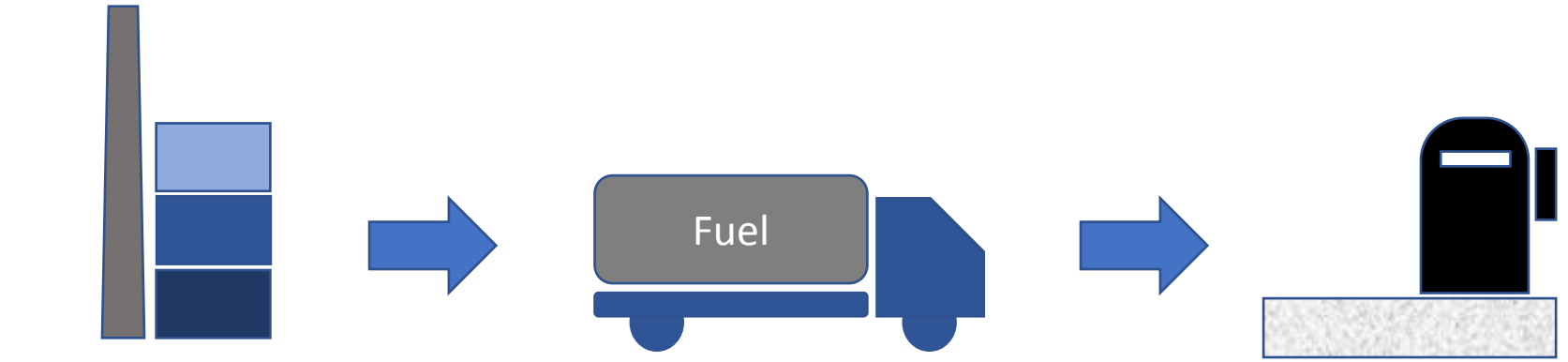
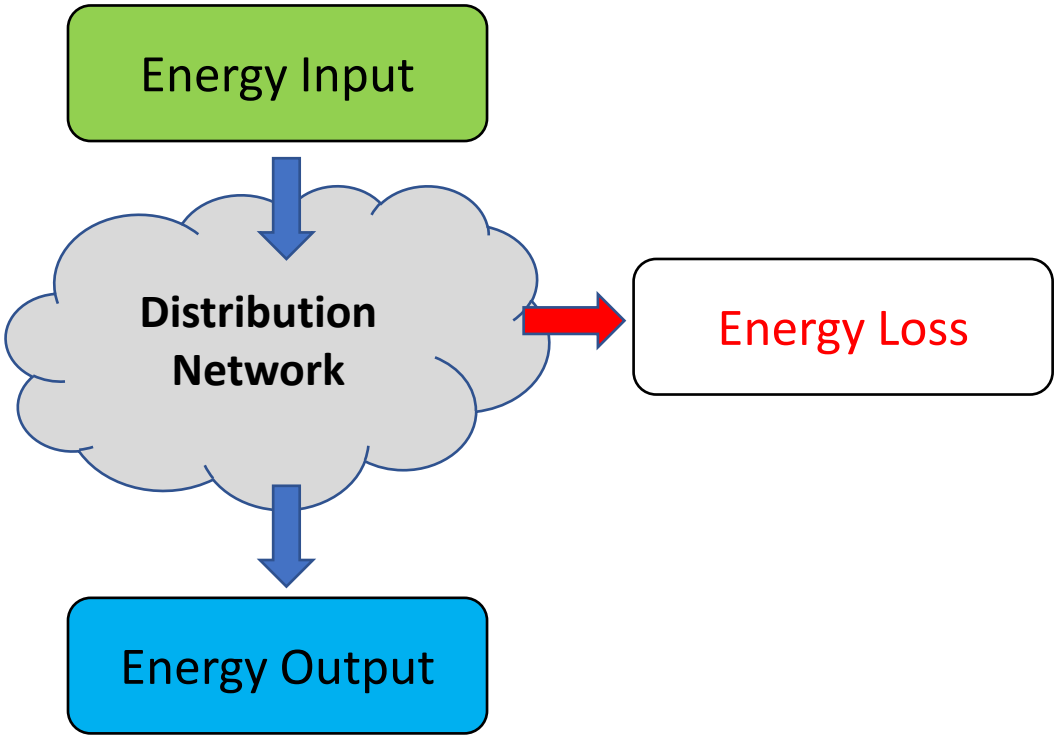
Distribution System Loss

Efficiency of Systems

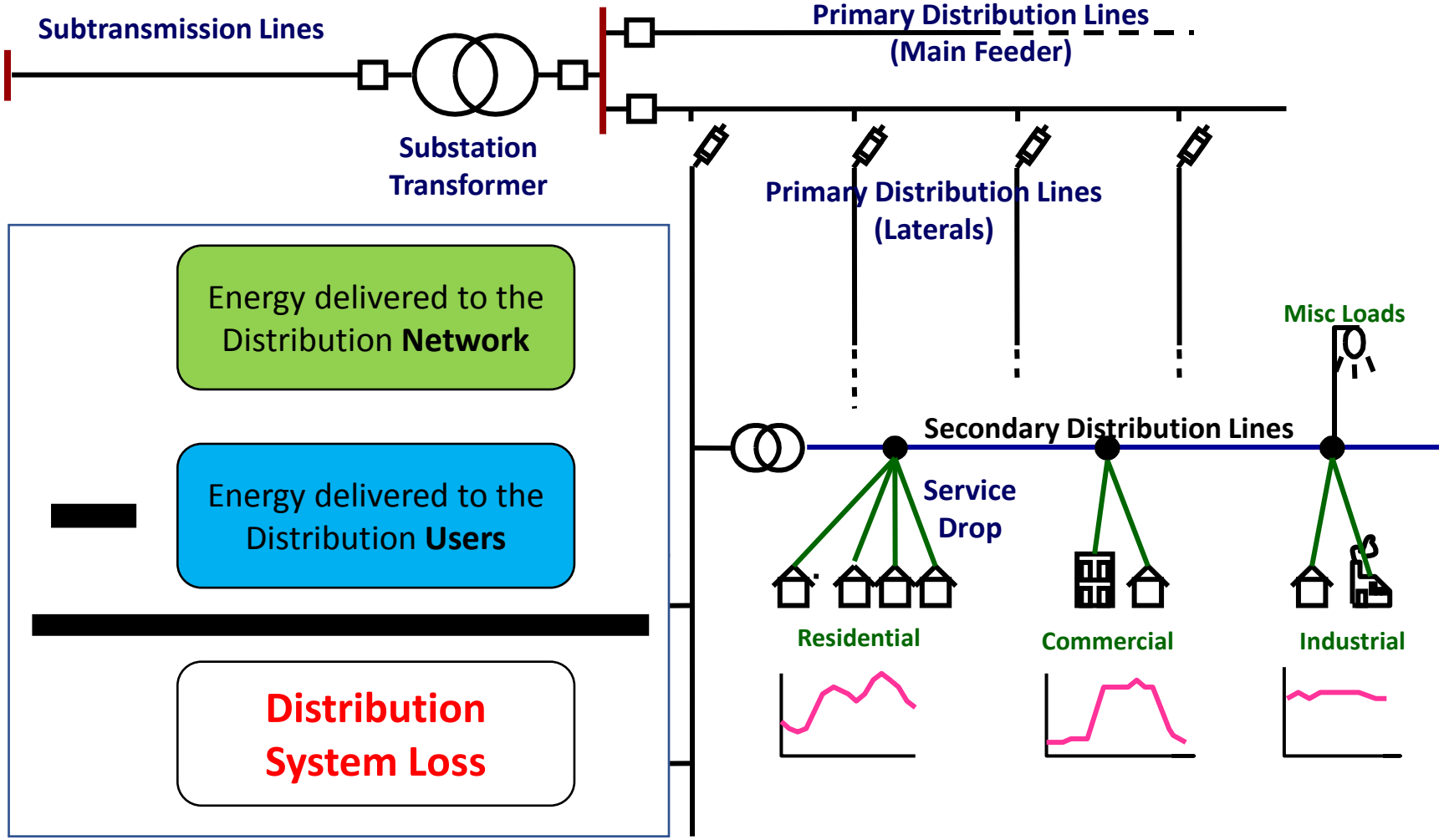
- Energy systems have losses.
  - Conversion of energy cannot achieve 100% efficiency.
  - **<u>Transport of energy</u>** cannot achieve 100% efficiency.

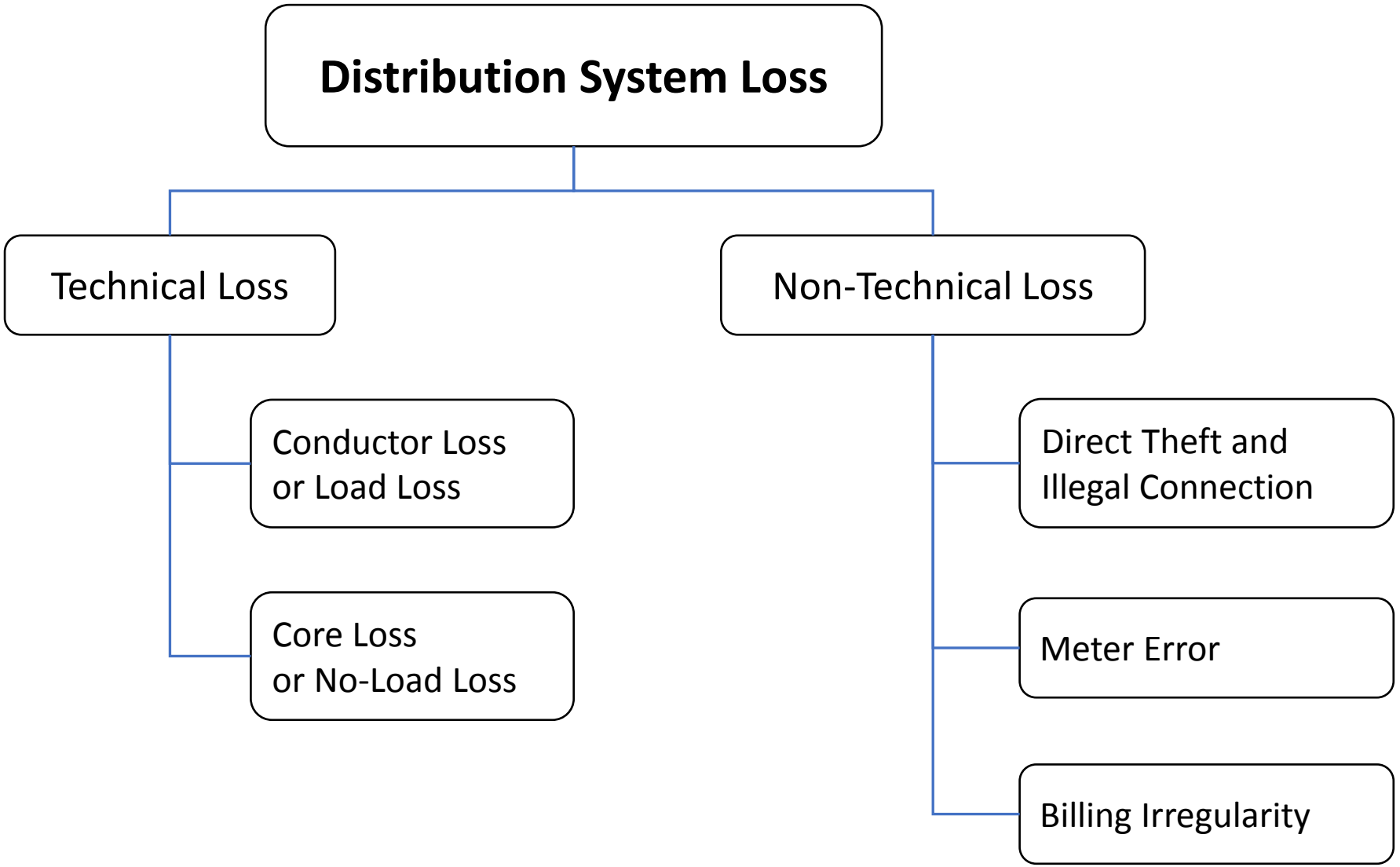


Distribution System Loss



Distribution System Loss




Distribution System Loss
Technical Loss
Non-Technical Loss
Conductor Loss or Load Loss
Core Loss or No-Load Loss
Direct Theft and Illegal Connection
Meter Error
Billing Irregularity

Technical Losses

- Technical loss is energy loss due to the physics of the system:
  - It is the physical properties of the components of the network that induces energy losses.

Technical Loss:
Conductor Loss or Load Loss

- Wires (conductors) have electrical **resistance** – a property of materials to resist the current.

$$Resistance = Resistivity \times \frac{Length}{Area}$$

  - Resistivity depends on wire material.
  - Length depends on distance between source and load.
  - Area (cross-sectional) depends on wire size.

Technical Loss:
Conductor Loss or Load Loss

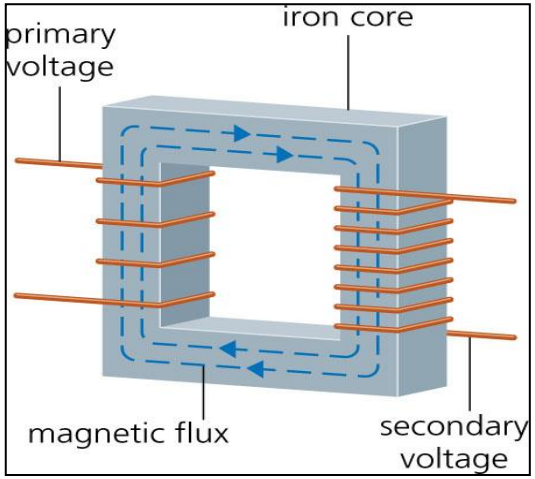
- **Conductor loss** is energy lost to overcome this resistance, and manifests as heat.

$$Conductor\ Loss = Current^2 \times Resistance$$

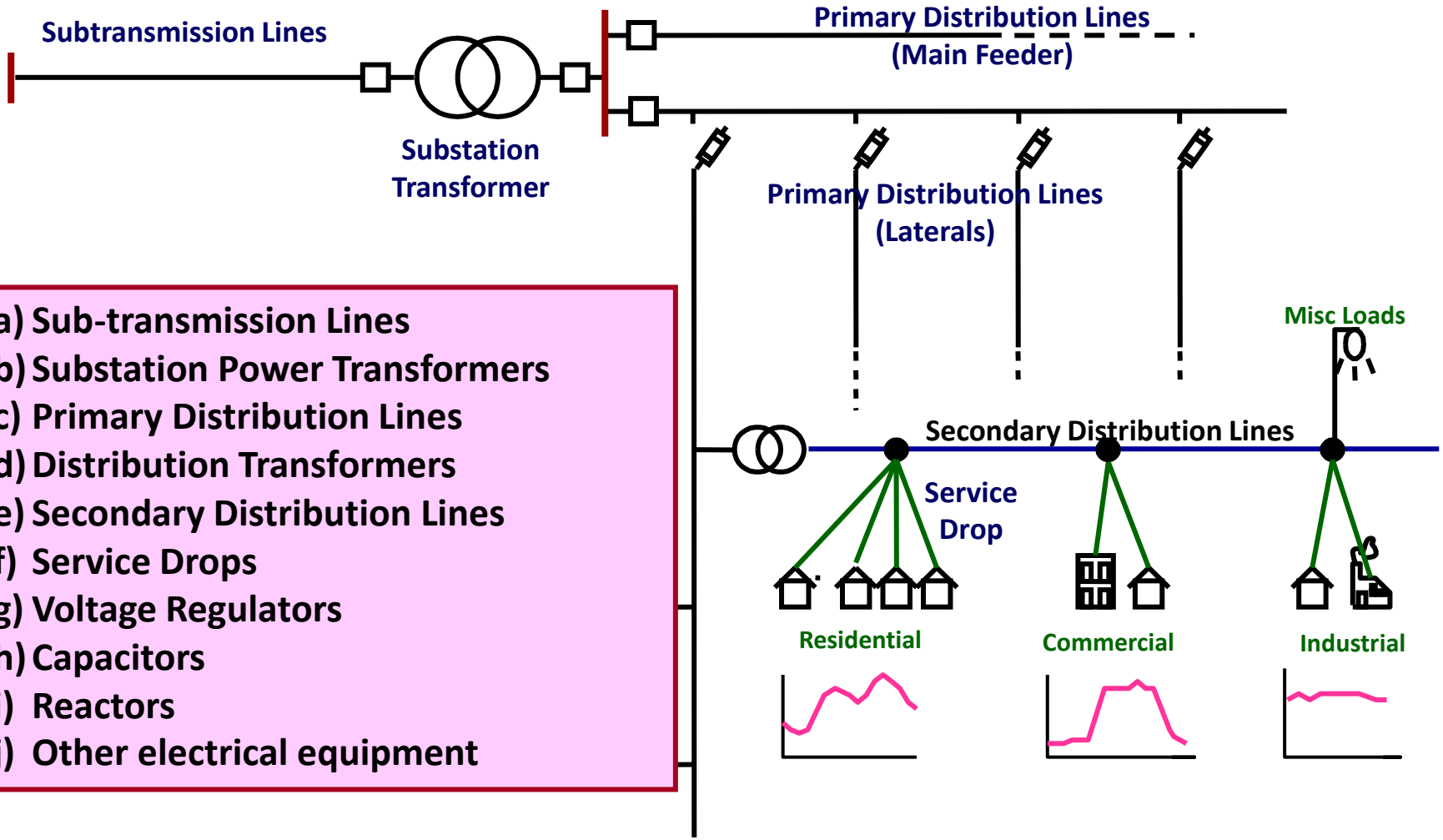
  - Current depends mostly on characteristics of the load (hence, load loss).
  - The distribution network also has effects on the current.

Technical Loss:
Transformer Core Loss or No-Load Loss

- **<u>No-Load Loss</u>**: When a transformer is energized, even when no load is connected, it already uses energy. The energy loss here is associated with the transformer core.



Where do technical losses it occur?



a) Sub-transmission Lines
b) Substation Power Transformers
c) Primary Distribution Lines
d) Distribution Transformers
e) Secondary Distribution Lines
f) Service Drops
g) Voltage Regulators
h) Capacitors
i) Reactors
j) Other electrical equipment

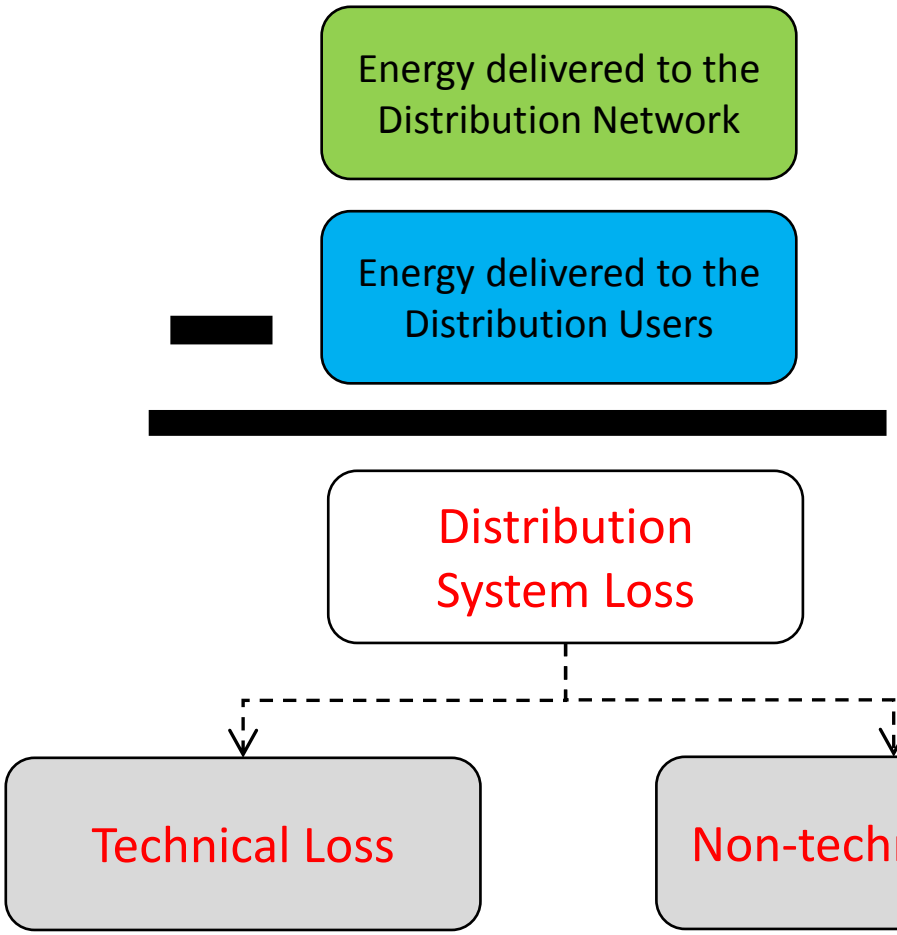
Non-technical Loss

- Non-technical Loss is energy loss due to human errors, whether intentional or not.

Examples of Non-technical Loss

- Illegal Connection and Direct Theft
  - Non-customer connects to network and draws energy.
  - Customer connects to network and draws energy but bypasses meter.
- Meter Error
  - Customer tampers with meter to reduce the energy it reads, thereby reducing customer's electric bill.
  - Defective meter, wear and tear, meter quality
- Billing irregularity
  - Meter reader connives with customer to reflect lower meter reading.
  - Billed energy is not accurate; may be due to errors in billing system or by billing personnel – honest errors and otherwise.

Distribution System Loss



Metered and billed to distribution utility (DU)

Metered and billed by DU to its customers

Calculated as difference of input and output

Can be obtained through technical simulations

Calculated as what's left after everything has been accounted for

System Loss Rate

System Loss Rate

- ERC Res. No. 26 Series of 2009, Article II Section 4:

$$SLR = (TGR + ATR) \times U + OSLA$$

Where

SLR	=	System Loss Rate, in PhP/kWh;
TGR	=	Total Generation Rate, in PhP/kWh;
ATR	=	Average Transmission Rate, in PhP/kWh;
U	=	Gross-Up Factor, in % *(see next slide – this factor is related to actual system loss and system loss cap)*; and
$OSLA$	=	Other System Loss Cost Adjustments, in PhP/kWh.

System Loss Rate – Gross-Up Factor

- ERC Res. No. 26 Series of 2009, Article II Section 4:

$$U = \frac{\%SL}{1 - \%SL_a}$$

Where U = Gross-Up Factor, in %;

$\%SL$ = Equal to either :
(1) actual system loss for the most recent 12-month period; or
(2) the system loss cap,
whichever is lower; and

$\%SL_a$ = The actual system loss for the most recent 12-month period.

Distribution Rate, CAPEX and OPEX

$$Rate = \frac{CAPEX + OPEX + Taxes - 0.5 \times ORI}{kWh_{forecast}}$$

Where	$Rate$	=	Distribution rate, in PhP/kWh;
	$CAPEX$	=	Capital expenses to be undertaken, in PhP;
	$OPEX$	=	Operating expenses of the DU, in PhP;
	$Taxes$	=	Taxes to be paid by the DU, in PhP;
	ORI	=	Other revenue items, in PhP; and
	$kWh_{forecast}$	=	Energy forecast, in kWh.

Price-Linked Incentives

- Price-linked performance incentives to electric cooperatives and private distribution utilities for distribution efficiency
  - Rate impact of incentives is based on distribution rate
  - In various RDWRs for private distribution utilities, and the RSEC-WR/TGP Rules for electric cooperatives

RDWR	=	Rules for Setting Distribution Wheeling Rates (private DUs)
RSEC-WR	=	Rules for Setting Electric Cooperatives Wheeling Rates
TGP Rules	=	Tariff Glide Path Rules

Price-Linked Incentives

Private Distribution Utilities

System Loss	Rate Impact
7.5% < SL ≤ 8.5%	None
6.5% < SL ≤ 7.5%	+0.0625%
SL ≤ 6.5%	+0.1250%

Electric Cooperatives

System Loss	Rate Impact
SL = Cap	None
Cap–1% ≤ SL < Cap	+0.30%
Cap–2% ≤ SL < Cap–1%	+0.50%
Cap–4% ≤ SL < Cap–2%	+0.70%
SL < Cap–4%	+0.90%

Notes:

1. *Rate impact is expressed as a percentage of the distribution rate.*
2. *Rate impact for electric cooperatives will halve after their First Regulatory Period.*