

Technical & Economic Feasibility of Hybrid MicroGrids

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Power Business at Island in Korea

Status of Islands in Korea

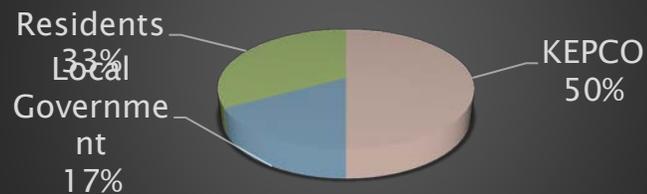
Section	Island connecting with KEPCO's power line	Islands with generating plant		Total
		Complete power supply	Incomplete power supply	
The number of islands	312	98	29	439
The number of population	373,925	46,782	153	420,860
The number of households	161,596	23,664	172	185,432
Power supplier	KEPCO	KEPCO Local Government Residents	Residents	

* Incomplete power supply means that the power is not supplied for 24 hours

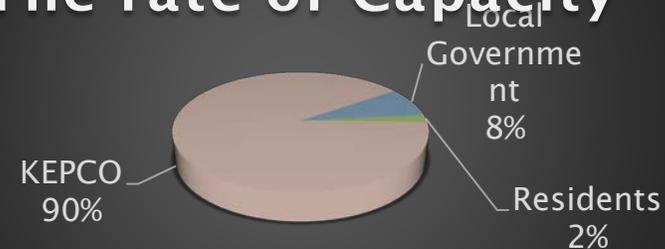
Status by Operation Types in Korea

Section	Complete Supply				Incomplete Supply	Total
	KEPCO	Local Govern.	Residents	Sub total		
# of Island	63	22	13	98	29	127
# of Population	43,887	2,778	117	46,782	153	46,935
# of households	22,367	1,186	111	23,664	172	23,836
The Capacity of Generators(kW)	91,295	7,468	417	99,180	1,331	100,511
# of generators	214	62	13	289	33	322

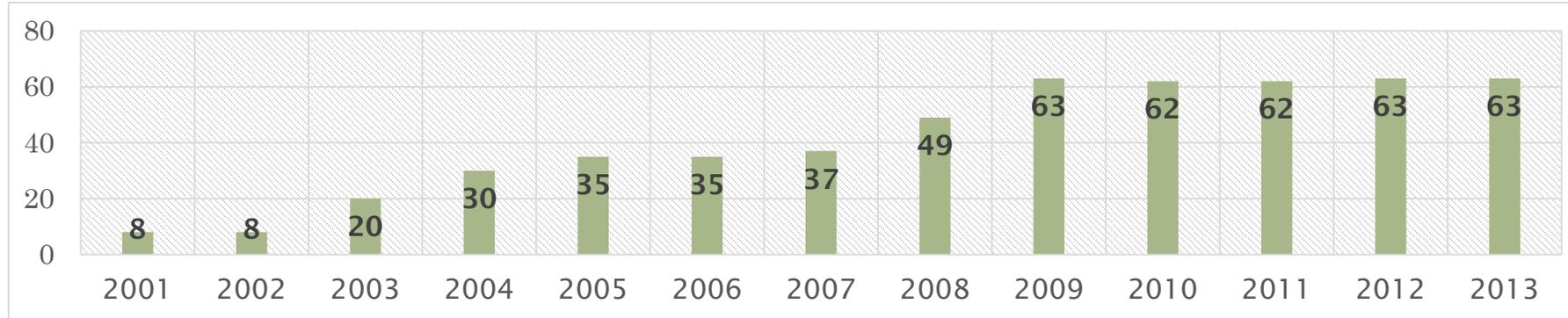
The rate of Islands



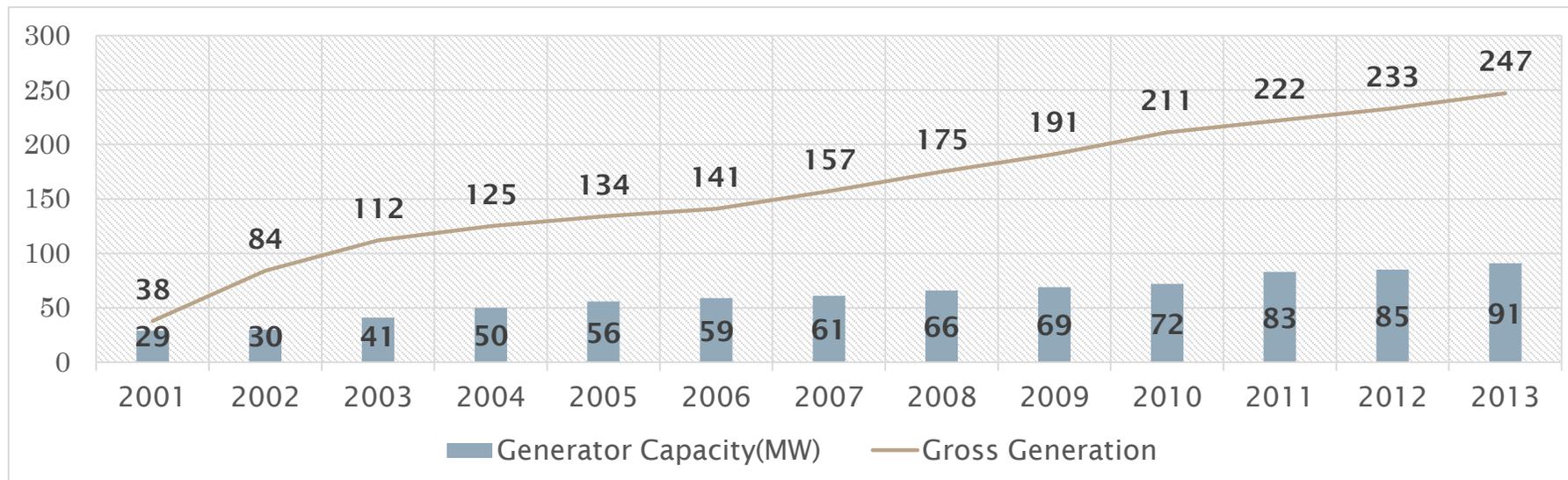
The rate of Capacity



The number of islands by year



Generator capacity by year

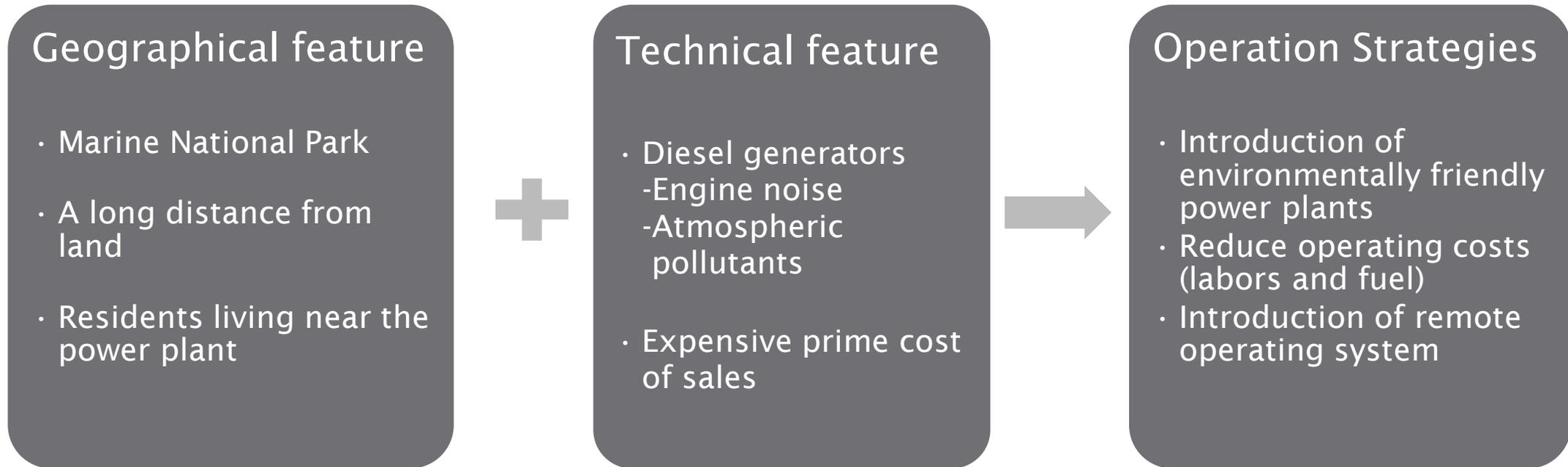


Status by Generating Types in Korea

Section	Diesel				Solar				Total
	KEPCO	Local Governments	Residents	Sub total	KEPCO	Local Governments	Residents	Sub total	
# of islands	54	19	16	89	9	3	26	38	127
The capacity of generators(kW)	90,790	7,355	3,639	101,784	505	113	535	1,153	102,937
The rate (%)	88.2	7.2	3.5	98.9	0.5	0.1	0.5	1.1	100

* The rate is calculated by the capacity of generators

Island Power Business Features by KEPCO



- Improving efficiency and optimizing load management by ESS utilization
- Saving man-power by utilization of renewable energy (wind, solar) and Micro Grid
- Securing preemptive management skills by active introduction of renewable energy

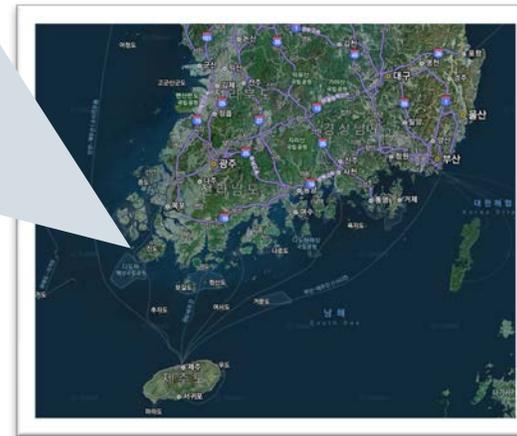


Remote Micro Grid in Gasado

About Gasado

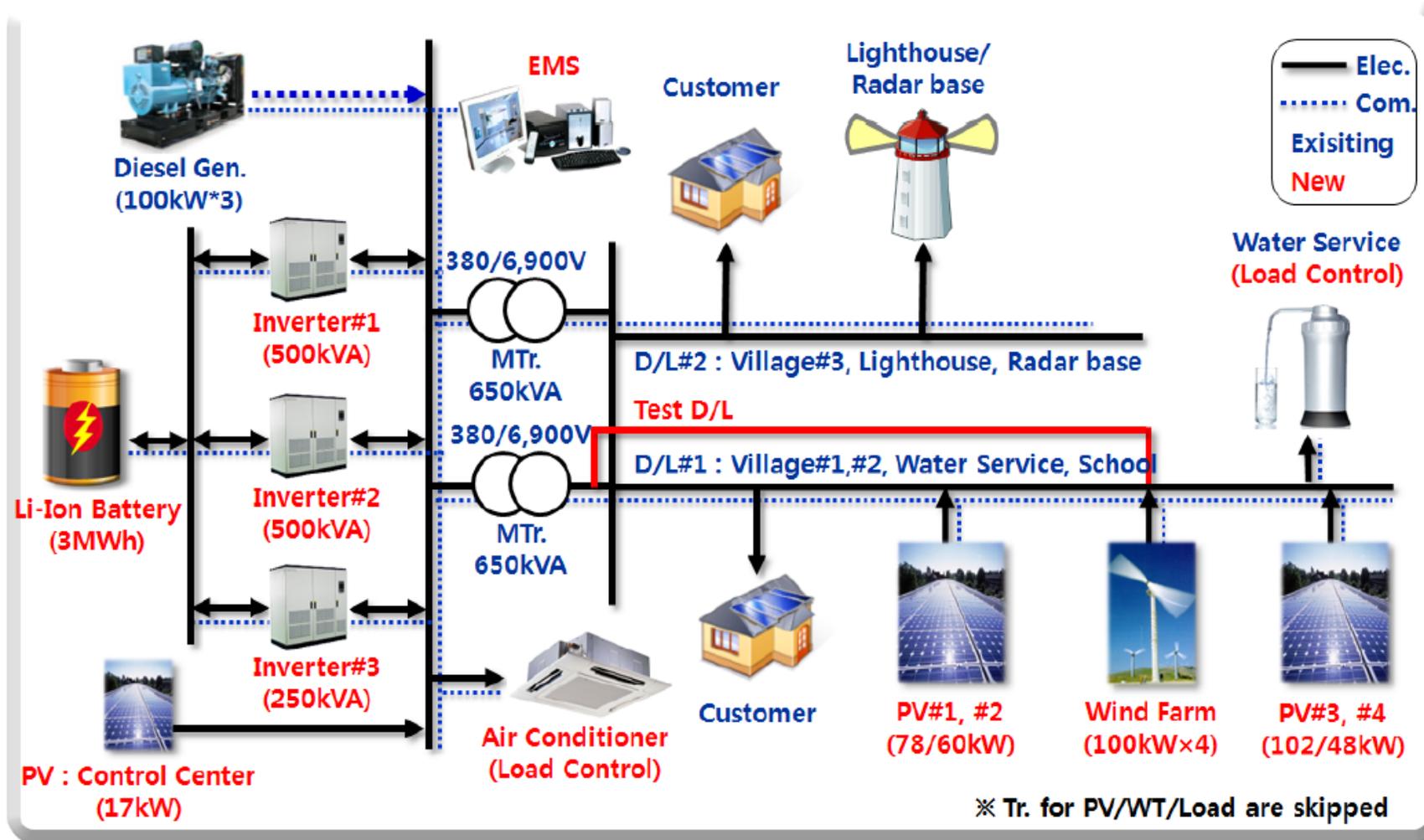


- ▶ distance from main land : 6km
- ▶ area : 6.4km²
- ▶ households : 168
- ▶ population : 286
- ▶ generators : diesel genset 100kW x 3
- ▶ load
 - average : 96kW
 - maximum : 173kW
 - minimum : 61kW
- ▶ facilities : radar station, light house, water supply
 - maximum load by air conditioner, heater at night



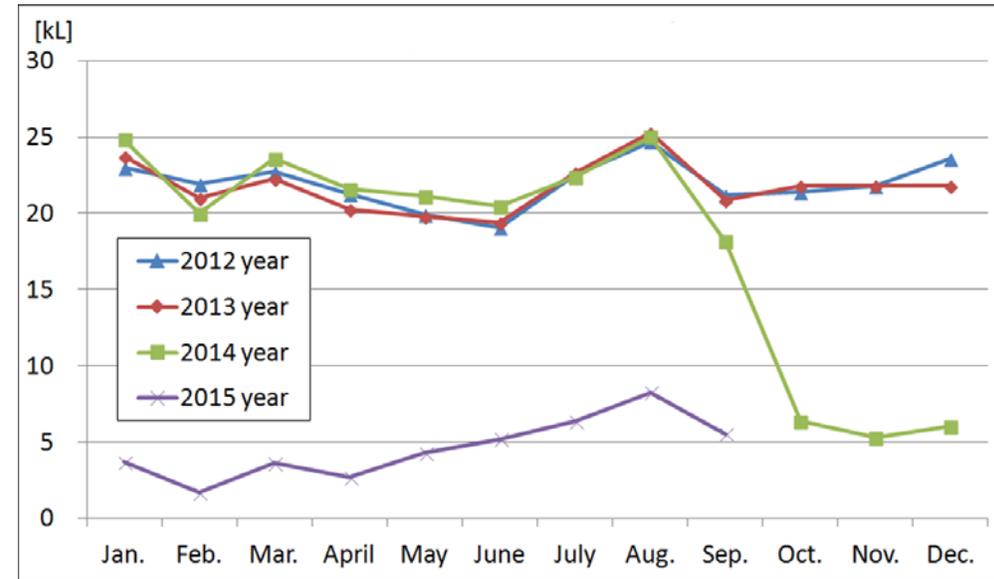
Remote MG Project in Gasado by KEPCO

- Inverter-based power system with automatic operation by EMS

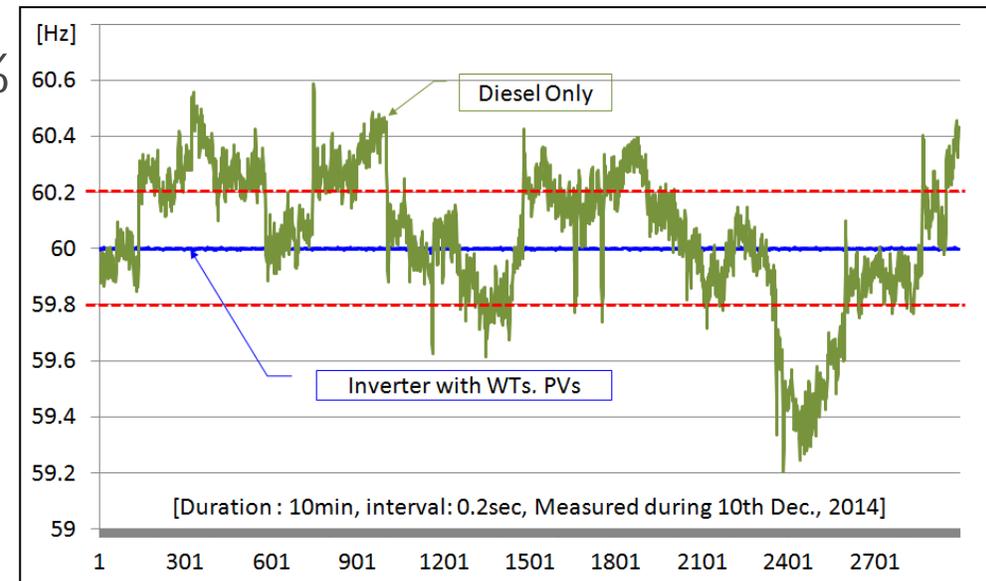


Operation Results of Remote MG in Gasado

- Fuel saving result : 81.7% (compare to 2014)
 - before (diesel power plant) : 155,511L
 - after (micro grid) : 28,387L



- Power Quality(frequency) maintain ratio : 100%
 - before (diesel power plant) : 57%
 - after (micro grid) : 100%





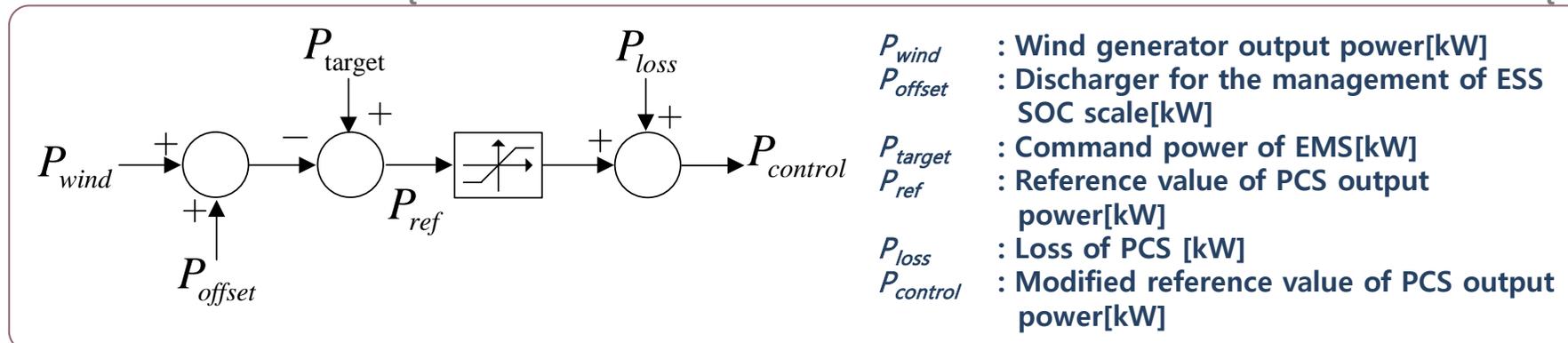
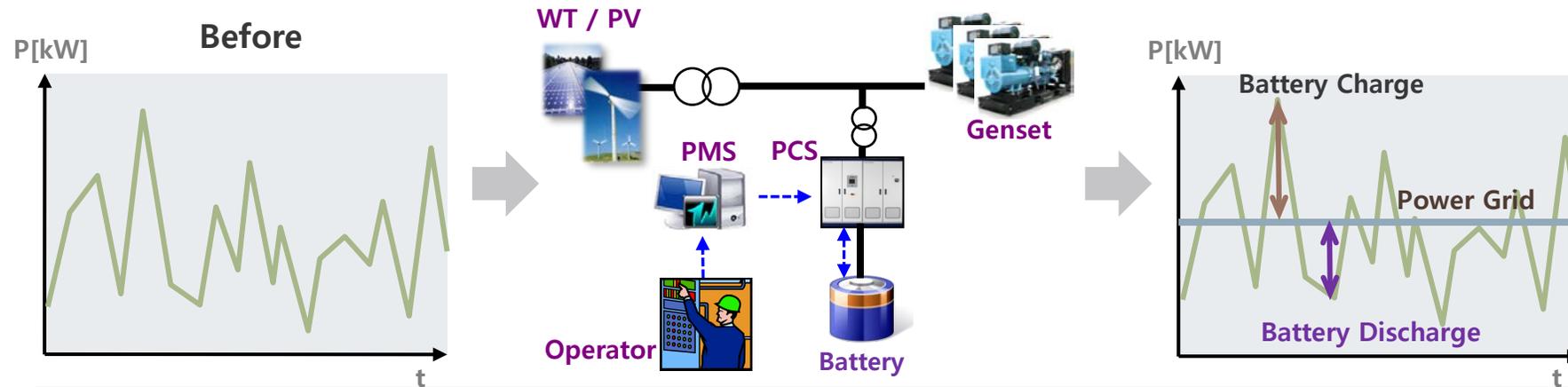
Hybrid Micro Grid in Geochado

Hybrid MG versus Isolated MG

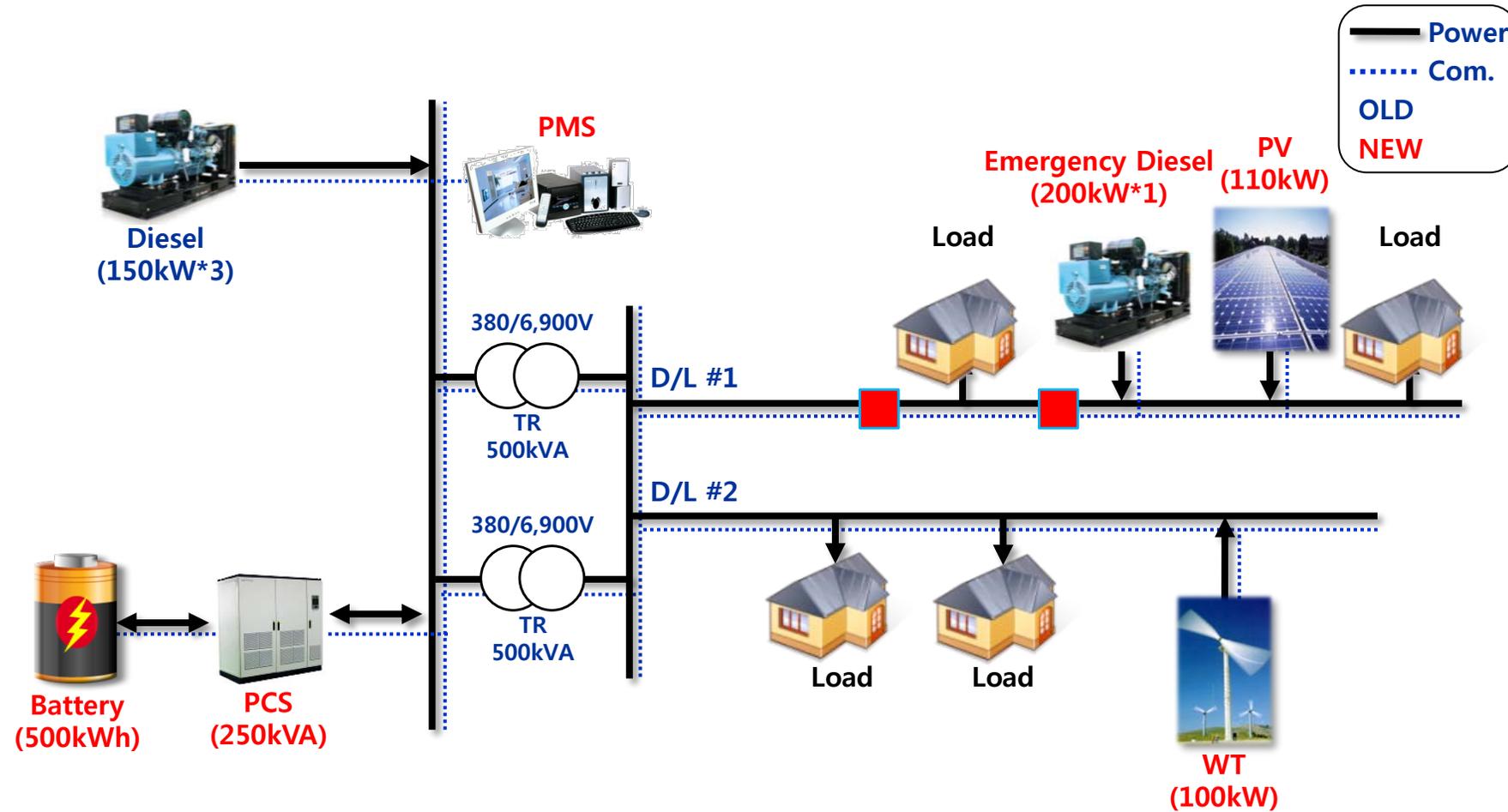
	Diesel Power Plant	Hybrid MG	Isolated MG
Main Power Generation	Diesel	Diesel + WT or Diesel + PV	Renewable Energy (WT, PV etc)
Frequency Control	Diesel	Diesel or WT + Load Control	Inverter + EMS
Voltage Control	Diesel	Diesel or Sync Phase Modifier	Inverter
V/f Maintain Rate	Low	High	Very High
Energy Storage	Fuel	Fuel + small ESS	ESS + small Fuel
EMS	X	△	O
Investment	Low	Low/Med/High	Very High
Operation Cost	Very High	Medium	Low

Hybrid Micro Grid Operation Concept

- Battery system and renewable energies are introduced into existing diesel power system
 - Cost Saving of energy (reduction of fuel usage)
 - Efficiency improvement of diesel generator
 - Improvement of V/f maintaining ratio



Geochado Hybrid MG System Diagram



About Geochado



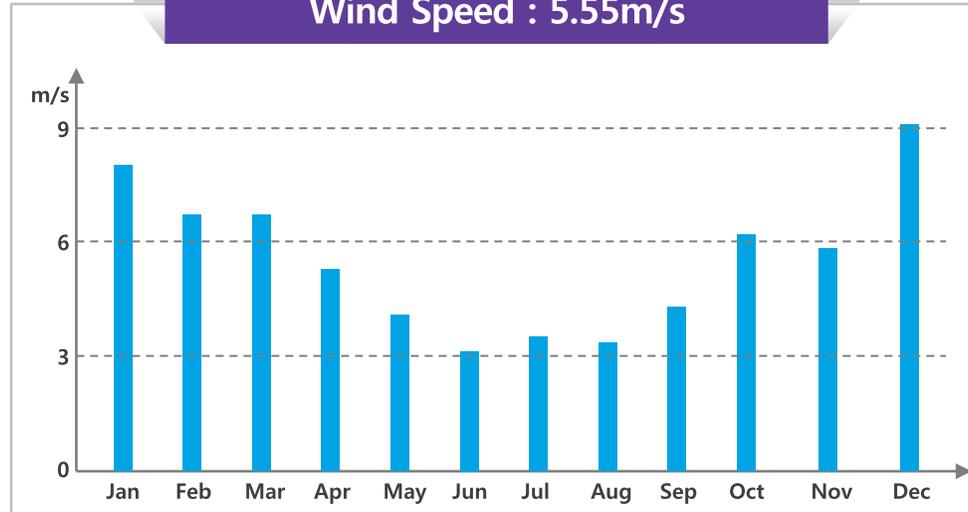
Population → 281 person, 147 household

Diesel Gen → 450kVA (150kVA x 3)

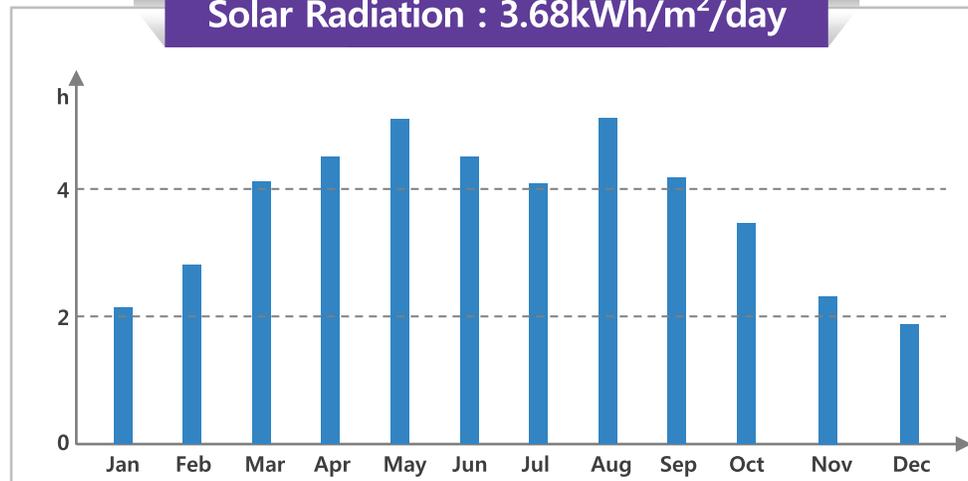
Grid → AC 380Vac, AC 6900Vac

Load → Avg 124kW (Max 305kW, Min 80kW)
Main load : fish drying facility

Wind Speed : 5.55m/s



Solar Radiation : 3.68kWh/m²/day

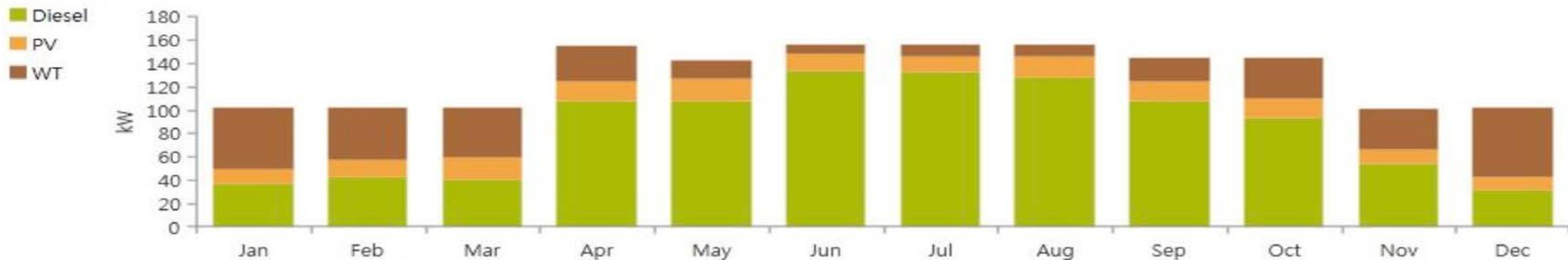


Economic Evaluation of Hybrid MG

	COE (Won/kWh)	TOC (Billion Won)	Operation (billion Won/y)	Investment (Billion Won)	Fuel Use (kL)	Diesel Operation (hour)
Before MG	920	14.91	0.93	1.0	343	8,760
After MG	850	13.78	0.74	2.66	222	3,308

- Generation quantity

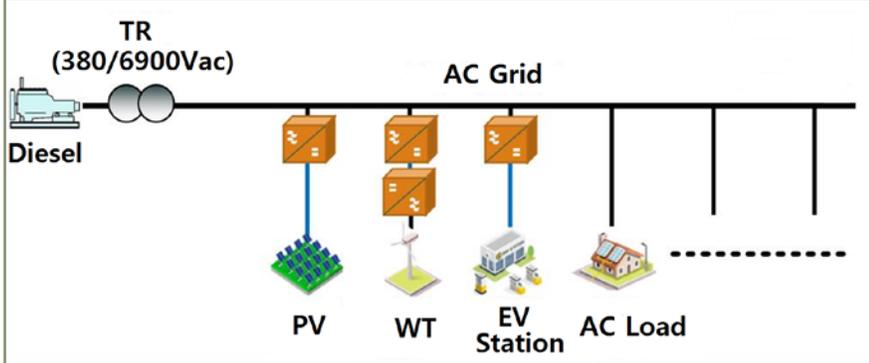
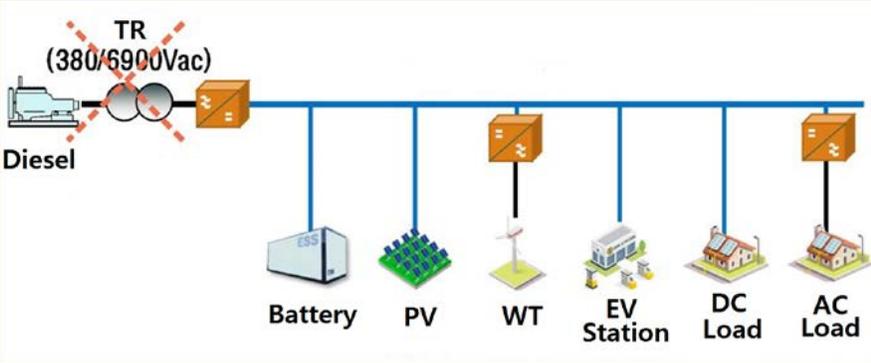
	Diesel	WT	PV	Surplus	Total	Ren.
Generation (MWh)	739	264	135	11.7	1,150	31.8%



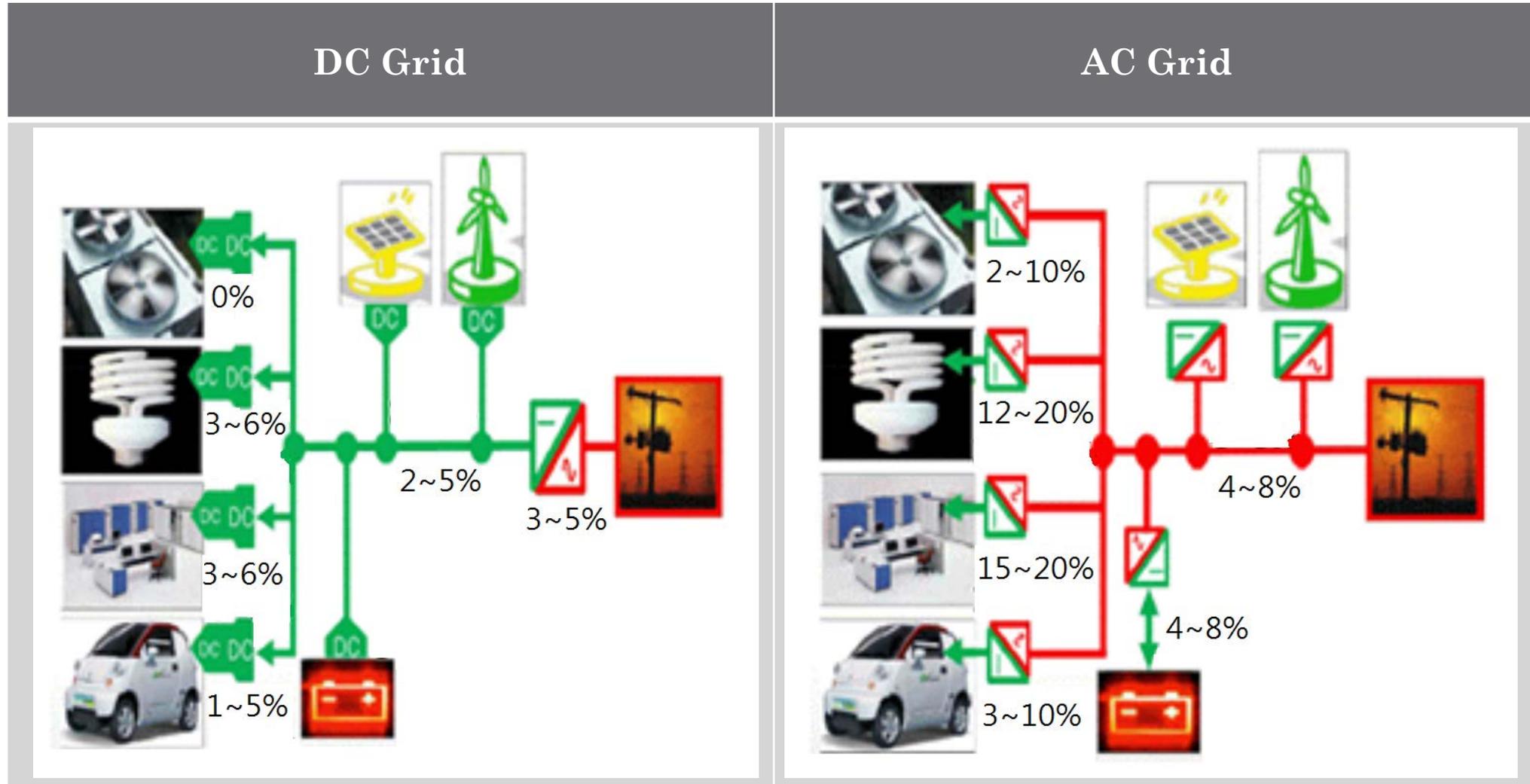


Next Challenge _ working with DC based MG

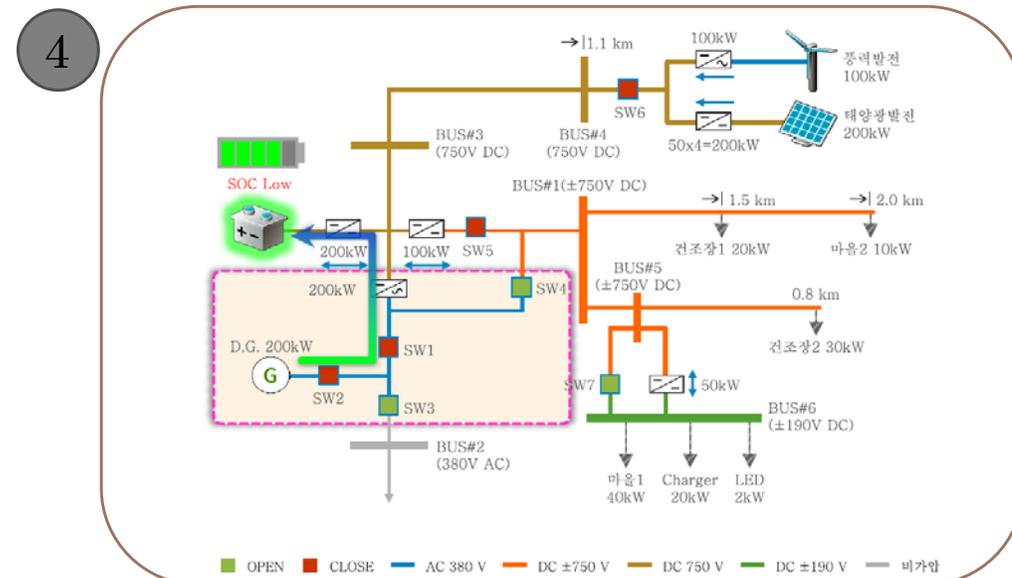
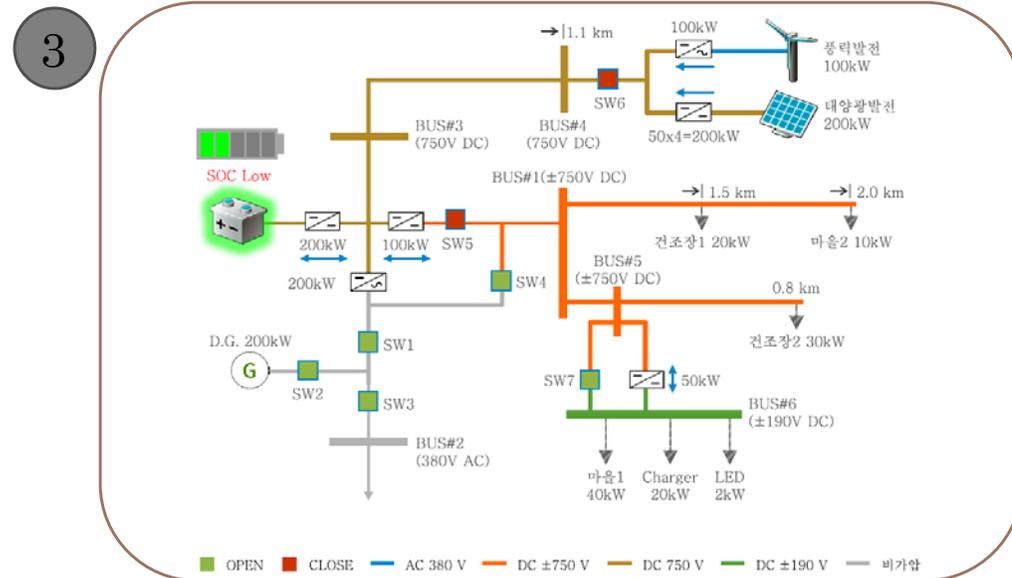
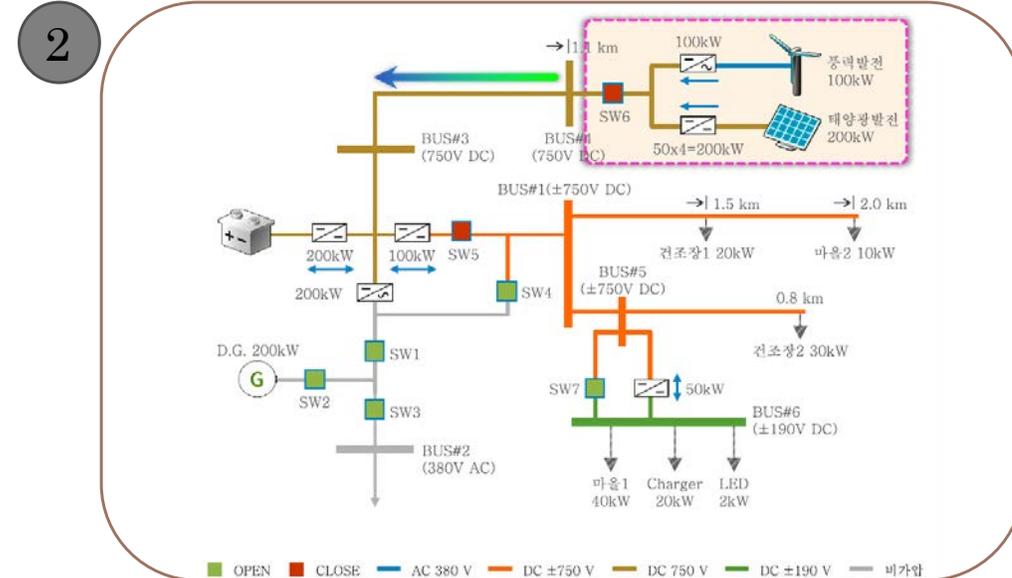
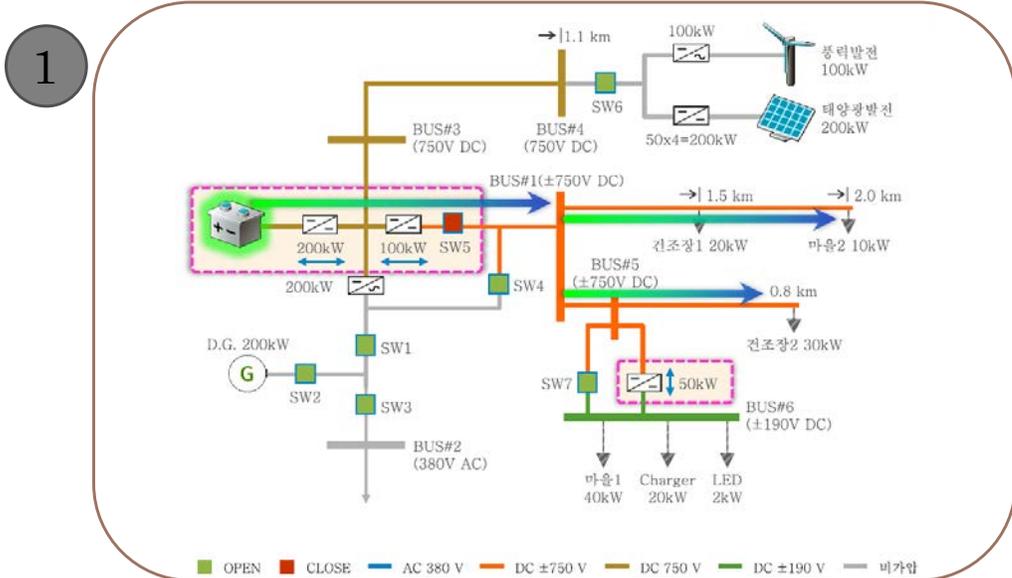
2nd Phase: DC based Hybrid Micro Grid

	AC based Diesel Power Plant	DC based Hybrid MG
<p>Concept</p>	 	 
<p>Power Generation</p>	<p>Diesel : 8760hours (@fuel use : 343kl)</p>	<p>Diesel : 117kl (AC based Hybrid MG was 222kl) Renewable energy fraction : up to 65% @PV 200kW, WT 100kW, Diesel 200kW, ESS 2000kWh</p>

Comparison Losses between AC and DC Grid

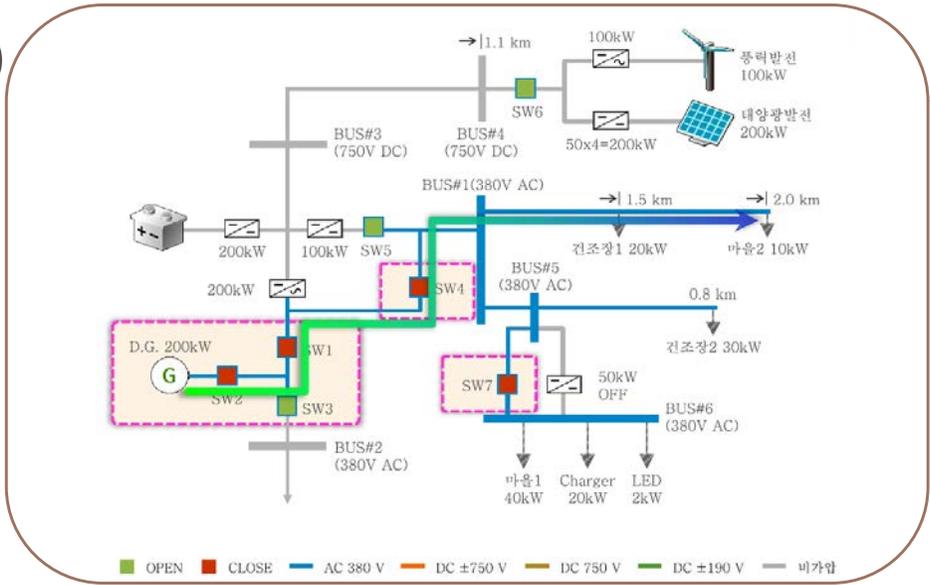


DC based Hybrid MG Operation Concept

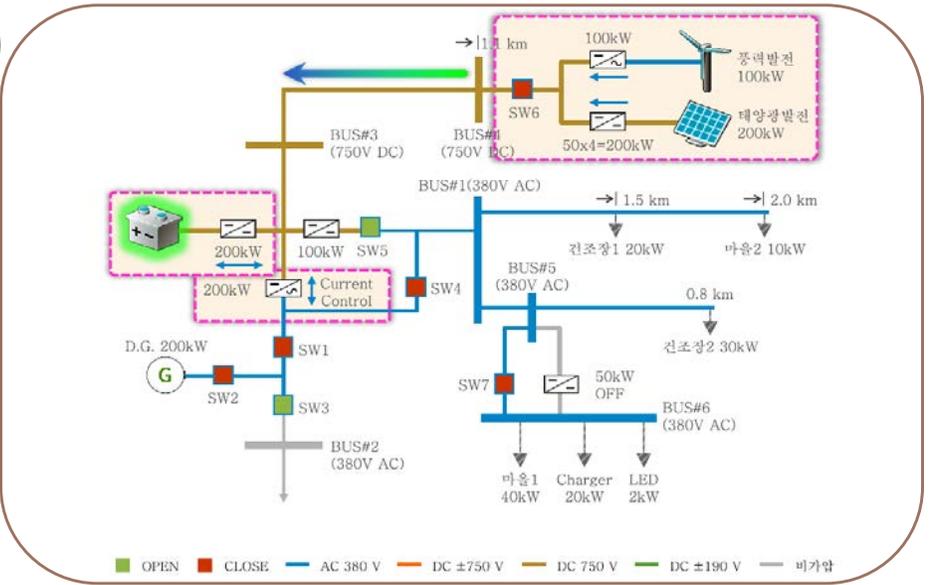


Will be operated as AC based Hybrid MG

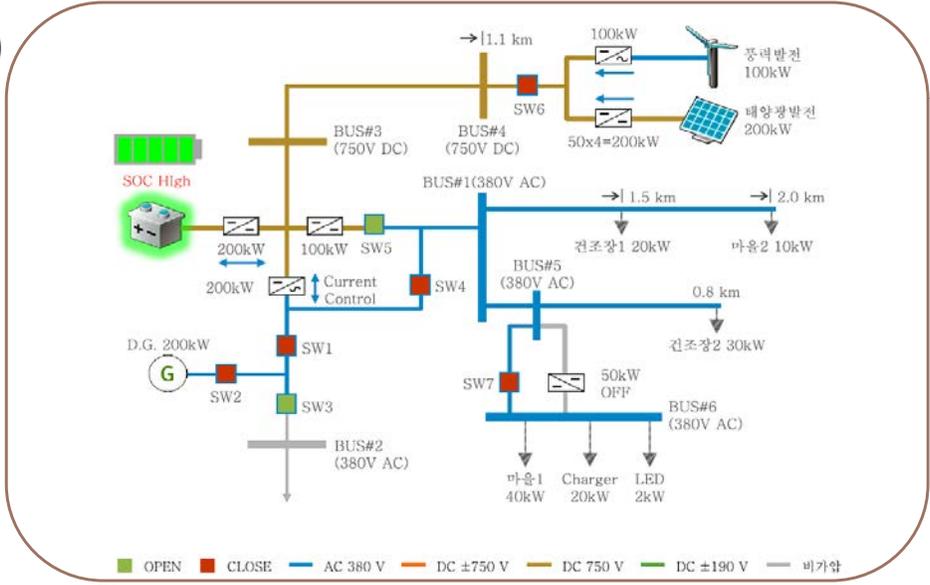
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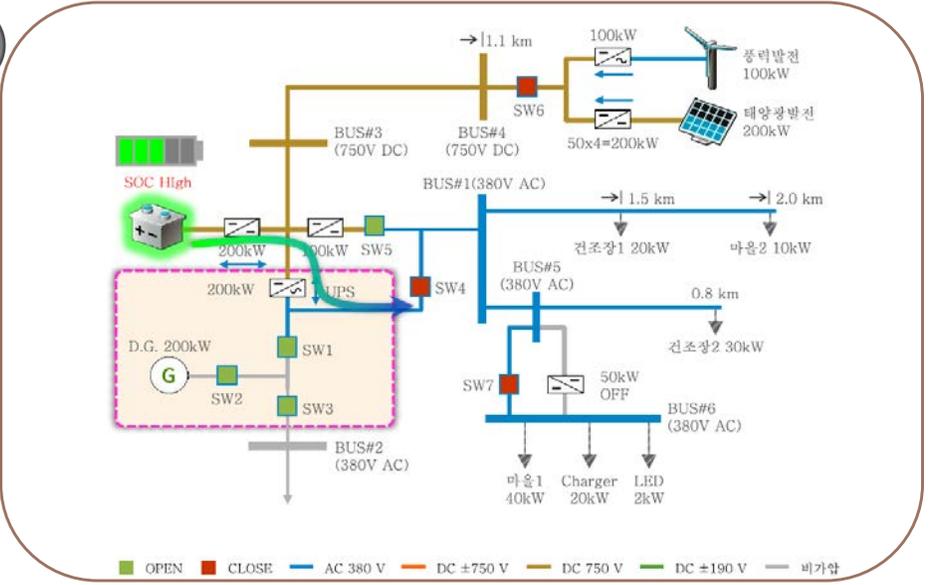
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Thank you for your attention ~

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Discussion