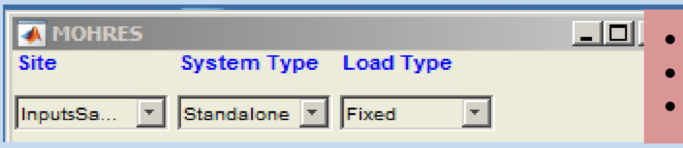
Case Study 3- Optimal Retrofitting of an Existing Energy System for Min LCE

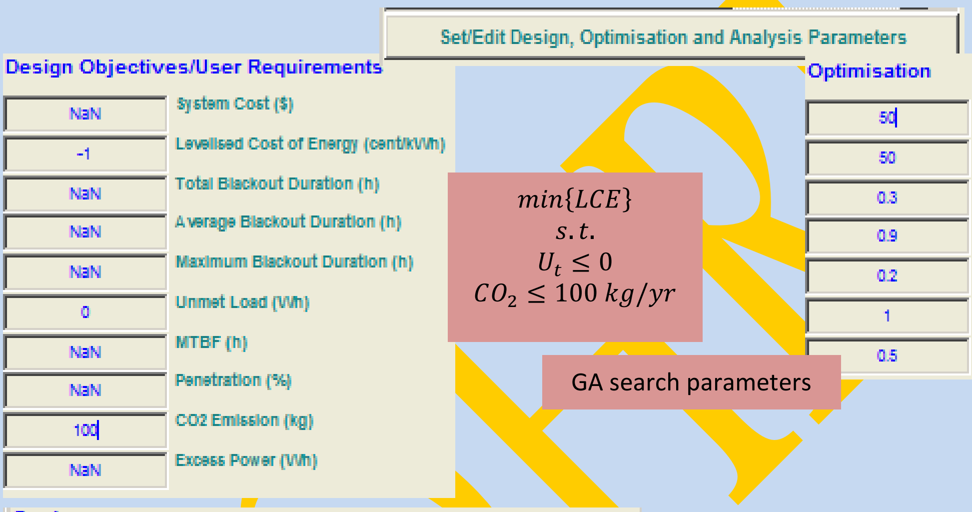
An existing PV-Diesel system ($A_{PV} = 40m^2$, $P_{D,nom} = 1k\ W$) is considered to be retrofitted to a Wind-PV-Battery-Diesel system with existing PV and Diesel generator but with CO_2 emission limited to 1000 kg/year.

Background Theory:

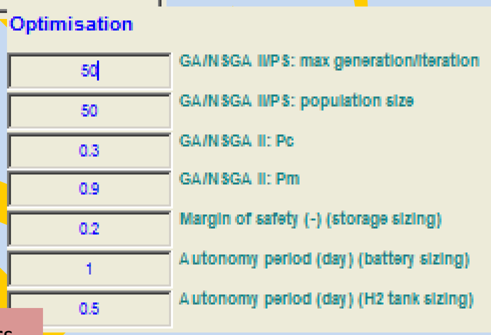
- **Integrated Configuration-Size Optimisation**
- **Deterministic Design**
- **Dispatch Strategy as Design Variable**
- **Single Objective Optimisation**
- **Genetic Algorithm**



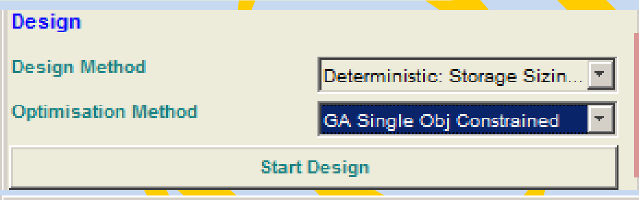
- InputsSample.xlsx
- Standalone
- Fixed



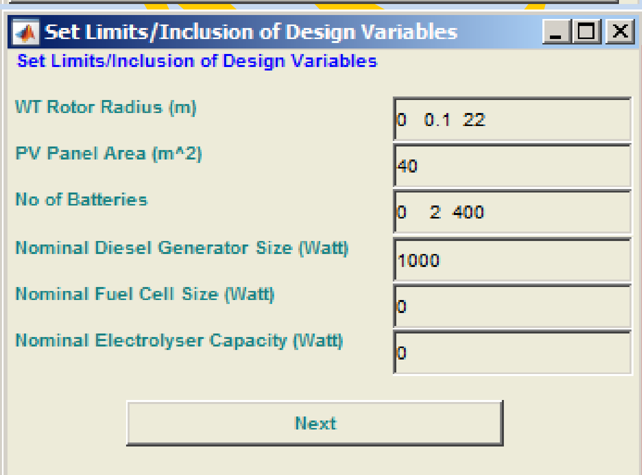
$$\begin{gathered} min\{LCE\} \\ s.t. \\ U_t \leq 0 \\ CO_2 \leq 100\ kg/yr \end{gathered}$$



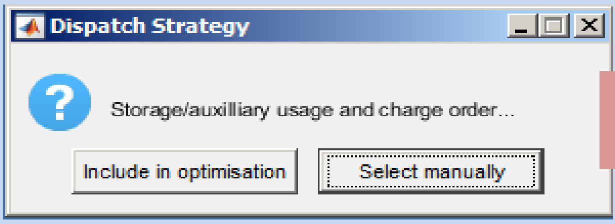
GA search parameters



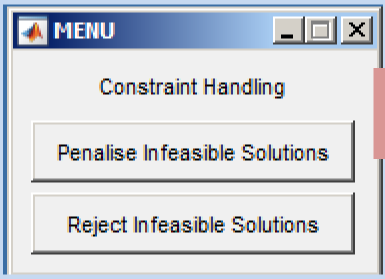
- Deterministic: Storage sizing along with other components
- Genetic Algorithm



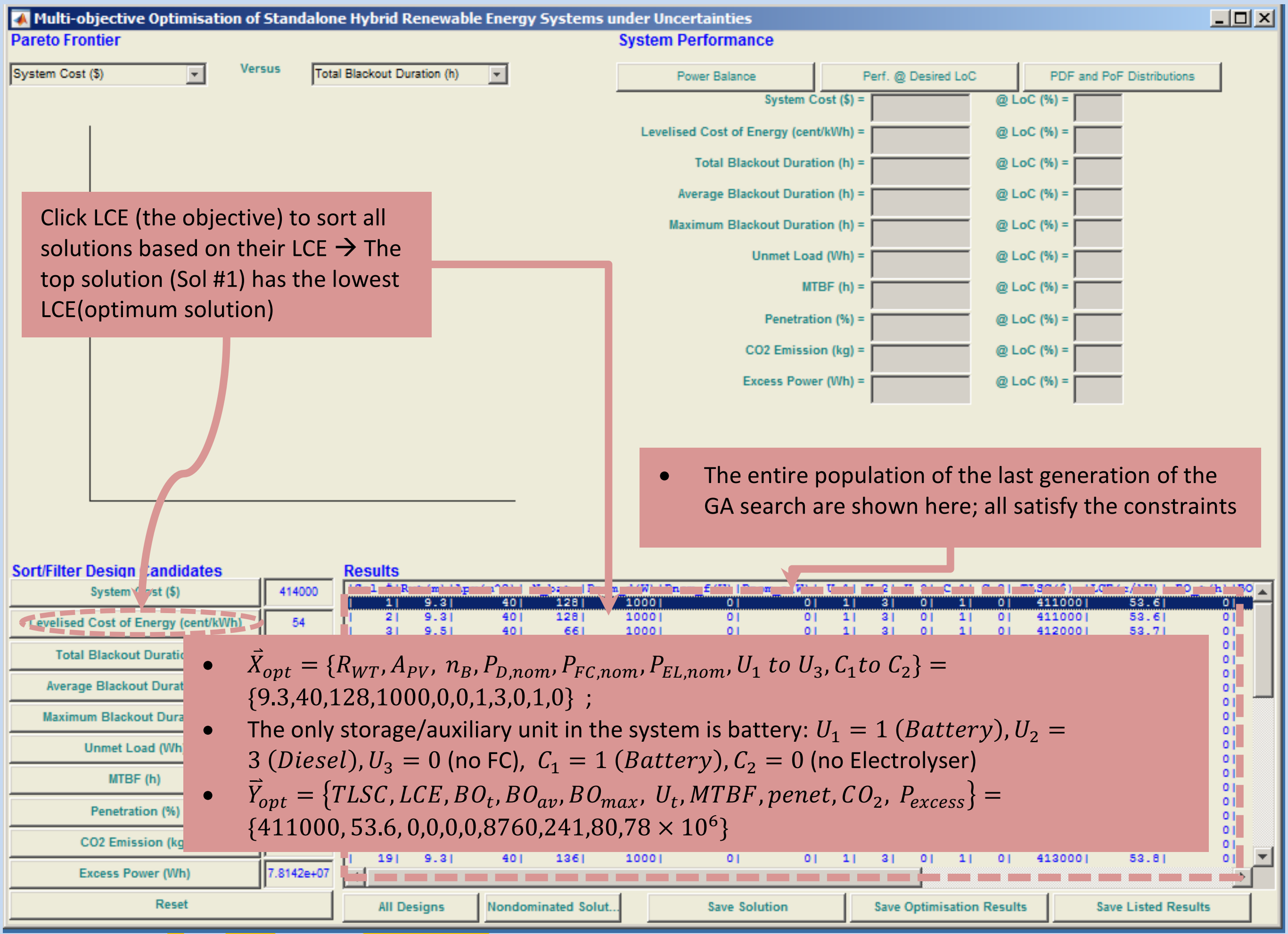
- Nonzero single Values (included in the system but excluded from optimisation):
    - $A_{PV} = 40m^2$
    - $P_{D,nom} = 1k\ W$
- Zero values(excluded from the configuration)
    - $P_{FC,nom} = 0$
    - $P_{EL,nom} = 0$
- Lower and upper limits for WT rotor and number of batteries populated automatically; upper limits are calculated based on worst case scenarios (editable); steps are also populated automatically, but are not applicable (ignored) in GA



- Include in optimisation: Add dispatch strategy to the set of design variables



- Reject Infeasible Solutions (this optimisation problem is not too constrained/ design space is not too rigid)



Click LCE (the objective) to sort all solutions based on their LCE → The top solution (Sol #1) has the lowest LCE(optimum solution)

- The entire population of the last generation of the GA search are shown here; all satisfy the constraints

- $\vec{X}_{opt} = \{R_{WT}, A_{PV}, n_B, P_{D,nom}, P_{FC,nom}, P_{EL,nom}, U_1\ to\ U_3, C_1 to\ C_2\} = \{9.3,40,128,1000,0,0,1,3,0,1,0\}$;
- The only storage/auxiliary unit in the system is battery: $U_1 = 1\,(Battery), U_2 = 3\,(Diesel), U_3 = 0$ (no FC), $C_1 = 1\,(Battery), C_2 = 0$ (no Electrolyser)
- $\vec{Y}_{opt} = \{TLSC, LCE, BO_t, BO_{av}, BO_{max}, U_t, MTBF, penet, CO_2, P_{excess}\} = \{411000, 53.6, 0,0,0,0,8760,241,80,78 \times 10^6\}$