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Optimization of the investments' distribution by the stages of the joint implementation projects' realisation

Some problems of the joint implementation projects' (JIP) realisation arising while investments are mobilized for such projects directed toward energy efficiency increase as well as greenhouse gas emissions' mitigation with respect to the Kyoto Protocol are considered.

Fuzzy-set estimate introduced for JIP allows deriving conclusions as of the investment process efficiency:

$$\mathrm{NPV} = -\sum_n \frac{I_n}{(1+r_n)^n} + \sum_n \Big(e_n \frac{I_n}{(1+r_n)^n} \cdot \frac{P_n}{(1+r_n)^n} \Big) + \frac{C}{(1+r_{N+1})^{N+1}}, \qquad (1)$$

where NPV – investments' net present value, I^* – investing party budget, I_n investments' value of the n-th period, e_n – parameter of technological cooperation efficiency, r_n – discount rate, P_n – reduced emission unit price, C – investment process net value liquidation cost. Parameters r_n, P_n, C have "fuzzy" nature. Therefore, it is expedient to apply triangular fuzzy numbers to describe such parameters.

Problem of investments' distribution optimisation with respect to the project realisation stages is solved as a problem of fuzzy mathematical programming (FMP). Problem posting supposes optimisation of the investments' distribution with respect to the project realisation stages aimed in maximal NPV effect under limitations on emissions' normalized Kyoto levels as well as on the budget of the investing party.

The problem of the FMP with the fuzzy parameters of the goal function (1): NPV $\to$ max, on the given set of allowed alternatives:

$$\sum_n I_n \leqslant I^*; \quad \sum_n e_n I_n \leqslant E^* - E_0; \quad I_n \geqslant 0,$$

where E^* – normalized Kyoto-level of GG emissions, E_n – emissions' level of the n-th period.

Triangular fuzzy numbers used as initial data for the fuzzy-set estimate of the JIP allow determining the intervals of the goal function's fuzzy coefficients' values.

Such an approach result in the problem of infinite number of goal functions. The problem is solved by searching for compromise solution transforming an infinite set of goal functions into unique compromise goal function. For instance, if for each interval of the function (1)

$$r_n = (r_{n\,\min}, \bar{r}_n, r_{n\,\max}); \quad P_n = (P_{n\,\min}, \bar{P}_n, P_{n\,\max}); \quad C = (C_{\min}, \bar{C}, C_{\max})$$

parameters' change, the only one representative is chosen, namely, if the value $\bar{r}_n, \bar{P}_n, \bar{C}$ with the greatest chance to appear is chosen for every intervals, we transfer from the problem with fuzzy parameters to the problem of linear mathematical programming with sharp coefficients, of the form:

$$\Big\{\mathrm{NPV} = -\sum_n \frac{I_n}{(1+\bar{r}_n)^n} + \sum_n (\bar{e}_n \cdot \frac{I_n}{(1+\bar{r}_n)^n} \cdot \frac{\bar{P}_n}{(1+\bar{r}_n)^n}) + \frac{\bar{C}}{(1+\bar{r}_{N+1})^{N+1}} \;\Big|$$
$$\sum_n I_n \leqslant I^*, \quad \sum_n e_n I_n \leqslant E^* - E_0, \quad I_n \geqslant 0\Big\} \to \max,$$

which can be solved by means of the simplex method.