KISTERS

Empowering decisions of tomorrow

Multi-criteria MILP optimization as an important contribution to the heating transition

Dominik Funken
Senior Product Owner
KISTERS AG, Germany

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/Agenda

1. Brief introduction
2. Why multi-criteria optimization?
3. Demo Video
4. Conclusion

My résumé

- **RWTH Aachen University (2009-2013)**
  - Study of mechanical engineering, graduation: B.Sc.

- **RWTH Aachen University (2013-2015)**
  - Study of energy techniques, graduation: M.Sc.

- **KISTERS AG** 2015-2020
  - Consultant for optimization projects
    - specialist for virtual power plants and district heating optimization

- **KISTERS AG since** 2020
  - Product Owner BelVis ResOpt (Ressource Optimization)

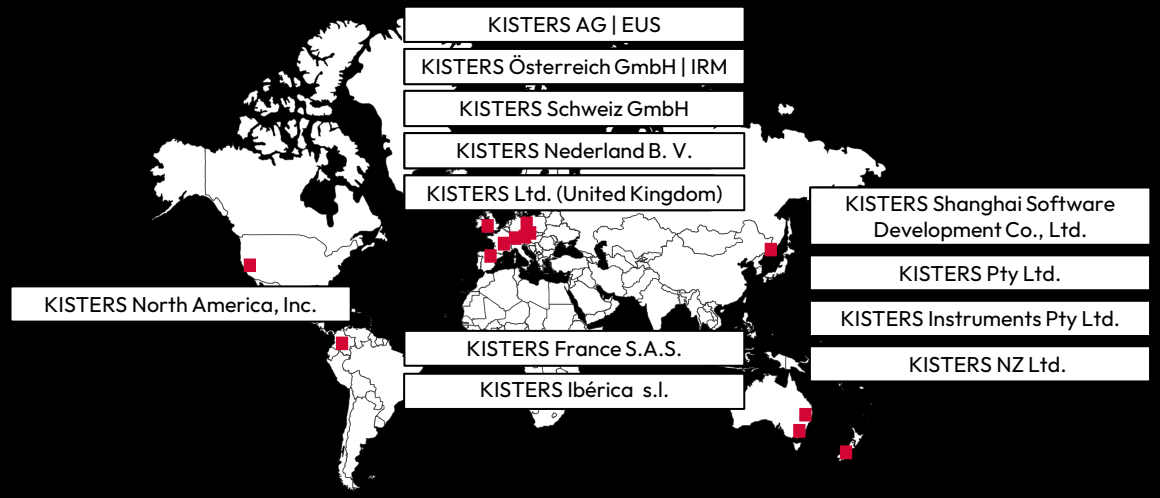
Dominik Funken

Senior Product Owner
BelVis ResOpt

Questions will be answered at the end in the Q&A session

/KISTERS at a glance

The KISTERS Group



A strong customer base

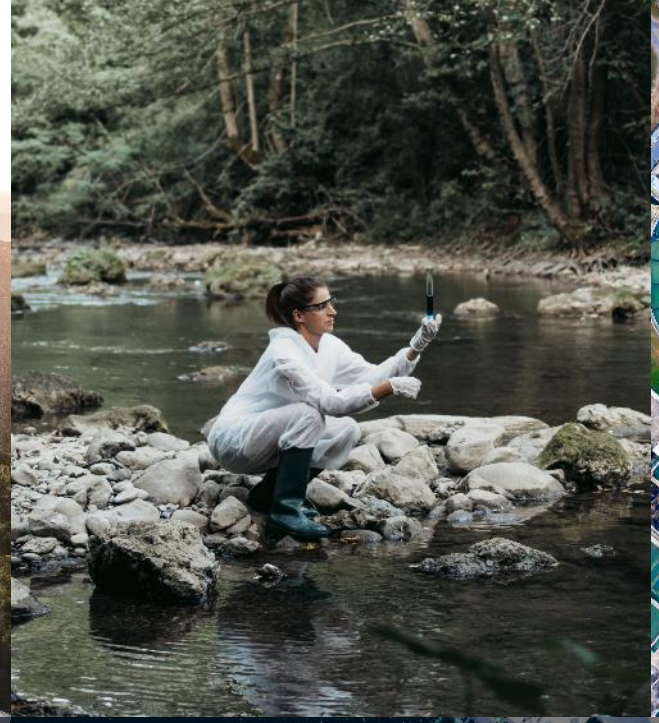
Business Units

- Energy
- Occupational Safety & Environmental Protection
- Environmental Consulting
- HydroMet
- 2D / 3D Printers & Scanners
- 3D Visualisation

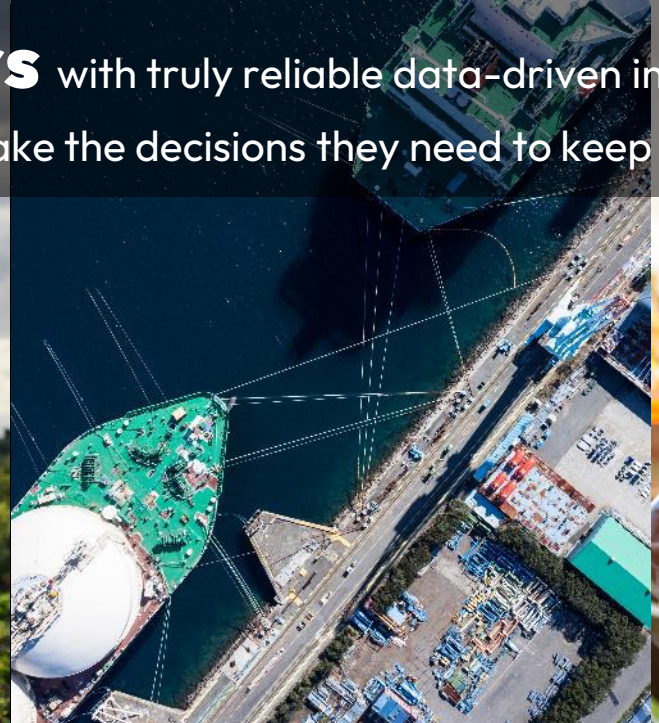
Corporate figures

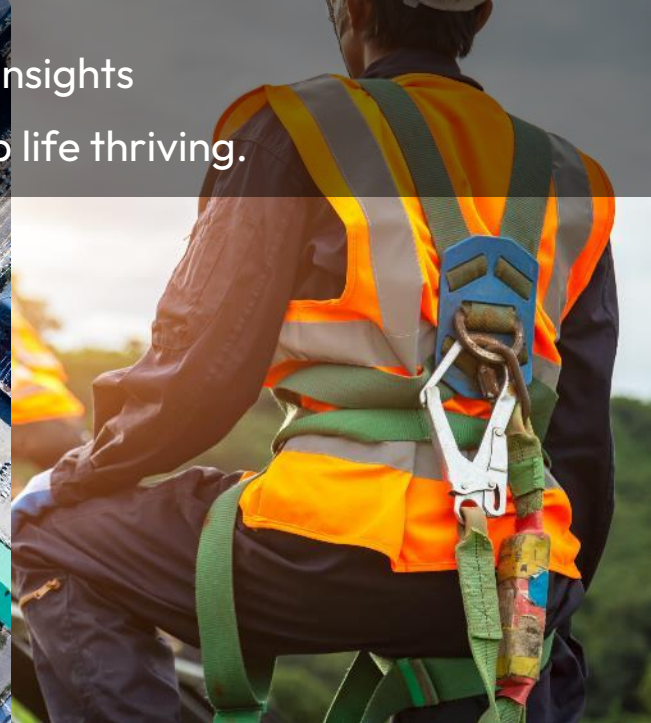
Key figures	2021
Number of permanent employees	700
Number of subsidiaries	13
Revenue in million euros	80

Our passion.



We **empower customers** with truly reliable data-driven insights and technology they can trust to help them make the decisions they need to keep life thriving.





Optimization with BelVis ResOpt

Assets (Water, Heat, Power, …)

Markets

Flexibility Optimization

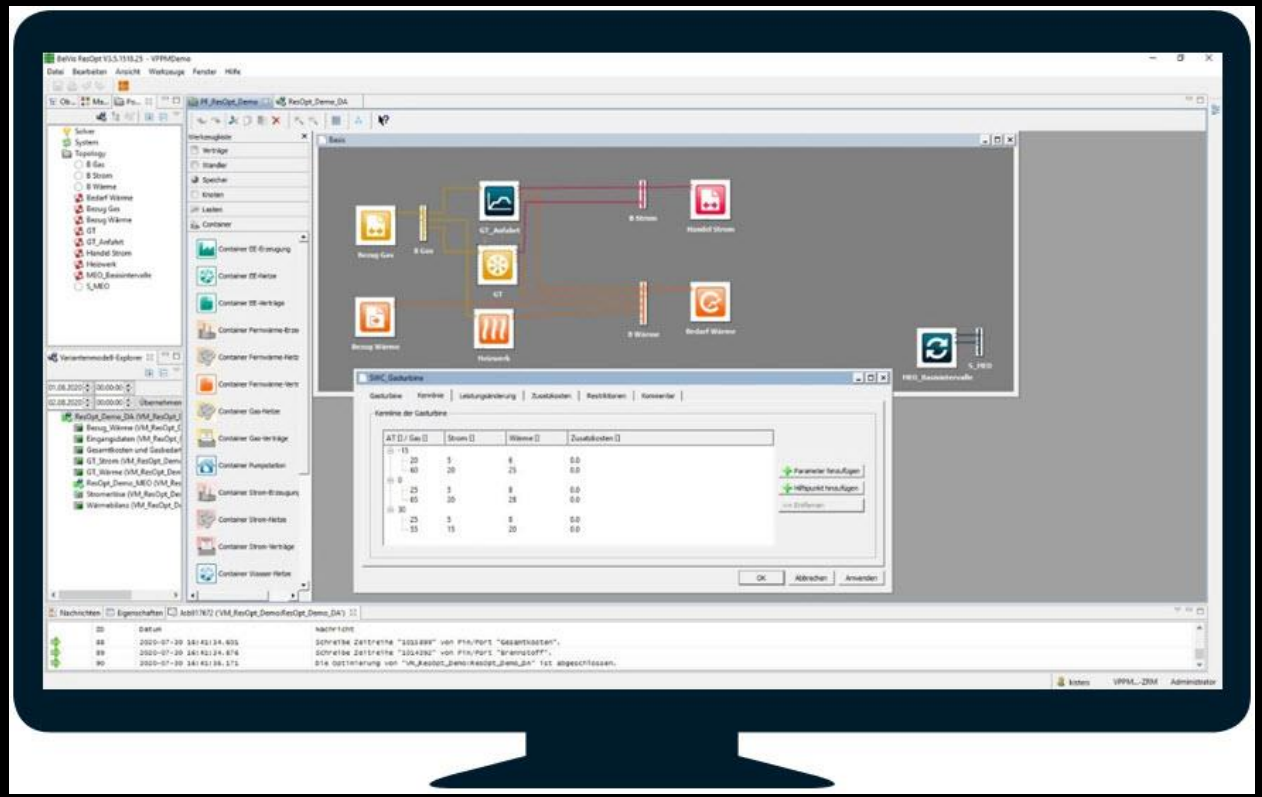
Industry

Renewable & Storages

Bildquellen: www.resoptde

BelVis ResOpt

- **Graphical** model editor
- Component library for **any resource** streams (individually extendable)
- **Cross-market** optimization
- **Flow temperature** optimization
- Multi-criteria optimization (costs, CO2)
- Powerful **variant models** integrated
- **Automation** of business processes with extensive workflow functions
- Proven **time series management** BelVis included



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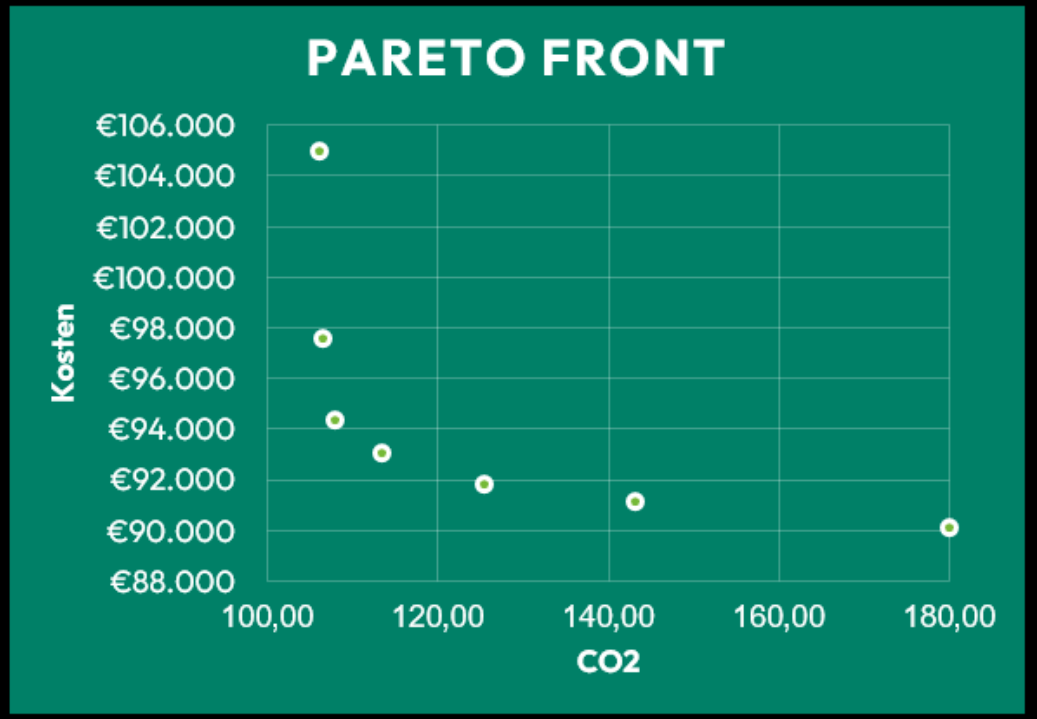
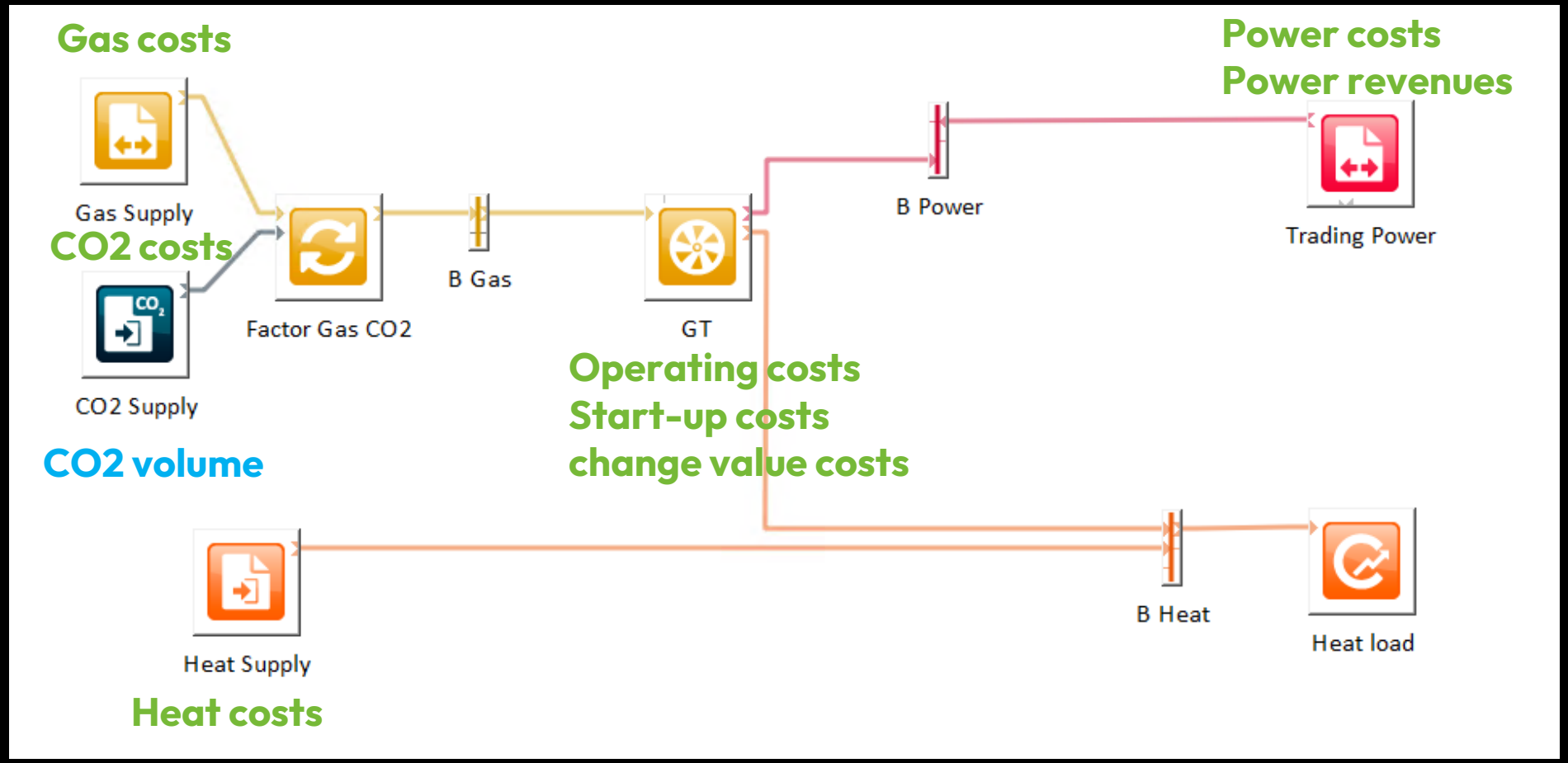
Multicriteria optimization

Consideration of more than one variable to be minimized



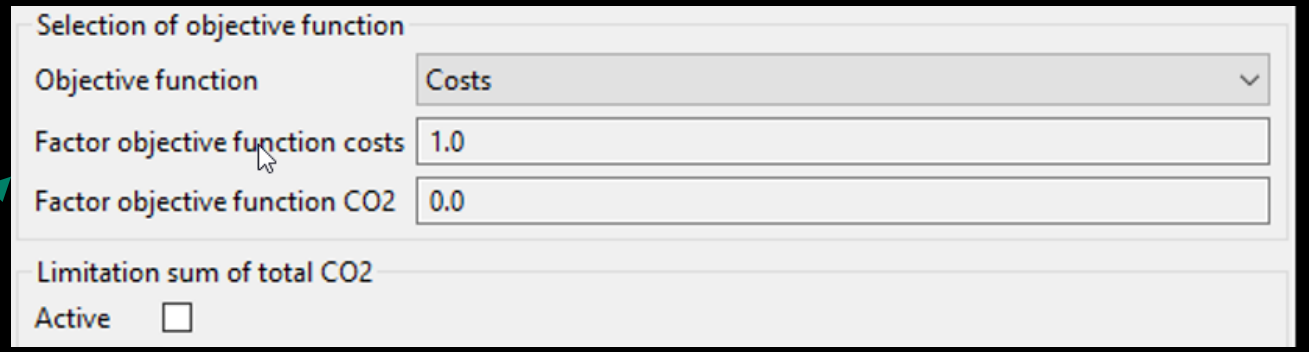
Demo MILP model

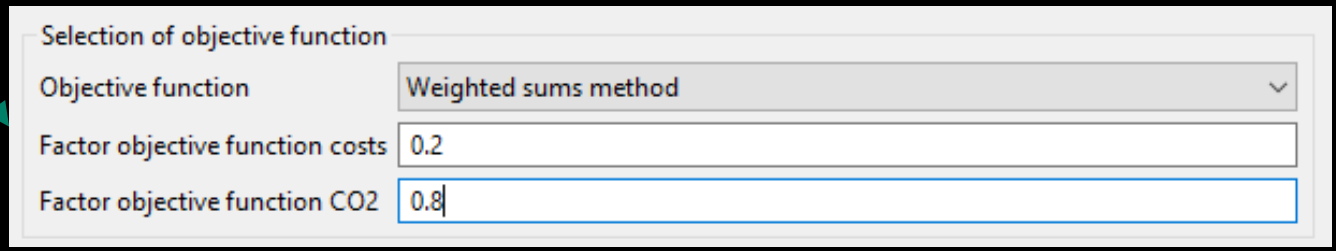


Objective function

Multi-criteria optimization

Objective function
- Costs
- CO2
- Weighted sums method

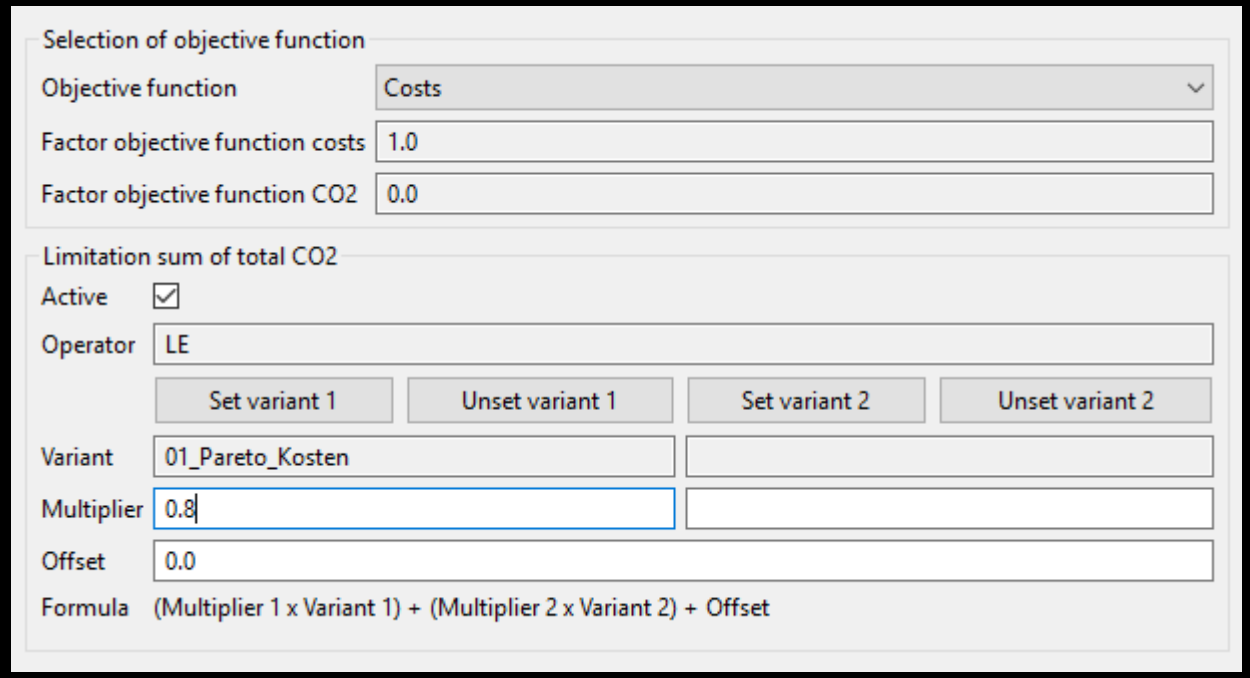




Limit objective function

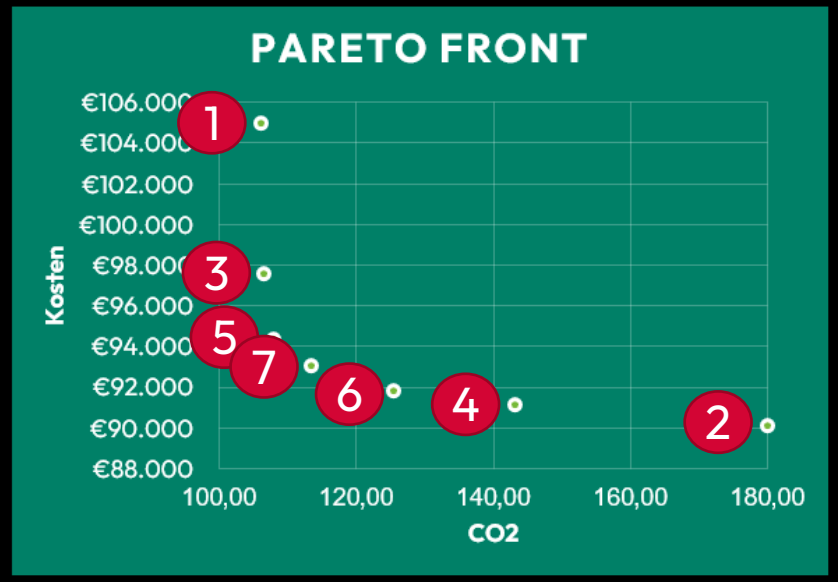
What are the minimum costs for 80% CO2 reduction

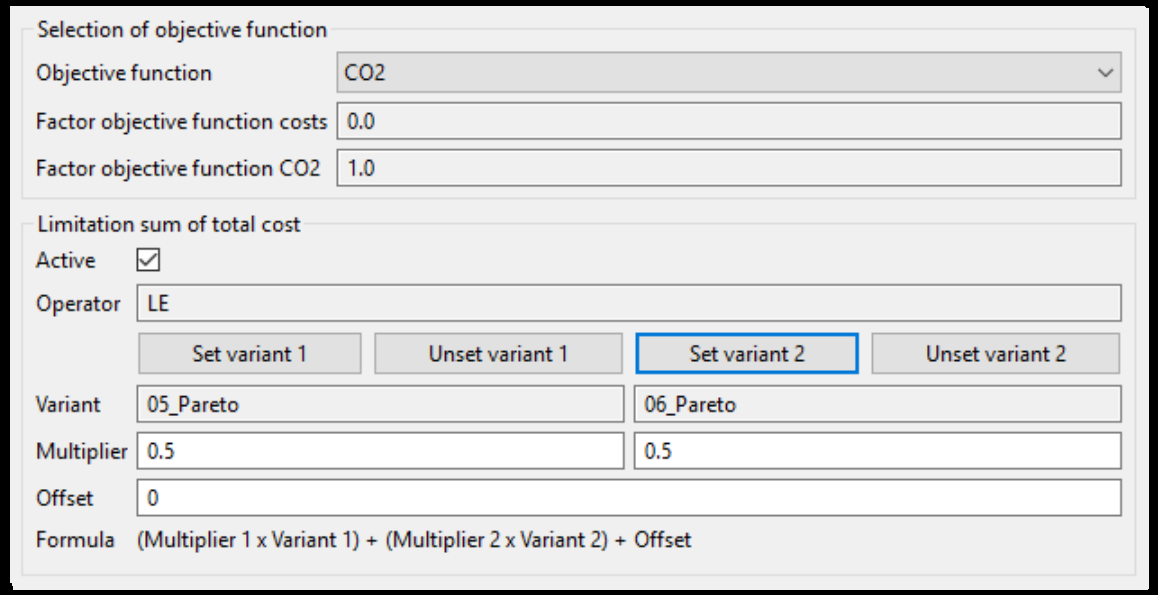
→ How much does a 20% reduction in CO2 cost?



Pareto Front

1. CO2-Minimal
2. costs-Minimal
3. CO2-Minimal
   1. $costs \leq 50\% * Variante_1 + 50\% * Variante_2$
4. costs-Minimal
   1. $CO_2 \leq 50\% * Variante_1 + 50\% * Variante_2$
5. CO2-Minimal
   1. $costs \leq 50\% * Variante_3 + 50\% * Variante_4$
6. costs-Minimal
   1. $CO_2 \leq 50\% * Variante_4 + 50\% * Variante_4$
7. CO2-Minimal
   1. $costs \leq 50\% * Variante_5 + 50\% * Variante_6$





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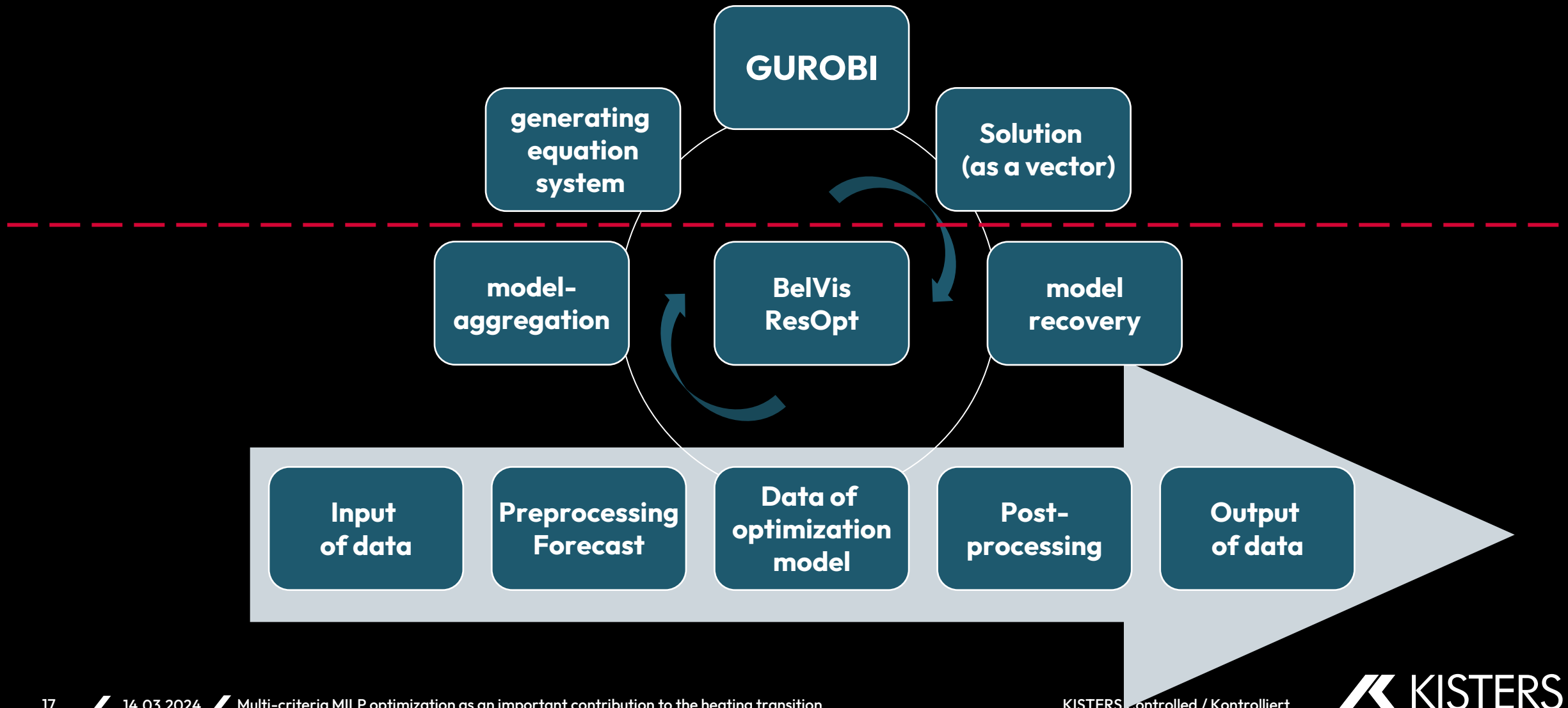
BelVis ResOpt: Automated optimization



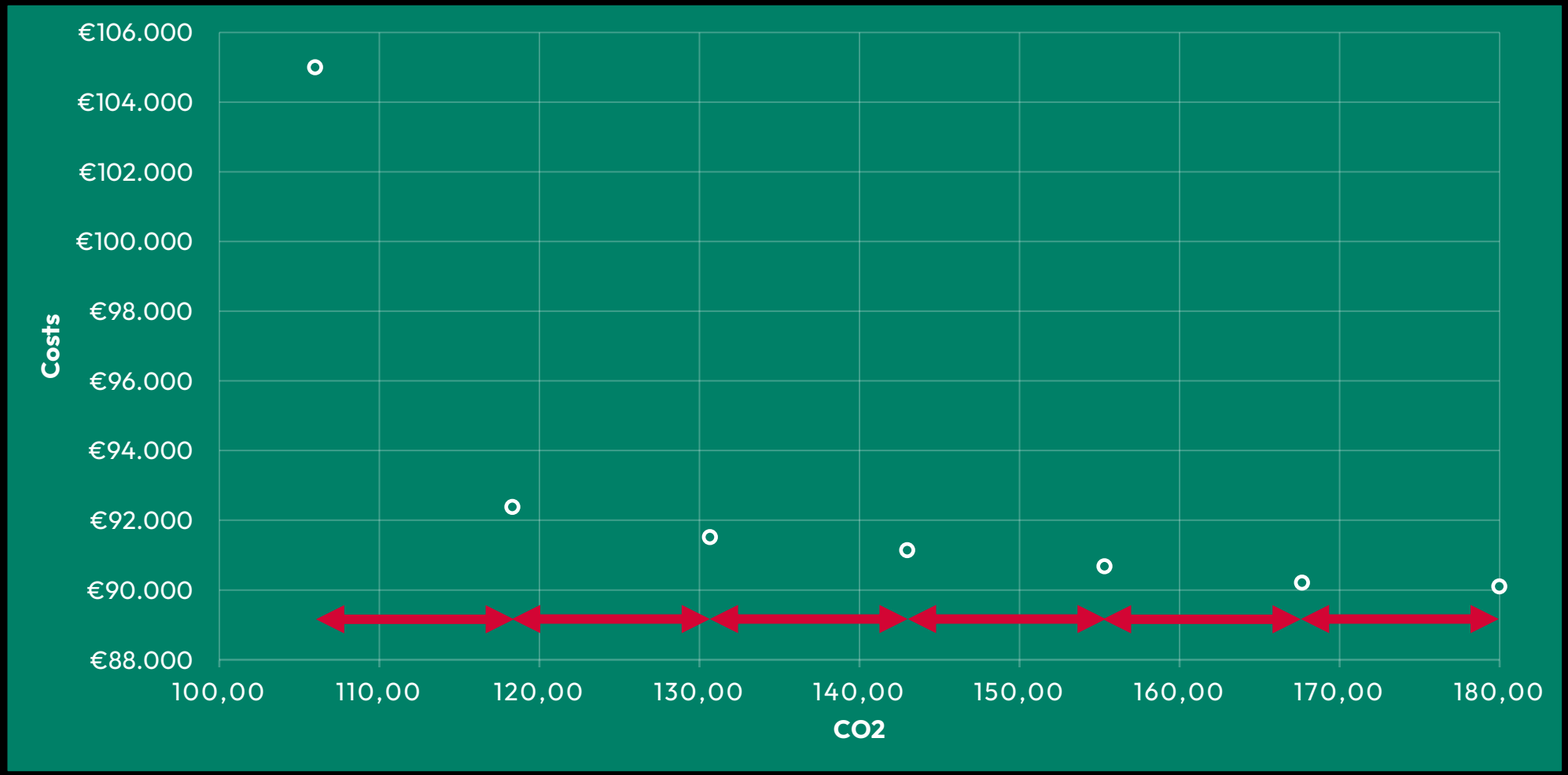
Requirements for gurobi

- Long optimization periods (>= years)
    - → large number of timesteps
- Often time coupling constraints (Storages, yearly restrictions)
    - → large number of binary variables
- calculation time (< hours)
    - → parallel calculations

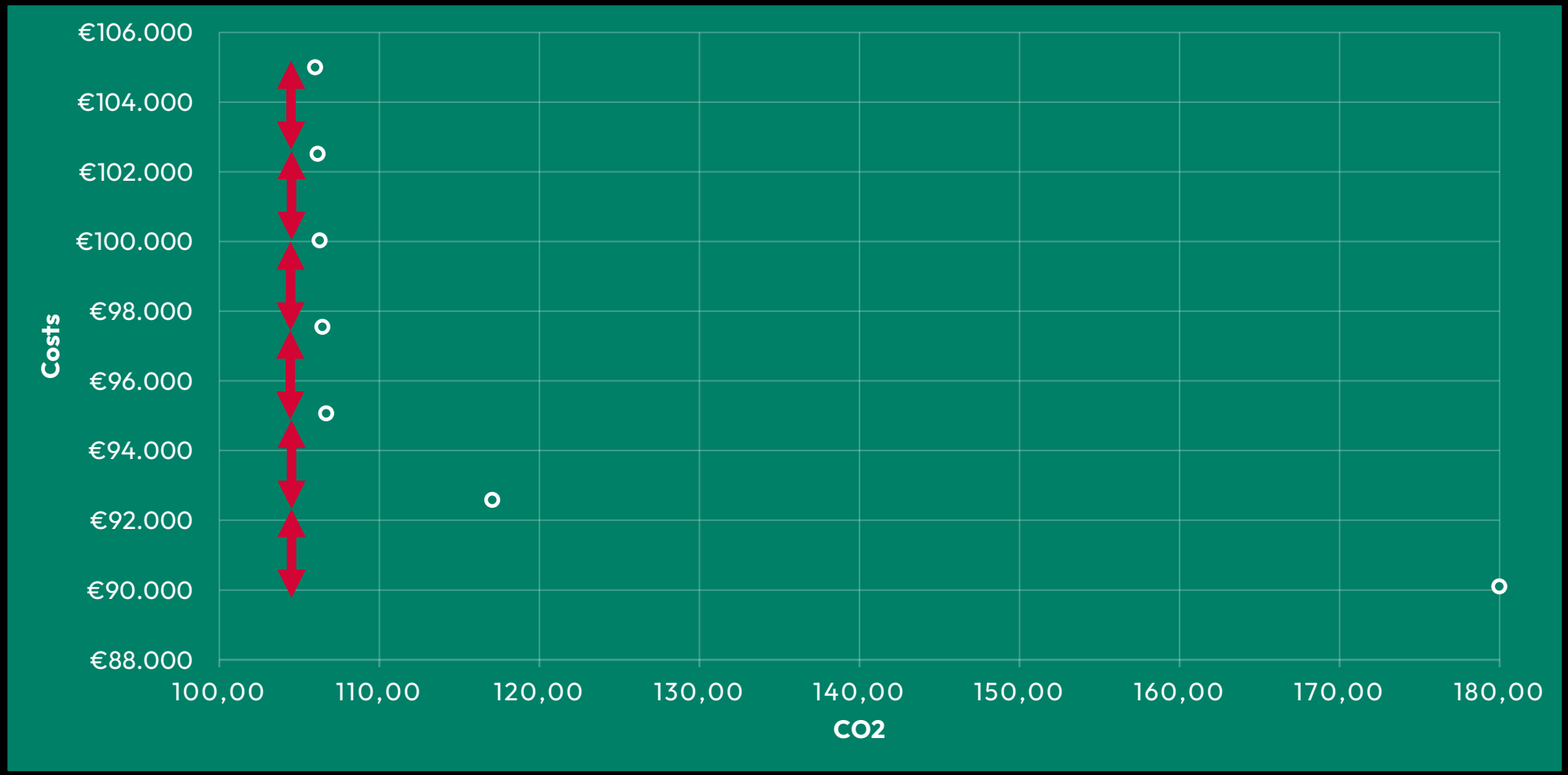
KISTERS offers several aggregation algorithms to reduce number of timesteps!

- Intervall reduction (time steps with similar data are summarized)
- Typical days
- Dynamic timegrid

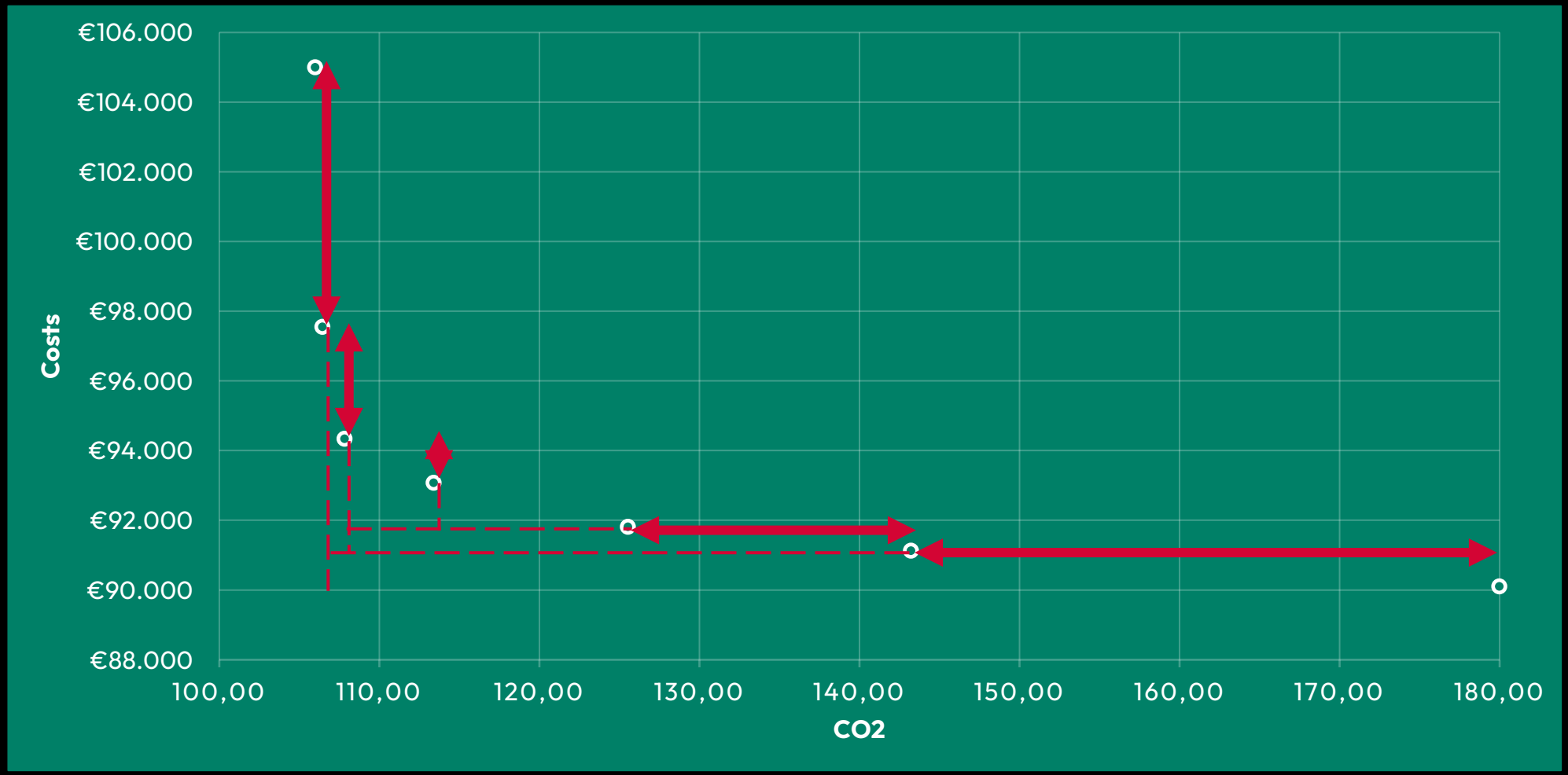
Pareto Front - equal distance on CO2 axis



Pareto Front - equal distance on costs axis



Pareto Front – distance 50% changing costs/CO2



Thank you

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