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Future Challenges with LV Grid Integration of Solar PV Resources: Impact Analysis and Monitoring Method

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PEA
PROVINCIAL ELECTRICITY AUTHORITY

Content

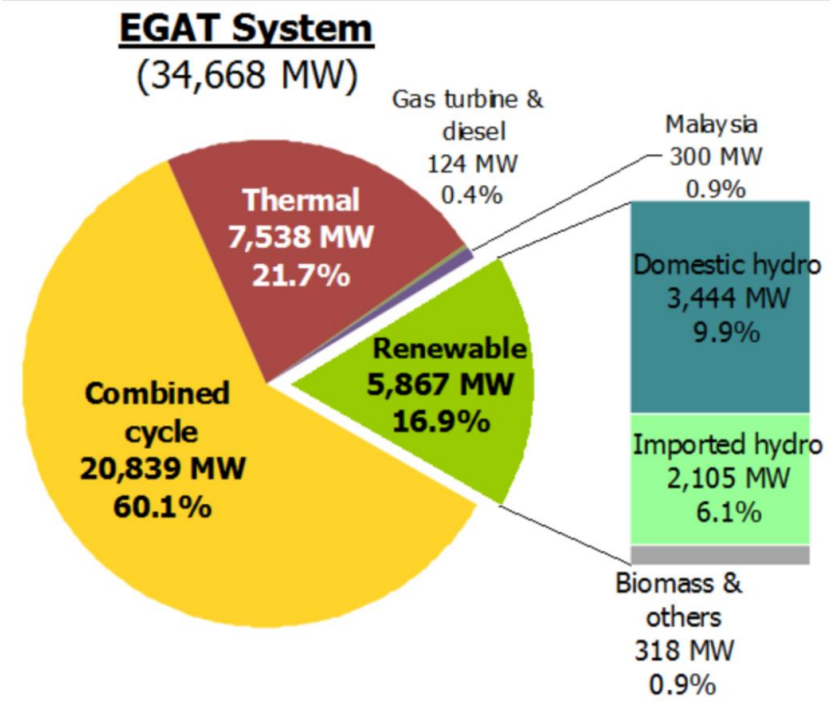
- Power development plan 2018 (PDP2018)
- Impact of PV to Power Distribution
- Experimental method and result
- Monitoring device : Transformer Load Management (TLM)
- Conclusions

Power Producer by year 2015

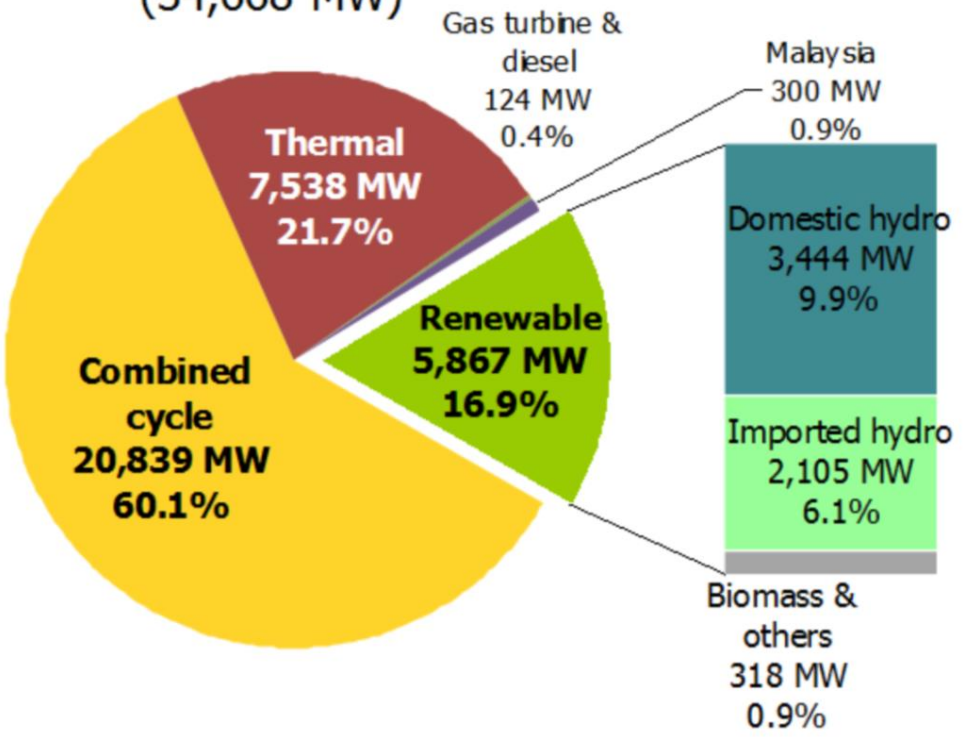
PDP 2015

Classified by power producer

- EGAT	15,482	MW	41.2	Percent
- Independent Power Producers (IPPs)	13,167	MW	35.0	Percent
- Small Power Producers (SPPs)	4,530	MW	12.0	Percent
- Very Small Power Producers (VSPPs)	2,029	MW	5.4	Percent
- Power imports	2,404	MW	6.4	Percent
Total	**37,612**	**MW**		

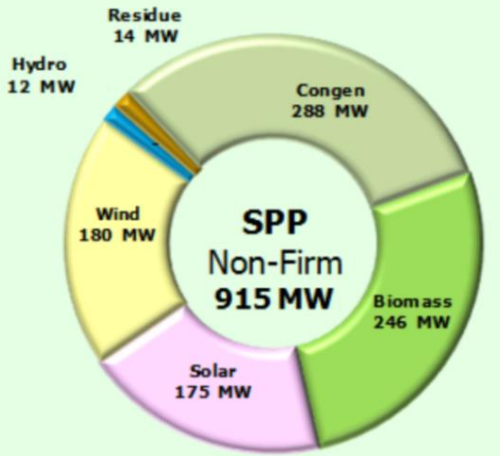


EGAT System
(34,668 MW)

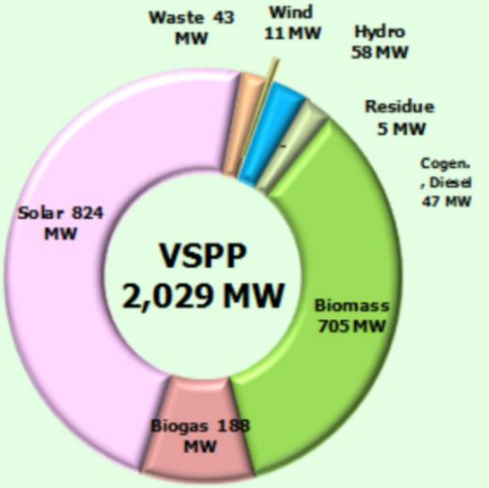


Thailand power system	37,612 MW
- EGAT system	34,668 MW
- SPP Non-Firm (RE, Cogeneration)	915 MW
- VSPP (RE, Cogeneration)	2,029 MW

Contract capacity of non-firm SPP

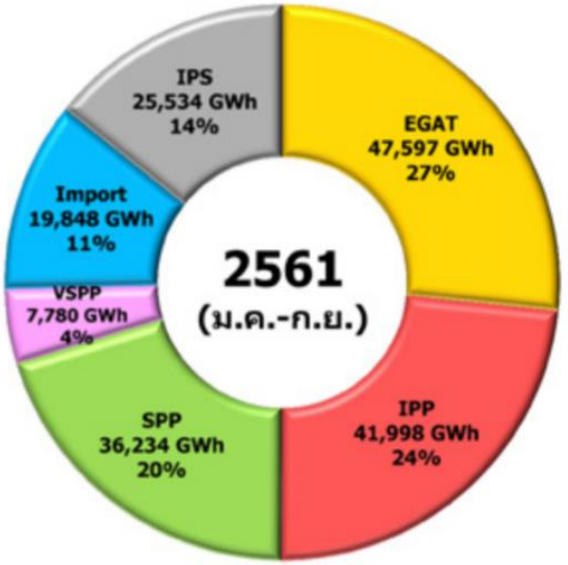


Contract capacity of VSPP



Energy survey found Changing in power producer by 2018

Categorized in Power Producer Situation



By September 2018
Total 55,117 MW

- EGAT 27%
- Independent Power Producers (IPPs) 24%
- Small Power Producers (SPPs) 20%
- **Prosumer / Direct sale 14%**
- Very Small Power Producers (VSPPs) 4%
- Power Imports 11%

New PDP2018 revised

-Big Project not success
- More RE
- More Self-Gen
- Change of Peak Time from Day to Night

New PDP2018

Household could generate their own electricity through solar rooftops and sell the surplus power to other users

100MW/year
quota by
PDP2018

Power Development Plan 2018 (PDP2018)

Renewable Energy/ Energy Conservations	Power Contact (MW)
Solar Energy	10,000
Biomass	3,376
Biogas	546
Solar Energy co with Dam	2,725
Wind Power	1,485
Energy from Waste	44
Energy Conservations Policy	-
Total in 2037	**18,176**

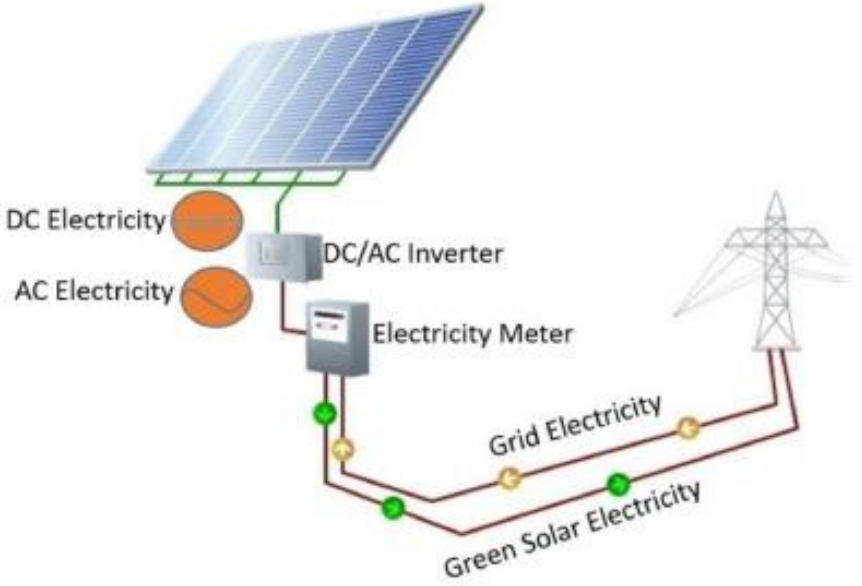
Impact of Solar PV

- Many impacts on the medium and low voltage power system:

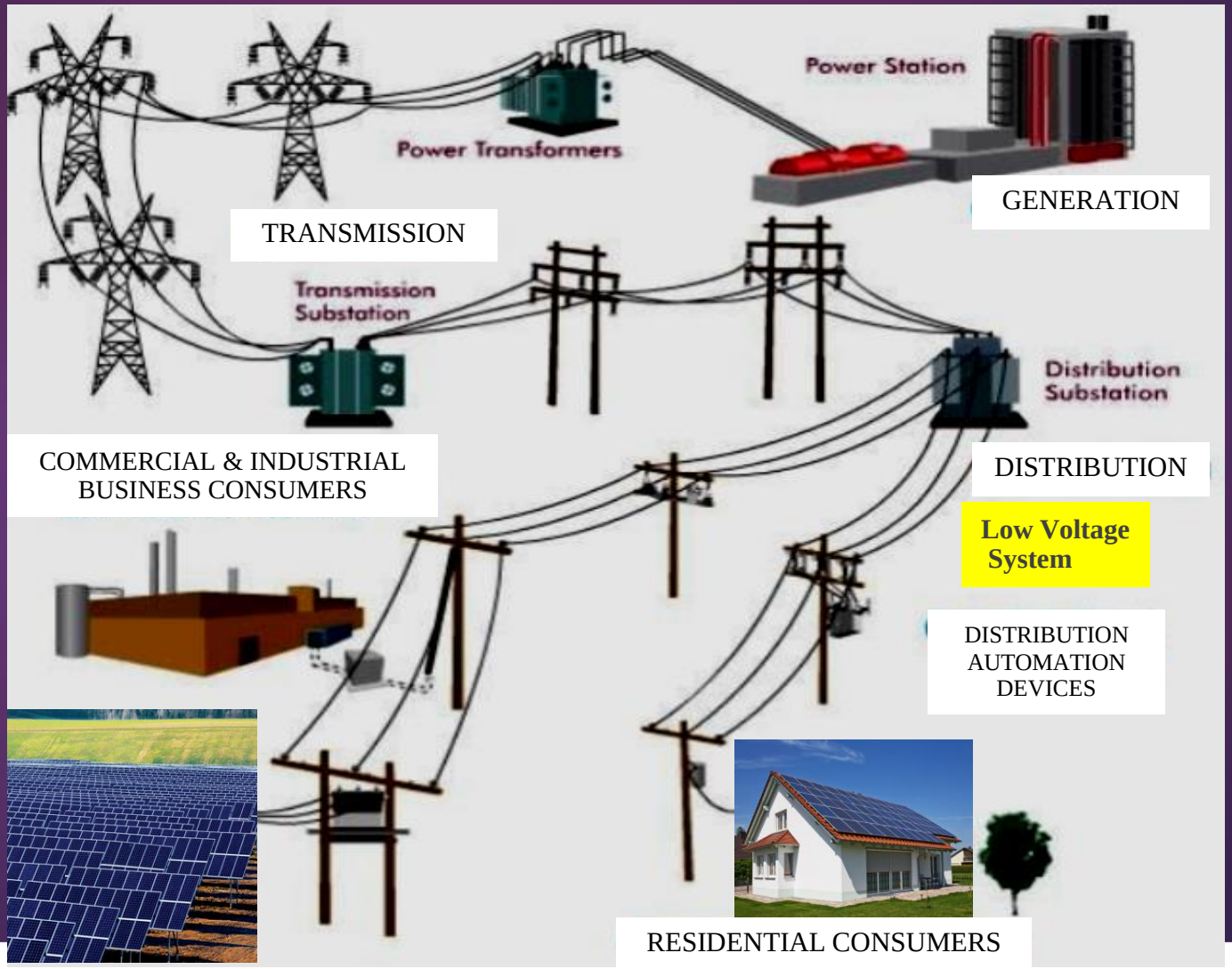
(a) line or transformer overloading by over supply

(b) voltage changes, power quality issues

(c) complicated for operation and maintenance planning.

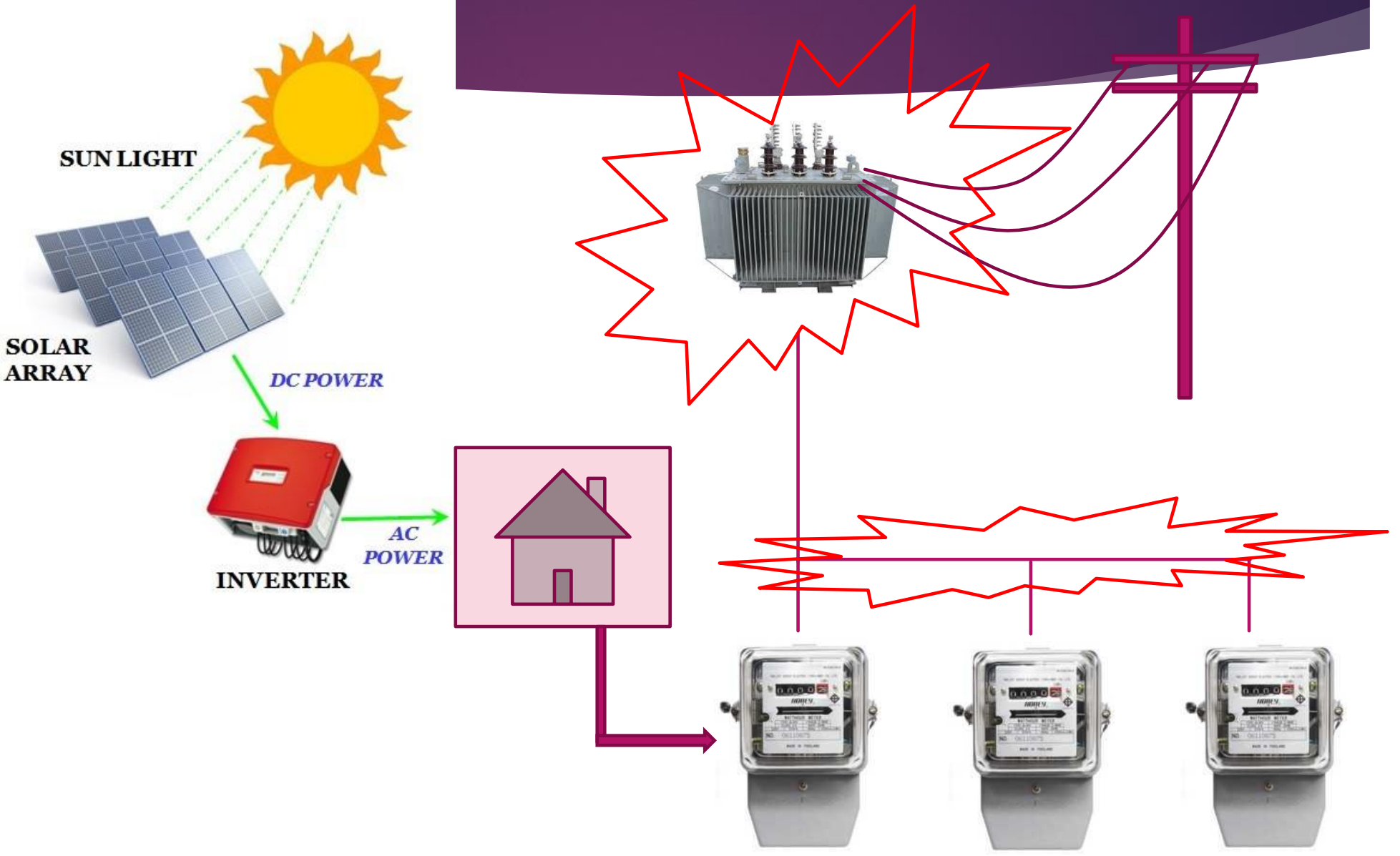


Power System and Power Distribution



http://sosc.poly.edu, 2015.

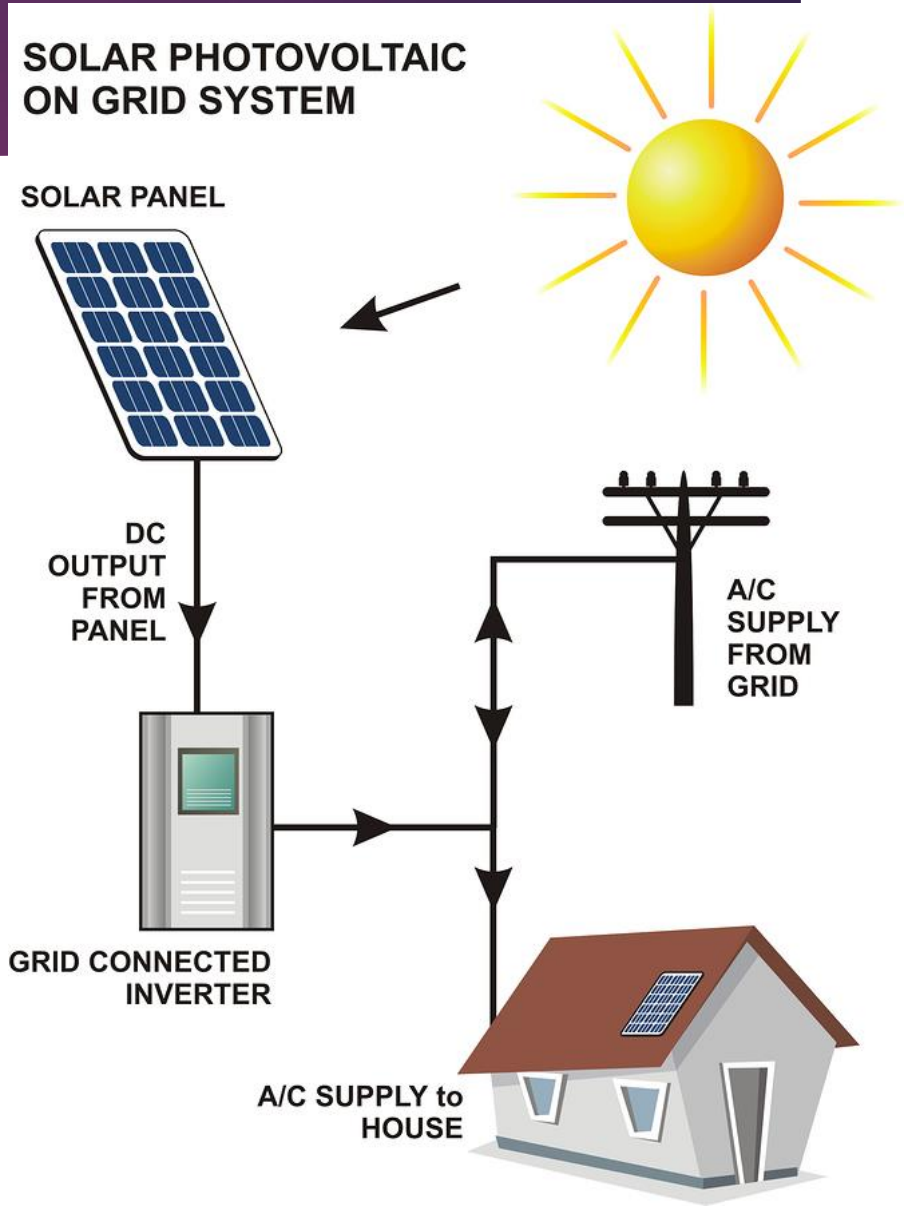
Line or transformer overloading



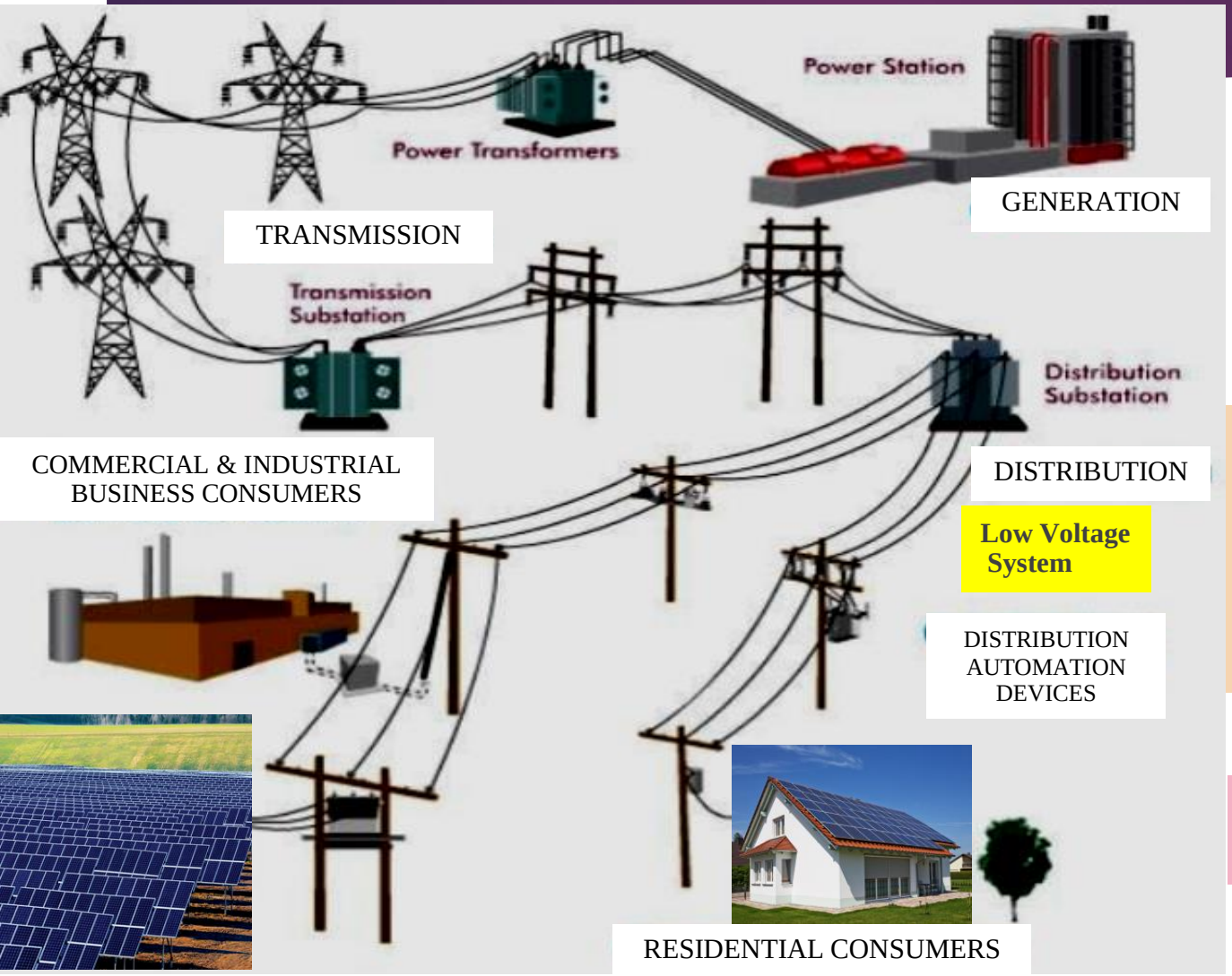
Power Quality Issues

Power quality issues caused by Inverter
- Harmonics – IEEE519
- Flicker – IEC61000

Voltage change:
- The voltage rise, in particular, where high penetration of solar-PV energy is connected near the end of lightly loaded feeders.



Operation and maintenance planning



Characteristic of Protection changed

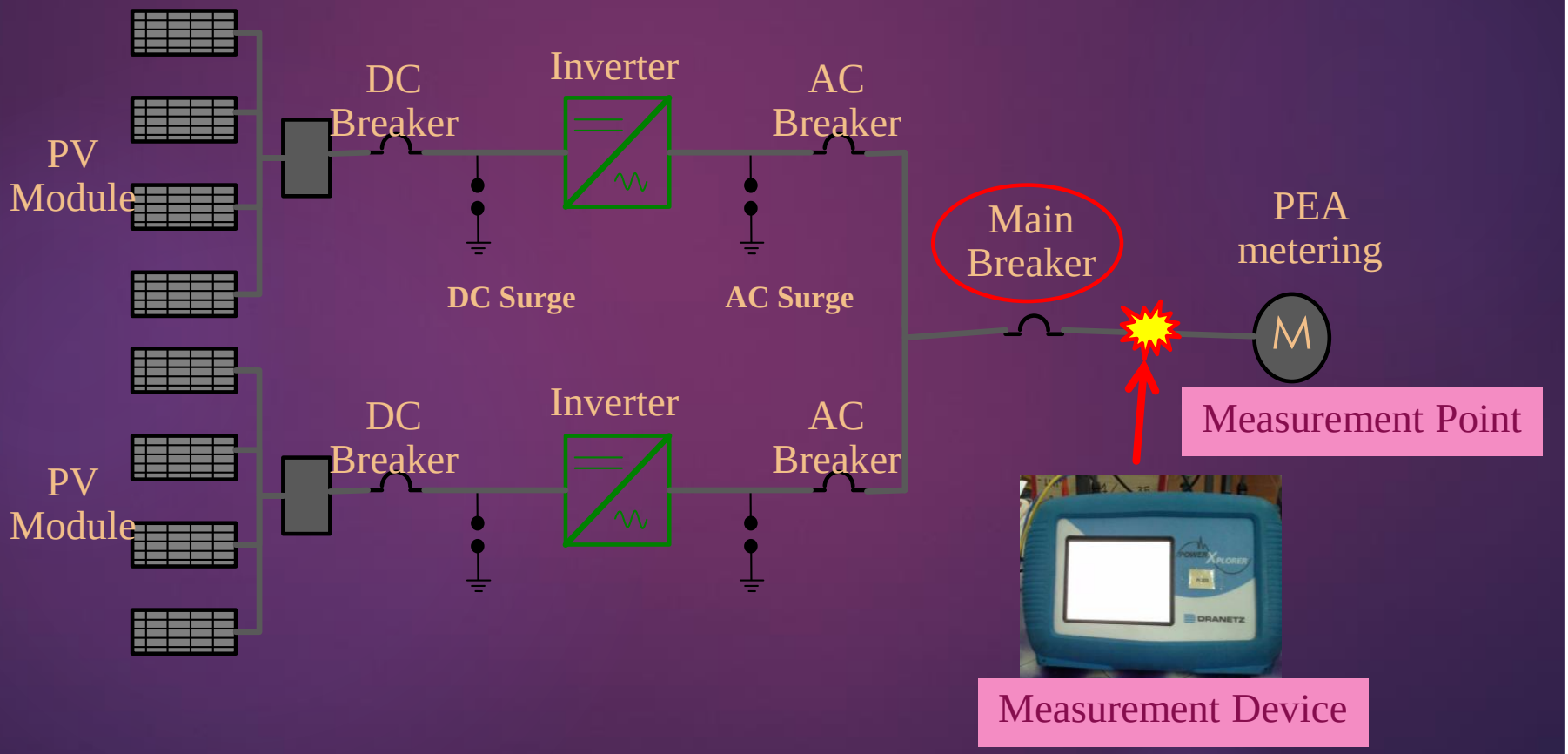
Difficulty to forecast load and distribution transformer size

Fool load profile

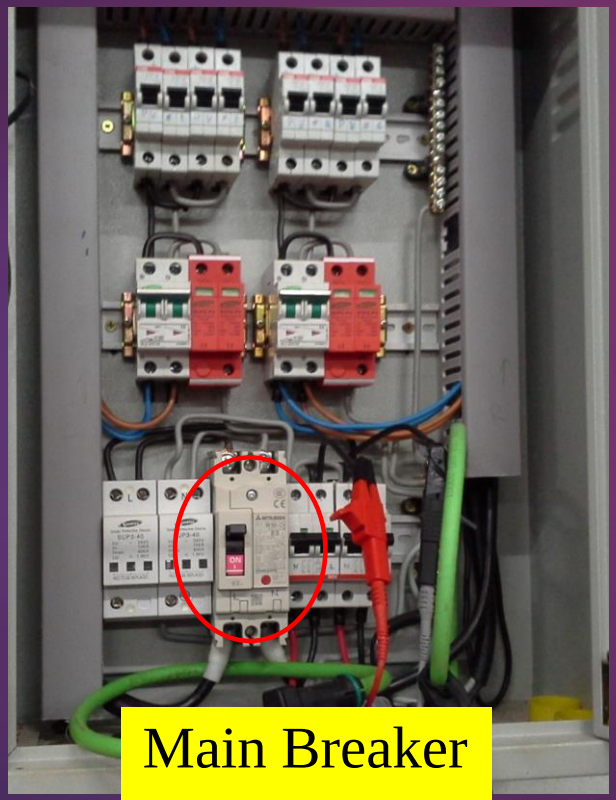
Evaluate Situation

- High levels of solar rooftop PV penetration necessitate new and innovative approaches to managing the technical issues and complexity.
- Residential solar rooftop case study:
  - 5-10kW/house
  - Install monitor equipment to monitor a house with solar rooftop 2 set of panel; 2*5kW
  - Power meter recorder install after the utility meter

Experimental method



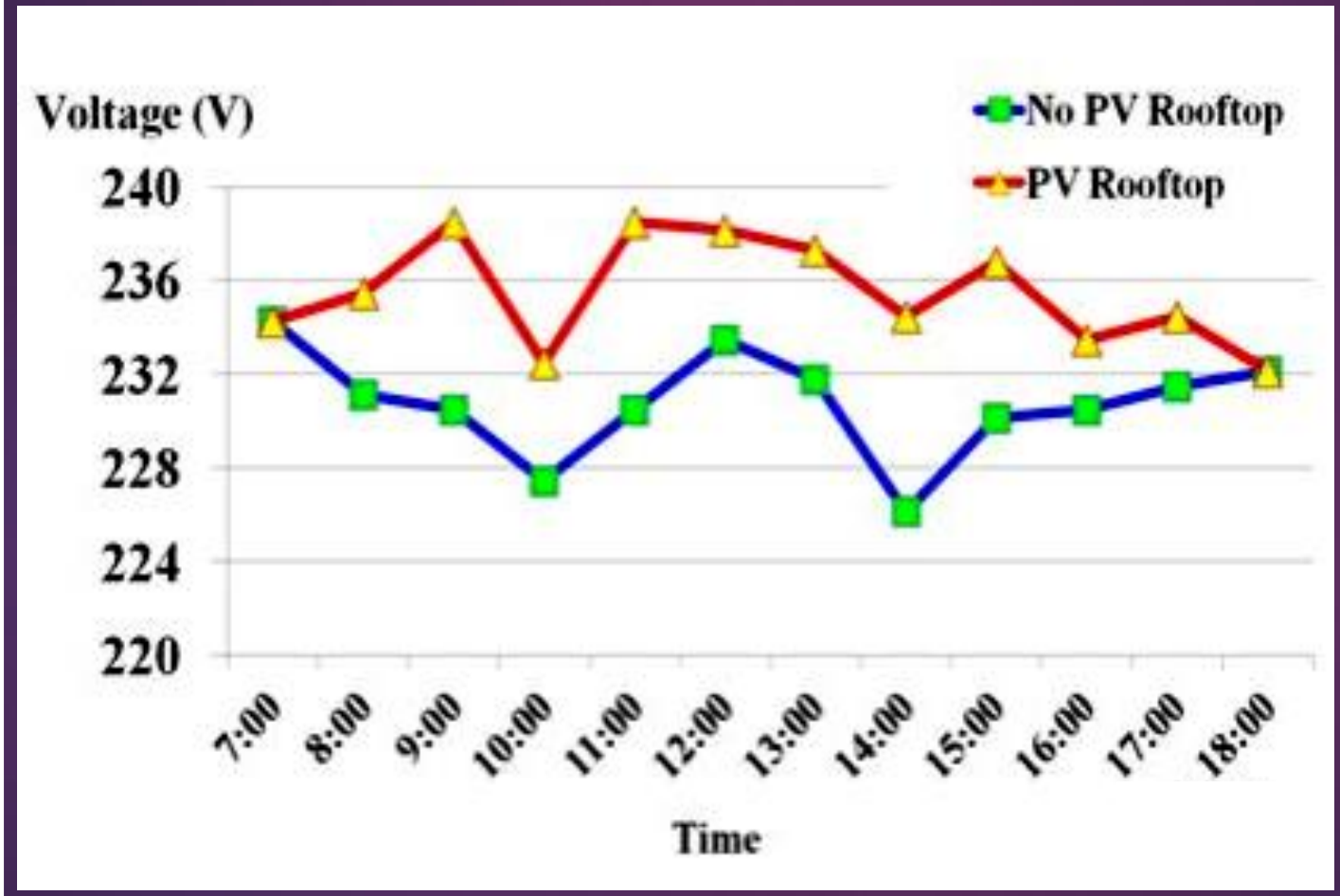
Measurement Device and Installation



Main Breaker

Disturbance Analyzer Equipment

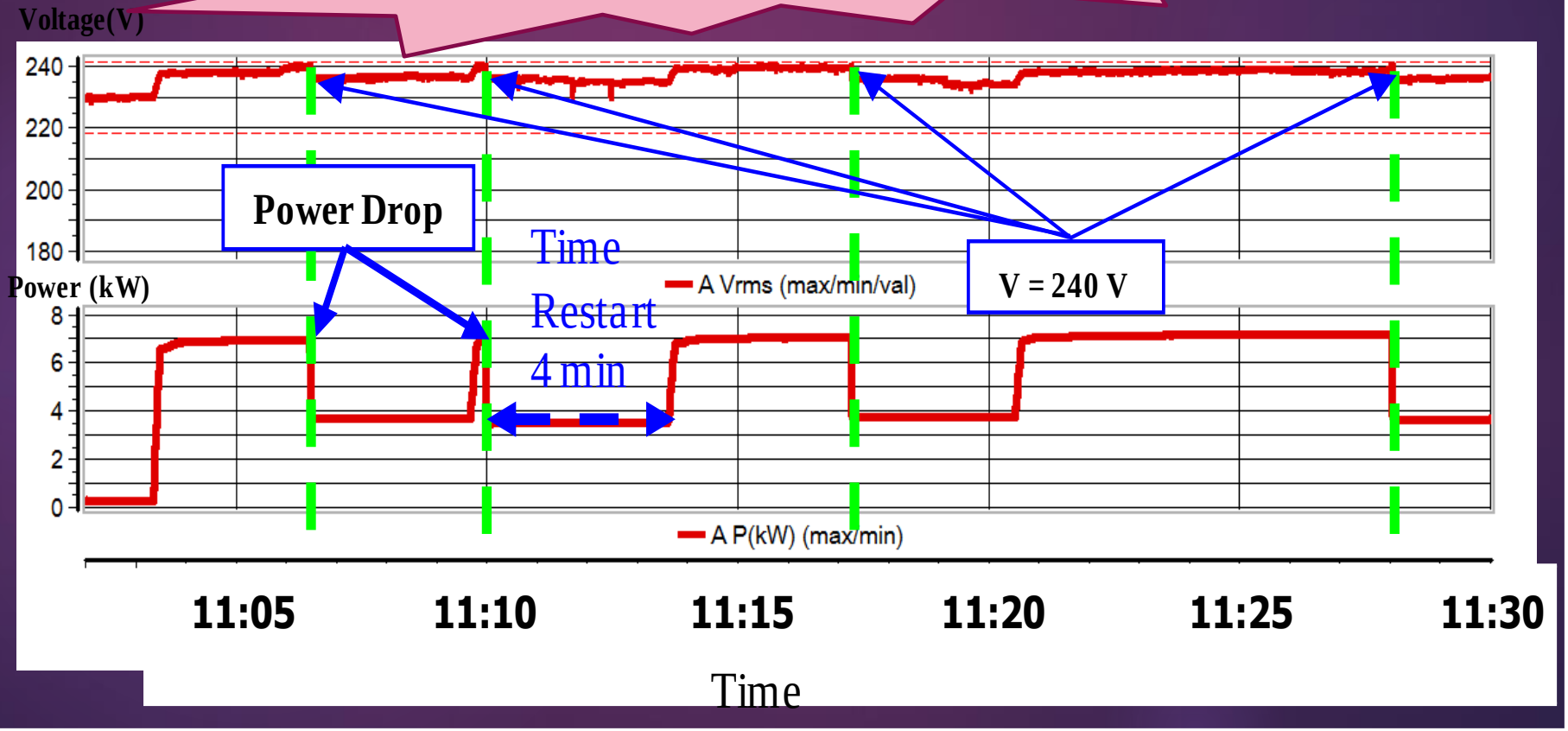
Voltage: No PV Rooftop & PV Rooftop



Voltage Rise:
3 - 8 V

Voltage during Measurement Point: 11:00 – 11:30 AM

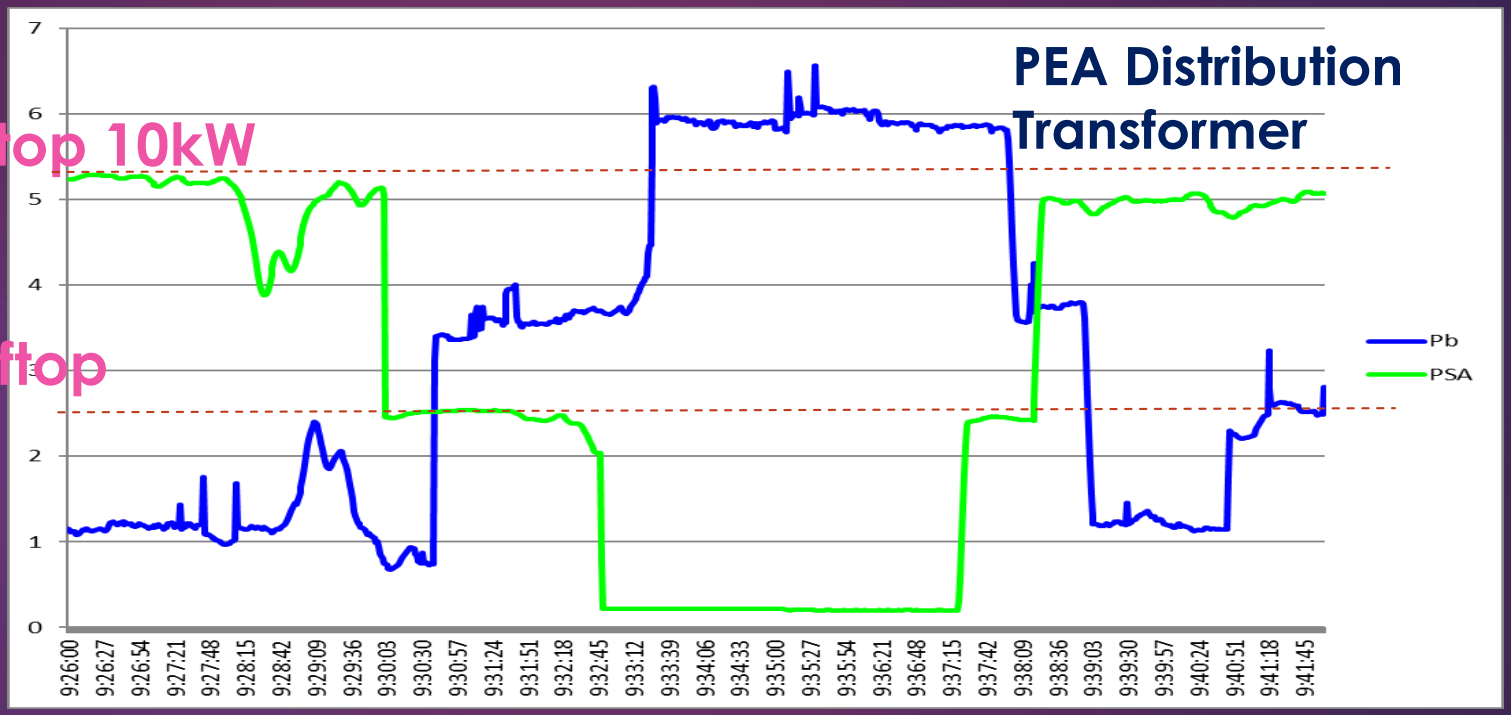
Over Voltage Limit when
Max Generate



Load Profile between PV Rooftop and Distribution Transformer

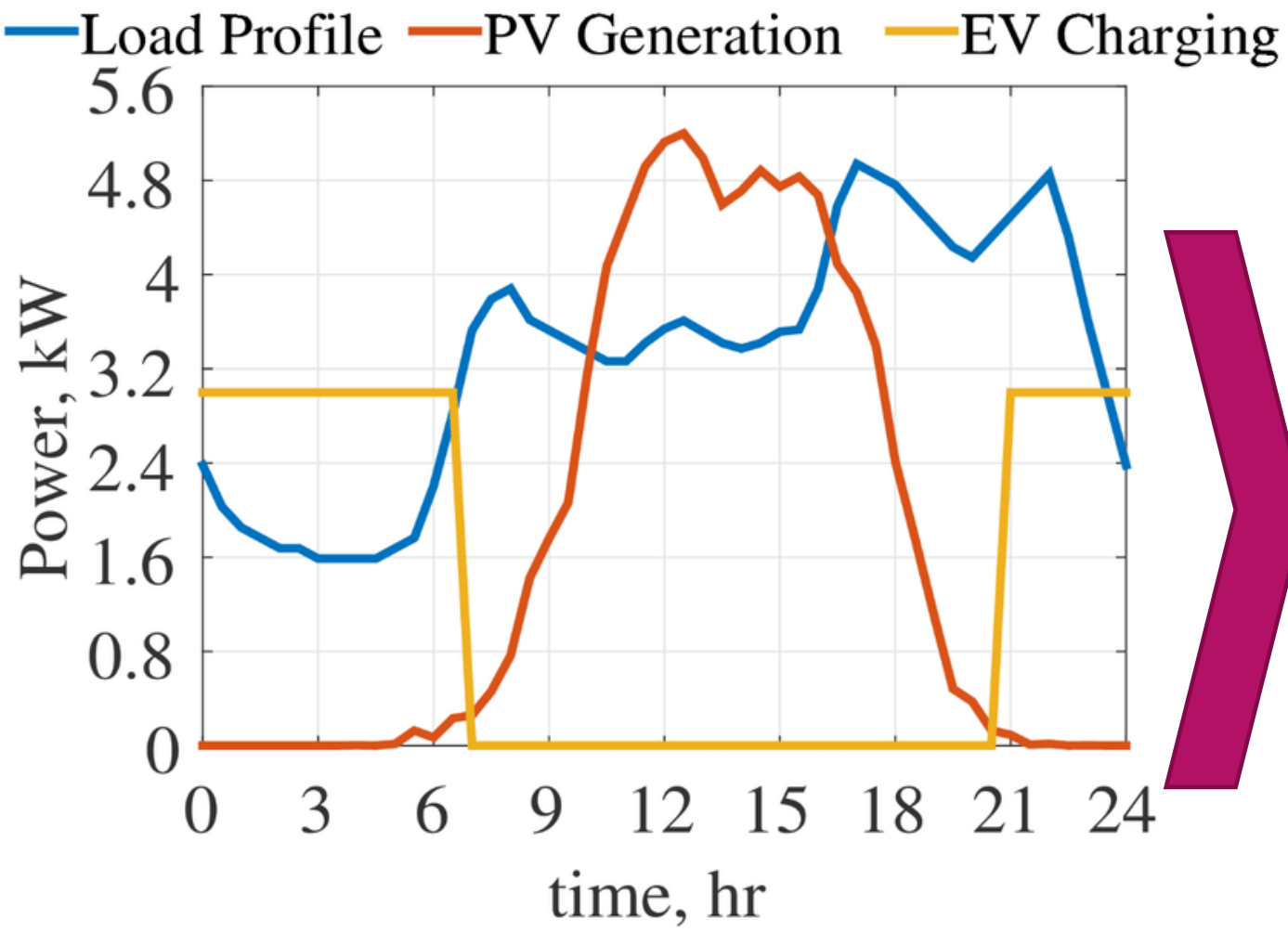
Solar Rooftop 10kW

Solar Rooftop 5kW



Fluctuation in Tr Load caused by PV Gen

EV Charging Station and PV Load Profile



EV user behavior

- Home Charging
- Night time Charging

PEA area : 12 Areas

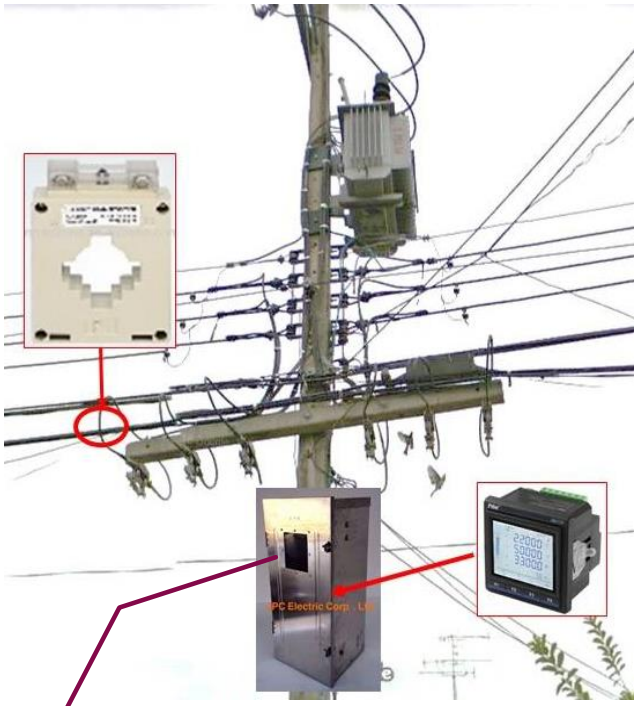
PEA NE1 Area

- Distribution transformer: total 3,694 MVA
- PEA owned: 27,036 sets
- Customer owned: 21,324 sets

Monitoring Tool

- The monitoring equipment researched by PEA NE1(Northeast area1 Regional Head Office) is the pilot project to monitor and collect data from the low voltage system with solar rooftop connected.

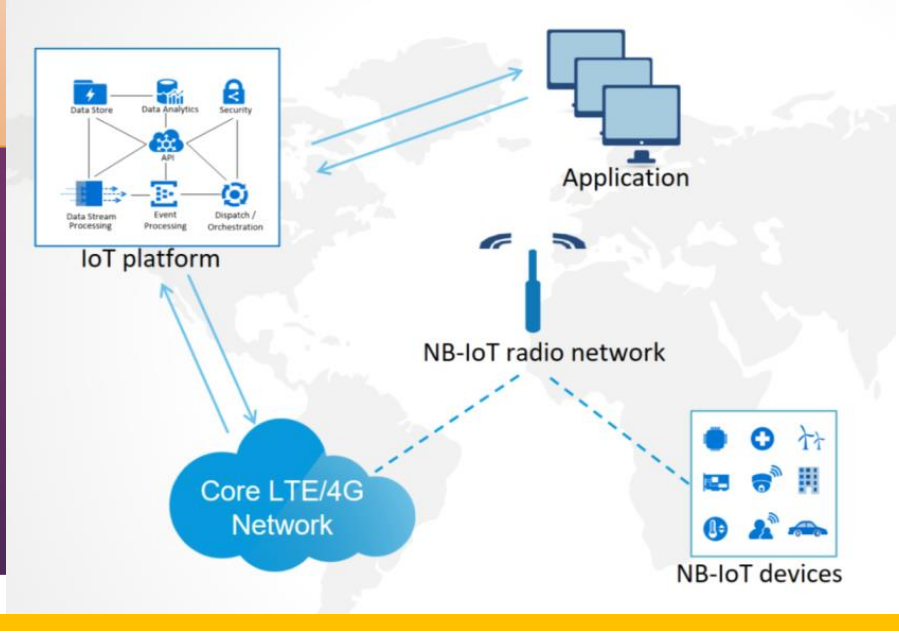
- The **Transformer Load Management or TLM** was installed in the PEA low voltage distribution system to record the information of voltage, power flow and loss.



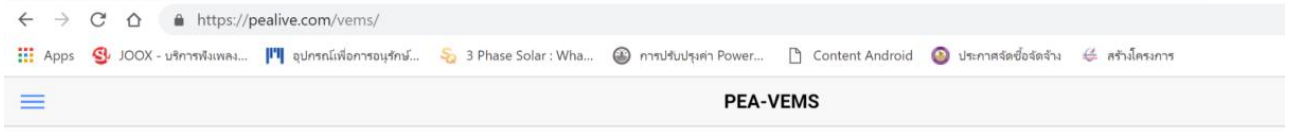
TLM

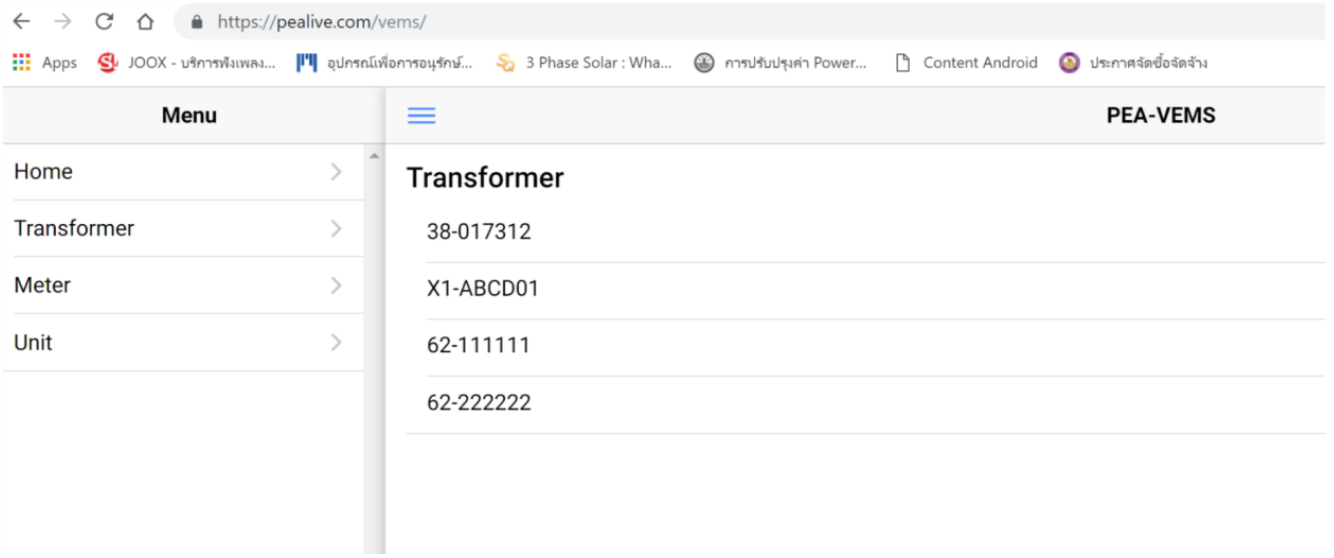
Monitoring Device : Transformer Load Management

- Install the TLM in study area near Udonthani town.
- Distribution transformer size 160 kVA
- Study period: 2018
- Data analysis
- NB IoT Module

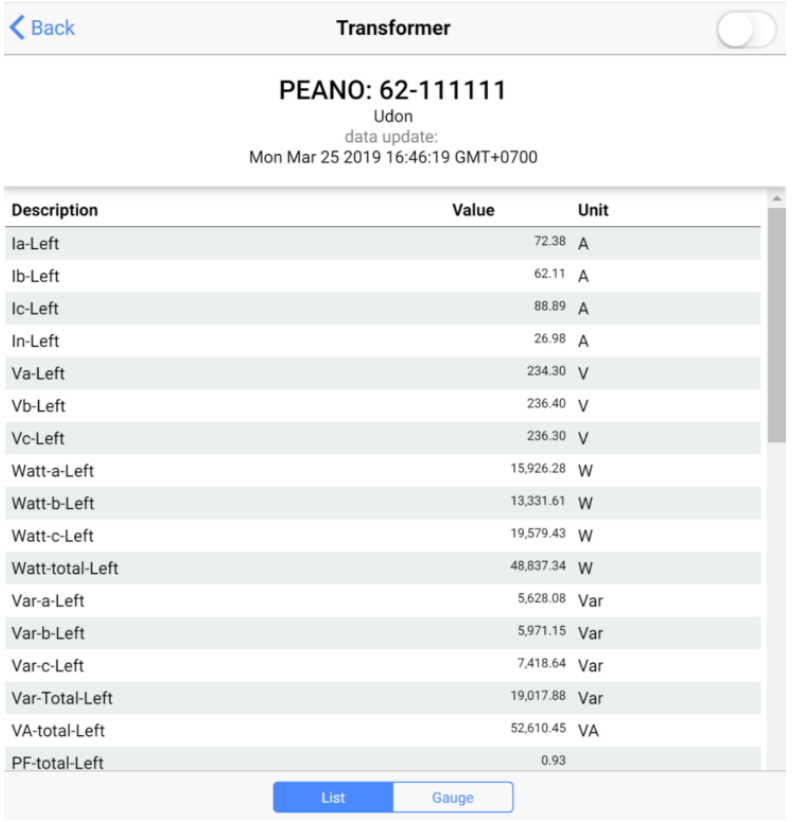


Web-based Monitoring Interface Application

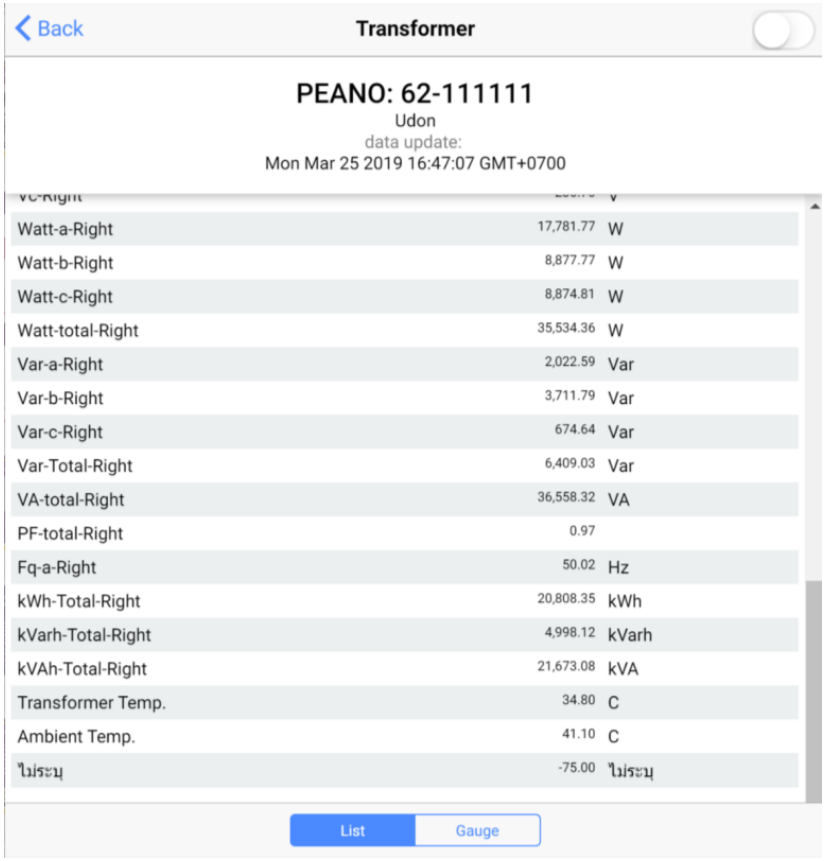




Sample of Data

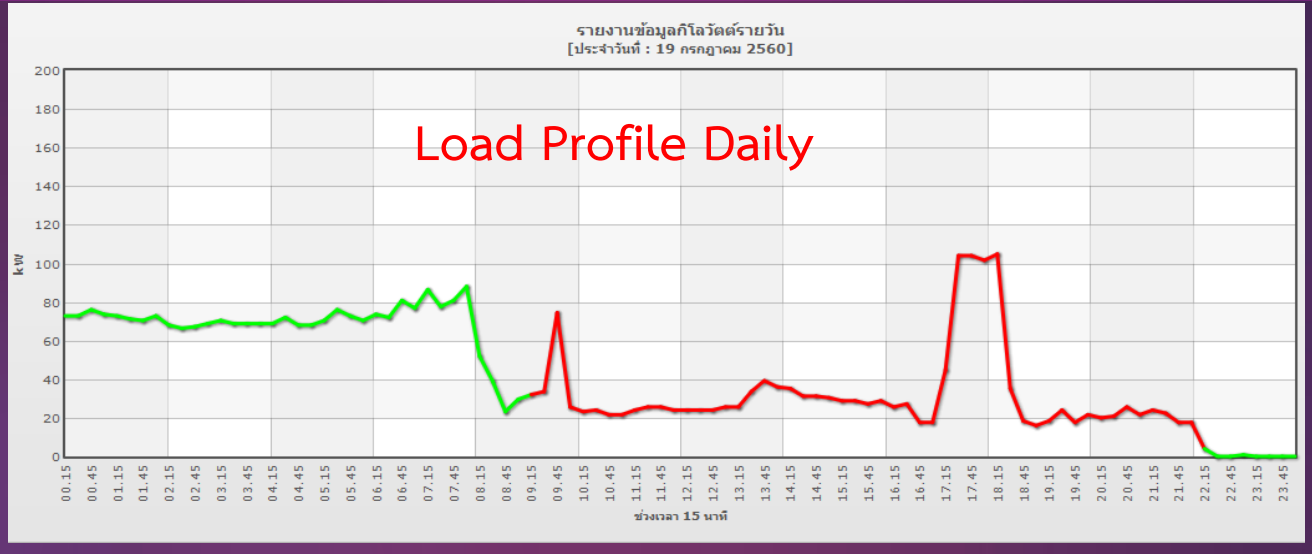


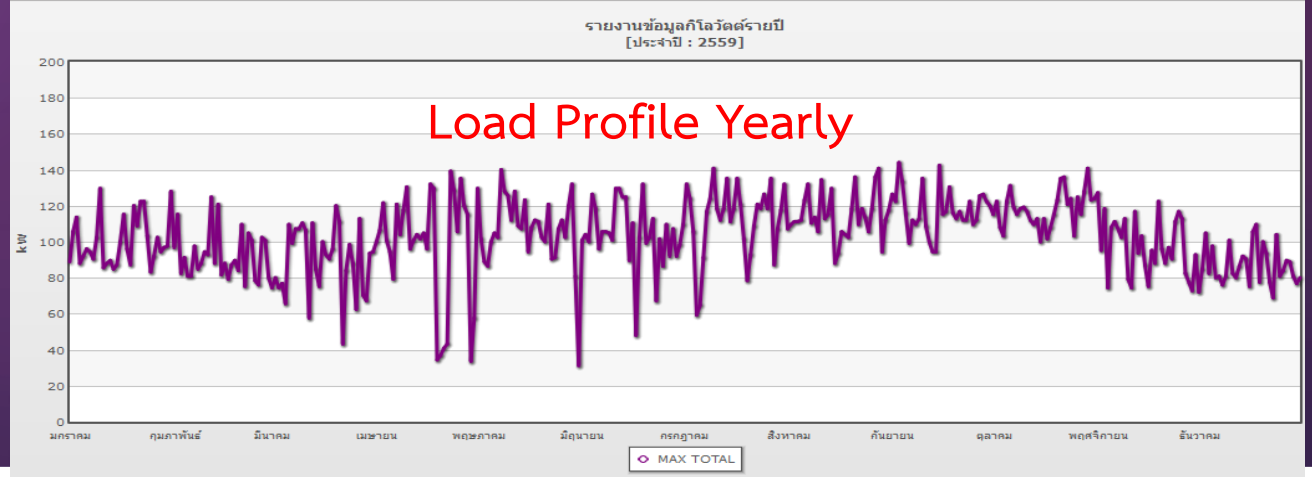
Description	Value	Unit
Ia-Left	72.38	A
Ib-Left	62.11	A
Ic-Left	88.89	A
In-Left	26.98	A
Va-Left	234.30	V
Vb-Left	236.40	V
Vc-Left	236.30	V
Watt-a-Left	15,926.28	W
Watt-b-Left	13,331.61	W
Watt-c-Left	19,579.43	W
Watt-total-Left	48,837.34	W
Var-a-Left	5,628.08	Var
Var-b-Left	5,971.15	Var
Var-c-Left	7,418.64	Var
Var-Total-Left	19,017.88	Var
VA-total-Left	52,610.45	VA
PF-total-Left	0.93	



Watt-a-Right	17,781.77	W
Watt-b-Right	8,877.77	W
Watt-c-Right	8,874.81	W
Watt-total-Right	35,534.36	W
Var-a-Right	2,022.59	Var
Var-b-Right	3,711.79	Var
Var-c-Right	674.64	Var
Var-Total-Right	6,409.03	Var
VA-total-Right	36,558.32	VA
PF-total-Right	0.97	
Fq-a-Right	50.02	Hz
kWh-Total-Right	20,808.35	kWh
kVarh-Total-Right	4,998.12	kVarh
kVAh-Total-Right	21,673.08	kVA
Transformer Temp.	34.80	C
Ambient Temp.	41.10	C
ไม่ระบุ	-75.00	ไม่ระบุ

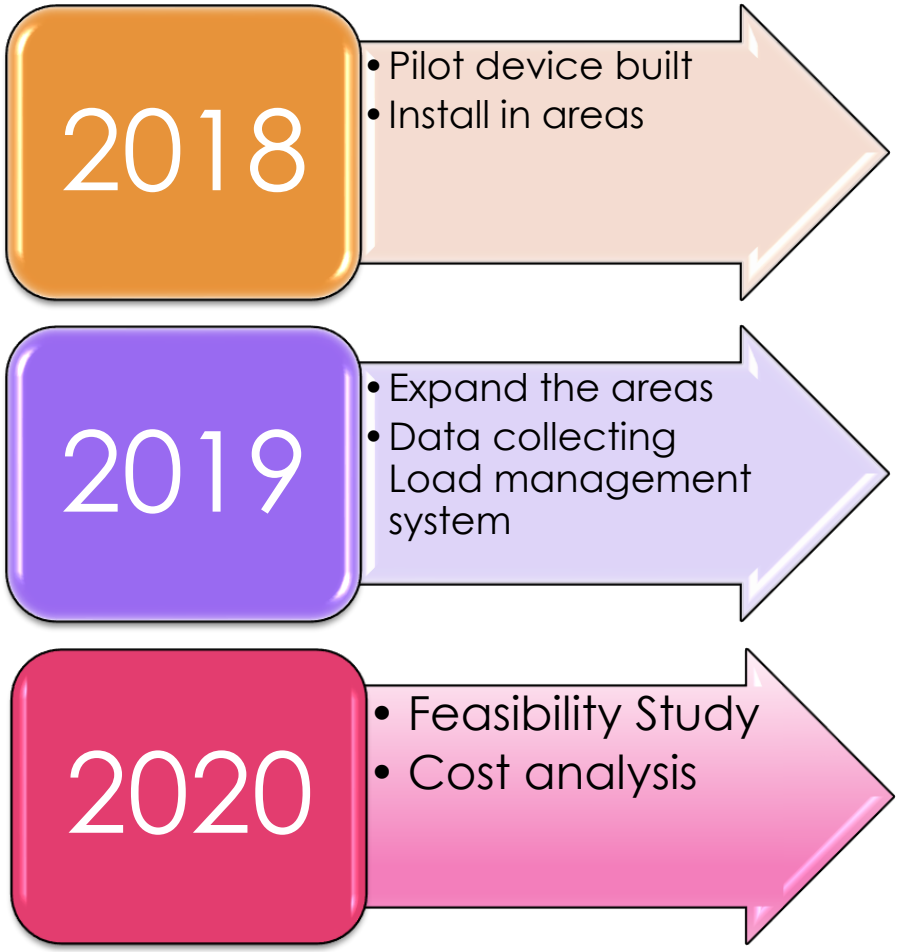
Monitoring Device : Transformer Load Management





The data analysis support:

- the phase allocations could be done by the data to mitigate the voltage imbalance problems by single-phase rooftop PV.
- manage the impact of the solar rooftop
- support the operation& maintenance plan.



CONCLUSIONS

The widespread of solar PV or other distribution generators installed in the distribution networks will fundamentally change the nature of the distribution business from passive distribution networks to active distribution networks with autonomous control. The modern distribution system will necessitate adequate record keeping and associated processes.

Keep improving existing business

Enhance new business

Employ innovation and technology

Nourish human resource

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THANK YOU

Q/A