Willkommen
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Bienvenue

Optimization-based planning of local energy systems

Bridging the research-practice gap

L. Andrew Bollinger

Empa, Urban Energy Systems Laboratory
Dübendorf, Switzerland

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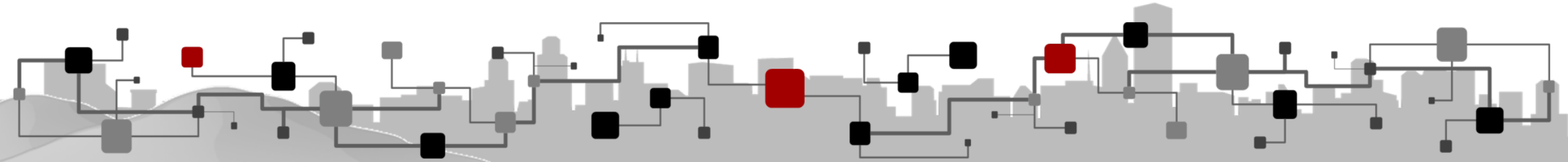
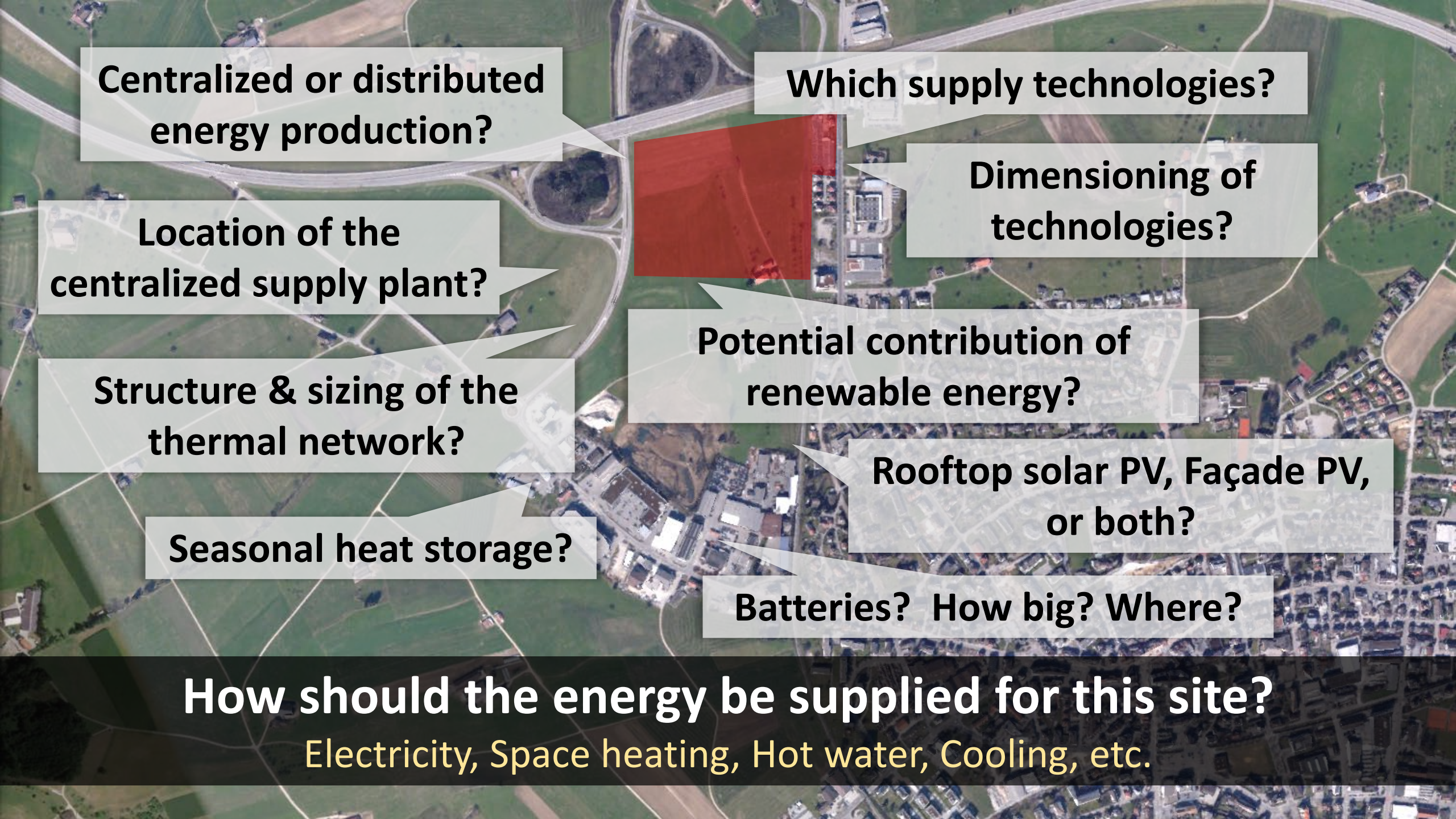


Optimization-based planning of local energy systems


Centralized or distributed energy production?
Which supply technologies?
Dimensioning of technologies?
Location of the centralized supply plant?
Potential contribution of renewable energy?
Structure & sizing of the thermal network?
Rooftop solar PV, Façade PV, or both?
Seasonal heat storage?
Batteries? How big? Where?
How should the energy be supplied for this site?
Electricity, Space heating, Hot water, Cooling, etc.

Conventional approach

OPTION 1

Decentralized (building level) **gas boilers**

No active cooling

No thermal network

OPTION 2

Centralized **gas CHP** unit

80°C thermal network

No active cooling

OPTION 3

Decentralized (building level) **heat pumps**

10°C thermal network

Rooftop **solar PV**

Gas boiler for peak load

OPTION 4

Centralized **heat pump** (reversible)

Hybrid network for cooling & heating

Rooftop & Façade **PV**

OPTION 5

Connection to external thermal network

No active cooling

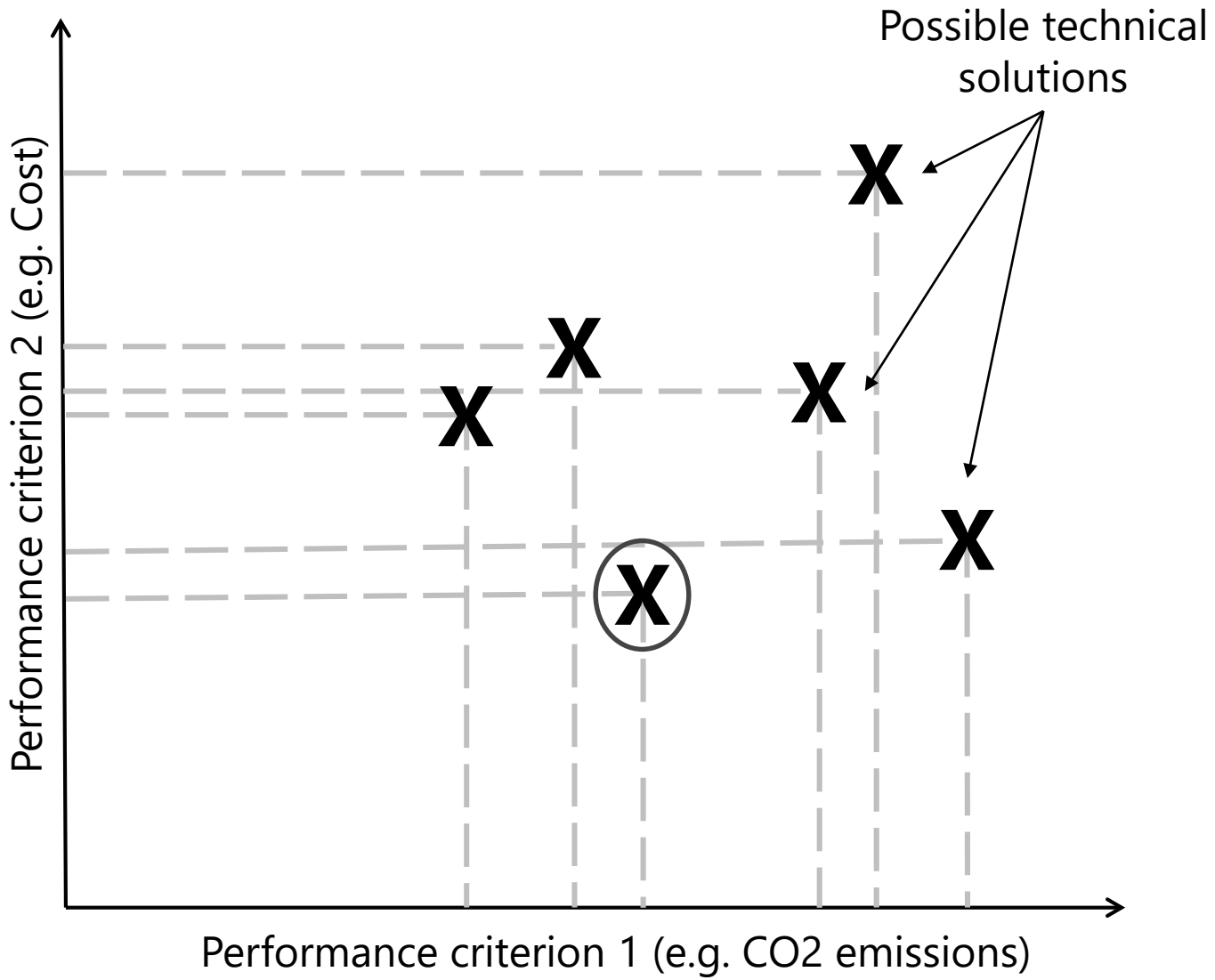
Rooftop solar PV with batteries

OPTION 6

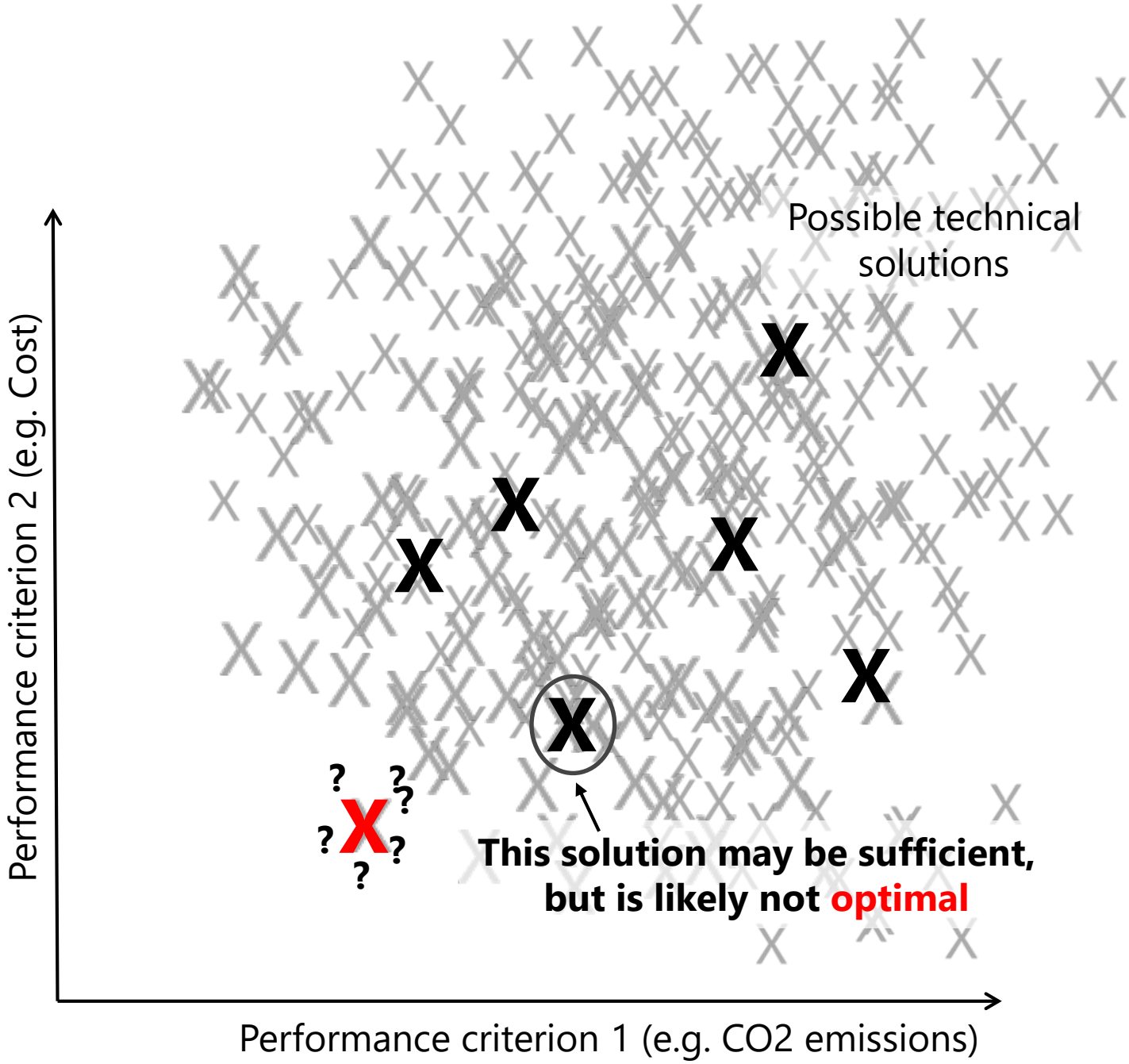
Centralized **wood CHP** unit

80°C thermal network

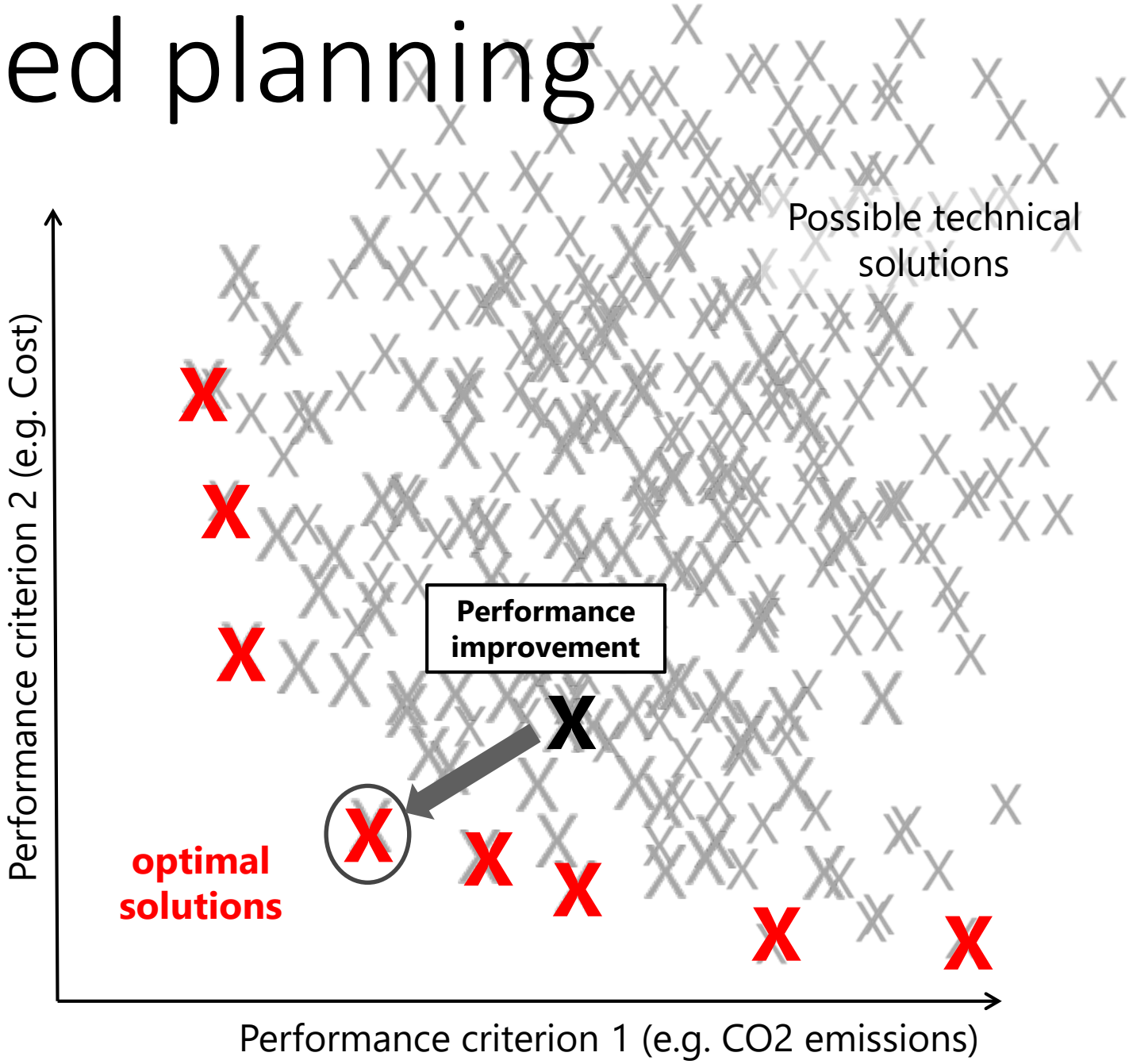
Decentralized chillers



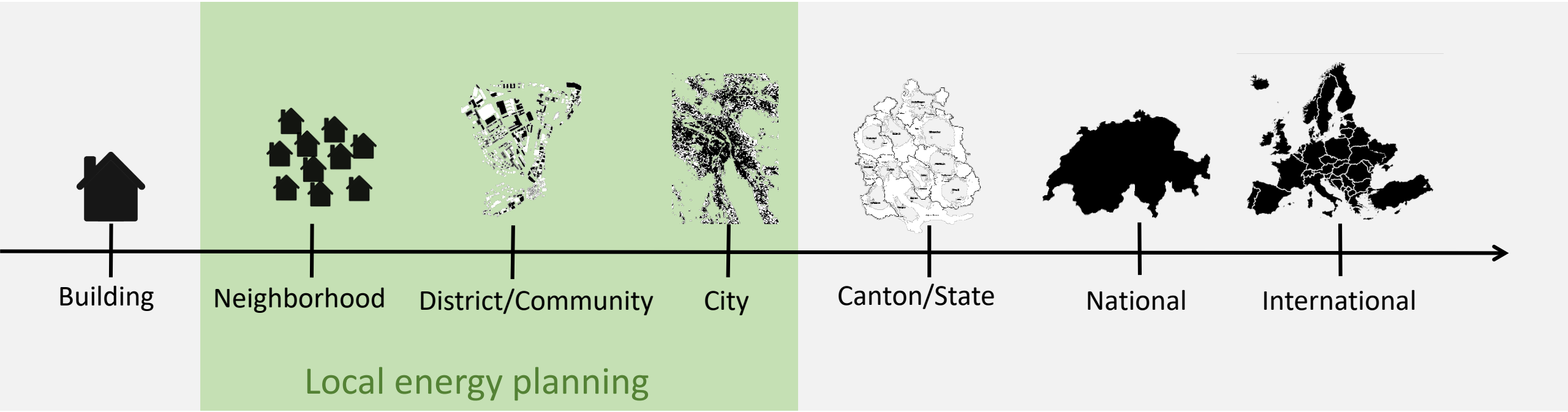
The problem


Possible technical solutions
Performance criterion 2 (e.g. Cost)
Performance criterion 1 (e.g. CO2 emissions)
This solution may be sufficient, but is likely not optimal

Optimization-based planning

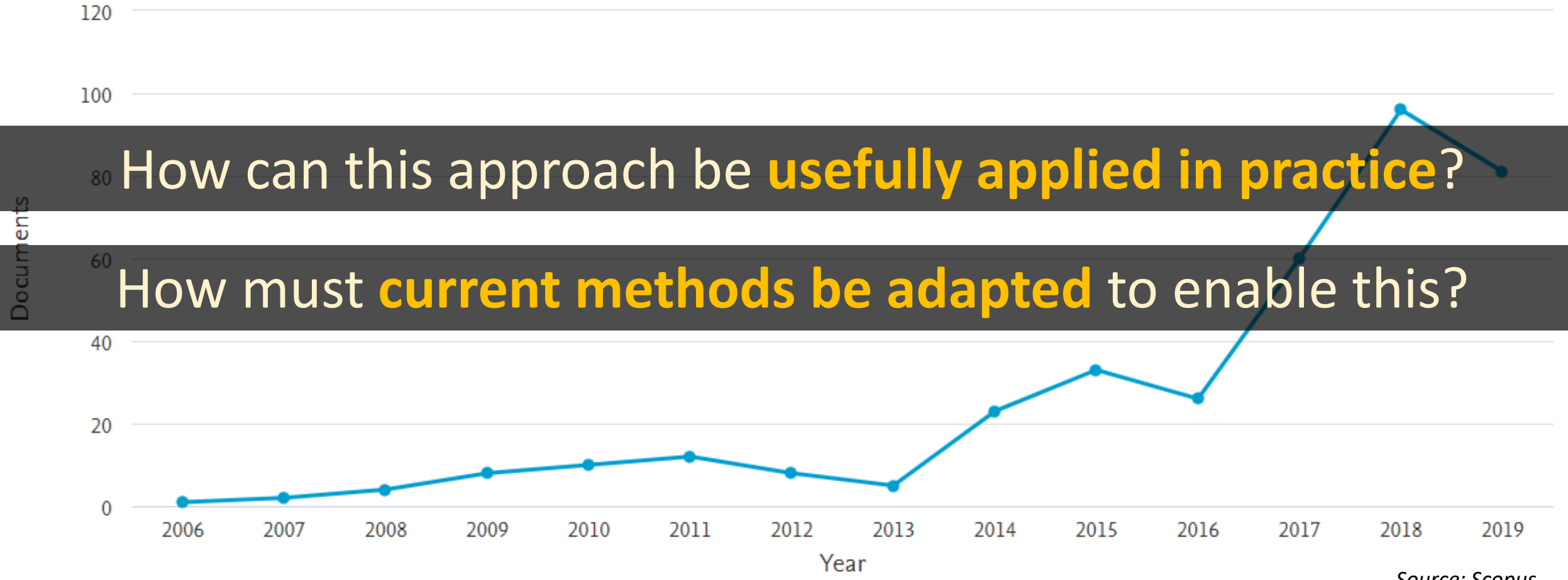


…of local energy systems



Scientific literature

Scientific publications per year – “Energy hub” optimization



How can this approach be **usefully applied in practice**?

How must **current methods be adapted** to enable this?

Source: Scopus

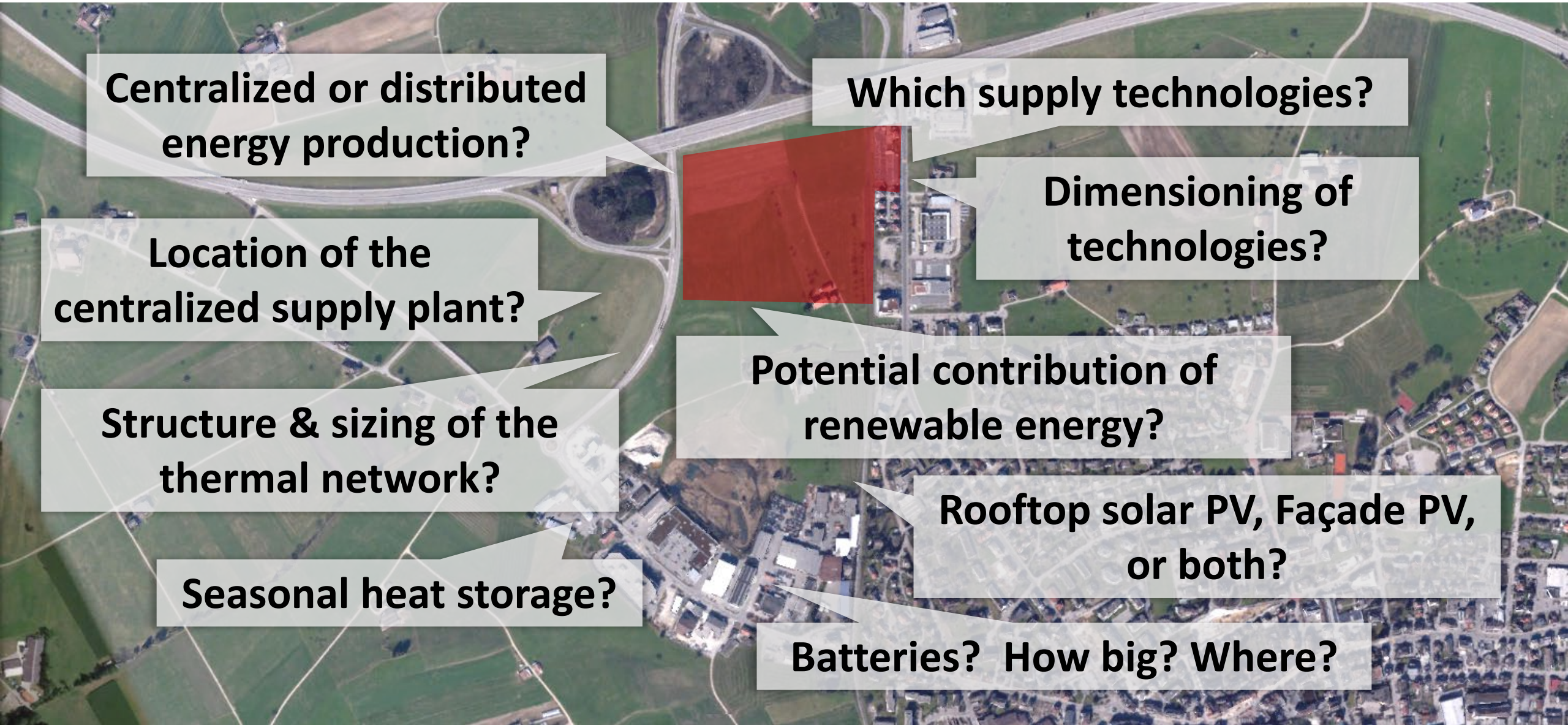
Methodology

Case studies

Case study	Main industry partner	Size of site (buildings)	Type of site	Location
1	Municipal authority	10-20	Existing	Zürich, CH
2	Local utility	10-20	Greenfield	Gossau, CH
3	Local utility	600	Existing	Baden, CH
4	Engineering consultancy	1000+	Existing	Brig-Glis, CH

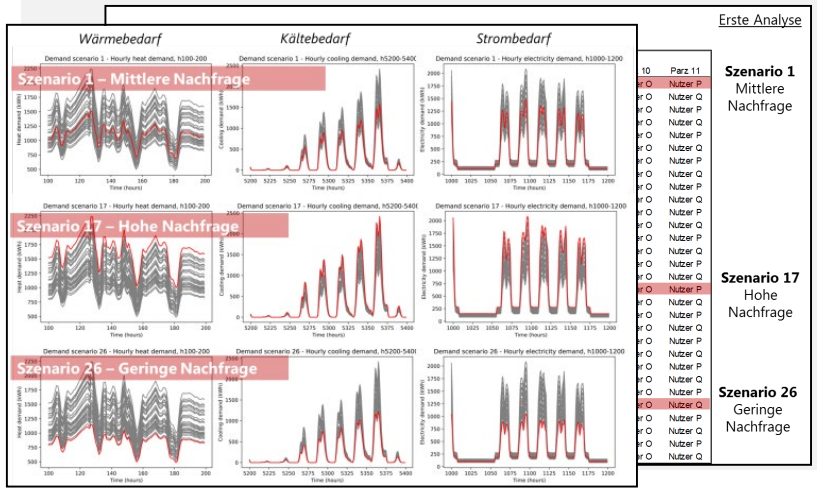
Case study

Partners: St. Galler Stadtwerke, Stadtwerke Gossau, Migros Ostschweiz, Hochschule Luzern



Case study

Energy demand profiles



Energy supply technologies

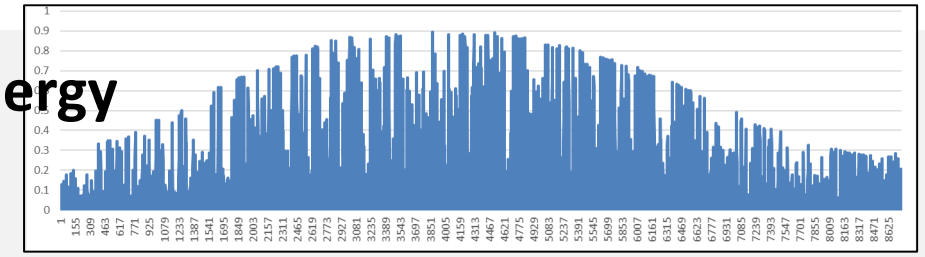
Areal	Netz	Parzelle	Speicher
			Batterie
Kälte		Reversible WP	
		Kältemaschine	Kältespeicher (Parzelle)
		Rückkühlung	

3 thermal network scenarios:

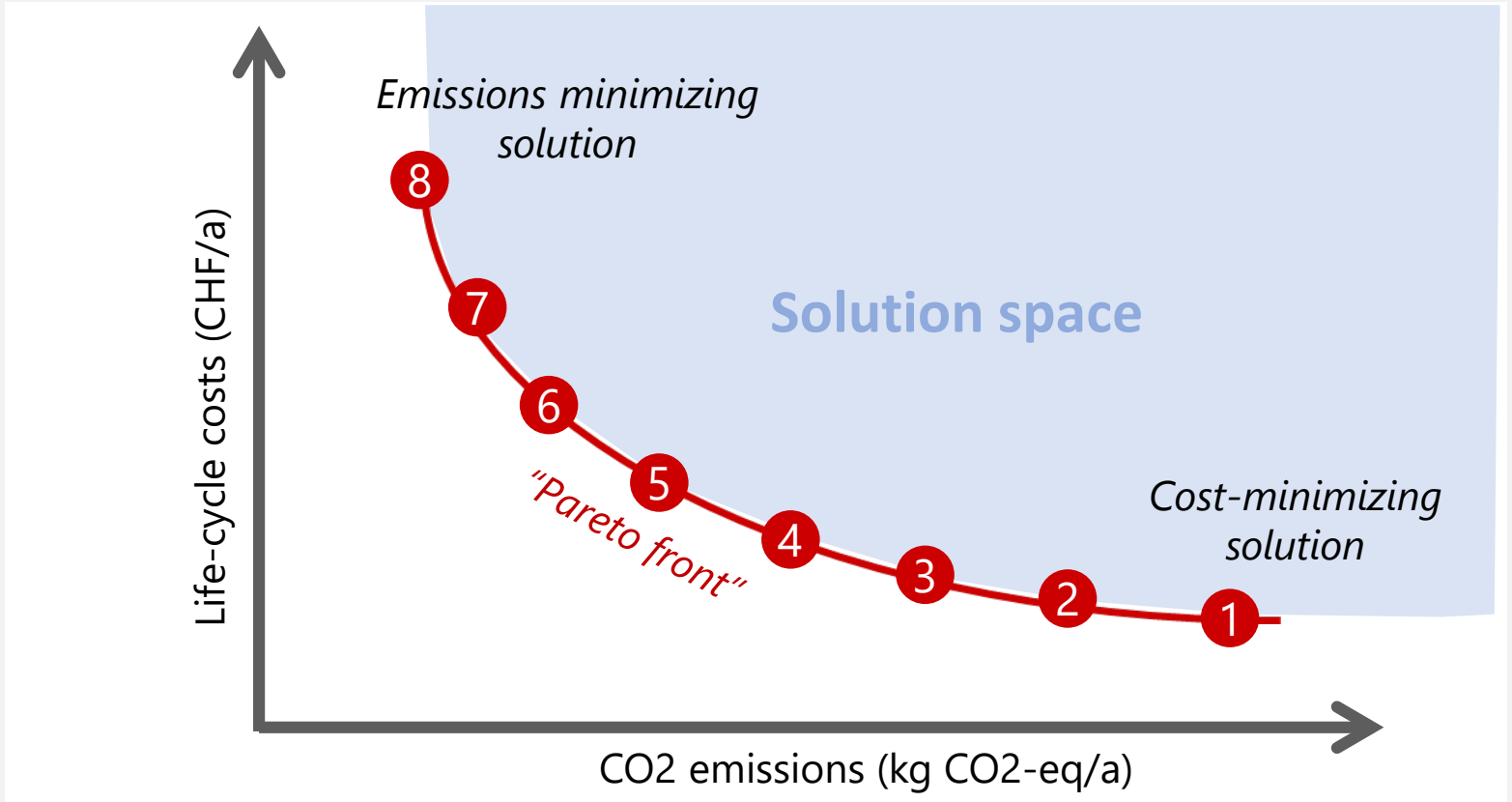
- High-temperature network
- Low-temperature network
- Hybrid network

Renewable energy potentials

Solar energy



Optimization



Key learnings

Key learnings

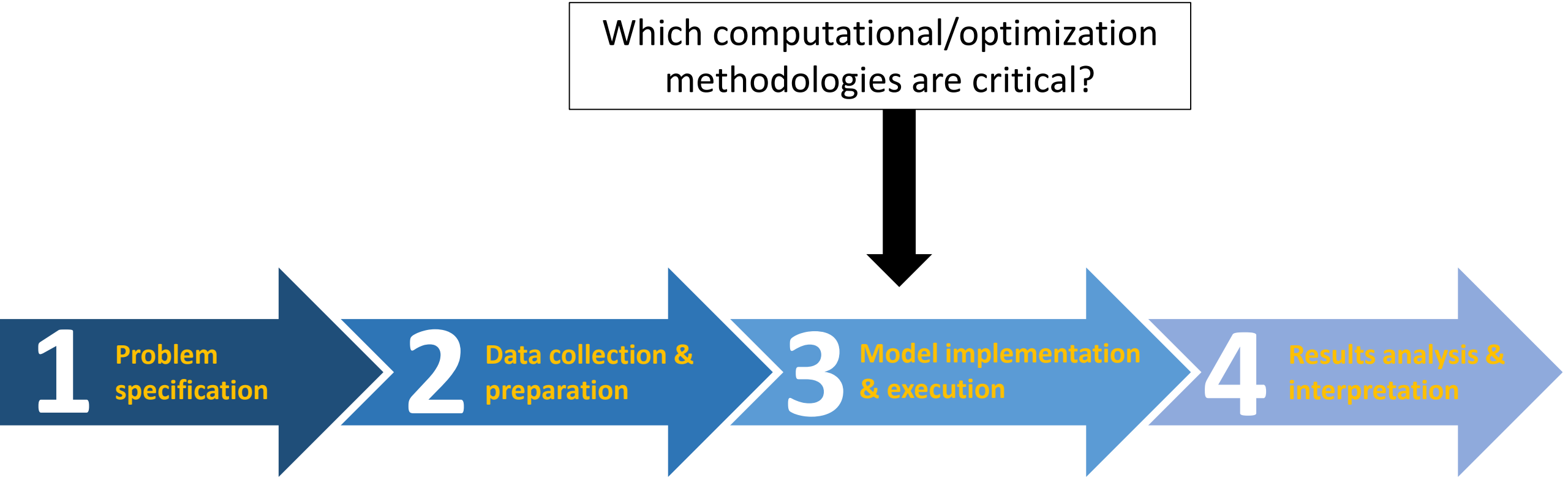
Generally took significantly longer than anticipated

Missing, inconsistent and erroneous values in building databases and monitored data required significant manual effort to correct

The intensity and temporal distribution of **industrial energy demands** are often not precisely known, and may be decisive to the optimal supply system

Technology capital/installation costs may be highly local and context dependent – no good, comprehensive databases exist.

Key learnings



Key learnings

Methodology	Case study			
	1	2	3	4
Network optimization		thermal	thermal	
Spatial clustering			density-based	
Temporal decomposition	typical days	typical days	typical days	
Multi-stage optimization	3-stage			
Uncertainty handling	scenarios	scenarios		scenarios

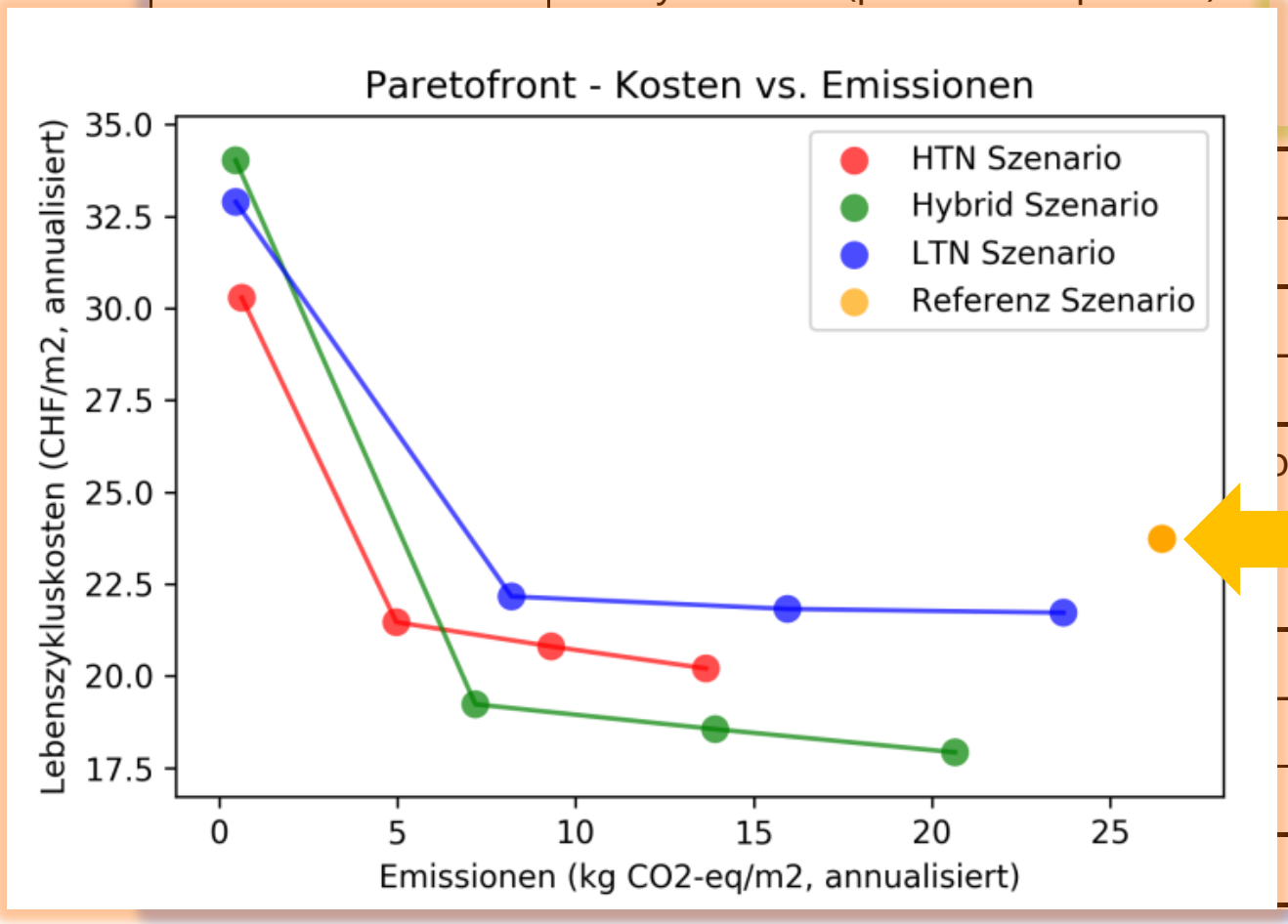
Holistic, multi-energy optimization-based approach is valuable to the problem owners

Methodologies to **reduce solving time** without compromising solution accuracy are critical

Key learnings

Key learnings

Category	Indicator
	Life-cycle costs (per kWh or per m2)



Indicators must align with the **perspective and priorities of the problem owner**

It must be possible to answer the question **WHY a given solution is optimal**

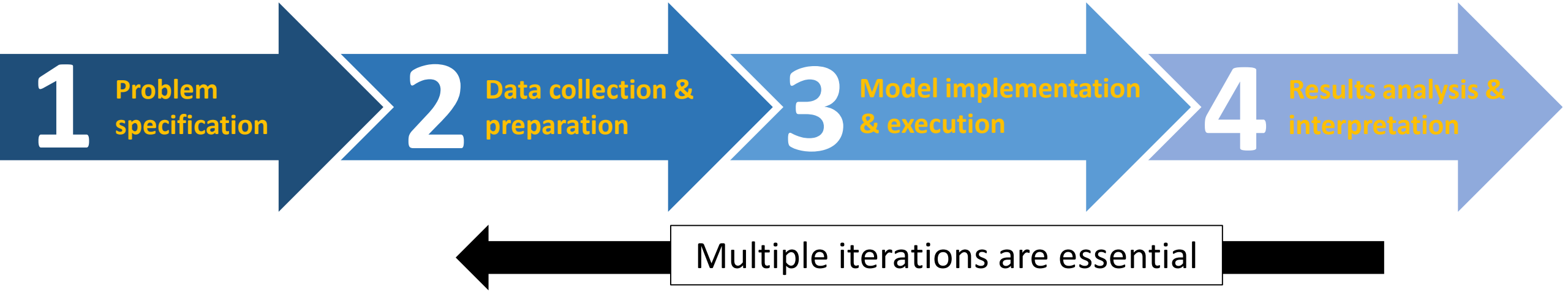
optimal set &

Key learnings

To **adapt the analysis based on stakeholder input**

To **facilitate learning on the part of stakeholders** with regard to the value and limitations of the approach and the results

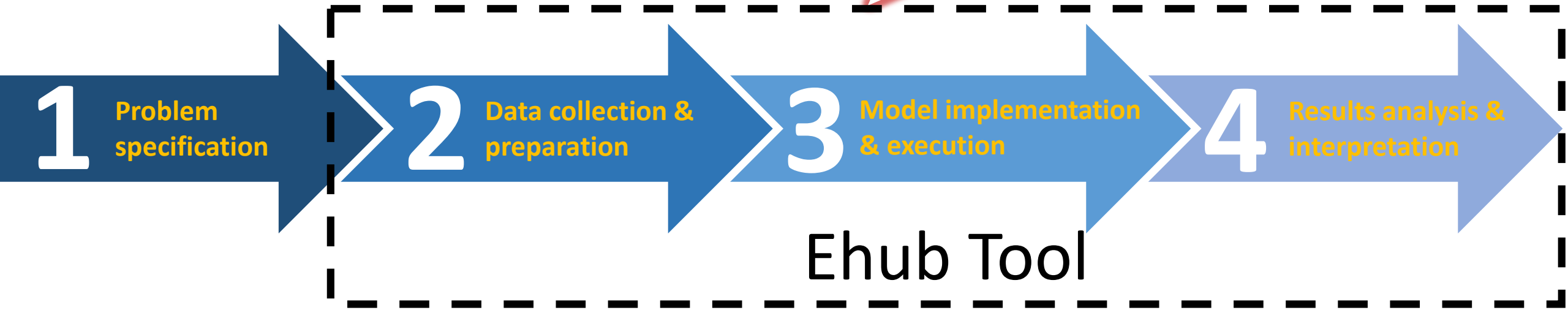
5-6 iterations were typically required



Next steps

Next steps

How must this tool be adapted to effectively support optimization-based local energy planning in practice?



Thank you for your attention.

andrew.bollinger@empa.ch
Empa, Urban Energy Systems Laboratory, Dübendorf, Switzerland