

Comparison of control strategies of an off-grid Carnot battery combined with renewable energy resources: Priority of electrical and Carnot battery

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LEAP-RE REPTES Project

Renewable plants integrated with pumped thermal energy storage for sustainable satisfaction of energy and agricultural needs of African communities

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Techno-economic Optimization

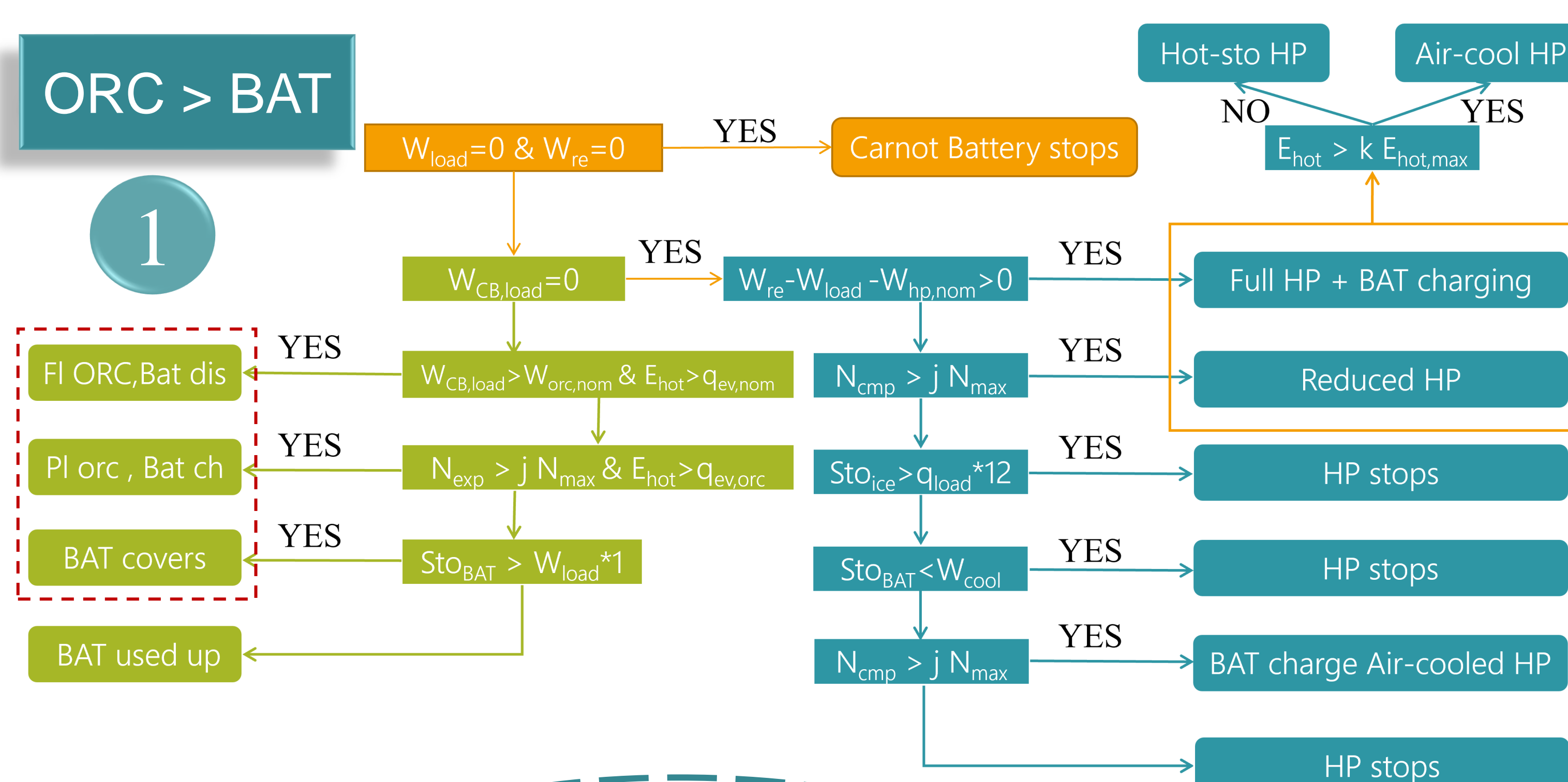
$$E_{gen} = W_{load} + Q_{load}/EER$$

$$LCOE = \frac{C_{inv} + \sum_{i=1}^{LT} \frac{C_{OM} + C_{grid} + C_{diesel}}{(1+r)^i}}{\sum_{i=1}^{LT} \frac{E_{gen}}{(1+r)^i}}$$

LT = 25 yr (lifetime); $r = 0.05$ (discount rate); EER = 2.73 (Energy Efficiency Ratio of cold rooms used now)

ORC > BAT

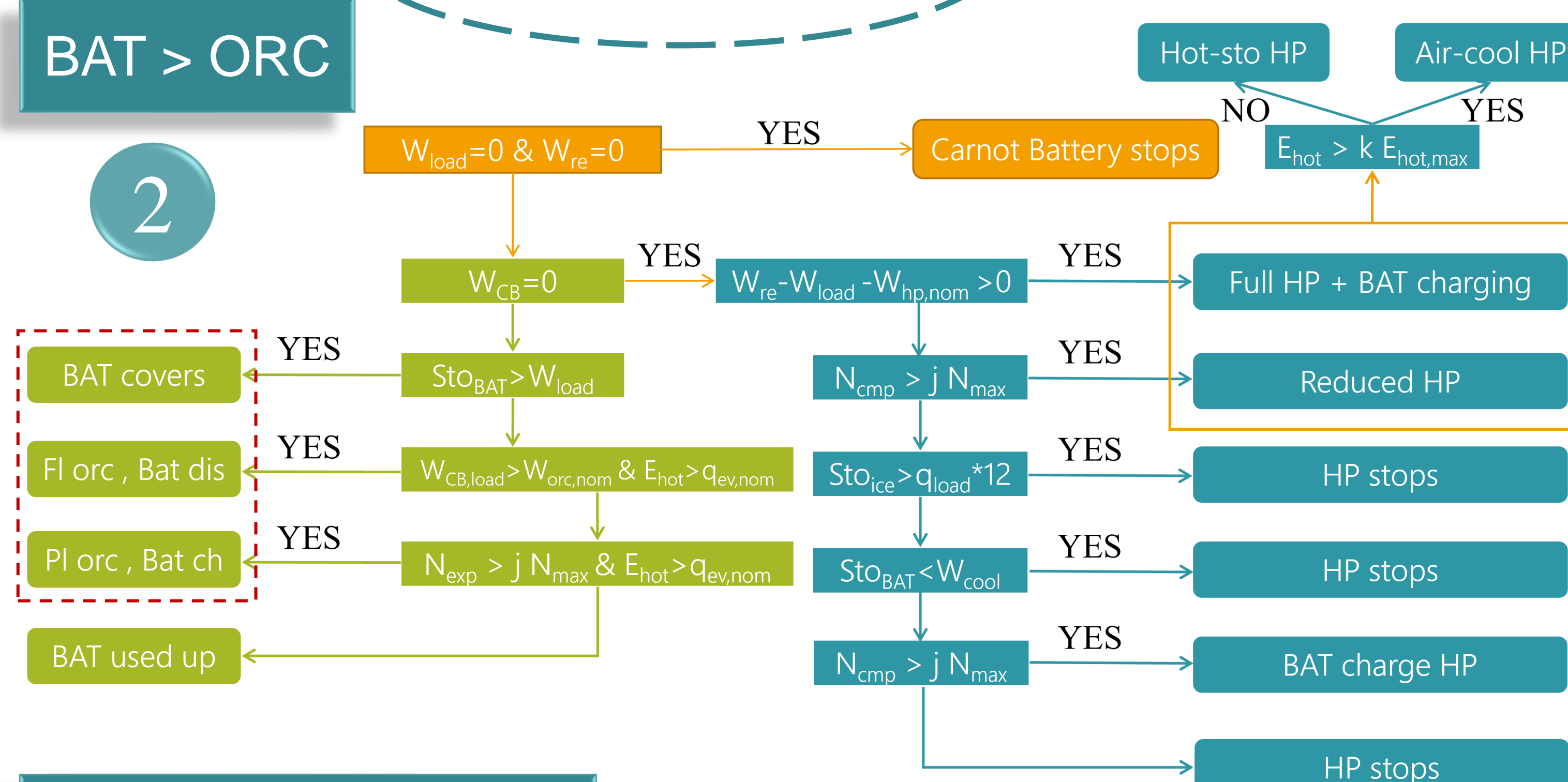
1



2 Strategies

BAT > ORC

2



Optimization Results

Properties	Unit	ORC > BAT	BAT > ORC
LCOE	€/kWh	0.2146	0.1704
COP _{air}	-	2.78	2.67
COP _{hot}	-	1.72	1.62
η_{ORC}	-	6.35 %	6.82 %
C _{invest}	€	398421	315318
W _{ORC,nom}	kW	20.6	16.2
E _{grid}	kWh/year	5808	5662
E _{generator}	kWh/year	9362	7570
E _{ORC}	kWh/year	6034	405

Conclusions

Advantages

ORC > BAT

Stable SOC of 3 storage.
High utilization of ORC.

BAT > ORC

Low LCOE.

Low dependence on the grid.

Disadvantages

Higher dependence on the grid.

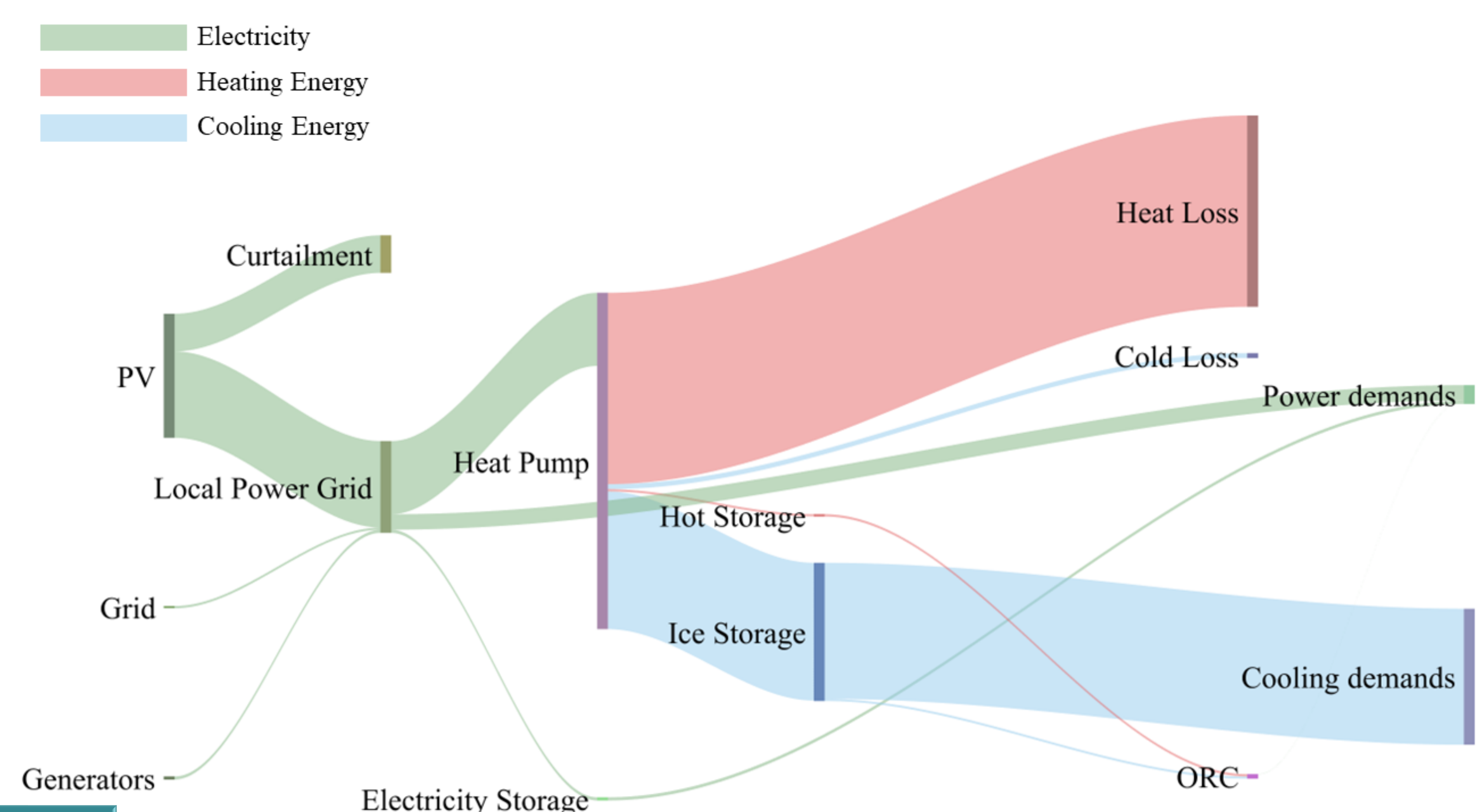
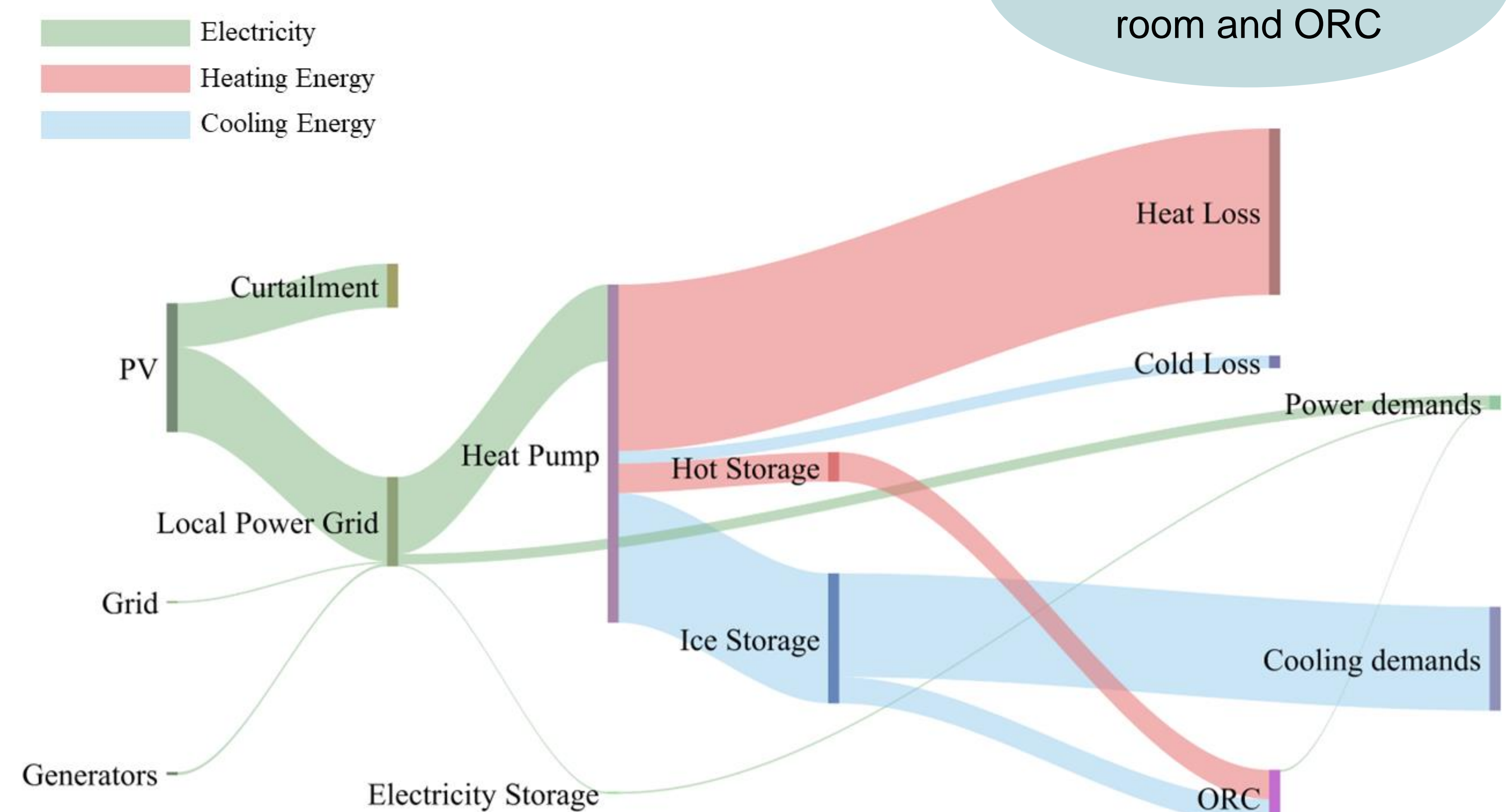
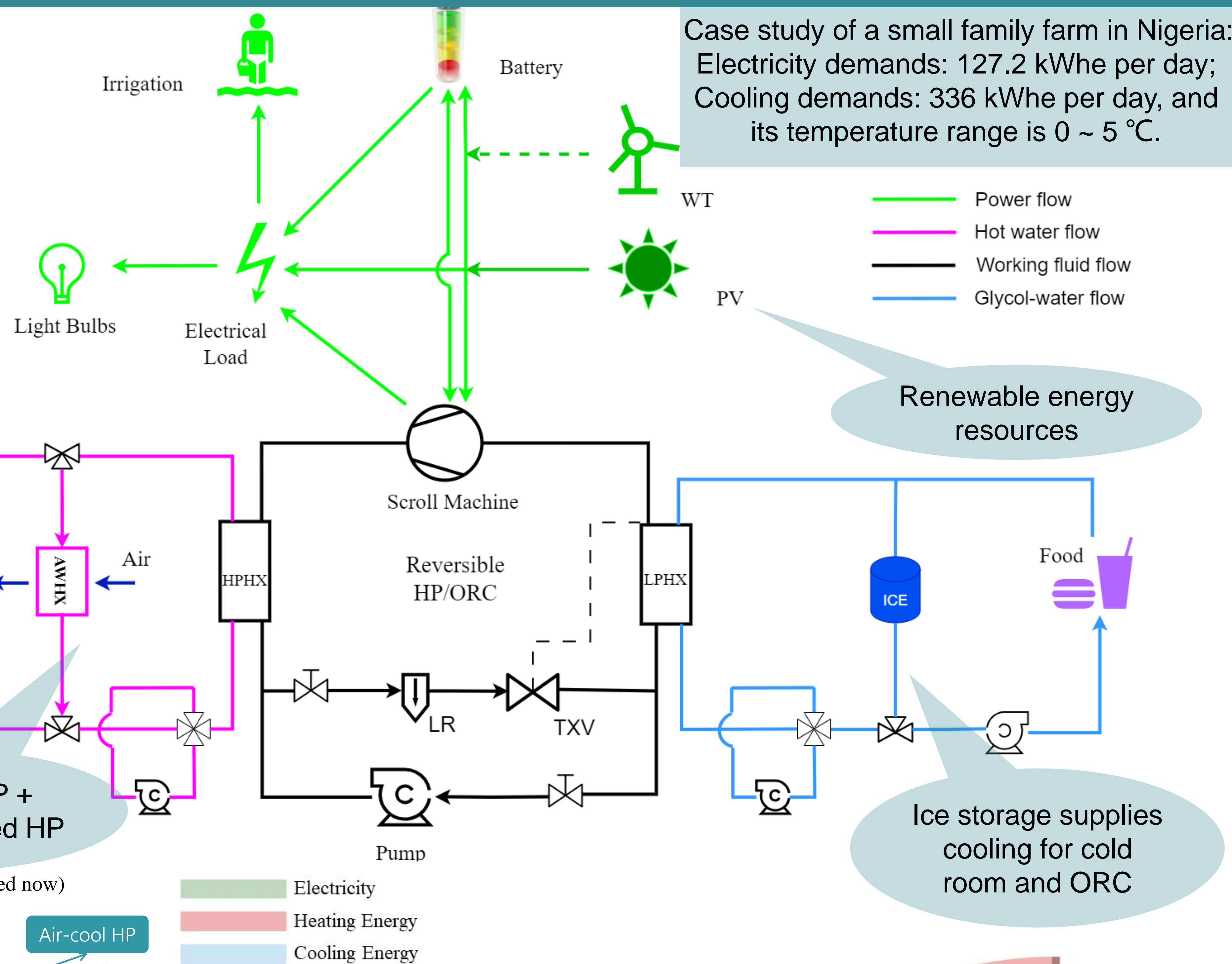
Low utilization of lithium-ion battery.

Large variation of SOC.

- Low utilization of ORC.

Strategy 1 makes SOC stable and always healthy but relies on more grid / diesel generators. Strategy 2 performs better in LCOE, but its ORC operating time remains at a low level.

Note: Based on the questionnaire survey results, the average reliability of the grid in this farm is 40%.



Acknowledgment

Acknowledgment

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References

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