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How to enforce non-anticipativity in microgrid sizing optimization ?

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► **To cite this version:**

Pierre Haessig, Jean Fruchthieu Nikiema, Nabil Sadou, Elsy El Sayegh. How to enforce non-anticipativity in microgrid sizing optimization?. Openmod Grenoble workshop 2024, Mar 2024, Grenoble, France. . hal-04543567

HAL Id: hal-04543567

<https://hal.science/hal-04543567>

Submitted on 12 Apr 2024

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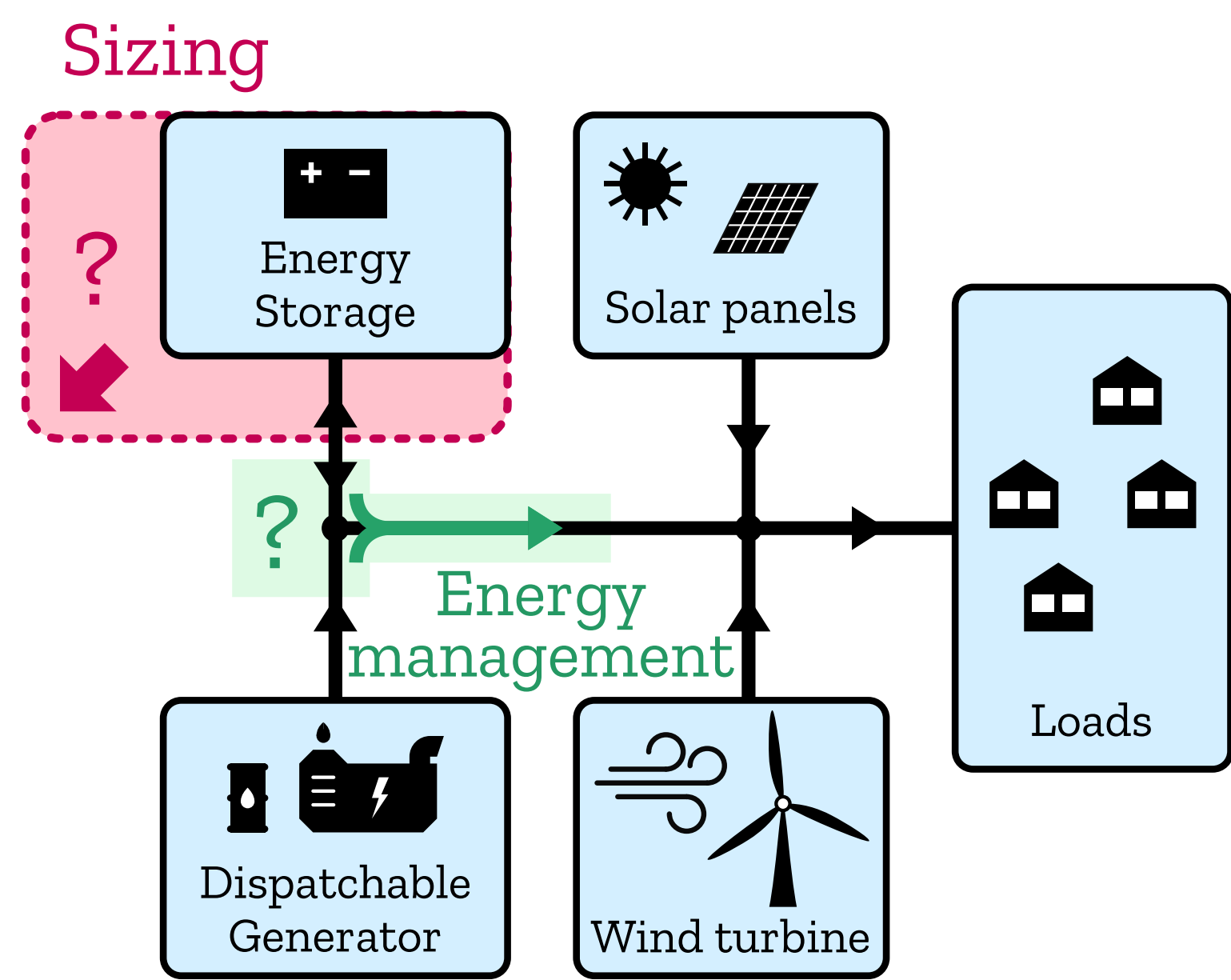


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Microgrid optimal design: definition & challenges

Microgrids
 Definition: **standalone energy systems**, e.g. needed for rural electrification



Microgrid design objectives:
 (min) Lifecycle cost = Investment + Operation + Replace
 (max) Quality of Service (→ min load shedding)
 and also: environmental impact...

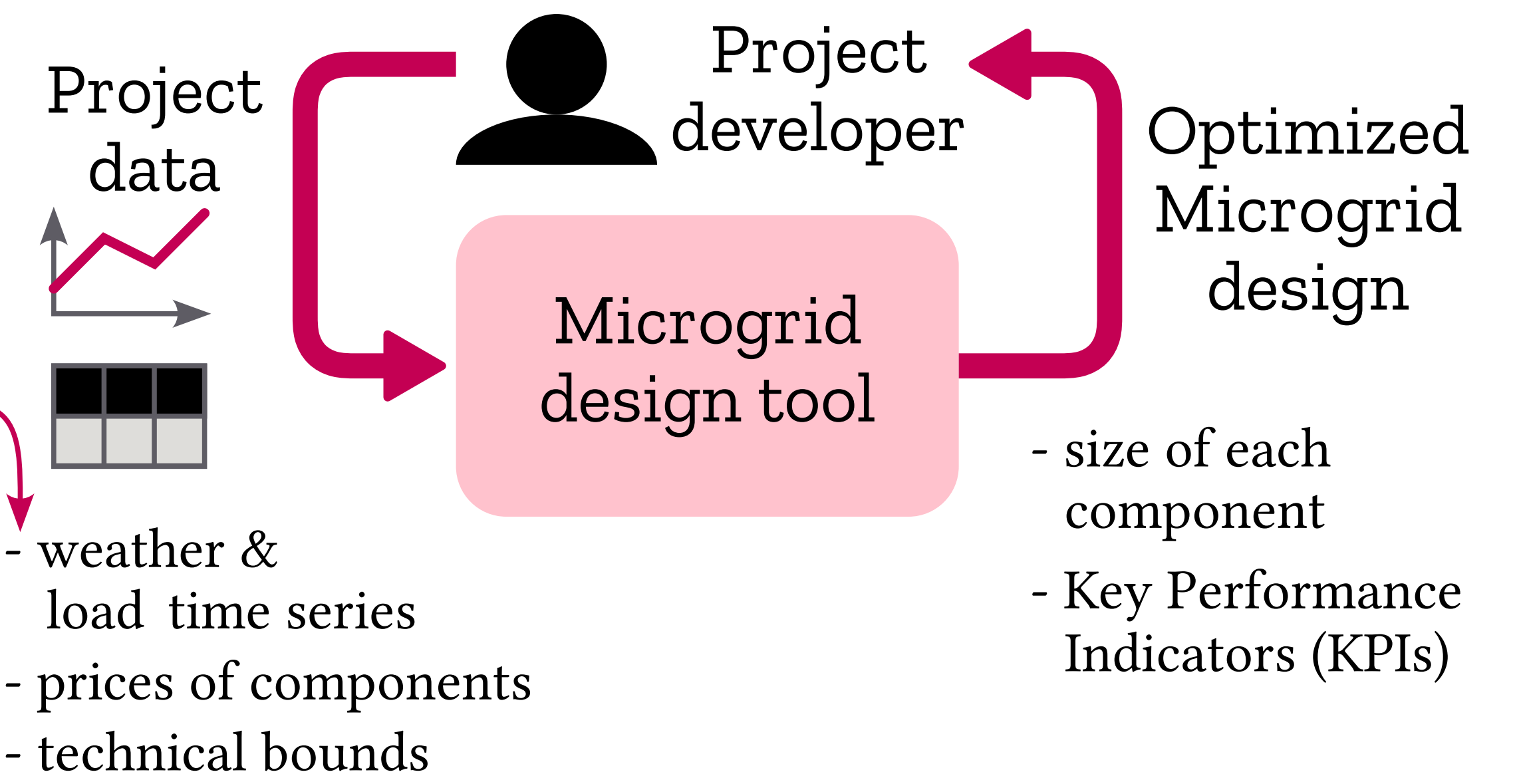
Two *intertwined* optimization problems:
 ○ Microgrid **sizing**: find the optimal components' size
 ○ **Energy management (EM)**: choose, at each instant, the optimal power flows

Fact: due to uncertainty of project data, **anticipative** Energy Management may not be applicable on field.

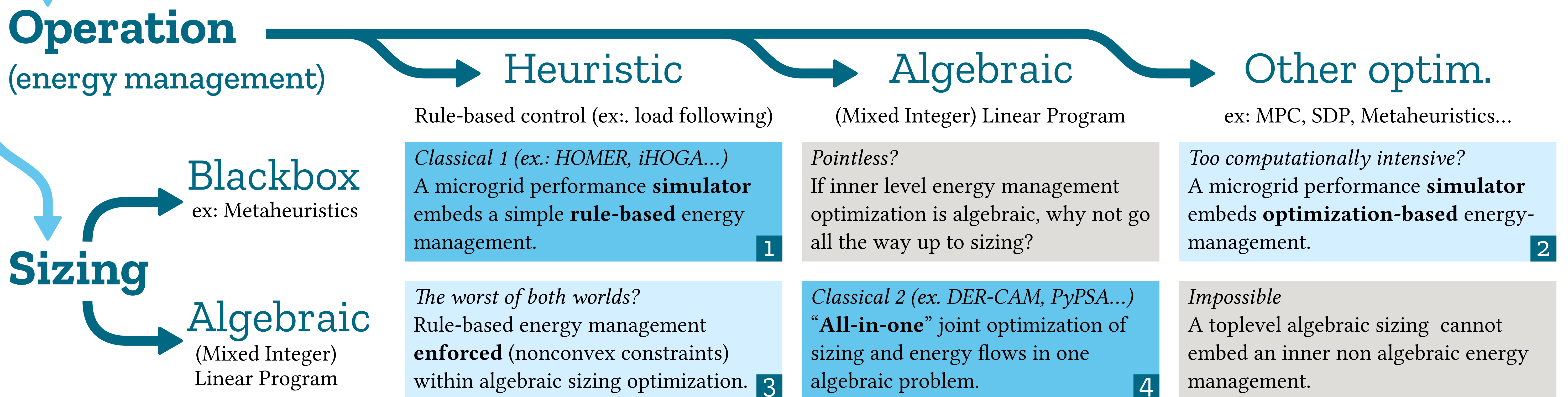
Q: Which **microgrid model formulation** yield:
 ○ reliable & **fast** convergence? (~ in seconds)
 ○ **non anticipative operation**?

Microgrid sizing tool

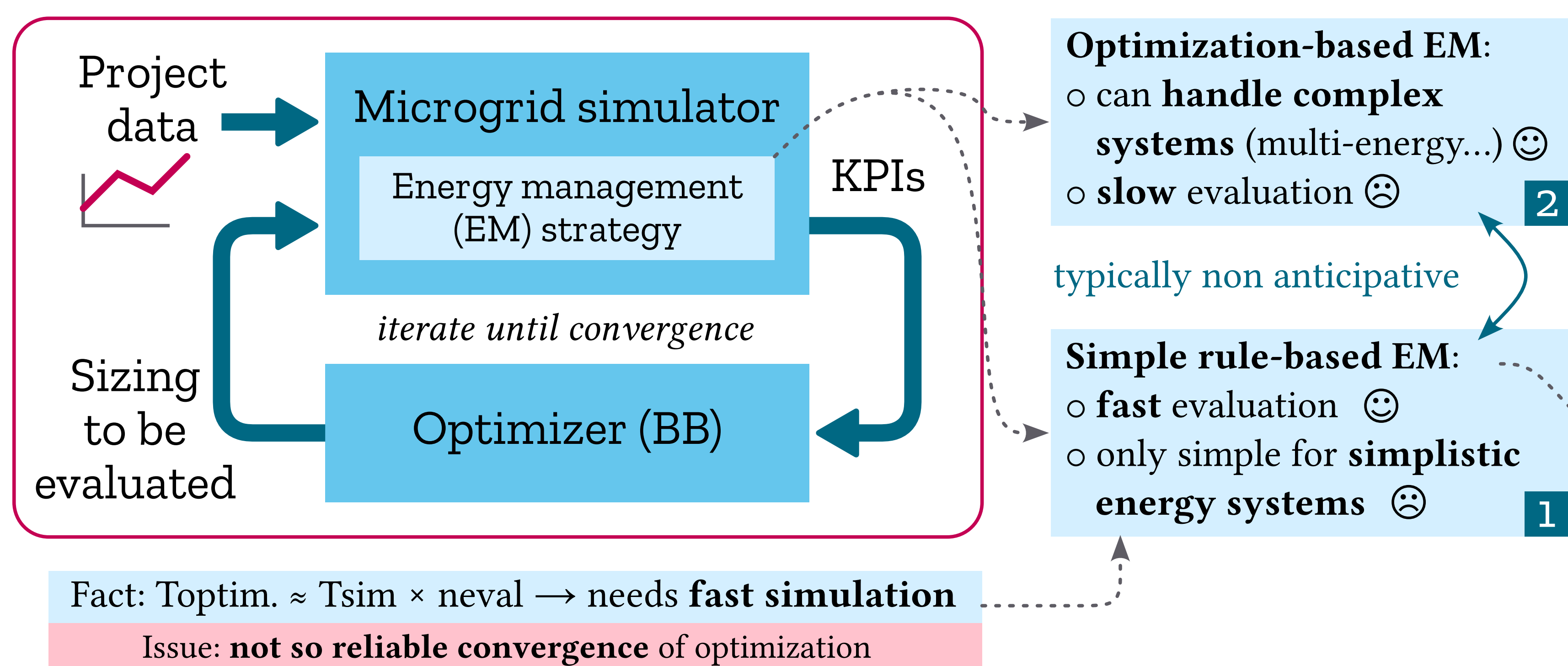
Since each project is a specific design → need for reliable microgrid sizing tool



Different formulations for sizing & operation optimization

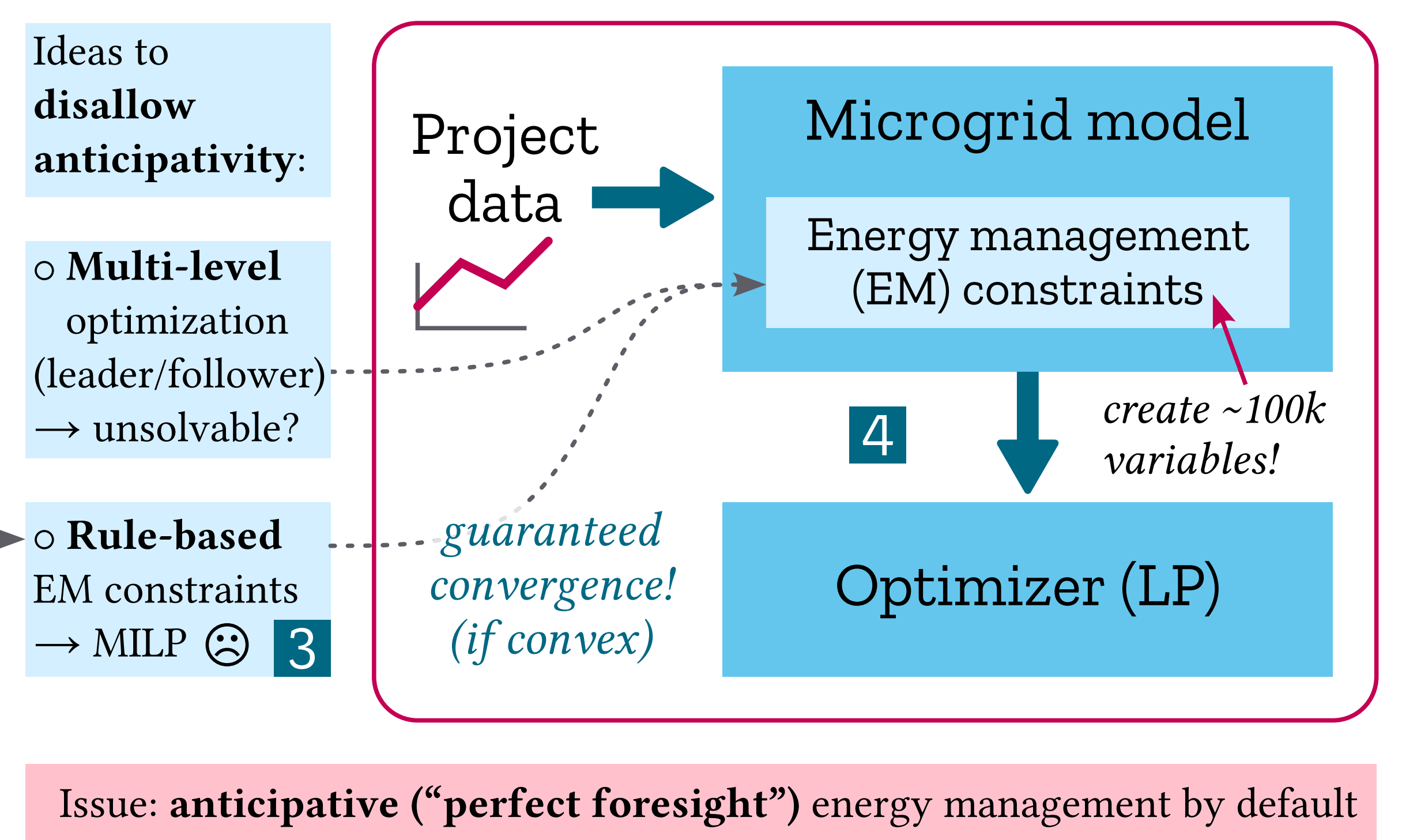


Blackbox sizing with embedded energy management **1 & 2**



Fact: $T_{optim.} \approx T_{sim} \times n_{eval} \rightarrow$ needs **fast simulation**
 Issue: **not so reliable convergence** of optimization

Algebraic all-in-one sizing & energy management **3 & 4**



Issue: **anticipative** (“perfect foresight”) energy management by default

Tools **Microgrids.X**

<https://pierreh.eu/Microgrids-X/>
 Github: Microgrids-X/Microgrids.jl

Operational & economic simulation of Microgrids
 - with simple rule-based energy management
 - with sizing optimization example

| | |
|---|---|
| Three implementations | NEW Algebraic variant: JuMP based in progress... |
| Julia the fastest one: 0.15 ms/sim | Matlab Python with in-browser demo version |

Conclusions

No clear winning approach

Non anticipative energy management typically implies **blackbox** sizing optimization with *either*:
 ○ simplistic energy system (rule-based control) or
 ○ prohibitively slow evaluation time (optimization-based energy management)

Algebraic sizing optimization models typically assumes **anticipative** (“perfect foresight”) energy management

Perspectives

For blackbox optimization:
 - Use Bayesian optimization to circumvent the increased simulation time due to optimization-based energy management (Model Predictive control, Stochastic Dynamic Programming)

For algebraic optimization:
 - Is there an efficient way to enforce **non anticipative** Energy Management?