Multi-Objective Unit Commitment for Renewable Energy Integration Considering Cost and Life Cycle Assessment

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Background

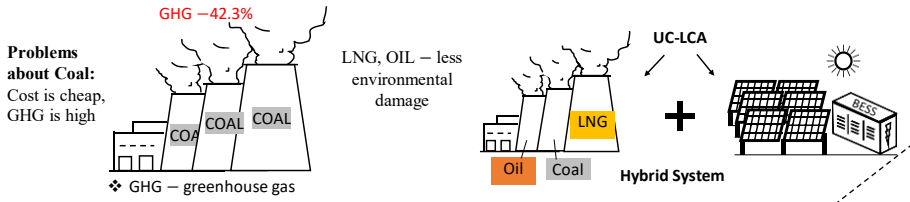
Japan's GHG net zero by 2050, requires taking quick action.

Fossil fuel power plants **produce a lot of GHG emissions.**

Problem

1. RES 100% is **impossible**

2. Only the reduction of CO2 is not enough to evaluate the GHG net zero



Solutions:

1. Fossil fuel balance combination: Oil, LNG and Coal

1.2. Hybrid System: **Thermal Power + PV**

2. Life Cycle Assessment **(LCA) to evaluate GHG net zero**

Proposal methodology of UC - LCA

Operation Cost

Fuel Cost
Start-up Cost

Coal ⇨ Find optimal schedule for UC - LCA

$$OF_{MO} = \omega \times OF_{cost} + (1-\omega) \times OF_{LCA}$$

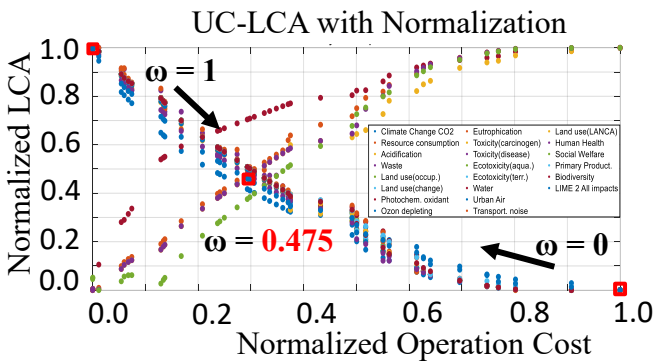
Environmental impact

LCA → LNG, Oil ⇨

1. $OF_{cost} = \min \sum_{t=1}^{24} \sum_{i=1}^{11} [FC + SC_i \cdot u_{i,t}(1 - u_{i,t-1})$

2. $OF_{LCA} = \min \sum_{t=1}^{24} [K_{i,LCA}^{(S)} \times g_{i,t} \times u_{i,t}]$

Result



ω	Cost × 10^9 JPY	CO2 × 10^6 [kg]	All impacts × 10^6 JPY
0.000	1.957	58.867	244.07
0.475	**1.367**	**62.239**	**277.96**
1.000	1.069	68.031	327.63

❖ MOP: Multi-Objective Opt.ω = 0.475

52%	14%	34%
Coal	LNG	Oil