Modeling LDES in Grid Planning & Operations

Opportunities and Challenges of using AI

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Agenda

- Form Energy
- Formware™
- Challenges of modeling LDES
- How AI (learning-based algorithms in this context) can help?
- AI vs classical optimization methods

Form Energy, Energy Storage For A Better World

2017

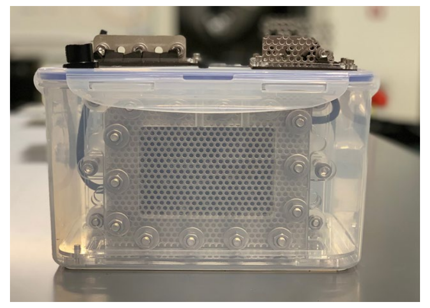
- Form Energy spun out of MIT and founded to address **multi-day energy storage** technology gap

2018

- Iron-air technology selected after exhaustive technology evaluation and downselection effort
- $4M ARPA-E award

2019

- Key iron-air cell performance proof points demonstrated at laboratory scale (~100 cm^2)



2020

- 1.5MW Pilot Project with GRE announced
- $2M CA Energy Commission award
- Large-format testing (>3,000 cm^2)
- Acquired NantEnergy air cathode IP

2021

- $240M Series D, led by ArcelorMittal
- First module (>1m^3) on test

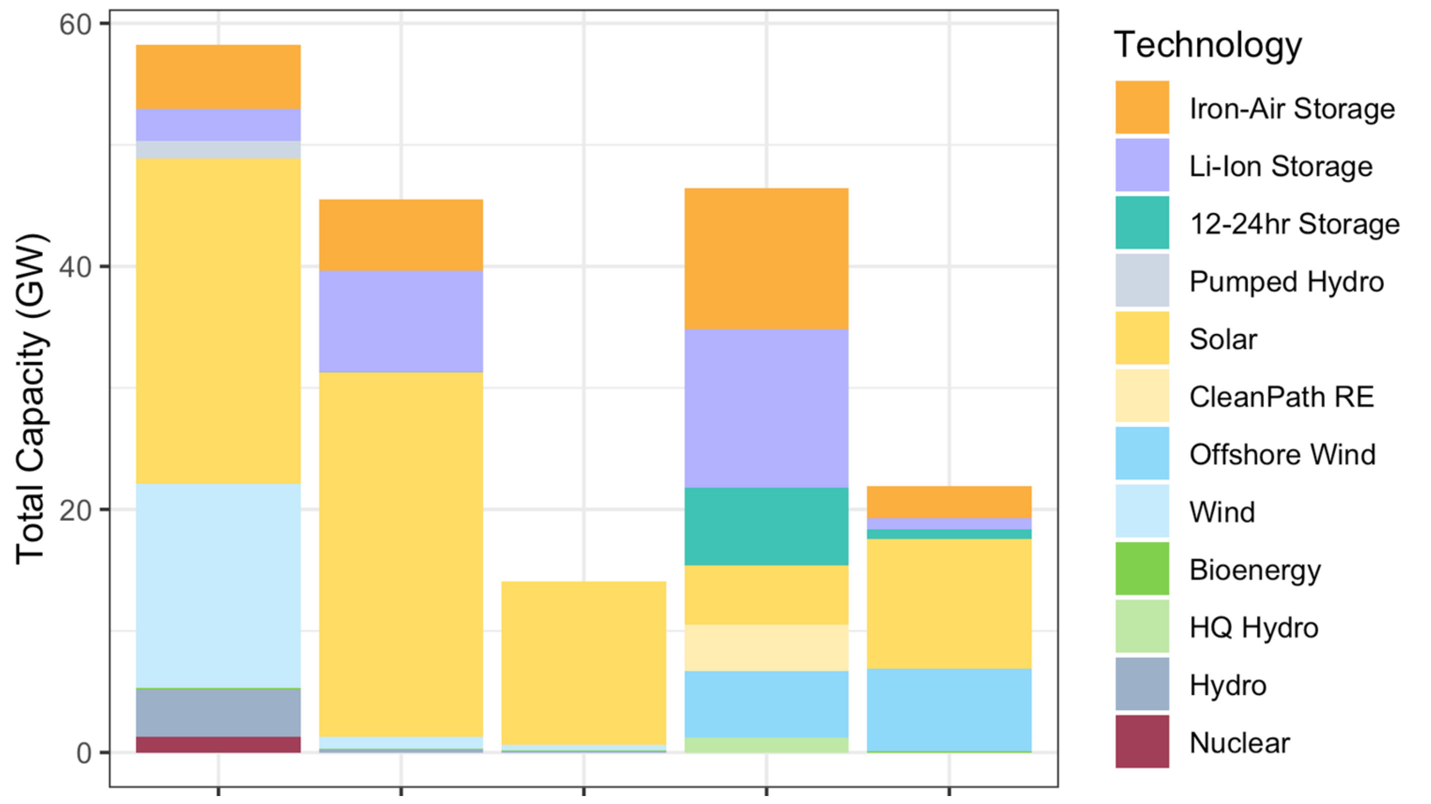
2022

- Up to 15 MW Pilot Project with Georgia Power announced
- $450M Series E, led by TPG Rise
- First multi-module system on test
- 500MW/yr production site selection process initiated

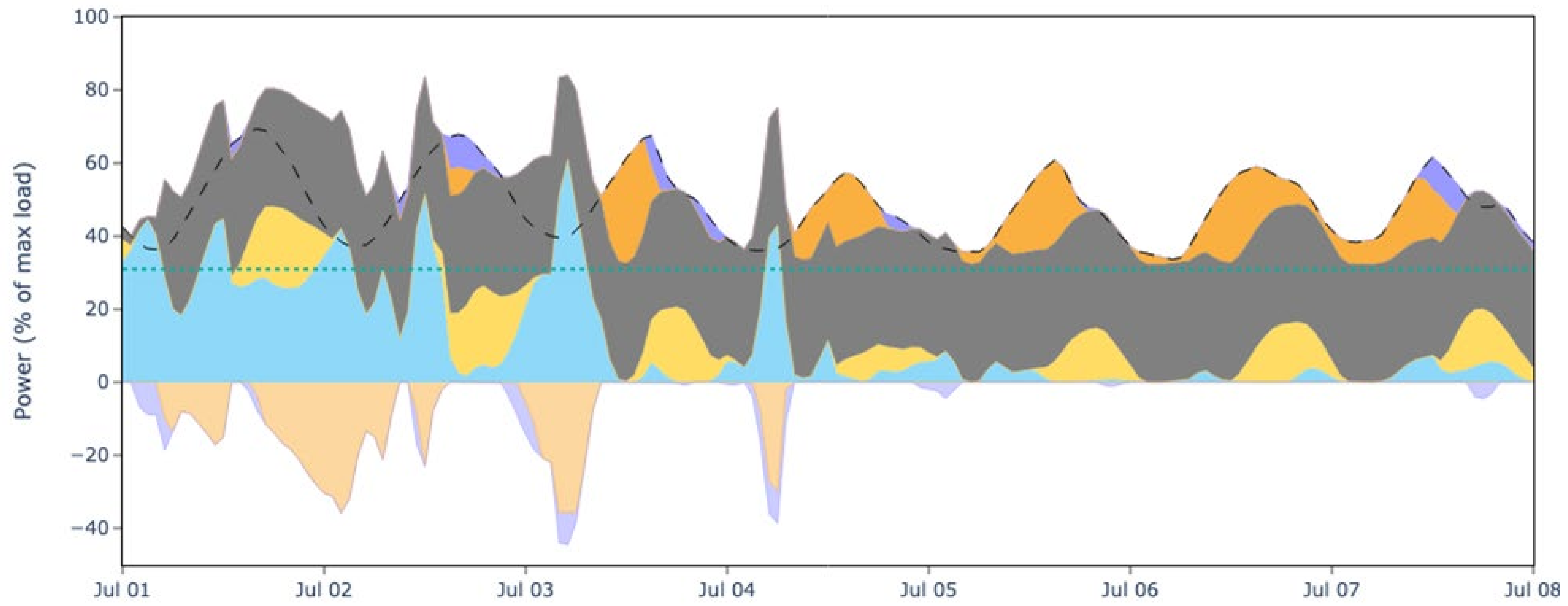
2023

- Broke ground at 500MW/yr Form Factory 1
- Announced projects with Xcel Energy, Dominion Energy & NYSERDA totaling 35 MW

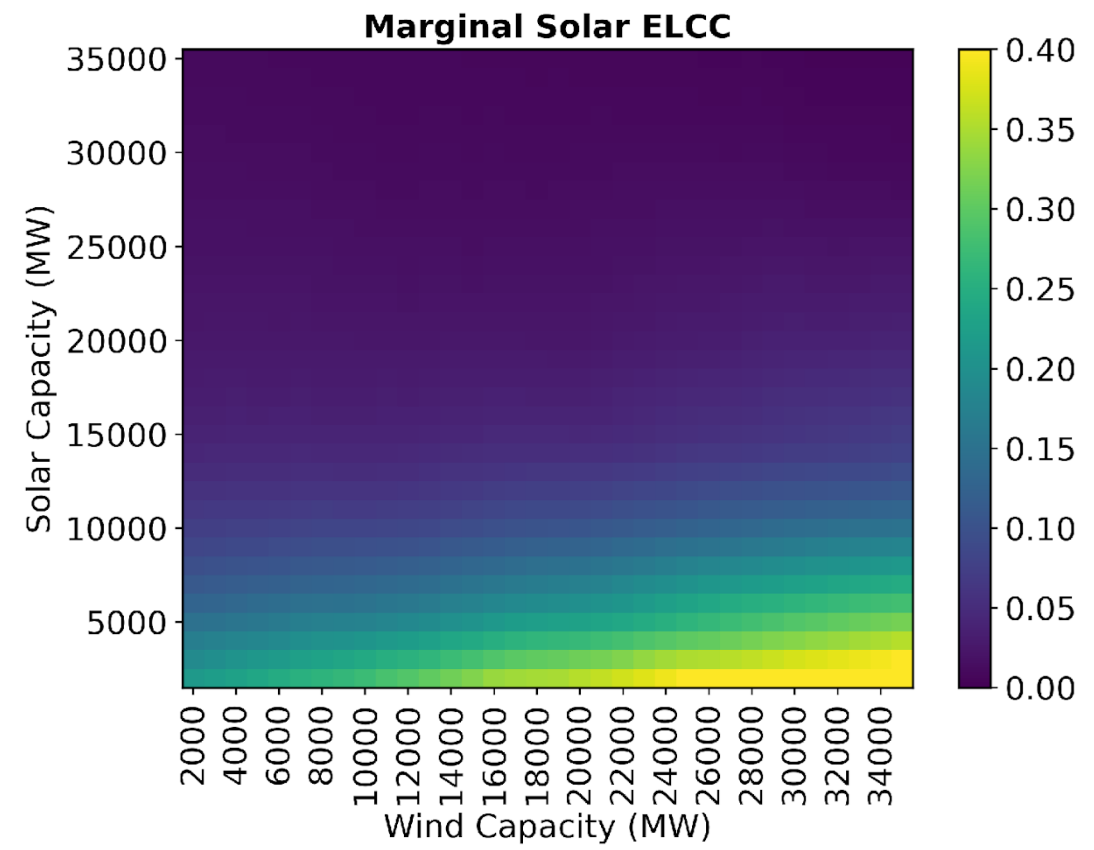
Formware™, Form's Grid Modeling Software



Capacity Expansion
What should I build?



Unit Commitment & Economic Dispatch
How should I operate it?

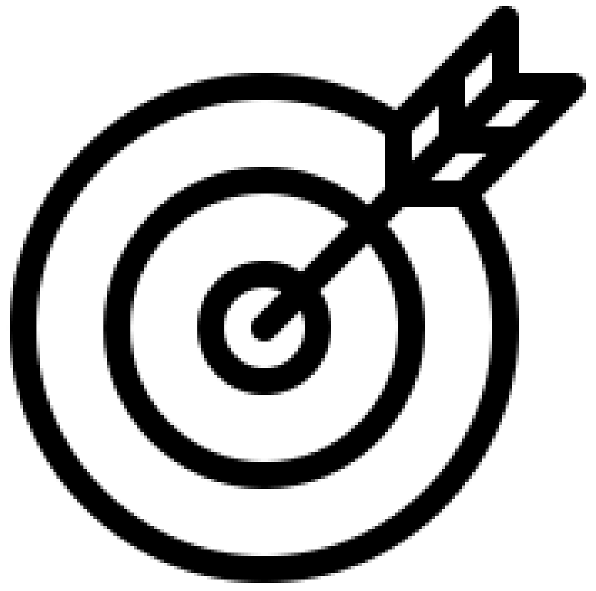


Reliability & Adequacy
How reliable is it?

Formware Differentiators From Competitors

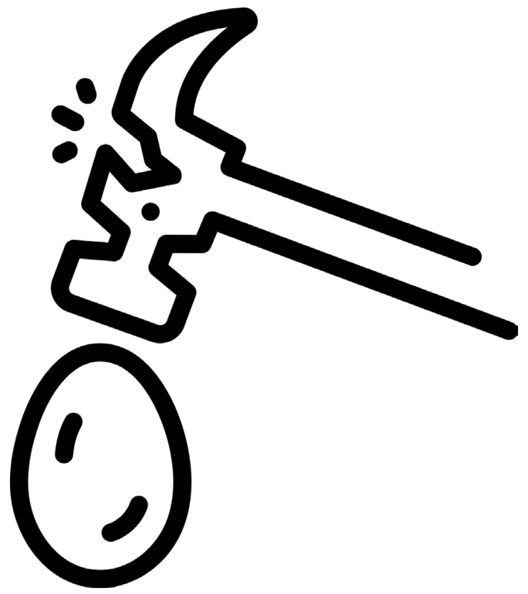
- **Granularity:** hourly ("8760") capacity expansion blends traditional resource expansion & operational models
- **Rich data:** exhaustive demand, generation, commodities, and transmission data driven by weather fundamentals
- **Multi-Scenario Co-Optimization:** co-optimization across weather and grid conditions ensures robust outcomes
- **Technology-Inclusivity:** captures all emerging technologies, including detailed representation of Form technology

Challenges of modeling LDES (and the grid)



Accuracy

- High fidelity asset models
- System constraints



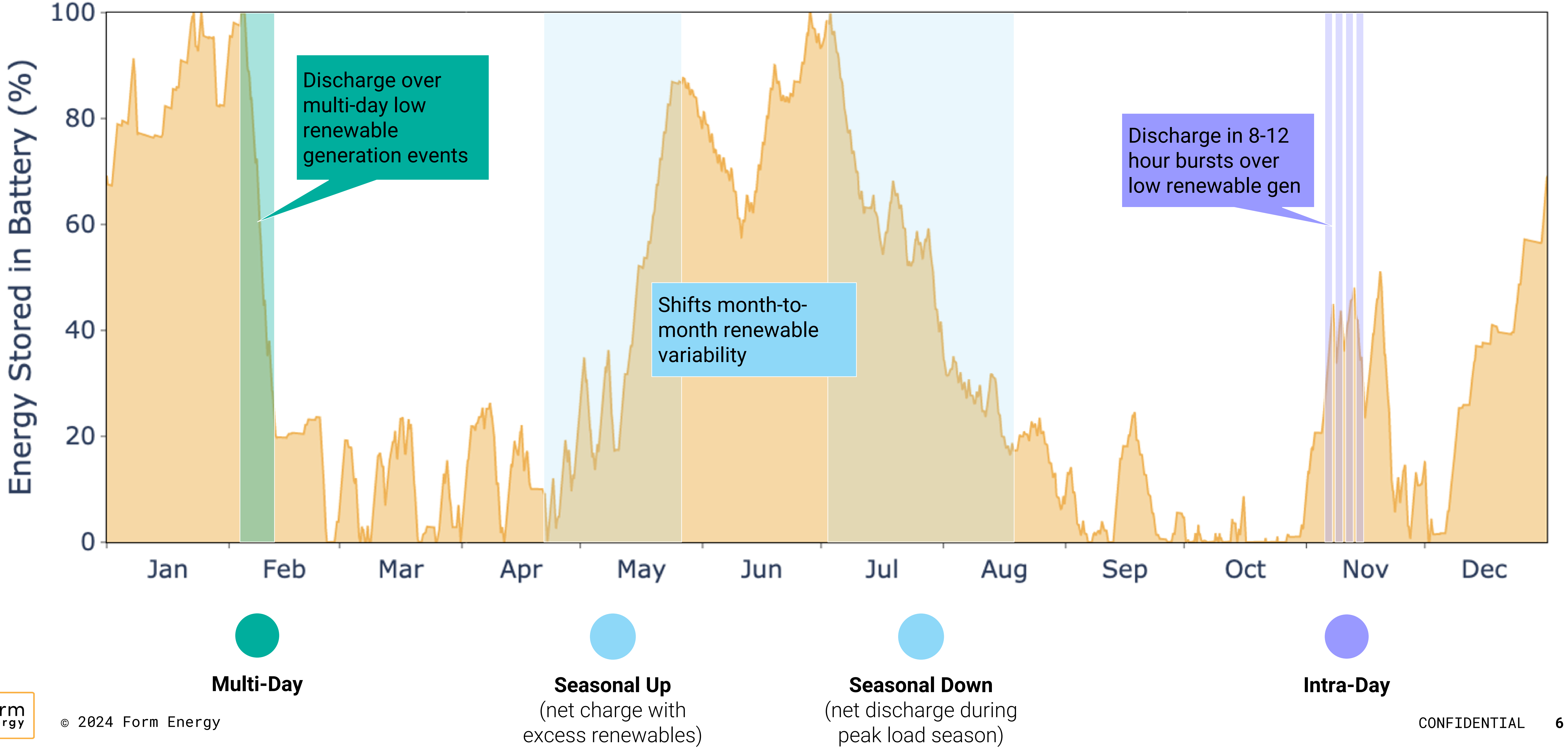
Robustness

- High temporal resolution
- High system granularity

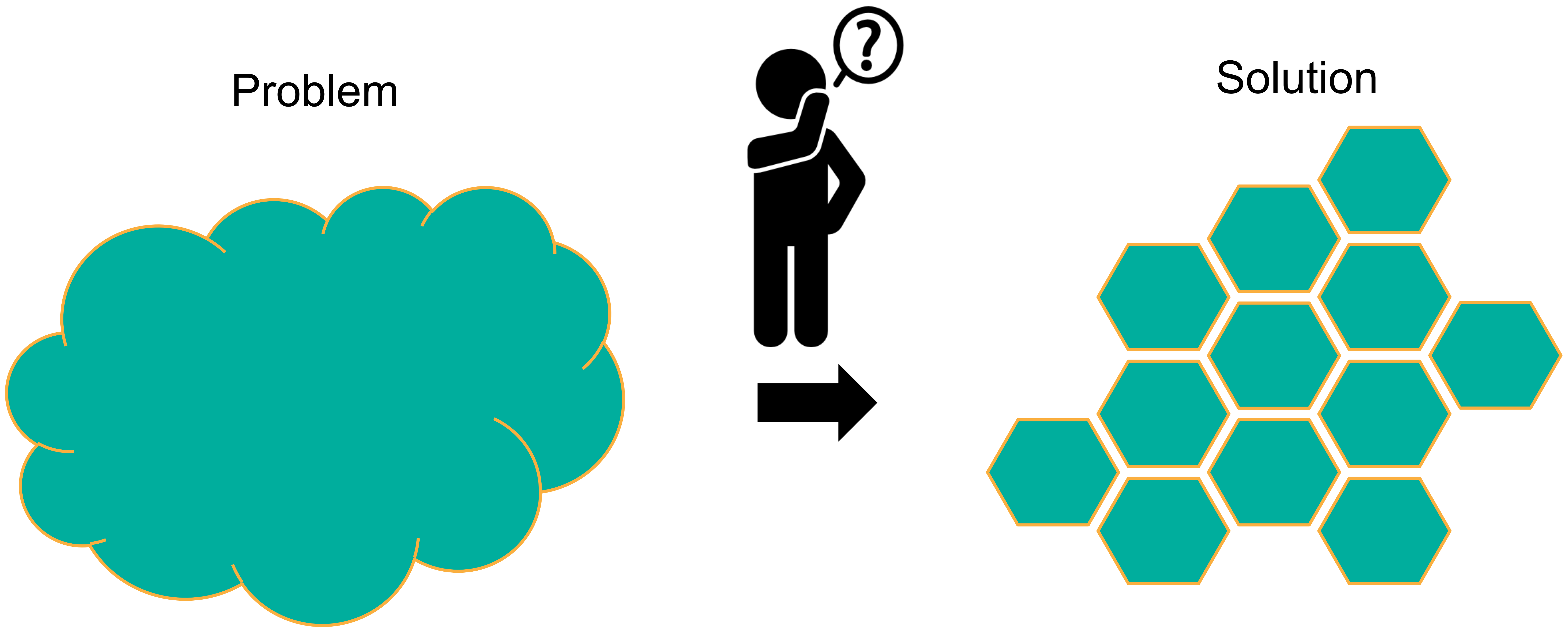
Reliability

- Multi-weather year reliability co-optimization
- Multi-investment year planning

LDES operates year-round to balance seasonal, multi-day, and intra-day variability in renewables



How AI can help?



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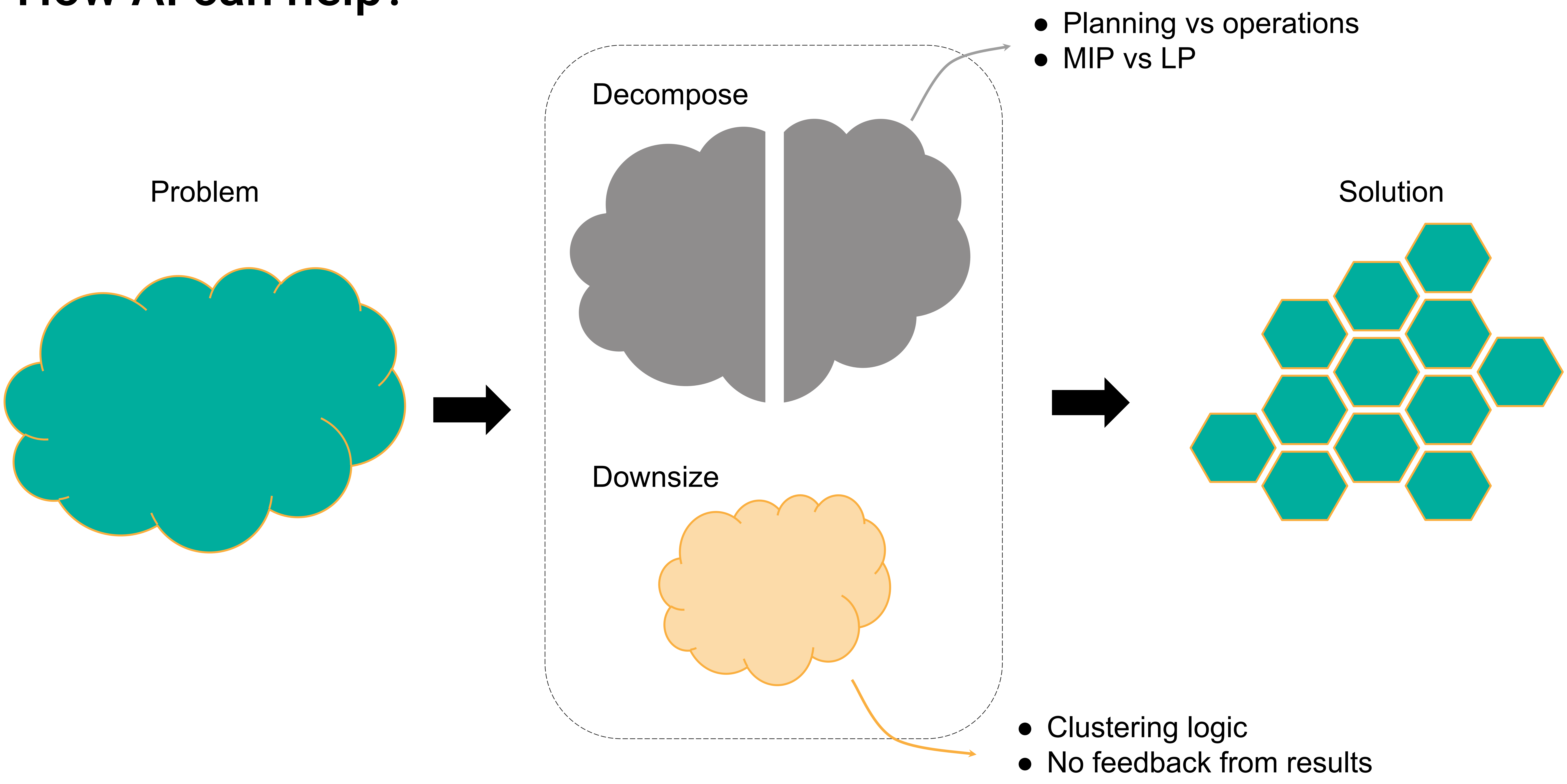

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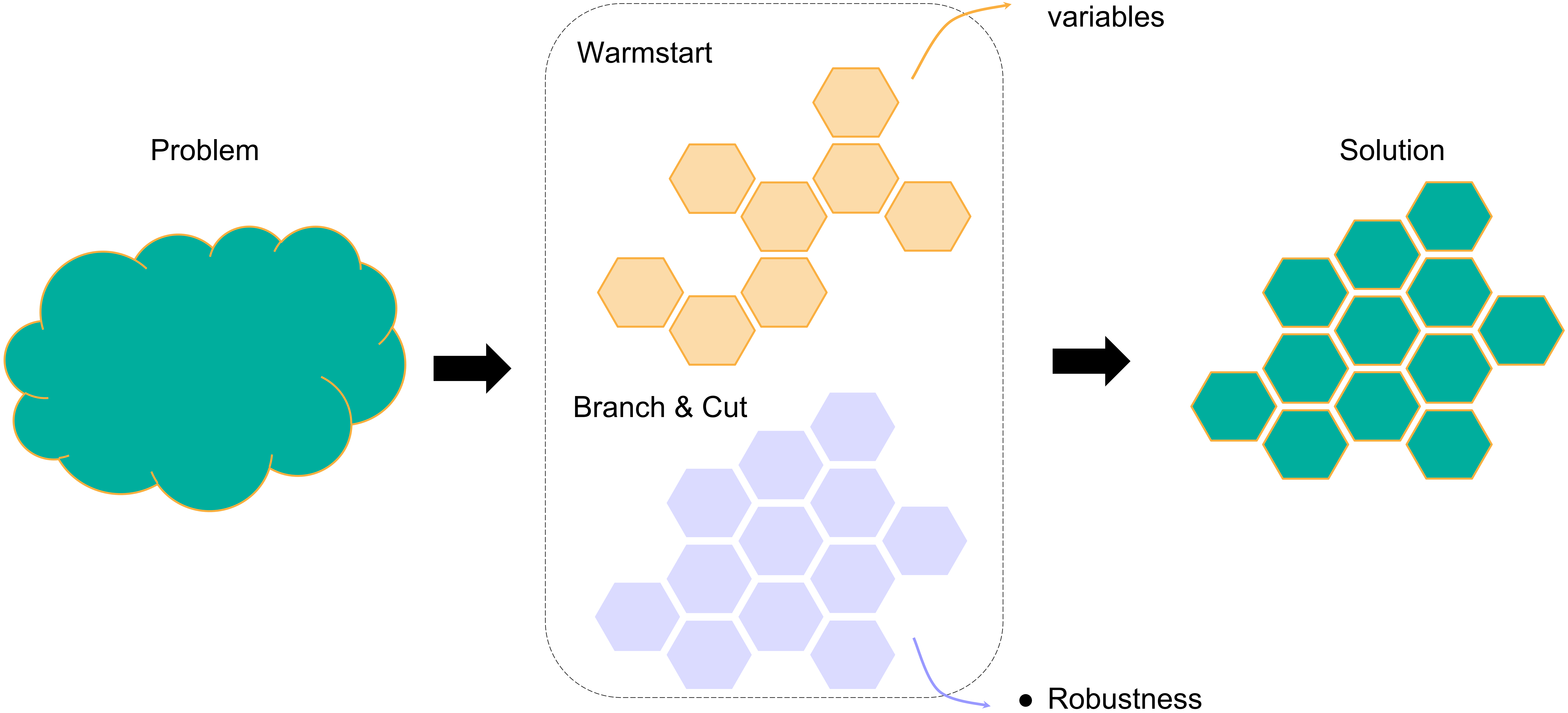
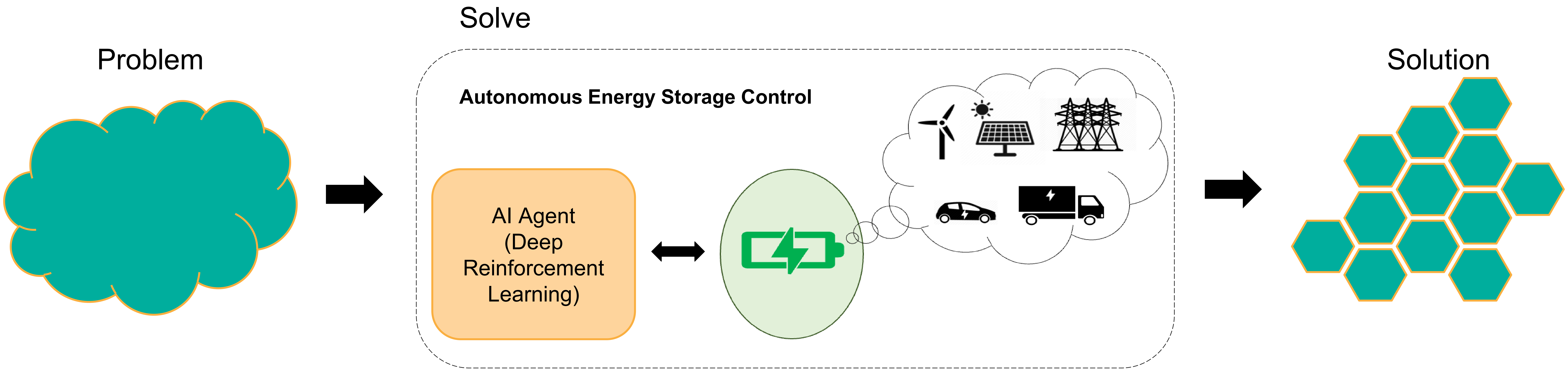


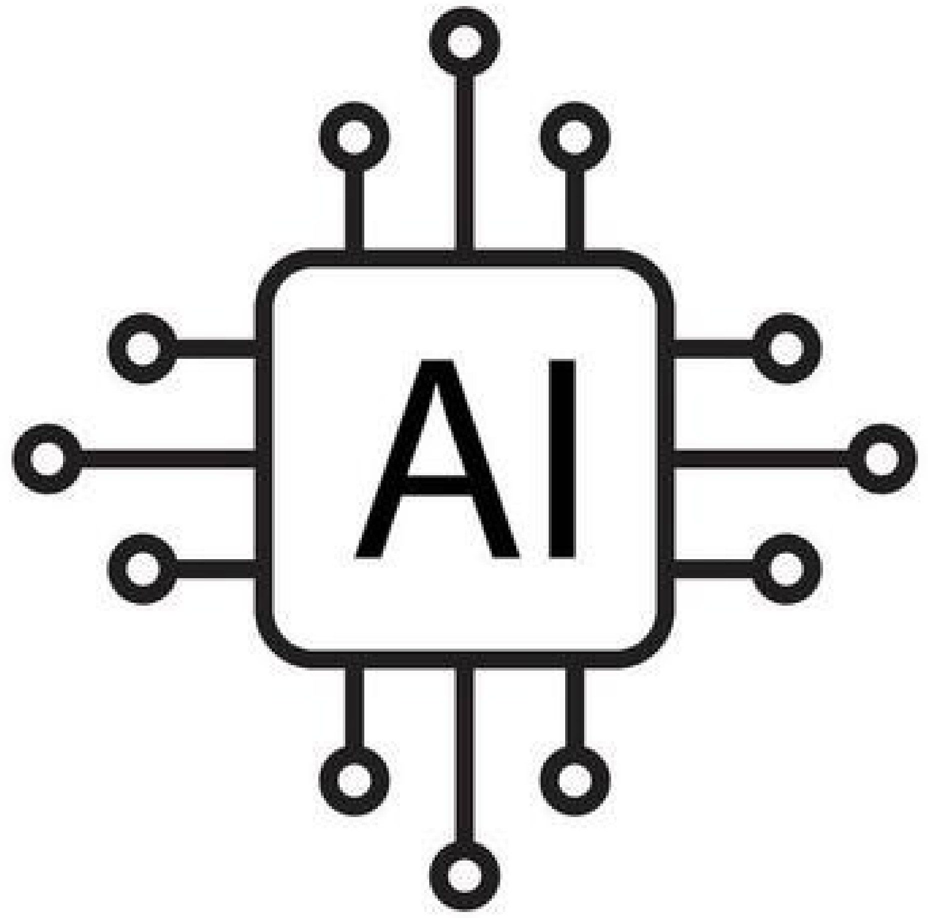
- Training data vs number of variables
- Robustness

How AI can help?



AI vs classical optimization methods

- Confidence in success
  - *Resources vs results / odds vs payout*
  - *AI is not the sure bet but a lucrative one!*
- Accuracy
  - *Achieving global optima with LP / MILP vs AI*
- Training requirement
  - *Availability and richness of database*
- Data security
  - *In-house vs off-the-shelf AI tools*



Thank You!

Let’s stay in touch!

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