European Energy Transition and Society: moving towards Implementation, 16-17 Oct 2025, Brussels

Is there no alternative?

It is time energy planning models looked beyond cost-optimal solutions

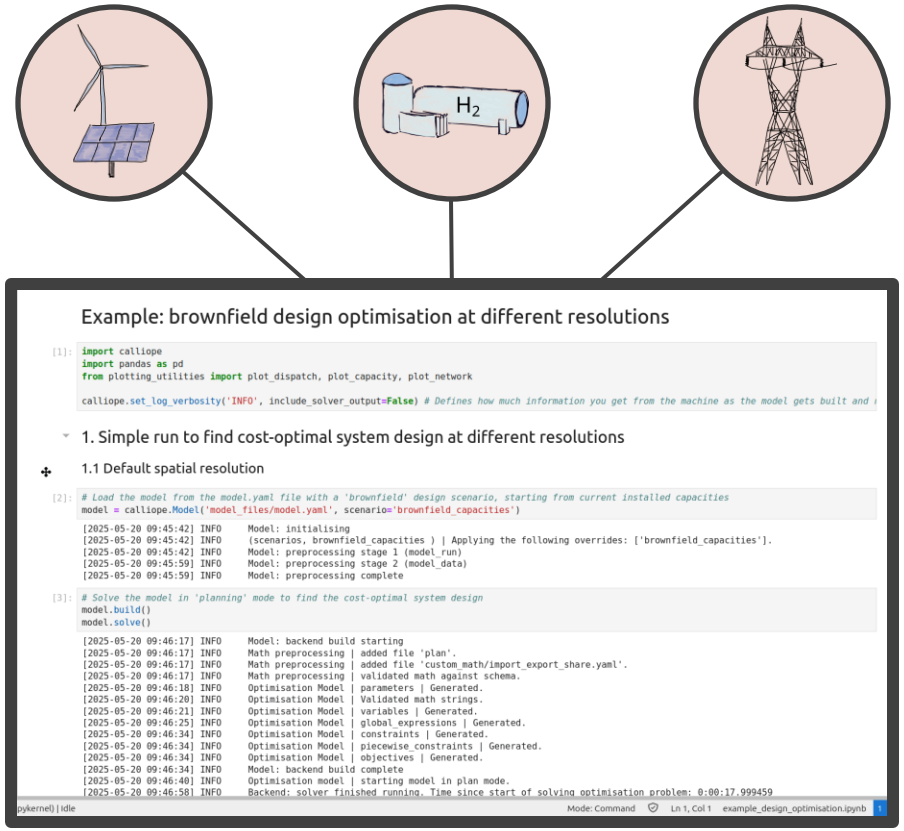
Francesco Lombardi, Koen van Greevenbroek, Aleksander Grochowicz, Michael Lau, Fabian Neumann, Neha Patankar, Oskar Vågerö

Based on: *Near-optimal energy planning strategies with modeling to generate alternatives to flexibly explore practically desirable options.* Joule, 2025. doi.org/p8b5

Part A.
What’s wrong with conventional cost optimisation

The standard.
Optimising the system re-design

We must deploy new renewable, transmission and storage capacity.
But **how much**? and **where**?

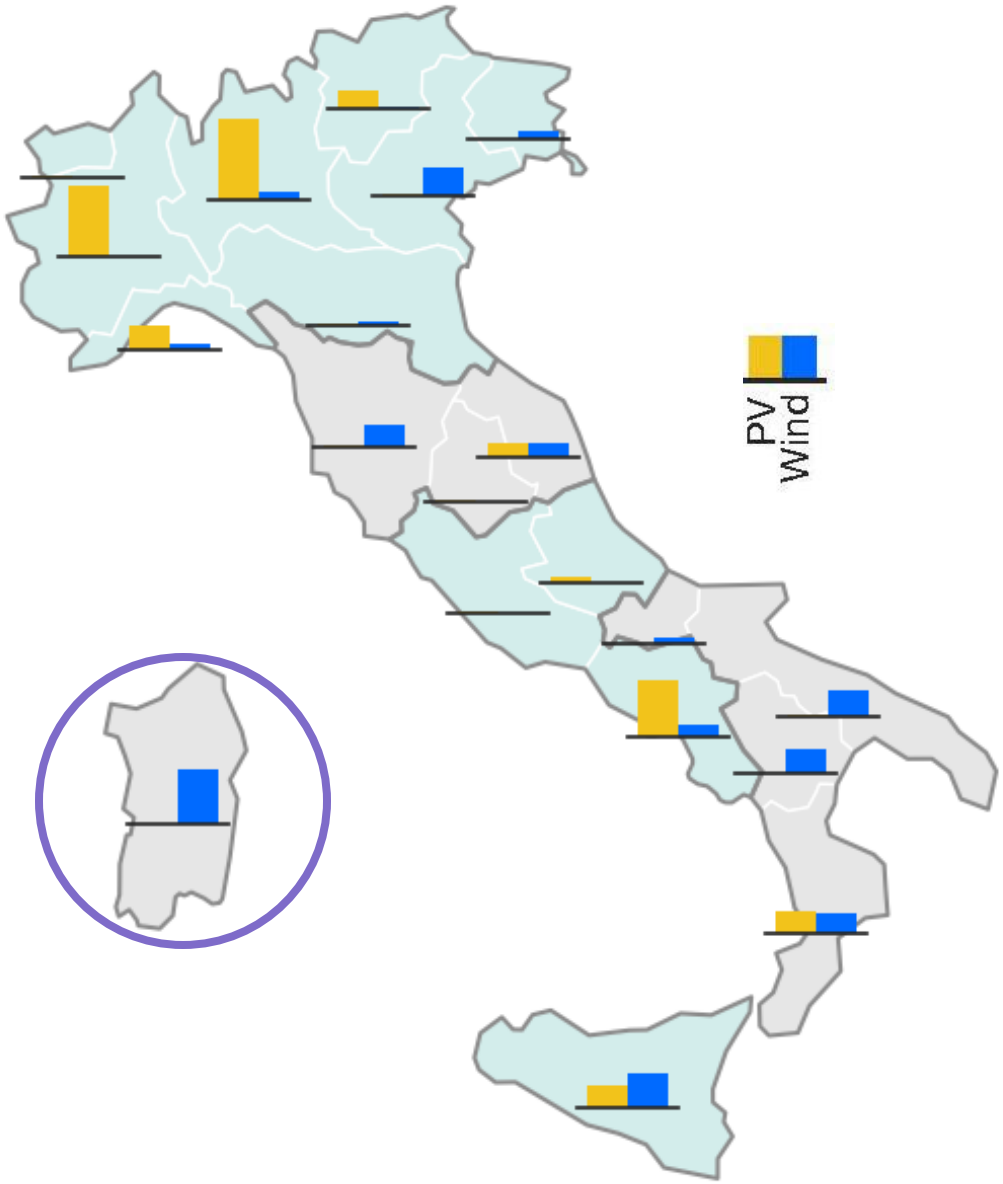


Energy planning models provide quantitative insights on such questions.

How? turning those into a mathematical problem, for which an ‘optimal’ solution can be found

minimum cost

Cost-optimality.
Is it desirable?

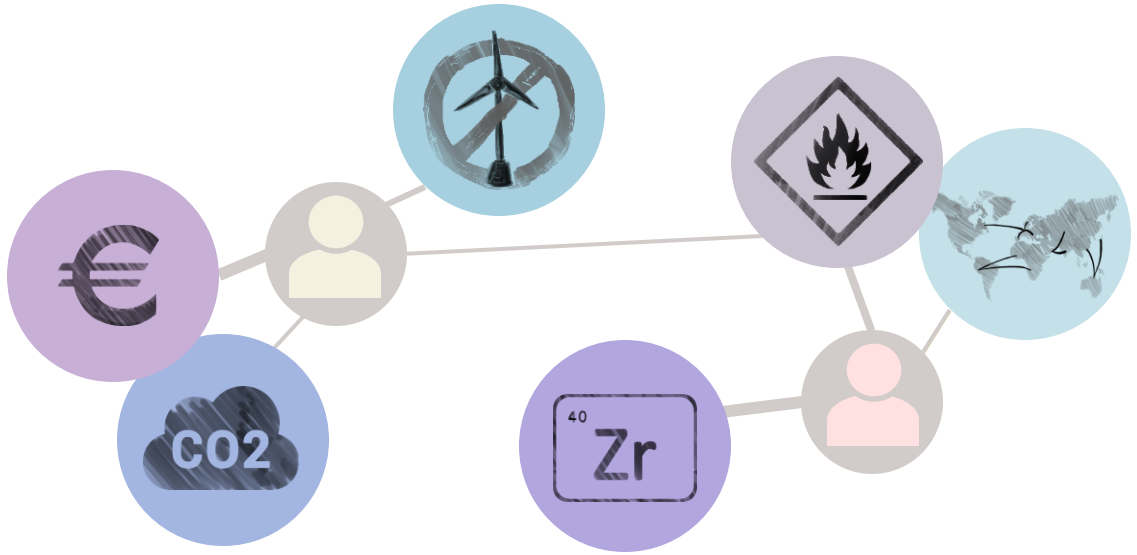


Lombardi, Pickering, Colombo, Pfenninger. *Joule*, 2020. doi.org/gg8z6v

Cost-optimality.
Generalisable shortcomings

Two issues when applied to energy transition planning:

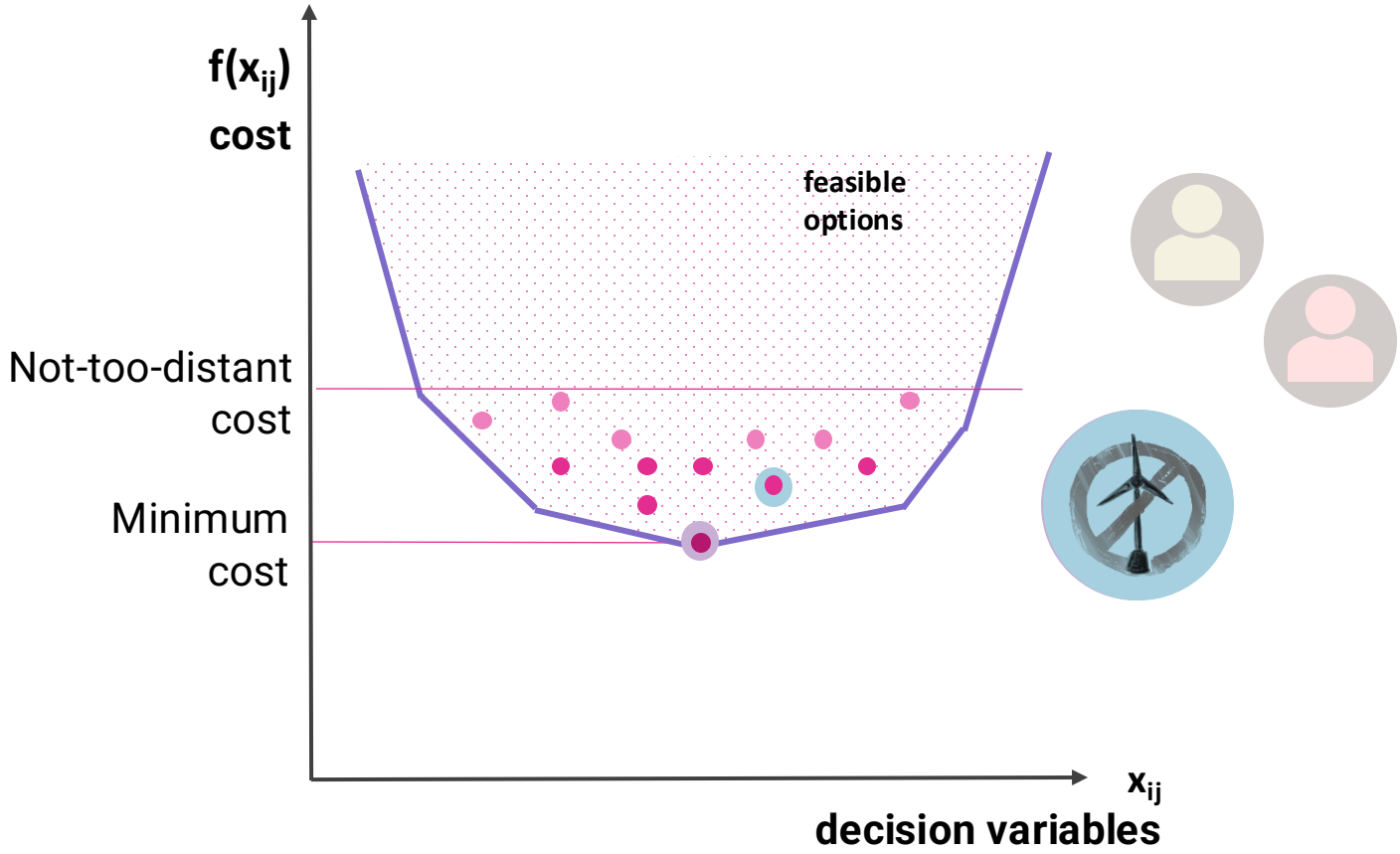
1. Real-world decisions involve much more than economic cost (social acceptance, environmental impact, ...)



Cost-optimality.
Generalisable shortcomings

Two issues when applied to energy transition planning:

2. It is pointless to fixate on the minimum cost considering the uncertainty surrounding all cost assumptions



Cost-optimality.
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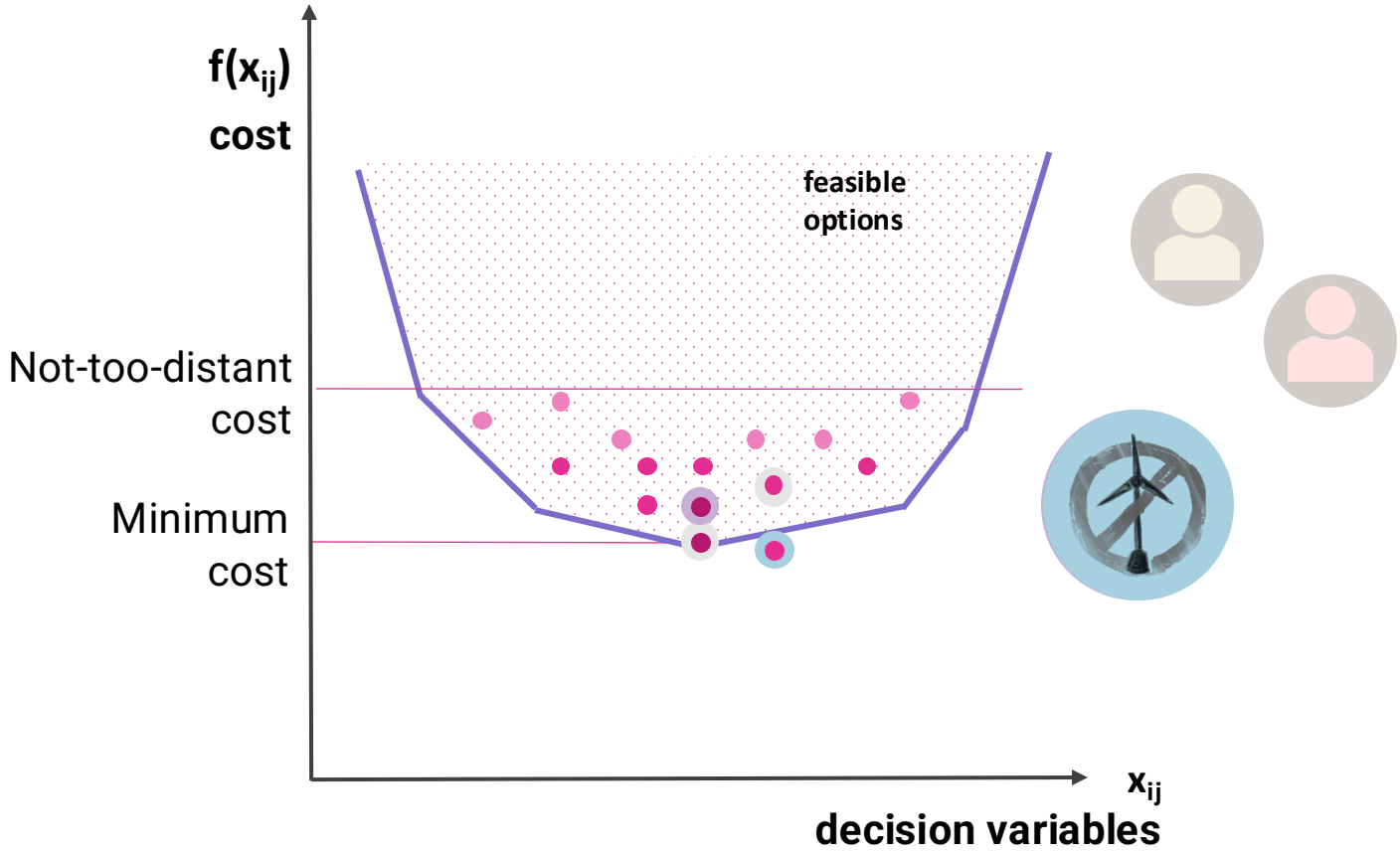
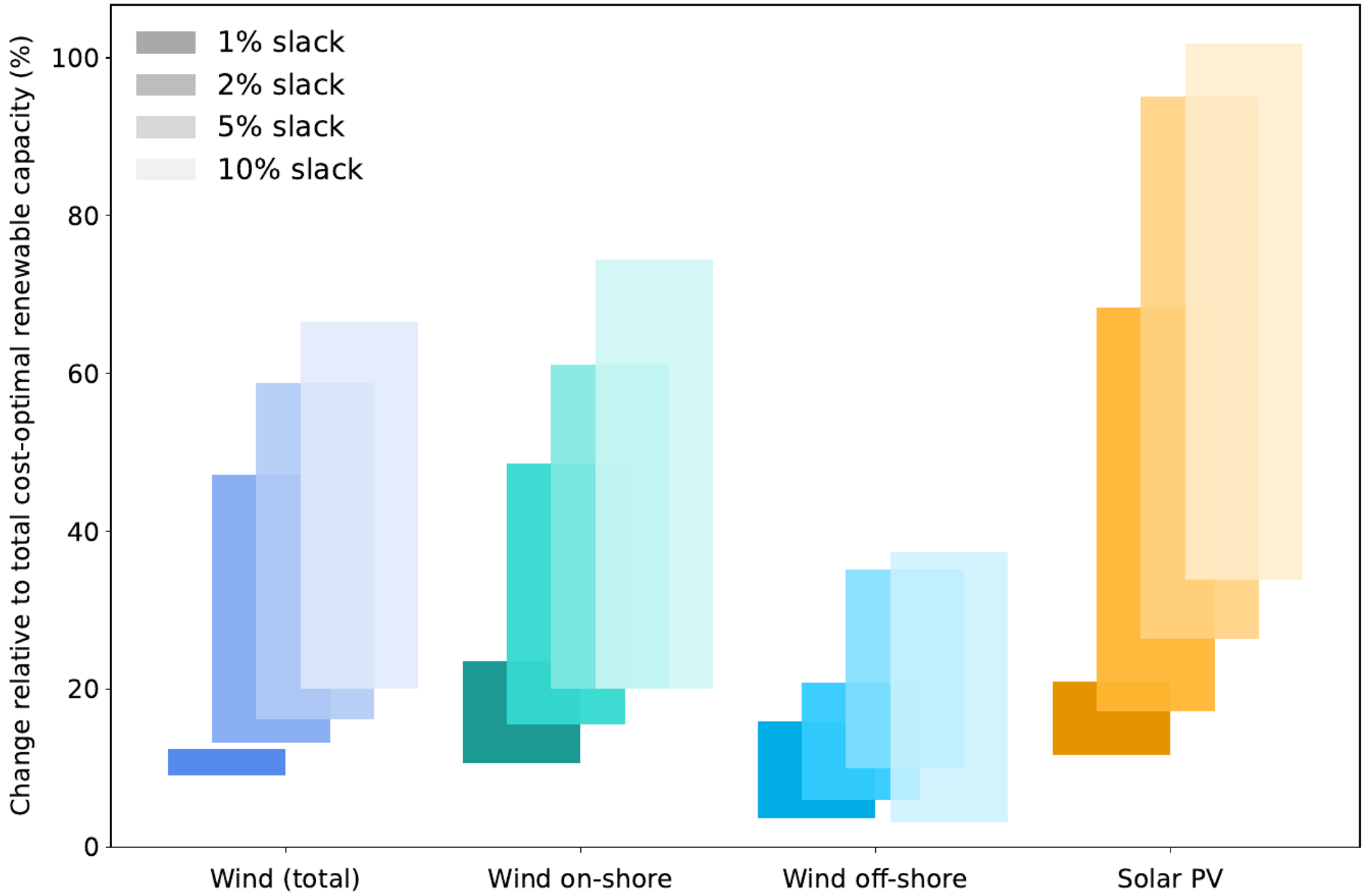
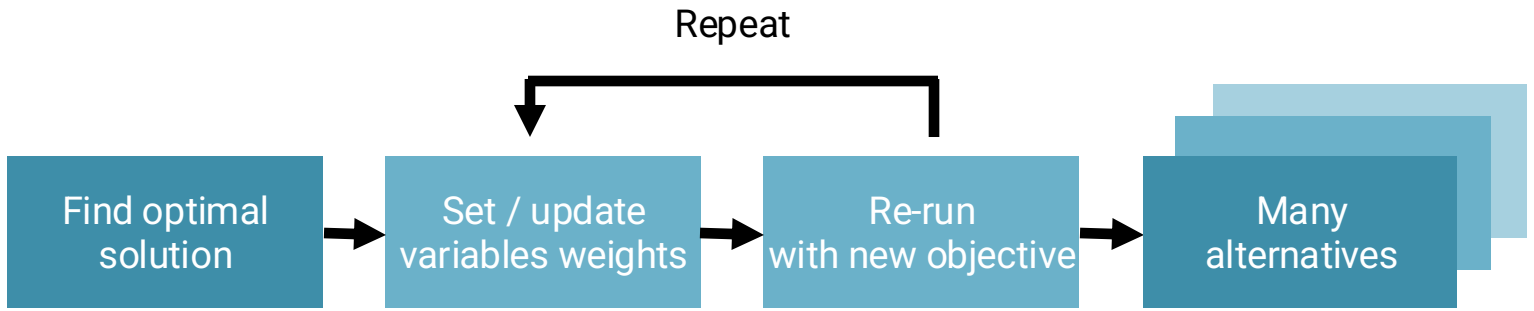




Lombardi, van Greevenbroek, Grochowicz, Lau, Neumann, Patankar, Vågerö. *Joule*, 2025. doi.org/p8b5

Part B.
(Next-generation) Modelling to Generate Alternatives

Modelling to Generate Alternatives.



min *cost*

min *weighted sum of decision variables*

while *cost within n% of optimum*

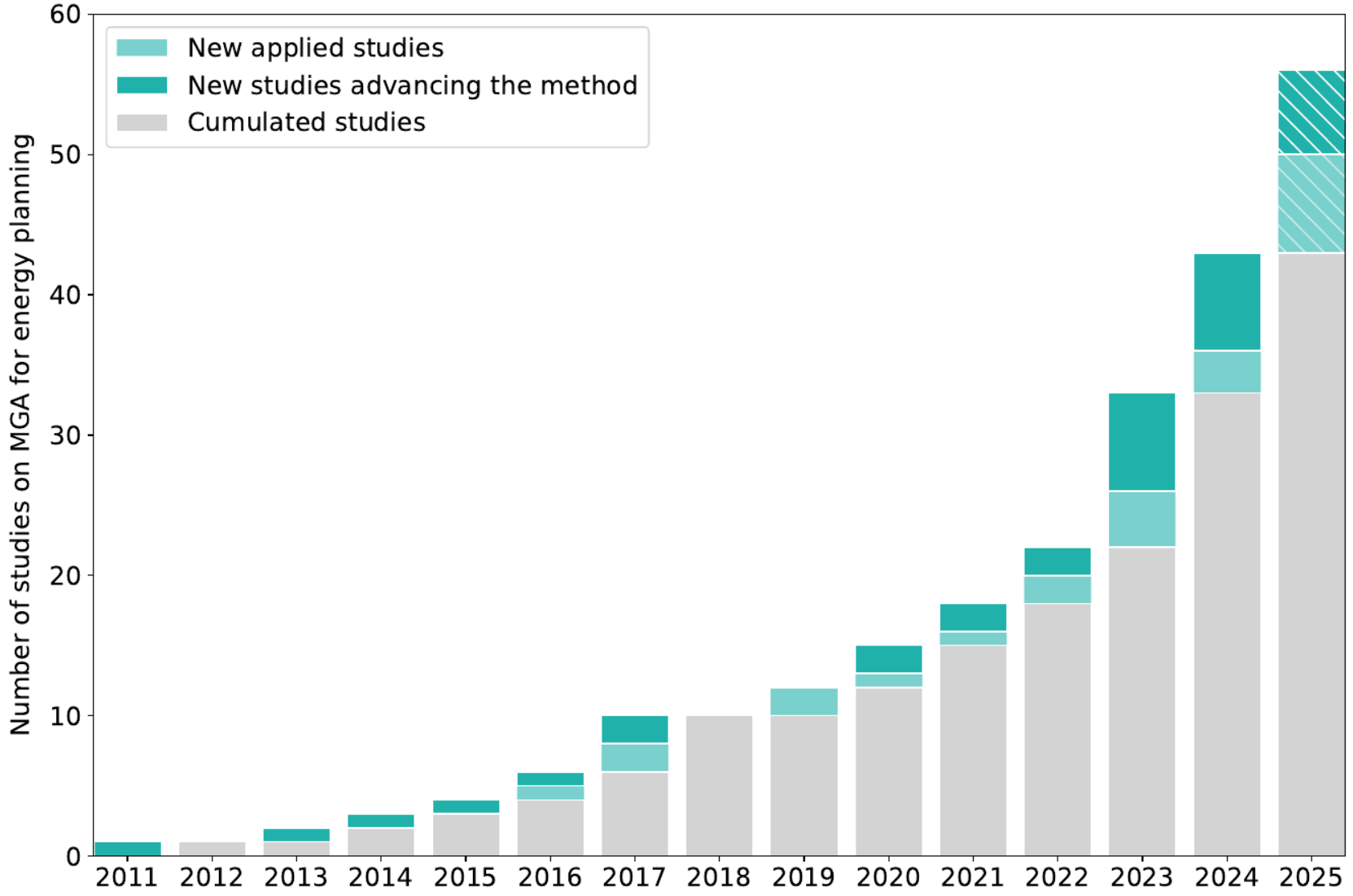
simple brilliant idea, application limited to 'small' models

Equivalent to:

max *difference from previous solutions*

Adapted from: Lombardi, Pickering, Pfenninger. *Applied Energy*, 2023. doi.org/j457

Modelling to Generate Alternatives.



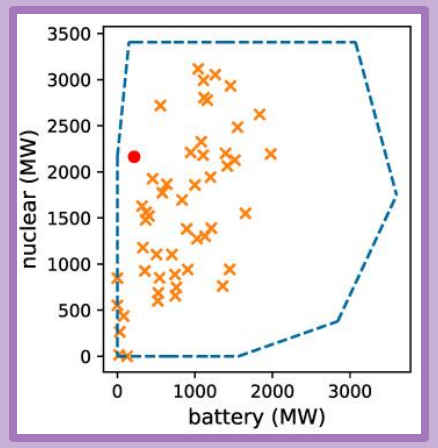
Lombardi, van Greevenbroek, Grochowicz, Lau, Neumann, Patankar, Vågerö. *Joule,* 2025. doi.org/p8b5

Next-gen MGA.

(selected illustrative examples)

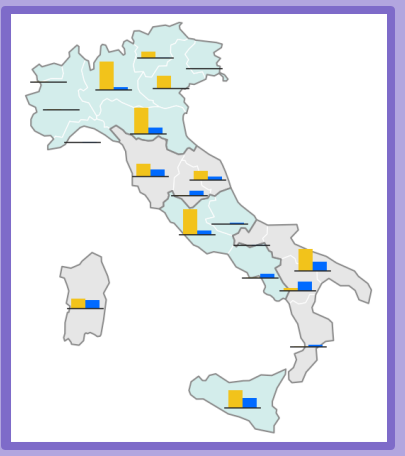
Lau, Patankar, Jenkins. *Env. Res.: Energy*, 2025. doi.org/p8nk

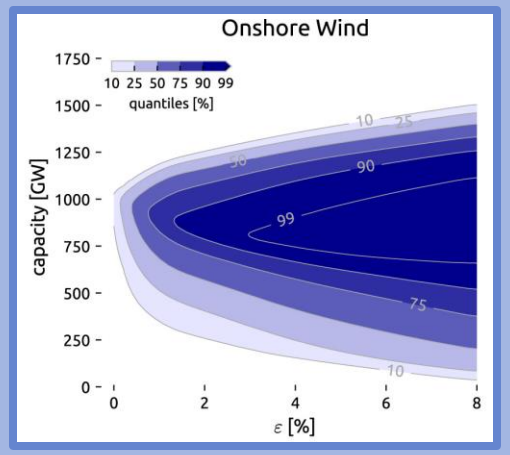
More efficient and robust computation



Lombardi, Pickering, Pfenninger. *App. En.*, 2023. doi.org/j457

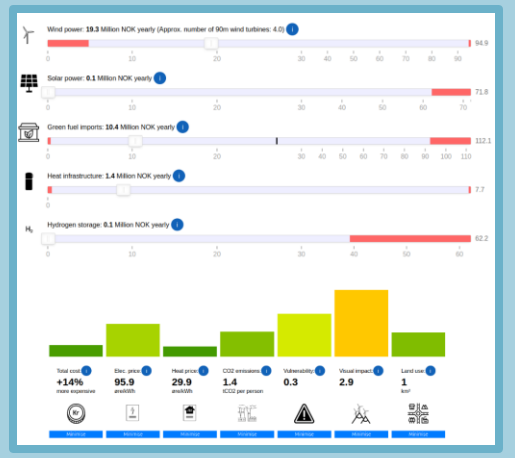
Tailored search for spatial aspects





Integration with parametric uncertainty

Neumann, Brown. *iScience*, 2023. doi.org/g27qjq



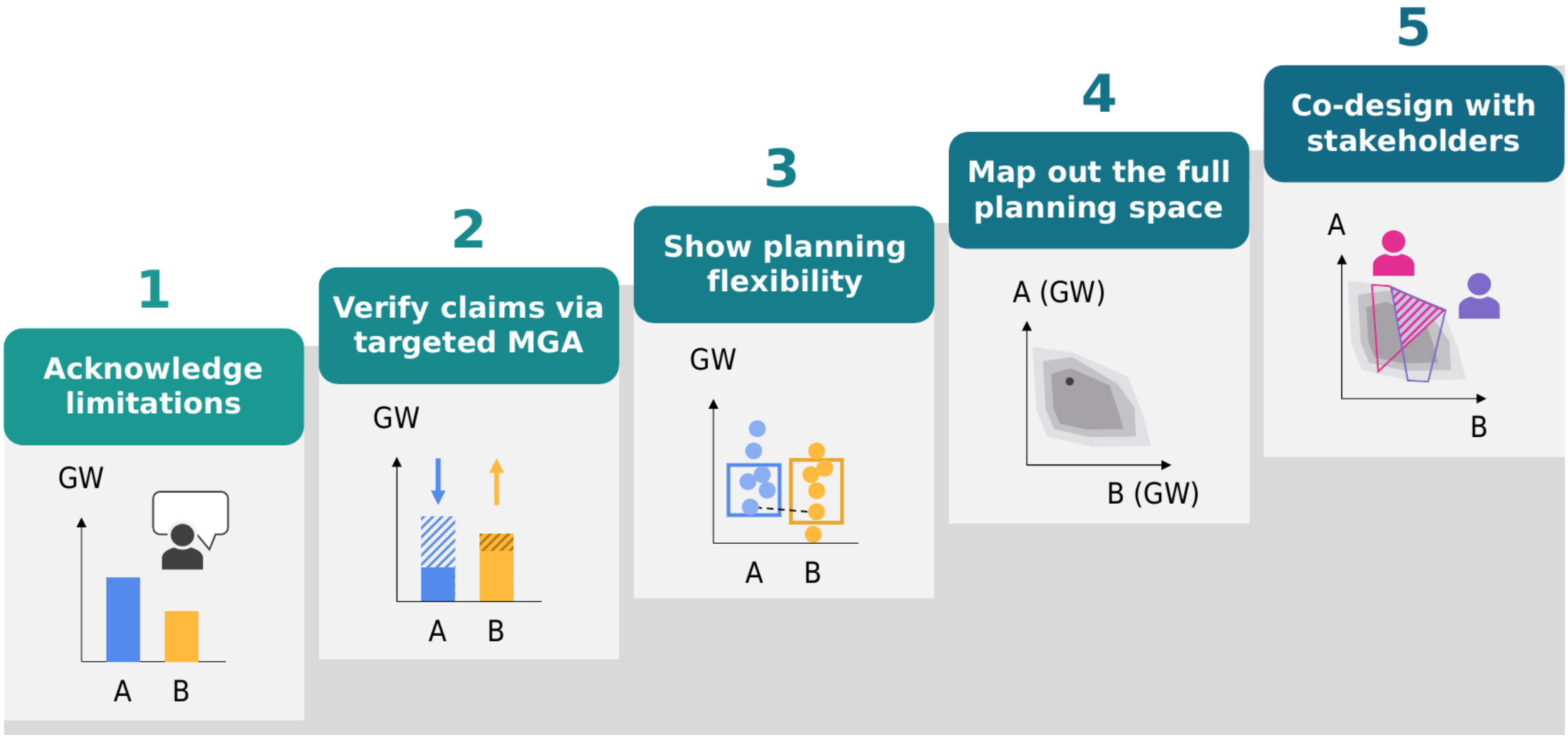
Intuitive and practically applicable outputs

Vågerö, van Greevenbroek, Grochowicz, Roithner. *arXiv*, 2025. doi.org/p8nm

Part C.

Integrate MGA in your analysis in five flexible levels

An MGA integration ladder.



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Cost-optimal planning provides a false sense of exactness

Next-gen MGA enables technically-robust and socially-viable plans

Tailored MGA checks on key insights are simple but very helpful