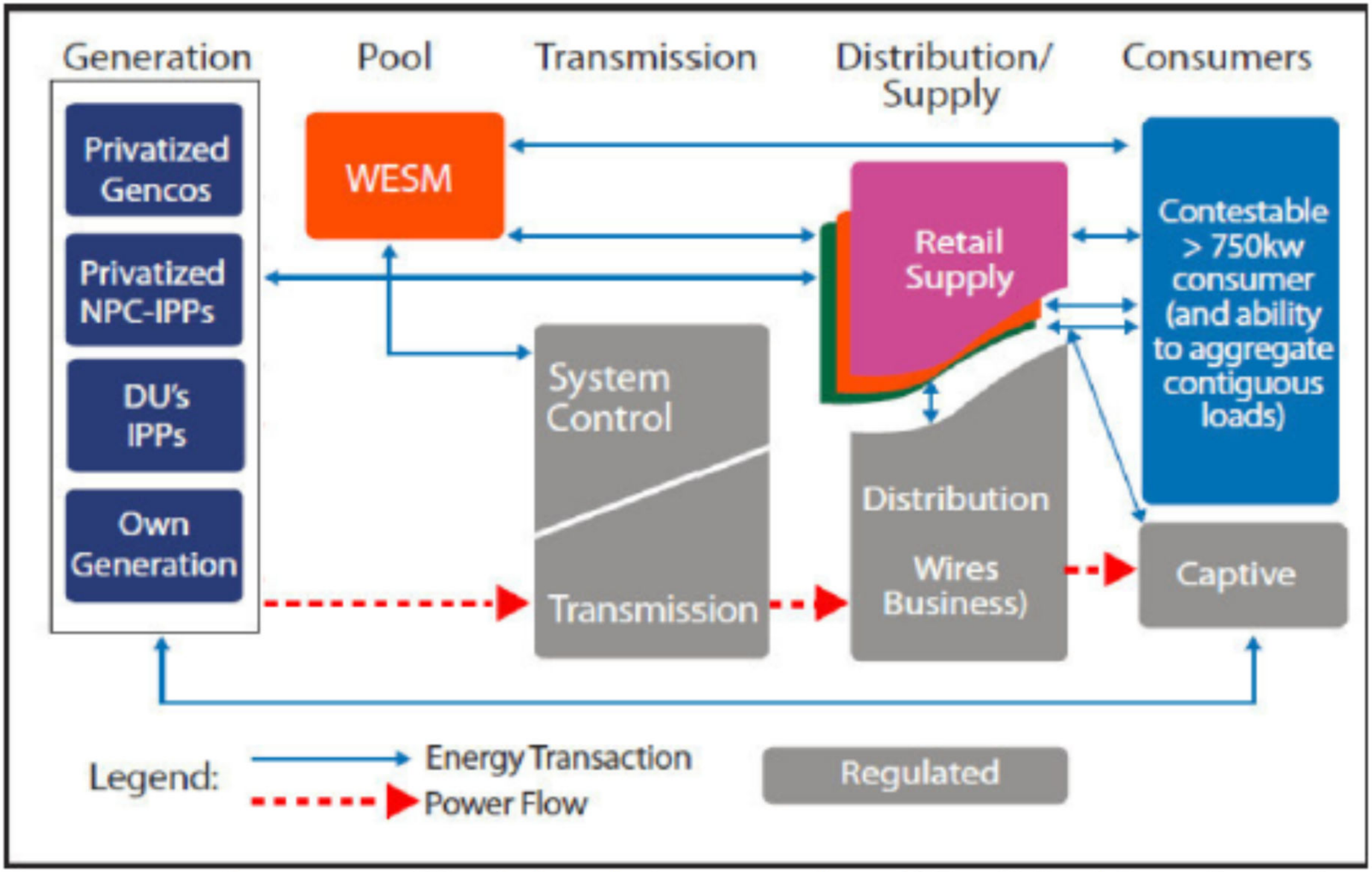
Energy only bid based pool

Use to settle energy quantities not covered under bilateral agreements

Market participants

- Market Operator
- System Operator
- Transmission(TRANSCO)
- Gencos
- Discos(Distribution Utilities)
- Retail Electricity Suppliers(RES)
- Final Customers(Bulk Customers, Contestable Customers, Captive Customers)

Power sector after Market reforms



Genco = generation company, IPP = independent power producer, NPC = National Power Corporation, WESM = wholesale electricity spot market.

Note: TransCo is the public sector asset owner and the National Grid Corporation of the Philippines the private operator and concessionaire for the transmission system.

Market Operator Role

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Market Operator(PEMC) use Market Dispatch Optimization Model(MDOM) to calculate **hourly nodal prices** with optimal scheduling

Inputs of MDOM
- Market Offers from trading participants
- System Conditions and requirements from the system operator

Outputs of MDOM
- System Marginal cost
- Generation output level for each generating resource
- Transmission line flows
- Transmission losses
- Energy prices at each market trading node

- PEMC provide system operator with generation schedule
  (However actual dispatch is implemented by system operator considering real state of system)

- Payments are settled within one month. Bilateral contracts are settled outside market

System Operators Role

- Be responsible for and **operate the power system** in accordance with the WESM Rules, the Grid Code and any instruction issued by the Market Operator or the ERC.
- Provide **central dispatch to all generation facilities and loads connected**, directly or indirectly, to the transmission system in accordance with the dispatch schedule submitted by the Market Operator.
- **Contribute towards the development of procedures**, processes or systems, or to assist with any aspect of the operation of the spot market, in coordination with the Market Operator.
- Maintaining short-term reliability
- Least-cost dispatch and system operation
- Congestion management
- Coordinate the operation of ancillary services
- Accountability of system operations

Energy Regulatory Commission(ERC) responsibilities

- Approve price determination methodology for wholesale electricity spot market(WESM)
- Enforce Grid Code & Distribution Code
- Define rules for setting transmission & distribution wheeling rates
- Formulate other related rules & regulations such as issuance of licenses to retailers, rules for contestability, rules for customer switching, code of conduct for competitive retail participants

Ancillary Services

CEYLON ELECTRICITY BOARD Enrich Life through Power

System Operator(NGCP) is responsible for arranging adequate ancillary services

- By competitive tendering process administrated by system operator
- By negotiating contracts with ancillary service providers

MO establish and administer spot market for purchase of reserve.
Payments are settled via Market operator

Cost of those ancillary services are paid by all electricity consumers

No capacity charge is paid except for ones already covered under bilateral agreements

Transmission and distribution wheeling prices are set according to Energy Regulatory Commission (ERC) guidelines

Renewable Resources

FIT tariff is paid to renewables irrespective of market price.(Introduced in 2008)

Difference between spot price and FIT rate is paid by TRANSCO via FIT-ALL fund which is built from customer universal charge(user tax)

Renewable plants enjoy priority dispatch since 2015

Renewable Portfolio Standards(RPS) impose obligation on Discos to source an agreed upon portion of its energy supply from eligible suppliers

Expect to achieve 35% renewable share by 2035.

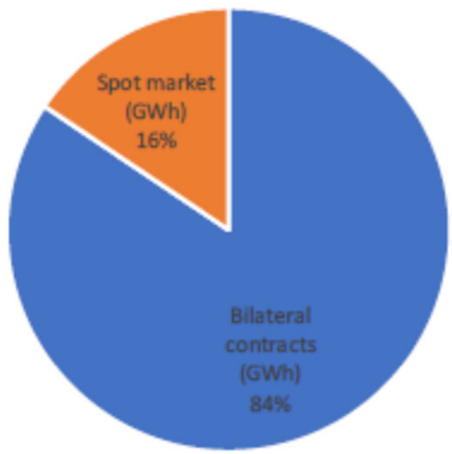
Approved FIT rates are applied for period of at least 12 years.

Renewable Technology	Approved FIT in 2012 (P/kWh)	FIT update in 2015 (P/kWh)	Approved FIT (2015 USD/MWh)
Run-of-river hydro	5.90	-	130
Biomass	6.63	-	146
Wind	8.53	7.40	163
Solar	**9.68**	**8.69**	**191**

Milestone related to Electricity Market Formation

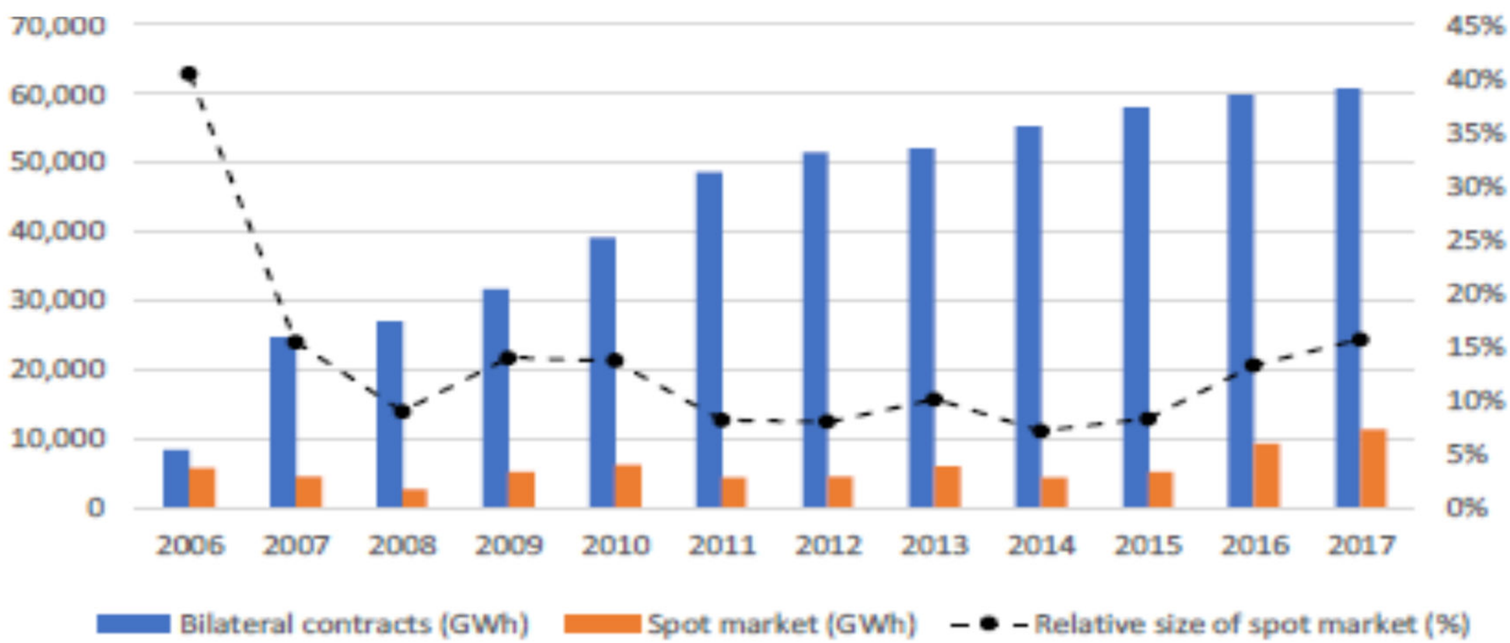
Early 1990s	Daily brownouts from 7 to 12 hours were experienced
Mid 1990s	High generation cost was experienced following introduction of IPPs
1997	Economy was severely affected during East Asian economic crisis
2001	Electric Power Industry Reform Act was passed
2001	Grid Code & distribution Code were amendment
2003/2004	Transmission & Distribution wheeling rate guidelines were formed
2006	Wholesale electricity spot market was commenced in Luzon
2008	Introduction of FIT tariff for renewable
2010	Integration of Visayas region with Luzon expanding electricity market
2013	Separate Wholesale electricity spot market was commenced in Minandoa
2013	Lower offer price ceiling was introduced following alleged market manipulation resulting spot price spike

Wholesale Market share

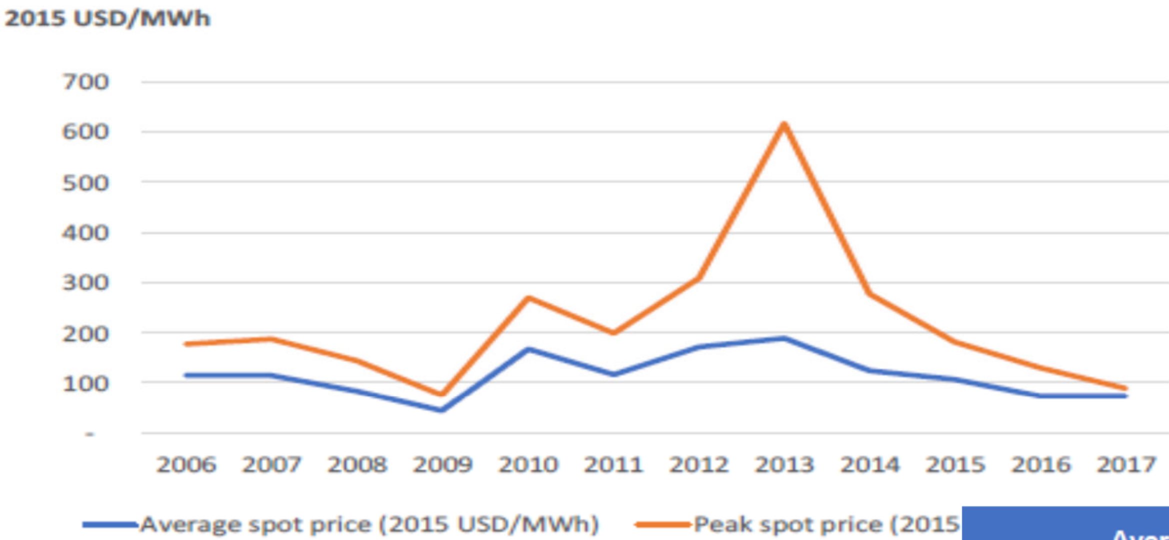


Only energy not covered under bilateral contracts is purchased via spot market

Majority of energy transactions are covered via bilateral contracts signed between private parties



Spot Price Regulations



Market ceiling cap has been reduced since 2013 to avoid unhealthy spot market price hike

Year	Average spot price (2015 P/MWh)	Average spot price (2015 USD/MWh)	Peak spot price (2015 USD/MWh)
2006	7,154	116	179
2007	6,451	116	189
2008	4,292	84	145
2009	2,372	45	76
2010	8,250	169	269
2011	5,417	117	200
2012	7,684	173	311
2013	8,357	190	618
2014	5,669	126	278
2015	4,465	98	168
2016	3,278	69	121
2017	3,205	65	78

Market share constraints

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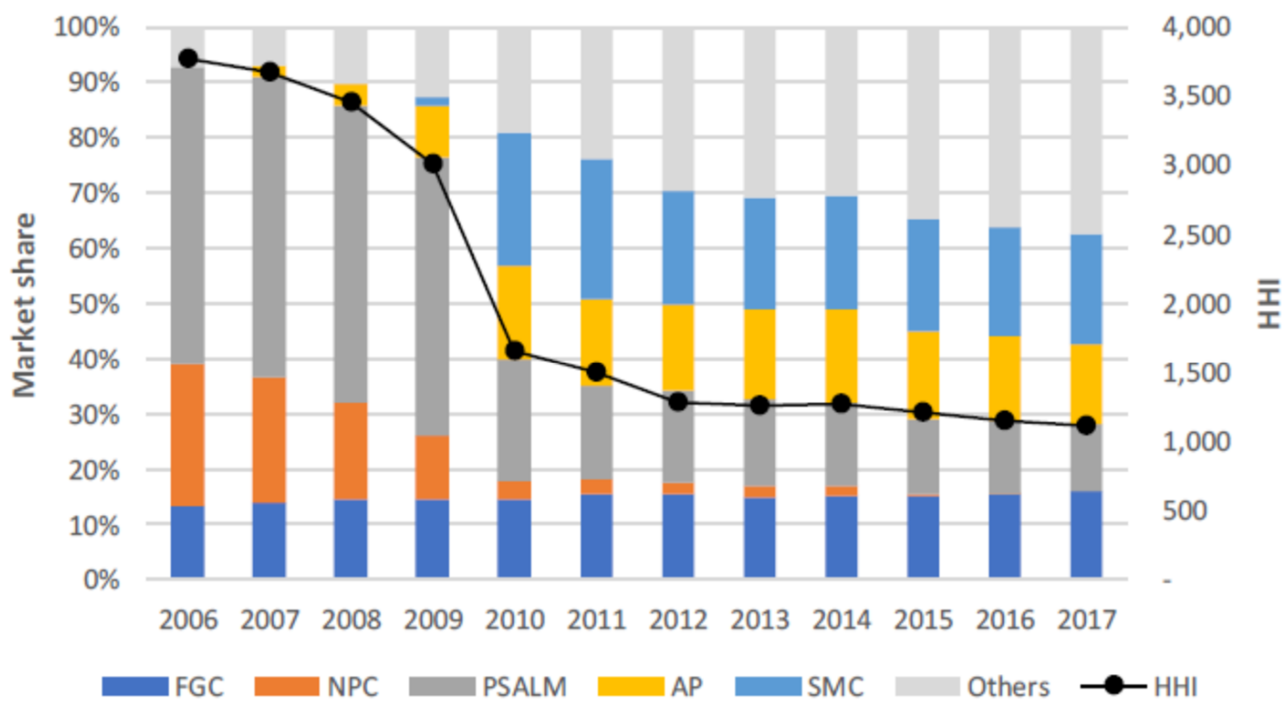
Limit on the maximum market share for generation capacities
30 % for each of the three island regions & 25% for the country as a whole



Drivers of spot market price

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- Increased wholesale competition
- More efficient use of generation & transmission resources
- Increased investment in power infrastructure(Generation & Transmission)
- Increasing generation by renewable resources with FIT Tariff and priority dispatch
- Aging & outages of generation & transmission infrastructure
- Tariff reforms
- Contractual positions of market players

Conclusion

Overall, the Philippine power market has partially delivered the objectives of competitive outcomes and sustainability.

Industry reform brought about by EPIRA in 2001 was very slowly implemented, with the wholesale spot market beginning operations in 2006, that is, with a 4 year delay with respect to plans; and retail competition established only partially in 2013, and yet to become fully operational

- **Security of supply** -Several widespread blackouts have occurred over the past five years during tight periods, due to low fuel or hydro generation availability, maintenance of major power plants and forced facilities outage

- **Competition -**The Philippine wholesale spot market has been successful in introducing market driven forces to power system operation. Spot price largely reflect demand & supply condition. Spot price have fallen by 38% since inception of market

Conclusion Ctd..

CEYLON ELECTRICITY BOARD Enrich Life through Power

- **Sustainability-**The Philippine power sector has become more reliant on fossil fuels and particularly imported coal over the past decade. Capacity additions have been primarily in coal power plants, with coal-based generation growing, reaching 50% of total power output in 2017.

- **Future challenges-**The Philippines needs to continue to expand its power generation capacity to meet fast growing electricity demand needs. Philippines to continue to diversify its power generation mix and harness the potential for renewable generation, to improve both security of supply and sustainability

- **Lessons Learnt-** The case of the Philippines illustrates the benefits and challenges that open and competitive wholesale markets can provide over time, highlighting several structural and institutional issues which are key for reaping the benefits of competitive power markets


Thank You

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Effective Power System Use through Policy and System

Zone Pricing in UK

September , 2020

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

Power Flow Trend in UK

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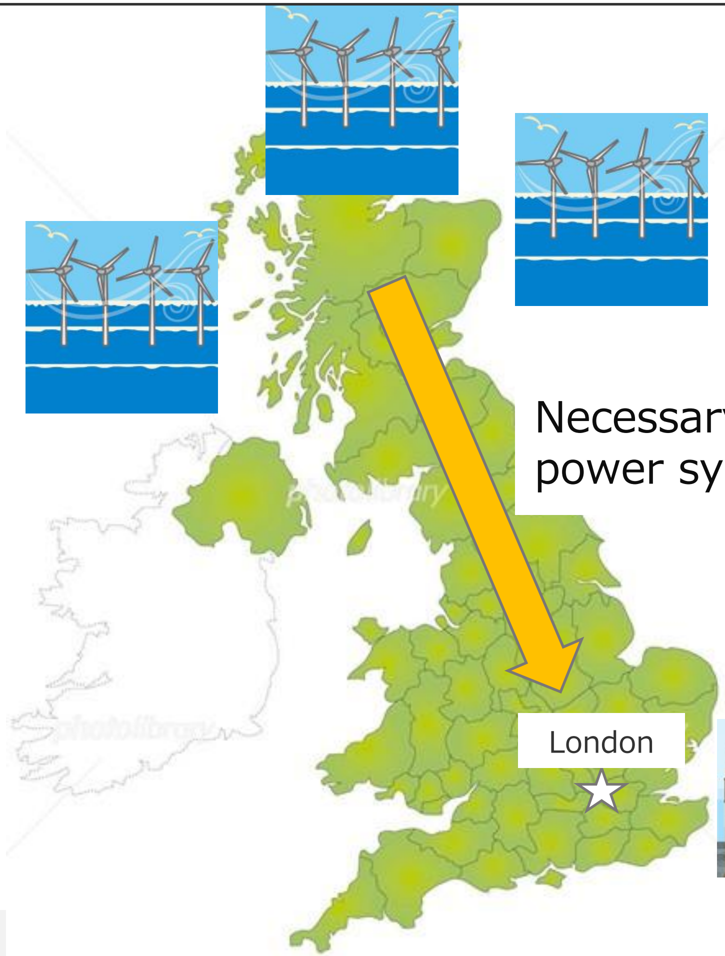
- Wind resources are abundant in the north. Large demand areas, including London, are generally south.
- Power flow from the north to the south is prominent.
- Mitigating the heavy power flow and reducing grid development cost are issues.

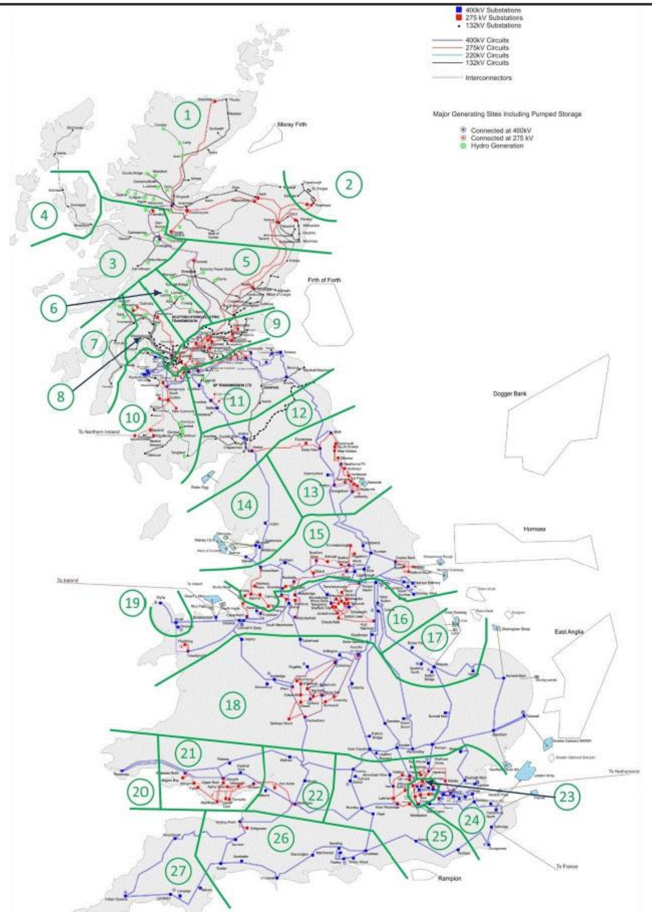


Necessary to develop power system

To develop power sources for local production for local consumption is ideal

Grid Development Cost Reduction through Zone Pricing

- Zone pricing and nodal pricing schemes exist for transmission congestion management. UK adopts the Zoon pricing.
- Wheeling charge is set by zone in order to reduce power system development cost through giving incentive to power producers to locate power site to the South.



Area is divided into 27 zones on the assumption that there is no congestion inside each zone

Power producers are encouraged to install the plants in the South by setting the Zone pricing high in the northern regions and low (or negative) in the southern regions.

Cost reduction of interconnection between North and South

Source: METI, National Grid (Forecast TNUoS, Tariffs for 2019/20)

Composition of Wheeling Charge（TNUoS）

Transmission Network Use of System (TNUoS) charges borne by generators consist of the Wider Tariff, which is affected by zones, and other costs, which is Local Tariffs, based on geographic factors (Local Circuit Tariff and Local Substation Tariff).

Wider Tariff	To recover the costs incurred by the generator for the use of the whole system
Local Tariff	To recover the costs of use of assets in the immediate vicinity of the connection site

Embedded Network System Charge: When connecting to a distribution line instead of a transmission line, a Distribution Use of System (DUoS) charge must be paid to the Distribution Network Owner (DNO). That is included in the TNUoS payment.

Source: National Grid (Forecast TNUoS, Tariffs for 2019/20)

Composition of Wider Tariff

The Wider Tariff is calculated differently depending on the type of power generation.

Conventional Carbon Generators
(Biomass, CHP, Coal, Gas, Pump Storage)

Peak Element + (Year Round Shared Element × ALF) + (Year Round Not Shared Element × ALF) + Residual Element

Conventional Low Carbon Generators
(Hydro, Nuclear)

Peak Element + (Year Round Shared Element × ALF) + Year Round Not Shared Element + Residual Element

Intermittent Generators
(Wind, Wave, Tidal)

(Year Round Shared Element × ALF) + Year Round Not Shared Element + Residual Element

Peak Element	➢ The investment cost of transmission lines to meet peak demand ➢ Intermittent generators, such as wind power producers, do not bear this charge
Year Round Shared Element	➢ The investment cost of transmission lines to output power ➢ Annual load factors are calculated and taken into account based on output and transmission line usage over the past five years, based on the idea that transmission lines are shared among generators.
Year round not shared Element	➢ The investment cost of transmission lines required to output power from low-carbon generators ➢ The idea that transmission lines are occupied by low-carbon power sources and annual load factors are not taken into account.
Residual Element	➢ Element to recover the investment cost of Transmission lines, but there is a cap

Source: National Grid (Forecast TNUoS (Tariffs for 2019/20), Introduction to Final Generator Payments)

2019/20 Tariff by Zone (Wider Tariff)

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- The northern regions have higher tariff and the southern regions have lower zone tariff.
- Business owners would have an incentive to develop power station in the South.

Zone	Zone Name	System Peak Tariff (£/kW)	Shared Year Round Tariff (£/kW)	Not Shared Year Round Tariff (£/kW)	Residual Tariff (£/kW)	Example tariffs for a generator of each technology type: Conventional Carbon 80% Tariff (£/kW)	Conventional Low Carbon 80% Tariff (£/kW)	Intermittent 40% Tariff (£/kW)
1	North Scotland	2.644727	17.784775	16.345645	-3.291240	26.657823	29.926952	20.168315
2	East Aberdeenshire	4.867379	10.302484	16.345645	-3.291240	22.894642	26.163771	17.175399
3	Western Highlands	2.077981	17.936305	16.355925	-3.291240	26.220525	29.491710	20.239207
4	Skye and Lochalsh	-4.039890	17.936305	16.240455	-3.291240	20.010278	23.258369	20.123737
5	Eastern Grampian and Tayside	3.058380	15.461012	15.747873	-3.291240	24.734248	27.883823	18.641038
6	Central Grampian	3.777984	14.711406	15.423790	-3.291240	24.594901	27.679659	18.017112
7	Argyll	3.166931	11.710463	27.236802	-3.291240	31.033503	36.480863	28.629747
8	The Trossachs	3.579469	11.710463	14.061990	-3.291240	20.906191	23.718589	15.454935
9	Stirlingshire and Fife	2.385707	8.911269	13.187811	-3.291240	16.773731	19.411293	13.461079
10	South West Scotlands	2.429307	9.452900	13.331080	-3.291240	17.365251	20.031467	13.821000
11	Lothian and Borders	3.671094	9.452900	7.498705	-3.291240	13.941138	15.440879	7.988625
12	Solway and Cheviot	1.967298	5.395649	7.552484	-3.291240	9.034564	10.545061	6.419504
13	North East England	3.888934	3.009497	3.947429	-3.291240	6.163235	6.952721	1.859988
14	North Lancashire and The Lakes	1.593156	3.009497	2.666575	-3.291240	2.842774	3.376089	0.579134
15	South Lancashire, Yorkshire and Humber	4.480390	0.788798	0.117713	-3.291240	1.914359	1.937901	-2.858008
16	North Midlands and North Wales	3.946194	-0.821362		-3.291240	-0.002136	-0.002136	-3.619785
17	South Lincolnshire and North Norfolk	2.124119	-0.466464		-3.291240	-1.540292	-1.540292	-3.477826
18	Mid Wales and The Midlands	1.216122	-0.240749		-3.291240	-2.267717	-2.267717	-3.387540
19	Anglesey and Snowdon	4.442770	-0.635745		-3.291240	0.642934	0.642934	-3.545538
20	Pembrokeshire	9.183173	-4.517385		-3.291240	2.278025	2.278025	-5.098194
21	South Wales & Gloucester	6.180217	-4.492046		-3.291240	-0.704660	-0.704660	-5.088058
22	Cotswold	3.033858	2.270828	-6.740769	-3.291240	-3.833335	-5.181489	-9.123678
23	Central London	-5.759783	2.270828	-6.615453	-3.291240	-12.526723	-13.849814	-8.998362
24	Essex and Kent	-4.082301	2.270828		-3.291240	-5.556879	-5.556879	-2.382909
25	Oxfordshire, Surrey and Sussex	-1.521341	-2.983857		-3.291240	-7.199667	-7.199667	-4.484783
26	Somerset and Wessex	-1.407710	-4.220289		-3.291240	-8.075181	-8.075181	-4.979356
27	West Devon and Cornwall	0.052621	-5.724538		-3.291240	-7.818249	-7.818249	-5.581055

Zone tariff getting lower as it is closer to south

North Scotland, Conventional Carbon Generators: 2.64+17.8×0.8+16.3×0.8-3.29=26.66
North Scotland, Intermittent Generators: 17.8×0.3+16.3 -3.29=20.17

Source: National Grid (Forecast TNUoS, Tariffs for 2019/20)

(Ref.) Local Substation Tariff, Local Circuit Tariff

- Local substation tariffs reflect the cost of the first transmission substation to which transmission connected generators connect
- Transmission connected generator is not directly connected to the Main Interconnected Transmission System (MITS), the onshore local circuit tariffs reflect the cost and flows on circuits between its connection and the MITS

Local Substation Tariff

Substation Rating	Connection Type	132kV	275kV	400kV
<1320 MW	No redundancy	0.197988	0.113261	0.081607
<1320 MW	Redundancy	0.436150	0.269848	0.196255
>=1320 MW	No redundancy	0	0.355124	0.256827
>=1320 MW	Redundancy	0	0.583024	0.425559

Local Circuit Tariff

Substation Name	(£/kW)	Substation Name	(£/kW)	Substation Name	(£/kW)	Substation Name	(£/kW)
Achruach	4.233361	Dunlaw Extension	1.479979	Lochay	0.360863	Millennium South	0.928601
Aigas	0.644948	Dunhill	1.412438	Luichart	0.565540	Aberdeen Bay	2.571147
An Suidhe	-0.941215	Dumnaglass	1.830822	Mark Hill	0.863413	Killingholme	0.700825
Arecleoch	2.048112	Edinbane	6.748862	Marchwood	0.376358	Middleton	0.109808
Baglan Bay	0.750203	Ewe Hill	1.355115	Millennium Wind	1.800997		
Beinneun Wind Farm	1.481122	Fallago	0.199489	Moffat	0.169514		
Bhlaraidh Wind Farm	0.648898	Farr	3.515921	Mossford	0.441973		
Black Hill	1.531435	Fernoch	4.337616	Nant	2.474770		
BlackCraig Wind Farm	6.207678	Ffestiniogg	0.249487	Necton	-0.362207		
Black Law	1.723120	Finlarig	0.315755	Rhigos	0.100382		
BlackLaw Extension	3.654099	Foyers	0.742535	Rocksavage	0.017458		
Carrington	-0.032852	Galawhistle	1.458487	Saltend	0.336249		
Clyde (North)	0.108145	Glendoe	1.813886	South Humber Bank	0.934341		
Clyde (South)	0.125064	Glenglass	2.938700	Spalding	0.277674		
Corriegarth	3.108877	Gordonbush	0.196764	Strathbrora	0.069805		
Corriemoillie	1.640653	Griffin Wind	9.567902	Stronelairg	1.417687		
Coryton	0.051519	Hadyard Hill	2.729474	Strathy Wind	2.029059		
Cruachan	1.865597	Harestanes	2.474525	Wester Dod	0.368974		
Crystal Rig	0.033422	Hartlepool	0.592087	Whitelee	0.104656		
Culligran	1.709128	Hedon	0.178440	Whitelee Extension	0.290944		
Deanie	2.807854	Invergarry	1.399172	Gills Bay	2.483408		
Dersalloch	2.375375	Kilgallioch	1.037840	Kype Muir	1.462664		
Didcot	0.515325	Kilmorack	0.194752	Middle Muir	1.954673		
Dinorwig	2.365979	Langage	0.648640	Dorenell	2.069507		

Source: National Grid (Forecast TNUoS, Tariffs for 2019/20)

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Effective Power System Use through Policy and System
Loss Factor in Australia

September, 2020

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

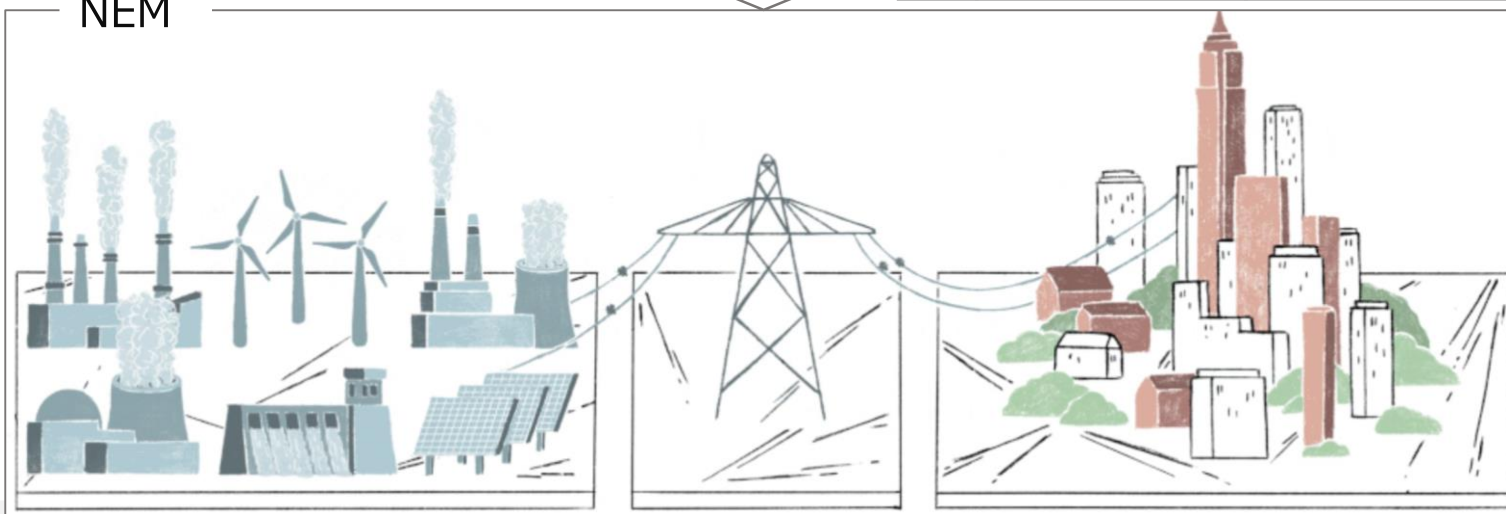
Australian Power Market

- Zone pricing and nodal pricing schemes exist for transmission congestion management. Australia adopts the nodal pricing.
- In the National Energy Market (NEM), the Australian Energy Market Operator (AEMO) is responsible for ensuring the reliability and efficiency of electricity supply.
- The concept of Marginal Loss Factor (MLF) has been introduced to ensure efficiency in NEM.

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Operation of System and Market

NEM



What is MLF

- The MLF represents the marginal electrical transmission losses between a generation connection point and the regional reference node (RRN)

The MLF is defined in terms of this small increase in load as

MLF = (Changing in network losses + Change in load) / (Change in load)

That is:

$$MLF = 1 + \boxed{\Delta_{loss} / \Delta_{load\ increment}}$$

-: G > L at Connection point

+: L > G at Connection point

Where

Δ_{loss} = change in network

$\Delta_{load\ increment}$ = incremental increase in load at connection point

Source: AEMO (Treatment of Loss Factors in the National Electricity Market, MLF Engagement Session)

MLF from the perspective of Power Producers

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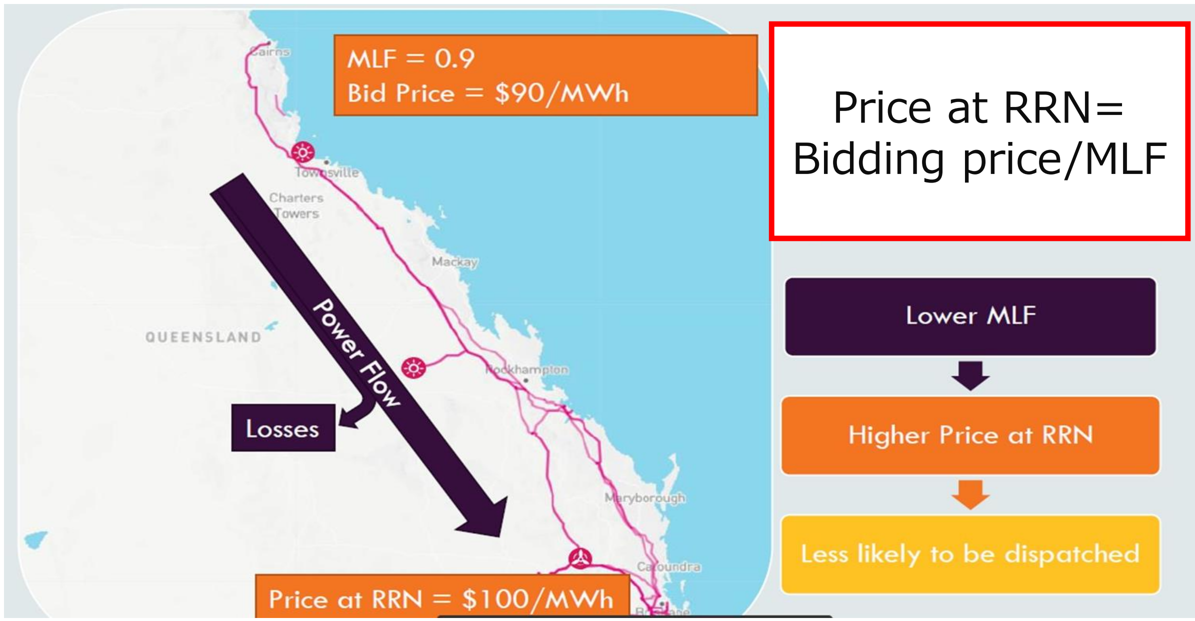
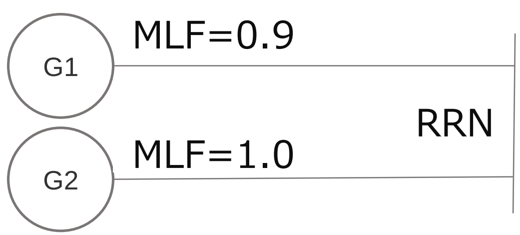
- Price at the RRN is the basement
- Generators at connection points with low MLF are less likely to be dispatched.



(E.g.
Bidding price $90/MWh is same for both generators



	Price at RRN	Judgement
G1	90/0.9=$100/MWh	Not Good
G2	90/1.0=$90/MWh	Better

Incentives for power plants to be built in areas with large MLF

Source: AEMO (Treatment of Loss Factors in the National Electricity Market, MLF Engagement Session)

MLF from the perspective of Consumers

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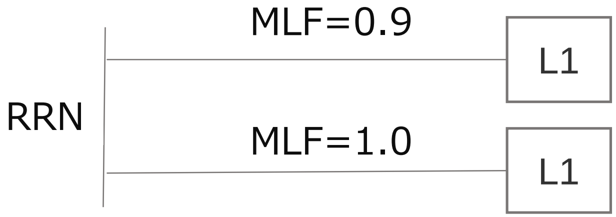
- Bigger MLF is more preferable for consumers.

Spot Price = Price at RRN × MLF

Payment by Customers = Spot price × Consumption



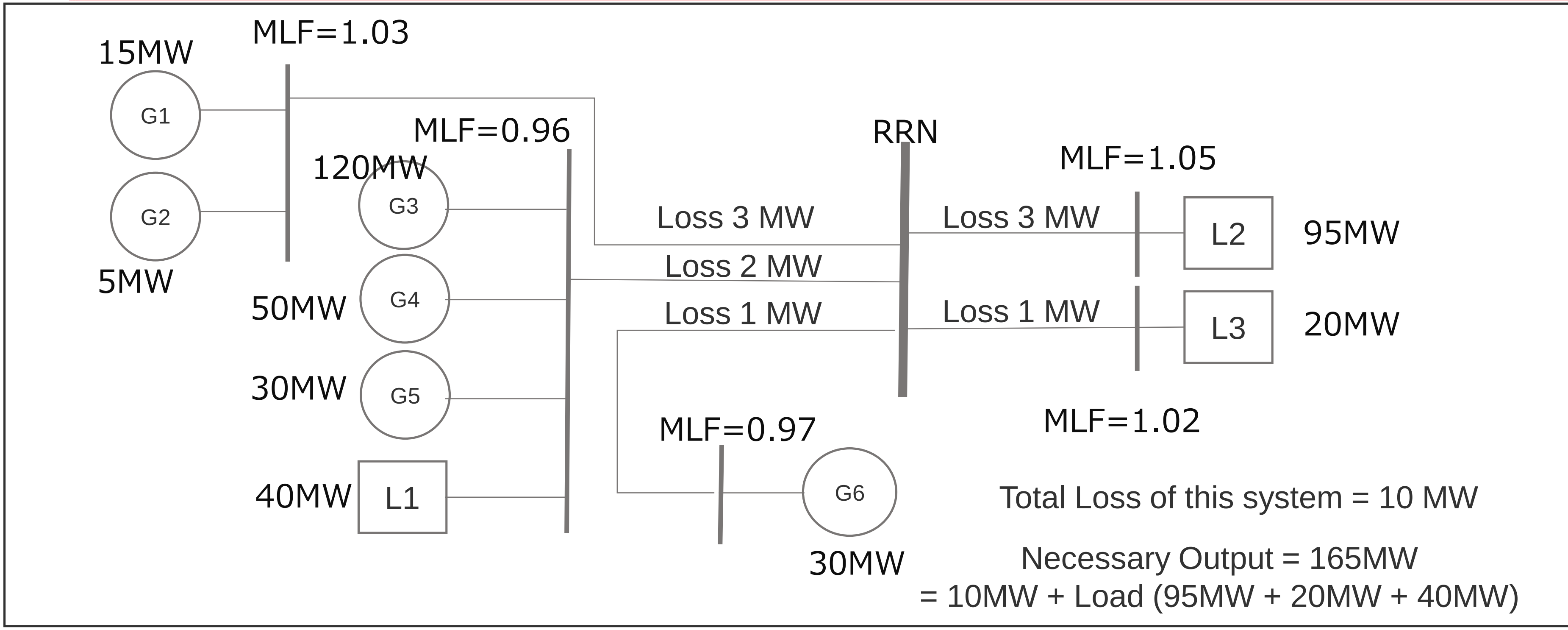
E.g.
RRN = $100/MWh
Consumption=100MWh

	Payment by Customers	Judgement
L1	100×0.9×100=$9,000	Better
L2	100×1.0×100=$10,000	Not Good

Consumers are incentivized to locate their business (consumption) at the point where MLF is large

Source: AEMO (Treatment of Loss Factors in the National Electricity Market, MLF Engagement Session)

Practical Example



	Bidding Price	Price at RRN
G1	$20	20/1.03=$19.42
G2	$50	50/1.03=$48.54
G3	$0	0/0.96=$0
G4	$25	25/0.96=$26.04
G5	$30	30/0.96=$31.25
G6	$25	25/0.97=$25.77

Merit Order

	Bidding Price	Price at RRN	Cumulative	Judgement
G3	$0	$0	120MW	Dispatched
G1	$20	$19.42	135MW	Dispatched
G6	$25	**$25.77**	165MW	Dispatched
G4	$25	$26.04	215MW	Not Dispatched
G5	$30	$31.25	245MW	Not Dispatched
G2	$50	$48.54	250MW	Not Dispatched

Source: AEMO (Treatment of Loss Factors in the National Electricity Market, MLF Engagement Session)

Practical Example cont'd

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Basement price for the market is set at $25.77

Payment from Customers to Pool Market

Market Customers	Load	Unit Price (Price at RRN x MLF)	Payment by Customers
L1	95MW	$27.06 = 25.77 x 1.05	$2,571
L2	20MW	$26.29 = 25.77 x 1.02	$526
L3	40MW	$26.54 = 25.77 x 1.03	$1,062
		Total	$4,159

Payment from Pool Market to Generators

Generators	Dispatched Output	Unit Price (Price at RRN x MLF)	Payment by Customers
G3	120MW	$24.74 = 25.77 x 0.96	$2,969
G1	15MW	$26.54 = 25.77 x 1.03	$398
G6	30MW	$25.00 = 25.77 x 0.97	$750
		Total	$4,117

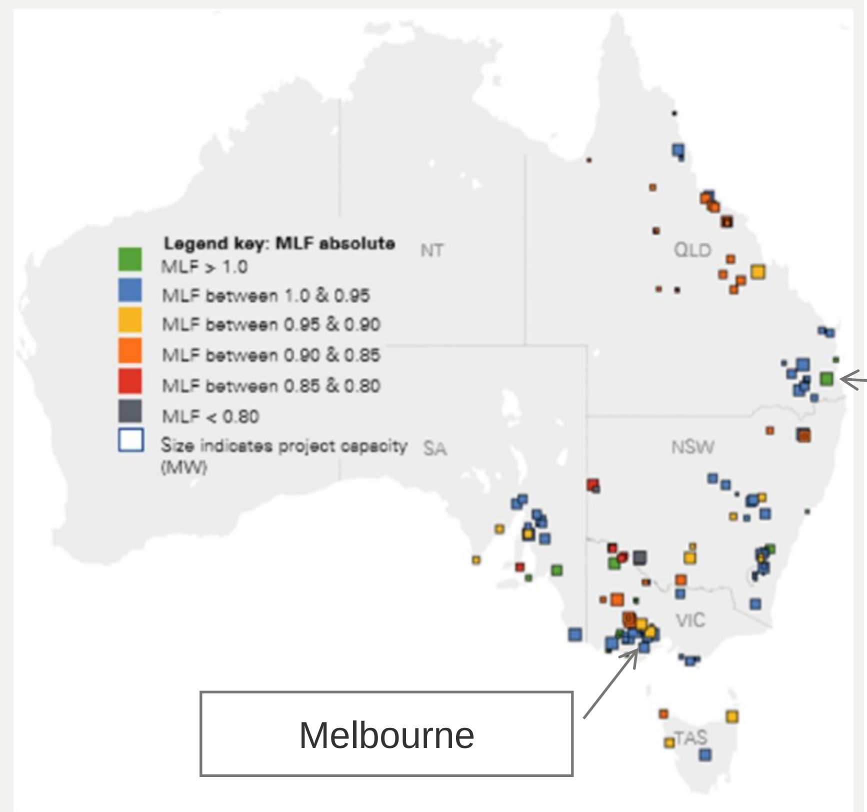
For this example, the loads pay slightly more to the pool for their energy demand than the Generators are paid for energy produced ($4,159 - $4,117 = $42). In the NEM, this settlement surplus would be returned to Market Customers through reduced network charges.

Source: AEMO (Treatment of Loss Factors in the National Electricity Market, MLF Engagement Session)

Summary of MLF

- MLF is high in areas with demand over supply, such as large cities, while MLF is low in areas with supply over demand, such as the suburbs.
- Suburbs are easier to locate power sources, but they are less profitable and hardly being dispatched. →The market is designed to incentivize power producers to locate power sources in areas with high MLF.

Figure 1: 2020-21 MLFs for a range of renewable generators



MLF is generally large in big cities

Gold Coast

MLFs for the next financial year are published on 1 April. Annually revised.

Source: Australian Energy Council

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Soorya Bala Sangramaya
(Battle for Solar Energy)
Roof top Solar Power Generation Project (RSPGP)

December , 2020

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

Background and Project Target

Background

The Ministry of Power and Renewable Energy has launched a new community based power generation project titled 'Soorya Bala Sangramaya' (Battle for Solar Energy) in collaboration with Sustainable Energy Authority (SEA), Ceylon Electricity Board (CEB) and Lanka Electricity Company Limited (LECO) to promote the setting up of small solar power plants on the rooftops of households, religious places, hotels, commercial establishments and industries.

Project Target

It is expected to add 200 MW of solar electricity to the national grid by 2020 and 1000 MW by 2025 through this intervention.

Source: SEA HP

Project Funding

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With the assistance of ADB, business owners are entitled to get a concessional loan.

- Interest rate (Maximum): 4% / year
- Repayment term (Maximum): 10 years
- Applied facilities: Installed capacity per customer (Maximum): 50kW

ADB

50m USD

GoSL

MoSMM※1

※1 Ministry of Finance and Mass Media

Fund management

Technical Support

MoP

SEA

PIU※2

※2 Project Implementation Unit

Participating Financial Institutions (PFI)

Bank of Ceylon, Commercial Bank of Ceylon, DFCC Bank, etc.

Source: RSPGP Project HP

https://www.rooftopsolar.lk/index.php

Standards to be adhered to

PV Project owners need to form facilities in accordance with the following criteria

- "SAFETY OF HYBRID INVERTER FOR SOLAR PV SYSTEM" designated by SRI LANKA STANDARDS INSTITUTION
- Supporting Standards:
  - CODE OF PRACTICE
  - POWER CONVERTERS
  - SWITCHGEAR AND CONTROLGEAR
  - DC CABLE
  - PHOTOVOLTAIC (PV) MODULES
  - PERFORMANCE TESTING AND ENERGY RATING
  - PROTECTION AGAINST LIGHTNING
  - LOW VOLTAGE SURGE PROTECTIVE DEVICES
  - LIGHTNING PROTECTION SYSTEM COMPONENTS

Source: SEA HP

Application and Approval Process of Loan Scheme

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Step 1: Potential Sub-borrower prepares a technical and financial proposal in consultation with a PV service provider

Step 2: Sub-borrower applies for individual connection approval from CEB or LECO by submitting the technical proposal

Step 3: CEB/LECO grants approval based on network absorption capacity and in conformity to their technical guidelines

Step 4: Sub-borrower applies for a loan through the preferred PFI, submitting the loan application, the technical/financial proposal along with confirmation for connection by CEB/LECO

Step 5: Upon sub-loan evaluation, PFI clear the sub-loan application that would meet the project loan conditions, technical specifications, and other eligibility criteria stipulated in this manual

Step 6: The sub-borrower / PFI pays the agreed portion of the project cost to the PV service provider

Step 7: The service provider install the system in accordance with specifications in the technical proposal in conformity to guidelines and specifications established by the project

Step 8: An accredited engineer registered with CEB/LECO inspects the installed rooftop solar PV system for compliance with project and utility guidelines and original technical proposal specification. The accredited engineer issues a compliance certificate

Step 9: The sub-borrower requests for system connection from CEB/LECO by submitting the compliance certificate

Step 10: CEB/LECO sign the connection agreement and provide the grid connection

Step 11: The sub-borrower submits the compliance certificate and the grid connection agreement to PFI for release of balance loan funds

Step 12: PFI checks the compliance and connection certificates and disburse the remaining loan funds to sub-borrower or directly to the service provider

- Service providers entitled to Loan
  - ✓ Residential rooftop: solar PV system installed on an existing permanent residential building rooftop
  - ✓ Commercial-scale rooftop: solar PV systems installed on an existing permanent commercial-scale building rooftop
  - ✓ Single sub-borrower may apply for multiple subprojects subject to a maximum cumulative capacity of 50 kW
- ADB funding for subprojects are available as detailed below:
  - ✓ Upto 100% of the subprojects cost for residential rooftop subprojects with a subproject cost not exceeding LKR 1.5 million
  - ✓ Upto 80% of the subproject cost for, residential subprojects with a subproject cost exceeding LKR 1.5 million and all commercial rooftop subprojects

Source: SEA HP

Mandatory Items Vendors/Service Providers shall comply

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Applicant company, having capacity to deliver the complete package of services including survey, design, supply of equipment/materials, installation & commissioning and post installation back up support must register at the Sri Lanka Sustainable Energy Authority to engage in Solar PV Roof Top installation in Sri Lanka.

Major items

- Applicant company shall provide minimum warranties:
  a. Solar PV panel –
     - 10 years (manufacturer warranty),
     - Minimum performance of 90% of the rated output for first 12 years, and 80% of the rated output for the next 12.5 years, and
     - 25-year performance warranty that guarantees a maximum degradation will not exceed 2.5% in the first year, and 0.5–0.7%/yr thereafter
  b. Inverter – 10 years (manufacturer warranty)
  c. Mounting and Wirings – Warranty cover by the service provider for mounting structure and wiring for5 years
- Applicant company shall obtain comprehensive insurance cover for equipment damage and accidental workman compensation during installation

Source: SEA HP

Project Monitoring

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- A comprehensive web-based IT Solution Package established by the PIU shall monitor project progress, fund movements, capacity installed and energy served to the grid by PV systems financed by the Project
- The database shall facilitate the periodic report requirements of the ADB and GoSL
- periodic energy generation data shall be captured online by CEB/LECO through Smart Meters installed by CEB/LECO at each location to facilitate performance monitoring. This interface will be used to transit data on monthly basis.

Source: SEA HP

Technical Training

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- Part of the Fund from ADB is being used to train technicians and hold workshops to promote PV project implementation
- Organizer: Rooftop Solar PV Power Generation Project (RSPGP) and SEA.

Invitation to Training Course

Training Course for Rooftop Solar PV System Installation for Technicians
August 19th – 23rd, 2019
Organized by Solar Rooftop Power Generation Project (RSPGP) in collaboration with Sri Lanka Sustainable Energy Authority (SLSEA)

We are pleased to announce of the above workshop jointly organized by Rooftop Solar PV Power Generation Project (RSPGP) and Sri Lanka Sustainable Energy Authority (SLSEA). The workshop is funded by the Asian Development Bank (ADB) under RSPG Project.

Target Audience: Technicians of Rooftop Solar PV industry

Date: August 19th – 23rd, 2019

Venue: Agrarian Research and Training Institute (ARTI) 114, Wijerama Mawatha, Colombo 7

Maximum No of Participants: 40

Course Fee Funded by RSPGP

The closing date for nomination: 5th August 2019

Participants for the workshop will be selected on the following basis

- One participant each from SLSEA registered Solar PV service providing companies
- First come first served basis after announcing the workshop through a group e mail by SLSEA to all the registered companies.
- Involvement of nominees in rooftop solar PV design/installation during the last six month period
- Nominees shall be technicians at NVQ 3 level.

The agenda of the program is given below,

The program will be repeated depending on the demand for training of wider group of technicians.

If participants travelling from long distances require hostel facilities in Colombo please indicate in your application.

Please note the solar company is required to ensure its nominee is present at the workshop on all five days and follow all modules offered under the program. Only such participants will be certified as having followed the program under the RSPG Project.

Interested companies are invited to send their nominations in the attached nomination form to following e mail; with a copy to .

Source: SEA HP

Training items

- ➢ Introduction to electricity
- ➢ Introduction to solar resource and Solar PV Technology
- ➢ Applications of Solar Photo-Voltaic (PV) and Optimizing its Benefits
- ➢ Design, Installation, Commissioning & Maintenance of Small Scale Grid Connected Solar PV systems
- ➢ Lightning and Surge Protection of Solar PV Systems
- ➢ Safety aspects in working with solar PV systems
- ➢ Conducting site inspection for solar PV system design & best practices
- ➢ Sri Lanka Standards for grid connected PV Systems
- ➢ Common Mistakes in Solar PV Installations
- ➢ Field demonstration of Rooftop Solar PV installation

"Rivi Balaya Liya Saviyata" Workshop for Women

- This is the workshop which is specially designed to provide knowledge on best practices and address awareness and capacity gaps to empower the women workforce of the country towards solar energy related opportunities in emerging local and global markets and gradually empower women on skills related to solar energy.
- Organizer: SEA under "Soorya Bala Sangramaya" Program
- Target Group: Female only; Age limit below 30 years

Main Workshop items

- Basics of Electronic and Electrical
- Installation of Grid Connected Systems CEB and LECO Areas
- Introduction to SLSI standards on Solar PV Installations
- Regulations for Solar Energy Suppliers and Best Practices
- Common Issues in Solar PV installations
- Designing and Installation of Solar PV systems
- Case Studies (Visits to Manufacturing Industries in SL)
- Field Visit (Hambantota Solar Energy Park and installation sites)

Source: SEA HP

Registered PV Providers

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- Vendors/service providers (applicant company), having capacity to deliver the complete package of services including survey, design, supply of equipment/materials, installation & commissioning and post installation back up support must register at the Sri Lanka Sustainable Energy Authority to engage in Solar PV Roof Top installation in Sri Lanka.

No. of Registered service providers is 228

	SLSEA Reg, No	Company Name	Address	Old Address	Contact No	Fax no	E-mail	Web
226	S00325	K.H.M. Fernando & Sons (Pvt) Ltd	37, Senanayaka Veediya, Kandy		777258840			www.knmsolar.com
227	S00326	S & K Ceylon Investment Holdings (Pvt) Ltd	No:361, Matara Rd, Dewata, Galle		775878877			
228	S00327	Matrix Lanka Solar & Technologies (Pvt) Ltd	No: 227/5/A/B/B, Bandaragama rd, Kesbewa		719785827/ 0772170258			

Source: SEA HP

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இலங்கை நிலைபெறுதகு வலு அதிகாரசபை
Sri Lanka Sustainable Energy Authority

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இலங்கை மின்சார சபை
CEYLON ELECTRICITY BOARD

CHUBU Electric Power

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Approval Process for On-grid Variable Renewable Energy Project Development

February 16th, 2021

Sri Lanka Sustainable Energy Authority
Ceylon Electricity Board
Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

Project Name, Period, Counterpart and Related Organizations

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Project Name

The Project for Capacity Development on the Power Sector Master Plan Implementation Program

Project Period

March, 2020 ~ March, 2023

Main Counterpart

Ceylon Electricity Board (CEB)

Related Organizations

- Ministry of Power, Energy and Business Development
- Public Utility Commission of Sri Lanka (PUCSL)
- Sustainable Energy Authority (SEA)
- Lanka Electricity Company (LECO)

Project Purpose and Expected Outputs

Project Purpose

Institutional capacity for improving transmission and distribution operational reliability is enhanced to get prepared for increased share of renewable energy planned in the LTGEP (Long Term Generation Expansion Plan)

Expected Outputs of the Project

1. Capacity of corporate strategy and planning for variable renewable energy (VRE) is enhanced (WG1 activities)
2. Capacity of system development and operation for transmission network in response to increased share of VRE is enhanced (WG2 activities)
3. Capacity of distribution network operation is improved (WG3 activities)

Why JICA Expert Team requests SEA to join the Project?

SEA vision for renewable energy development

- SEA promotes the widespread adoption and sustainable use of renewable energy in the pursuit of sustainable development, energy access, energy security and low carbon economic growth and prosperity.
- At present, the power generation sector is dominated by liquid petroleum fuels. As at 2017, Sri Lanka expended 29.5% of its export earnings on fuel imports. The country's financial resources therefore are heavily drained out of the country due to high import costs. Thus, veering away from imported energy resources and focusing more on renewable energy resources is deemed an urgent necessity.

- ◆ CEB and JICA Expert Team has discussed reasonability of some new scheme (e.g. FIT scheme review, Fuel cost adjustment) for VRE.
- ◆ JICA Expert Team thinks that adapting existing VRE approval process to the current situation may promote VRE introduction.
- ◆ SEA opinions and information are essential to review the system and policy.

Image of how to proceed with Approval Process Review

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① JICA Expert Team confirms to SEA about our understanding and concern for SEA guideline (Today's discussion)

② JICA Expert Team will prepare a questionnaire based on today's discussion and send it to SEA

③ JICA Expert Team will introduce the approval process in Japan
- ✓ Approval process in Ministry of Economy, Trade and Industry
- ✓ Investigation flow in Chubu Electric Power Company

④ JICA Expert Team would like to prepare a proposal document with SEA and make a presentation at the system and policy seminar. Image is as follows;
- ➢ Difference between Sri Lanka and Japan is ~.
- ➢ Bottleneck in Sri Lanka is ~.
- ➢ Japan study that can be reflected in case of Sri Lanka is ~.

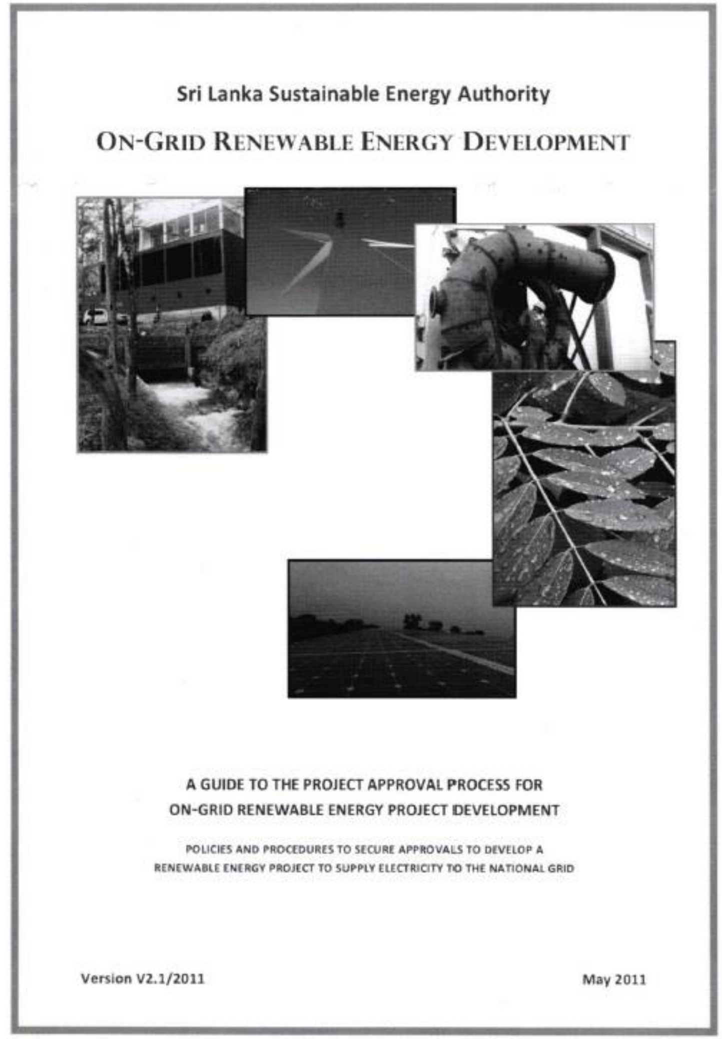
To shorten time until approval
- Existing guideline will be revised
- XXXX shall be improved
- YYYY process shall be added to approval process in SEA guideline
- ZZZZ shall be stipulated in SEA guideline

01 Current Approval Process for On-grid VRE Project Development in Sri Lanka

SEA Guideline

Could you confirm and revise it and add some comments?

- SEA guideline was published in **May 2011**.
- Guideline published in May 2011 is latest version.
- The guideline explains the process and procedures to be followed by parties intending to develop on-grid RE projects of **all types and capacities**.
- **Any person (an individual or a company) can apply** for a VRE project anytime, irrespective of whether the person holds any rights to the resource or land rights.



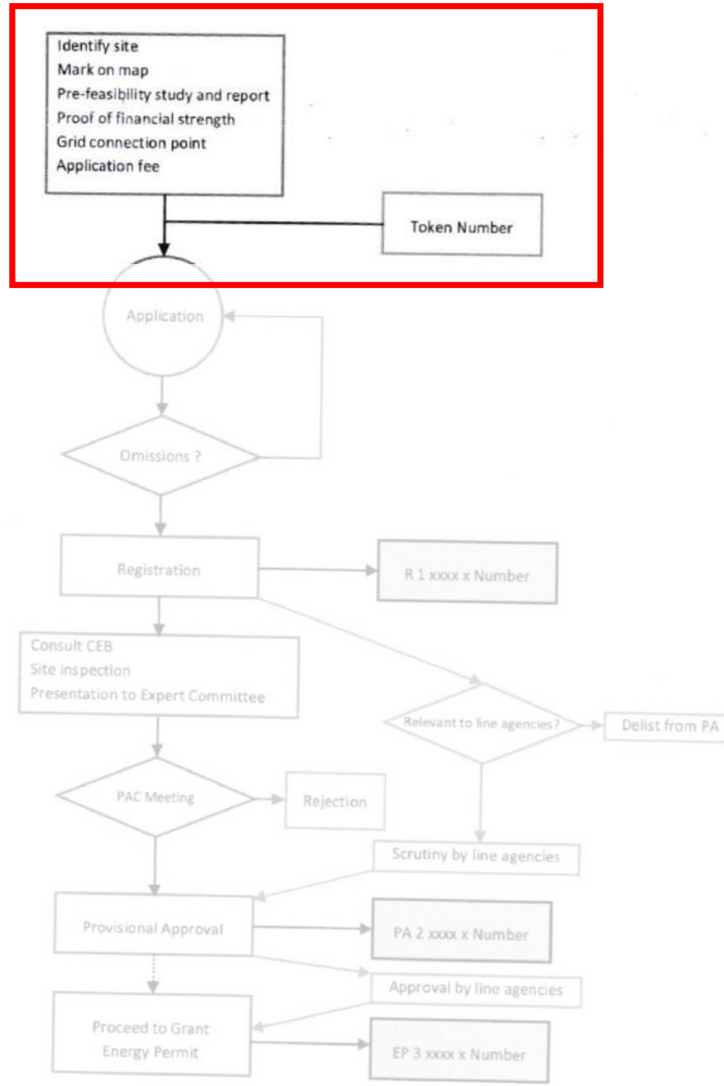
New Application Flowchart

Could you confirm and revise it and add some comments?

- A complete application form will have to be made after payment of the application fee to SEA. The fee has not been revised.

Amount of power proposed to be generated	Fee to be paid on application and reapplication
1,000 kW or part thereof	LKR 100,000
Each additional 1,000 kW	LKR 50,000 payable on pro rata basis

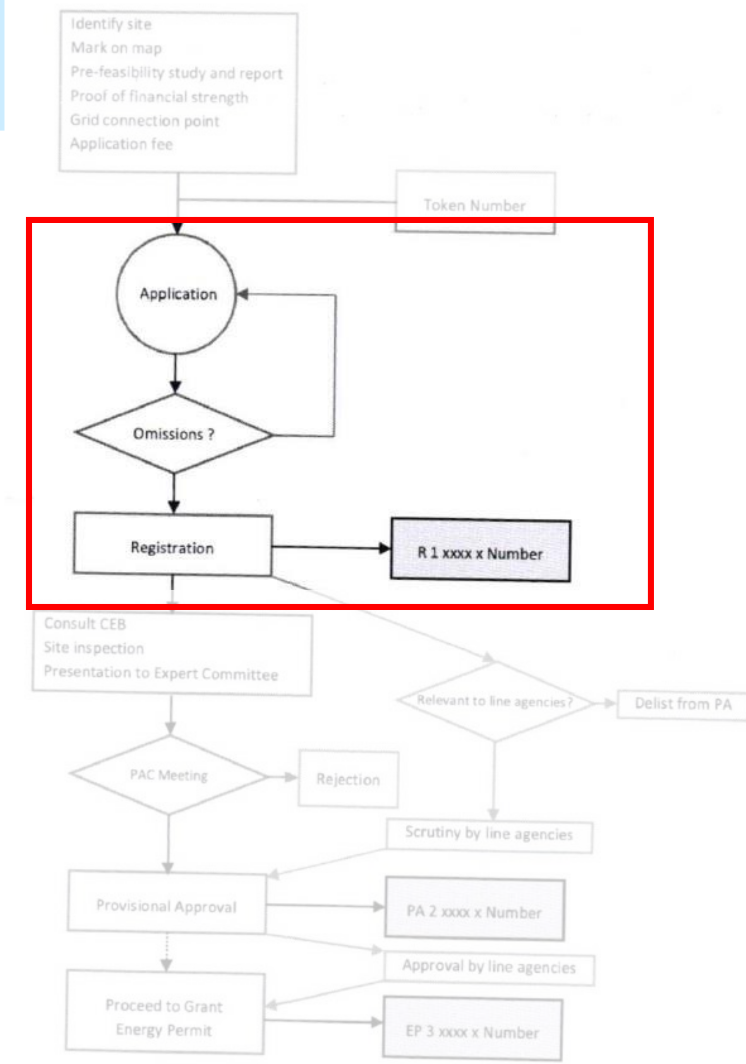
- To resolve conflicts arising out of two ore more applicants applying for the same resource site at the same time, an <u>**Electronic Token**</u> will be provided at SEA office.



New Application Flowchart

Could you confirm and revise it and add some comments?

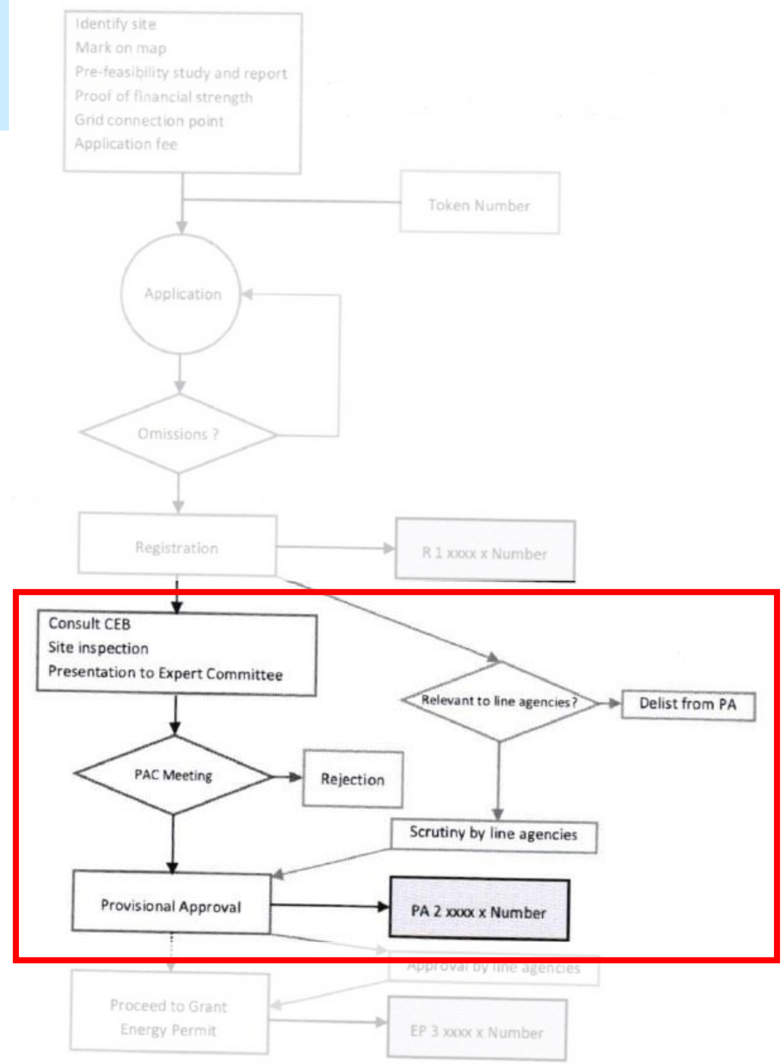
- **<u>Registration number</u>** (R 1 xxxx x) will be issued to the applicant who submit complete application forms.
- Registration number will be marked on the receipt issued in acceptance of the application fee.
- Any application, after an initial inspection having obvious omissions will be returned unregistered to the applicant, requesting the attention to the said omissions.
  The applicants who fail to submit complete application forms runs the risk of another party applying for the same resource site.



New Application Flowchart

Could you confirm and revise it and add some comments?

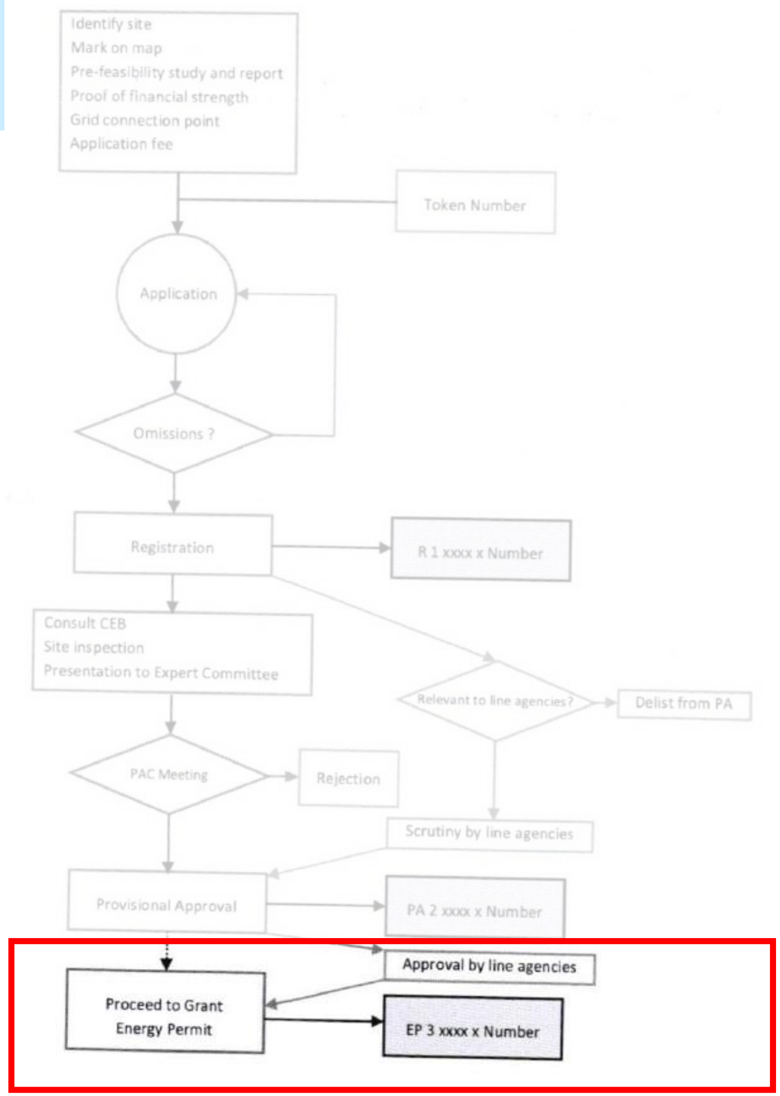
- **<u>Provisional Approval number</u>** (PA 2 xxxx x) will be issued to the applicant.
- Based on the information provided in the pre-feasibility report, all applications received by SEA, will be evaluated to ascertain the possibility of securing grid connection, in consultation with CEB.
- All line agencies will be prompted to indicate the relevance of their approval for proposed projects at the meeting of Project Approving Committee (PAC) after receipt of an application.



New Application Flowchart

Could you confirm and revise it and add some comments?

- **Energy Permit** (EP 3 xxxx x) will be issued to the applicant.
- Energy Permit is valid for a period of 20 years from the date of commercial operation of the project.
- Once issued with an Energy Permit, the status of the Applicants is changed to that of a Developer, a person having permission to develop an VRE project.
- A period of 20 years is allowed to the Developer for construction, from the date of the Energy Permit.



Issues to be tackled under Current Situation

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CEB provided these information with JICA Expert Team.
Could you confirm and revise it and add some comments?

- Bottleneck in approval process is to take much time (e.g. there is the case that it takes maximum 18 months to get approval).

- There is wide range of project approving authorities that the project developers have to visit. The project developer needs to secure approval from each and every institution prior to the obtaining of energy permit and generation license.

List of project approving authorities

- Central Environmental Authority
- Divisional Secretary
- Pradeshiya Saba (local government)
- Depart of Irrigation
- Department of Wild Life
- Coast conservation & coastal management Department (for project in coastal areas)
- Urban Development Authority
- Civil Aviation (for wind)
- Department of Archeology

Issues to be tackled under Current Situation

CHUBU Electric Power
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There is case that it takes maximum 18 months to get approval

Considering construction period, it will take more than 18 months until commercial operation start. As a result, it may prevent investor to recover investment cost, and investor may hesitate VRE development. In other words, it may slow down VRE installation in Sri Lanka.

SEA guideline does not mention how long time will be taken in each process

It is difficult for investor to make VRE development plan. Investor may hesitate VRE development. In Japan, investigation of connection to grid by electric power company is stipulated in Ministry guideline, it helps investor to make VRE development plan.

- Basic period until approval shall be clarified.
- Which process in flowchart of guideline is taking the longest?
- Is there any process to be shortened? How about SEA opinion?
- Latest version of guideline is May 2011 version. So far, is there any action to revise the guideline? Did any developer request to accelerate the process?

Any Info.

Could you describe clearly by yourself?

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Sri Lanka Sustainable Energy Authority

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இலங்கை மின்சார சபை
CEYLON ELECTRICITY BOARD

CHUBU
Electric Power

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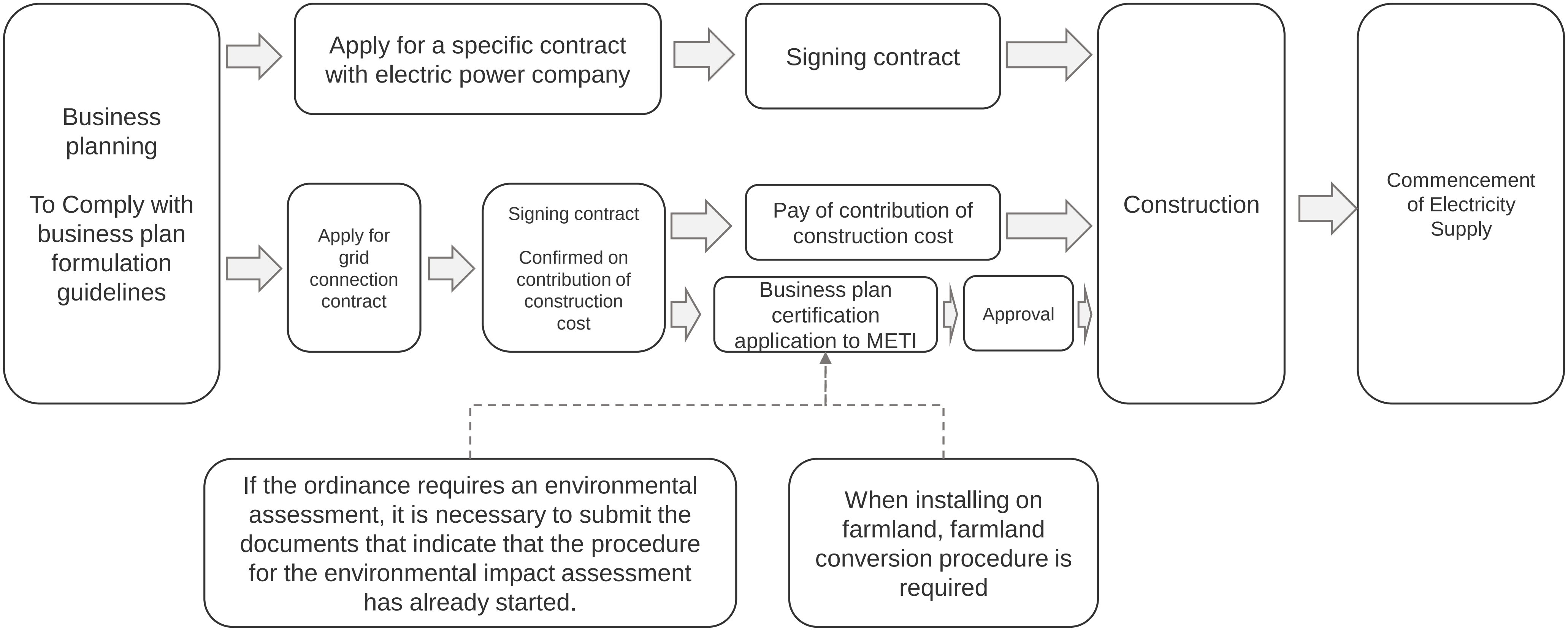
02 Current Approval Process for On-grid VRE Project Development in Japan

Under preparation

FIT Approval Procedure for less than 50kW

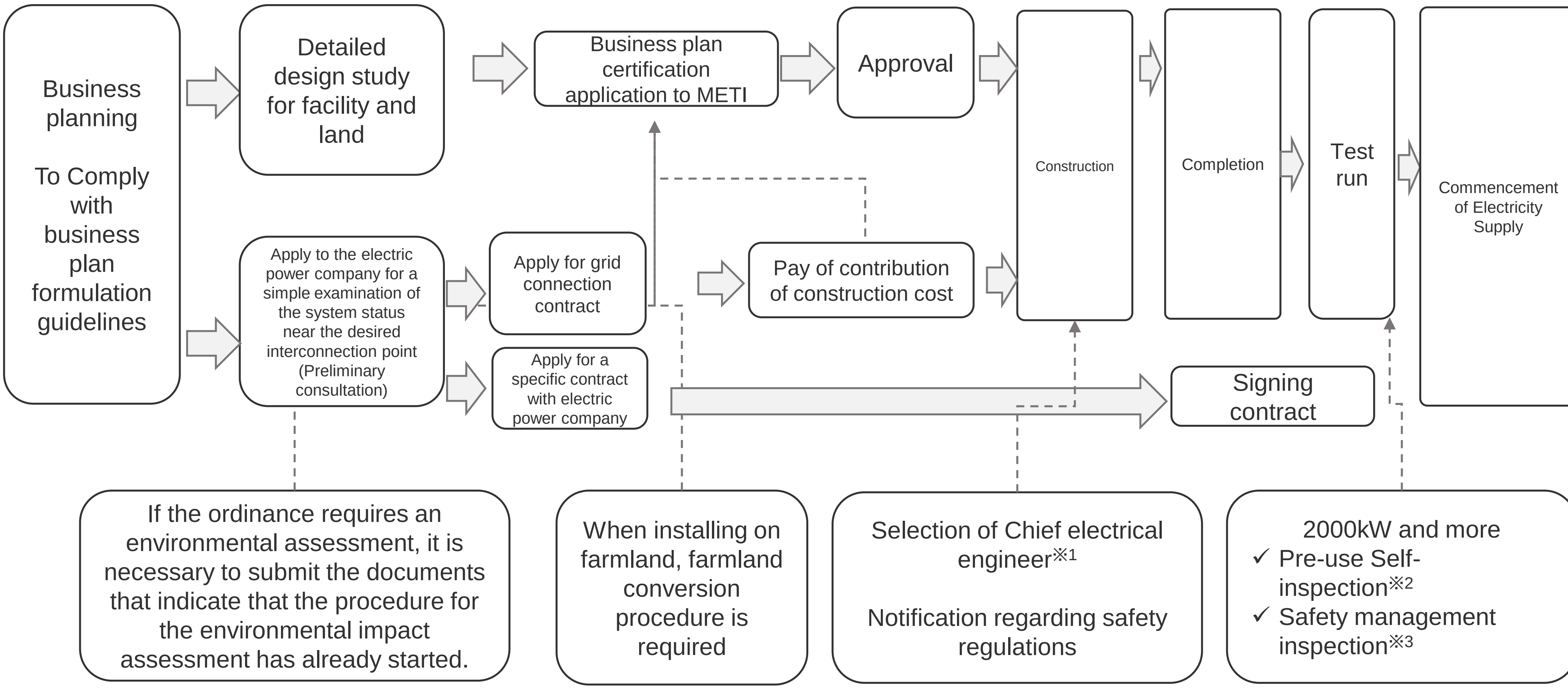
There are many tasks and procedures involved in business plan approval from the government, including the grid connection contract with electric power company.



Source: Agency for Natural Resource and Energy

FIT Approval Procedure for 50kW and more

There are many restrictions and the procedure is more complicated compared to case of less than 50kW



※1: Security supervisor for construction, maintenance, operation, etc. related to electric facility

※2: Business operator voluntarily confirms the electric facilities for business use that have been submitted of the construction plan notification.

※3: Conducted by a METI-approved inspection body within one month after the completion of Pre-use Self-inspection

Source: Agency for Natural Resource and Energy

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இலங்கை நிலைபெறுதகு வலு அதிகாரசபை
Sri Lanka Sustainable Energy Authority

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இலங்கை மின்சார சபை
CEYLON ELECTRICITY BOARD

CHUBU Electric Power

NIPPON KOEI

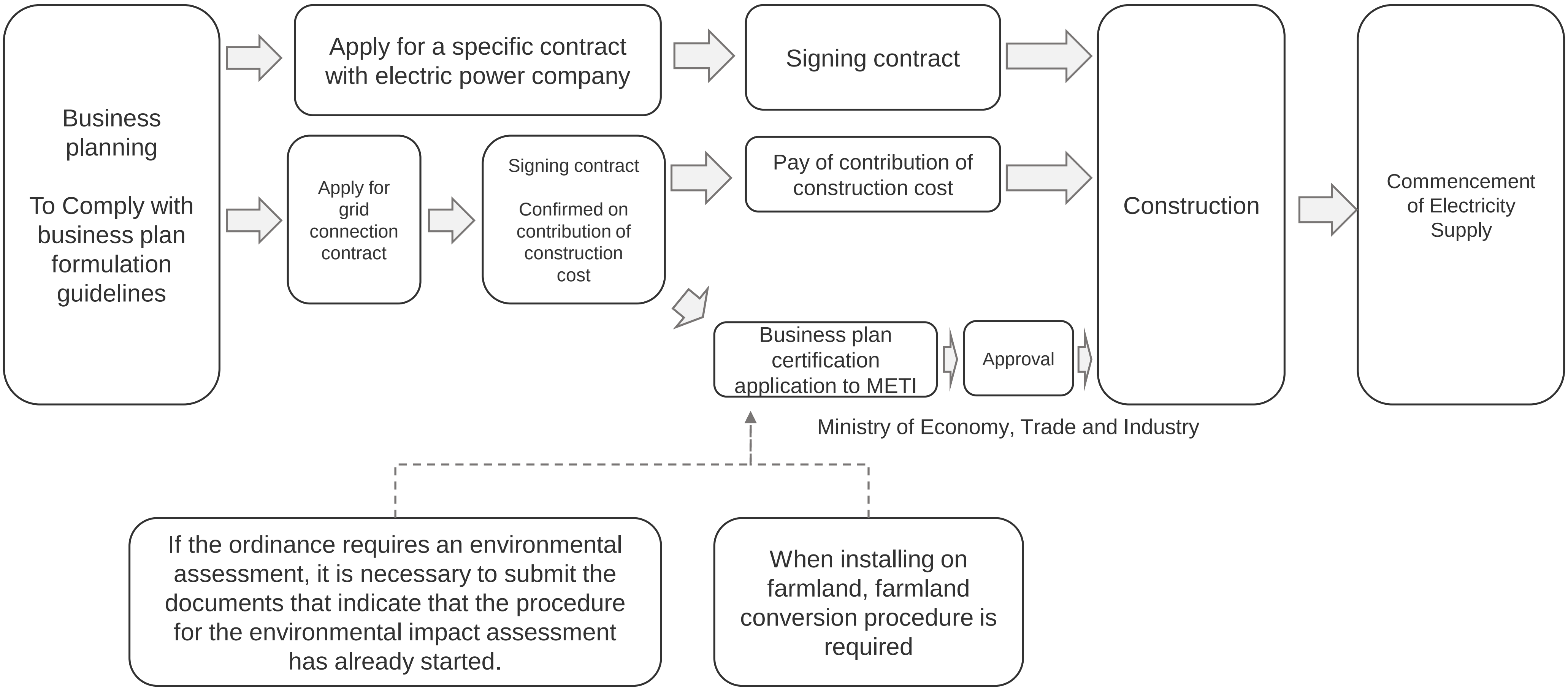
FIT Approval Process
on Ministry of Economy, Trade and Industry in Japan

April 22nd, 2021

Sri Lanka Sustainable Energy Authority
Ceylon Electricity Board
Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

FIT Approval Procedure for less than 50kW

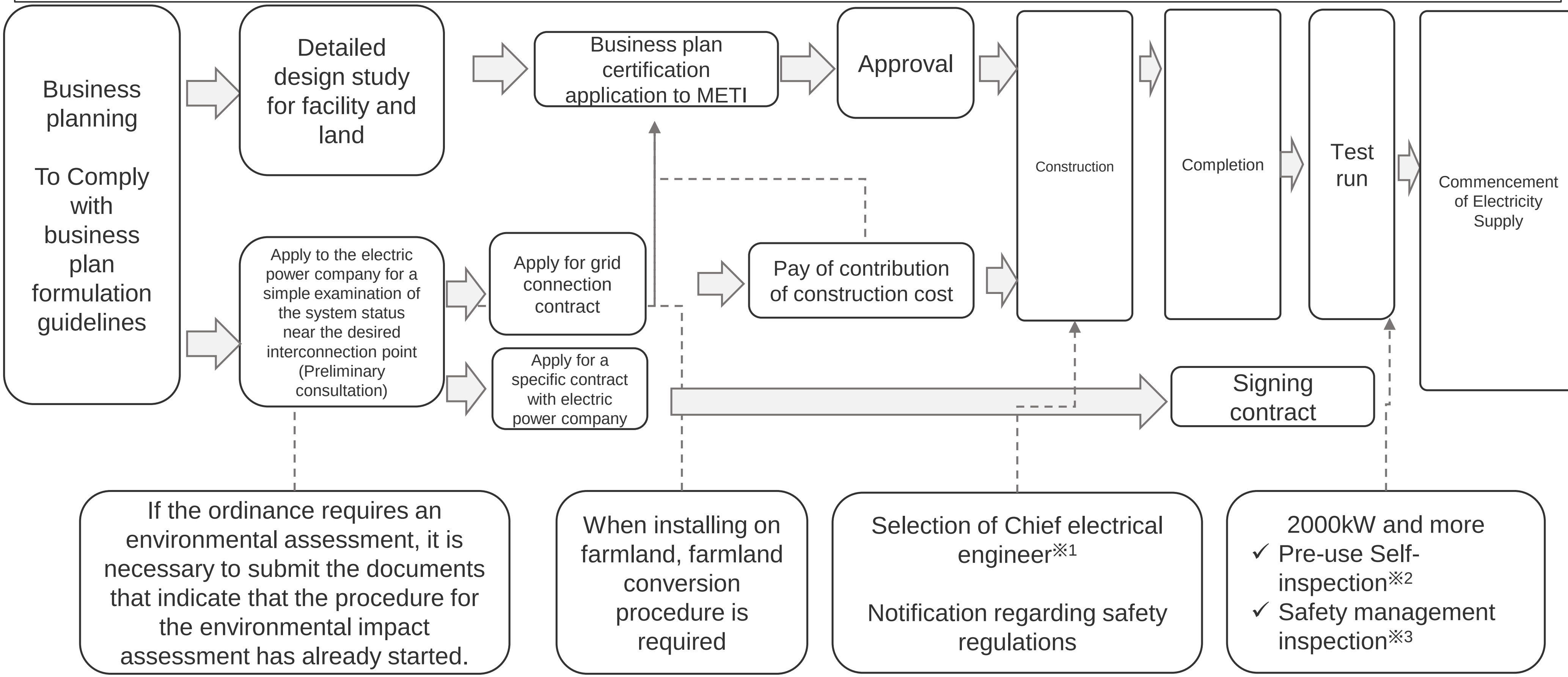
There are many tasks and procedures involved in business plan approval from the government, including the grid connection contract with electric power company.



Source: Agency for Natural Resource and Energy

FIT Approval Procedure for 50kW and more more 250kW: Competitive bidding

There are many restrictions and the procedure is more complicated compared to case of less than 50kW



※1: Security supervisor for construction, maintenance, operation, etc. related to electric facility

※2: Business operator voluntarily confirms the electric facilities for business use that have been submitted of the construction plan notification.

※3: Conducted by a METI-approved inspection body within one month after the completion of Pre-use Self-inspection

Source: Agency for Natural Resource and Energy

Business Plan Formulation Guideline

- "**Obligation matters**" and "**recommendation matters**" are described.
- If the obligation matters are violated, improvement orders or cancellation of certified FIT tariff may be taken.
- If the recommendation matters are ignored, administrative guidance from government or other authorities may be taken.

Obligation	Recommendation
■ To explain business plan to local government and to confirm relevant laws and regulations. ■ To install sign with information such as the name of power generation company, the name of the person in charge of maintenance, and their contact. ■ To install fence to keep out outsiders. ■ To establish O&M plan ■ To dispose of the power generation facilities as soon as possible after the end of the project.	□ To promote appropriate communication with local residents through a seminar. □ To take appropriate measures so that the operating noise from facilities does not affect the local residents and the surrounding environment. □ To operate and maintain with reference to the guideline created by non-government organizations □ To continue the project as much as possible, even after FIT period ends.

Source: Agency for Natural Resource and Energy

Condition of FIT Approval

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To obtain certification, generation plan must meet all of the following criteria:

Items	Note
Land Acquisition	Being recognized as having ownership or the right to use or being able to obtain them for sure
No dividing project into small ones	Do not install multiple VRE power generation projects in the same place (Supplementary explanation) To avoid problems such as avoiding safety regulations by changing high-voltage equipment with low-voltage equipment and increasing management cost of electric power companies.
Facility fixed	Power generation facility has been decided
Consent acquisition on grid connection	Consent to connect to the electric line of the electric power company
Operation and Maintenance	To establish the necessary implementation organization for proper O&M
Disposal of equipment	Appropriate plan for handling generation facilities when finishing power generation
Compliance with relevant laws and regulations	To comply with the provisions of relevant laws and regulations (including ordinances)

If you violate these compliance items stipulated in the certification conditions, it will be considered as non-conformity with the certification criteria, and measures such as guidance/advice, improvement orders, and cancellation of certification will be taken.

Source: Agency for Natural Resource and Energy

Public Announcement of Certified Business Plan

CHUBU Electric Power
NIPPON KOEI

Anyone can see the certified business plan on Web site of Agency for Natural Resource and Energy in METI (except for solar PV less than 20kW)

① ID of VRE power plant
② Owner company name of VRE power plant
③ Address, contact and representative of owner company
④ Power source
⑤ Output (kW)

⑥ Address of VRE facilities
⑦ Total of solar module output (kW)
⑧ Date the business plan was certified
⑨ Status of securing disposal cost
(reporting is mandatory from April of 2018)

① 設備ID	② 発電事業者名	③ 代表者名	③ 事業者の住所	③ 事業者の電話番号	④ 発電設備区分
AH78322C22	中部電力株式会社	林　欣吾	愛知県名古屋市東区東新町1	052-973-2717	太陽光

Chubu Electric Power Company

Solar

⑤ 発電出力(kW)	⑥ 発電設備の所在地 代表住所	⑦ 太陽電池の合計出力(kW)	⑧ 新規認定日	⑨ 廃棄費用の積立状況
8,000.0	静岡県静岡市清水区三保字乾尻3797－68	10,448.8	2017年2月28日	–

February 28th, 2017

Source: Agency for Natural Resource and Energy

Operation Start Deadline

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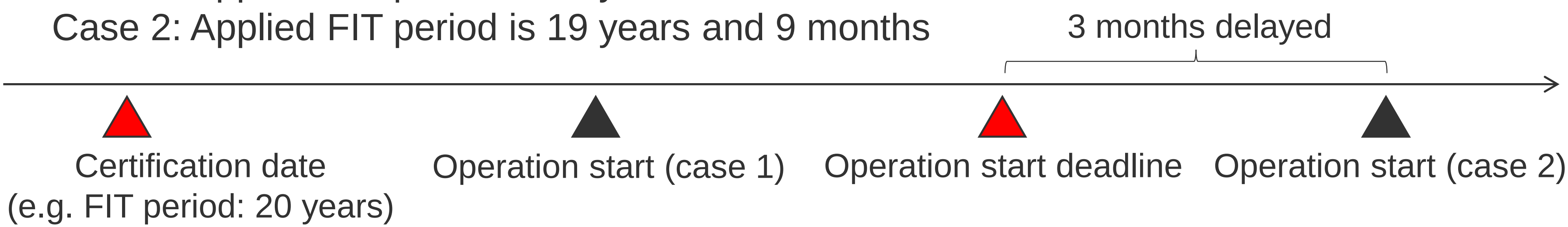
- Operation start deadline is set for each VRE according to the characteristics of each VRE.
- If the operation start is exceeded from the following, the period that certified FIT tariff is applied will be shortened on a monthly basis by the excess period.

  Case 1: Applied FIT period is 20 years

  Case 2: Applied FIT period is 19 years and 9 months



Solar PV	3 years (5 years*) - Less than 10kW: certification is cancelled if operation is not started within 1 year
Wind power	4 years (8 years*)
Small hydropower (less than 1MW)	7 years
Geothermal	4 years (8 years*)
Biomass	4 years

* Environmental assessment is conducted based on the Environmental Impact Assessment Law at the time of application for certification

Source: Agency for Natural Resource and Energy

JICA

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இலங்கை மின்சார சபை
CEYLON ELECTRICITY BOARD

CHUBU
Electric Power

NIPPON KOEI

Approval Process for On-grid Variable Renewable Energy Project Development

August, 2021

Sri Lanka Sustainable Energy Authority
Ceylon Electricity Board
Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

Project Purpose and Expected Outputs

Project Purpose

Institutional capacity for improving transmission and distribution operational reliability is enhanced to get prepared for increased share of renewable energy planned in the LTGEP (Long Term Generation Expansion Plan)

Expected Outputs of the Project

1. Capacity of corporate strategy and planning for variable renewable energy (VRE) is enhanced (WG1 activities)
2. Capacity of system development and operation for transmission network in response to increased share of VRE is enhanced (WG2 activities)
3. Capacity of distribution network operation is improved (WG3 activities)

Image of how to proceed with Approval Process Review

CHUBU Electric Power
NIPPON KOEI

① JICA Expert Team confirms to SEA about our understanding and concern for SEA guideline

② JICA Expert Team will prepare a questionnaire based on today's discussion and send it to SEA

③ JICA Expert Team will introduce the approval process in Japan

- ✓ Approval process in Ministry of Economy, Trade and Industry
- ✓ Investigation flow in Chubu Electric Power Company

④ JICA Expert Team would like to prepare a proposal document with SEA and make a presentation at the system and policy seminar. Proposal image is as follows;

- ➢ Difference between Sri Lanka and Japan is ~.
- ➢ Bottleneck in Sri Lanka is ~.
- ➢ Japan study that can be reflected in case of Sri Lanka is ~.

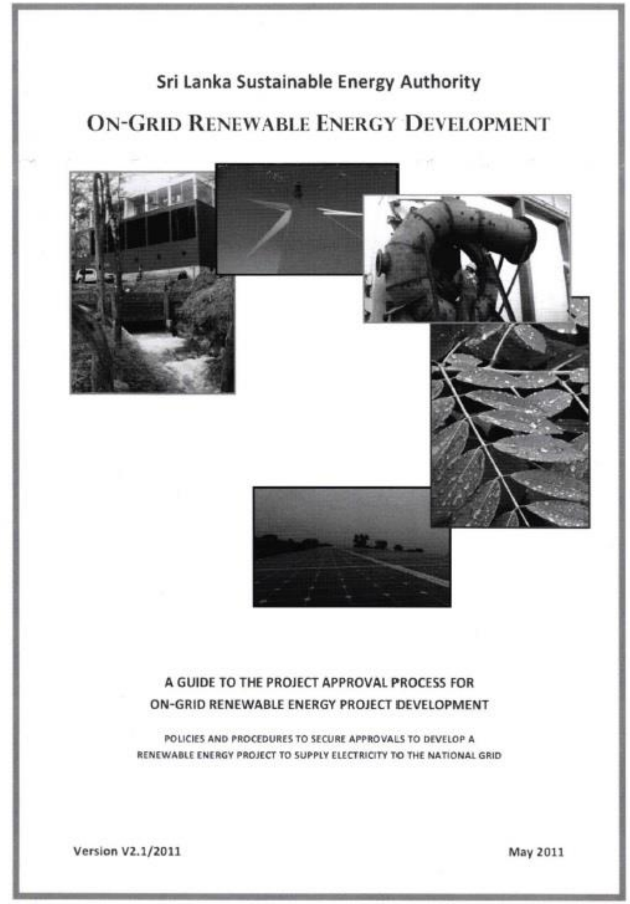
To shorten time until approval

- Existing guideline will be revised
- XXXX shall be improved
- YYYY process shall be added to approval process in SEA guideline
- ZZZZ shall be stipulated in SEA guideline

Current Approval Process for On-grid VRE Project Development in Sri Lanka

SEA Guideline

- SEA guideline was published in **<u>May 2011</u>**.
- Guideline published in May 2011 is latest version.
- The guideline explains the process and procedures to be followed by parties intending to develop on-grid RE projects of **<u>all types and capacities</u>**.
- **<u>Any person (an individual or a company) can apply</u>** for a VRE project, irrespective of whether the person holds any rights to the resource or land rights.
- Application is basically proceeded based on first come first served. However, in case of solar PV and wind power, only selected applicants under CEB tendering process can apply to SEA.
- The above procedure is not stipulated in existing SEA guideline and SEA is considering to revise the guideline.


Sri Lanka Sustainable Energy Authority

ON-GRID RENEWABLE ENERGY DEVELOPMENT

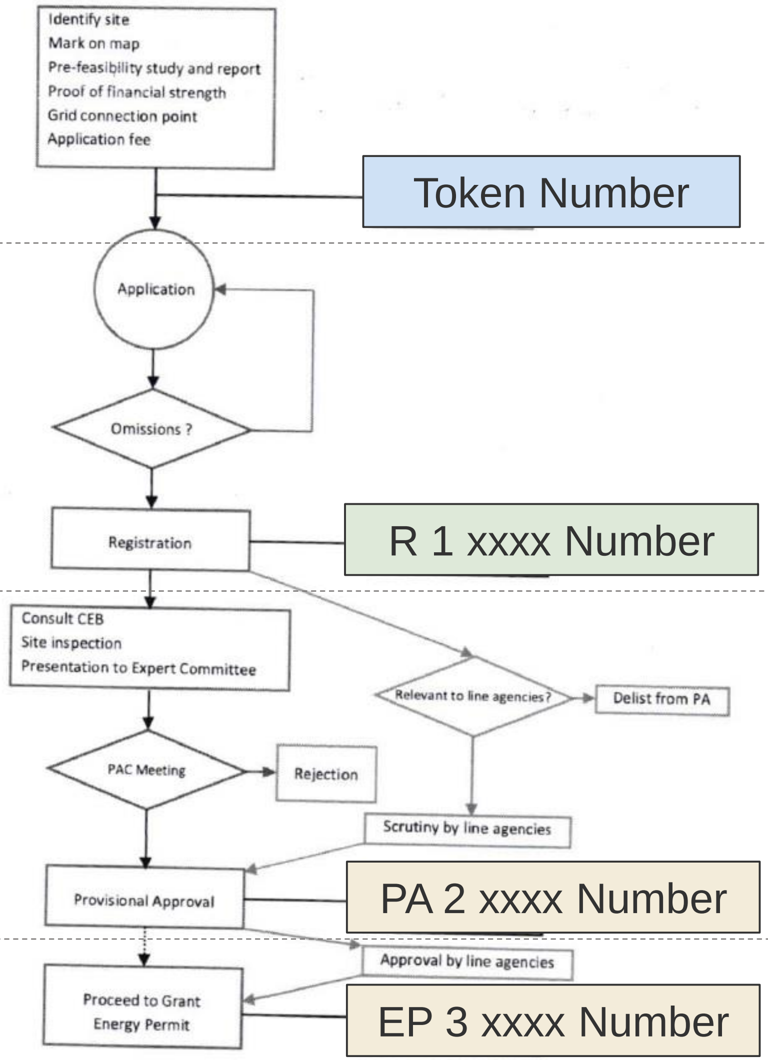
A GUIDE TO THE PROJECT APPROVAL PROCESS FOR ON-GRID RENEWABLE ENERGY PROJECT DEVELOPMENT

POLICIES AND PROCEDURES TO SECURE APPROVALS TO DEVELOP A RENEWABLE ENERGY PROJECT TO SUPPLY ELECTRICITY TO THE NATIONAL GRID

Version V2.1/2011

May 2011

New Application Flowchart



To resolve conflicts for the same resource site at the same time, SEA provides an **Electronic Token**.

Registration number (R 1 xxxx x) will be issued to the applicant who submit complete application forms.

Provisional Approval number (PA 2 xxxx x) will be issued to the applicant.

Energy Permit number (EP 3 xxxx x) will be issued to the applicant.

New Application Flowchart -Electronic Token-

< Flowchart >

Identify site
Mark on map
Pre-feasibility study and report
Proof of financial strength
Grid connection point
Application fee

↓ → Token Number

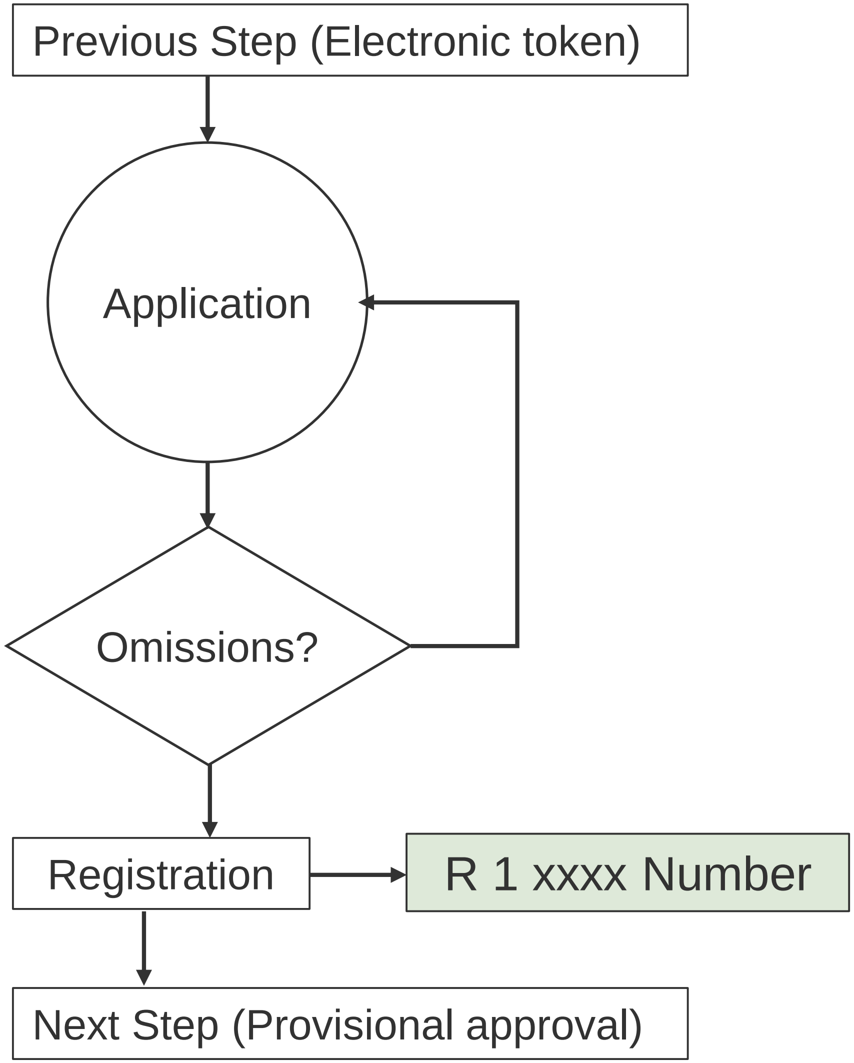
Next Step (Registration number)

- To resolve conflicts arising out of two or more applicants applying for the same resource site at the same time, SEA provides an **Electronic Token** at SEA office.
- A complete application form will have to be made after payment of the application fee to SEA.

Amount of power proposed to be generated	Fee to be paid on application and re-application
1,000kW or part thereof	100,000 LKR
Each additional 1,000kW	50,000 LKR payable on pro rata basis

New Application Flowchart -Registration-

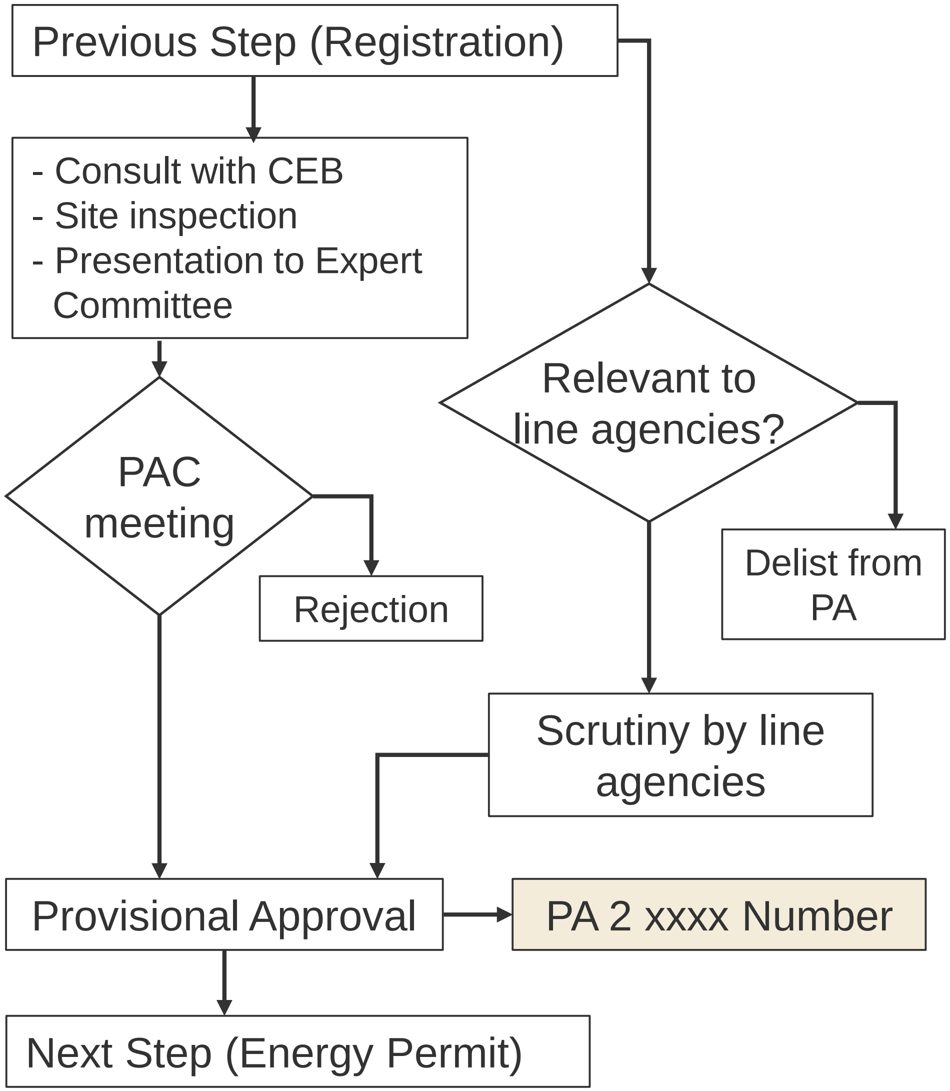
< Flowchart >



- **Registration number** (R 1 xxxx x) will be issued to the applicant who submit complete application forms.
- Registration number will be marked on the receipt issued in acceptance of the application fee.
- Any application, after an initial inspection having obvious omissions will be returned unregistered to the applicant, requesting the attention to the said omissions.
  The applicants who fail to submit complete application forms runs the risk of another party applying for the same resource site.

New Application Flowchart -Provisional Approval-

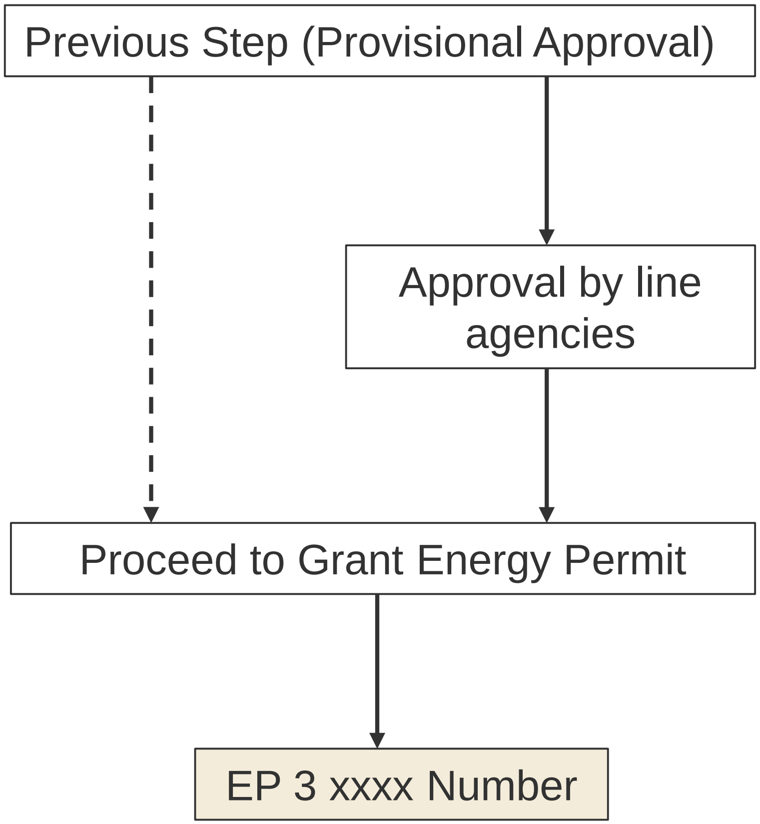
< Flowchart >



- **<u>Provisional Approval number</u>** (PA 2 xxxx x) will be issued to the applicant.
- Based on the information provided in the pre-feasibility report, all applications received by SEA, will be evaluated to ascertain the possibility of securing grid connection, in consultation with CEB.
- All line agencies will be prompted to indicate the relevance of their approval for proposed projects at the meeting of Project Approving Committee (PAC) after receipt of an application.
- This procedure will take about one (1) month.
- Expiry of PA is one (1) year.

New Application Flowchart -Energy Permit-

< Flowchart >



- **<u>Energy Permit</u>** (EP 3 xxxx x) will be issued to the applicant.
- <u>Energy Permit is valid for a period of 20 years</u> from the date of commercial operation of the project. (20 years includes construction period. If construction period exceed, EP can be extended by SEA board based on recommendation from Advisory Committee appointed by the Minister (state Minister) (one member from CEB))
- Once issued with an Energy Permit, the status of the Applicants is changed to that of a Developer, a person having permission to develop an VRE project.
- A period of 20 years is allowed to the Developer for construction, from the date of the Energy Permit.

02 Issues to be tackled under Current Situation

Issues to be tackled under Current Situation

CHUBU Electric Power
NIPPON KOEI

- Bottleneck in approval process is to take much time (e.g. there is the case that it takes maximum 24 months to get approval).

Considering construction period, it will take more than 24 months until commercial operation start. As a result, it may prevent investor to recover investment cost, and investor may hesitate VRE development. In other words, it may slow down VRE installation in Sri Lanka.

- There is wide range of project approving authorities that the project developers have to visit. The project developer needs to secure approval from each and every institution prior to the obtaining of energy permit and generation license.
- SEA guideline does not mention how long time will be taken in each process

It is difficult for investor to make VRE development plan. Investor may hesitate VRE development. In Japan, investigation of connection to grid by electric power company is stipulated in Ministry guideline, it helps investor to make VRE development plan.

Basic period until approval shall be clarified in a guideline to be revised.

jica

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Sri Lanka Sustainable Energy Authority

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இலங்கை மின்சார சபை
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Electric Power

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Approval Process for on-grid VRE Project Development
WG1
Japanese Approval Process in VRE

September 30th, 2021

INDEX

1. Process from Application to Permission

Organization Chart [Ministries and Agencies]

The Cabinet

- The Ministry of Agriculture, Forestry and Fisheries
  - The Forestry Agency
  - The Fishery Agency
- The Ministry of Economy, Trade and Industry
  - The Department of Economy, Trade and Industry
  - The Agency for Natural Resources and Energy

METI: The Ministry of economy, trade and industry
DETI: The Department of economy, trade and industry

Outline of the Whole Approval process

Power company
Applicant
DETI

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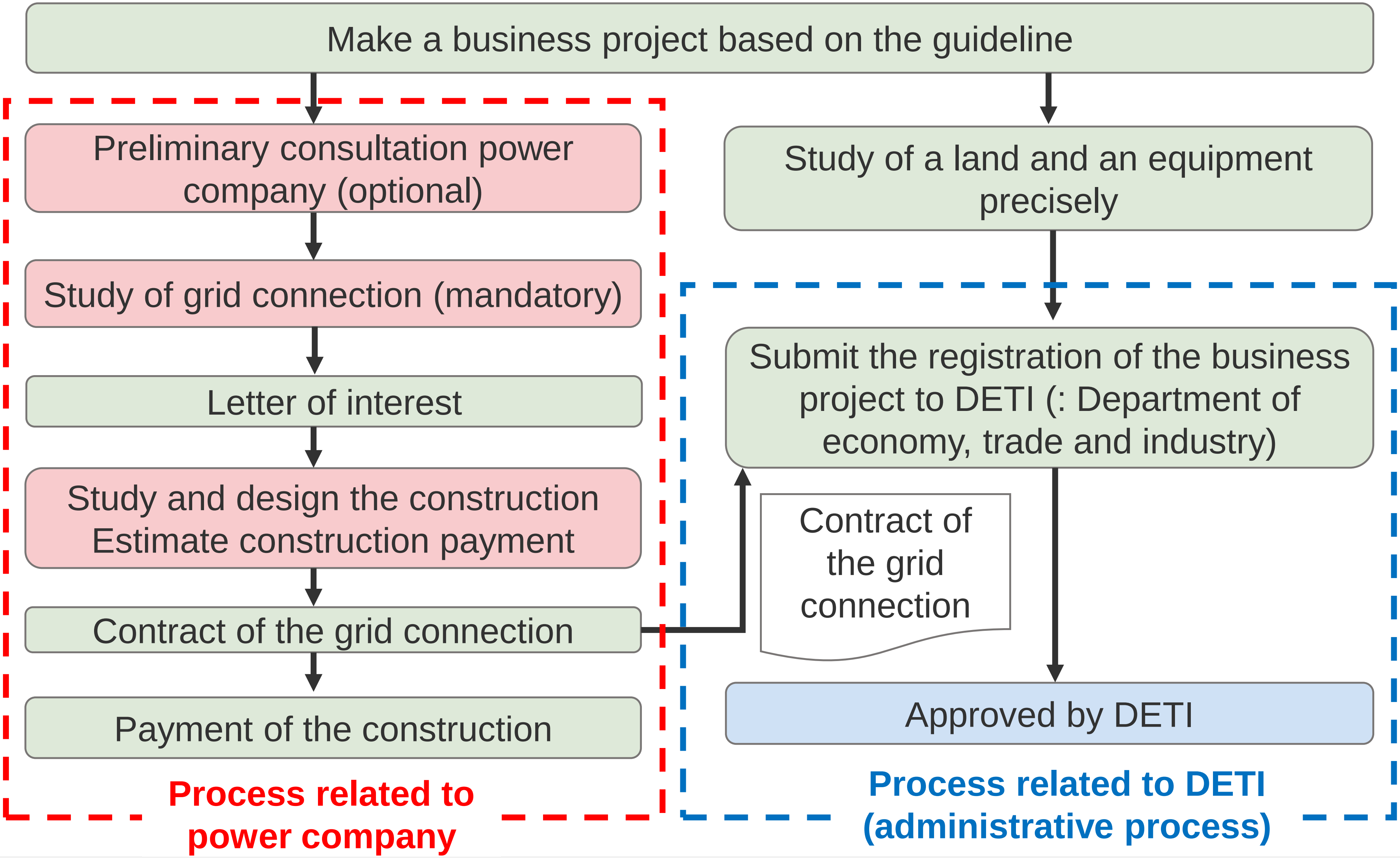


Outline of the Process Related to DETI

Read the guideline and make the business project

Guideline is ranging from planning to operation. Regional comprehension and related laws are included. The guideline is revised every year.

Register the electronic application

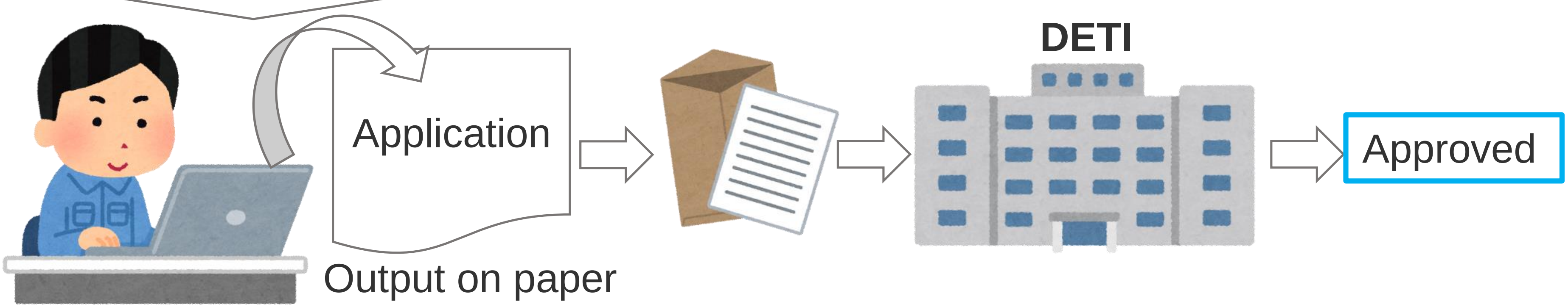
Electronic application: register information of applicants and certification application. There are detailed manuals.

Output the application to paper and send it to DETI

Submit the application downloaded by the electronic application to DETI (: Department of economy, trade and industry)

Obtain the permission

If there are no faults, the application is permitted within **3 months**.



Guidelines of Renewable Energy Development

There exist guidelines of renewable energy development on the Web: PV, Wind, Hydro, Geothermal, Biomass.

Business plan development guideline (PV)

Month of revision :Revised every year

The Agency for Natural Resource and Energy

事業計画策定ガイドライン
（太陽光発電）

２０１７年３月策定
２０１８年４月改訂
２０１９年４月改訂
２０２０年４月改訂
２０２１年４月改訂

資源エネルギー庁

Source: The Agency for Natural Resource and Energy HP

Guidelines of Renewable Energy Development

CHUBU Electric Power
NIPPON KOEI

The related laws list in the guidelines

Law

Procedure profile

Jurisdiction

付録

1. 主な関係法令リスト

付表1 太陽光発電事業に係る主な土地関係法令

法令	手続	所管
海岸法	海岸保全区域等の占用許可等	国土交通省 農林水産省
河川法	河川区域占用許可手続 河川区域内工作物設置許可手続 河川区域内掘削許可手続	国土交通省
環境影響評価法	環境影響評価手続	環境省 経済産業省
急傾斜地の崩壊による災害の防止に関する法律	急傾斜地崩壊危険区域内の行為許可	国土交通省
景観法	景観法に基づく届出手続	国土交通省
港湾法	臨港地区内における行為の届出 港湾区域内の水域又は港湾隣接地域における占用の許可	国土交通省
国土利用計画法	土地売買届出手続	国土交通省
砂防法	砂防指定地内行為許可手続	国土交通省
地すべり等防止法	地すべり防止区域の開発前許可申請手続	国土交通省
自然環境保全法	自然環境保全地域内での開発許可申請手続等	環境省
自然公園法	工作物新築許可申請手続等	環境省
消防法	危険物取扱所設置等許可届手続	総務省
振動規制法	特定施設設置届出手続	環境省
森林法	林地開発許可等手続 伐採及び伐採後の造林の届出手続	農林水産省
絶滅のおそれがある野生動植物の種の保存に関する法律	国内希少野生動植物種の捕獲等の許可手続 生息地等保護区の管理地区内等における行為許可等手続	環境省
騒音規制法	特定施設設置届出手続	環境省
宅地造成等規制法	宅地造成に関する工事の許可申請手続	国土交通省
鳥獣の保護及び管理並びに狩猟の適正化に関する法律	特別保護地区内における行為許可手続	環境省

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Source: The Agency for Natural Resource and Energy HP

2. Laws and Related Ministry

Laws and Related Ministry (1)

Law	Ministry
Seaside	Land / Agriculture, forestry and fisheries
River	Land
Environmental effect	Environment
Slope collapse prevention	Economy, trade and industry
Scenery	Land
Coast	Land
Use of Country land	Land
Sand control	Land
Land slide prevention	Land
Environmental preservation	Environment
Natural park	Environment
Fire protection	Public management, home affairs, posts and telecommunications
Vibration regulation	Environment

Laws and Related Ministry (2)

Law	Ministry
<u>Forest</u>	**<u>Agriculture, forestry and fisheries</u>**
Endangered species protection	Environment
Noise regulation	Environment
Building regulation	Land
Beasts and birds protection	Environment
Road	Land
City planning	Land
Soil contamination provision	Environment
Agricultural promotion	Agriculture, forestry and fisheries
Farmland	Agriculture, forestry and fisheries
Waste disposal and cleaning	Environment
Cultural resource	Education, culture, sports, science and technology

Outline of the Related Laws

The image of the related laws would be efficient for understanding

Action Category Process and period by the scale of area

Inquiry

Law

Link reference

太陽光発電の導入・設置に係る主な関係法規・手続き等～(1)立地・土地利用関連

※出力容量当りの土地面積を、1kW当り20m2(500kW当り1ha)とし

土地・開発区域等の面積 ／ (太陽光発電システム出力容量の目安※): 0m2～(0kW) | 300m2～(15kW) | 1,000m2～(50kW) | 2,000m2～(100kW) | 3,000m2～(150kW) | 5,000m2～(250kW) | 1ha～(500kW) | 4ha～(2.0MW) | 5ha～(2.5MW) | 50ha～(25MW) | 100ha～(50MW)

1-1) 立地・土地利用全般

関係法令 【主なリンク先】土地利用ハンドブック(福島県HP)	主な行為・状態	地域・区域・区分・範囲		土地・開発区域等の面積 ／ (太陽光発電システム出力容量の目安※)	問合せ先 (提出先)	(参考資料) 【リンク先】
国土利用計画法	土地取引 (土地売買、使用貸借権設定等)	注視区域・監視区域 注1)	市街化区域	2,000m2以上	(県)地方振興局 企画商工課 地域づくり・商工労政課	国土利用計画法 [総務省ポータルサイト]
			都市計画区域(上記を除く)	5,000m2以上 届出[契約日の6週間前]		
			その他の区域	1ha以上		
		注視区域・監視区域外	市街化区域	2,000m2以上		
			都市計画区域(上記を除く)	5,000m2以上 届出(事後)[契約日から2週間以内]		
			その他の区域	1ha以上		
福島県大規模土地利用事前指導要領	大規模な土地利用・開発行為 (土地の形質変更等)	農転許可を要する農地を含む場合		4ha超 事前協議書 [処理期間：12週間程度]	(県)地方振興局 企画商工課 地域づくり・商工労政課	福島市都市計画法の開発許可事務の処理に関する要領(福島市)[PDF]
		その他の場合		5ha以上		
都市計画法	開発行為(主として建築物の建築、特定工作物の建設等を目的とする開発行為) ※太陽光発電設備は、原則「建築物」に該当しないので、開発許可は不要	線引き都市計画区域	市街化調整区域	許可[行為着手前]	(県)建設事務所 総務部行政課 (市町村) 開発許可担当課	開発許可制度について(福島県HP)
			市街化区域	1,000m2以上		
		非線引都市計画区域・準都市計画区域 注2)		3,000m2以上		開発許可制度の手引(福島県HP)
		その他の区域		1ha以上		
農業振興地域の整備に関する法律 <農振法>	農用地区域からの除外 (農地転用の用途等)	農用地区域内の農地		申出[行為着手前]	(県)農林事務所 企画部 指導調整課 (市町村)農振法担当課	
農地法	農地転用 (農地の転用目的での権利移動等)	市街化区域内の農地		届出[処理期間：40日間以内]	(県)農林事務所 企画部 指導調整課 (市町村) 農業委員会	農地法関係事務処理の手引(福島県HP) 農地転用等の制限(福島県)[PDF] 支柱を立てて営農を継続する太陽光発電設備等についての農地転用許可制度の取扱いについて(農水省HP) 営農型発電設備の農地転用について(福島県HP)
		市街化区域外	第3種農地	許可[処理期間：40日間以内]		
			第2種農地	許可(条件付)[処理期間：40日間以内]		
			第1種農地/甲種農地/農用地区域内農地	《原則、不許可》		
	農地一時転用(ソーラーシェアリング：農地に支柱を立てて、営農を継続しながら設備設置)		第1種農地/甲種農地/農用地区域内農地	許可(一時転用) ※転用期間3年(3年毎の更新必要)		
森林法(保安林)	開発行為(土石・樹根の採掘、開墾等の土地形質変更)	保安林		《原則、不許可》	(県)農林事務所 森林林業部 森林土木課	民有保安林の状況(福島県)[PDF] 林地開発許可制度の案施(福島県HP)
	保安林の指定解除(森林以外の用途に転用)			解除申請[行為着手前]		
森林法(地域森林計画の対象民有林)	開発行為(土石・樹根の採掘、開墾等の土地形質変更)	地域森林計画の対象民有林 (保安林を除く) ※「国有林/保安林」以外のほとんどの森林が該当		1ha超 許可[処理期間：40日間以内]		伐採及び伐採後の造林の届出制度(林野庁)[PDF]
	木竹の伐採等			届出[行為着手30日前]	(市町村) 林務担当課	

注1)現在、福島県内で「注視区域・監視区域」の指定はない

注2)現在、福島県内で「準都市計画区域」の指定はない

＊4ha超 ⇒ 大臣許可　＊4ha以下 ⇒ 知事許可
＊郡山市/白河市/相馬市/大玉村の2ha以下 ⇒ 各市村の農業委員会許可

Source: Fukushima renewable energy promotion center general corporate juridical person

3. Forest Law

Reserved Forest

■ Purpose

- Water yield, sand control, preservation of wind and flood damage etc.

■ Authority

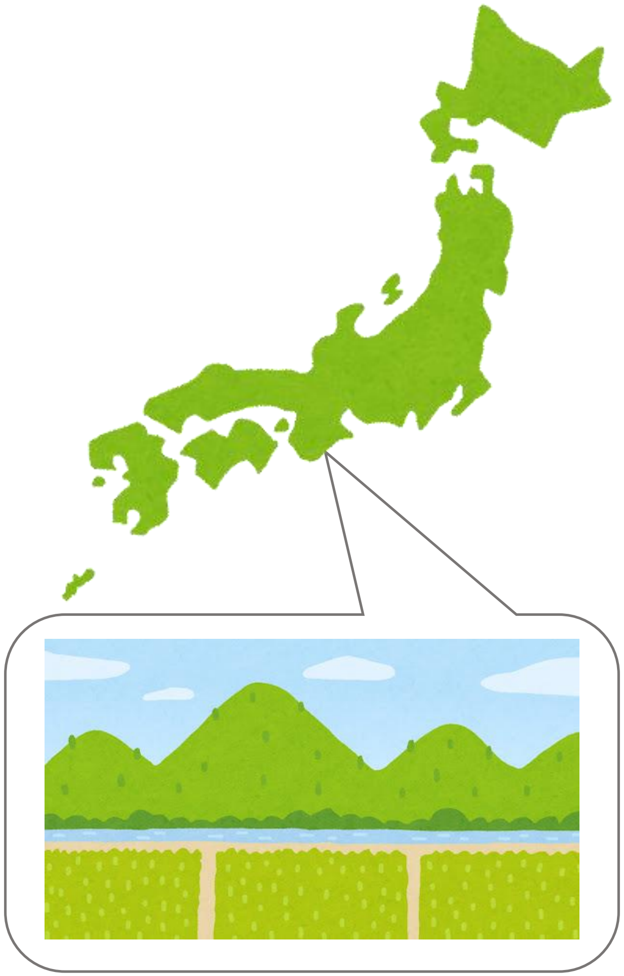
- Designated by the Ministry of Agriculture, Forestry and Fisheries
- Based on forest low

■ Properties

- As many as 17 kinds: water yield accounts for most of the area
- 50% of the whole forest area in Japan
- 30% of the whole land area in Japan

cf. Forests account for 70% of the whole land area in Japan

About Forest in Japan



70% of the land area is forest

Forest category

Reserved Forest [50%]

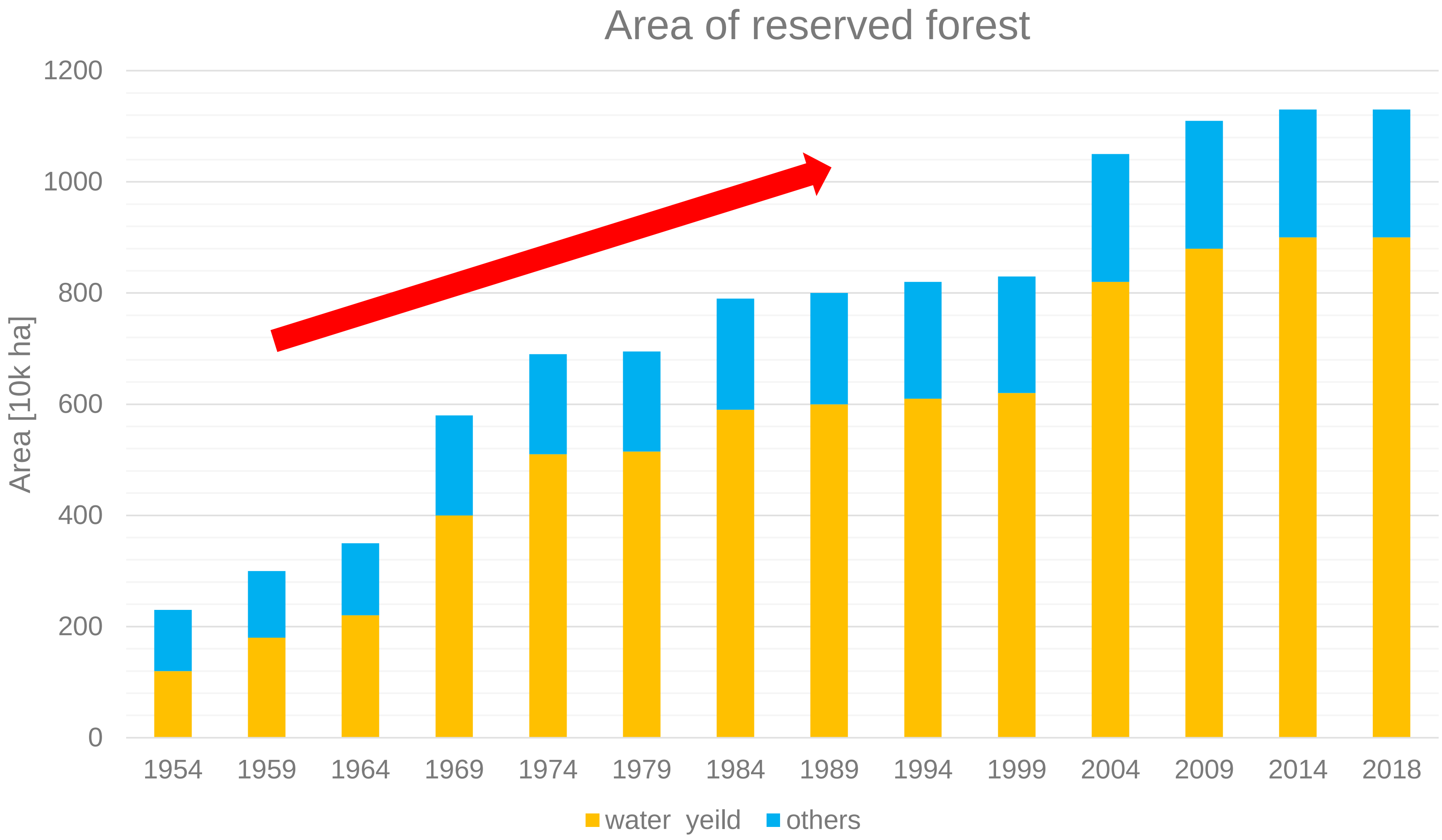
Planning possible forest (Forest where development could be potentially permitted)

The national forest [30%]

Private forest [70%]

Source: The Forestry Agency HP

Forest Law



Source: The Forestry Agency HP (https://www.rinya.maff.go.jp/j/tisan/tisan/con_2_2_2.html)

Approval Procedure

The institution of preservation of forests

- **Reserved** forest
  - Regulation of cutting and change of the landform
- Forest **development** permission
  - Regulation of the development

Reserved forest	**The others**
Cancellation application of the designation (Authorized by the Minister or the Governor of a prefecture)	Over 1ha: Forest development permission (Authorized by the Governor of a prefecture)
Work permission in the area (Authorized by the Governor of a prefecture)	Within 1ha: Cutting forest notification to (Authorized by the chief of municipality)

Source: The Forestry Agency HP

Approval Procedure

CHUBU Electric Power
NIPPON KOEI

Development in reserved forests is basically not permitted, so the cancellation of the reserved forest designation is needed for the development

Time-consuming

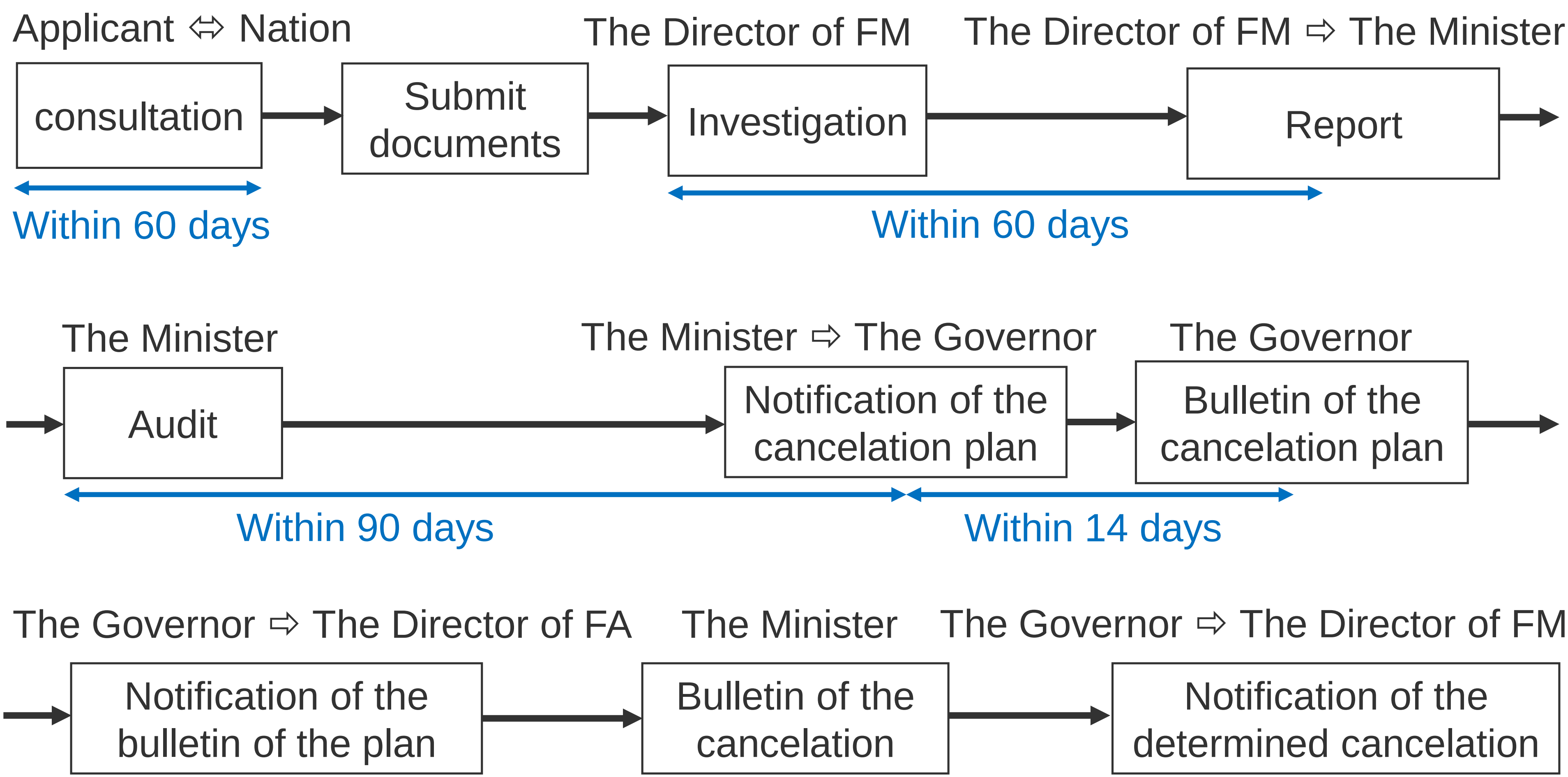
Reserved forest	The others
Cancellation application of the designation (Authorized by the Minister or the Governor of a prefecture)	Over 1ha: Forest development permission (Authorized by the Governor of a prefecture)
Work permission in the area (Authorized by the Governor of a prefecture)	Within 1ha: Cutting forest notification (Authorized by the chief of municipality)

Period of process: 40 days

Submit it 30days before the work

Source: The Forestry Agency HP

Outline of the Cancellation Process



The Minister	:	The Minister of Agriculture, Forestry and Fisheries
The Director of FM	:	The Director of the Forest Management
The Director of FA	:	The Director General of the Forest Agency
The Governor	:	The Prefectural Governor

Source: The Ministry of economy, trade and industry HP

4. Wrap Up

Wrap Up

- Approval process in VRE in Japan
  - Part of the process can be done on the web
- The guidelines
  - Revised every year
  - Laws are listed in the guidelines
- Related laws
  - There exists WEB page showing the summary of the laws: contents, procedure, period and reference
- Forest law
  - Refer the forest law to give an example of the related laws
  - In the process of the development, it takes much time when the ministers are related, such as cancellation process of the reserved forest

4. Inquiry / Future Plan

Inquiry / Future Plan

Inquiry

- Please give us the ideas of the approval process which could be efficient for the applicants to make a business plan of VRE
- Please give us the actual documents of approval process in VRE
  - ➢Let's find out the process which could possible be shortened

Future plan

- Meeting on 8th Oct.
- JICA Experts activities in Sri Lanka
  - ➢1st group: between 18th Oct. and 29th Oct.
  - ➢2nd group: between 8th Nov. and 19th Nov.
- Please refer next page written in the minutes of meeting of 8th activity

Reconfirmation

Excerpt of the minutes of meeting 8 activity

- Study of Approval process for on-grid VRE project development
  - ✓ The CEB confirm the time required for various application processes with the installation of renewable energy and provide application documents. JICA Expert Team confirm the content and period of the application steps in Japan. By comparing between Sri Lanka's and Japanese steps, shortening of steps will be examined in following activity.
    - SEA will share the application documents and the required time of each steps with JICA Expert team by September 10th, 2021.
    - JICA Expert team will compare the application steps and documents in Sri Lanka with Japanese one's and find out time consuming steps. JICA Expert team will show SEA the steps that can be expected to be shortened by September 30th, 2021.
    - SEA will consider and share the issues when introducing the new ideas with JICA Expert team by October 10th, 2021.
    - JICA Expert team will reconsider the shortening the steps based on SEA confirmation and provide SEA the results of reconsideration by October 20th, 2021.
    - SEA will discuss the shortening the steps with JICA Expert team during the 9th field activity.

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இலங்கை நிலைபெறுதகு வலு அதிகாரசபை
Sri Lanka Sustainable Energy Authority

ලංකා විදුලිබල මණ්ඩලය
இலங்கை மின்சார சபை
CEYLON ELECTRICITY BOARD

CHUBU
Electric Power

NIPPON KOEI

CHUBU Electric Power

NIPPON KOEI

Outline of Renewable Energy System

July 3, 2020

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

Characteristics of Renewable Energy

RE technology	Characteristics		Development volume (2008～2017) in Japan
	Advantage	Disadvantage	
Solar PV 	・No risk of fuel depletion ・No CO_2 during power generation	・The amount of generation depends on the weather ・Extensive land is required for installing panels (・high-cost power generation in Japan)	36,180MW
Wind 	・No risk of fuel depletion ・No CO_2 during power generation ・When the wind blows, it can generate 24 hours electricity	・The amount of electricity generated depends on the wind speed and the wind direction ・Noise problem to neighborhood due to sound generated from windmill (・high-cost power generation in Japan)	1,800MW

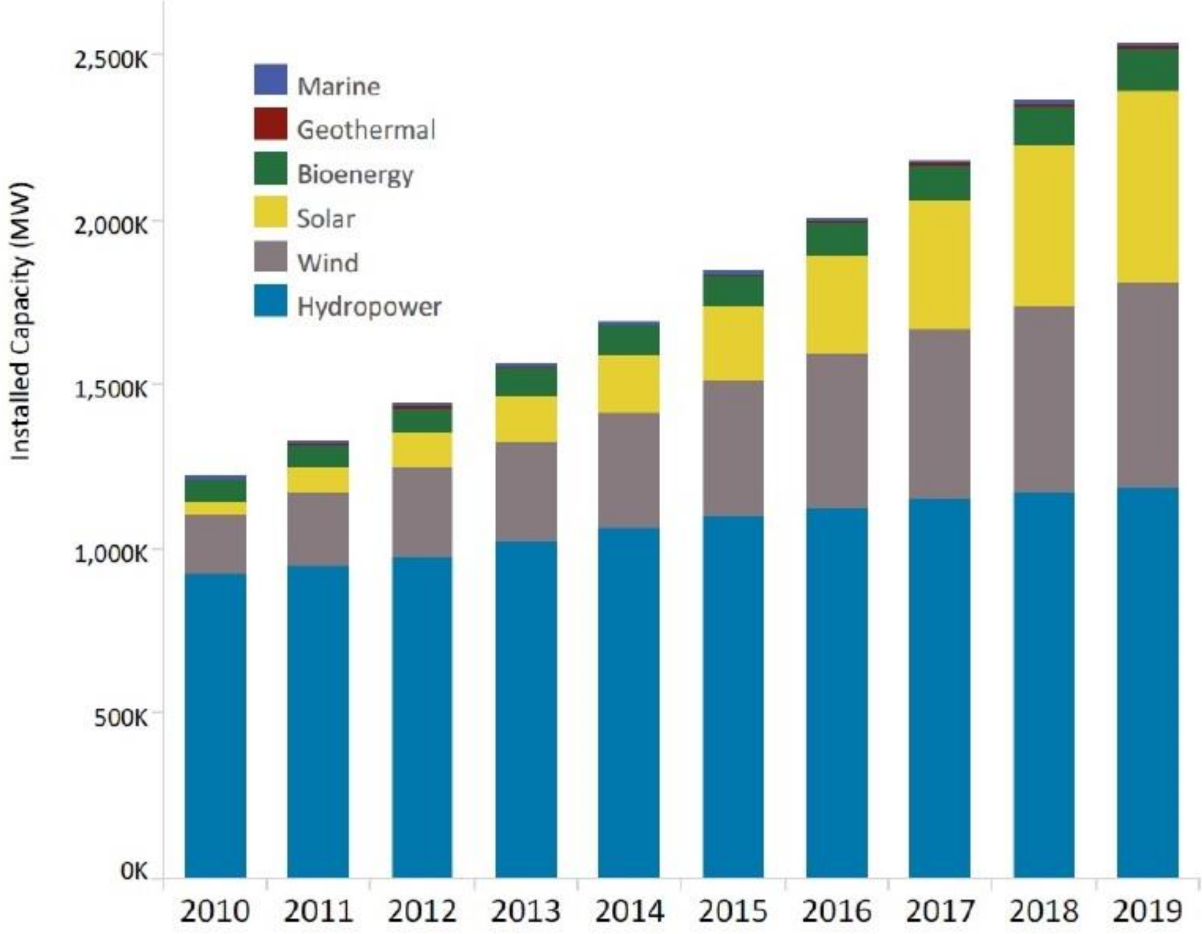
Since Sri Lanka has much potential for solar PV and onshore wind power, introduction of them will be accelerated as Master Plan report mentioned.

Characteristics of Renewable Energy

RE technology	Characteristics		Development volume (2008～2017) in Japan
	Advantage	Disadvantage	
Bioenergy 	・Stable power supply is possible regardless of climate and weather. ・It is possible to procure fuel (wood, waste etc.) in Japan.	・Costs for collection and storage of bioenergy resources. ・Concern of stable fuel supply	1,370MW
Geothermal 	・Stable power supply regardless of climate and weather. ・Abundant resources. （Japan is the third largest resource country in the world）	・high-cost power generation ・Development is not proceeding due to power system constraints, environmental considerations.	270MW
Small hydro power 	・Stable power supply ・No CO2 during power generation ・Capacity factor is high	・Amount of electricity generated depends on rainfall. ・In some country, most of the water sources are already developed.	17MW

Global Transition of Installation Capacity of RE

CHUBU Electric Power



Installed capacity in 2019 [GW]

Marine (wave)	0.5
Geothermal	14
Bioenergy	124
Solar	586
Onshore wind	595
Offshore wind	28
Hydropower	1,189
Total	2,537

Source: Renewable Capacity Statistics 2020, IRENA
Press Release on April 6, 2020, IRENA

- Installed capacity of RE in 2019 is 2,537 GW globally, which increased 7.5% from 2018
- Wind and Solar power accounted for 90% of the world's newly added RE capacity

Global Transition of Installation Capacity of RE

CHUBU Electric Power

Solar energy

Asia continued to dominate global solar capacity expansion with a 56 GW increase, but this was lower than in 2018. Other major increases were in the United States, Australia, Spain, Ukraine and Germany.

Wind energy

Wind performed particularly well in 2019, expanding by nearly 60 GW. China and the United States continued to dominate with increases of 26 GW and 9 GW respectively.

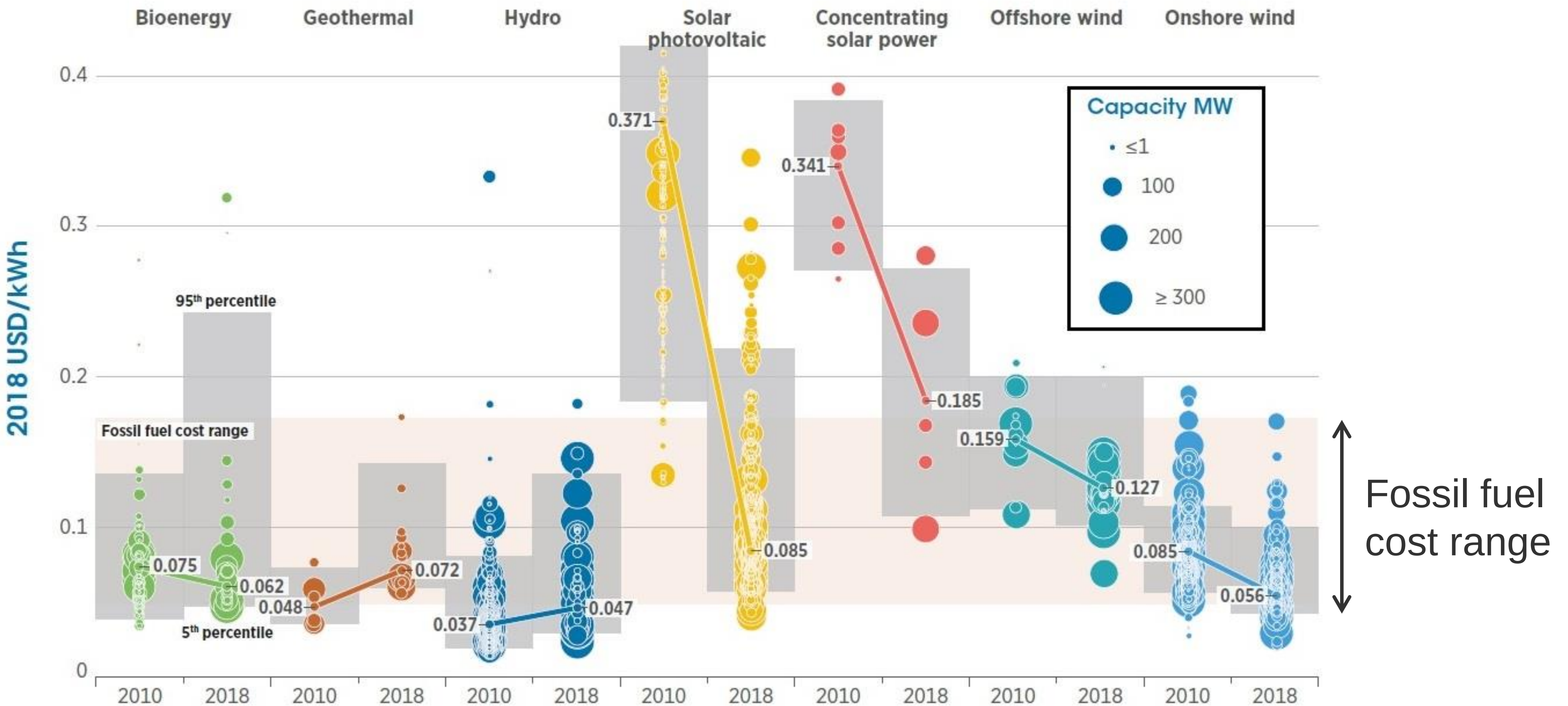
Hydropower

Growth was unusually low in 2019, possibly because some large projects missed their expected completion dates. China and Brazil accounted for most of the expansion, each adding more than 4 GW.

Bioenergy

Expansion of bioenergy capacity remained modest in 2019. China accounted for half of all new capacity (+3.3 GW). Germany, Italy, Japan and Turkey also saw expansion.

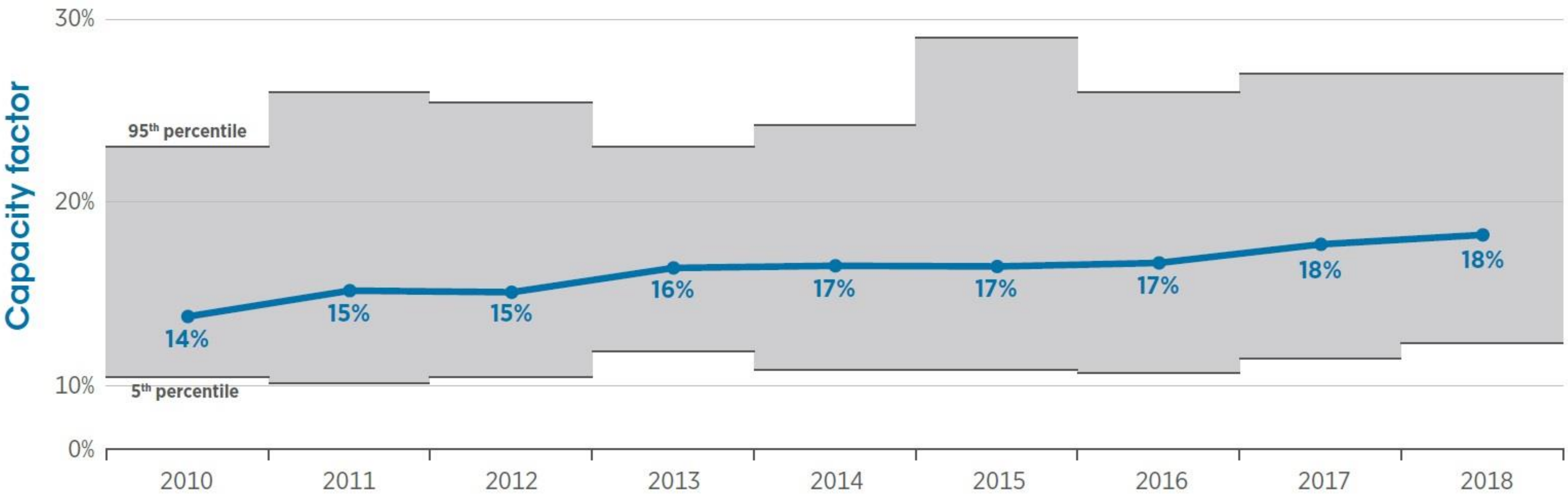
Levelized Cost of Electricity (LCOE) of Utility-scale RE Technologies 2010 - 2018



Source: Renewable Power Generation Costs in 2018, IRENA

- LCOE for solar power, wind power and bioenergy has been reduced from 2010 to 2018
- LCOE for almost RE technologies were at the lower-end of the fossil fuel cost range
- LCOE reduction has been mainly driven by improvement of capacity factor and competitive global supply chains

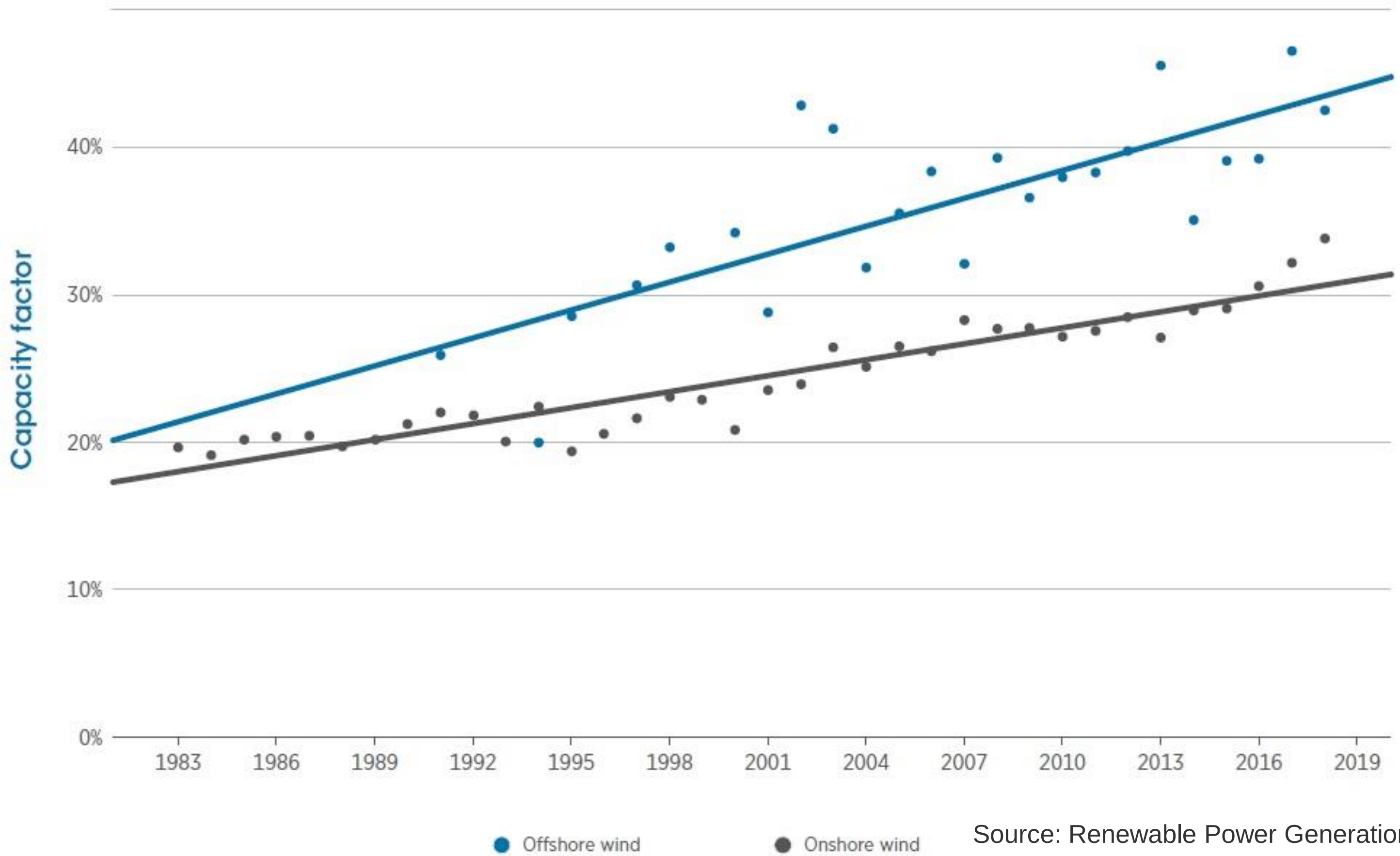
Capacity Factor for Utility-scale solar PV, 2010 - 2018



Source: Renewable Power Generation Costs in 2018, IRENA

The global capacity factor for new utility-scale solar PV, by year commissioned, has increased from 14% in 2010 to 18% in 2018 as the share of deployment in sunnier locations has risen.

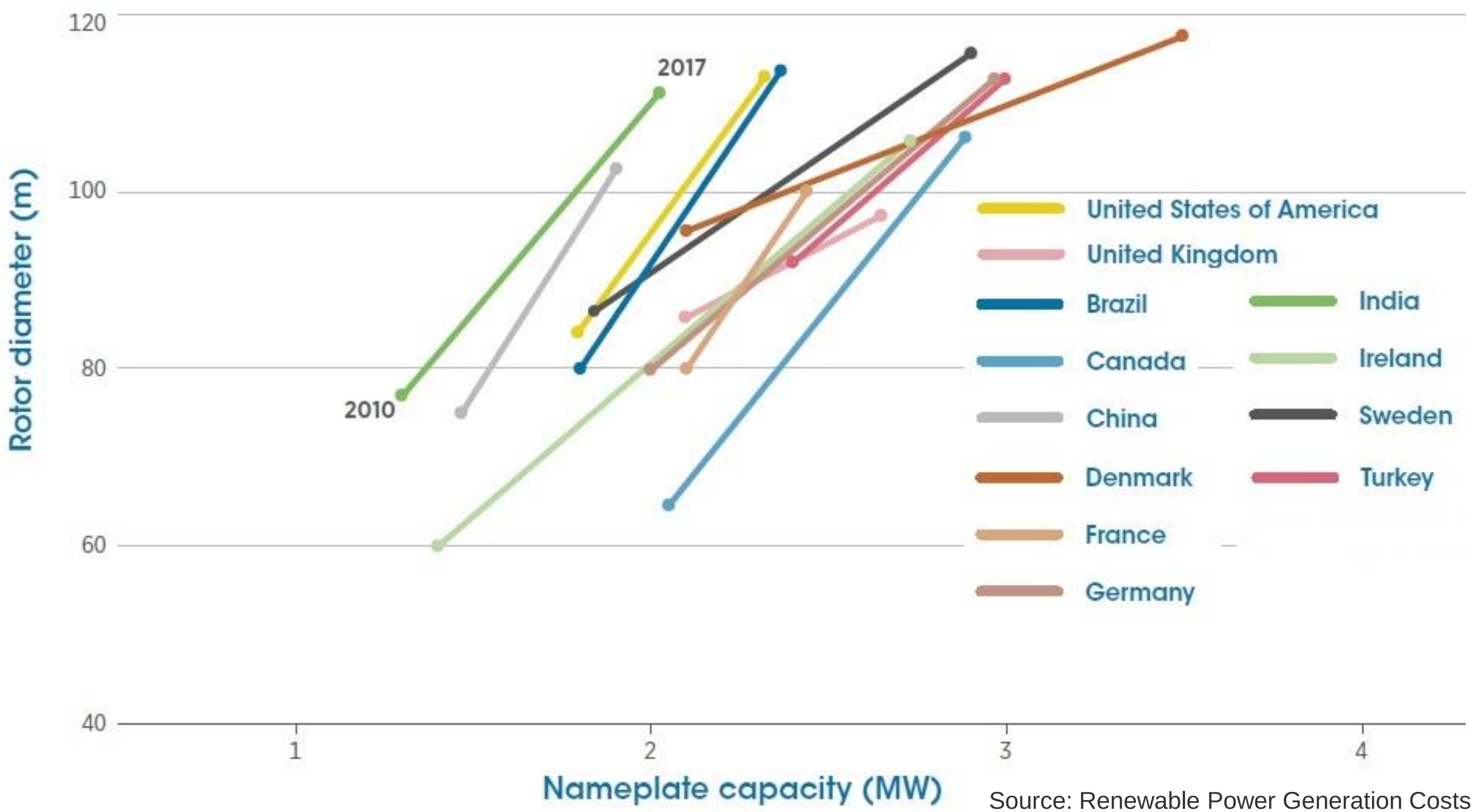
Capacity Factor for Onshore and Offshore Wind Power, 1983 - 2018



Source: Renewable Power Generation Costs in 2018, IRENA

Driven by technology improvements, capacity factors have improved substantially for onshore and offshore wind between 1983 and 2018. The capacity factor of new onshore wind projects increased from 20% in 1983 to 34% in 2018, and from 26% in 1991 to between 43% and 47% in 2018 and 2017 respectively for offshore wind.

Weighted Average Rotor Diameter and Nameplate Capacity Evolution, 2010 - 2018



Source: Renewable Power Generation Costs in 2018, IRENA

All major onshore wind markets have seen rapid growth in both rotor diameter and the capacity of turbines since 2010. Denmark had the largest turbines and rotor diameters on average in 2017. Average turbine capacity ranged from 1.9 MW to 3.5 MW, and rotor diameter from 97 to 118 m, by country.

World's Most Powerful Offshore Wind Turbine 12MW

GE Renewable Energy has revealed the first manufactured components of 12 MW offshore wind turbine at its production site in Saint-Nazaire, France.

Specification

Output	12 MW
Rotor diameter	220 m
Blade length	107 m
Total height	260 m
Capacity factor	63%

Source: GE website

It is expected that LCOE of offshore wind power will be reduced.

Thank you for your kind attention

以下、QA対応

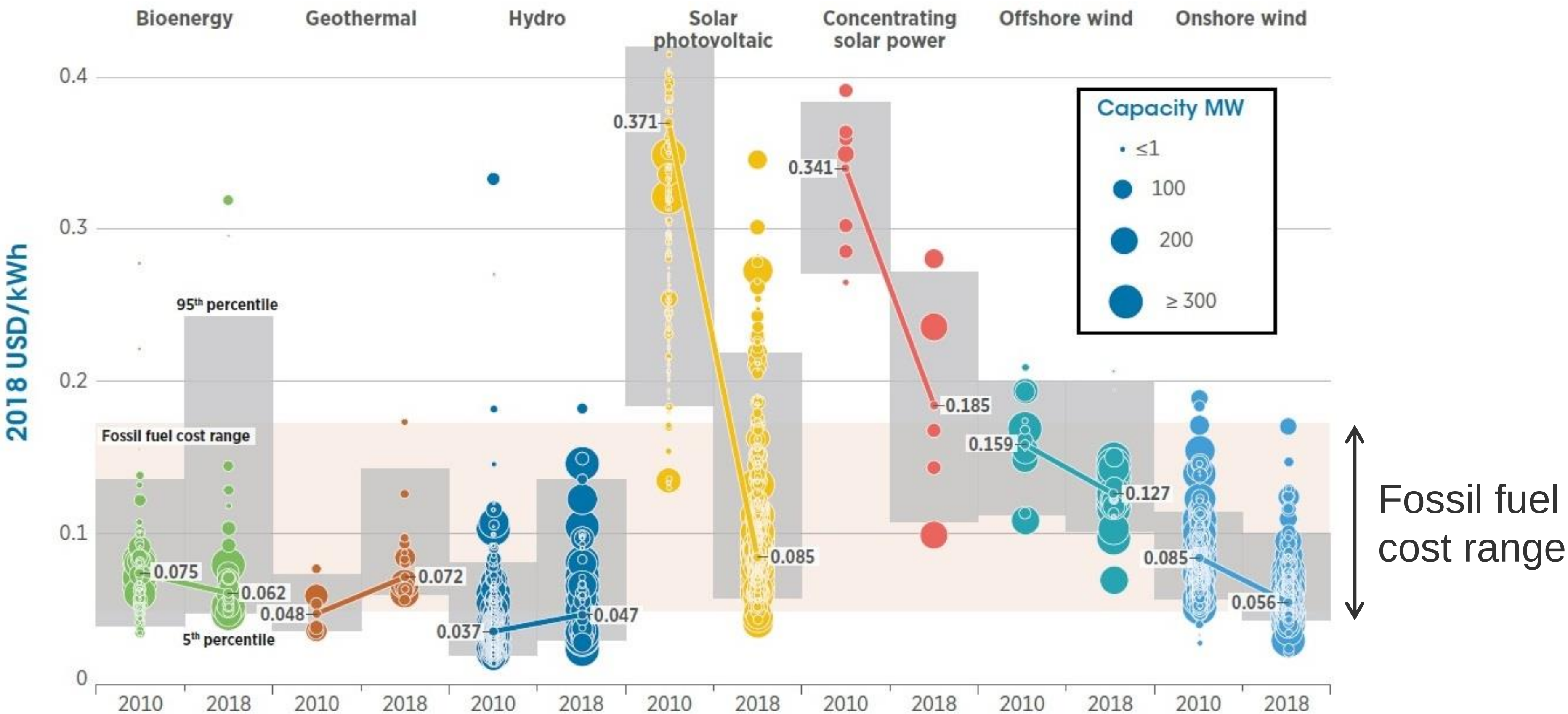
Levelized Cost of Electricity (LCOE)

The LCOE of an energy-generating asset can be thought of as the average total cost of building and operating the asset, per unit of total electricity generated over an assumed lifetime.

$$\text{LCOE formula: } \frac{\text{Present Value of Total Cost Over the Lifetime}}{\text{Present Value of All Electricity Generated Over the Lifetime}}$$

LCOE doesn’t include subsidy.

Reason of LCOE Reduction

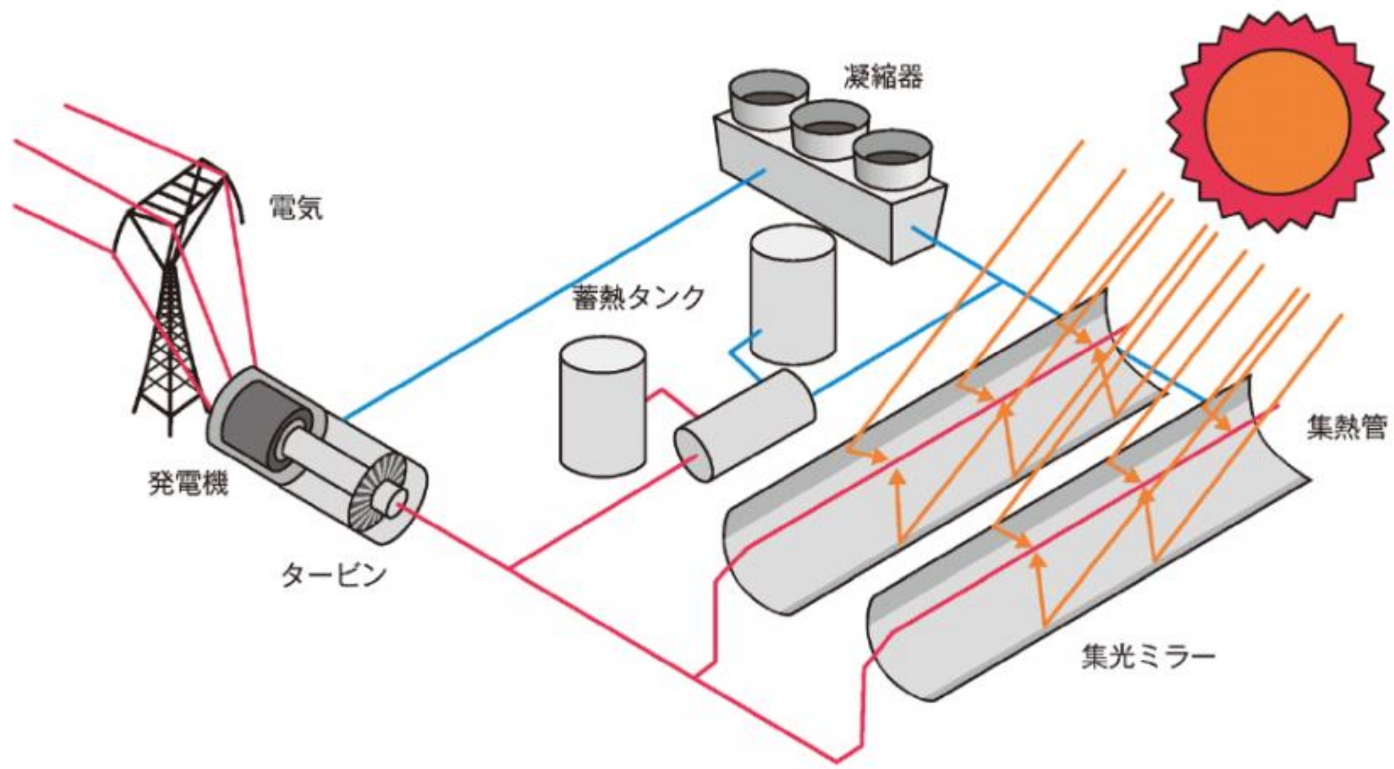


Source: Renewable Power Generation Costs in 2018, IRENA

[USD / kWh]

	Bioenergy	Geothermal	Hydro	Solar PV	CSP	Offshore wind	Onshore wind
LCOE in 2018	0.062	0.072	0.047	0.085	0.185	0.127	0.056

Concentrating Solar Power



Solar Photovoltaics
Benchmark prices for modules in Europe in December 2018

Module Type	USD/kW
Low-cost manufacturers	216
Mainstream manufacturers	306
High-efficiency	400
All black	420

Renewable Power Generation Costs in 2018, IRENA

電圧変動が機器に与える影響

家庭用電気機器

電気冷蔵庫、洗濯機、脱水機、掃除機、ポンプ、扇風機･･･などの家庭用の電気機器は、一般に±10%以下の電圧変化で支障がないよう設計されている。（電気用品安全法）

誘導電動機においては、その電圧が始動特性に影響するため、電圧が低下すると定格電圧時に比べ回転力（トルク）が低下する。

電圧不平衡が機器に与える影響

電圧不平衡（逆相電圧）が大きいと、誘導電動機から大きな電流（逆相電流）が生じ、過大な温度上昇･効率低下･トルクの減少が生じる。

あるいは電圧が高い相に接続される太陽光発電設備からの出力抑制を招く。

電圧に関する法令

＜電気事業法施行規則＞第38条：電圧及び周波数の値

（電圧）

標準電圧	維持すべき値※
100V	101±6Vを越えない値
200V	202±20Vを越えない値

※維持すべき電圧の端数はS17当時の屋内電圧降下　電灯：0.4～1.65V　動力：0.4～6V

＜電気事業法施行規則＞第３９条：電圧及び周波数の測定方法等（一部抜粋）

第１項　二

測定は、測定箇所ごとに、毎年、供給区域又は供給地点を管轄する経済産業局長が指定する期間において一回連続して二十四時間行うこと。

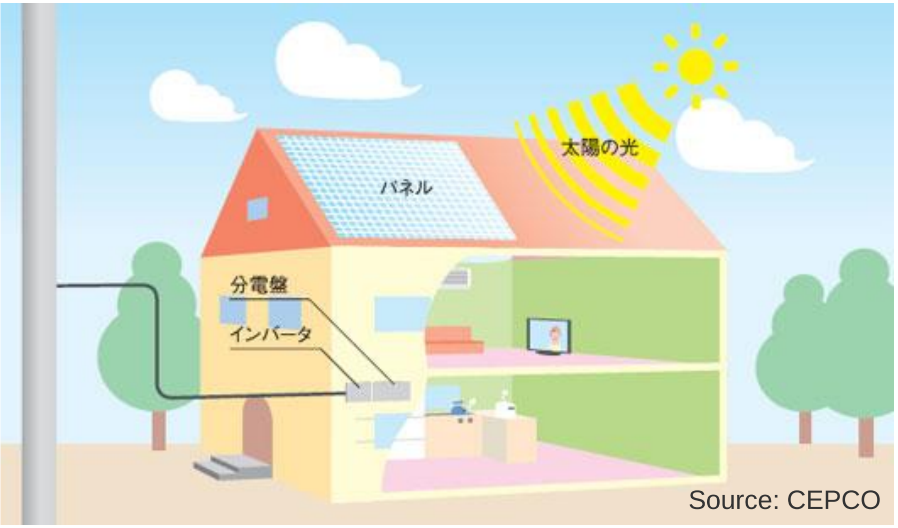
第３項　一　二

測定電圧の三十分平均最大値および三十分平均最小値並びにそれぞれの発生時刻

・30分平均値で適正電圧の判断を実施

Characteristics of PV Generation in Japan

- Residential used to be a primary sector, but after introducing FIT scheme, commercial sector has been increasing
- Business sector often is interconnected to HV (distribution systems) grids
- Primary capacity range of residential sector is 3-5 kW, connected to LV systems (100 V)
- In Japan, Kyushu or Chubu Area on the Pacific Ocean side in favorable solar radiation condition have a lot of PV generators connected to the power grids



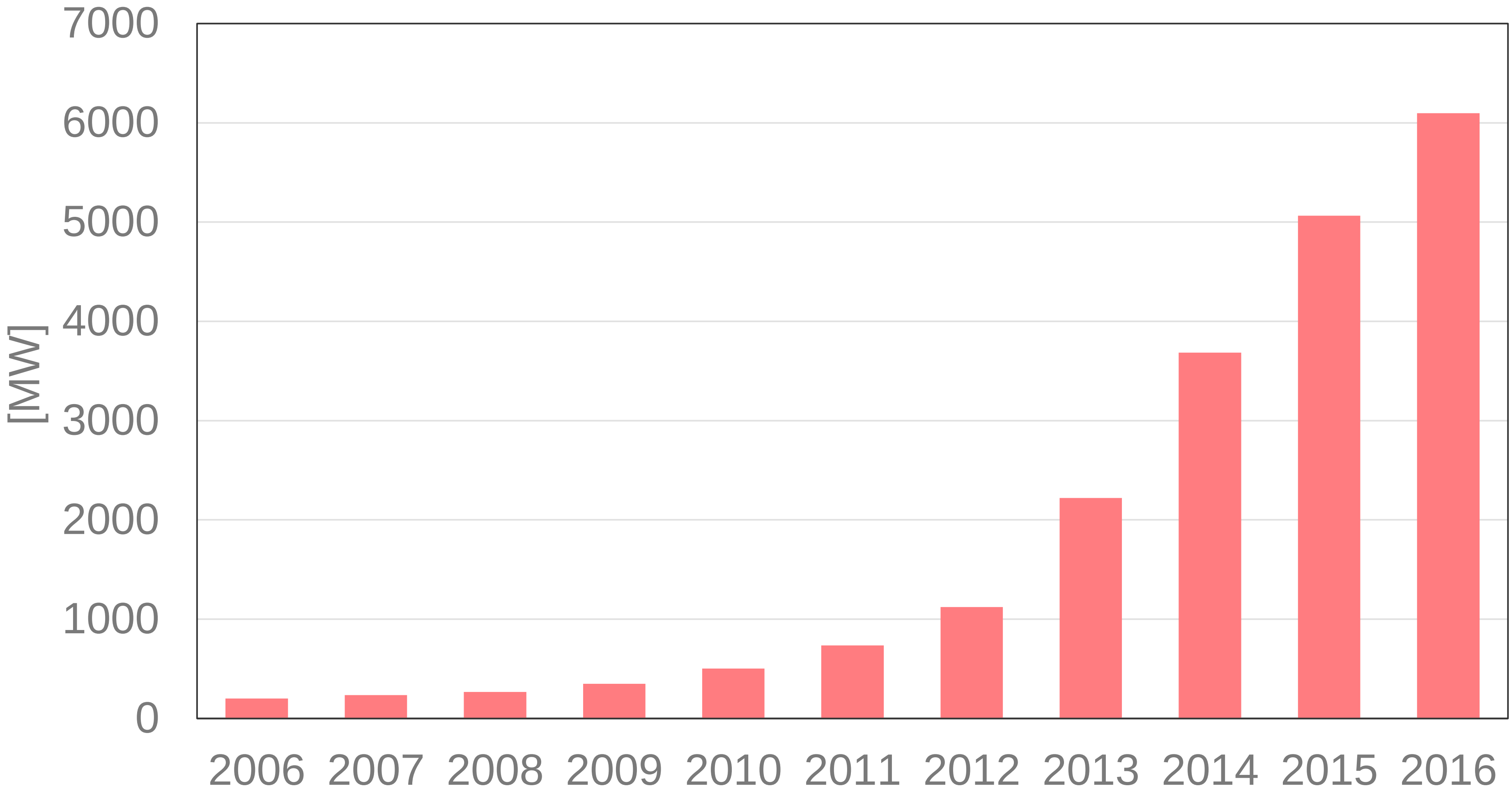
Source: CEPCO

Characteristics of Wind Power Generation in Japan

- Commercial is a primary sector
- Scale of wind farms is a few to dozens MW
- Interconnected to systems of 77 kV or lower
- Concentrates on certain areas
- In Japan, concentrates on Hokkaido, Tohoku and northern areas due to favorable wind conditions

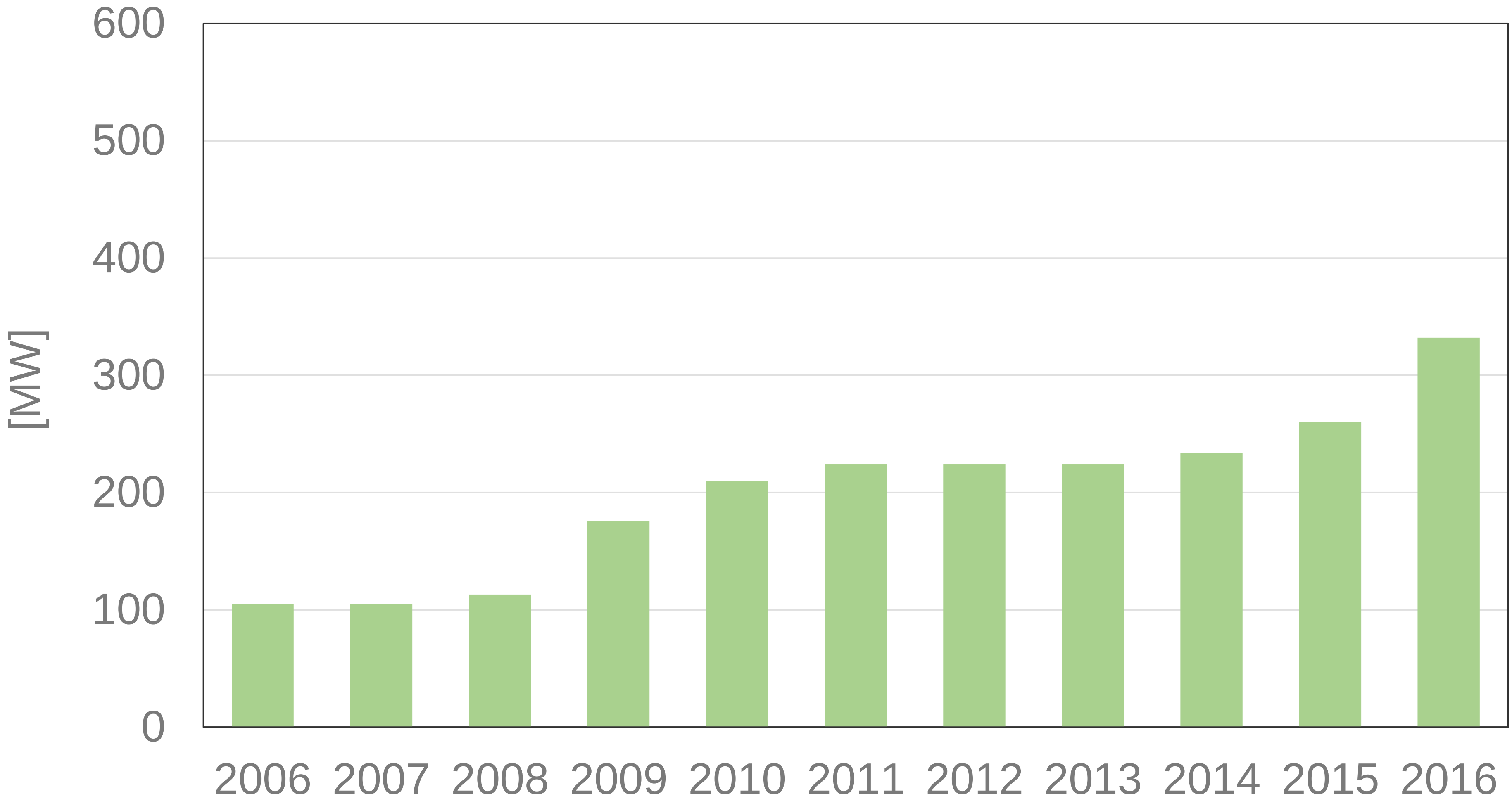
Source: CEPCO

Transition of Introduction of PV Generation (CEPCO Area)



Due to favorable solar radiation condition, PV generation is growing rapidly in Chubu EPCo Area

Transition of Introduction of Wind Power Generation (CEPCO Area)



Introduction of wind power generation is not increasing due to unfavorable wind conditions in CEPCO Area

Introduction Ratio of PV and Wind Power Generation in CEPCO

CHUBU Electric Power

◇PV power generation

- Installed capacity against peak demand is about <u>25%</u>
- Ratio against annual energy sales is about 3%

◇Wind power generation

- Installed capacity against peak demand is about <u>1%</u>
- Ratio against annual energy sales is under 0.5%

➢ Installed capacity of PV generation is large, at 25%, but generated energy is low, only 3%

➢ Installed capacity and energy generated from wind power are quite low, both below 1%

Operation and Maintenance of Solar PV

JICA Expert Team

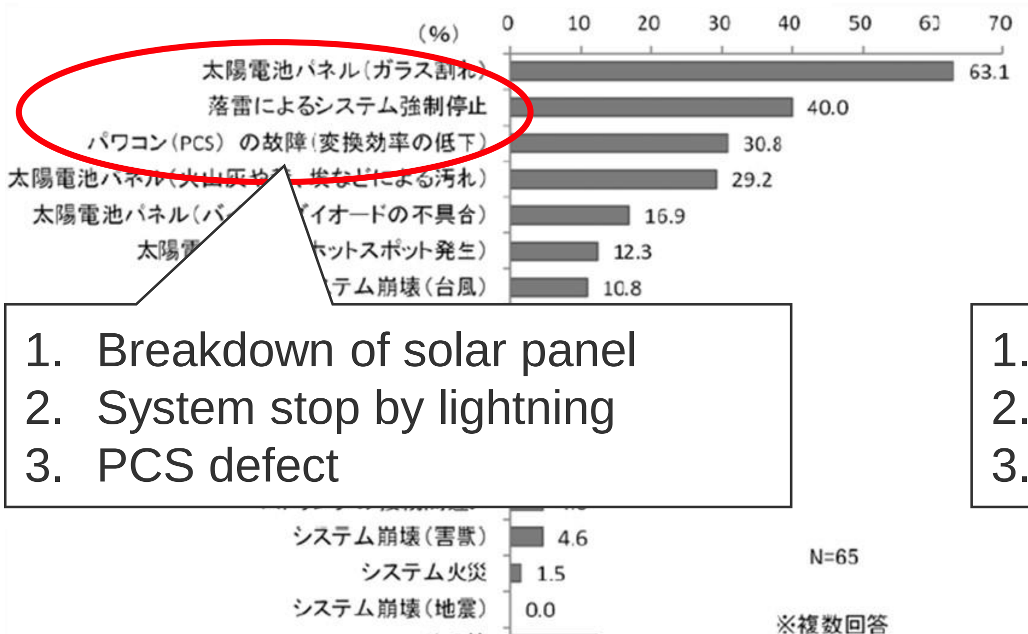
July, 2020

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

Troubles and Challenges of Solar Power Station

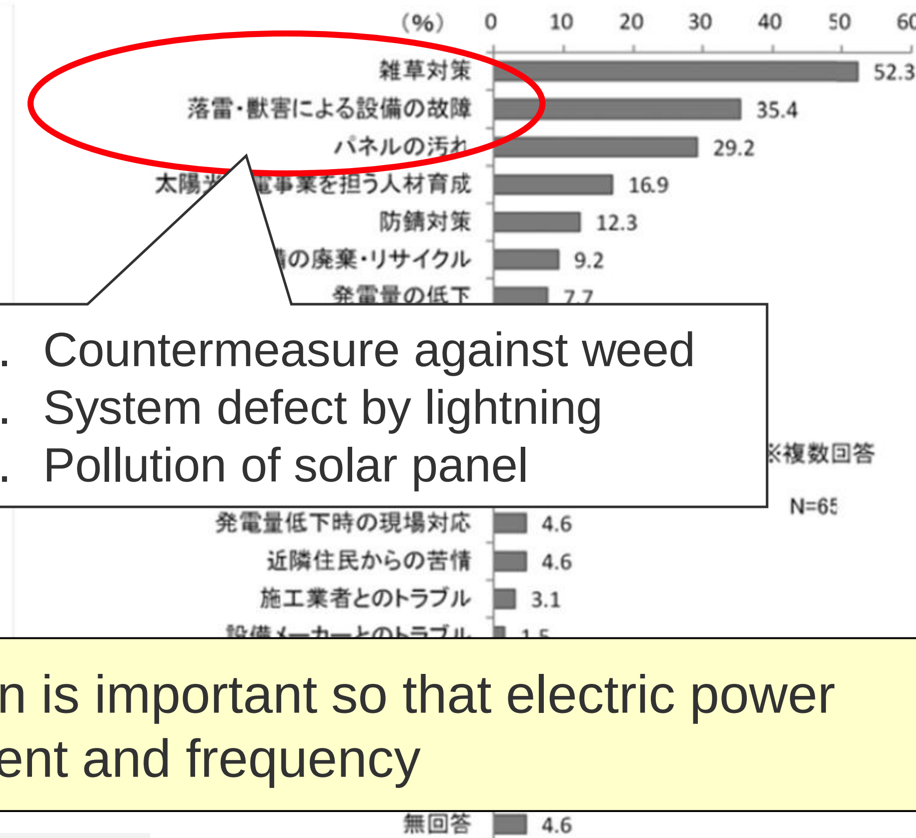
- Main causes against troubles are breakdown of solar panel, system stop by lightning and defect of PCS (Power Conditioning System)
- Biggest challenge is countermeasure against weed

Troubles in solar power station



1. Breakdown of solar panel
2. System stop by lightning
3. PCS defect

Challenges in solar power station



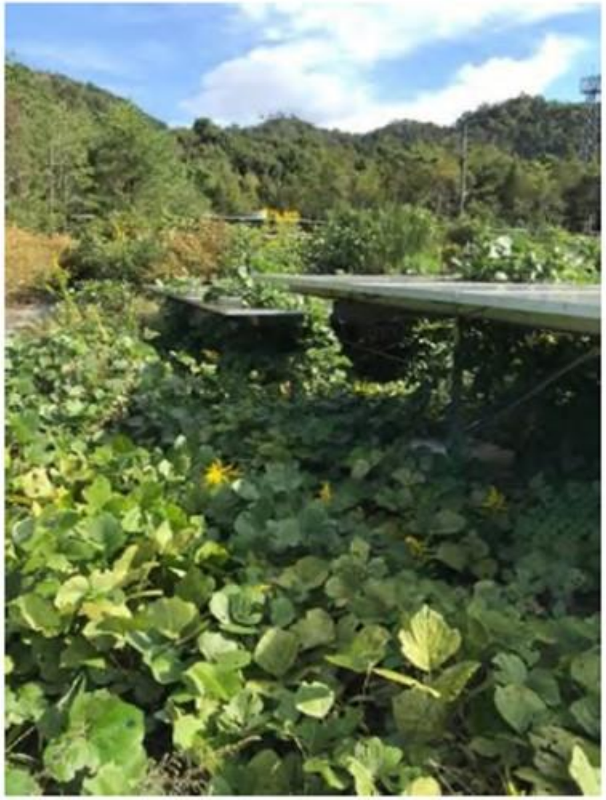
1. Countermeasure against weed
2. System defect by lightning
3. Pollution of solar panel

Stable power supply from RE power station is important so that electric power company can manage stable voltage, current and frequency

Source: (Only Japanese) H28年度太陽光発電の長期安定電源化に向けたサポート体制構築に関する調査事業, 交易財団法人九州経済調査協会

Troubles caused by Weed

- ➢ Reduction of the amount of power generation (There is a case that the amount of power generation is less than 90%)
- ➢ Cost increase of weed removal
- ➢ Complain from neighboring people because of bad landscape



Source: Japan Photovoltaic Energy Association

- ✓ Weed from neighboring area
- ✓ Weed cutting in only area of power station is not enough

[Countermeasure]
- Periodical weed cutting
- High quality weed killer

Troubles caused by Lightning

- System stop and PCS defect by lightning
- PCS defect by induction lightning (There is few defect by direct lightning because height of solar station is lower than wind power)
- Prompt detection of defect PCS is necessary to reduce loss of selling power

Insulation breakdown of connector by lightning

Prompt detection of defect by monitoring the amount of power generation using remote supervisor system

Reducing loss of selling power

Source: Japan Photovoltaic Energy Association

Solar Panel Damage by Typhoon, Gust of Wind and Stone dropped by Birds

- Collapsed solar panels by typhoon or gust of wind
- Solar panel damage by flying objects
- Solar panel damage by stones that birds drop from the air (It is assumed that bird recognizes the reflection of the bird on the solar panel as an enemy)

Collapsed solar panels

Damage by flying objects

source: Japan Photovoltaic Energy Association

Foundation Damage from Flood or Heavy Rain

- (Left) Foundation damage from flood
- (Right) Foundation damage from heavy rain (without flood)

- ✓ Reinforcement of foundation with adequate concrete
- ✓ Selection of installation location in consideration of past rainfall amount

source: Japan Photovoltaic Energy Association

Stable Power Supply from RE

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Momentary voltage drop or load increase/decrease in distribution line (within 1 sec.)

Disconnection of many at the same time

Sudden voltage drop

Sudden frequency fluctuation

Bad effect on power quality (bad effect to other customers)

For stable operation of distribution network, continued power supply is necessary when momentary voltage drop or load change

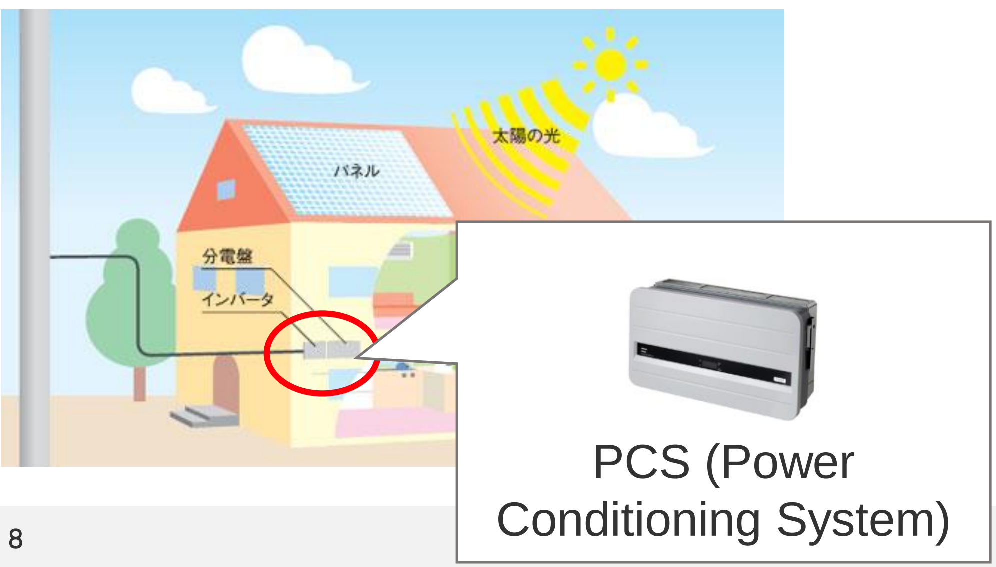
Guideline established by Ministry states that RE Equipment to be connected to distribution line must meet **Fault Ride Through (FRT)**

- ✓ Prevention of undesired disconnection
- ✓ Stable power supply from RE

<u>Fault Ride Through (FRT)</u>

Function as a power conditioner necessary to maintain the voltage and frequency of the power system.

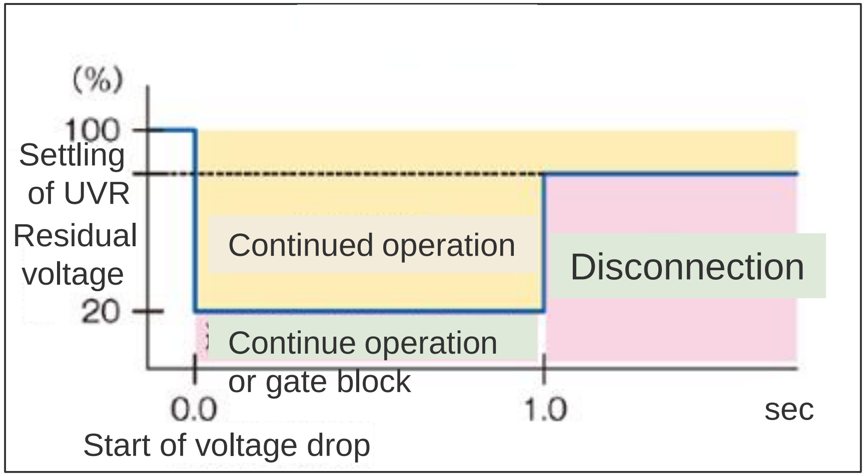
Provisions for solar power generation connected to distribution
① Continued operation in case of momentary voltage drop
② Rapid output restoration after voltage recovery
③ Operation continued in case of frequency fluctuation



CEPCO permits connection only to power station that have equipment that meets FRT (Customer or its agency must submit the evidence to CEPCO)

Voltage Drop Tolerance in FRT

Voltage drop tolerance

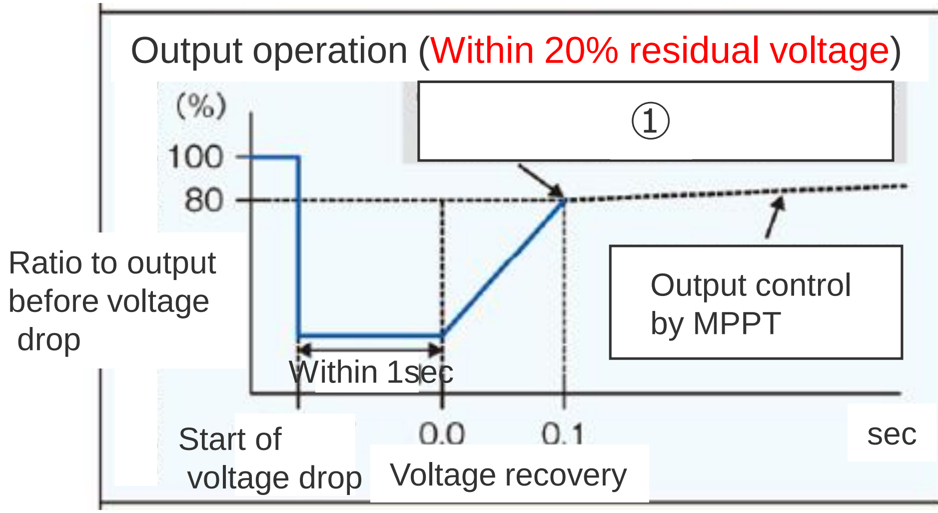


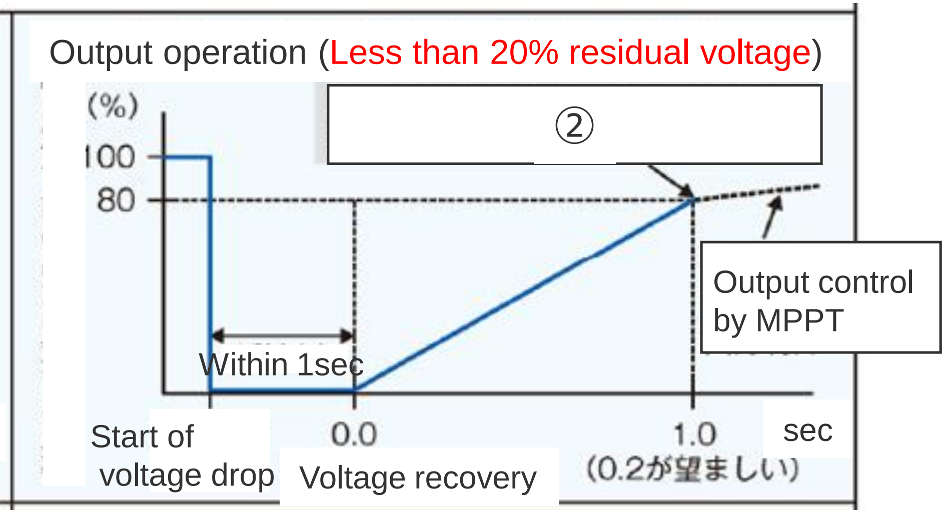
Disconnection:
Detach power generation equipment etc. from electric power system

UVR: under voltage relay

① :	80% or more of the output before the voltage drop within 0.1 seconds after returning to the voltage
② :	80% or more of the output before the voltage drop within 1.0 seconds after returning to the voltage

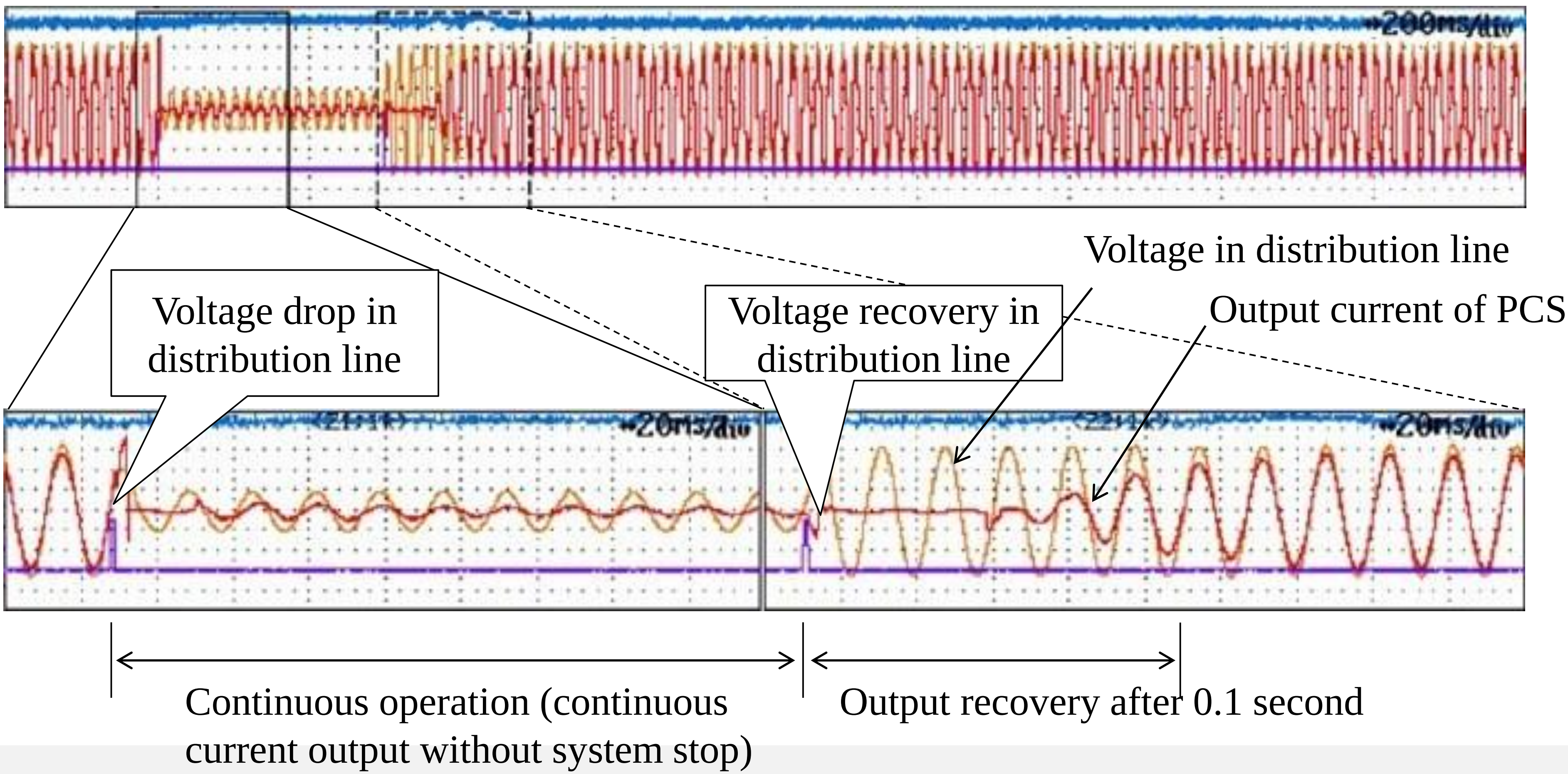
MPPT:
System that makes it possible to obtain the maximum amount of electricity generation in the weather





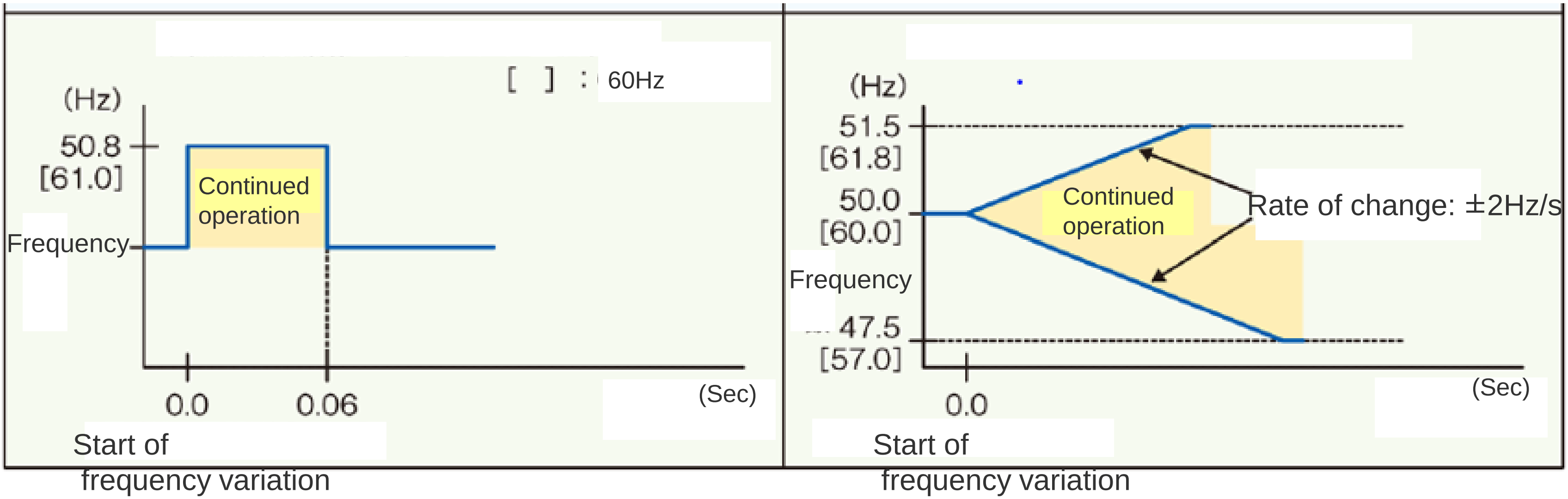
Test Example of Voltage Recovery

Equipment to be installed in power station (including rooftop PV) should pass test below



Frequency Variation Tolerance in FRT

Frequency variation tolerance



Frequency variation

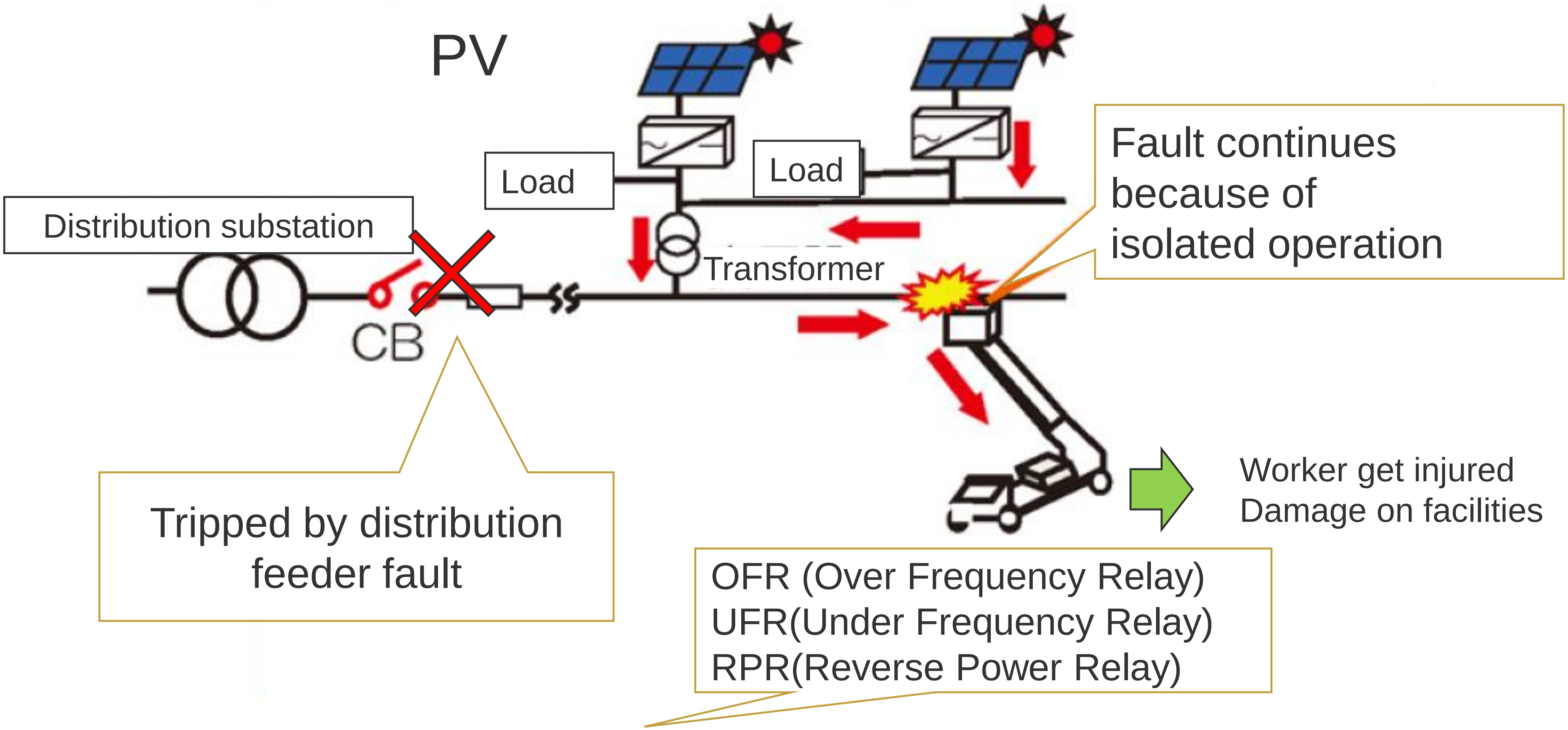
Required functions of the power conditioner system

・Operation is continued within 0.06 seconds after the frequency starts to rise.

・Frequency fluctuation is controlled within ± 2 Hz / s

Prevention from Isolated Operation

Image of isolated operation in distribution system



According to **technical standard**, isolated operation must be detected and PV are disconnected immediately

Thank you for your kind attention

CHUBU Electric Power

NIPPON KOEI

O&M of Offshore Wind Power Plant

JICA Expert Team

October, 2020

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

Contents

1. Outline of offshore wind power
2. O&M cost
3. O&M condition in Japan and other countries
   - Periodical inspection (example in Japan)
   - Periodical Inspection (example in other countries)
   - Examples of replacement and failure

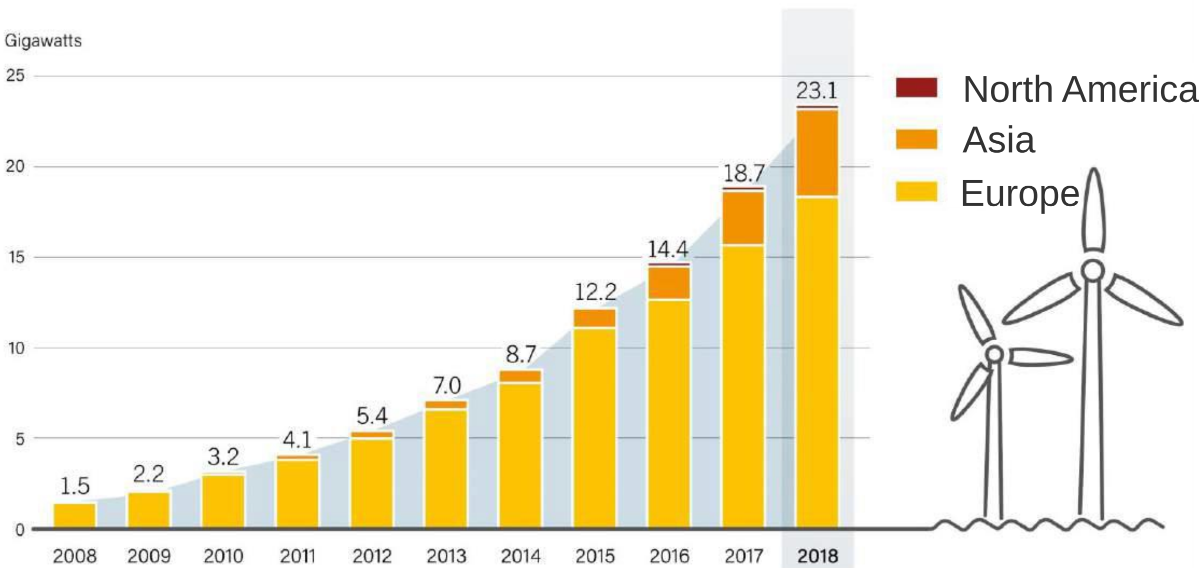
Contents

Global Capacity of Offshore Wind Power

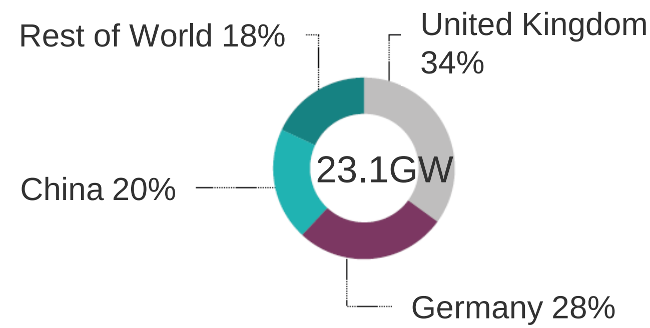
CHUBU Electric Power
NIPPON KOEI

- Offshore wind power has been rapidly increased.
- As of 2018, the installation is progressing mainly in Europe, especially for the United Kingdom and Germany. In Asia, the installation is progressing especially in China.
- China has a large amount capacity of new installation in a single year. If this trend will continue, cumulative capacity in China will become the top in 2025.

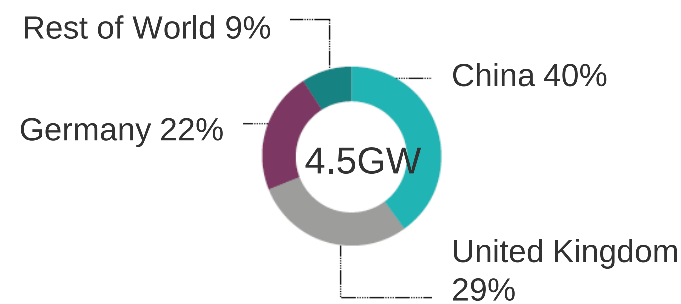
Wind Power Offshore Global Capacity by Region, 2008 - 2018



Total installation



New installation



Source: REN21 "Renewables 2019 Global Status Report"

Source: GWEC "Global Wind Report 2018"

Political Target in some Region and Countries

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- The region with the most ambitious target is Europe. Cumulative total capacity will be 65 GW to 85 GW by 2030.
- China sets goals based on "5 years plan.“ (about 11GW is now under construction)
- In USA, each state sets individual targets (nationwide total 22 GW).

Region / Country	Target Capacity	Target Year
Europe	65 - 85 GW	2030
China	10 GW	2020
USA	22 GW	2030
India	5 GW	2022
Taiwan	5.5 GW	2025
Korea	12 GW	2030

Country	Capacity	Year
UK	30 GW	2030
Germany	15 - 20 GW	2030
Netherland	11.5 GW	2030
Denmark	5.3 GW	2030
Poland	5 GW	2030
France	4.7 - 5.2 GW	2028
Belgium	4 GW	2030
Ireland	3.5 GW	2030
Italy	0.9 GW	2030

Source: IEA “World Energy Outlook 2019

High Capacity Factor

- Capacity factor* of offshore wind power is higher than that of other VRE (world average in 2018: offshore wind 43%, onshore wind 34%, solar PV 18%)
- Capacity factor has increased from 38% in 2010 to 43% in 2018, and is expected to improve to 58% in 2030 and 60% in 2050.

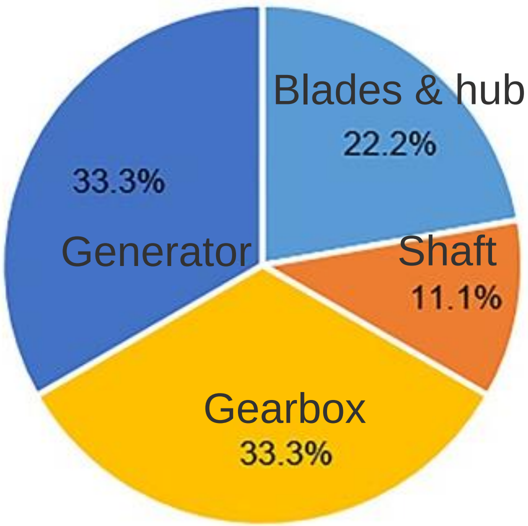
*Capacity factor is defined as the ratio of the total actual energy produced or supply over a definite period, to the energy that would have been produced if the plant (generating unit) had operated continuously at the maximum rating. The capacity factor mainly depends on the type of the fuel.

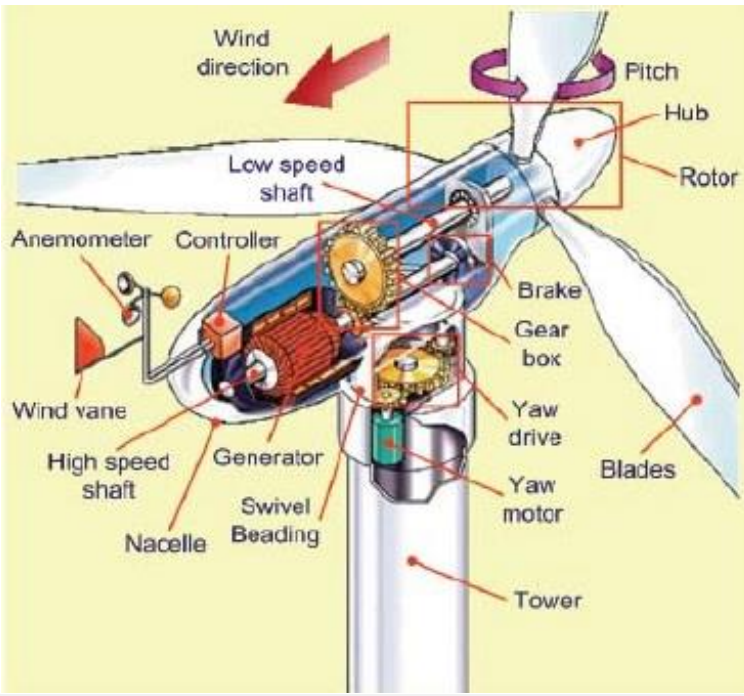
$$\text{Capacity Factor [\%]} = \frac{\text{Total actual energy produced [kWh]}}{\text{Power plant capacity [kW]} \times 365 \text{ days} \times 24 \text{ hours}} \times 100$$

Power Interruption Time in each Equipment

- Repair work of Generator and Gearbox accounts for 95% of repair work with major replacement
- Gearbox and generator have similar failure times with power interruption, but the frequency of failures in gearbox is larger than that of generator. Because gearbox has a large number of components and is a part that controls shifting and power transmission.

Power interruption time due to failure





On average, failures including minor repair occur about 8 times a year in each unit.

Source: Failure Rate, Repair Time and Unscheduled O&M Cost Analysis of Offshore Wind Turbines

Contents

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Breakdown of Cost for Wind Power Plant

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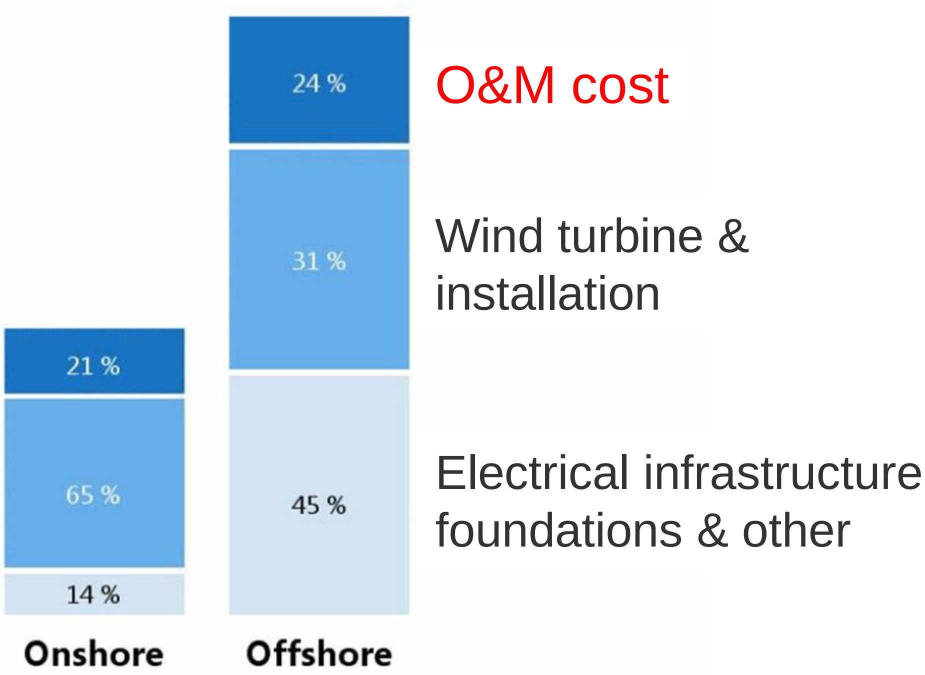
- O&M cost accounts for 24% of the total cost.
- Since the installed capacity will increase in the future, O&M cost will increase.
- It is important to improve the reliability of each component to reduce O&M cost.



Cost comparison between onshore and offshore wind projects

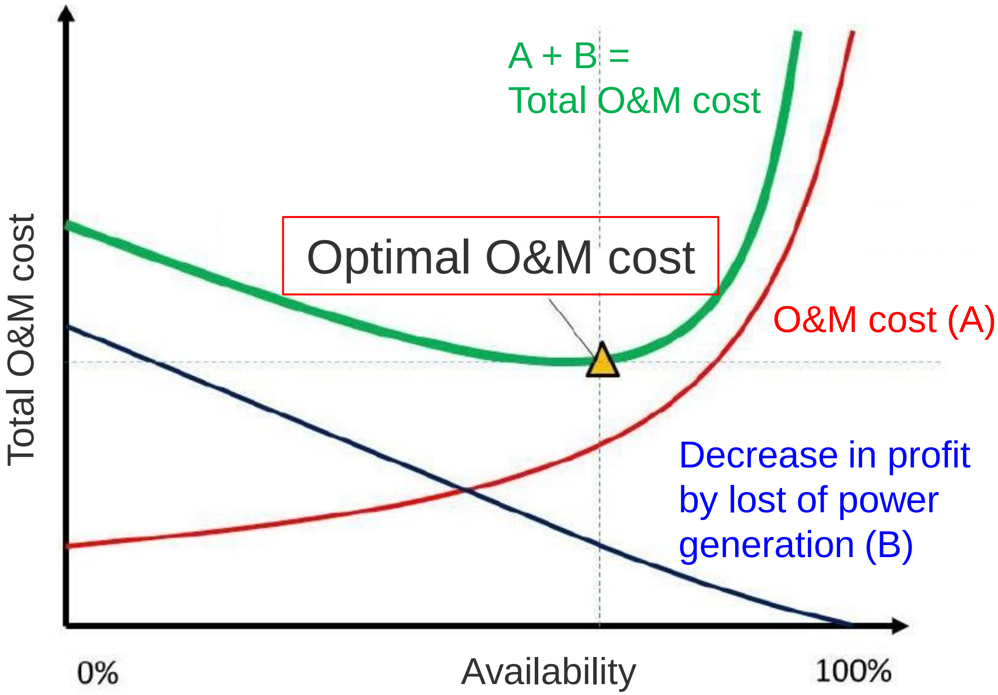
Source: REN21 "Renewables 2019 Global Status Report"

The number of parts for wind power plant is very large (about 10,000 to 20,000 parts), and to product these parts is a major industry. (Approximately 10,000 to 30,000 parts in car industry)

Optimal O&M Cost

- Availability* of offshore wind power is about 90% (world average).
- Availability of onshore wind power is about 95% - 98% (world average).
- Therefore, no operation time during maintenance of offshore wind power is longer than that of onshore wind power, and decrease in profit by lost of power generation tends to be large.

* Availability = (certain period - no operation time during maintenance or failure) / (certain period)

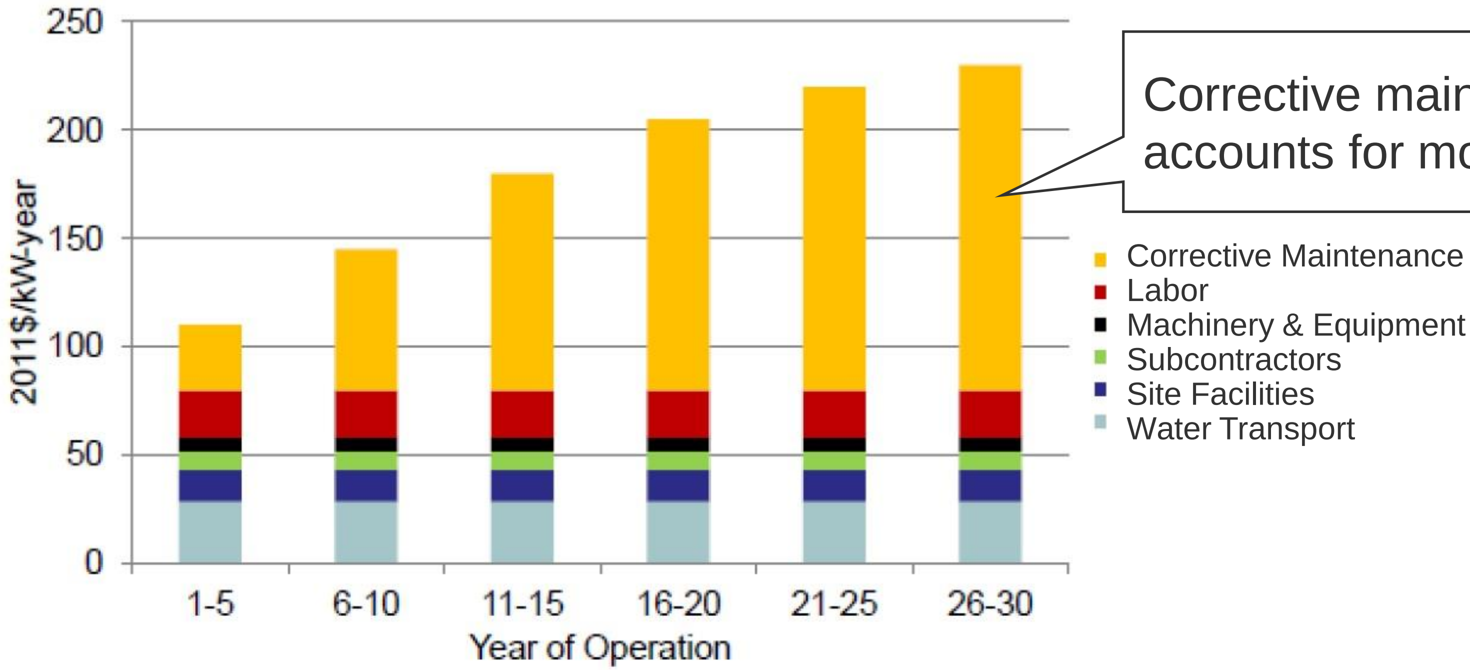


When we evaluate O&M cost, we need to find optimal O&M cost considering availability. It is necessary to make an appropriate O&M plan at the initial stage of installing wind power plant and operate an economical business.

Unfortunately, there is no clear relationship among O&M cost, wind turbine size, water depth, and distance from shore. Therefore, it is necessary to evaluate the costs at individual point.

Source: NEDO

Transition in O&M Cost after Installation and its Breakdown



Corrective maintenance cost accounts for most of the total cost.

- ➢ Since the wind turbines will become larger and wind power plant will be installed more offshore in the future, new logistic solutions will be required. (e.g. location of storage for repair parts, waiting place of ship for patrol)
- ➢ Lifetime analysis for each part will be also required.

- ➢ Accommodation facilities (fixed type or floating type) have also been introduced in places far from the shore (about 75 km or more).

Example of O&M Cost in Other Countries

Country	Wind firm	Output [MW]	Water depth [m]	Distance from shore [km]	O&M cost [USD / kW・year]
U.K.	North Hoyle	60	5 - 12	3 - 10	72
	Scoroby Sand	60	2 - 10	2.5	38
	Kentish Flats	90	5	8.5	40
	Barrow	90	21 - 23	7	71
Denmark	Middlgrunden	40	2 - 6	2	43
	Rφdsand II	207	6 - 12	23	103
Netherland	Prinses Amalia	120	19 - 24	23	164

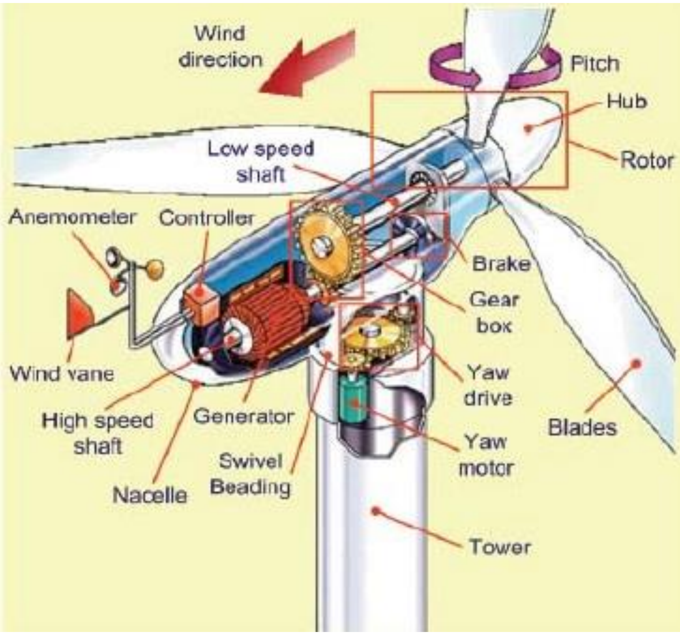
O&M cost is calculated considering the probability of wind turbine failure.

- There is no clear relationship among O&M cost, total output, water depth and distance from shore.
- O&M cost needs to be estimated at individual points

Contents

Periodical Inspection (Example in Japan)

Parts	Main Items	Maintenance period
Nacelle (Gearbox, Generator, Shaft, Control panel), Rotor, Blades	Confirmation of appearance, Indicators , Connectors, Oil change and replenishment, Loose nuts and bolts, Rust, Cleaning, etc.	1 - 2 time(s) / year
Tower	Confirmation of appearance, Loose nuts and bolts, Rust, Cleaning, etc.	1 - 2 time(s) / year



Nacelle inside Source: Kajima Corporation

Source: Blade Partners Co., Ltd.

Periodical Inspection (Example in Japan)

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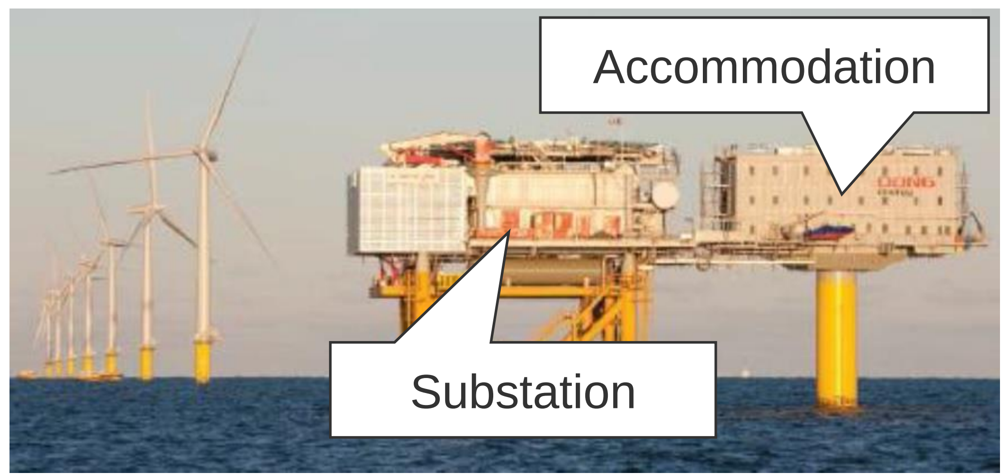
Parts	Main Items	Maintenance period
Foundation	・Concrete parts ✓ Crack and Peeling of concrete ✓ Corrosion, Exposure and Breakage of steel in concrete parts ・Steel parts ✓ Painting condition, Rust and Dent	1 time / year
	[Additional inspection by power producer] ・Concrete strength test ・Steel parts corrosion test	1 time / 2 year
	[Additional inspection by power producer] Pitting corrosion around foundation	1 time / 5 year

Periodical Inspection (Example in other Countries)

Country	Wind firm	Output [MW]	Water depth [m]	Distance from shore [km]	Maintenance period [/unit/year]
Germany	Alpha Ventus	30	30	45	1
	Bard Offshore 1	400	39 - 41	89	1
Belgium	Thornton Bank	30	17 - 23	30	1
Denmark	Horns Rev II	209.3	9 - 17	27 - 35	Anytime*1

*1 There is accommodation in the wind firm, with up to 24 persons. The world's first offshore wind power plant with accommodation facilities.



Example of Replacement (Gearbox, Generator)

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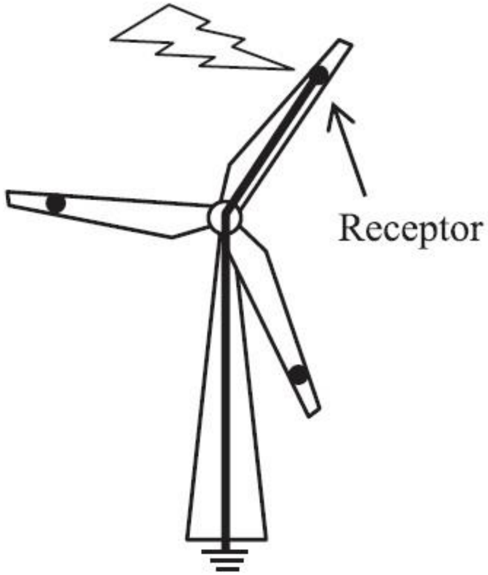
Gearbox and generator parts replacement due to aging

Gearbox	**Old Gearbox removal**	**Main shaft cleaning**	**New Gearbox installation**
			
Generator	Bearing bracket removal	Bearing removal	Bearing Installation
			

Source: Hokutaku Renewable Service

Damage by Lightning

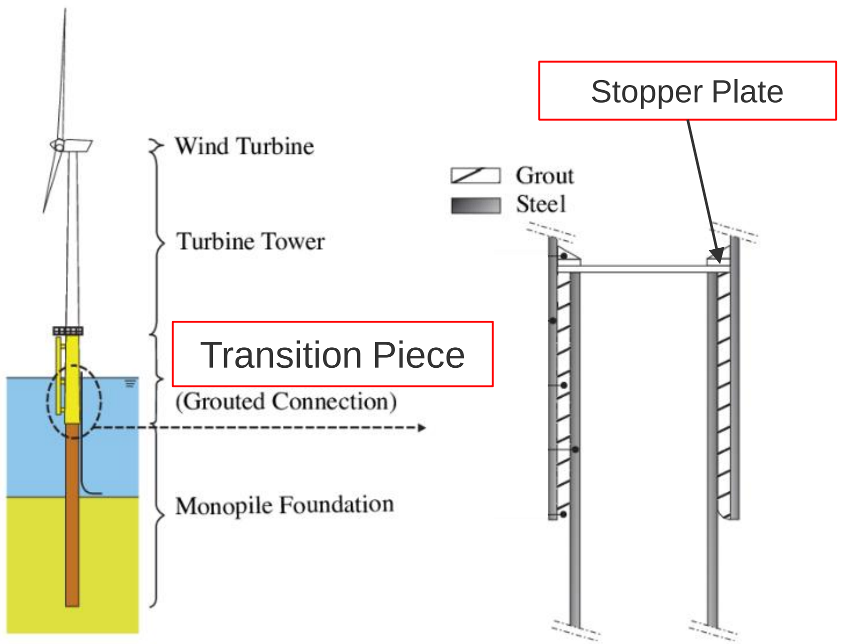
- Wind power facility is damaged by lightning because wind power facility is tall and there are no similar tall buildings around wind power facility.
- To accumulate small damage on the blade causes deterioration of the blades even if the blades does not burn out by one time lightning.
- In order to minimize the damage by lightning, IEC61400 (Wind Generator Systems) stipulates the functions that blade should have (receptors, pointed shapes to induce lightning to blade, etc.).



Source: Conference Paper, The update of IEC 61400-24 lightning protection of wind turbines

Subsidence of Transition Piece due to Lack of Grouting

- Transition Piece is the equipment for connecting the foundation and the tower body.
- Horizontal tilt can be adjusted up to 0.5 degrees.
- If the grout is insufficient, the transition piece will sink. Then, a large force is applied to the stopper plate and there is a risk of damage progress.



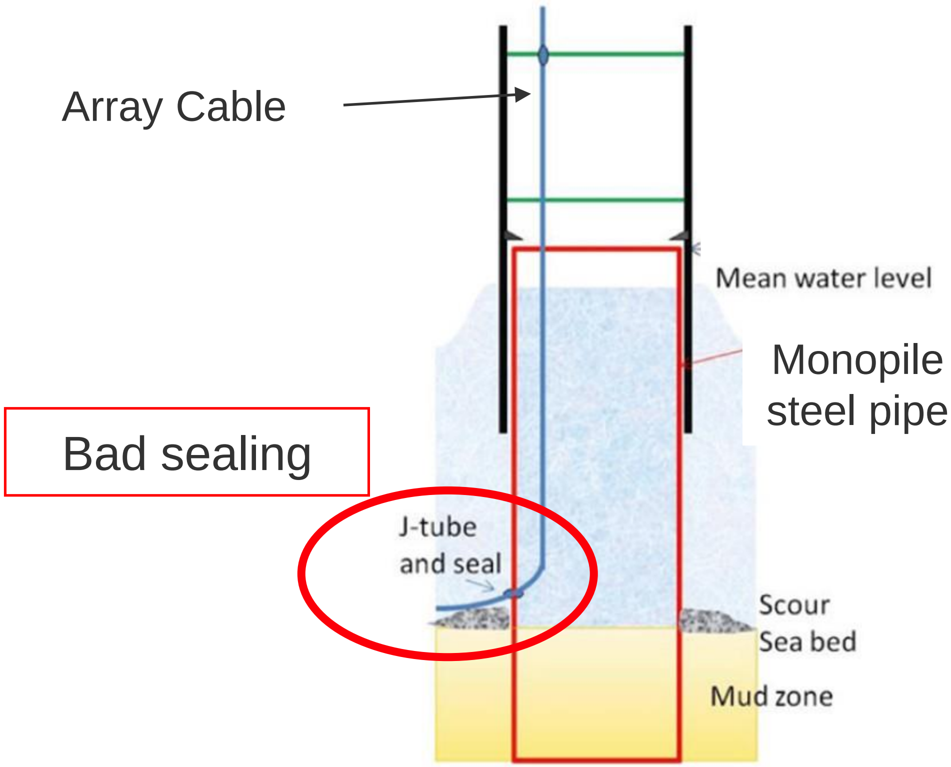
Useful URL to understand grouting

https://www.youtube.com/watch?v=3UMO1uFp8Ok

Source: Conference Paper, The update of IEC 61400-24 lightning protection of wind turbines

Foundation Corrosion

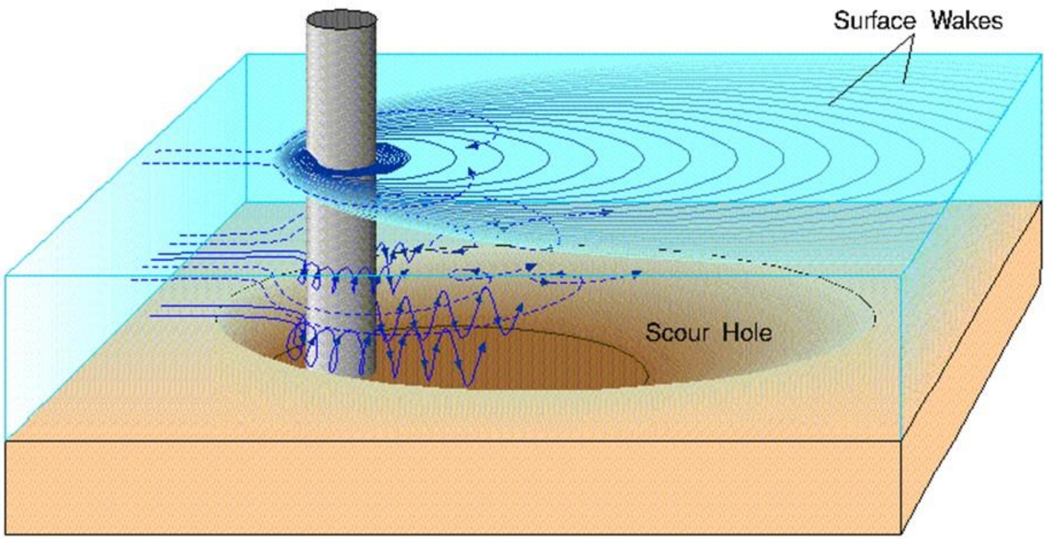
- Corrosion of Monopile steel pipes and foundations occurs due to flooding caused by defective sealing materials between Array Cable and Monopile. As the result, durability will decrease and the operation period will be shortened.

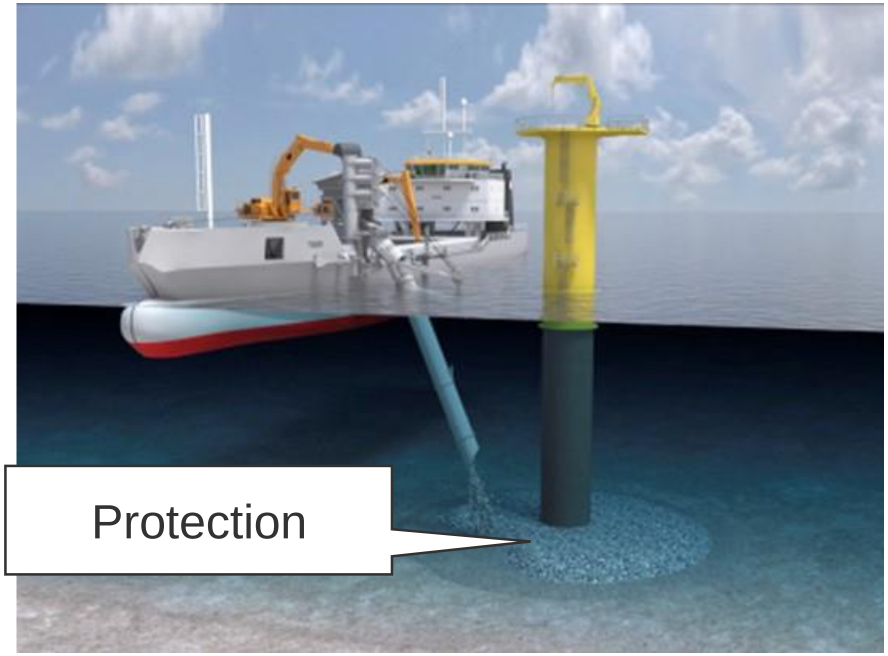


Source: Fast Track Expert Panel

Pitting Corrosion around Foundation

- A phenomenon in which the area around the foundation is dug.
- As it progresses, durability will decrease due to the vibration and deterioration by frequent stress, and the operation period will be shortened.
- Protection around the foundation should be implemented





Source: Fast Track Expert Panel

CHUBU
Electric Power

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Democratic Socialist Republic of Sri Lanka

The Project for Capacity Development on the Power Sector Master Plan Implementation Program

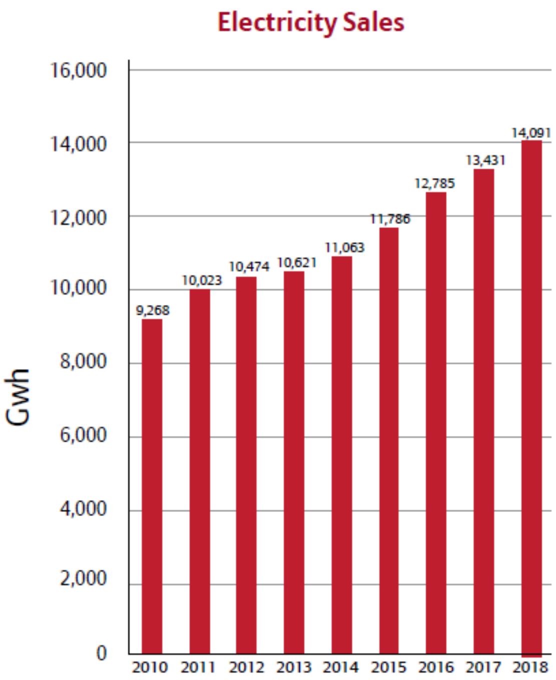
Financial Status of CEB

September, 2020

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

1. Operational Performance

- CEB's electricity energy sales has increased consistently as demand grows over years
- However, CEB has continuously recorded gross deficit recently
- Also, finance cost (interest payments) has hiked quickly resulting in large net loss (- 12.6% of sales and – 3.3% ROA in 2018)



(LKR million)

	2014	2015	2016	2017	2018
Summary Income Statement					
Revenue	202,645	188,684	206,811	218,450	229,571
Cost of Sales	(213,646)	(168,781)	(222,097)	(260,273)	(250,891)
Gross Profit/ (Loss)	(11,001)	19,903	(15,286)	(41,823)	(21,320)
Other Income & Gain	5,871	8,292	10,323	8,143	9,450
Administrative Expenses	(3,146)	(4,087)	(4,965)	(5,110)	(5,425)
Finance Income	304	434	1,048	1,194	1,466
Finance Cost	(7,030)	(5,134)	(4,311)	(8,415)	(13,036)
Profit/ (Loss) before Income Tax	(15,002)	19,408	(13,191)	(46,011)	(28,865)
Operational Performance					
Average selling price per unit (LKR/kWh)	18.50	16.00	16.18	16.26	16.29
Average cost per unit at selling point (LKR/kWh)	20.00	15.07	18.08	20.34	19.12
Gross profit margin	-5.4%	10.5%	-7.4%	-19.1%	-9.3%
Net Cash Flow from Operations (LKR million) *	-	21,353	18,441	22,051	(17,273)
New Bank Loans (LKR million) *	-	319	6,049	2,582	62,169

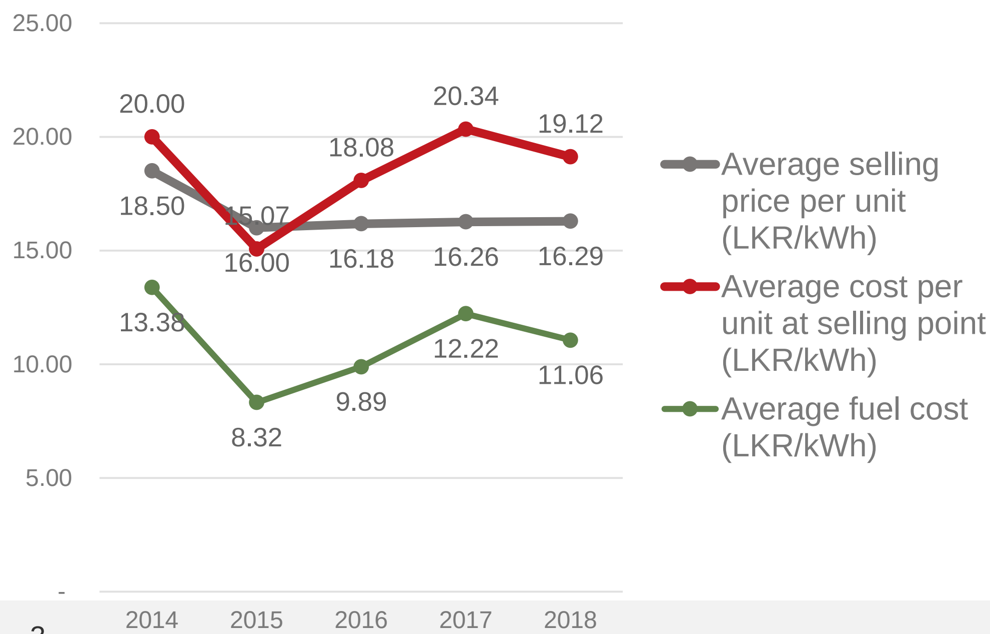
* Indicators from financial analysis in CEB Corporate Plan 2019-2023

Average electricity selling price vs. average cost

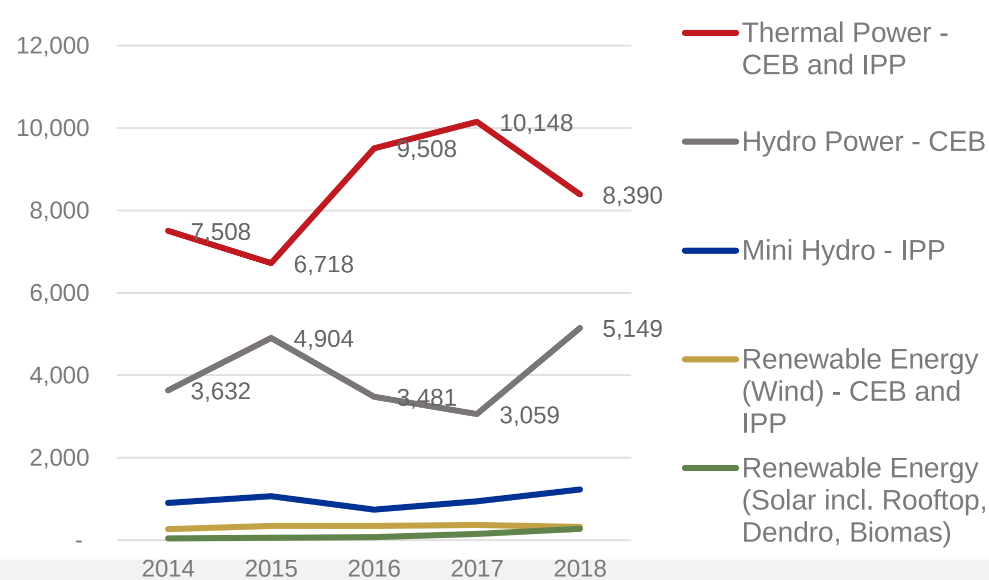
CHUBU Electric Power
NIPPON KOEI

- The main cause of CEB's operational deficit is that the recent selling price does not reflect the generation and distribution cost.
- Average selling price stuck around LKR 16.20/kWh as average cost fluctuates around LKR 18 – 20/kWh. Fuel cost change directly affects the average cost as the thermal power accounts for around 60% of total generation.
- The situation was worsened during the period with dry hydrology conditions as CEB had to depend on high cost thermal power generation instead of hydro power.

Average selling price and cost



Energy Generation by Source (GWh)



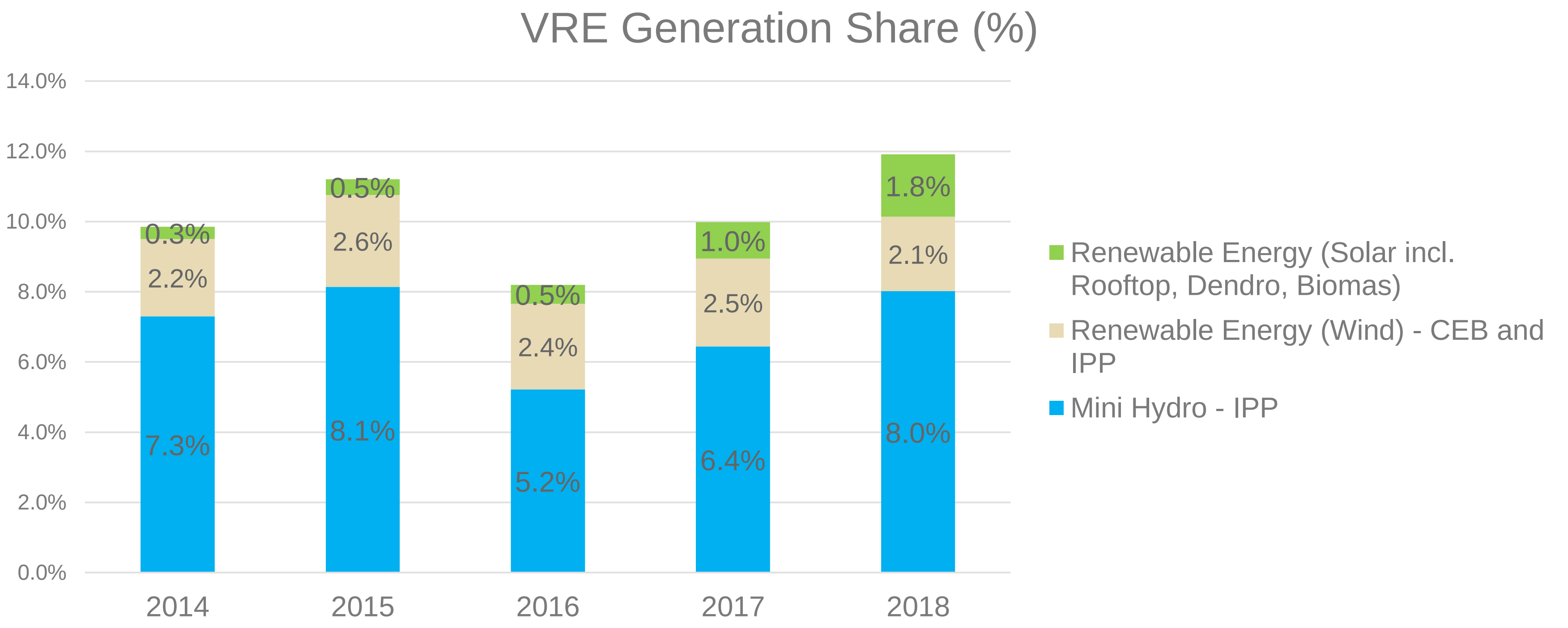
Average electricity revenue by customer category

- CEB’s average electricity revenue is steady over recent years because electricity tariff has not been revised since 2014.
- As compared to the total average, domestic, industrial and religious customers enjoy lower tariff level by cross-subsidizing from other customer categories.

Avg. Price LKR/kWh	2016	2017	2018
Domestic	13.42	13.48	13.60
Non-domestic			
Religious	7.15	7.21	7.28
General Purpose	23.90	23.74	23.78
Hotel	17.74	17.73	17.62
Industrial	14.63	14.77	14.72
Government	18.34	18.26	18.23
Bulk Supply to LECO	15.77	15.79	15.53
Total	16.18	16.26	16.29

NCRE generation trend and related costs

- Non-conventional Renewable Energy's share has grown gradually over years.
- Especially, solar, dendro and biomas generation share has increased from 0.3% in 2014 to 1.8% in 2018.
- In the face of increasing VRE generation, further financial burden is anticipated for CEB's operation:
    - Investment in transmission and distribution facilities for stable power system
    - Payments for VRE generation cost



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NCRE generation tariff system

NCRE generation tariff system other than PV

Generation Type	Up to 10MW	Over 10MW
Mini-hydro	Three-Tier Tariff	Independent PPA
Mini-hydro-local		
Wind		
Wind-local		
Biomass		
Agro & Industrial waste		
Waste Heat		

PV generation tariff type

Capacity / PV Type	Up to 50kW	Up to 10MW	Over 10MW
Roof-top PV	Select Metering System out of three systems i) Net Metering ii) Net Account iii) Net Plus	N/A	N/A
PV Plant other than roof-top	Competitive Bidding and Independent PPA		

NCRE generation tariff (three-tier tariff and rooftop PV)

- Most NCRE purchase tariffs are set higher than the current electricity selling price (LKR 16.2/kWh). This may cause more financial burden to CEB as NCRE generation further grows in future.
- Do larger-scale NCRE plants have more efficient PPA tariff through competitive bidding?

Three-tier Tariff (Cabinet approval March 2014)

Technology/ Source	Escalable Base O&M Rate (year 1-20)	Escalable Base Fuel Rate (year 1-20)	Non-escalable (fixed rate)		
			Tier 1: Years 1-8	Tier 2: Years 9-15	Tier 3: Year 16-20
Mini-hydro	1.83	None	15.56	5.98	3.40
Mini-hydro-local	1.88	None	15.97	6.14	3.49
Wind	1.30	None	22.05	8.48	4.82
Wind-local	1.33	None	22.60	8.69	4.94
Biomass	1.52	12.25	9.67	3.72	2.11
Biomass 16yr onwards	1.90				
Agro & Industrial waste	1.52	6.13	9.65	3.71	2.11
Agro & Indus 16yr onwards	1.90				
Waste Heat	0.48	None	9.14	3.52	2.00
Escalation rate for year 2013	5.16%	3.44%			

Other renewable energy technology:

Flat tariff of Rs. 23.10 / kWh (non-escalable for 20 years)

Rooftop PV

- **Net Metering**: No payments for generation
- **Net Accounting**: LKR 22.00/kWh (first 7 years) and LKR 15.00/kWh (next 13 years) for net export energy to CEB
- **Net Plus**: LKR 22.00/kWh (first 7 years) and LKR 15.00/kWh (next 13 years) for all energy generated

2. Financial Position

- Current ratio indicates CEB had ability to meet its short-term obligations from 2014 to 2016 but it was gradually deteriorated from 2017.
- Assets have consistently increased as CEB invested in its power system and generation facilities.
- Funding structure increasingly relies on debt financing as indicated by the debt to assets ratio. (0.48 in 2014 to 0.73 in 2018)
- The debt service coverage ratio (DSCR) was greater than 1.0 in 2015 – 2016 indicating the core operation was able to generate sufficient cash flow to meet the debt service (interest payments and principal repayments). However, the ratio has dropped since 2017 indicating CEB's financial viability has been deteriorated.

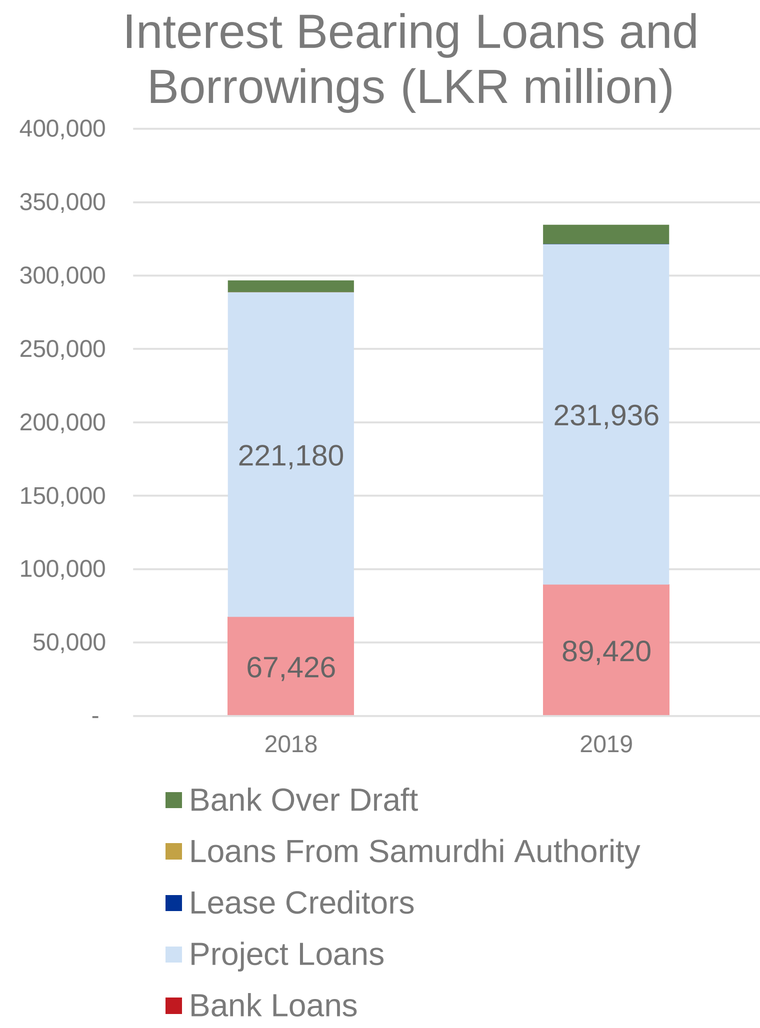
(LKR million)

	2014	2015	2016	2017	2018
Summary Balance Sheet					
Assets	764,035	776,852	804,354	831,990	870,920
Property, Plant & Equipment	681,471	694,415	704,695	724,065	747,049
Liabilities	369,204	347,225	390,991	464,798	533,276
Interest Bearing Loans and Borrowings	202,821	198,344	201,752	214,564	281,262
Equity	394,831	429,627	413,363	367,192	337,644
Contributed Capital	289,038	302,228	302,695	302,695	302,695
Reserves	27,434	28,463	30,283	32,783	34,830
Retained Earnings	78,359	98,936	80,385	31,714	119
Total Equity & Liabilities	764,035	776,852	804,354	831,990	870,920
Financial Indicators					
Current Ratio	0.87	1.16	0.89	0.62	0.73
Debt to Assets	0.48	0.45	0.49	0.56	0.61
Debt Service Coverage Ratio (DSCR) *	-	2.94	1.04	(0.80)	0.29

* Indicators from financial analysis in CEB Corporate Plan 2019-2023

Debt Structure and Government Capital Injection

- Most borrowings of CEB are project loans provided by bilateral and multilateral financial institutions such as ADB, JICA, AFD, etc.; 91% of which (LKR 210 billion) are subsidiary loans through GOSL treasury.
- Subsidiary loan interest rates are as high as 6% - 10% p.a. (Subsidiary loan conditions for JICA loans are not determined)
- In 2019 LKR 16.9 billion debt to treasury was transferred to equity.



3. Electricity Tariff Revision and Government Subsidy

Electricity Tariff Revision

- The Tariff Methodology allows electricity utilities to apply their electricity tariff to include all costs for generation, transmission and distribution such as capital expenditure, depreciation, return on assets, operational expenses, inflation, etc.
- Based on the regulations, tariff review is implemented for each five-year tariff period and tariff adjustments are made semi-annually upon request by CEB subject to approval by PUCSL.
- No revisions are made since the last revision in 2014 because PUCSL does not allow the tariff hike for end consumers.

Government Subsidy

- CEB is entitled to receive government subsidy based on the Procedure for Review and Adjustment of Tariff (July 2016) to avoid tariff increase for low income customers (Samurdhi beneficiaries).
- Accordingly, CEB files request for subsidy every year; for instance, CEB requested LKR 85 billion in 2019 for the subsidy. However, the government has not provided any direct subsidy to CEB in line with those regulations. As a result, CEB is not allowed to recover reasonable expenses on a regular basis.
- Instead of the direct subsidy, GOSL provided LKR 48 billion by offsetting CEB's fuel expense dues to Ceylon Petroleum Corporation (CPC) in 2020. Likewise, some project cost amounting to LKR 46.8 million was paid by GOSL instead of the subsidy.

4. Next Steps: Financial Projection of CEB

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Next Steps in Further Activities

1. Financial Status Analysis

- Analysis of recent financial status
- <u>Shows current challenges</u>

2. Projection under Existing Policies

- Scenario under current VRE regulatory setup
- <u>Shows unsustainable power system operation</u>

3. Projection under Proposed Policies

- Scenario under proposed improvement of VRE policies and regulations
- <u>Shows sustainable power system operation and VRE development in future</u>

<u>Proposed NCRE Policies</u>

Examples:

- Government subsidy for excess electricity purchase
- VRE levy charge to customers to fund FIT payments
- New tariff system adopting fuel cost adjustment, etc.…

5. Corporate Financial Planning and Monitoring

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Budgeting Process and Monitoring Framework of CEB

Stage	Process	Section/ Department	In charge
Planning/ Budgeting	Preparation of Preliminary Financial Plan (PFP)	Finance Division	AFM (Corporate)
	PFP provides the upper ceilings for operational & maintenance cost for each division		
	Based on the upper ceiling provided in the PFP, each Division needs to prepare their divisional financial budgets	Each Division (9 Division in CEB)	AGM/AFM of each Division
	Prepare the CEB Master Budget	Finance Division	AFM (Corporate)
Monitoring & Evaluation	Variance Analysis of Actual vs. Budget on monthly basis	Finance Division	AFM (Corporate)
	Calculation the Key Performance Indicators (KPIs)	Corporate Strategy/Finance Division	AGM(CS)/FM/ AFM (Corporate)
	Revise the budget if necessary	Finance Division	AFM (Corporate)

Corporate Plan 2019 – 2023 and Action Plan 2020

- Corporate Plan provides financial analysis of CEB's performance (2015 - 2018) and financial projection for the 2019 – 2023 period.

- The financial projection of Corporate Plan and Action Plan 2020 shows CEB's net loss will increase under the assumption that the average electricity tariff (LKR 16.20/kWh) is not revised over the period.

	2019	2020	2021	2022	2023
Average Tariff (LKR/kWh)	16.20	16.20	16.20	16.20	16.20
Average Cost per Unit (LKR/kWh)	22.83	23.72	25.09	26.73	24.70
Net Profit (Loss) before Other Income (LKR million)	(99,040)	(120,062)	(149,092)	(185,334)	(157,061)
Estimated Subsidy (LKR million)	103,678	120,984	149,092	185,334	157,061

Key Performance Indicators (KPIs) 2019 [Excerpt]

Corporate Goals and KPIs [Excerpt]		KPI Figures				KPI Target 2019	Basis for Target KPI
		Q1-2019	Q2-2019	Q3-2019	Q4-2019		
1.	**Make CEB Financially Stronger**						
1.1	Gearing Ratio	0.48	0.49	0.54	0.48	0.67	Approved budget 2019
1.2	Percentage of Operation Profit over Total Revenue	-28%	-28%	-34%	-27%	-31%	Ditto
1.3	Percentage Change of Financial Cost (Year-to-year Basis)	27%	45%	56%	73%	-14%	Annual budget 2018 to 2019
1.4	Percentage Change of Short-term Borrowing (Year-to-year Basis)	-45%	-1%	-18%	85%	-31%	Ditto
2.	**Enhance low cost electricity generation**						
2.1	Average Electricity Cost per Unit of Electricity (LKR)	15.85	16.65	17.06	15.76	15.94	Approved budget 2019
2.2	Average Operational Cost per Unit of Electicity Sold (LKR)	3.72	3.78	4.63	5.48	5.19	Ditto
2.3	% of Electircity Generated from Plants Having a Unit Cost above Average Generation Cost (energy)	37%	38%	14%	14%	14%	Ditto
3.	**Provide electricity to entire country at an affordable price**						
3.1	Overall Elecrification Level	99.8%	99.8%	99.8%	99.8%	100%	Achievable target estimated
3.2	Average Household Electricity Expenditure Ratio	1.5%	1.7%	1.7%	1.5%	2.0%	Considering regional/world values
8.	**Optimize integration of green energy**						
8.1	No of Green energy projects integrated to the grid	1,006	979	1,137	1,058	-	-
8.2	% Increase of installed capacity from renewable sources	3.82%	3.67%	4.68%	4.67%	4.00%	Achievable target estimated
8.3	Percentage of green energy produced over total energy	28.42%	21.71%	32.63%	56.27%	30.00%	Ditto
8.4	Average emission index (kg./kWh)	0.601	0.622	0.562	0.391	0.500	Ditto

6. Clarifications and Discussion Points

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1. Clarifications

(1) Electricity Bill Collection Rate

(Unit: million Rs.)

Year	2015	2016	2017	2018	2019
Electricity bill collection	189,289	224,931	238,564	230,394	261,728
Revenue	188,625	206,892	218,450	229,571	242,934
Bill collection rate	100%	109%	109%	100%	108%

- Why over 100%? What is the definition of bill collection rate?

(2) Verifiable Indicator for Project Design Matrix

Project Purpose	Verifiable Indicator	Means of Verification
Institutional Capacity for improving transmission and distribution operational reliability is enhanced to get prepared for increased share of VRE planned in LTGEP.	(1) Corporate finance plan is updated periodically.	(1) CEB management report
	(2)… (3)……	(2)… (3)……

- What is the appropriate document to verify the annual corporate planning?

Action Plan? Annual Budget and KPI targets?

2. Discussion Points for Improvement of CEB Finances

(1) Electricity tariff revision and government subsidy

- It is observed that overall electricity tariff level increase (increase in the average selling price) is imperative to recover the constant operational deficit of CEB.
- It is also observed that the average household electricity expenditure ratio indicates tariff increase may be tolerable among customers.
- In terms of regulations, it seems that the tariff methodology that enables cost recovery has been already established.
- The problem seems to be the actual execution of regulations by the regulatory agency and the government (PUCSL approval to tariff revision proposal and GOSL subsidy support).

→ What would be the viable process/ strategy for CEB to achieve the necessary tariff revision? How can the JICA project support CEB's effort?

→ Within the tariff structure, are any alteration necessary? (e.g. further application of TOU, alteration of cross-subsidy level, etc.)

(2) NCRE Purchase Tariff

- Most small-scale NCRE purchase tariffs are set higher than CEB's electricity selling price and may cause more financial burden to CEB as NCRE generation further grows in future.

→ <u>What would be the viable NCRE tariff level/structure in future to promote NCRE development?</u>

→ <u>Do current larger-scale PV and other NCRE plants sell at more efficient prices through competitive bidding and independent PPAs?</u>

(3) Debt Structure of CEB

- CEB's funding structure increasingly relies on debt financing, most of which consists of treasury's subsidiary loans derived from donor loans. Subsidiary loan interest rates are as high as 6% - 10% p.a. which might be significant financial burden to CEB over time.

→ <u>Is there need for a comprehensive debt restructuring program?</u>

<u>3. Request for data/information for financial projection</u>

- Financial model prepared for Corporate Plan and/or annual budget

Follow-up information and inquiry

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International comparison of electricity rates and generation sources

Country		Sri Lanka		Thailand		Indonesia		Vietnam		Laos	
Population (Millions)		21.4		66.4		264.2		93.7		6.9	
GDP per Capita (USD/Capita)		4,101		7,604		3,972		2,551		2,706	
Electrification Ratio (%)		99.3		100		97.1		99.1		93.5	
Average Electricity Rate (US Cent/kWh) *		10.03		11.63/10.80 (MEA/PEA)		7.88		6.49		8.56	
Gross Electric power Production By Major Power Utilities & IPPs (GWh)	Hydro	5,149	33%	7,597	4%	21,636	8%	84,984	40%	22,582	65%
	Thermal	8,393	55%	152,239	86%	235,405	83%	124,196	59%	12,020	35%
	VRE etc.	1,832	12%	17,800	10%	26,770	9%	3,121	1%	63	0%
	Total	15,374		177,636	**	283,811		212,300		34,665	

Year of data: 2018 (Some of the data comes from statistical data of 2017)
* Estimated by calculation: Average Electricity Rate = Electricity Sales Revenue / Electricity Sold
** Net import electricity of Thailand is around 25,600GWh.
*** Net export electricity of Laos is around 26,400GWh.

Follow-up information and inquiry

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Inquiry for data/information

- Financial model (calculation spreadsheets) prepared for (i) CEB Action Plan and (ii) Annual Budget
- Explanation on difference between electricity sales revenue recognition and bill collection
- Documents related to the debt restructuring and interest rate reduction for CEB in 2020
- Calculation sheets by CEB for (i) tariff adjustment request and (ii) government subsidy request

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The Project for Capacity Development on the Power Sector Master Plan Implementation Program

Progress of Financial Projection

December 8, 2020

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

1. Financial Projection: Relation with WG1 Activities

CHUBU Electric Power
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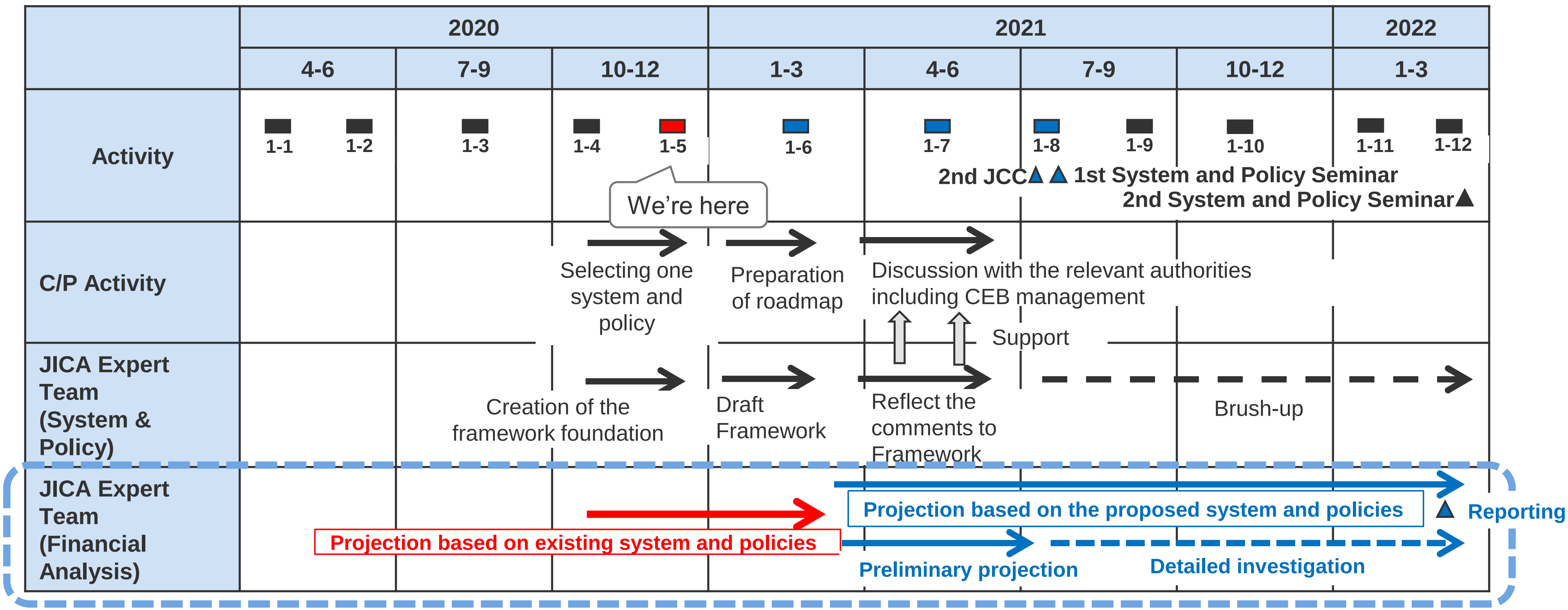
Up to May 2021

- **Financial projection under existing policies with various case scenarios (base case, tariff level increase, etc.)**
- Preliminary projection under newly proposed policies
- Review and discussion about electricity tariff issues and proposing policies

July 2021
1st System and Policy Seminar



2. Major Assumptions

Projection Period		2020 – 2030 (tentative)
Power System	Generation	Current generation source shares + LTGEP Note: Detailed shares of VRE sources necessary
	Transmission & Distribution	Current power system facilities + Master Plan
Revenue	Demand projection	LTGEP 2020 – 2039 (Base Case)
	Electricity tariff	Current tariff schedule (Base Case)
OPEX	Fuel Cost	Current fuel price level or LTGEP (Base Case)
	Other operational expenditure	Current OPEX level
Non-CEB generation cost	FIT scheme for renewables IPP generation	Current FIT scheme (Base Case) Current PPA Tariff
Debt	Bank Loans and Treasury Subsidiary Loans	Outstanding debt + new loans for CAPEX needs (following the existing loan conditions)
Other variables	……	Basically follow the recent transactional practices read in the financial statements

3. Status

- Data inputs of 2017-2019 financial results
- Review and data inputs of LTGEP 2020-2039 (draft) is underway

TO DO:

- 2020 Budget
- Generation and consumption forecast (LTGEP)
- OPEX projection (current level + LTGEP)
- Existing loans (project loans and bank loans)
- CAPEX projection (LTGEP)
- New loans (current loan conditions)
- Preliminary cash flow projection
- Pro-forma financial statements

4. Request for CEB

- **<u>Pending data and information including new request</u>:**
  1. Financial Model (Excel Spreadsheet) used for the preparation of Corporate Plan 2019 – 2023 projection
  2. Excel spreadsheet of CEB financial status used in CEB's PowerPoint Presentation for WG1 (28 Oct 2020)
  3. Excel spreadsheet of CEB Budget 2020
  4. Other data and information as required in the course of work

- **<u>Web meeting with selected CEB officials for financial data collection and detailed explanation on the financial projection spreadsheet (About two hours: Early January 2021)</u>**

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The Project for Capacity Development on the Power Sector Master Plan Implementation Program

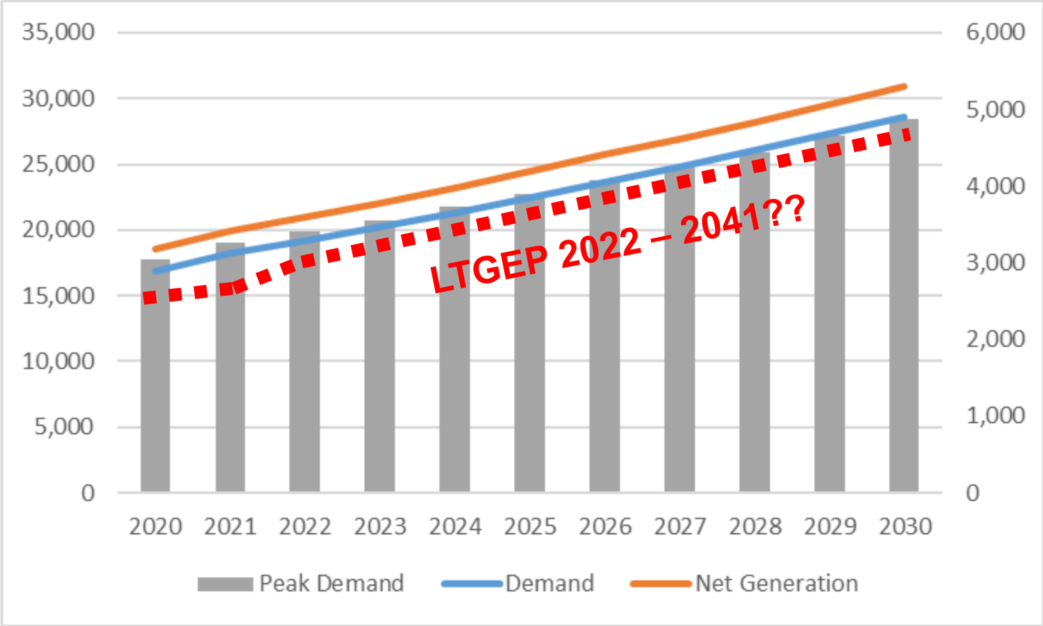
Follow up on CEB Financial Analysis

March 2020

Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

Demand and Generation (LTGEP)

- LTGEP 2020 – 2039 projects steady increase in demand and generation based on the previous economic assumptions.
- Currently the updating to LTGEP 2022 – 2041 is underway and planned to be submitted in April 2021.
- The updated LTGEP 2022 – 2041 will have decreased demand projection reflecting COVID-19 impacts
- The demand decrease in 2020 was recorded as much as around 2,000 GWh (10%).



CEB Loans and Borrowings – Term Loans (Bank Loans)

- Term loans accounts for 26.7% of total borrowings
- Weighted average interest rate is estimated at 7.48%

	Value (LKR mn)	Interest Rate	Weighted Average
Term Loans (Bank Loans)	**97,059**	**6.83% - 11.78%**	**7.48%**
People's Bank	56,560	6.83% - 7.33%	7.25%
National Savings Bank	7,499	7.33% - 11.78%	8.81%
Bank of Ceylon	20,000	7.35%	7.35%
Seylan Bank	2,000	6.85%	6.85%
NSB+Sampath+Seylan	10,000	8.16%	8.16%
NTB	1,000	7.35%	7.35%

CEB Project Loans – Treasury Loans

- All treasury loans are denominated in LKR?
- What is the status of "not finalized" interest rates?

	Value (LKR mn)	Interest Rate	Assumption
Project Loans			
Treasury Loans	**221,857**		**2.85%**
Puttalam Coal Power project 155 Mn	15,116	6 months LIBOR* + 1%	1.20%
Puttalam Coal Power Project 300Mn	30,222	2.00%	2.00%
Puttalam Coal Power Project - Phase ii	96,903	2.00%	2.00%
New laxapana & Wimalasurendra Rehabilitation project	39	10.00%	10.00%
Clean Energy & Access Improvement Project (SLA I)	3,970	10.00%	10.00%
Clean Energy Access Improvement Project (SLA II)	615	10.00%	10.00%
Sustainable Power Sector Support Project	3,712	10.00%	10.00%
Habarana Veyangoda Transmission Line Project	10,319	Not Finalized	2.00% ?
Greater Colombo trans & Distribution loss reduction	22,004	Not Finalized	2.00% ?
Clean Energy Net work efficiency Improve: Project	17,076	10.00%	10.00%
National Transmission & Distribution Network Development	6,065	Not Finalized	2.00% ?
Green Power Dev. & Energy efficiency improvement Project	6,034	0.00%	0.00%
Green Power Dev. & Energy Efficiency Improvement Project	4,079	Not Finalized	2.00% ?
Construction four grid Substation AFD-1011-04-L	4,439	Not Finalized	2.00% ?
Green Power Dev. & Energy Efficiency Improvement Project (Tranche 2)	1,263	10.00%	10.00%

* Current 6 months USD LIBOR = 0.2%

CEB Project Loans – Bank Loans (Direct Borrowings)

- These project bank loans (ADB etc.) are denominated in USD?

	Value (LKR mn)	Interest Rate	Assumption
Project Loans			
Bank Loans (Direct Borrowings)	**43,077**		**1.37%**
Broadland Hydro Power Project (HNB)	964	6 months LIBOR* + 6.3%	6.50%
Broadland Hydro Power Project (ICB)	5,011	6 months LIBOR + 3.2%	3.40%
Green Power Dev. & Energy Efficiency Improvement Project (ADB)	7,689	6 months LIBOR + 0.6%-0.1% + Premium 0.1%	0.90% ?
Green Power Dev. & Energy Efficiency Improvement Project (ADB)	3,895	2.00%	2.00%
Supporting Elec.supply reliability improvement Project (ADB)	5,078	6 months LIBOR + 0.6%-0.1% + Premium 0.1%	0.90% ?
Mannar Wind Power Generation Project (ADB)	20,441	6 months LIBOR + 0.6%-0.1%	0.80% ?

* Current 6 months USD LIBOR = 0.2%

Other Loans – LEC and Samurdhi Authority

	Value (LKR mn)	Interest Rate	Weighted Average
Other Loans	**2,044**		**9.51%**
Loans from Related Party			
Lanka Electricity Company (Pvt) Ltd	2,000	9.50%	9.50%
Loans from Other Govt. Institutions			
Samurdhi Authority	44	10.00%	10.00%

Summary – Loans and Borrowings (Dec 2020 Draft Accounts)

	Value (LKR mn)	Share	Est. Avg. Interest Rate
Terms Loans (Bank Loans)	**97,059**	**26.7%**	**7.48%**
Project Loans			
Treasury Loans	**221,857**	**60.9%**	**2.85%**
Bank Loans (Direct Borrowings)	**43,077**	**11.8%**	**1.37%**
Other Loans	**2,044**	**0.6%**	**9.51%**
Total	**364,037**	**100.0%**	**3.95%**

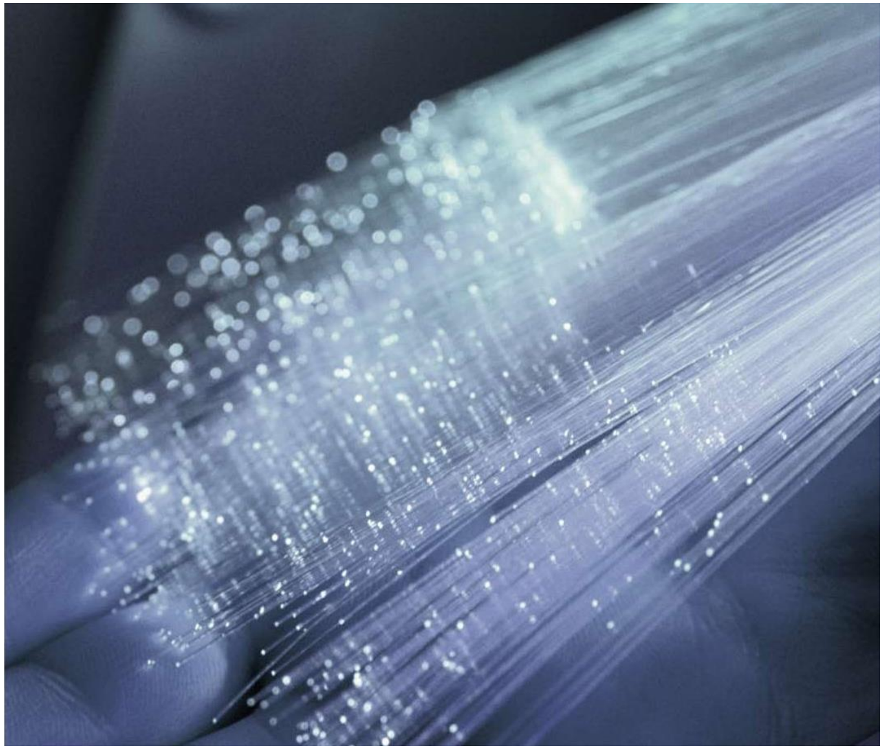
Clarifications/ Questions

- Latest LTGEP (2022 – 2041) draft to be submitted to PUCSL
- Latest Corporate Plan and its financial analysis
- 2020 Actual Accounts (Draft Financial Statements)
- 2021 Budget

Further steps

- Detailed generation cost analysis by the generation sources especially VRE
- Pro forma financial statements and financial indicators (financial ratios)
- Detailed debt analysis and subsidy requirement estimation
- Projection under case scenarios (sensitivity analysis)

  increasing average tariff level, adjustment of cross subsidy tariff, etc.



CAPACITY DEVELOPMENT FOR POWER SECTOR REGULATION
TA No. 7265-SRI

Tariff methodology for DLs and TL

MERCADOS
ENERGY MARKETS INTERNATIONAL
Finding new paths for energy markets

ADB

PUCSL
Public Utilities Commission of Sri Lanka
Regulator for Infrastructure Industries

mercados
ENERGY MARKETS INTERNATIONAL

RMA
Energy Consultants

MADRID
MILAN
MOSCOW
NEW DELHI
ANKARA

Non-uniform tariff

- Introduction of the cost-reflected tariffs implies that:
  - Each DL should have its own tariffs as distribution cost will not the same across the 5 regions
  - Drawback: this is not the current situation and the removal of the current practice of uniform tariffs may generate some changes in end-user bills.
  - From the customers point of view, the distribution cost is a minor part of the total end-user bill (about 20 %). Therefore the effect of removing the current practice will be minor but still an effect.

- Uniform tariff solves this problem but:
- requires a mechanism to equalise the allowed revenues and the collected revenue of the DLs. It can be done:
  - through the use of differential input costs (for example, requiring those DLs with the lowest costs to pay a higher charge for purchased energy than other DLs)
    - Applied for instance in Vietnam
    - Less transparent but simpler to implement
  - through transfers between DLs.
    - Applied in many countries (e.g. Turkey, Spain)
    - More complex to implement
    - Increase the regulatory burden.

Non-uniform tariff

•Uniform tariff is policy decision, not a technical one (same nature that subsidy policy)

•In case of uniform tariff, the use of differentiated SB Bulk supply tariffs is recommend

•Distorted bulk supply tariffs are not an issue in Sri Lanka – no retail competition and private agents

•Simpler to implement, mainly if a revenue cap is implemented as suggested

•Need to:

- •Increase frequency Diff adjustment (quarterly or less)
- •Remove Diff from revenue control formula
- •Estimate ex-ante diff and ex post adjustment of Diff lagged one period
- •Monthly SB Invoicing will include the capacity and energy cost +/- a proportional share of diff ex-ante +/- diff ex-post

Crucial issues in tariff design

Guiding principles

- *Cost of supply:* Tariff rate should be cost reflective and consider all required costs.
- *Efficient use of energy:* Tariff rate should generate proper signal for customers promoting energy efficiency.
- *Fairness to consumers and sensitiveness to social considerations:* Customers should be rated according to the way they use the electricity system, although some considerations to social aspects can be taken into account.
- *Simplicity to administer:* Tariff rate setting should be simple and transparent in order to minimize administrative costs for both the Regulatory Agency and the firm.
- *Easily understood by consumers:* Both the tariff structure and the tariff rates should be easily understood by customers.
- *Stable:* The more stable the tariff structure and the pricing, the better. Allocation of costs may vary from time to time as load profile for the different customer groups may change along time.

Democratic Socialist Republic of Sri Lanka

The Project for Capacity Development on the Power Sector Master Plan Implementation Program

CEB Financial Analysis

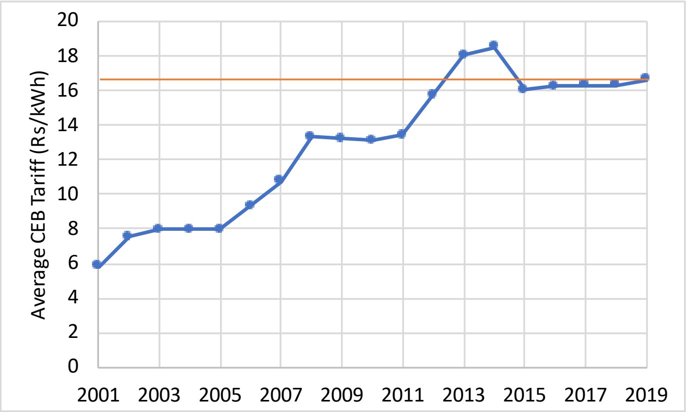
December 2021

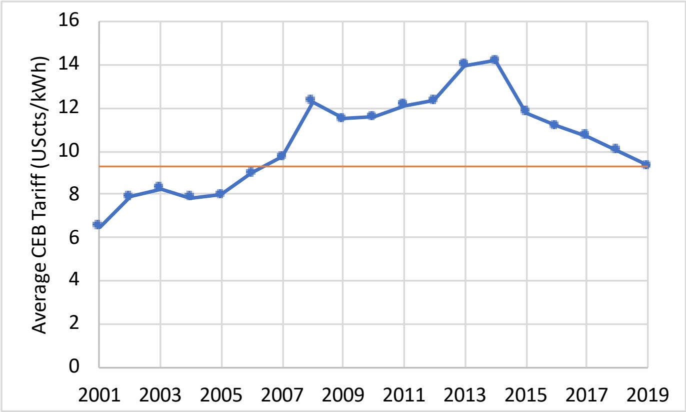
Chubu Electric Power Co., Inc.
Nippon Koei Co., Ltd.

1. Deteriorating financial status of CEB
(“A FOUR-YEAR ROAD MAP FOR FINANCIAL RECOVERY”)

Electricity Tariff

- Electricity sales tariffs approved by PUCSL have been persistently below CEB’s costs since 2011 though CEB has made regular tariff submissions required by the regulations.
- Electricity tariffs were reduced about 25% in 2014 and have not been revised until present. As a result, the US cents-based average tariff have been kept decreasing, reaching the level of 2007.





Generation Source

- Any large and lower-cost generation facilities have not been commissioned since 2014.
  - Trincomalee coal fired power plant at Sampur 500 MW (Production cost: LKR 7.39/kWh)
  - LNG fired combined cycle power plant 300 MW new, 600 MW converted (LKR 15.50/kWh)

Feed-in Tariff

- Cost reflective tariffs for rooftop solar PV have not been revised since 2016, while equipment prices and interest rates have reduced significantly.
- In 2019, renewable energy from small power producers was purchased at an average price of LKR 17.43 per kWh.
- Purchases from rooftop solar PV was at LKR 22 per kWh.

2. Financial Forecast "Do Nothing" Scenario

("A FOUR-YEAR ROAD MAP FOR FINANCIAL RECOVERY")

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- With no tariff increases or government support, the forecast shows continuous short-term debt repayments and annual revenue shortfall increase.
- The "do-nothing" scenario is not viable, with additional short-term borrowings by CEB reaching LKR 786 billion by 2025.

Description	2021	2022	2023	2024	2025
Electricity sold (GWh)	15,719	16,824	17,934	18,741	19,585
Average electricity tariff required (LKR/kWh) to meet all obligations and to breakeven every year from 2021 onward	23.96	26.55	29.17	28.57	30.54
If customer tariffs are not increased					
Average electricity tariff (LKR/kWh)	16.63	16.63	16.63	16.63	16.63
Annual revenue shortfall (LKR million)	115,221	166,892	224,895	223,770	272,421
Additional short-term debts (LKR million)	96,000	130,100	216,100	216,000	239,000

→ Similar results will be anticipated in the projection based on the latest LTGEP

3. Upward Scenarios for Financial Projection

[Scenario 2 from “(“A FOUR-YEAR ROAD MAP FOR FINANCIAL RECOVERY”)]

- Tariff increases of LKR 1.50 per kWh (75 cents per kWh every six months) will be implemented every year over 2021-2024.
- From 2025, the tariff methodology established under the Electricity Act 2009 will be operational.
- The government’s financial support
  - (a) Taking over the short-term debt principal repayments
  - (b) Pays the annual subsidy calculated for 2021-2023
- From 2024, there will be no subsidies required because prices will match costs.

→ Similar upward scenarios will be introduced in the financial projection

	2021	2022	2023	2024	2025	2026 ….
Scenario 1: No government support						
Electricity tariff change (LKR/kWh)	+2.40	+2.40	+2.40	+2.40	(0.16)	Price = cost
Yearly revenue shortfall possibly financed with more borrowings by CEB (LKR billion)	76.6	79.6	77.7	No new borrowings, but ongoing short terms debts to be settled		
Scenario 2: Government pays annual shortfall and repays short-term debts						
Electricity tariff change (LKR/kWh)	+1.50	+1.50	+1.50	+1.50	+0.15	Price = cost
Yearly shortfall paid by government (LKR billion)	91.5	102.5	112.8	No further commitments		
Principal of short-term debts paid by the government (LKR billion)	7.6	4.8	18.8	15.9	15.7	More payments
Scenario 3: As scenario 2 + no return on assets for CEB 2021-2023						
Electricity tariff change (LKR/kWh)	+1.27	+1.27	+1.27	+1.27	+1.29	Price = cost
Yearly shortfall paid by government (LKR billion)	79.2	93.4	107.6	No further commitments		
Principal of short-term debt repayment paid by the government (LKR billion)	7.6	4.8	18.8	15.9	15.7	More payments
Scenario 4: As scenario 3 + fuel at international prices						
Electricity tariff change (LKR/kWh)	+1.11	+1.11	+1.11	+1.11	+1.33	Price = cost
Yearly shortfall paid by government (LKR billion)	38.8	45.2	55.2	No further commitments		
Principal of short-term debt repayment paid by the government (LKR billion)	7.6	4.8	18.8	15.9	15.7	More payments
Scenario 5: As scenario 4, but with no tariff increase in 2021, recovery in 2025						
Electricity tariff change (LKR/kWh)	No increase	1.18	1.18	1.18	1.18	Price = cost
Yearly shortfall paid by government (LKR billion)	56.4	62.9	73.3	17.8	No further commitments	
Principal of short-term debt repayment paid by the government (LKR billion)	7.6	4.8	18.8	15.9	15.7	More payments

Unit Generation Cost for Mega solar PV

Yellow color cell: Manual input cell	Exchange rate (as of 7 June 2021)			
	1 USD =	197.5	LKR	
Orange color cell: Automatic calculated cell	1 USD =	109.4	JPY	

Scale of PV system	100.0	kW				
Unit cost for installation	180,000	LKR/kW	911	USD/kW	99,706	JPY/kW
Capacity Factor	17.0	%				
Generated power per kW in first installation year	1,489	kWh/kW				
Deterioration rate per year (Japan: 0.27% / year)	0.70	% / year				
O&M cost per year (0.9% of installation cost)	1,620	LKR/kW/year	8.20	USD/kW/year	897	JPY/kW/year

Item	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	16th year	17th year	18th year	19th year	20th year	total
Power generation efficiency [%]	100	99.30	98.60	97.90	97.20	96.50	95.80	95.10	94.40	93.70	93.00	92.30	91.60	90.90	90.20	89.50	88.80	88.10	87.40	86.70	
Generated power [kWh]	148,920	147,878	146,835	145,793	144,750	143,708	142,665	141,623	140,580	139,538	138,496	137,453	136,411	135,368	134,326	133,283	132,241	131,199	130,156	129,114	2,780,336
O&M cost [LKR]	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	3,240,000

Present value of generated power [kWh]	1,390,097	kWh	Dis rate	8%	←20years	
Present value of system cost and O&M cost [LKR]	19,590,540	LKR	Discount rate: 8%(AWPL 6%+margin 2%)			
LCOE (System cost and O&M cost / generated power)	14.093	LKR/kWh	0.07	USD/kWh	0.13	JPY/kWh

Unit Generation Cost for Mega solar PV

Yellow color cell: Manual input cell		Exchange rate (as of 7 June 2021)		
		1 USD =	197.5	LKR
Orange color cell: Automatic calculated cell		1 USD =	109.4	JPY

Scale of PV system	100.0	kW				
Unit cost for installation	180,000	LKR/kW	911	USD/kW	99,706	JPY/kW
Capacity Factor	17.0	%				
Generated power per kW in first installation year	1,489	kWh/kW				
Deterioration rate per year (Japan: 0.27% / year)	0.70	% / year				
O&M cost per year (1% of installation cost)	1,800	LKR/kW/year	9.11	USD/kW/year	997	JPY/kW/year

Item	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	16th year	17th year	18th year	19th year	20th year	total
Power generation efficiency [%]	100	99.30	98.60	97.90	97.20	96.50	95.80	95.10	94.40	93.70	93.00	92.30	91.60	90.90	90.20	89.50	88.80	88.10	87.40	86.70	
Generated power [kWh]	148,920	147,878	146,835	145,793	144,750	143,708	142,665	141,623	140,580	139,538	138,496	137,453	136,411	135,368	134,326	133,283	132,241	131,199	130,156	129,114	2,780,336
O&M cost [LKR]	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	3,600,000

Present value of generated power [kWh]	1,390,097	kWh		Dis rate	8%	←20years
Present value of system cost and O&M cost [LKR]	19,767,267	LKR		Discount rate: 8%(AWPL 6%+margin 2%)		
LCOE (System cost and O&M cost / generated power)	14.220	LKR/kWh	0.07	USD/kWh	0.13	JPY/kWh

Unit Generation Cost for Mega solar PV

Yellow color cell: Manual input cell	Exchange rate (as of 7 June 2021)		
	1 USD =	197.5	LKR
Orange color cell: Automatic calculated cell	1 USD =	109.4	JPY

Scale of PV system	1,000.0	kW				
Unit cost for installation	95,000	LKR/kW	481	USD/kW	52,623	JPY/kW
Capacity Factor	17.0	%				
Generated power per kW in first installation year	1,489	kWh/kW				
Deterioration rate per year (Japan: 0.27% / year)	0.70	% / year				
O&M cost per year (1% of installation cost)	1,900	LKR/kW/year	9.62	USD/kW/year	1,052	JPY/kW/year

Item	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	16th year	17th year	18th year	19th year	20th year	total
Power generation efficiency [%]	100	99.30	98.60	97.90	97.20	96.50	95.80	95.10	94.40	93.70	93.00	92.30	91.60	90.90	90.20	89.50	88.80	88.10	87.40	86.70	
Generated power [kWh]	1,489,200	1,478,776	1,468,351	1,457,927	1,447,502	1,437,078	1,426,654	1,416,229	1,405,805	1,395,380	1,384,956	1,374,532	1,364,107	1,353,683	1,343,258	1,332,834	1,322,410	1,311,985	1,301,561	1,291,136	27,803,364
O&M cost [LKR]	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	1,900,000	38,000,000

Total project cost (Installation cost + O&M cost)	133,000,000	LKR				
Unit Generation Cost (Total project cost / total generated power)	4.78	LKR/kWh	0.02	USD/kWh	0.04	JPY/kWh

Tariff scheme and structure and what is preferred by CEB

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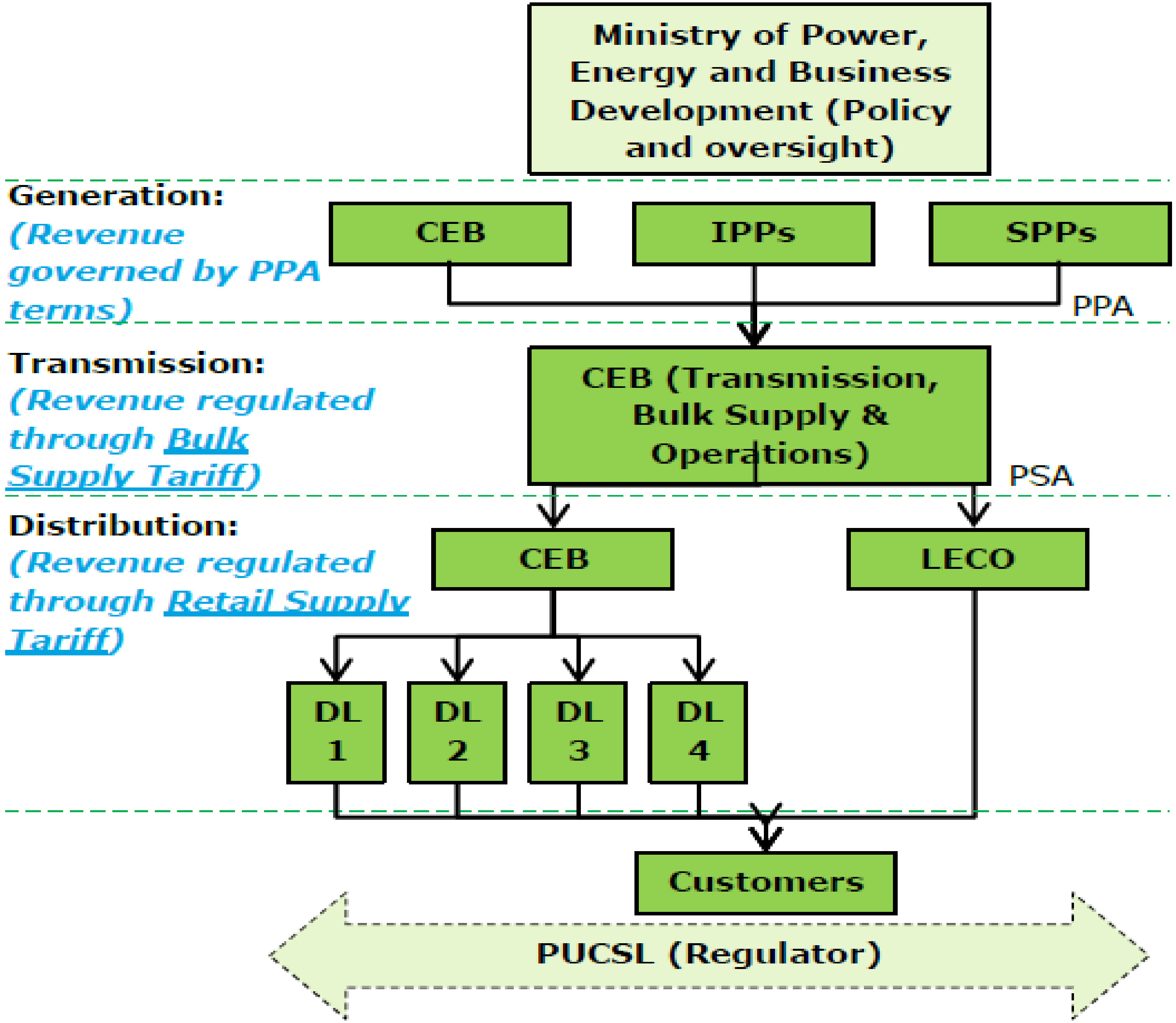
இலங்கை மின்சார சபை
CEYLON ELECTRICITY BOARD

Institutional Structure of the Sri Lankan Power Sector



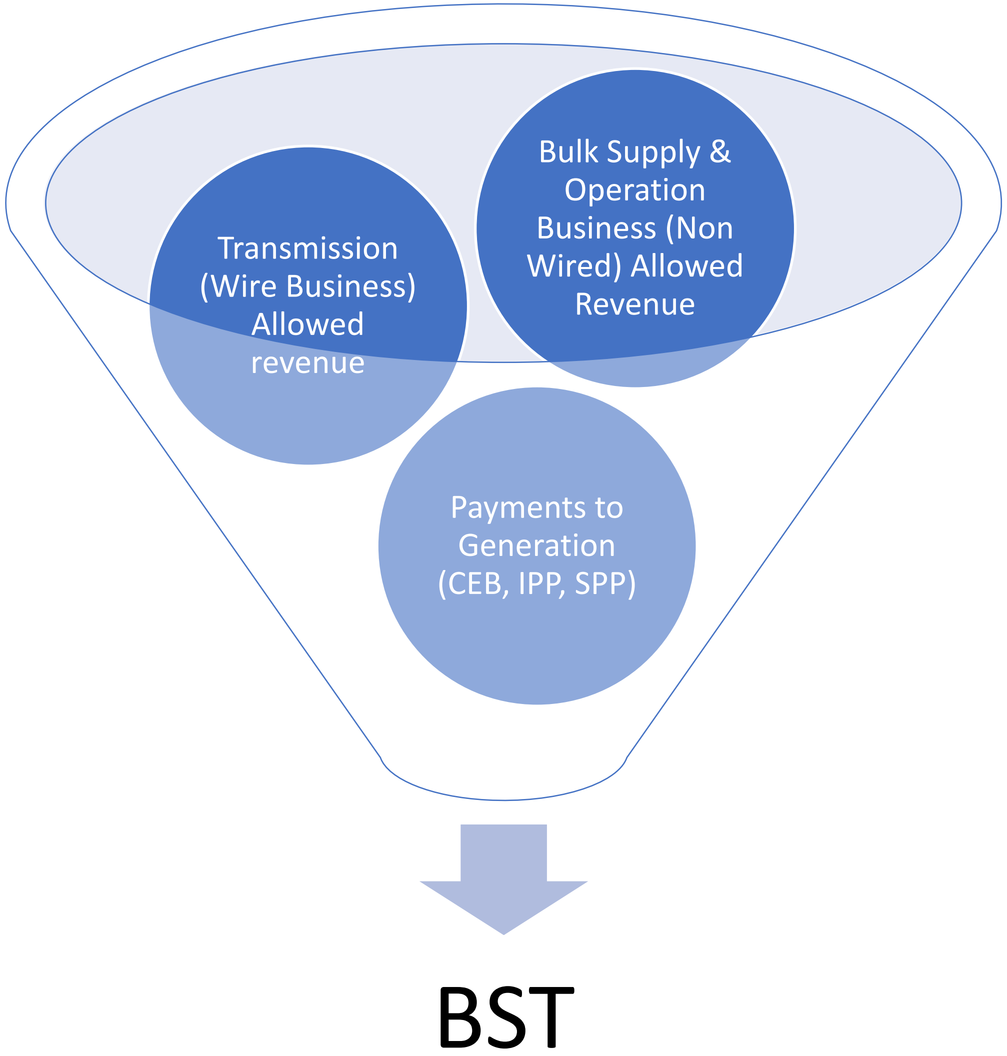
Existing Regulatory Framework for Tariff Determination

- Sri Lanka Electricity Act no 20 of 2009 and amendments later on – Tariff regulation is a function of PUCSL (Clause 3).
- Tariff Methodology, November 2015 -The PUCSL issued this to regulate the tariff-setting process and determine the Bulk Supply Tariff and Retail Supply Tariff.
- Electricity (Procedure for Review and Adjustment of Tariffs) Rules No. 03 of 2016 - A Gazette that sets out detailed procedure for tariff review and adjustments.

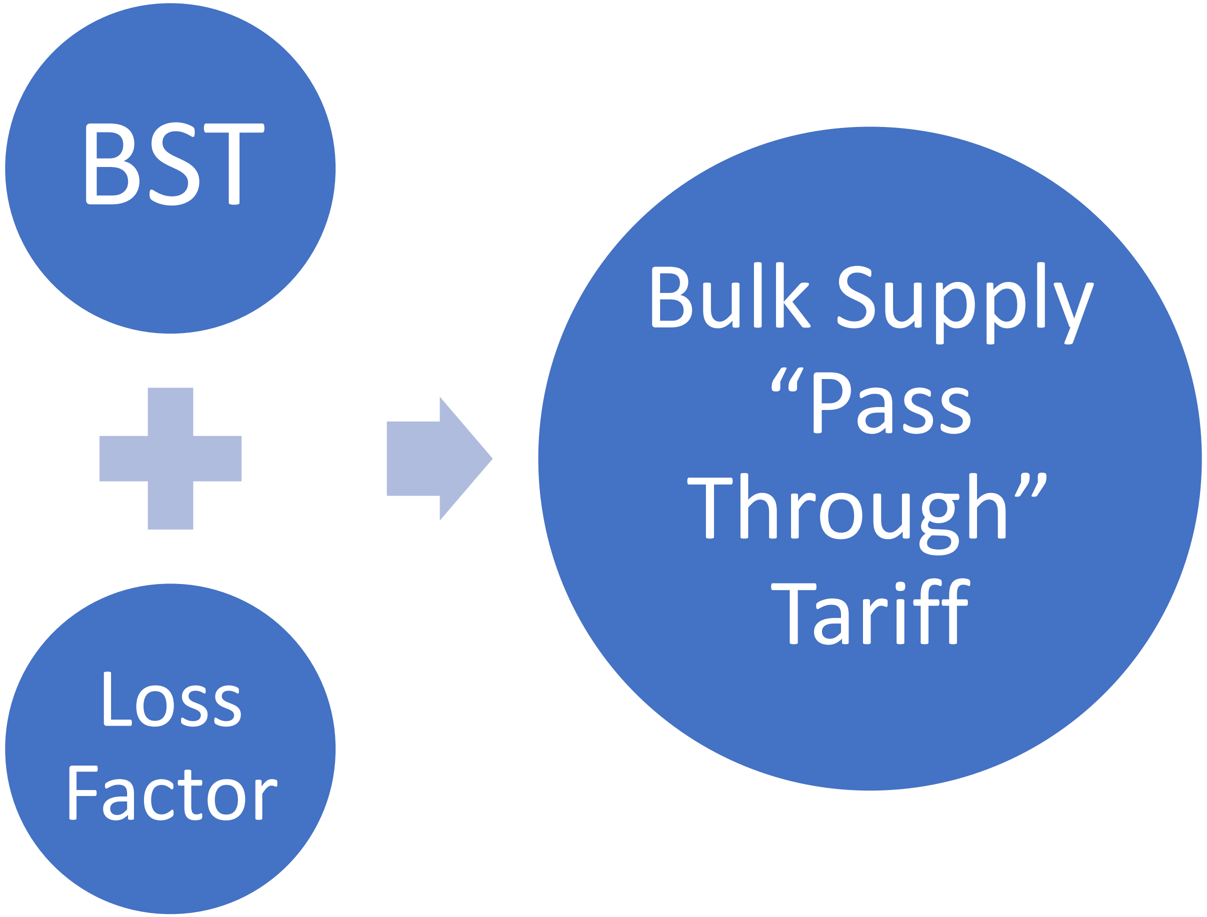
Existing Tariff Components (as per TM 2015)

- Bulk Supply Tariff - Tariff relating to electricity generation / purchase, use of Tr. System, bulk supply and system operation.
- Distribution Tariff - Tariff relating to the use of the licensee’s Distribution System (Dis. Allowed revenue).
- Retail Supply Tariff - For sale of power by Distribution Licensees to end users.

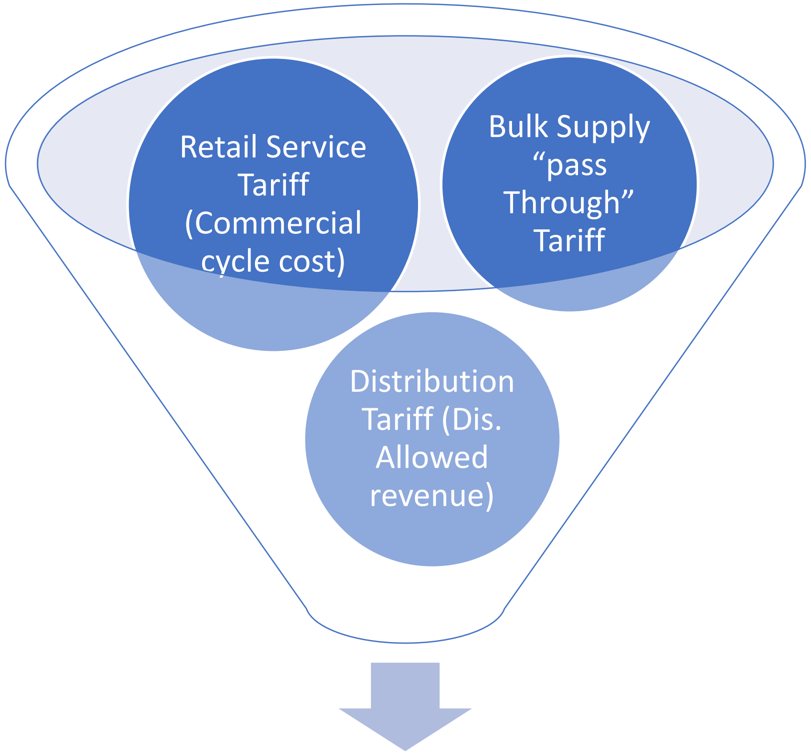
Bulk Supply Tariff (BST)



Bulk Supply "Pass Through" Tariff

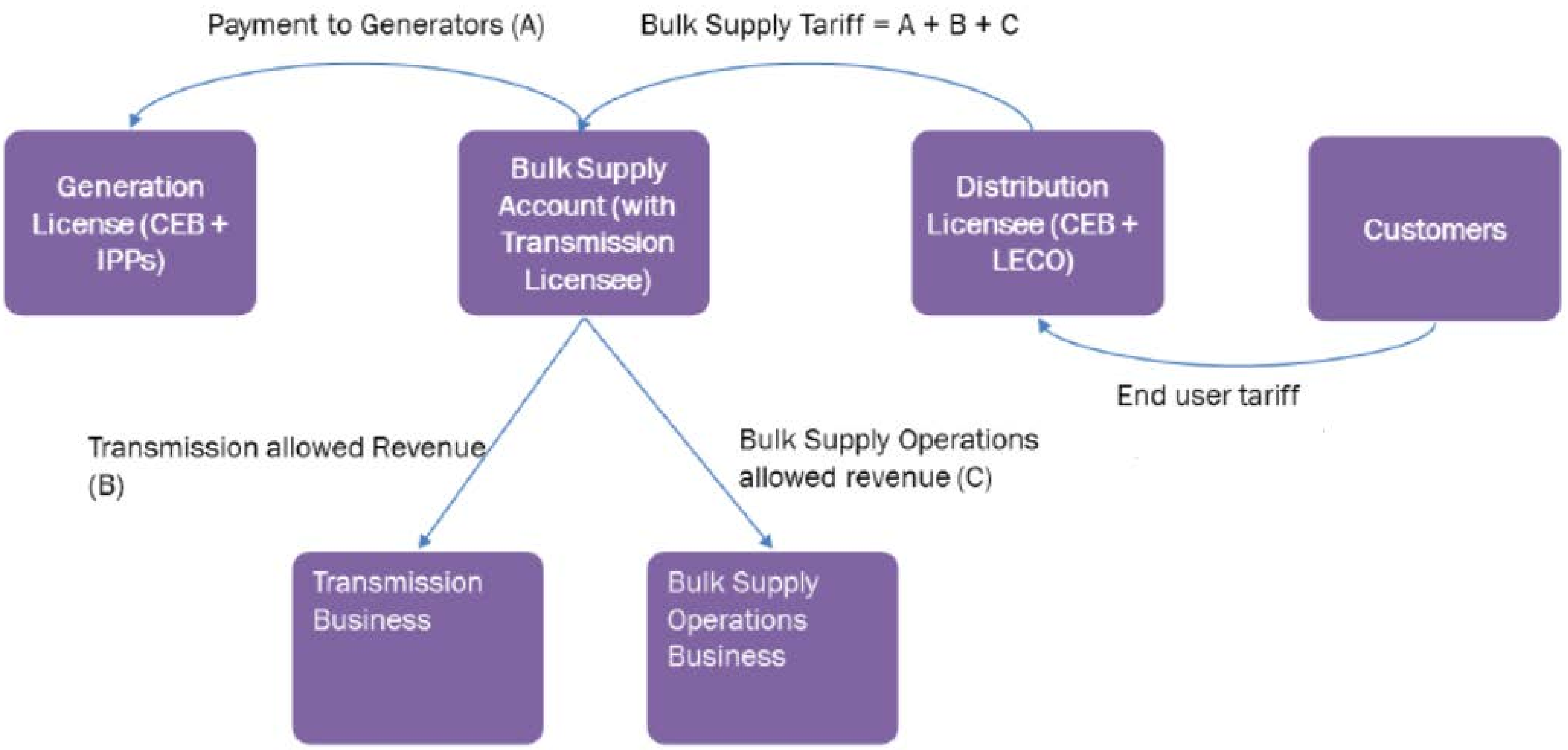


Retail Supply Tariff



Retail Supply Tariff (End User Tariff)

PUCSL Approved Tariff Methodology



End User Tariff

- Distribution Allowed Revenue varies for each DL depending on their customer mix, terrain, line lengths etc.
- Due to above differences; End Use tariff varies for customers in each DL and LECO.
- However, Government has fixed one end user tariff for the whole country until 2020.
- Fixed End User Tariff is commonly called as Uniform National Tariff or UNT.
- UNT is likely to be continued in future also.
- Until UNT exists; a temporary procedure called “Adjusted Bulk Supply Tariff” is in force.

Uniform National tariff (Last revised in 2014)

CEB TARIFF								
			lDOMESTIC		lToU for DOMESTIC		l NON DOMESTIC CATEGORIES	
EFFECTIVE FROM			16-09-2014		02-05-2017		15-11-2014	
(for each 30 - day billing period)								
					Unit Charge			Fixed Charge
DOMESTIC								
Consumption 0 - 60 kWh per month								
Block 1	-	0 - 30	units	@	Rs 2.50	per unit	+	Rs 30.00
Block 2	-	31 - 60	units	@	Rs 4.85	per unit	+	Rs 60.00
Consumption above 60 kWh per month								
Block 1	-	0 - 60	units	@	Rs 7.85	per unit	+	N/A
Block 2	-	61 - 90	units	@	Rs 10.00	per unit	+	Rs 90.00
Block 3	-	91 - 120	units	@	Rs 27.75	per unit	+	Rs 480.00
Block 4	-	121 - 180	units	@	Rs 32.00	per unit	+	Rs 480.00
Block 5	-	Above 180	units	@	Rs 45.00	per unit	+	Rs 540.00

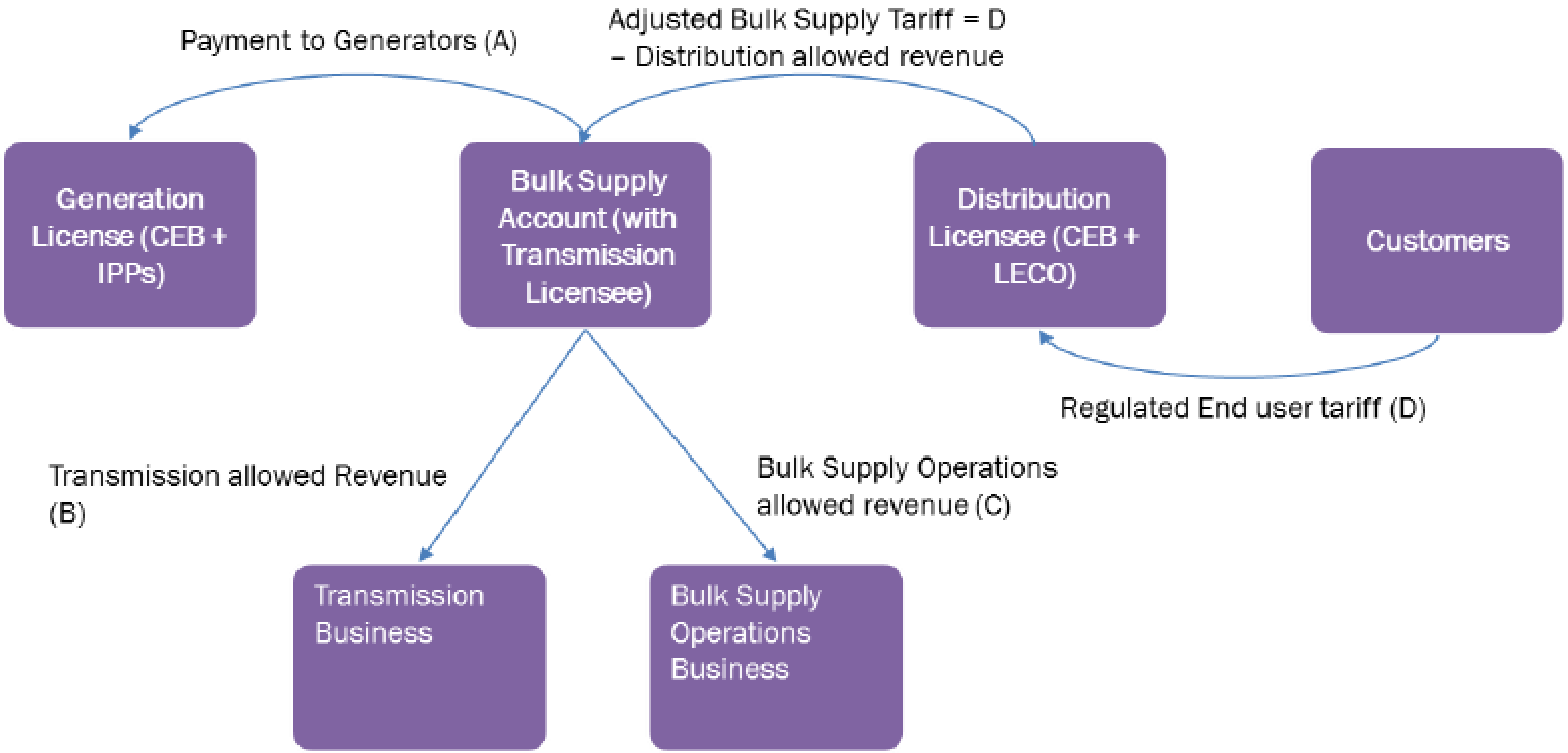
Time of Use Electricity Tariff for Domestic Consumers

Time of Use (ToU)	Energy Charge (Rs)	Fixed Charge (Rs)
Day (05.30 - 18.30 hrs)	25.00	540.00
Peak (18.30 - 22.30 hrs)	54.00	
Off Peak (22.30 - 05.30 hrs)	13.00	

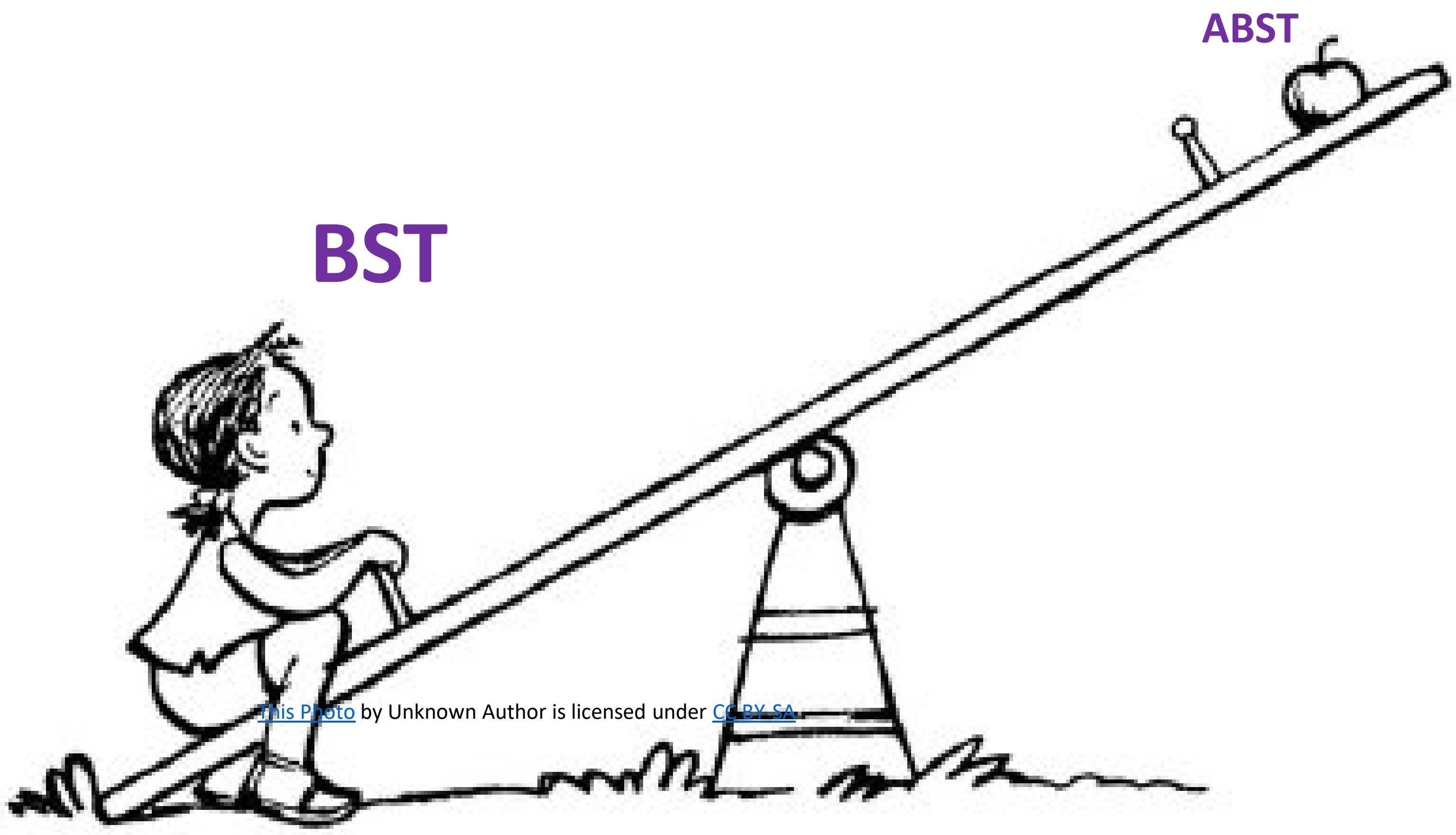
RELIGIOUS & CHARITABLE INSTITUTIONS

Block 1	-	0 - 30	units	@	Rs 1.90	per unit	+	Rs 30.00
Block 2	-	31 - 90	units	@	Rs 2.80	per unit	+	Rs 60.00
Block 3	-	91 - 120	units	@	Rs 6.75	per unit	+	Rs 180.00
Block 4	-	121 - 180	units	@	Rs 7.50	per unit	+	Rs 180.00
Block 5	-	Above 180	units	@	Rs 9.40	per unit	+	Rs 240.00

Adjusted Tariff Methodology



BST Vs. ABST

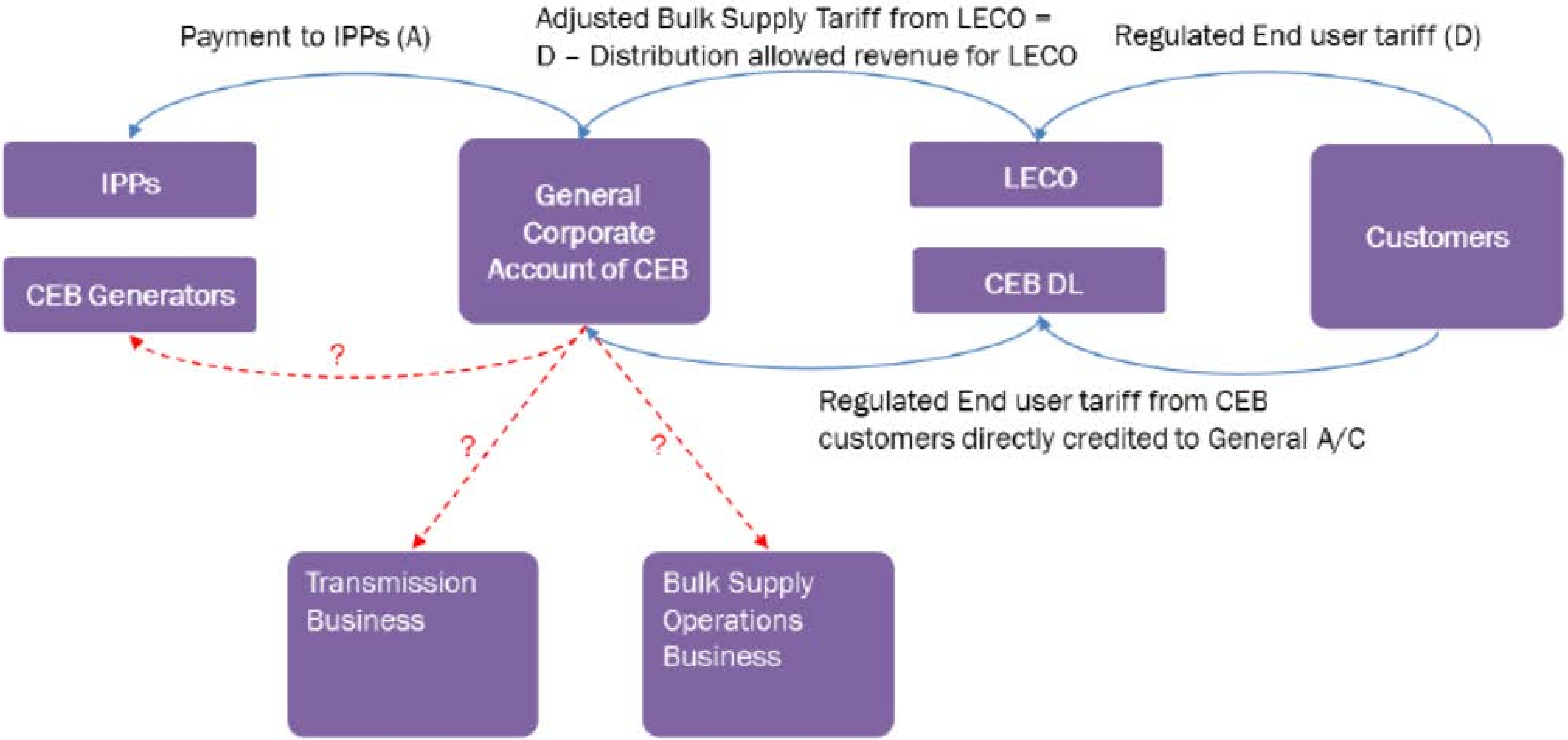


Adj BST

- Adj BST - BST is always negative since UNT is lower than the actual cost at selling point.
- This is a loss to Transmission Licensee.
- The loss is defined as subsidy to be pumped by the Government through National Budget.
- PUCSL has to recommend the Subsidy to Government. Procedure laid down in Elec. Rule No 03 of 2016.

No.	Year	Month/s	Subsidy Amount (MLKR)
1	2016	Jan-Dec	58,368.13
2	2017	Jan-Dec	80,875.66
3	2018	Jan-Dec	43,149.07
4	2019	Jan-Dec	101,916.42
5	2020	Jan- May	20,466.36
	Accumulated Total	Jan 2016 – May 2020	304,775.64

Current Cash Transaction amongst Licensees



What CEB has to say about Tariff

1. Tariff setting (economic regulation) is a responsibility of CEB until Sri Lanka Electricity Act (SLEA) No 20 of 2009 enacted.
2. Under Clause 66 (1) (d); the powers of CEB to formulate tariff has been repealed.
3. Now the economic regulation is in the Hands of PUCSL.
4. PUCSL has not been able to revise the tariff since 2014.
5. PUCSL has not been able to recommend the government for subsidy.
6. As a results CEB is making losses.

Economic regulation should be within CEB's purview.

What CEB has to say about Tariff Contd..

1. Distribution tariff and retail supply tariff is not currently prepared since UNT exist.
2. CEB has requested to prepare the both at least on papers to compare the differences of same with UNT.
3. However, those tariffs have never been prepared.
4. As a results there is no idea for how much the difference.

PUCSL is to be forced to prepare Distribution tariff and retail supply tariff even though UNT exists.

What CEB has to say about Tariff Contd..

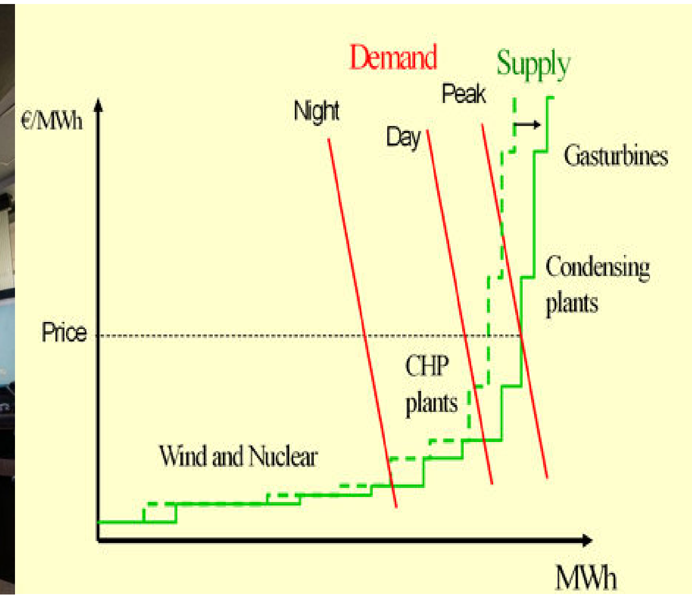
1. The number of tariff blocks in Residential and religious categories are too much.
2. It is unfair that customers with Higher consumption cross subsidize consumers with lower consumption.
3. It is not scientific to vary fix charge for each blocks based on consumption.
4. Tariff for roof top solar is always cheap for consumers due to disparity of rates given in the upper tariff blocks.
5. If Government opt to subsidize poor people use “Samurdhi” program instead electricity Tariff.

Rates of UNT have to be reviewed and revised.

Minimize cross subsidies

Cost reflective tariff has to be implemented.

Power market in Philippines



K.M.C.P Kulasekara
M.D.R.K Karunarathne
National System Control Centre

13th June 2022

CEYLON ELECTRICITY BOARD

CEYLON ELECTRICITY BOARD Enrich Life through Power

Country Overview

Population – 109.6 million(2020)

Three Main Regions- Luzon , Visayas and Mindanao

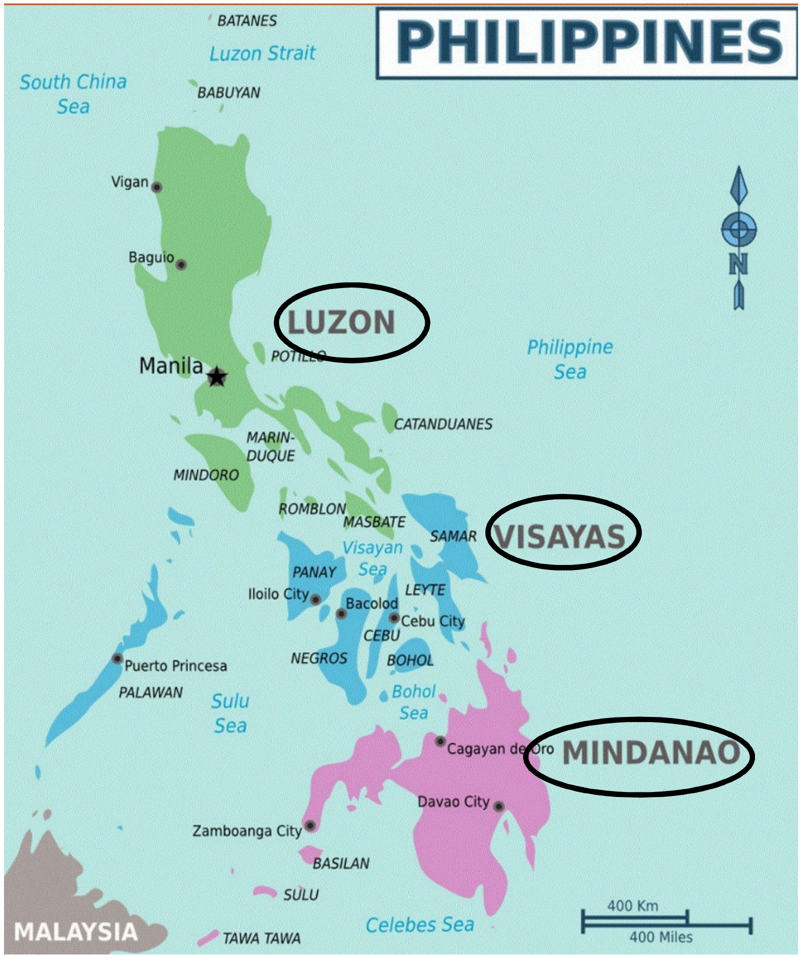
Electricity Sales- 78TWh(2017)

Annual Electricity sales growth-4.6 %

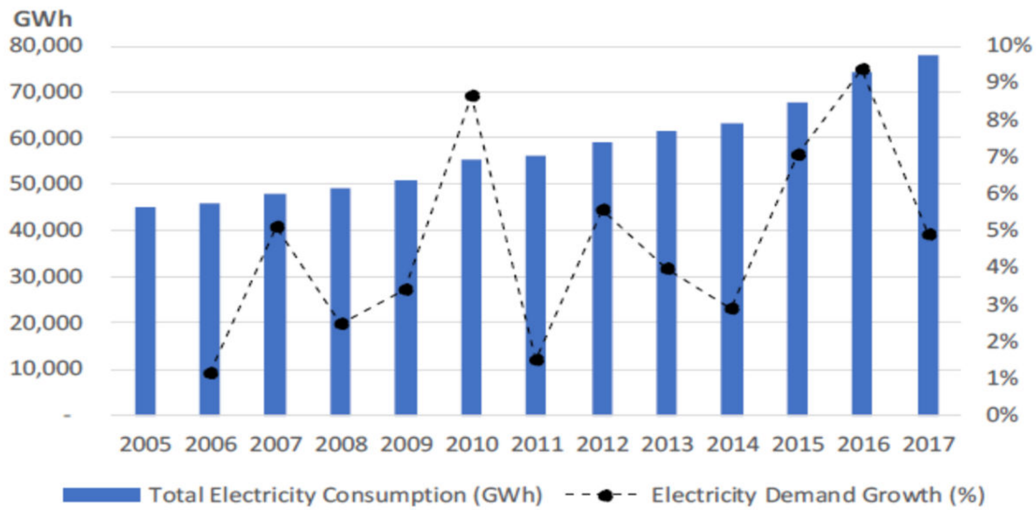
Major generation technologies

Coal 47%
Natural Gas 22%
Renewable 24%
Oil – 6.6 %

Generation capacity – 23 GW

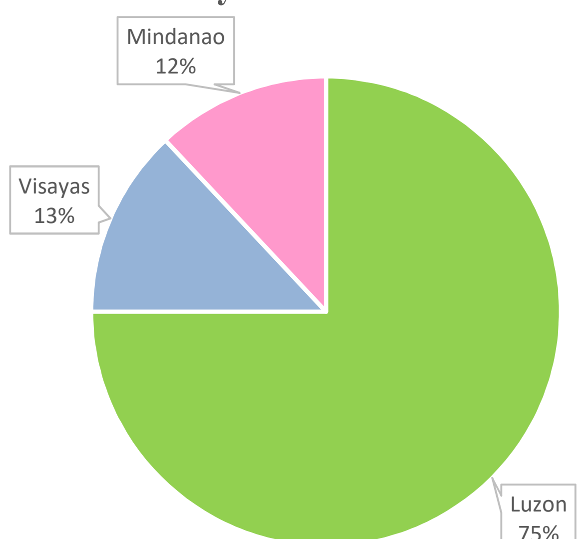


Energy Sector of Philippines

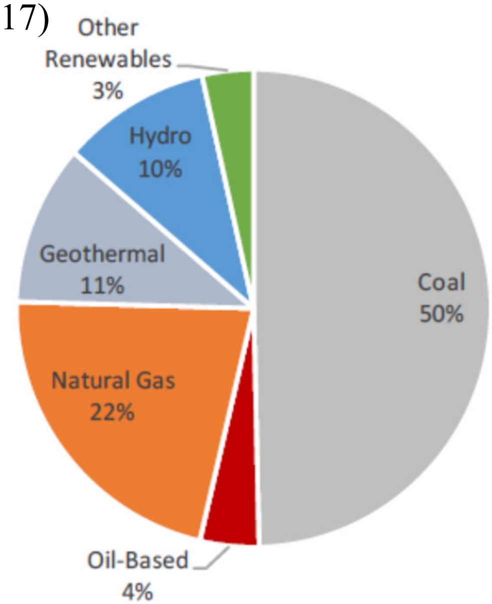


Electricity Consumption(2005-2017)

Electricity Demand Distribution



Technology wise generation share (2017)



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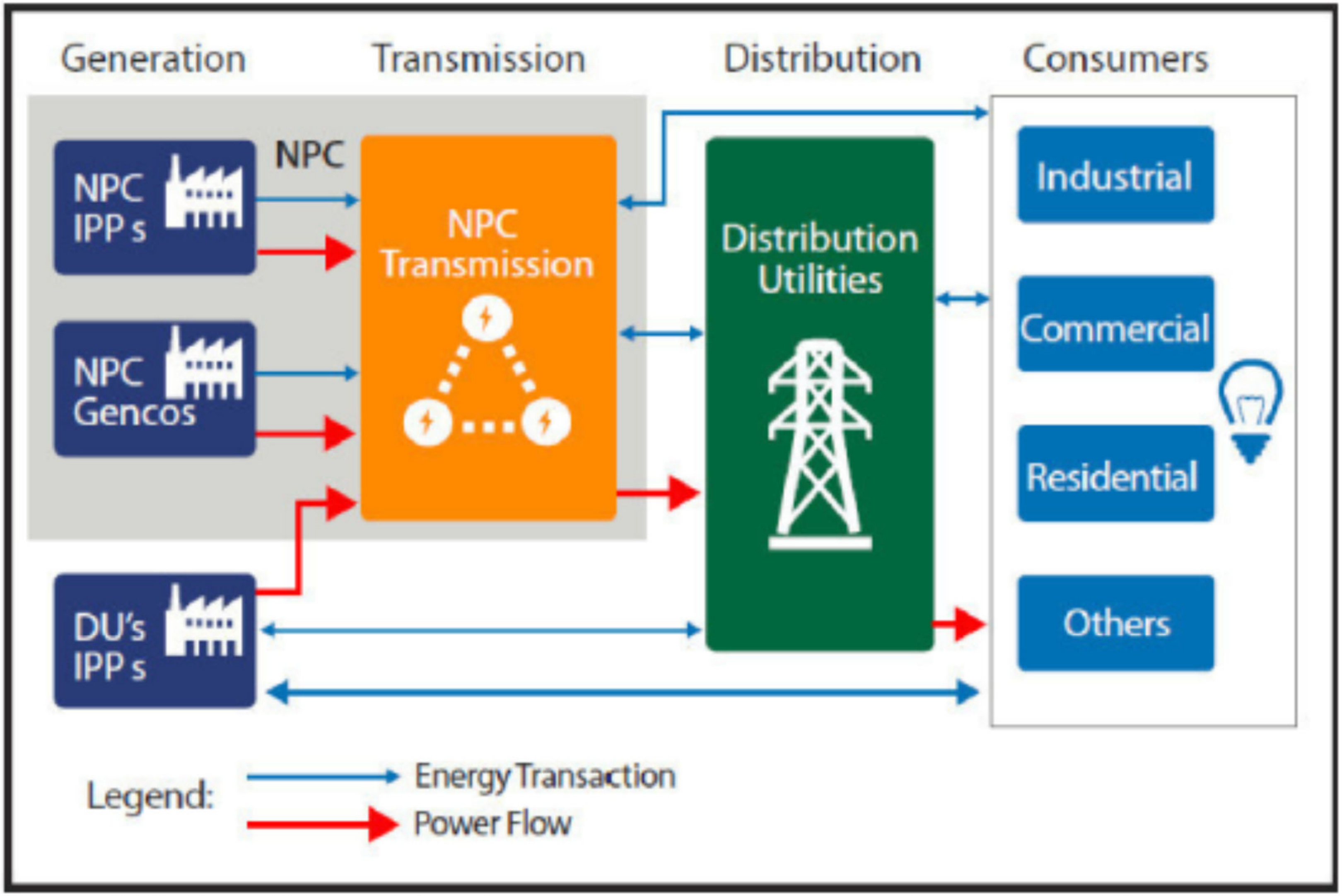
Power sector prior to Market reforms



DUs – distribution utilities and electricity cooperatives, Gencos – generation company, IPP – independent power producer, NPC = National Power Corporation,

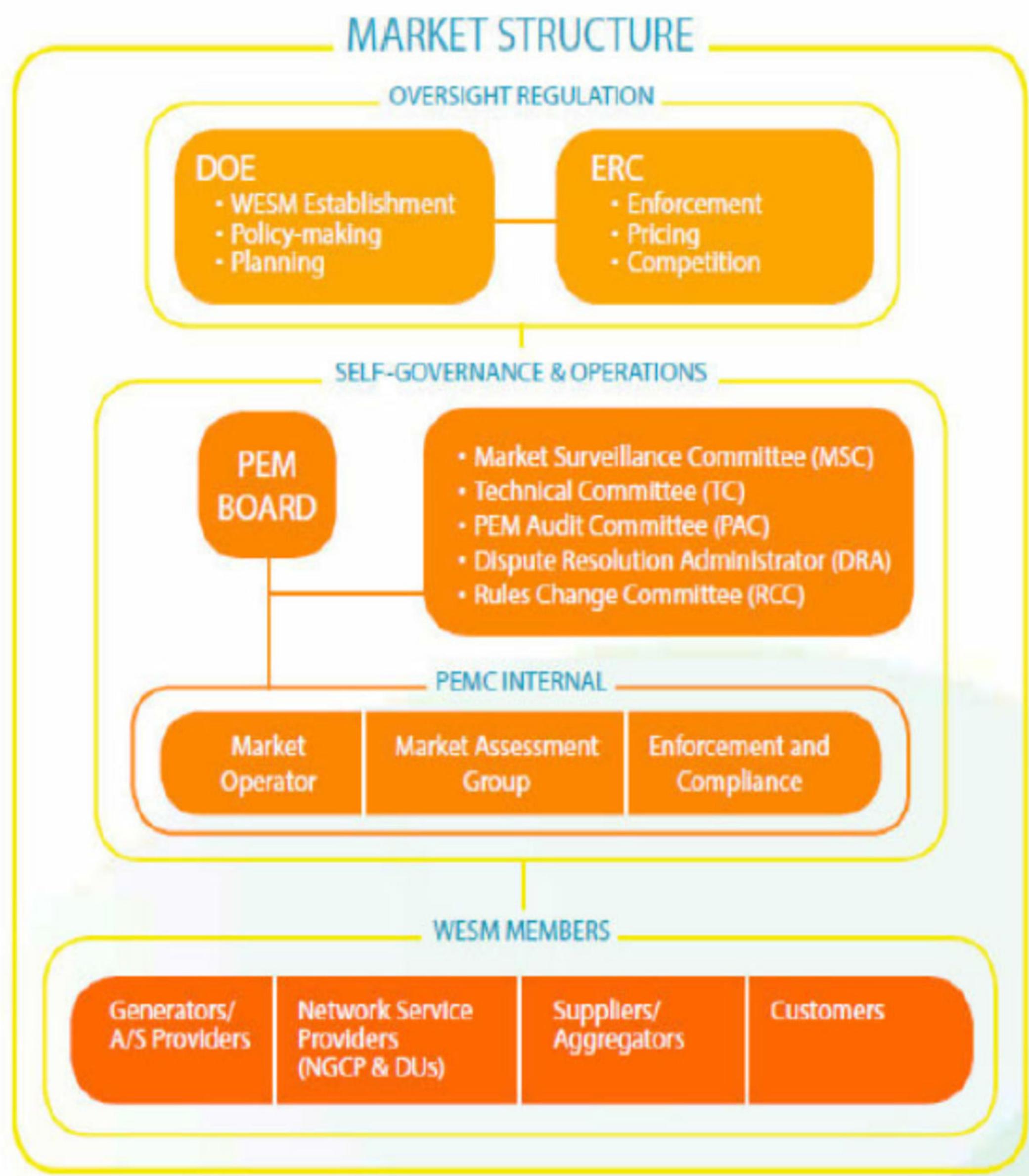
Market Design

- The Philippine power market is composed of **bilateral contracts**, and **an energy-only bid-based power pool** (the Wholesale Electricity Spot Market, or WESM).

- The **market operator** (PEMC) develops a least-cost generation schedule and determines the market clearing spot price considering all power injections and withdrawals from the grid, based on generation offers.

- The **spot price** is used to settle trade quantities which are not covered by contracts.

Electricity Market Structure



Hybrid Market

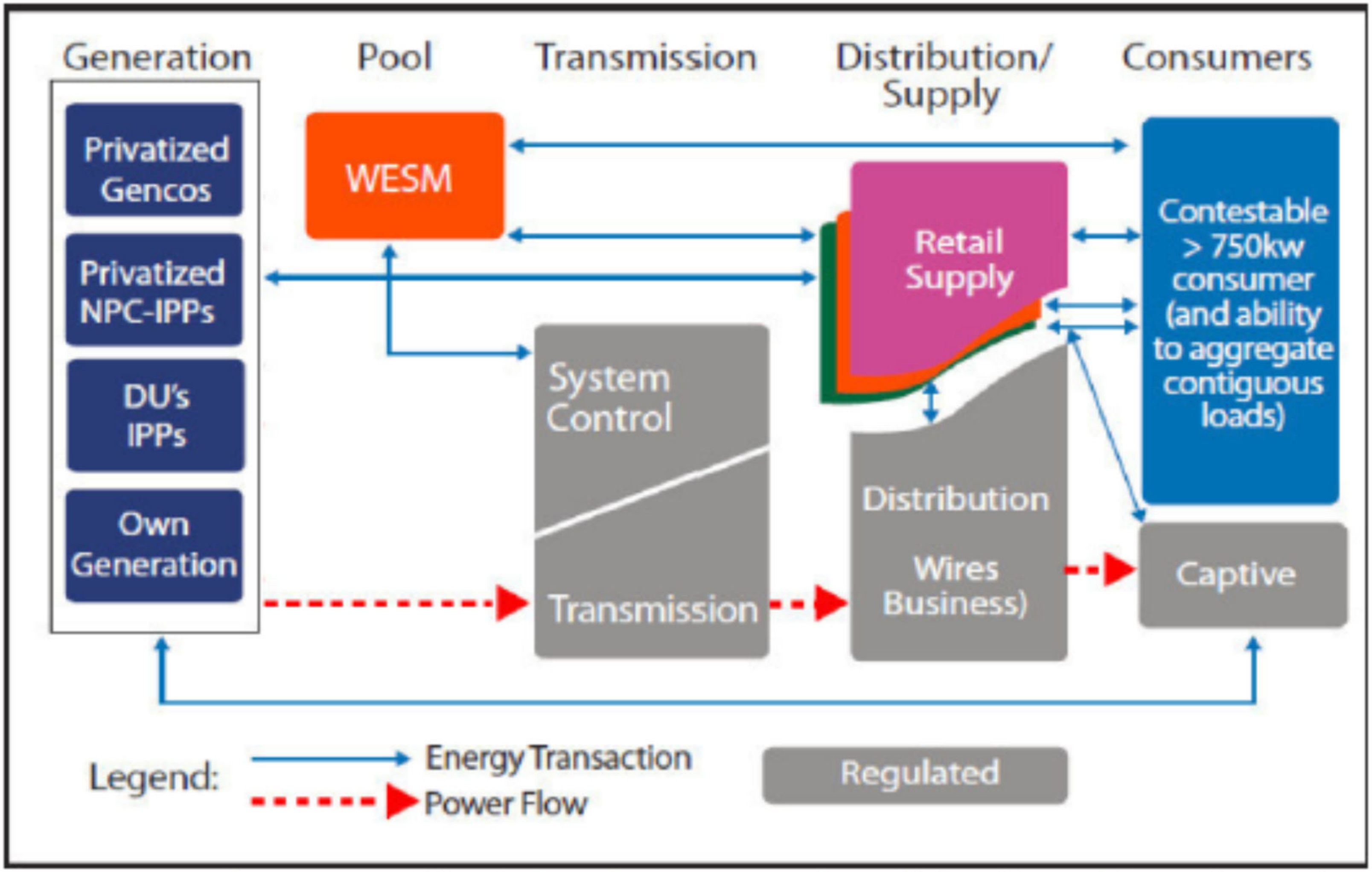
Energy only bid based pool

Use to settle energy quantities not covered under bilateral agreements

Market participants

- Market Operator
- System Operator
- Transmission(TRANSCO)
- Gencos
- Discos(Distribution Utilities)
- Retail Electricity Suppliers(RES)
- Final Customers(Bulk Customers, Contestable Customers, Captive Customers)

Power sector after Market reforms



Genco = generation company, IPP = independent power producer, NPC = National Power Corporation, WESM = wholesale electricity spot market.

Note: TransCo is the public sector asset owner and the National Grid Corporation of the Philippines the private operator and concessionaire for the transmission system.

Market Operator Role

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Market Operator(PEMC) use Market Dispatch Optimization Model(MDOM) to calculate **hourly nodal prices** with optimal scheduling

Inputs of MDOM

- Market Offers from trading participants
- System Conditions and requirements from the system operator

Outputs of MDOM

- System Marginal cost
- Generation output level for each generating resource
- Transmission line flows
- Transmission losses
- Energy prices at each market trading node

- PEMC provide system operator with generation schedule
  (However actual dispatch is implemented by system operator considering real state of system)

- Payments are settled within one month. Bilateral contracts are settled outside market

System Operators Role

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- Be responsible for and **operate the power system** in accordance with the WESM Rules, the Grid Code and any instruction issued by the Market Operator or the ERC.
- Provide **central dispatch to all generation facilities and loads connected**, directly or indirectly, to the transmission system in accordance with the dispatch schedule submitted by the Market Operator.
- **Contribute towards the development of procedures**, processes or systems, or to assist with any aspect of the operation of the spot market, in coordination with the Market Operator.
- Maintaining short-term reliability
- Least-cost dispatch and system operation
- Congestion management
- Coordinate the operation of ancillary services
- Accountability of system operations

Energy Regulatory Commission(ERC) responsibilities

- Approve price determination methodology for wholesale electricity spot market(WESM)
- Enforce Grid Code & Distribution Code
- Define rules for setting transmission & distribution wheeling rates
- Formulate other related rules & regulations such as issuance of licenses to retailers, rules for contestability, rules for customer switching, code of conduct for competitive retail participants

Ancillary Services

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System Operator(NGCP) is responsible for arranging adequate ancillary services

- By competitive tendering process administrated by system operator
- By negotiating contracts with ancillary service providers

MO establish and administer spot market for purchase of reserve.
Payments are settled via Market operator

Cost of those ancillary services are paid by all electricity consumers

No capacity charge is paid except for ones already covered under bilateral agreements

Transmission and distribution wheeling prices are set according to Energy Regulatory Commission (ERC) guidelines

Renewable Resources

FIT tariff is paid to renewables irrespective of market price.(Introduced in 2008)

Difference between spot price and FIT rate is paid by TRANSCO via FIT-ALL fund which is built from customer universal charge(user tax)

Renewable plants enjoy priority dispatch since 2015

Renewable Portfolio Standards(RPS) impose obligation on Discos to source an agreed upon portion of its energy supply from eligible suppliers

Expect to achieve 35% renewable share by 2035.

Approved FIT rates are applied for period of at least 12 years.

Renewable Technology	Approved FIT in 2012 (P/kWh)	FIT update in 2015 (P/kWh)	Approved FIT (2015 USD/MWh)
Run-of-river hydro	5.90	-	130
Biomass	6.63	-	146
Wind	8.53	7.40	163
Solar	**9.68**	**8.69**	**191**

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Milestone related to Electricity Market Formation

Early 1990s	Daily brownouts from 7 to 12 hours were experienced
Mid 1990s	High generation cost was experienced following introduction of IPPs
1997	Economy was severely affected during East Asian economic crisis
2001	Electric Power Industry Reform Act was passed
2001	Grid Code & distribution Code were amendment
2003/2004	Transmission & Distribution wheeling rate guidelines were formed
2006	Wholesale electricity spot market was commenced in Luzon
2008	Introduction of FIT tariff for renewable
2010	Integration of Visayas region with Luzon expanding electricity market
2013	Separate Wholesale electricity spot market was commenced in Minandoa
2013	Lower offer price ceiling was introduced following alleged market manipulation resulting spot price spike

Wholesale Market share

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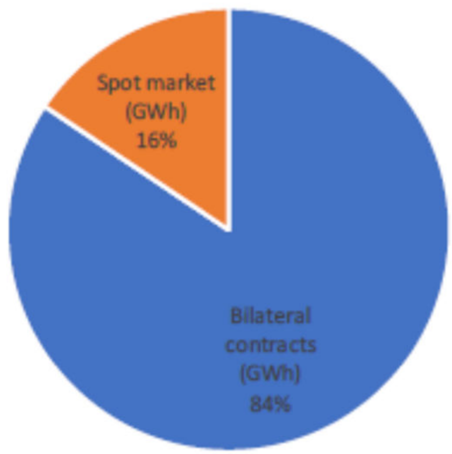
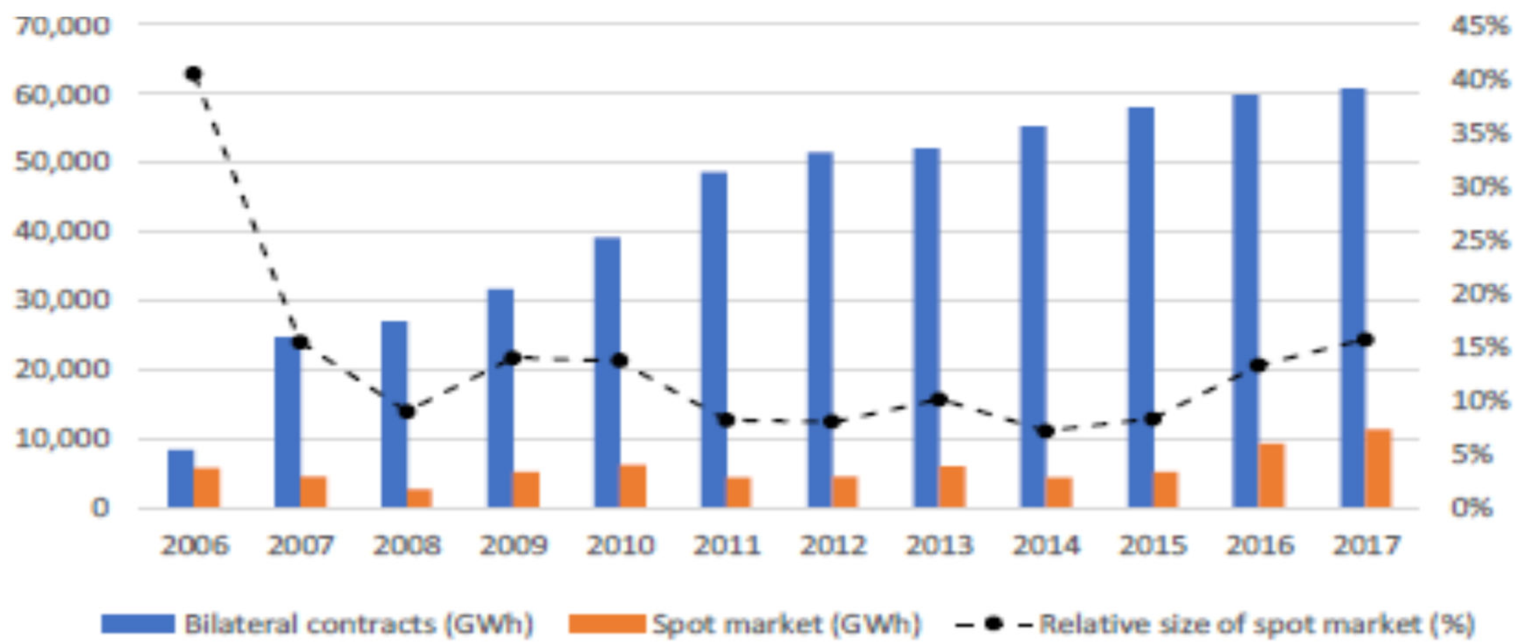


Only energy not covered under bilateral contracts is purchased via spot market

Majority of energy transactions are covered via bilateral contracts signed between private parties



Spot Price Regulations

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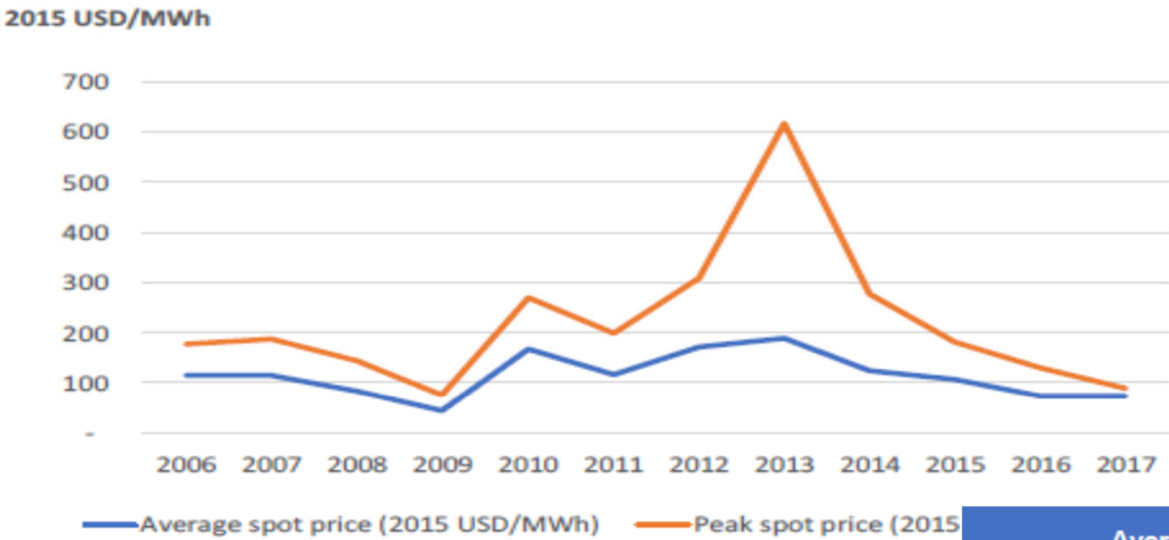

Market ceiling cap has been reduced since 2013 to avoid unhealthy spot market price hike

Year	Average spot price (2015 P/MWh)	Average spot price (2015 USD/MWh)	Peak spot price (2015 USD/MWh)
2006	7,154	116	179
2007	6,451	116	189
2008	4,292	84	145
2009	2,372	45	76
2010	8,250	169	269
2011	5,417	117	200
2012	7,684	173	311
2013	8,357	190	618
2014	5,669	126	278
2015	4,465	98	168
2016	3,278	69	121
2017	3,205	65	78

Market share constraints

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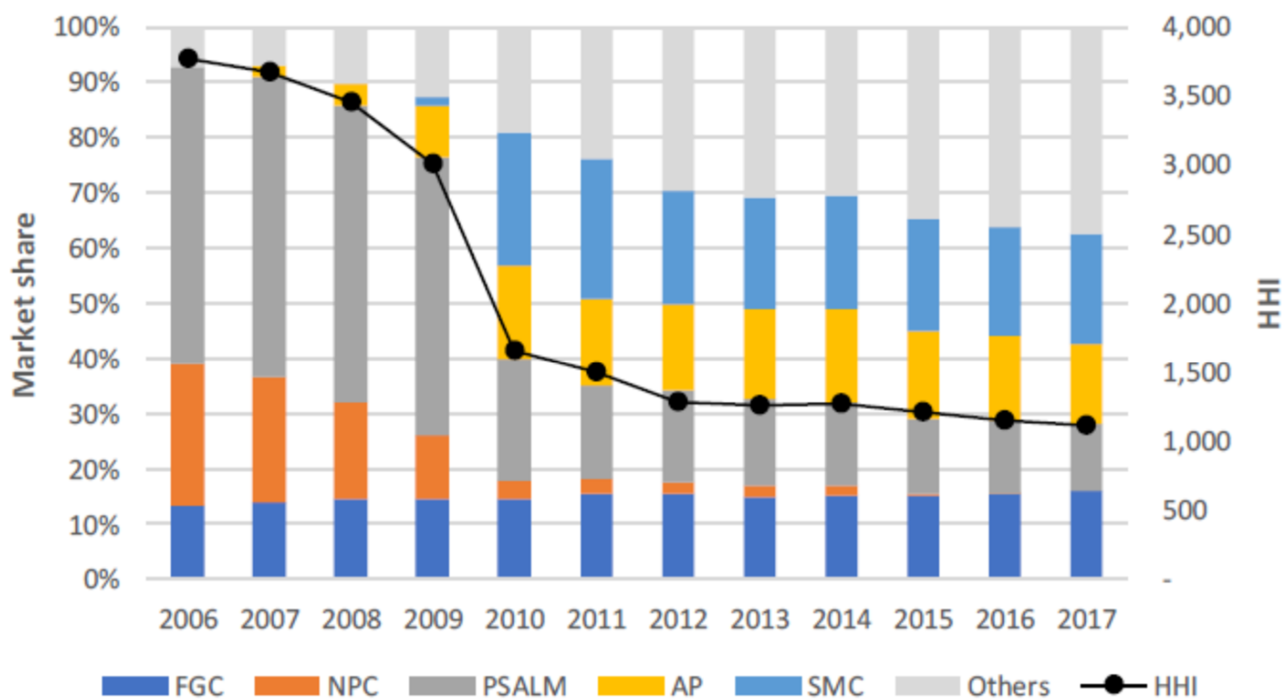
Limit on the maximum market share for generation capacities
30 % for each of the three island regions & 25% for the country as a whole



Drivers of spot market price

- Increased wholesale competition
- More efficient use of generation & transmission resources
- Increased investment in power infrastructure(Generation & Transmission)
- Increasing generation by renewable resources with FIT Tariff and priority dispatch
- Aging & outages of generation & transmission infrastructure
- Tariff reforms
- Contractual positions of market players

Conclusion

Overall, the Philippine power market has partially delivered the objectives of competitive outcomes and sustainability.

Industry reform brought about by EPIRA in 2001 was very slowly implemented, with the wholesale spot market beginning operations in 2006, that is, with a 4 year delay with respect to plans; and retail competition established only partially in 2013, and yet to become fully operational

- **Security of supply** -Several widespread blackouts have occurred over the past five years during tight periods, due to low fuel or hydro generation availability, maintenance of major power plants and forced facilities outage
- **Competition -**The Philippine wholesale spot market has been successful in introducing market driven forces to power system operation. Spot price largely reflect demand & supply condition. Spot price have fallen by 38% since inception of market

Conclusion Ctd..

CEYLON ELECTRICITY BOARD Enrich Life through Power

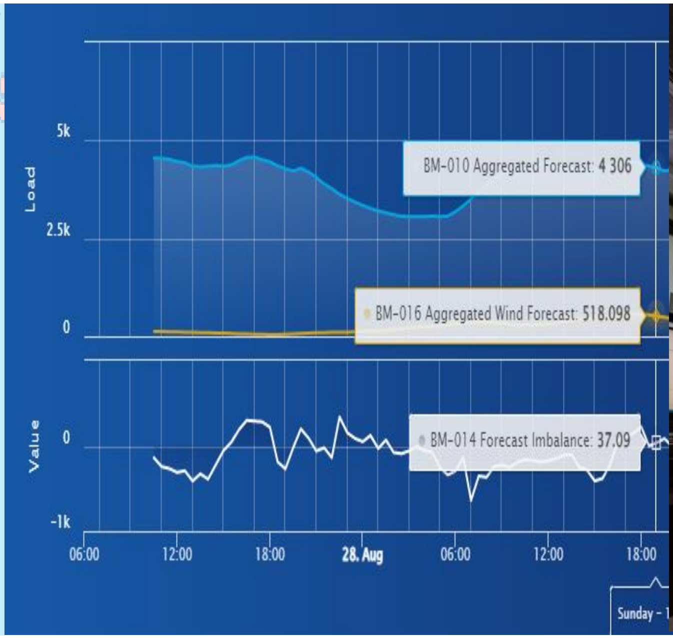
- **Sustainability-**The Philippine power sector has become more reliant on fossil fuels and particularly imported coal over the past decade. Capacity additions have been primarily in coal power plants, with coal-based generation growing, reaching 50% of total power output in 2017.

- **Future challenges-**The Philippines needs to continue to expand its power generation capacity to meet fast growing electricity demand needs. Philippines to continue to diversify its power generation mix and harness the potential for renewable generation, to improve both security of supply and sustainability

- **Lessons Learnt-** The case of the Philippines illustrates the benefits and challenges that open and competitive wholesale markets can provide over time, highlighting several structural and institutional issues which are key for reaping the benefits of competitive power markets


Thank You

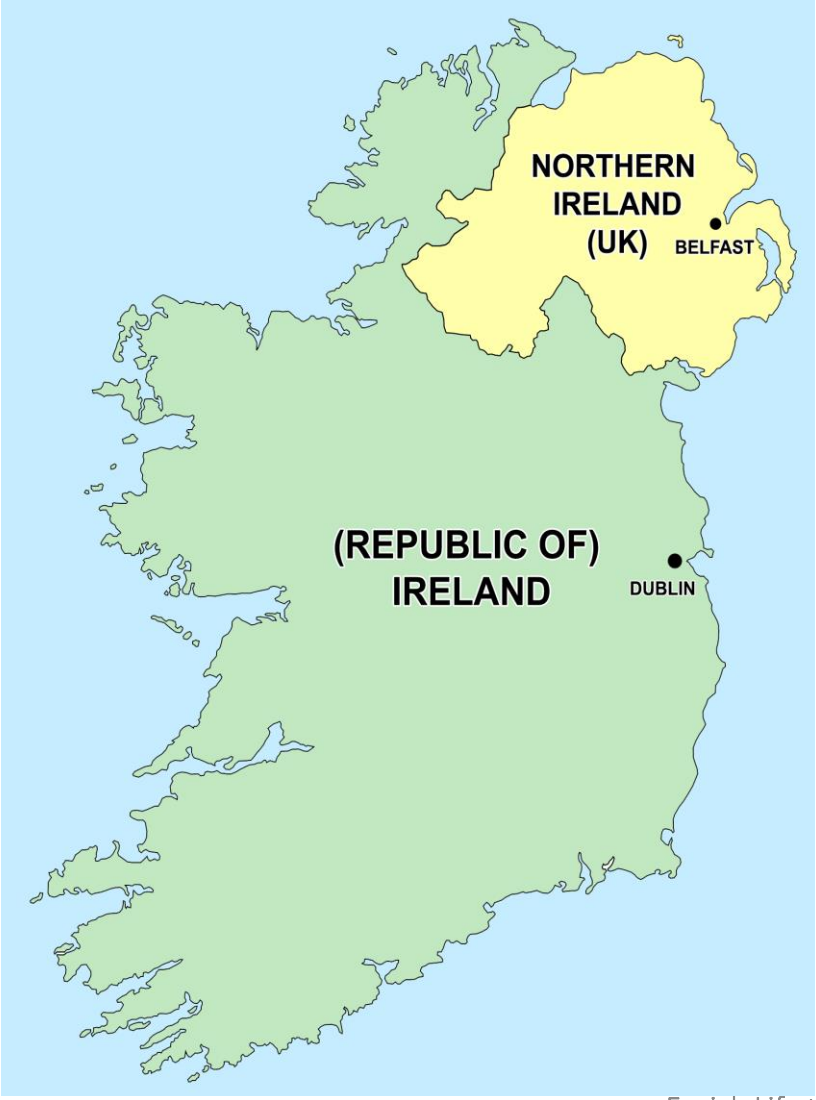
Power Market in Ireland



K.M.C.P Kulasekara
M.D.R.K Karunarathne
National System Control Centre
30th August 2022

CEYLON ELECTRICITY BOARD

Country Profile- Ireland & Northern Ireland



Combined Population – 7 million(2021)

Combined Area- 70,300 Sq. Km

Combined GDP - 550 USD Billion

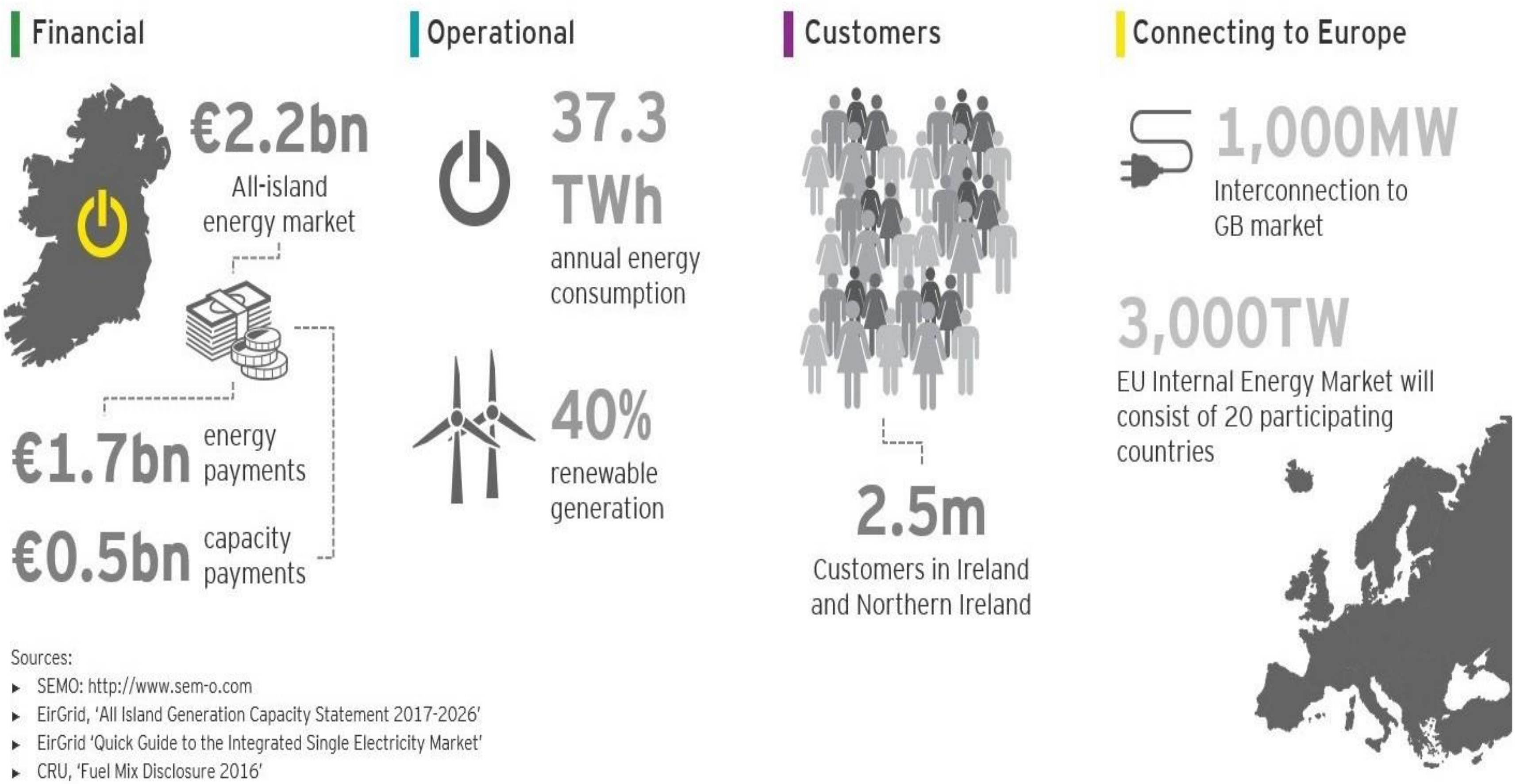
Combined Electricity Consumption- 36 TWh (2021)
(Ireland 28 TWh, Northern Ireland 8 TWh)

Combined Electricity Demand – 5.3 GW

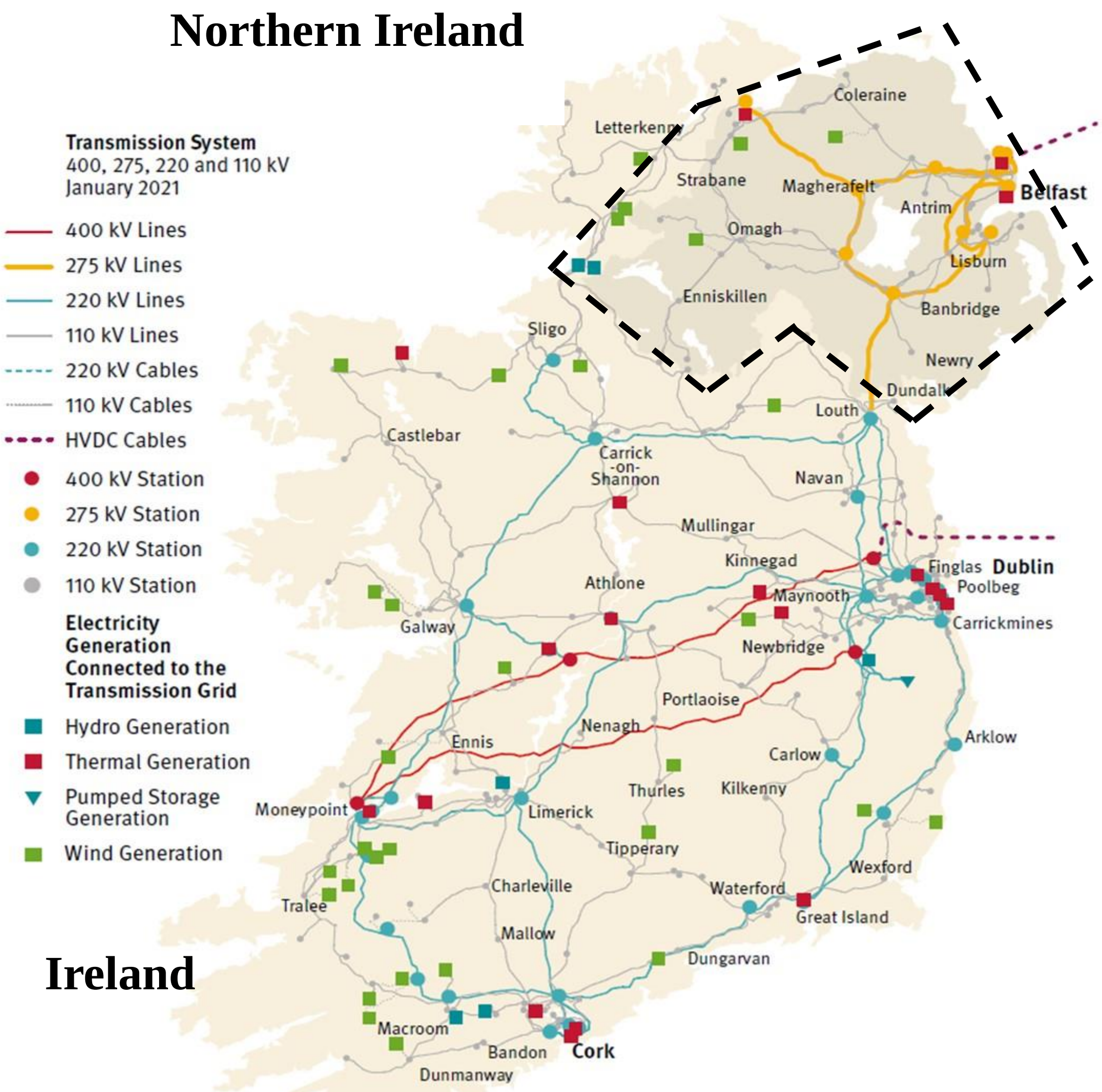
Combined Energy Mix -2020

Gas	44%
Coal	12%
Oil	1%
Renewable	43%

Ireland and Northern Ireland Electricity Market in Numbers as in 2020



Power System Configuration of whole Ireland



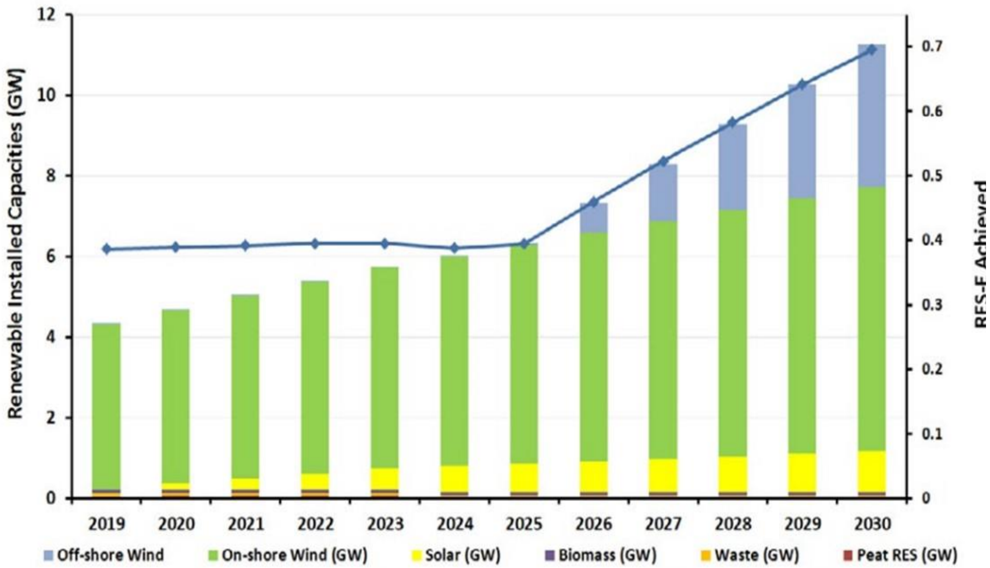
Ireland & Northern Ireland are connected through **two 110 kV ccts and one 275kV cct**

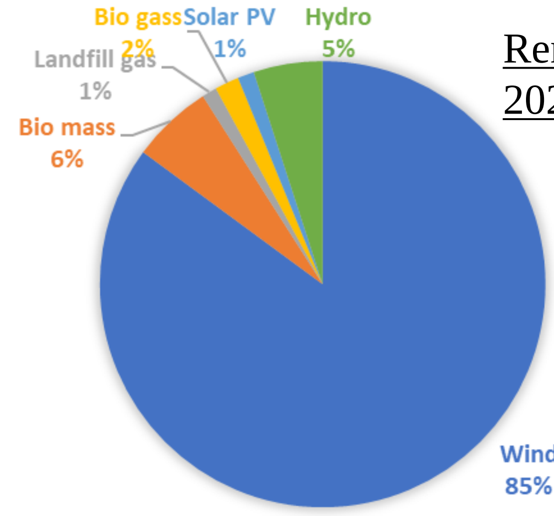
Ireland is connected with mainland UK with **500kV HVDC cable**

Northern Ireland Power System Operator- **SONI**

Ireland Power System Operator- **EriGRID**

Renewable Capacity addition forecast to achieve 70% target by 2030





Renewable mix 2020

In 2020, Renewable generation in Ireland and Northern Ireland accounted for 42% and 43.5 % of its total annual generation respectively

Wind generation in Ireland and Northern Ireland accounted for 86 % and 84.5% of its total renewable generation respectively

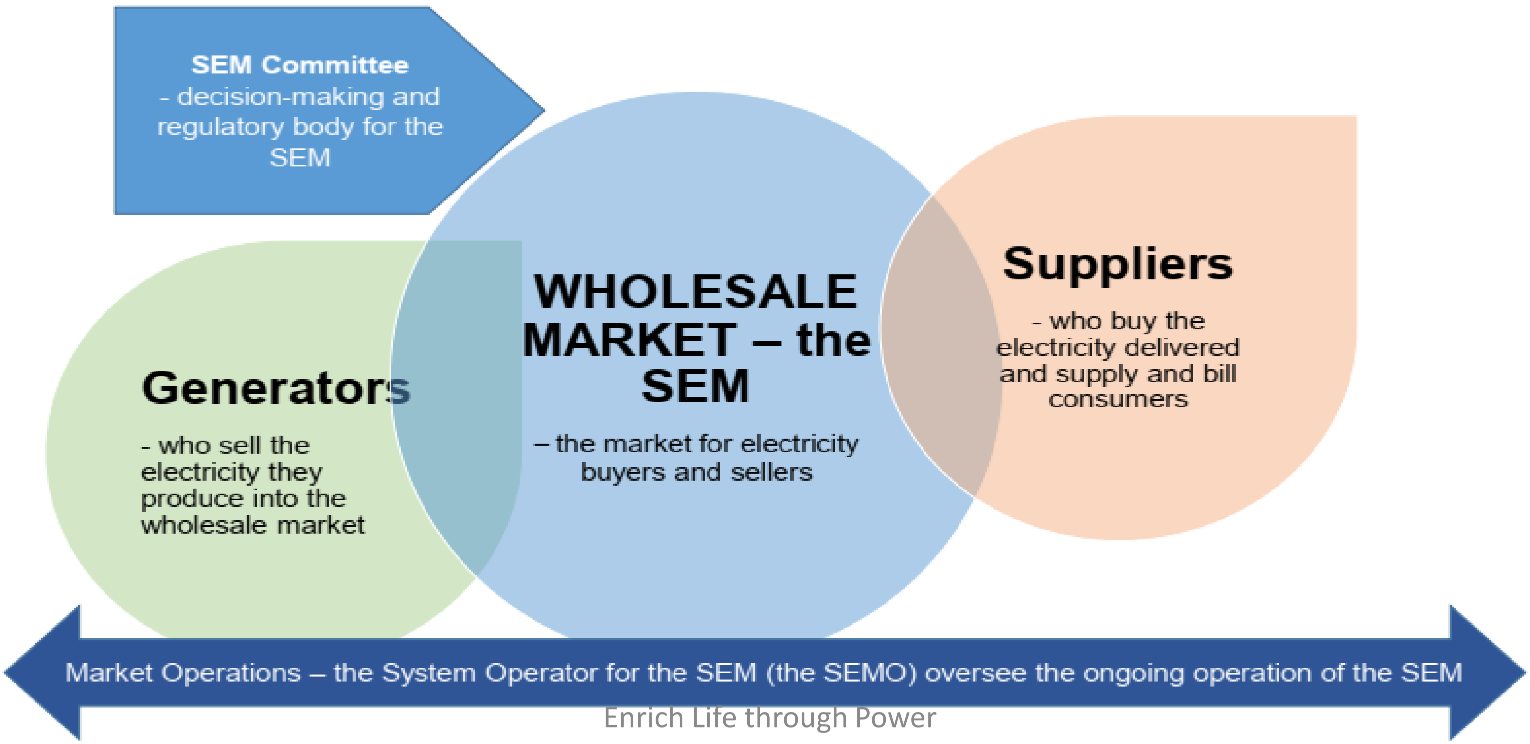
Total wind installed capacity by 2020- 5.7 GW

Market Design-SEM

Single Electricity Market (SEM) was formed in 2007 combining two separate Markets of Ireland and Northern Ireland in to one all island wholesale electricity Market.

SEM was operated by SEMO as a joint venture between EriGrid and SONI,

SEM was a central pool through which generators and suppliers trade electricity on the island of Ireland



Overview of SEM

- Generators submit bids (for capacity and selling price) to the SEMO to generate electricity for each half-hour of the following day

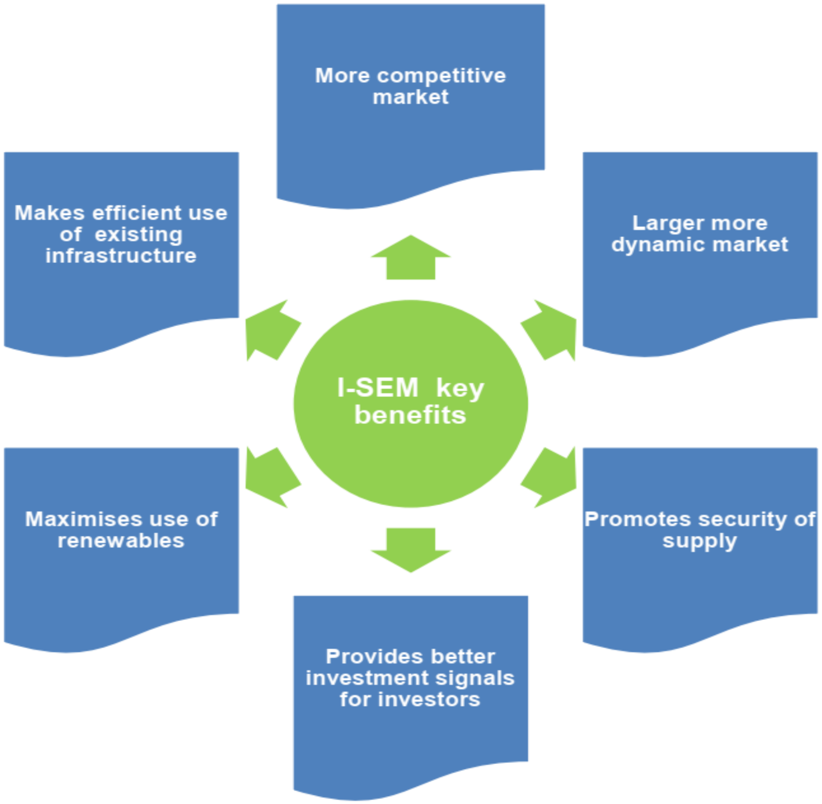
- These bids are stacked in order with the least expensive generators called on to provide power until demand is met

- The bids and demand set the energy price for each half-hour period, called the system marginal price (SMP), and this price is paid to all those generators who are scheduled to produce power – some generators will not be required and so will not receive an energy payment

- Generators also receive capacity payments if they are available to generate and also constraints payments if the power delivered by generators is different from that scheduled, due to the technical realities of operating a complex power system.

From SEM to I-SEM

- **Accordingly in 2018, Integrated Single Wholesale Market was formed while integrating the SEM with European Market via 500kV HVDC link.**
- It also ensured efficient operation of inter connection lines for supply and demand balance while sending appropriate price signals.
- Thus this ensured more competitive electricity prices in Market



I-SEM Key Benifits

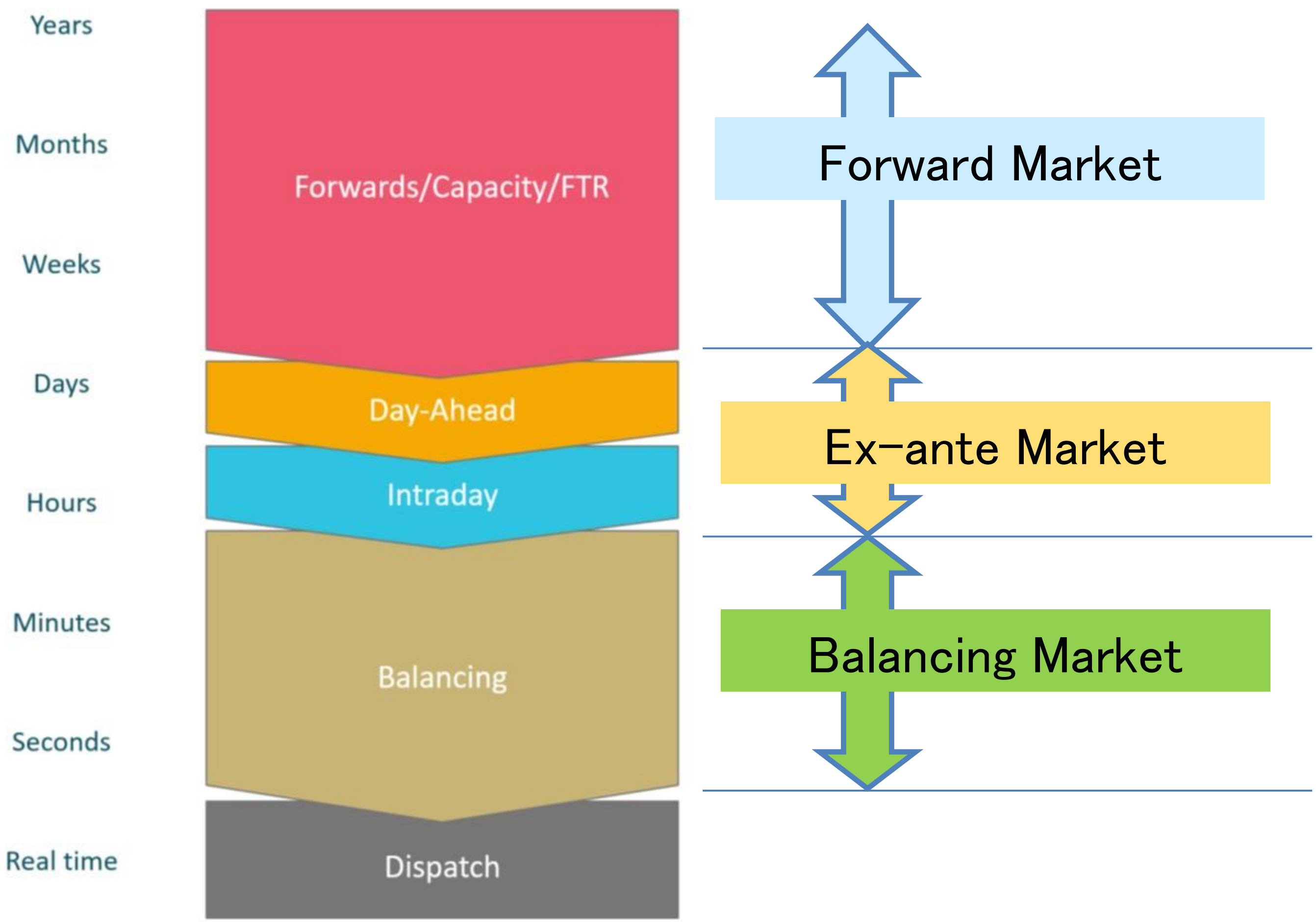
Key Differences between SEM & I-SEM

	SEM	I-SEM
Market structure	One pool and timeframe	Different markets with different timeframes
Trading opportunities	A single opportunity for generators to submit their bids each day.	Generators and suppliers will have multiple opportunities to trade (at Day Ahead and Intra Day stages
Setting the market price	All generator bids stacked up in order of merit, with the last generator (the most expensive) required to meet demand setting the price that suppliers pay. Suppliers are price takers.	Suppliers are price makers – they set limits on what they are willing to pay in each market and, where this crosses with what generators are willing to accept, this sets the market price.
Capacity payments to generators	The Capacity Payment Mechanism gives capacity payments to cover generators' fixed costs and are paid so long as the generator declares that it is available to run.	Generators are paid only when their output is required to meet demand and only if they can.
Trading across interconnectors with Great Britain	Capacity on interconnectors can be reserved to flow power in line with their trading approach. This may not deliver a cost-efficient flow.	Interconnection capacity allocated based on prices with electricity always flowing from the cheapest to the most expensive market.

Energy Markets

An overview of the performance of the market and of the trading arrangements that exist in a number of different timeframes

Market Time Frame



Opportunity to hedge their positions in the DAM[※1], IDM[※2] and BM by purchasing contracts-for-difference (CfDs) at a strike price

19 days before to one hour trading

TSO takes actions to keep the system balanced.
Only Generator can enter the bid.

※1: Day Ahead Market
※2: Intra Day Market

Who to Operates Which Market?

Day Ahead Market (DAM)

- DAM is a single pan-European energy trading platform in the ex ante time frame for scheduling bids and offers and interconnector flows across participating regions of Europe.

- Bids and offers can be submitted 19 days before the market closes at 11am the day before delivery. An algorithm, call Euphemia (the acronym for Pan-European Hybrid Electricity Market Integration Algorithm), determines the market price and position for all participants on an hourly basis.

	Market Opening	Market Close	Delivery Periods
Day Ahead Market (DAM)	11:00 (D-19)	11:00 (D-1)	23:00 – 23:00 (24 * 1 hr.)

Day Ahead Market (DAM) Cont'd

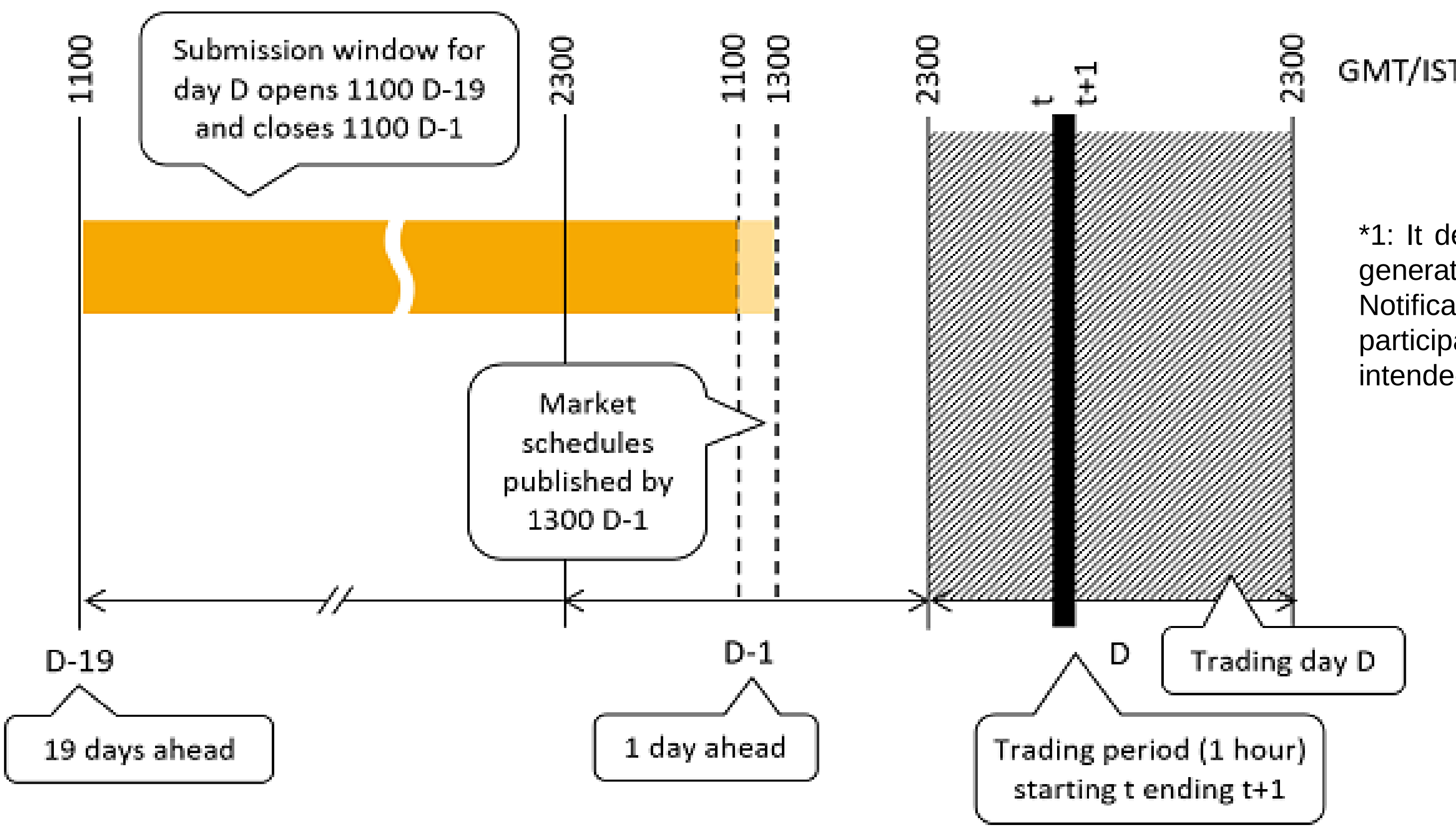
- The day ahead market (DAM) is the largest ex-ante market by volume and value.

- Participation in the DAM is not mandatory, but it is the only way of achieving a day-ahead position in the SEM that will minimize their exposure in the balancing market. Participants have opportunities to adjust their position by trading in the intraday market.

- Trading participants submit orders in the DAM to support their desired physical position for each 1-hour trading period.

Day Ahead Market (DAM) Cont'd

- Participants submit physical notifications*1 reflecting the agreed trades to the TSOs by 13:30 D-1.



*1: It defines the expected output of generator units. A PN(Physical Notification) should reflect the participant's best estimate of its intended level of generation

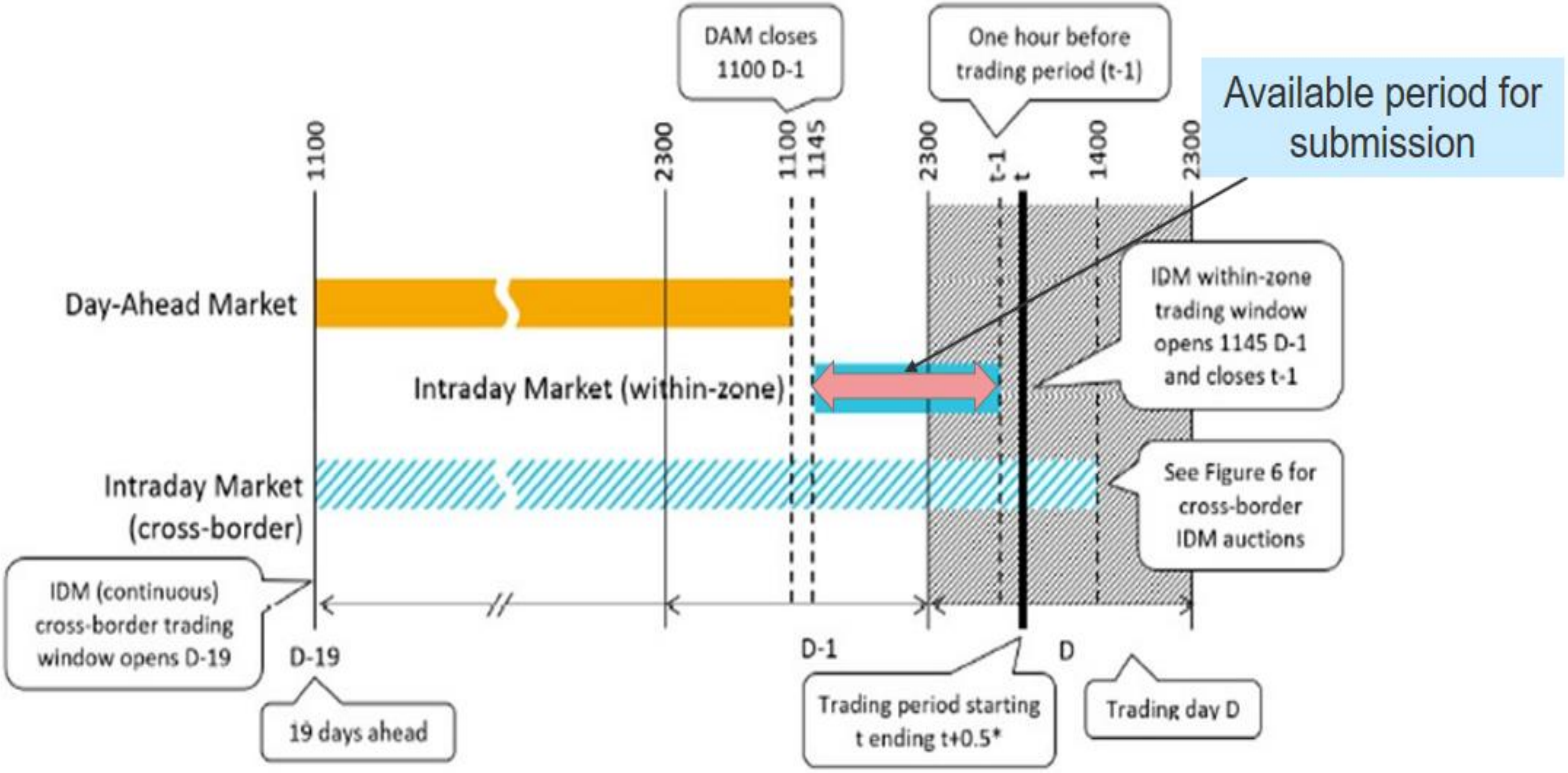
Intra Day Market (IDM)

- The intraday market (IDM) allows participants to adjust their physical positions closer to the time power is delivered.
- The IDM runs right up to one hour before trading and takes account of up to date market information including, for example, unscheduled plant outages or congestion on interconnectors.
- The market consists of three daily auctions with IDA-1 and IDA-2 coupled with the GB market via the interconnectors. The third Intraday Auction (IDA-3) is a local SEM auction that is not coupled with the GB bidding area.

Market Name	Order Book Opening	Order Book Closing	Delivery periods	Coupling
IDM Continuous Trading	11:45 (D-1)	1hr before real time (t-1)	48 * ½ hours	SEM only
IDA-1	23:00 (D -19)	17:30 (D-1)	23:00 - 23:00 (48* 1/2hrs)	SEM – GB
IDA-2	23:00 (D -19)	08:00 (D)	11:00 - 23:00 (24* 1/2hrs)	SEM –GB
IDA-3	23:00 (D -19)	14.00 (D)	17:00 - 23:00 (12* 1/2hrs)	SEM auction only

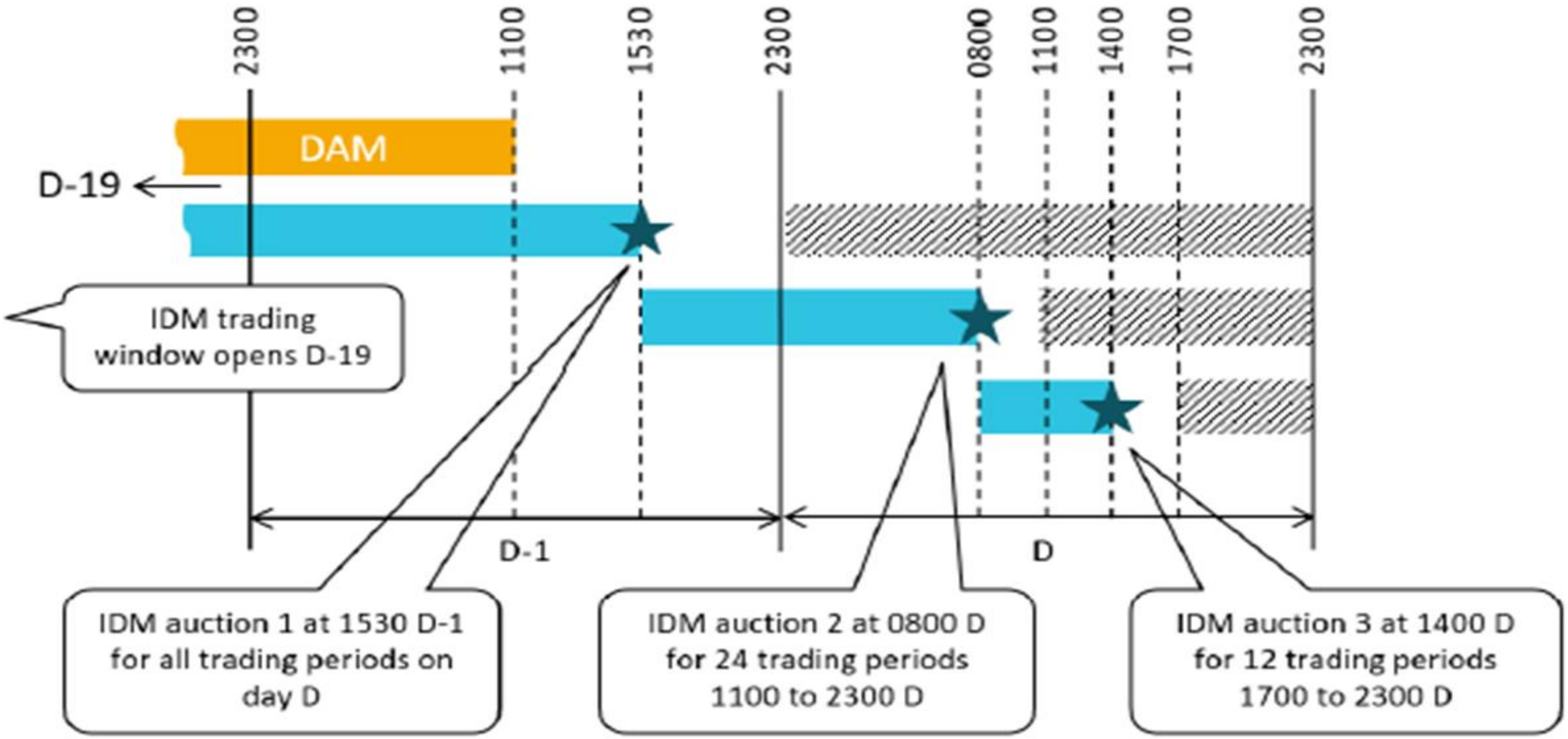
Intra Day Market (IDM) Cont'd

- The IDM trading day is divided into 48 (30-minute) trading periods.
- The submission window for within-zone trades opens at 11:45 D-1 and closes one hour before real time (t-1).



Intra Day Market (IDM) Cont'd

- Three auctions are open until:
  - (Auction 1) At 15:30 D-1 for all 48 trading periods on day D.
  - (Auction 2) At 8:00 on day D for the 24 trading periods from 11:00 to 23:00 D.
  - (Auction 3) At 14:00 on day D for the 12 trading periods from 17:00 to 23:00 D.



Balancing Market (BM)

- The BM is different from the other markets in that it reflects actions taken by the TSO to keep the system balanced and secure. Unlike the other ex-ante markets, participation in the Balancing Market is mandatory. The BM ensures that energy supply equals energy demand.

- It reflects actions taken by the TSO to keep the system balanced and secure for example, any differences between the market schedule and actual system demand, variations in wind forecasting, or following a plant failure.

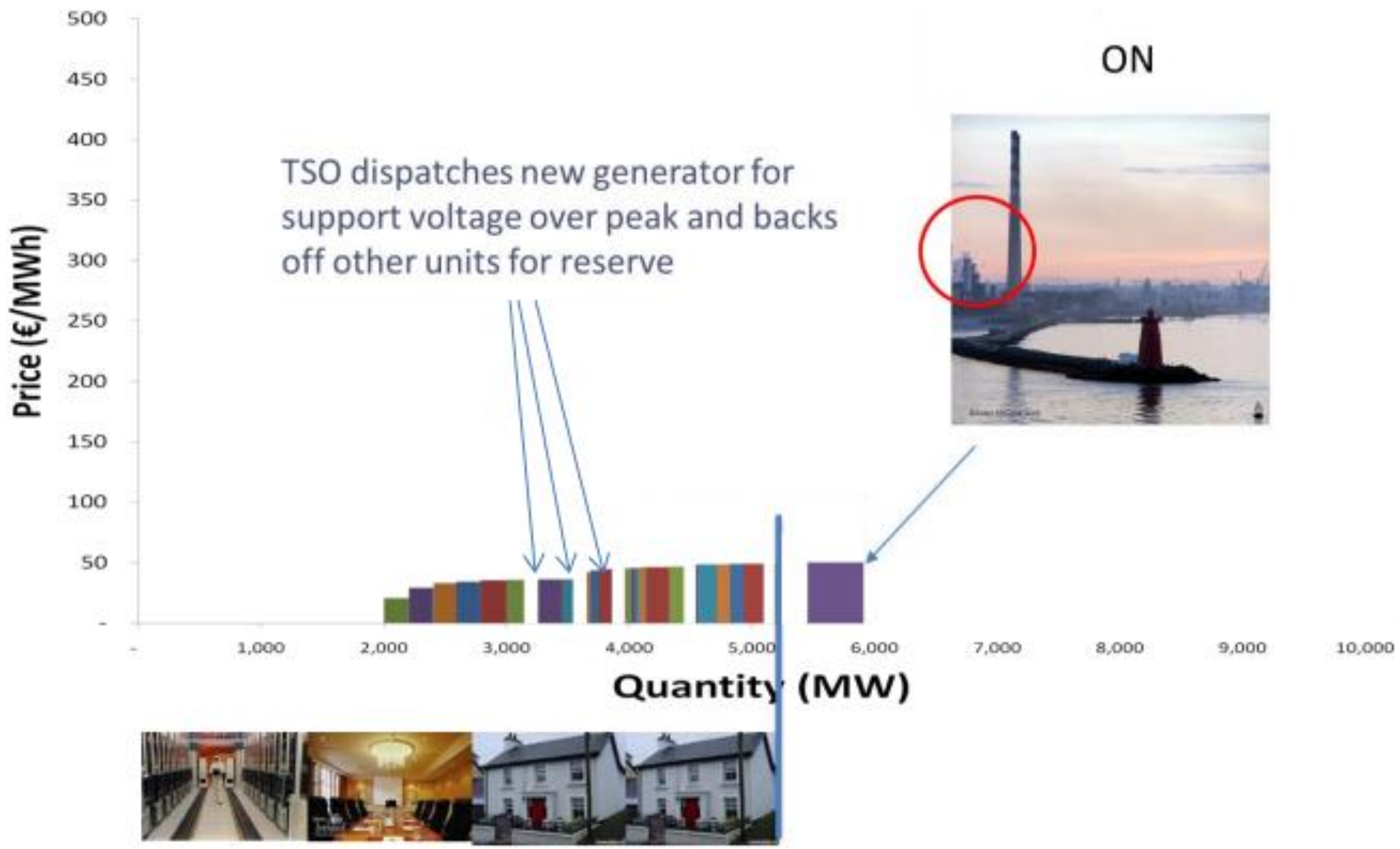
- The ex-ante markets match supply and demand, but are not designed to meet the technical requirements of a power system. For example:
  - Operating reserves
  - Inertia
  - System Non-Synchronous Penetration
  - Rate of Change of Frequency
  - Regional voltage support
  - Regional transmission constraints

Balancing Market (BM) Cont'd

❖ **System Balancing**

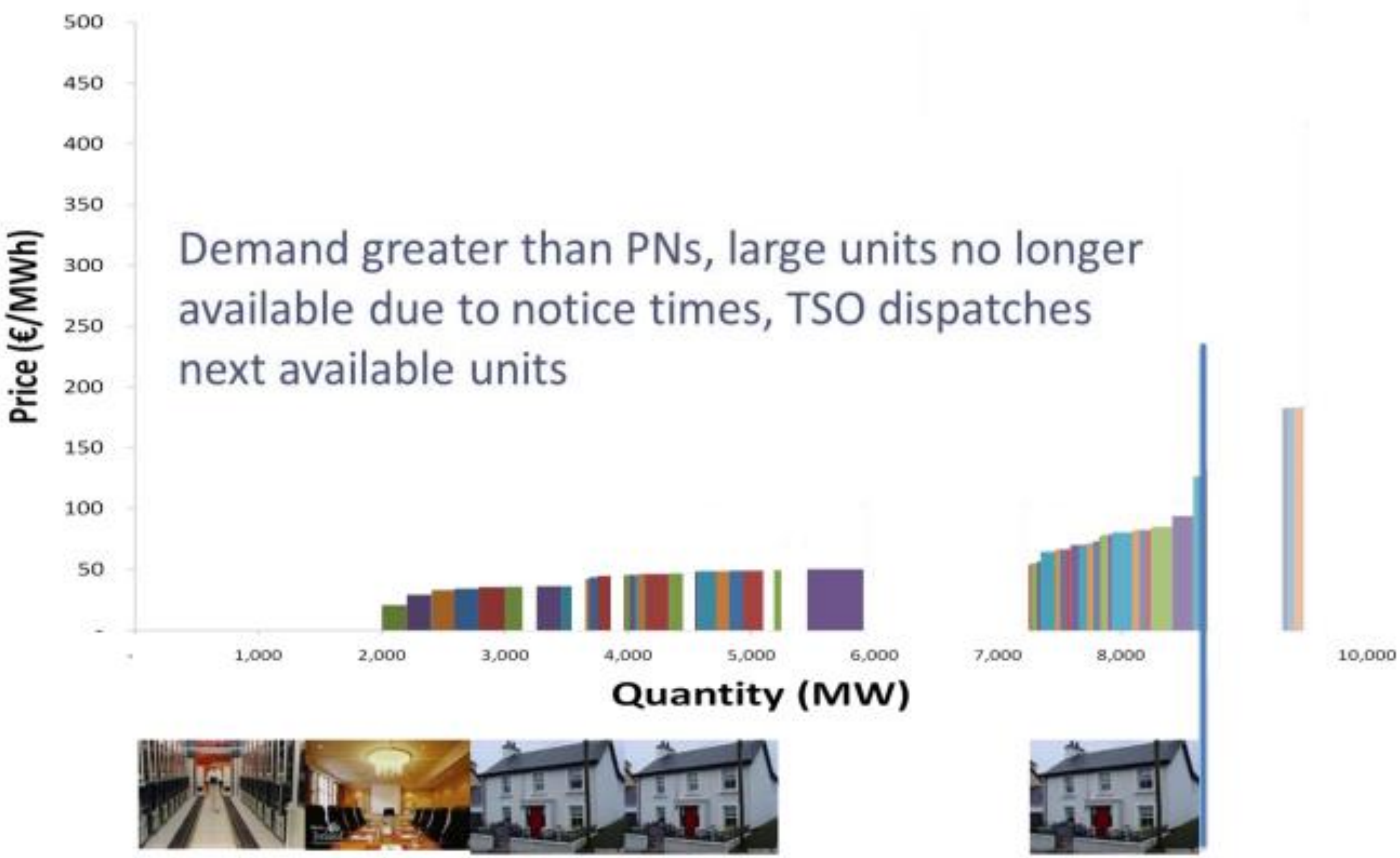
Balancing Market (BM) Cont'd

- System Balancing



Balancing Market (BM) Cont'd

❖ **System Balancing**



Balancing Market (BM) Cont'd

❖ Market operation

The responsibilities for market operation are split between the **TSOs and SEMO**.

The TSOs are responsible for:

- Market systems operation and access to market data.
- System balancing and dispatch.

And SEMO is responsible for:

- Registration of participants.
- Administration of the market rules for the settlement of imbalances and the capacity market in the Trading and Settlement Code.
- Receiving submissions from participants.
- Determining prices used in settlement.
- Receiving unit metering data from meter data providers (MDPs).
- Settlement and billing.
- Credit risk management.

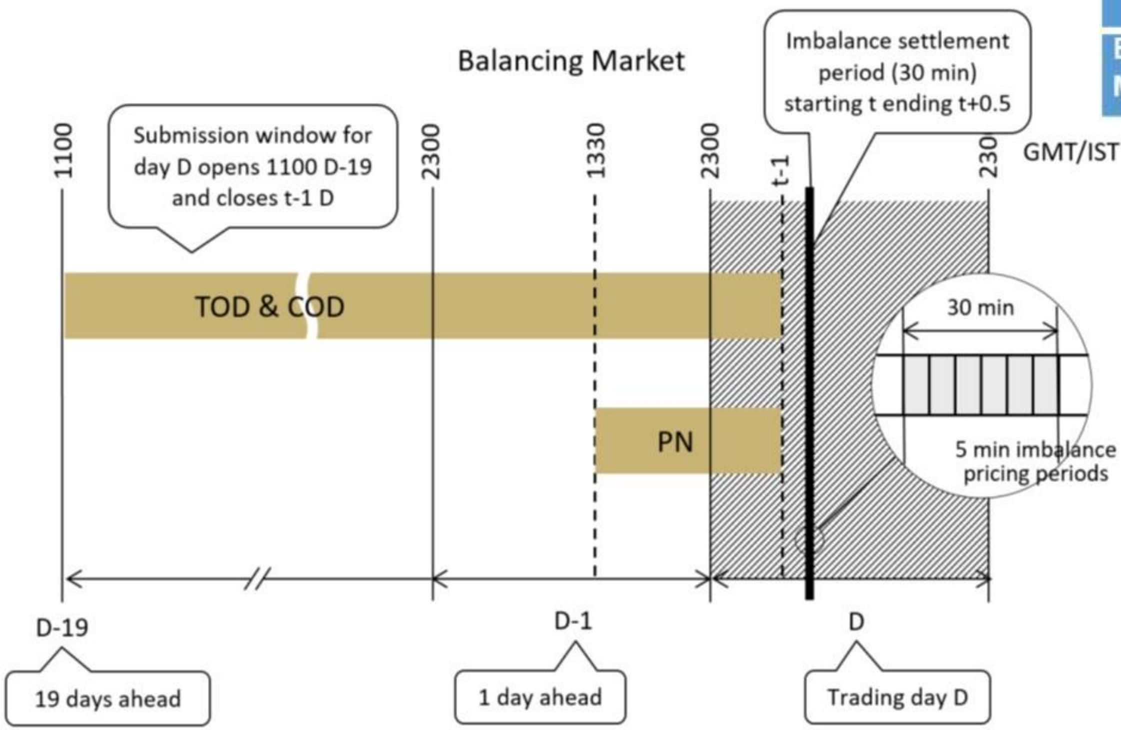
CEYLON ELECTRICITY BOARD Enrich Life through Power

Balancing Market (BM) Cont’d

❖ Market Timeline

- ➢ The BM trading day is divided into 48 (30-minute) imbalance settlement periods
- ➢ Within each imbalance settlement period there are six (5-minute) imbalance pricing periods
- ➢ The submission window for market data(TOD ※1, COD※2, PN※3) opens 19 days ahead of the trading day (D-19) and closes 1 hour before the start of each 30-minute imbalance settlement period (t-1).

Market Name	Market Opening	Market Close	Delivery Periods
Balancing Market	13.30 (D-1)	1hr before real time (t-1)	23:00 – 23:00 (48*1/2 hrs)



※1: Technical Offer Data, describes the physical characteristics of generator units such as capacity, minimum running levels, start-up and shut-down characteristics

※2: Commercial Offer Data, defines costs at which generators are prepared to increase or decrease their output

※3PN refers to Physical Notification

Forward Market (FWM)

- The Forwards market is a financial market. It provides participants with the opportunity to reduce their risk of exposure to significant movements in the price.
- These transactions can take place months to years ahead of the power being used.
- The Forwards Market provides participants with the opportunity to hedge their positions in the DAM, IDM and BM by purchasing contracts-for-difference (CfDs) at a strike price referenced to the price at which the participant sells energy in a specified market.

Forward Market cont'd

- When the market price exceeds the strike price, the party that sold the CfD pays the buyer the market price less the strike price on each unit of contracted capacity. And when the market price is less than the strike price, the buyer pays the difference to the seller.

- The Forwards Market (FWM) is a financial market and does not give rise to a physical schedule. A participant must participate in the DAM or IDM or both to be sure of achieving a physical notification in the BM.

Financial Transmission Right (FTR)

- This is a type of a financial hedge for those who wish to protect themselves from price differences between the All-Island market and Great Britain.

- FTR that entitles its owner to be paid the transmission price on a given transmission path, independent of their physical use of that path. An FTR returns revenue to the holder funded by the price differentials in the Day-Ahead Market across interconnectors.

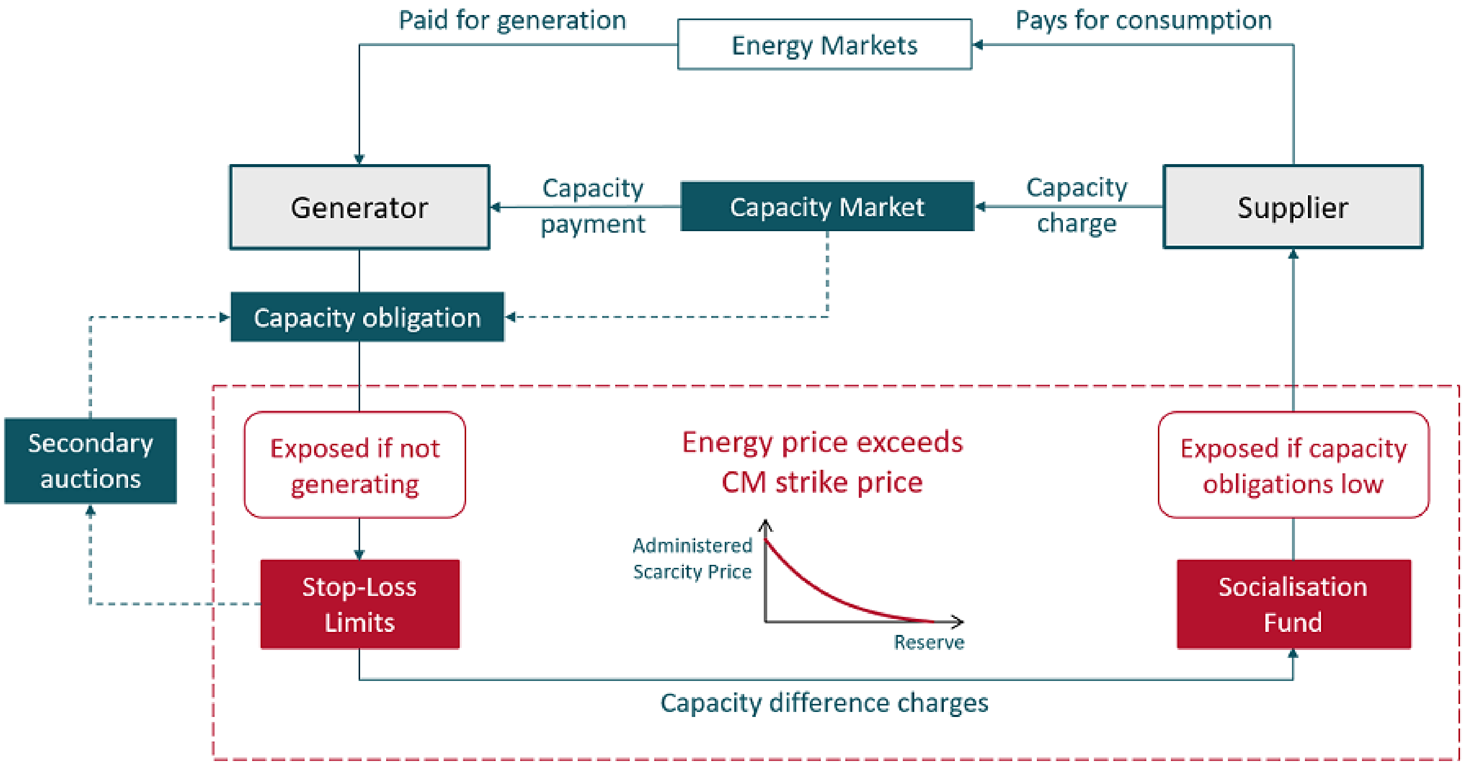
Capacity Market (CM)

- Capacity providers sell qualified capacity to the market based on the generation capacity required in a future capacity year.

- Capacity providers who are successful in the CM receive a regular capacity payment, which recovers fixed costs of power stations, and, in return, they have responsibility to generate when the system is stressed

Capacity Market cont'd

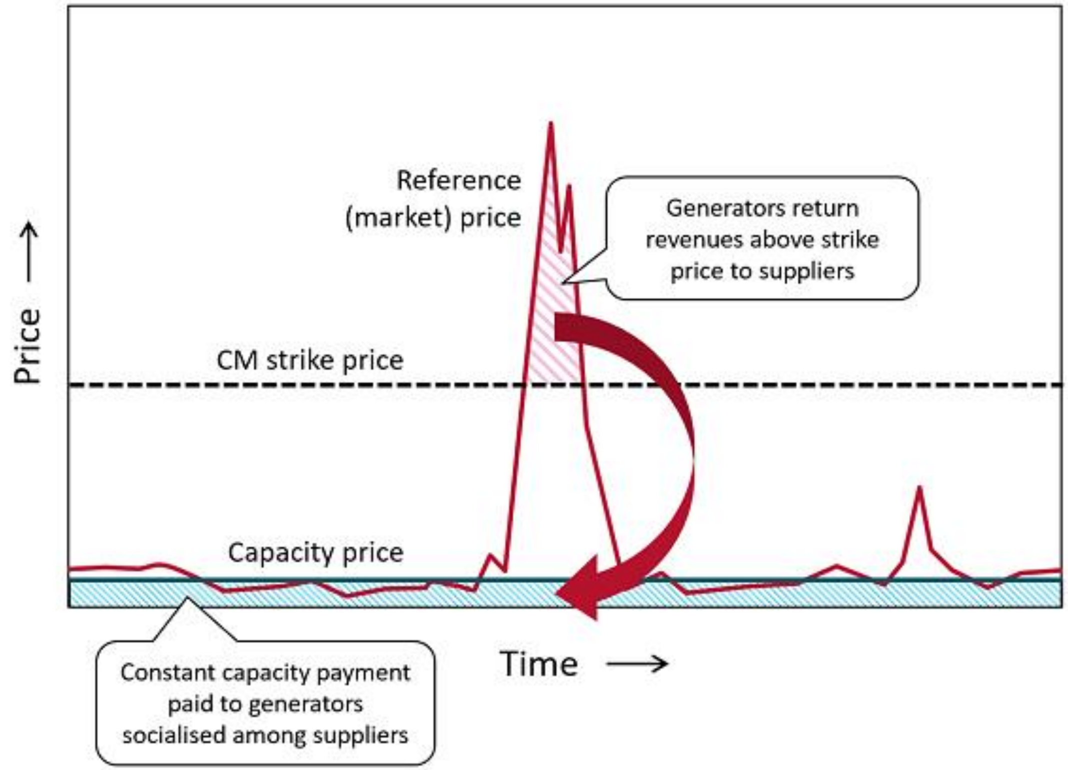
❖ Overview of the Capacity Market



➢ The cost of the CM is funded by suppliers. In return, suppliers are protected against high energy prices.

Capacity Market cont'd

- When energy prices exceed the strike price, the market pays the suppliers the difference between the energy price and the strike price.
- To fund this arrangement, generators must pay difference charges for capacity not delivered based on the difference between the strike price and a reference price.



Capacity Market cont'd

❖ Market timeline

➢ Capacity market auctions are run for a specified capacity year. The timelines for each auction are developed by the System Operators and approved by the Regulatory Authorities (RAs).

Capacity year

- The capacity year commences at the start of the trading day on 30 September and ends at the end of the trading day on 30 September in the following year.

Enduring arrangement

- Primary capacity auctions will be run four years ahead (T-4) of each capacity year and T-1 auctions will be held just before the start of the capacity year. The first T-4 auction will be run in 2018 for the capacity year ending 30 September 2022.

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Proposed Power Market Structure for Sri Lanka

K.M.C.P Kulasekara
M.D.R.K Karunarathne
National System Control Centre
02nd September 2022

Present Electricity Tariff and Issues

KVSM Kudaligama, Chief Engineer (Tariff)

Ceylon Electricity Board

17th August 2021

Present Tariff

(for each 30 - day billing period)	EXISTING TARIFF		
	DOMESTIC	**NON DOM. CATEGORIES**	**ToU for DOMESTIC**
EFFECTIVE FROM	**16-09-2014**	**15-11-2014**	**02-05-2017**
DOMESTIC	**Energy Charge (Rs/kWh)**		**Fixed Charge (Rs/Month)**
Block 1 - 0 - 30	2.50		30
Block 2 - 31 - 60	4.85		60
Block 1 - 0 - 60	7.85		N/A
Block 2 - 61 - 90	10.00		90
Block 3 - 91 - 120	27.75		480
Block 4 - 121 - 180	32.00		480
Block 5 - Above 180	45.00		540
Day (05.30 - 18.30 hrs)	25.00		540
Peak (18.30 - 22.30 hrs)	54.00		
Off Pk (22.30-05.30 hrs)	13.00		
Religious			
Block 1 - 0 - 30	1.90		30
Block 2 - 31 - 90	2.80		60
Block 3 - 91 - 120	6.75		180
Block 4 - 121 - 180	7.50		180
Block 5 - Above 180	9.40		240

OTHER CUSTOMER CATEGORIES

			General Purpose		Industrial		Hotel	Govt.
			GP 1-1	GP 1-2	IP 1-1	IP 1-2		
Rate 1 Supply at 400/230V Contract demand <= 42 kVA			For ≤ 300 kWh/mon.	For > 300 kWh/mon.	For ≤ 300 kWh/mon.	For > 300 kWh/mon.		
	Energy Charge (Rs/kWh)		18.30	22.85	10.80	12.20	21.50	14.65
	Fixed Charge (Rs/Month)		240	240	600	600	600	600
Rate 2 Supply at 400/230V Contract demand > 42 kVA	Energy Charge (Rs/kWh)	Day	21.80		11.00		14.65	
		Peak	26.60		20.50		23.50	14.55
		Off Peak	15.40		6.85		9.80	
	Demand Charge (Rs/kVA)		1100		1100		1100	1100
	Fixed Charge (Rs/Month)		3000		3000		3000	3000
Rate 3 Supply at 11 kV & above	Energy Charge (Rs/kWh)	Day	20.70		10.25		13.70	14.35
		Peak	25.50		23.50		22.50	
		Off Peak	14.35		5.90		8.80	
	Demand Charge (Rs/kVA)		1000		1000		1000	1000
	Fixed Charge (Rs/Month)		3000		3000		3000	3000

Street Lighting

Energy Charge (Rs/kWh)	17

Electric Vehicle Charging Rates at CEB Charging Stations

Time of Use (ToU)	DC Fast Charging (Rs/kWh)	Level 2 AC Charging (Rs/kWh)
Day	50	30
Peak	70	55
Off Peak	30	20

Issues

- **End-use customer tariffs at present are not cost-reflective**, whereas the Act requires the tariffs to be cost-reflective.
- Section 30(2)(a) of SLEA No. 20 of 2009
  - Electricity tariffs **be set by the relevant licensee.**
  - In accordance with **a cost reflective methodology approved by PUCSL**.
  - Licensees are **permitted to recover all reasonable costs**.

Issues Contd..

- **Absence of Regular Tariff revisions.**
- Last tariff revision was done in 2013.
- However, a 25% reduction was given to the customer after successful implementation of 3 x 300 MW Coal power plant at Norochcholei.
- According to some CEB studies, to recover the full cost of CEB tariff should be increased as follows.
  - Fixed Charge/Demand Charge – 40%
  - Energy Charge – 7.25 Rs./kWh
- Abrupt tariff variations for consumers should be avoided. Hence regular revisions are necessary.

Financial Status of CEB

	2013	2014	2015	2016	2017	2018	2019	2020
Electricity Sales (GWh)	10,621	11,063	11,786	12,785	13,431	14,091	14,611	14,287
Avg. Selling Pr. (Rs./kWh)	18.28	18.32	16.01	16.18	16.26	16.29	16.63	16.72
Total Cost @ selling Point (Rs./kWh)	16.95	20.15	15.11	18.12	20.85	19.22	24.12	21.20

Source: Statistical Digests, CEB

	2013	2014	2015	2016	2017	2018	2019	2020
Profit/ (Deficit) MLKR	26,270	(30,512)	2,025	(58,368)	(80,876)	(43,149)	(101,916)	(45,931)

Source : Bulk Supply Transaction Accounts

Major payable balances as at May 31, 2021

No.	Items	Amount (MLKR)
1	Independent power producers - Thermal Oil	39,731
2	NCRE	10,321
3	Ceylon Petroleum Corporation (with delay interest)	78,140
4	Term Loans to finance Working Capital	119,582
5	Senior Unsecured Listed Redeemable Rated Debentures	20,000
6	Project Loans (excludes Treasury Sub Loans serviced by Govt.)	49,259
	Total	317,032

Revenue Requirement of CEB Licensees for 2021

Item	Total estimated cost per annum (MLKR)	Estimation Basis
Generation Capacity Cost	64,345.86	BST Jan-June 2021 submission
Generation Energy Cost	193,182.35	-do-
Allowed Revenue TL	34,861.00	Draft Tariff Filing 2021-2025
Allowed Revenues		
DL1	26,929.00	-do-
DL2	22,774.00	-do-
DL3	14,559.00	-do-
DL4	10,561.00	-do-
Total	367,212.21	
Expected sales (GWh)	14,816	
The avg. cost @ point of supply (Rs./kWh)	24.79	

Issues Contd..

- Certain classes of customers are subsidized as a government policy, while others pay a surcharge to finance the cross subsidy.
- Example for December 2020 Data with 2% Covid recovery.

Tariff Category	Avg. Bill per customer (Rs/month)	Avg unit price (Rs/kWh)	Profit/(subsidy) per (Rs/kWh)
Domestic			
0-30	61.0	4.92	(11.75)
31-60	260.7	4.66	(12.01)
61-90	851.22	9.60	(7.11)

Customers subsidized

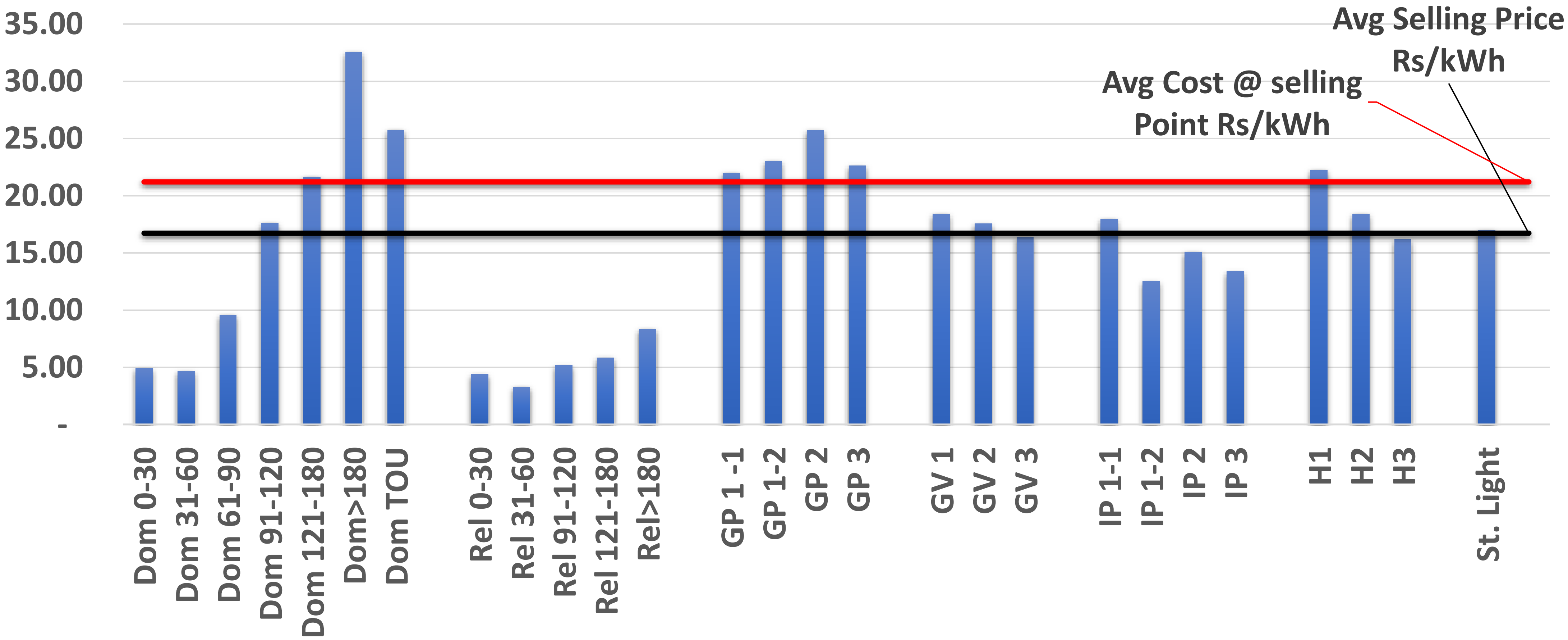
Issues Contd..

Tariff Category	Avg. Bill per customer (Rs/month)	Avg unit price Rs/kWh	Profit/(subsidy) per Rs/kWh
<u>**Domestic**</u>			
91-120	**2,159.76**	**17.6**	**0.93**
121-180	**3,662.47**	**21.6**	**4.96**
>181	**10,546.58**	**32.5**	**15.87**

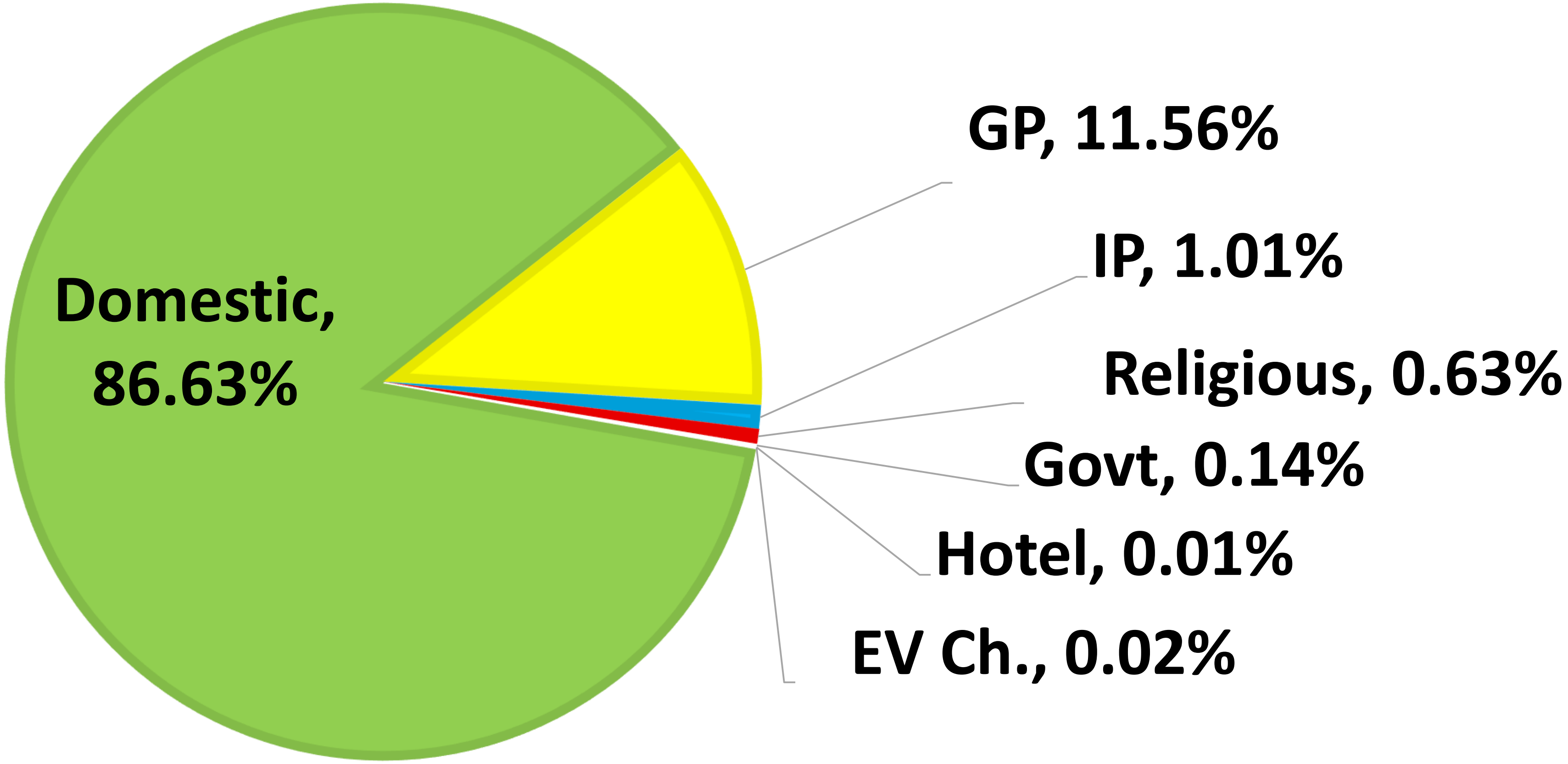
Customers Financing the Cross subsidy

- Subsidy mismatches exists between Categories.
- The removal of cross subsidies requires rebalancing the tariffs.

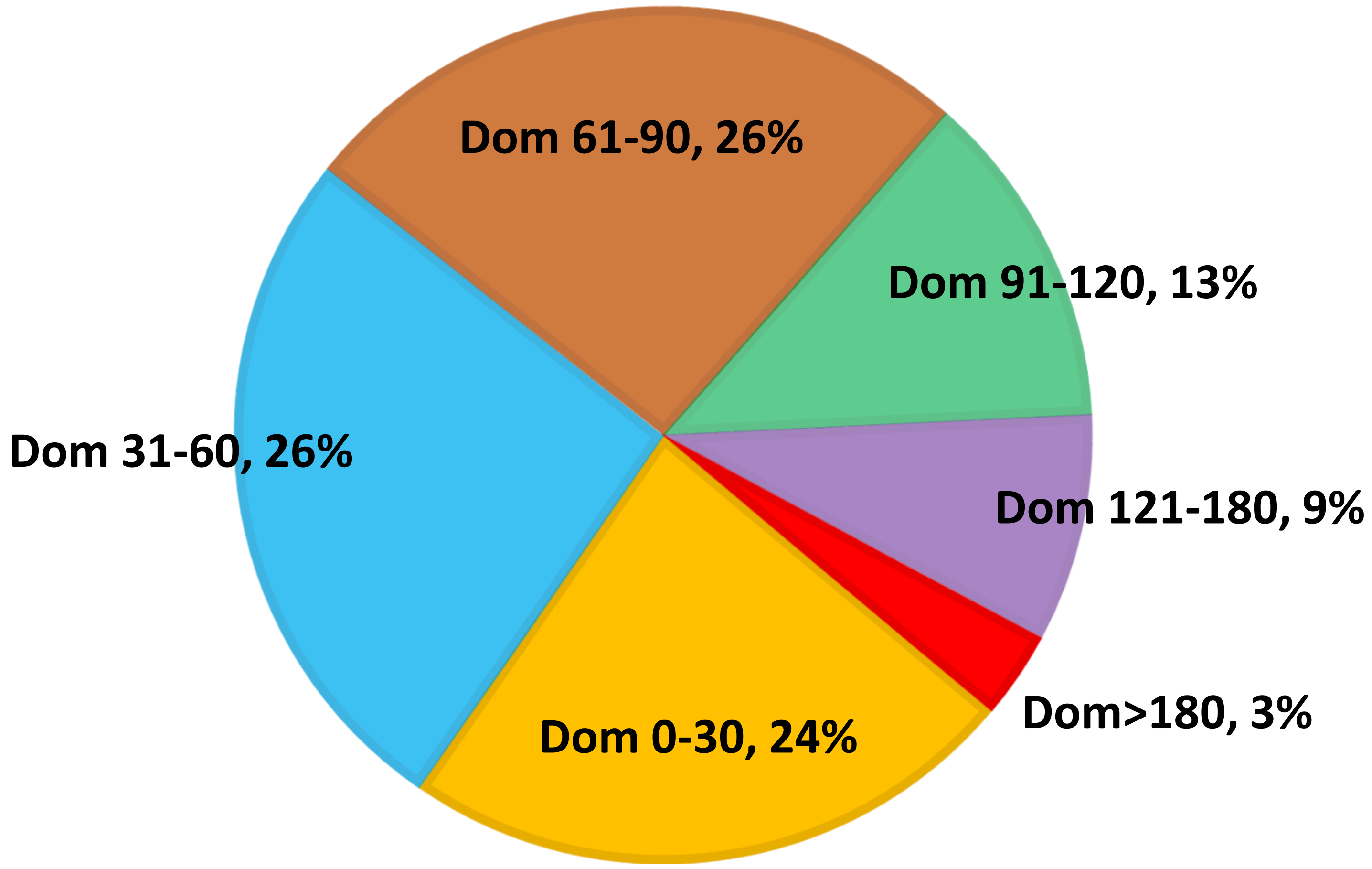
Cross Subsidy



Electricity Customer Base as at 2020



Domestic Customer Distribution as at 2020



Issues Contd..

- Life-line rates can be a solution.
- A household with basic requirements would use 30 kWh/month.
- Government to directly subsidise such customers through an appropriate mechanism such as “Samurdhi Scheme”.
- Then the subsidy would flow external to the electricity tariffs.

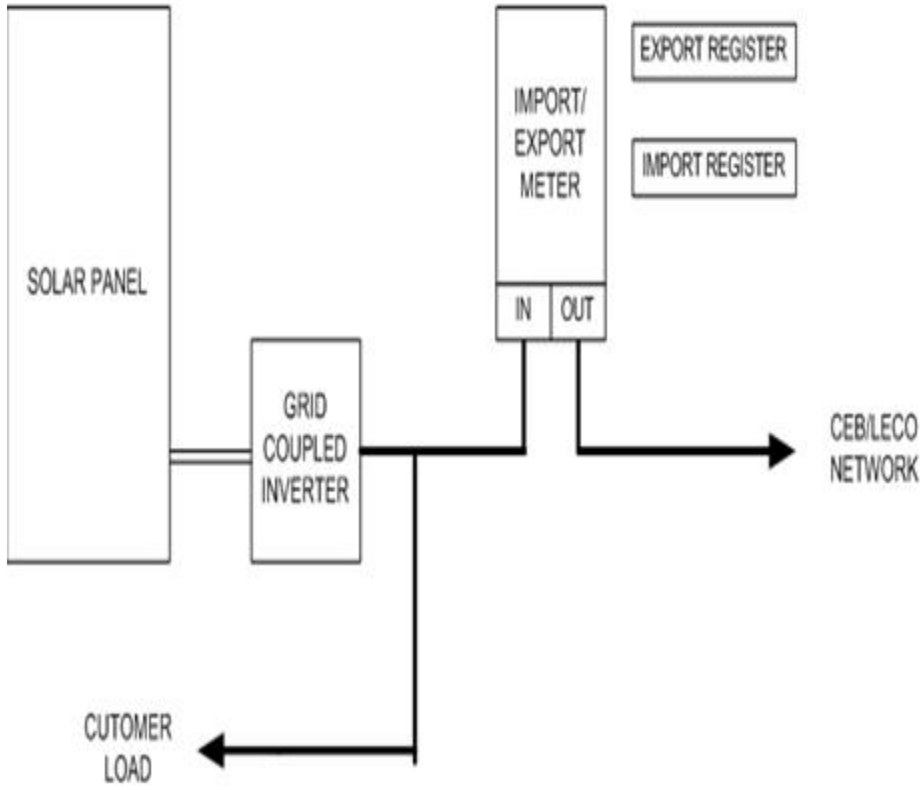
Issues Contd..

- Too many Tariff blocks and too many Tariff Categories.
- To achieve cost reflectivity it is necessary to reduce Tariff Blocks and unify consumer categories as much as possible.
    - Ex. Industrial, General and Hotel Purpose categories can be unified.
- Electricity tariffs are defined by means of customer categories rather than voltage level at which each customer is served (cost of supply depends on voltage).
- Setting the price of electricity in accordance with the purpose of electricity use, has caused many difficulties for DLs to determine the category to which each customer Belongs.
- Customers have complained to PUCSL of unfair classifications by DLs.
- Similarly, the block tariffs applied to household customers have burdened the DLs with the task of defining the boundaries of a household.

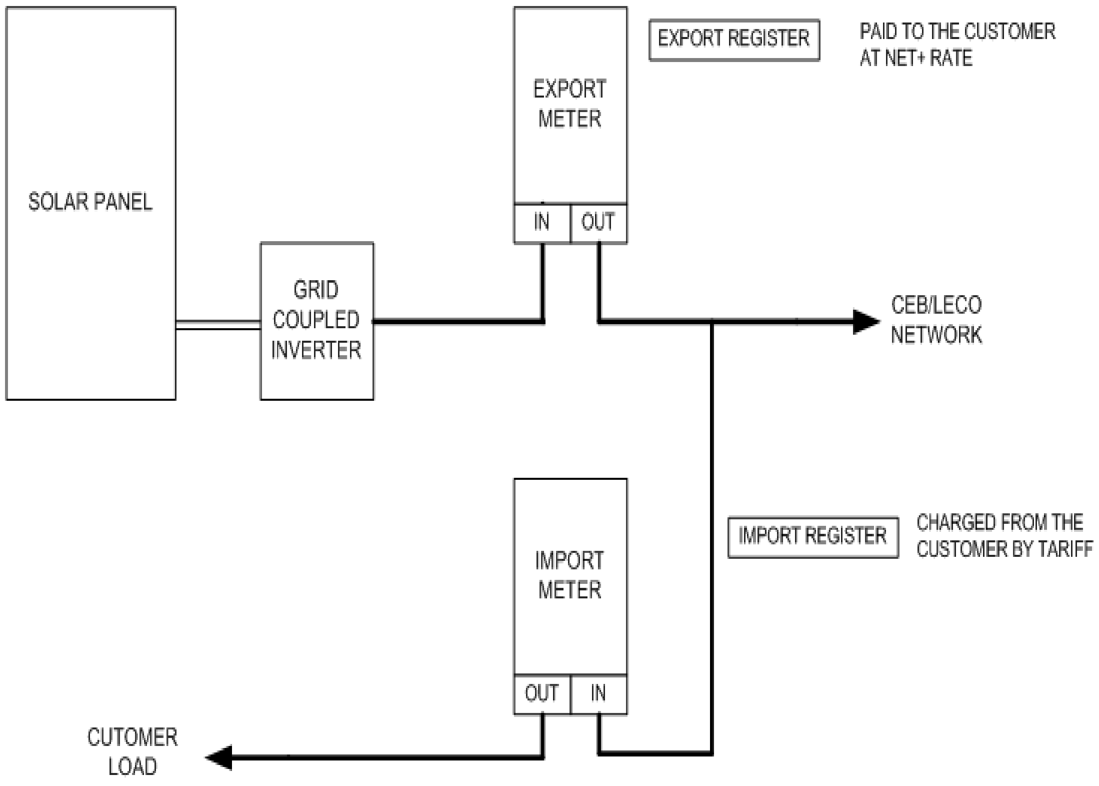
Issues Contd..

Electricity Tariffs Vs Rooftop Solar Schemes

Net metering/Net Accounting



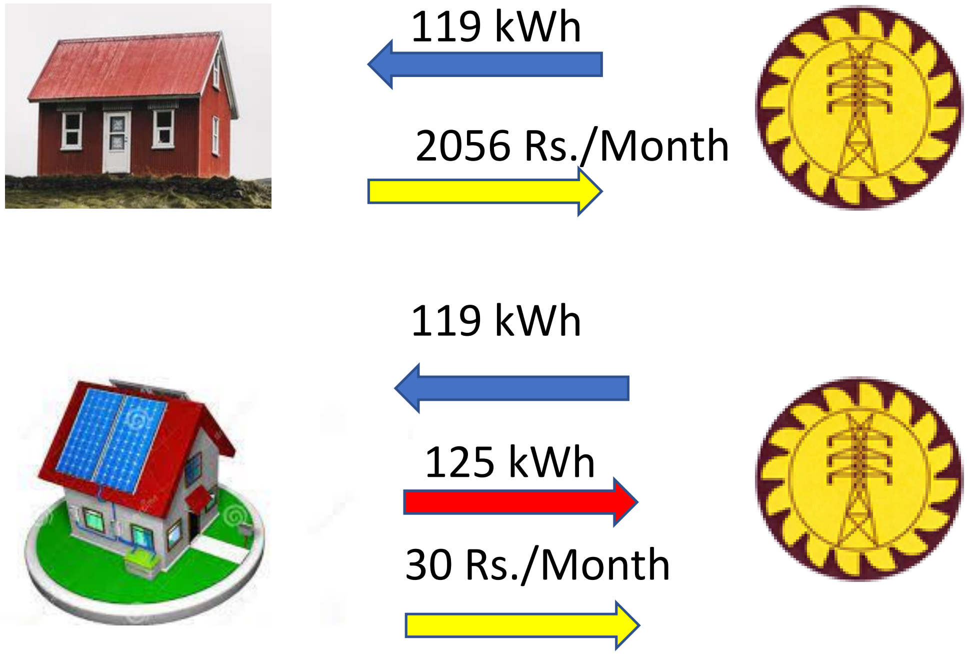
Net Plus Schemes



SCHEME III

Impact – 1 kWp rooftop Solar System

Net Metering

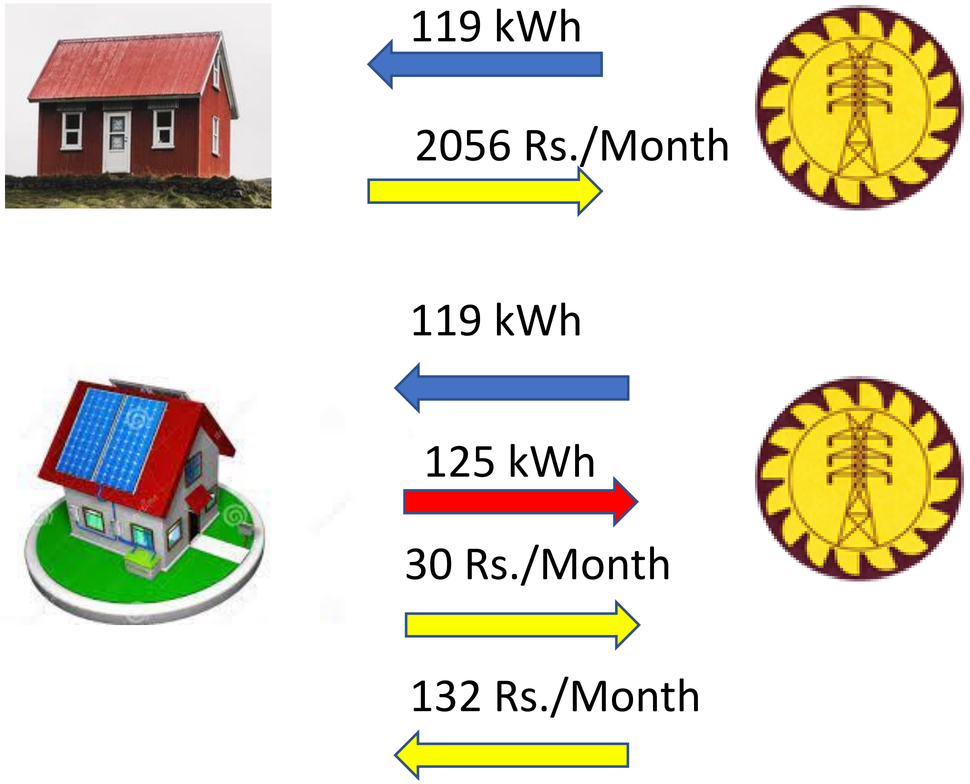


- Earnings from exported electricity - none (LKR 0)
  - Excess of 6 kWh carried forward for next bill & could bank for 10 yrs
  - After 10 yrs, utility keeps the unutilised ‘banked energy’
- Total profit 2,026 Rs./Month (i.e. 2056-30)
- Simple payback* period 6.2+ years

*assuming LKR150,000 cost per kW_p installed capacity

Impact - 1kWp system

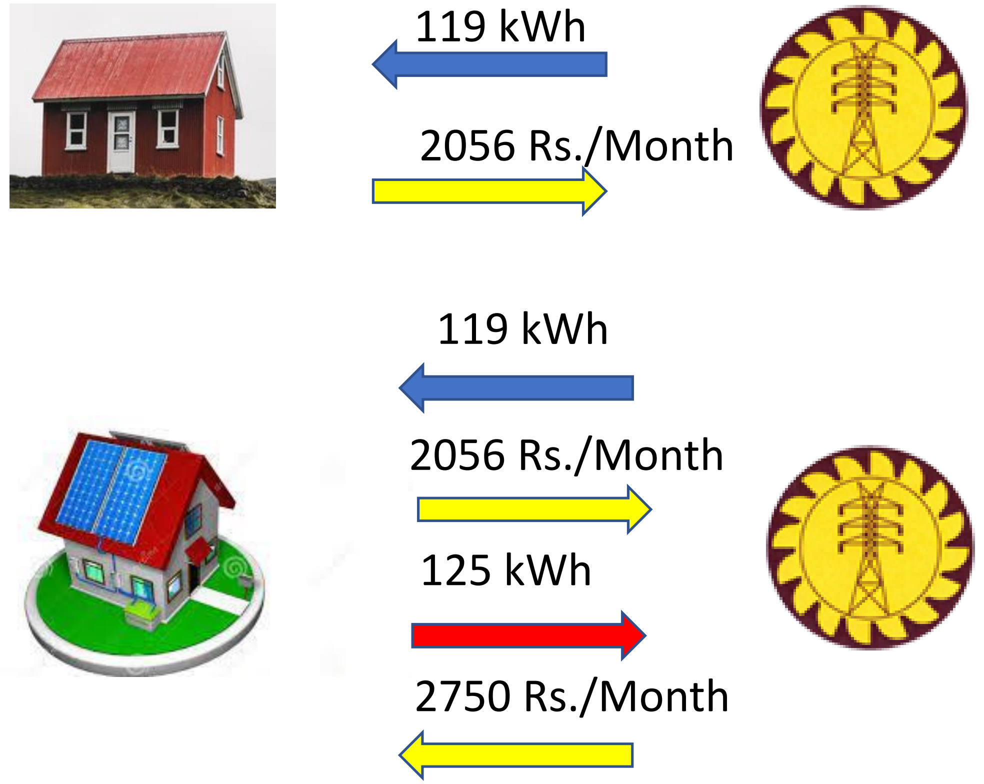
Net Accounting



- Earnings from exported electricity 6 kWh = 132 Rs./Month
- Total profit = 2,158 Rs./Month (2056-30+132)
- Simple payback period 5.7+ years

Impact - 1kWp system

Net Plus



- Total profit = 2,750 Rs./Month (i.e. 125 x 22).
- Simple payback period 4.5+ years.
- IP1-1 Customer with roof top solar.
    - - Purchased from CEB @ 10.80 Rs./kWh.
    - - Sell to CEB @ 22 Rs./kWh

Roof Top Solar Schemes

- Due to high Export Tariff a niche market is created.
- Most high end users may find it a worthy investment.
- Cross subsidy structure is distorted.
- Tariff revision with out revising Roof top solar export tariff may encourage affluent customers to put up solar.

SRI LANKA SUSTAINABLE ENERGY AUTHORITY ACT, No. 35 OF 2007

Renewable Energy Division

August -2020

Provisions in the Act for renewable energy development.. C-4, **The objects of the Authority shall be to..**

(a) ***Identify, assess and develop*** renewable energy resources with a view to enhancing energy security and thereby derive economic and social benefits to the country;

(b) Identify, promote, facilitate, implement and manage energy efficiency improvement and energy conservation programmes for use of energy in domestic, commercial, ***agricultural, transport***, industrial and any other relevant sector;

(c) Promote security, reliability and cost effectiveness of energy delivery to the country, by policy development and analysis and related information management; and

(d) Ensure that adequate funds are available for the Authority to implement its objects, consistent with minimum economic cost of energy and energy security for the nation

Cont…c-10 Project Approving Committee (PAC)

- (a) **Director-General** of the **Central Environmental Authority** appointed under the National Environmental Act, No. 47 of 1980;
- (b) **Conservator-General** of the **Forest Conservation Department** appointed under the Forest Ordinance (Chapter 451);
- (c) **Director-General** of the **Wild life Conservation Department** Appointed under the Fauna; and Flora Protection Ordinance (Chapter 469);
- (d) **Director-General** of the **Irrigation Department** appointed under Irrigation Ordinance (Chapter 453);
- (e) **Director-General** of the **Mahaweli Authority** of Sri Lanka established by the Mahaweli Authority of Sri Lanka Act, No. 23 of 1979;
- (f) **General-Manager** of the **Ceylon Electricity Board** appointed under the Ceylon Electrity Board Act, No. 17 of 1969;
- (g) **Land Commissioner** appointed under the **Land Development Ordinance** (Chpater 464);
- (h) **Director-General** of the **Board of Investment** of Sri Lanka appointed under the Lanka Board of Investment of Sri Lanka Law No. 4 of 1978;

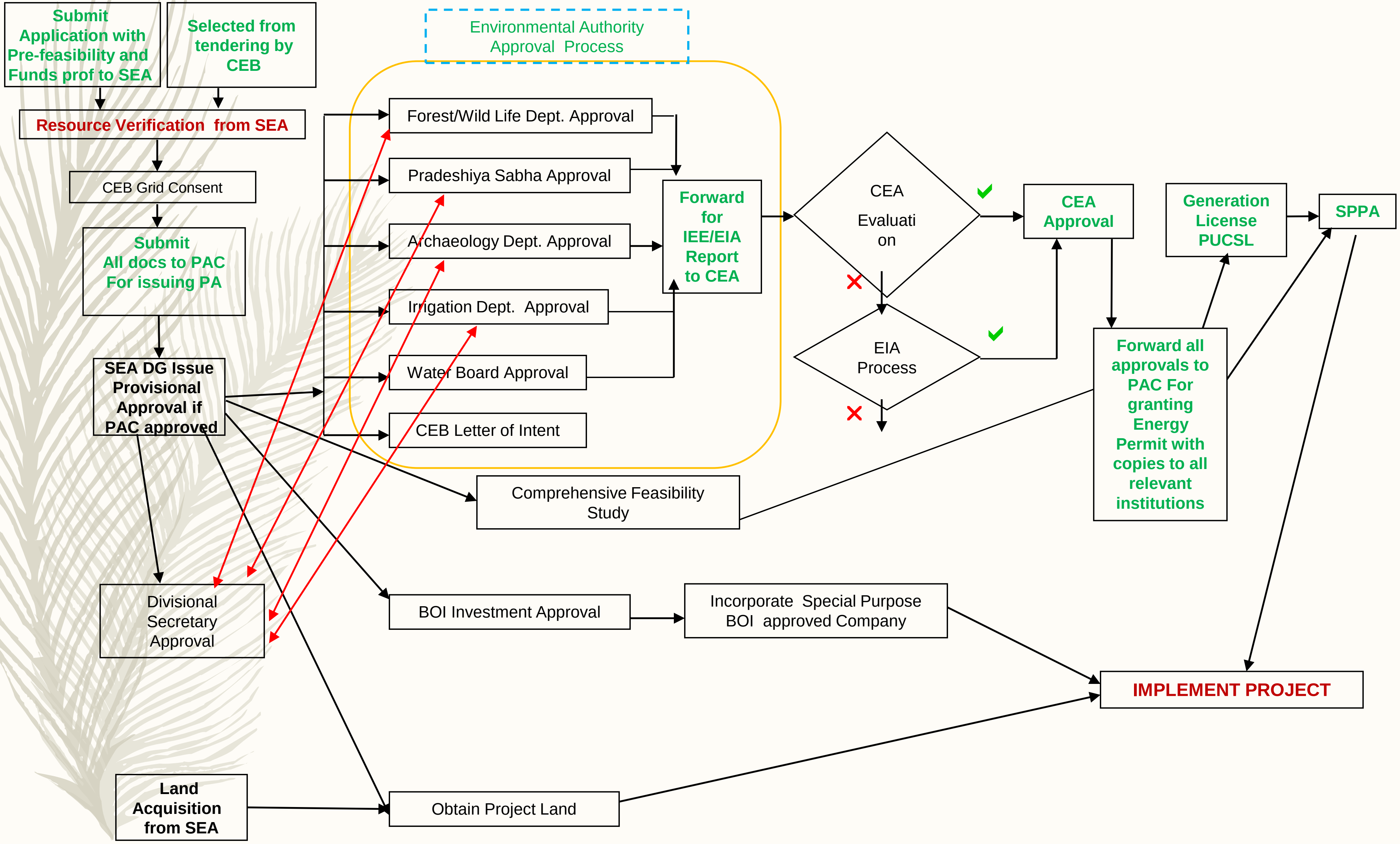
Cont…c-10 Project Approving Committee (PAC)

- (i) **Director-General** of the **Coast Conservation Department** appointed under the Coast Conservation Act, No. 57 of 1981;
- (j) **Director-General of the Authority**;
- (k) **Divisional Secretary of the Divisional Secretary's Division** within which a development project is to be implemented; and
- (l) **Chief Secretary of the Provincial Council** established for the province within which a development project is to be implemented.

(2) The Minister may nominate one person from among the members of the Committee, other than the member referred to in paragraph (k) of subsection (1), as the **Chairman of the Committee**.

(3) The **Director-General** of the Authority shall function as the **convenor** of all meetings of the Committee.

PROJECT APPROVING PROCESS AT SEA



Cont…c-16 On-grid renewable energy projects

(1) Notwithstanding the provisions in any other law to the contrary and subject to the provisions of section 71, no person shall engage in or carry on an on-grid renewable energy project for the generation and supply of power within a Development Area, except under the authority of a permit issued in that behalf by the Authority.

(2) A person who is desirous of engaging in and carrying on an on-grid renewable energy project within a Development Area, shall make an application to the Director-General for the same in the prescribed form together with the prescribed fee and the following documents :—

(a) a copy of a map of the geographical location of the proposed project;

(b) a brief description of the project, including the amount of power to be generated;

(c) the total estimated cost and financial model, including optimization criteria adopted;

(d) proof of availability of adequate finances or the manner in which the required finances for the project are to be obtained;

Cont…c-16 On-grid renewable energy projects

(e) project location i. e. Weir and Power House relative to river or stream system if it is a Hydro Power project, Wind Turbine and Structures if it is a Wind power project, Energy Plantation, Power House and Water Source if it is a Biomass Project and Conversion Facility relative to energy resource, if it is any other project ;

(f) a statement explaining how the applicant intends to evacuate electricity generated and the point at which the generator will be connected to the national grid and the geographical area traversed by the power line constructed for this purpose.

(3) On receipt of an application under subsection (2), the Director- General shall forthwith register such application along with the documents in a register maintained for that purpose, and issue a registration number to the applicant

Cont…c-17 Provisional approval to be granted(PA).

(1) The Director-General shall after carrying out such preliminary screening of the proposed project as he considers necessary and in consultation with the Ceylon Electricity Board, submit the registered application together with his observations on the proposed project, to the Committee for its approval.

(2) The Committee shall where it considers it appropriate :—

(a) **grant provisional approval** for the project which shall be communicated forthwith by the Director- General to the applicant in the prescribed form, with a request to submit such documents and other information as shall be prescribed for the purpose, within six months of such communication being received by the applicant; or

Cont…c-17 Provisional approval to be granted(PA).

(b) refuse to grant provisional approval for the project which shall be communicated forthwith by the Director-General to the applicant, stating the reasons for such refusal

(3) An extension of the period given for the submission of documents and information under paragraph (a) of subsection (1) may be granted by the Director- General where requested for, upto a maximum of another six months period.

(4) A provisional approval granted under paragraph (a) of subsection (1) shall be valid for a **period of one year** from the date on which such approval is granted and shall stand cancelled automatically, **if the documents and other information requested for is not submitted** prior to the expiry of the period of one year.