|  |  |
| --- | --- |
| ,, | Conversion efficiencies of GT, GB, and EC at ES 𝑖 |
|  | Upper and lower power limits of EC at ES *i* |
| , | Electrical load, thermal load, and cooling load demands at ES *i* during period *t* |
| , | Upper and lower power limits of the GT at ES *i* |
| , | Upper and lower limits of the GT ramping at ES *i* |

**Appendix 1**

|  |  |
| --- | --- |
|  | EC power of ES *i* during period *t* |
|  | Heat power of EB and GB during period *t* |
| , | Power of the GT and wind turbine at ES *i* during period *t*. |
| , | Power demands for EB and EC at ES *i* during period *t* |

1. urban ES

(1) Equipment Constraints

The constraints related to the equipment of urban ES include constraints on gas turbines and , gas boilers , photovoltaic power and curtailment constraints , wind power and curtailment constraints , and constraints related to electric chiller equipment .













(2) Grid-connected Power Change Constraints

Constraint limits the magnitude of change in the ES grid-connected power between adjacent time periods.



(3) Power Balance Constraints

The balance constraints for electricity, heat, gas, and cooling are to .









1. Suburban ES
2. Equipment Constraints

The renewable energy in suburban ES is mainly photovoltaic load, and the output constraint of renewable energy is .



(2) Energy Balance Constraints

The electrical power balance constraint is .



(3) Grid-connected Power Change Constraints

Constraint limits the magnitude of change in the ES grid-connected power between adjacent time periods.



**Appendix 2**

In the constraints established previously, there are some nonlinear constraints. By linearizing these terms, the entire model is transformed into a mixed-integer linear programming (MILP) problem. The linearization methods involved are as follows.

(1) Linearization of absolute value term

The absolute value term in equation (5) is linearized by introducing an auxiliary variable  to replace the absolute value term, resulting in:



(2) Linearization of piecewise function

The piecewise function in equation (8) is linearized by introducing an auxiliary variable :



This can be transformed into:



(3) Linearization of the max function

The max function in equation (17) is linearized, using  as an example, by introducing a 0-1 auxiliary variable , resulting in:



(4) Linearization of product of variables

The nonlinear term  in equation (19) (multiplication of a 0-1 variable and a continuous variable) is linearized:



The term  in equation (36) is linearized:

