

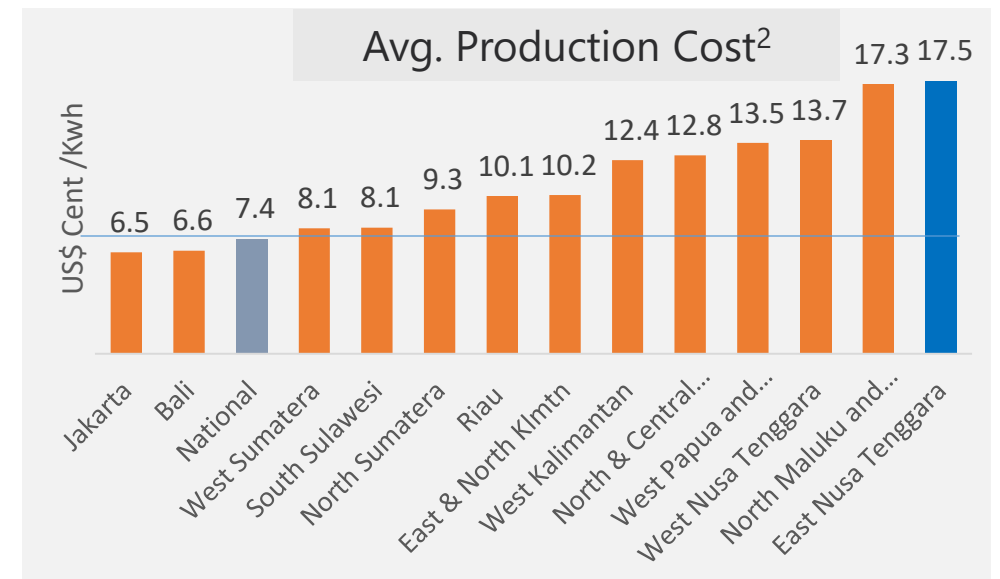
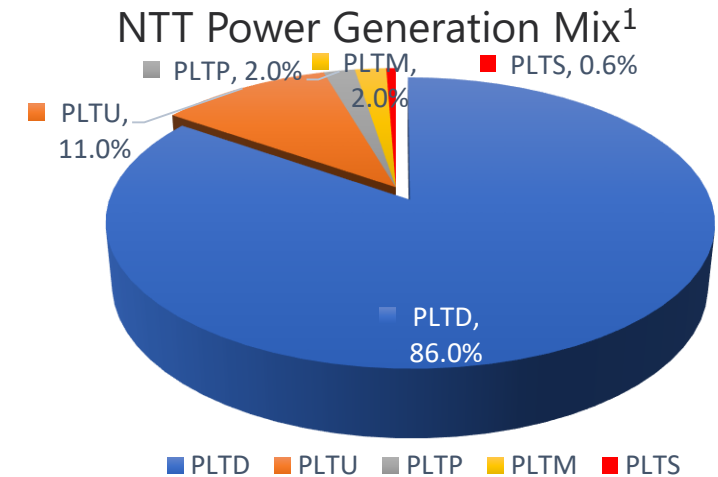
Solar PV Opportunities in Nusa Tenggara Timur

Handover Ceremony – Pre Feasibility Report



NTT Solar PV Opportunity

- NTT electrification ratio is 59%¹
- 86% power generation is fueled by diesel
 - High generation cost
- Geographical location presents both opportunity and challenge
 - Opportunity
 - High irradiation
 - Challenge
 - Archipelagic area hence low grid integration
 - High logistic costs
 - Daily load profile of typical rural areas versus sun shine



¹ at January 2017

² BPP, Kepmen ESDM No. 1404K/20/MEM/2017

GGGI Study on Solar PV in NTT



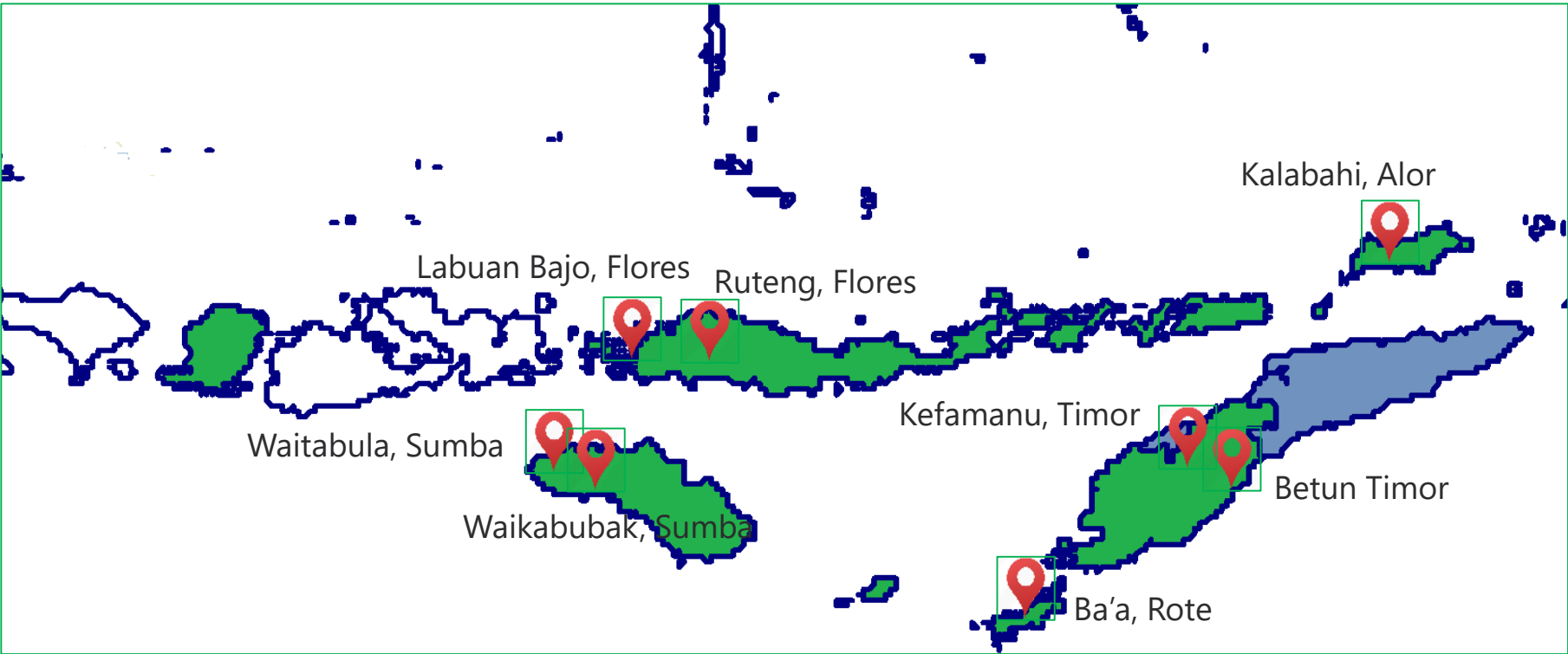
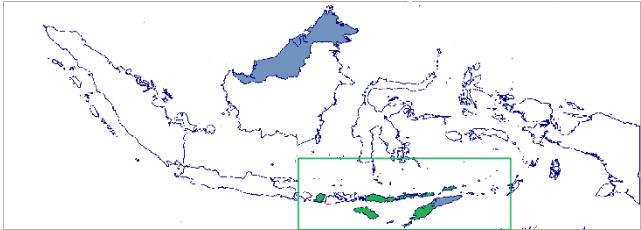
The study aimed to provide initial assessment on the development feasibility of hybrid solar PV installations in selected NTT sites

Tasks:

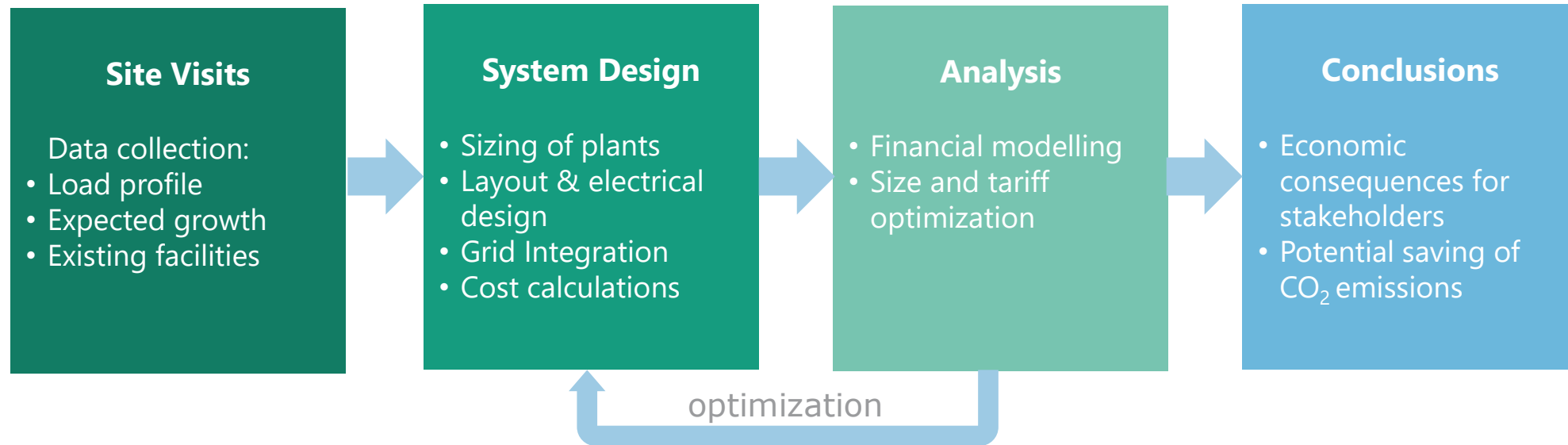
1. Find **optimal size** of two integrated technology options:
 - Solar PV
 - Solar PV & Battery
2. Analyse **the financial feasibility**
3. Calculate reduction of diesel consumption and CO₂ emission

Locations

Pre – Feasibility Study was conducted in 8 locations on 5 islands



Approach



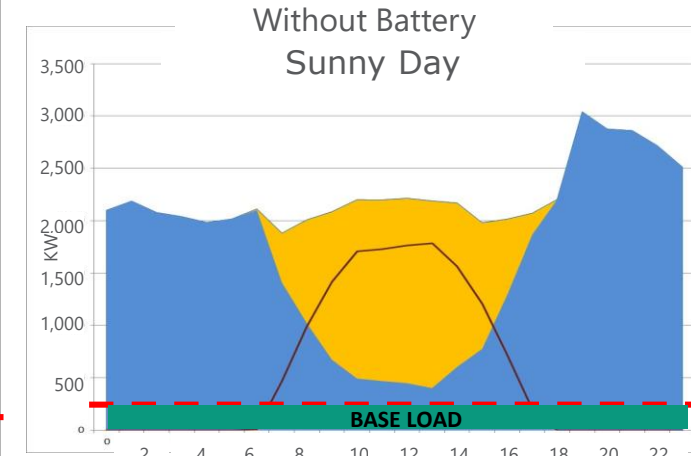
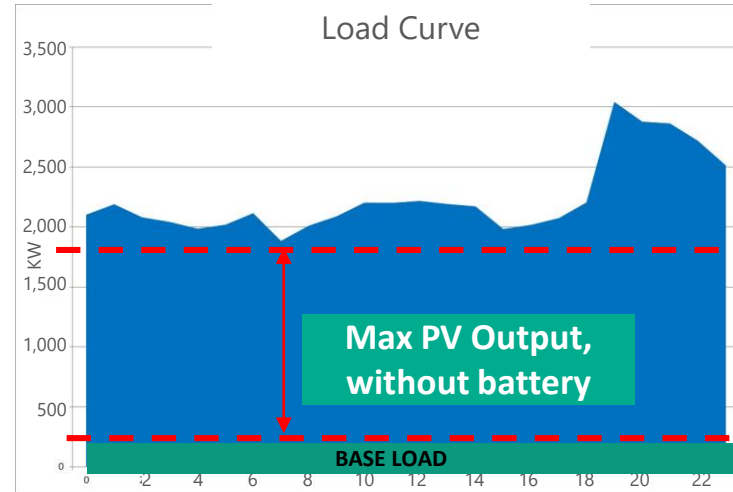
Site Data

Site/Location	Population		Economy		Power Supply		
	In 2015	Annual Growth Rate 2011-2015	Main Industries	Average growth rate 2011-2015	Installed Capacity (MW)	Energy demand (GWh/year)	Estimated annual growth
Kefamanu	244,714	1.2%	Farming	4.5%	7.1	20.7	5-6%
Betun	180,382	1.8%	Farming	4.8%	3.7	12.5	4-6%
Waitabula	319,119	2.2%	Farming, Tourism	5.1%	3.4	19.6	5%
Waikabubak	121,921	1.8%	Farming, Tourism	4.9%	3.4	17.7	5%
Ba'a	147,778	4.1%	Farming, Tourism	4.7%	3.7	21.2	5%
Kalabahi	199,915	0.9%	Farming, Tourism	4.7%	5.6	24.2	5%
Labuan Bajo	251,689	2.4%	Tourism, Farming	3.8%	8	39.1	5-8%
Ruteng	319,607	1.7%	Farming	5.3%	10	46.6	5%
TOTAL	1,785,125	1.9%				201.6	

Solar PV Sizing

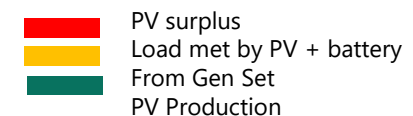
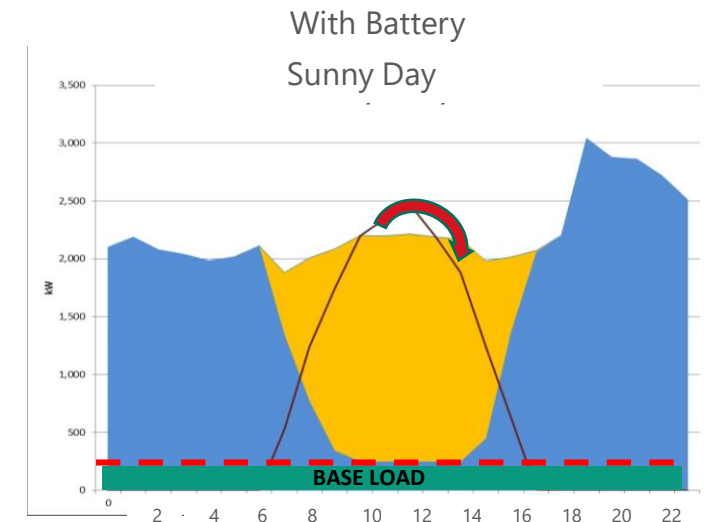
Without Battery

- Conventional diesel generator provides a (minimum) base-load
- Solar PV output meets residual load when sun shining
- Meaning all potential PV power use directly
→ No solar PV curtailing needed
- PV alone can reduce diesel genset output by up to 19%



With Battery

- Oversizing PV is attractive in term of lowering generation costs but high battery cost means optimization required:
 - Battery capacity large enough to accommodate all surplus PV energy
 - Battery capacity small enough such that all battery capacity is used
- Solar PV+battery storage system promotes grid stability to manage intermittent solar resources
- PV + battery can reduce diesel genset output by up to 23%



Result of Sizing and Financial Evaluation



- Key economic driver is tariff
- Total potential reduction CO2 emission is 22k-31k tonne per year and diesel consumption 8-11.8 million lt/year
- The bundling of projects increases scale and offers potential synergy

Rank	Site	Capacity MWp (+ MWh)	Tariff US\$ Cent/Kwh	Project IRR %	Equity IRR %	Reduction in			
						CO2 emission tonnes/yr	Diesel consump. lt/yr		
1	Kalabahi, Alor	2.5	14.9	High (13%-14%)	High (20%-24%)	2,776	1,048,000		
2	Baá, Rote	PV 2.4				2,496	943,000		
3	Kefamanu, Timor	2.1				2,364	892,000		
1	Kalabahi, Alor	4.1 + 0.5	14.2	High (11.5%-12%)	High (16%-17%)	4,281	1,618,000		
2	Baá, Rote	PV + B 3.6 + 0.5				3,764	1,423,000		
3	Kefamanu, Timor	3.6 + 0.5				3,971	1,499,000		
4	Waikabubak, Sumba	2.1	12.0 14.2	Medium (9.5%-11%)	Medium (11%-14%)	2,410	908,000		
5	Betun, Timor	PV 1.1				1,243	469,000		
6	Waitabula, Sumba	2.2				2,337	883,000		
4	Waikabubak, Sumba	3.2 + 0.5				Medium (8.5%-9.5%)	Medium (8.5%-11%)	3,605	1,360,000
5	Betun, Timor	PV + B 1.7 + 0.3						1,819	687,000
6	Waitabula, Sumba	3.6 + 0.5						3,729	1,410,000
7	Labuan Bajo, Flores	4.5	11.2	Low (8%-8.5%)	Low (7.5%-8.5%)	4,427	1,676,000		
8	Ruteng, Flores	PV 4.1				3,870	1,467,000		
7	Labuan Bajo, Flores	PV + B 6.4 + 1				7%	6%	6,290	2,384,000

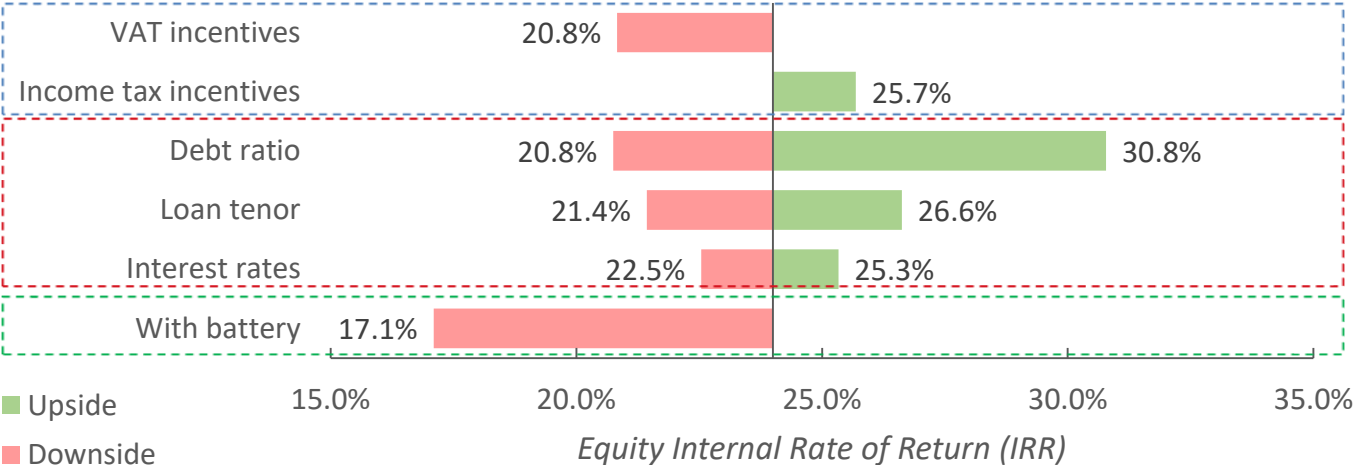
Impact on Generation Cost

Battery addition will give more reduction to PLTD's operational costs

	Sites	PV/PV+B	Solar share	Diesel & others	Max cost solar energy (85% of BPP)	Current average cost <i>USD c/kWh</i>	Avg cost with projects	Min. savings	Diesel Red. Avg. Mill lt/yr
			%	%				%	
1	Kalabahi	PV	16%	84%	14.9	17.5	17.1	2%	1.0
		PV+B	22%	78%	14.9	17.5	16.9	3%	1.6
2	Ba'a	PV	16%	84%	14.9	17.5	17.1	2%	0.9
		PV+B	24%	76%	14.9	17.5	16.9	4%	1.4
3	Kefamanu	PV	16%	84%	14.2	16.7	16.3	2%	0.9
		PV+B	24%	76%	14.2	16.7	16.1	4%	1.5
4	Waikabubak	PV	14%	86%	12.0	16.7	16.4	2%	0.9
		PV+B	18%	82%	12.0	16.7	16.3	3%	1.4
5	Betun	PV	19%	81%	14.2	14.2	13.8	3%	0.5
		PV+B	26%	74%	14.2	14.2	13.6	4%	0.7
6	Waitabula	PV	17%	83%	12.0	14.2	13.8	2%	0.9
		PV+B	25%	75%	12.0	14.2	13.7	4%	1.4
7	Labuhan Bajo	PV	16%	84%	11.2	13.2	12.8	2%	1.7
		PV+B	21%	79%	11.2	13.2	12.7	3%	2.4
8	Ruteng	PV	11%	89%	11.2	13.2	12.9	2%	1.5

Equity IRR Sensitivities

Tornado Chart: Sensitivity against Equity IRR - Kalabahi
Base Equity IRR = 24%



Other Basic Assumptions	
Items	Assumption
Tariff	85% of BPP
PPA Terms	20 years
WACC	9.11%
Inflation	5%

- Fiscal incentives as well as concessional loans will enhance investor returns
- Battery installation reduces investor's return. e.g. at Kalabahi site, investor requires to invest additional ~US\$210k* for battery installation and possible battery replacement in year 11th, resulting lower Equity IRR by 7%.

Variables for Tornado Chart	Downside	Base	Upside
VAT incentives	No	Yes	-
Income tax incentives	-	No	Yes
Loan tenor (years)	8	10	12
Loan Interest rates (%)	11.5%	10.5%	9.5%
Debt ratio (%)	60%	70%	80%
Battery	With	Without	

* Battery cost is US\$420/Kwh (including shipping)

Conclusion

- Diesel dominated generation system in NTT offers high tariff due to high generation cost which provides opportunity for both investor and PLN
- Total potential reduction CO2 emission is 22k-31k tonne per year and reduction of diesel consumption 8-11.8 million lt/year
- The high cost of battery dilutes investor returns, however provides lower generating cost for PLN and enhances grid stability.
- Bundling multiple projects delivers cost synergy and enhanced returns as long as project quality maintained
- Incentives are required in the lower tariff areas and for battery installation

Conclusion

- Project attractiveness
 - Good financial returns
 - 20 years offtake at fixed US\$ pricing
 - Rising fuel price increases PLN generating costs
 - Bundling delivers scale, cost synergies and enhanced returns
 - Excellent environmental credentials

Next Steps

- Conduct detailed feasibility and grid study
- Explore incentives for low generation cost areas and for battery installation, e.g. cost sharing with PLN

Thank You

