RSM Erasmus

Designing An Inter-Sectoral Energy Storage System

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Motivation – Renewable Energy Sources Require Flexibility

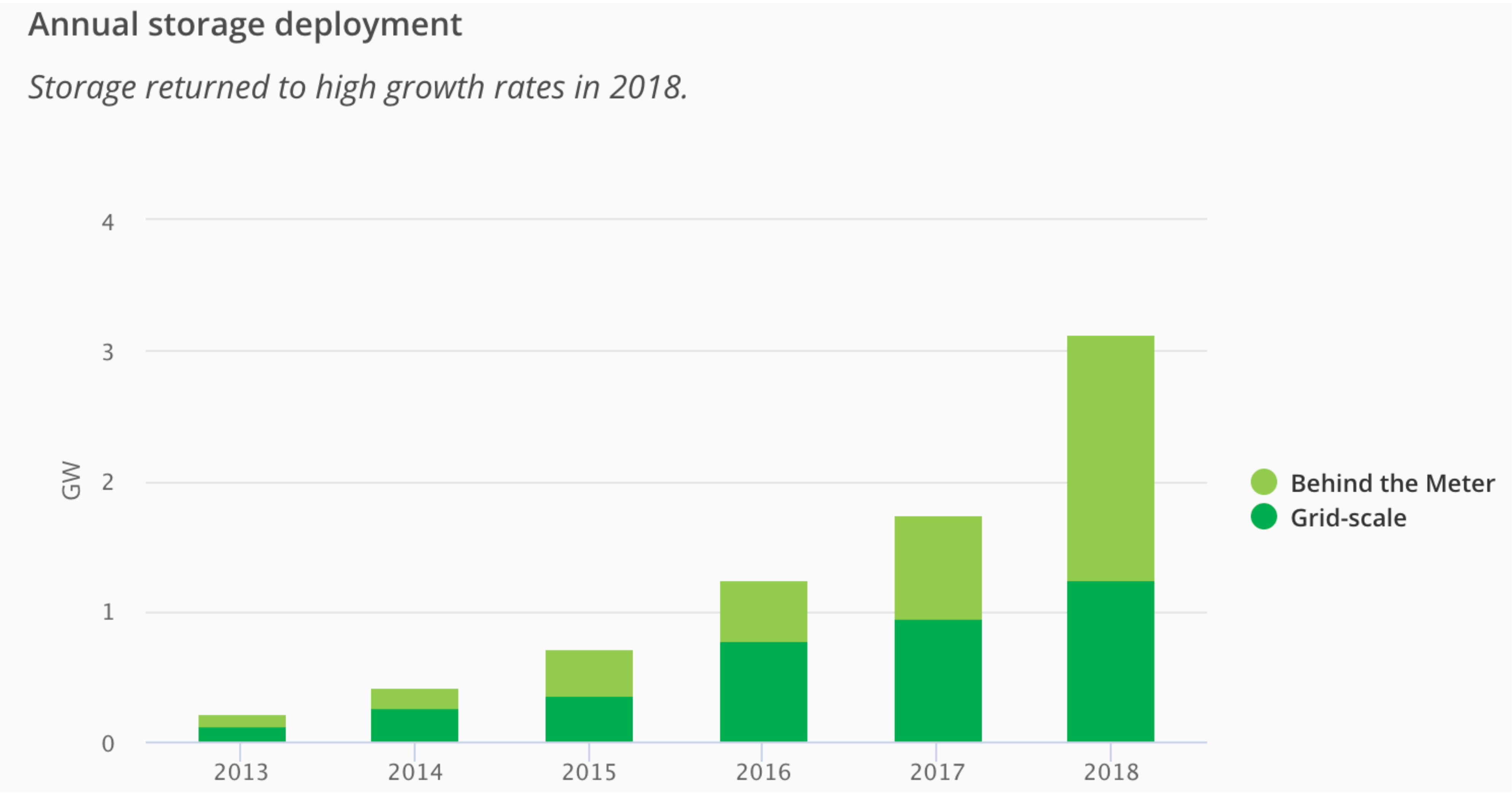
Increasing deployment of residential renewable energy sources

Intermittent production causes problems

- Time
- Amount

Need for **flexibility instruments.**

Motivation – Residential Energy Storage is on the Rise Globally



Source: IAE, 2019

Motivation – Hybrid Energy Storage Systems Offer Flexibility Potential

Energy Storage World Forum

PROGRAMME ACADEMY TICKETS WEBINAR SPEAKERS

Energy Storage News

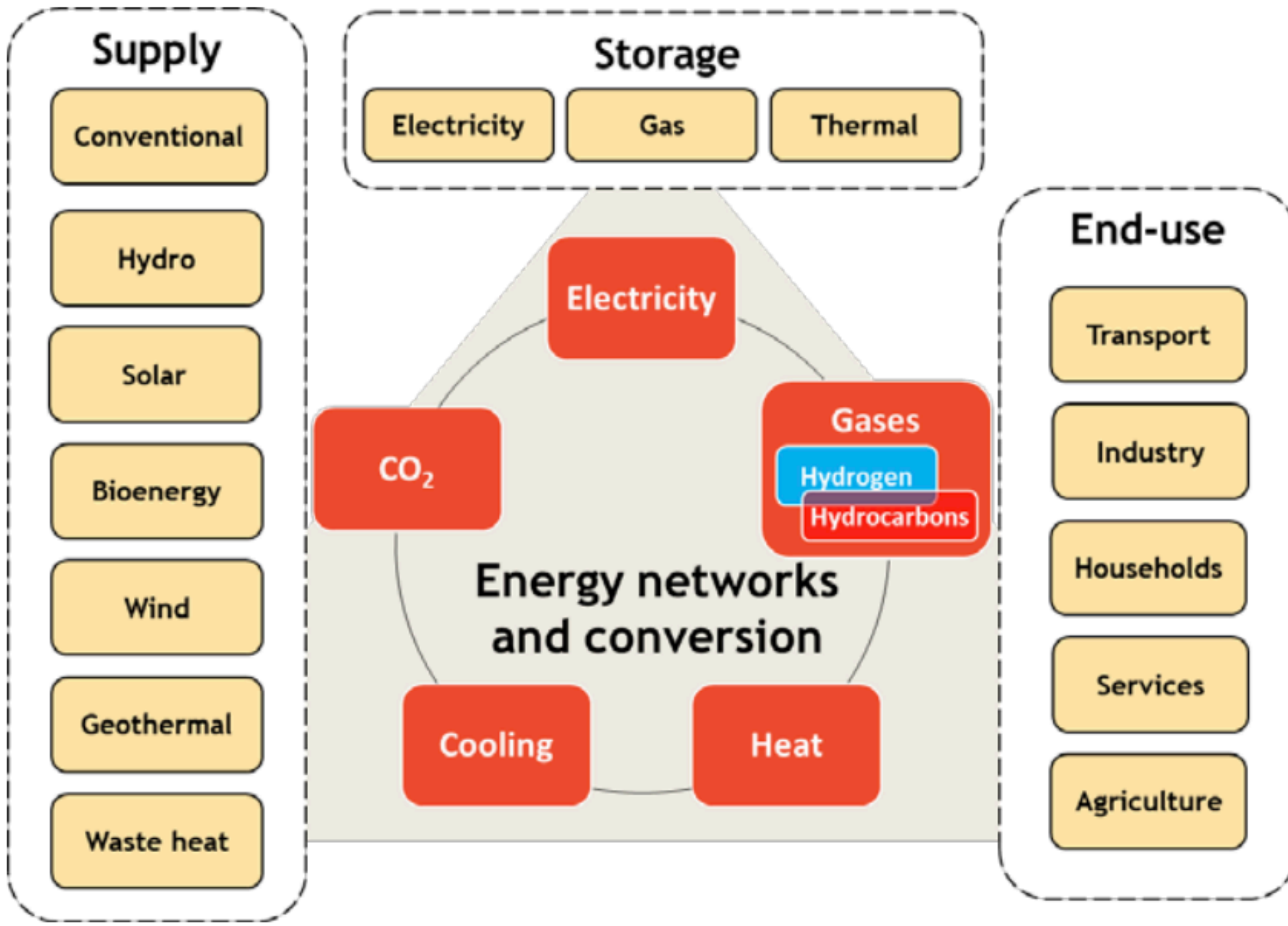
HYBRID ENERGY STORAGE: ARE COMBINED SOLUTIONS GAINING GROUND?

Hybrid energy storage systems

- Combine advantages of different types of storage systems

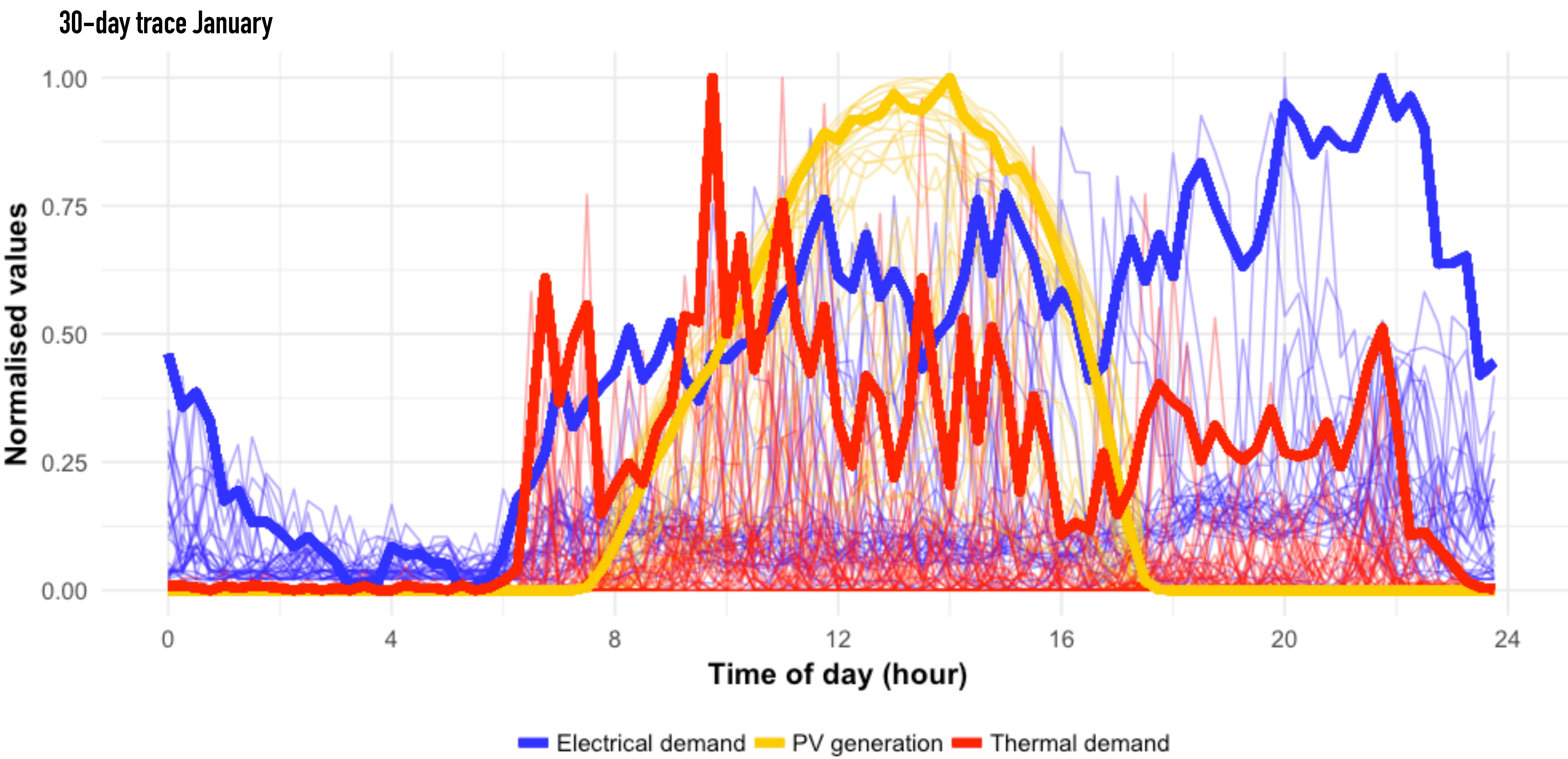
Motivation – Sector-Coupling

Figure 1: Coupling of the energy system sectors



Source: European Parliament, 2018

Differing traces



Source: van Lunteren & Ghiassi-Farrokhfal, n.d.

Problem Statement

Potential for inter-sectoral energy storage systems.

How do we **design** them?

Research Question

What are the optimal choices for operation and sizing of an islanded microgrid for a target system reliability?

Data

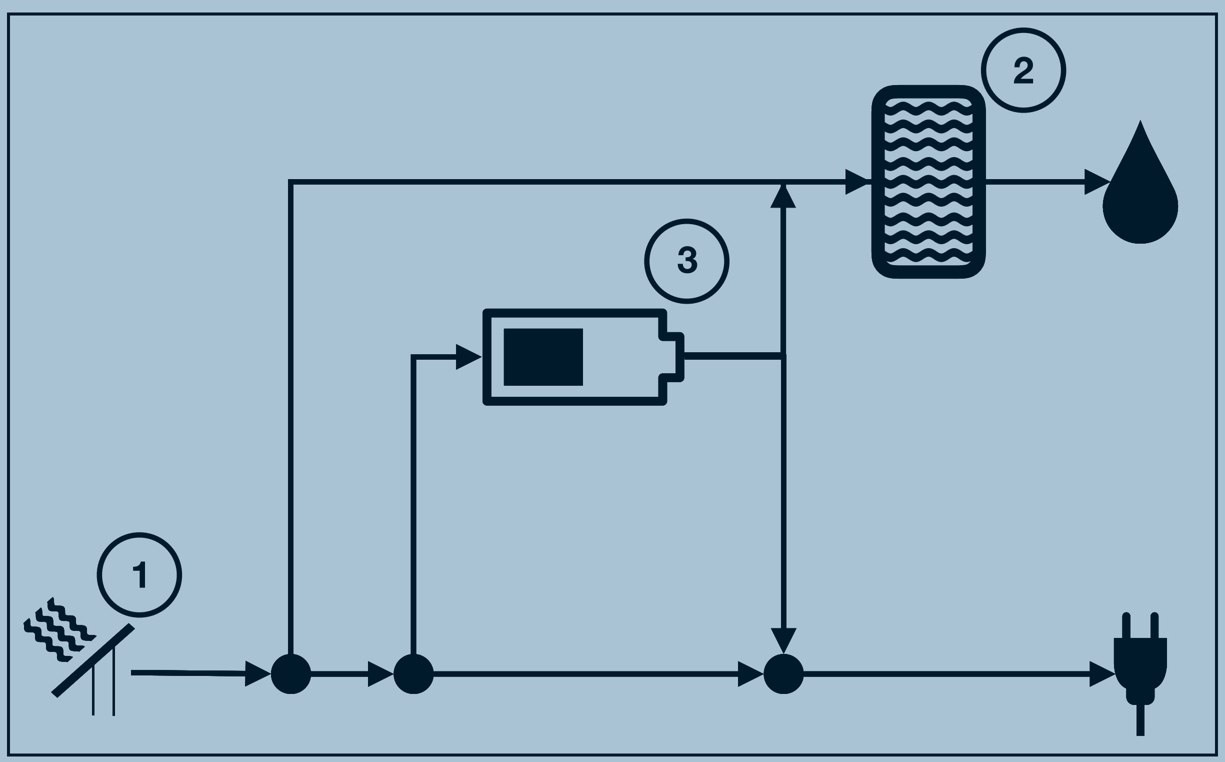
Simulation scenario based on real-world data from Pecan Street (Austin, Texas).

15-minute energy consumption and production data for **1 year**

Inclusion of **electrical demand** and **hot water demand**

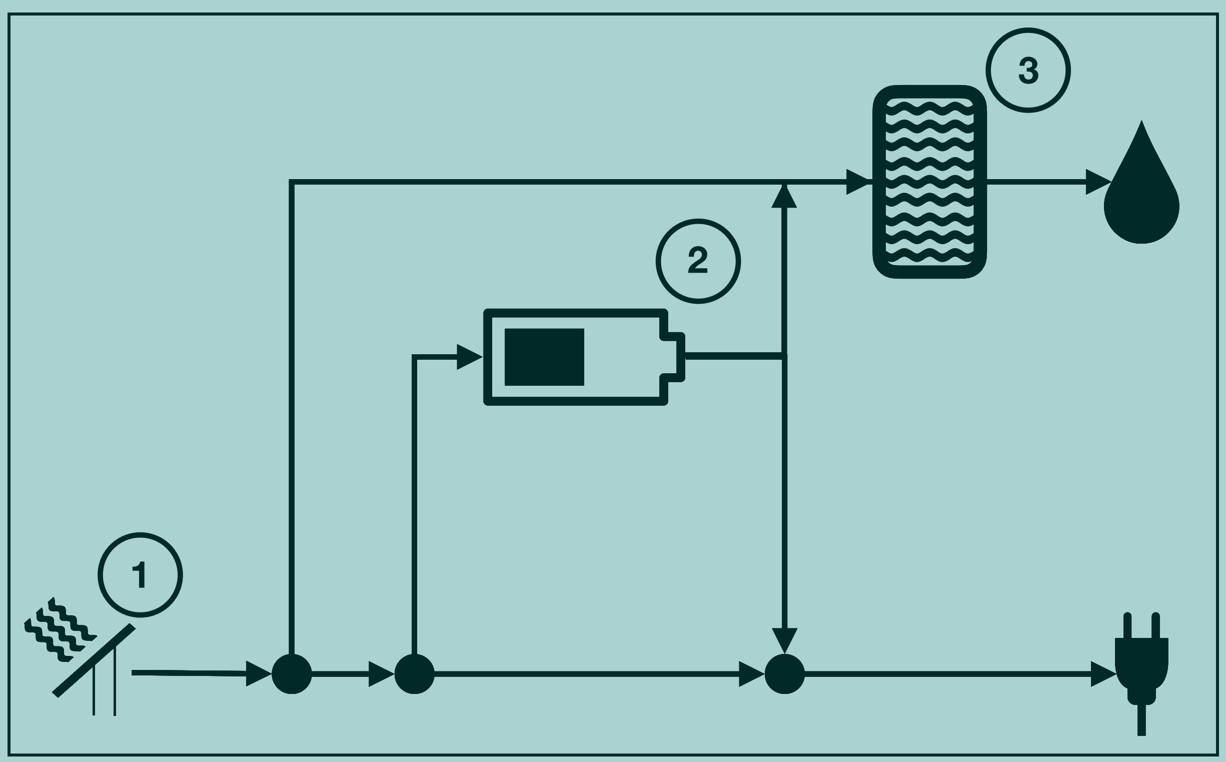
Approach – Two Scenarios

Scenario 1



1		Direct energy provision
2		Thermal storage device (TSD)
3		Electrical storage device (ESD)

Scenario 2



1		Direct energy provision
2		Electrical storage device (ESD)
3		Thermal storage device (TSD)

Approach – Optimization

Goal: Analyse optimal sizing under different reliability metrics and values.

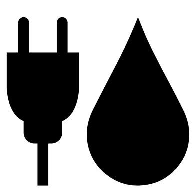
Metric	Definition	Considered values
Loss of load probability (LOLP)	$LOLP = \frac{\sum times \quad demand \quad cannot \quad be \quad met}{\sum times \quad demand \quad to \quad be \quad met}$	0.01, 0.05
Unmet load (UL)	$UL = \frac{\sum demand \quad that \quad cannot \quad be \quad met}{\sum demand}$	0.01, 0.05

🔋	Lithium-ion battery	{0:5:250 kWh}
	Heat pump + hot water storage	{0:2:100 kWh}

Approach – Overview

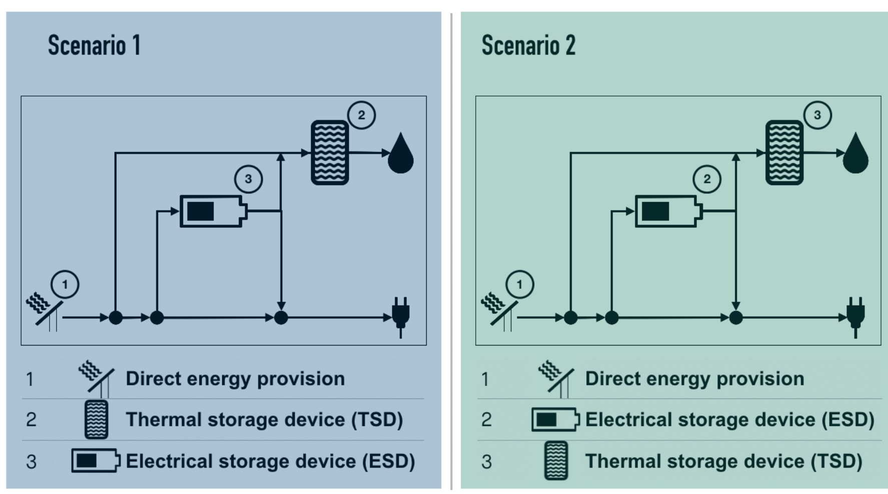
What are the optimal choices for **operation** and **sizing** of an islanded microgrid for a **target system reliability**?

Meet



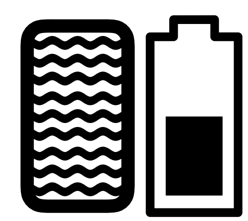
Two types of demand

Consider



Two scenarios

Vary



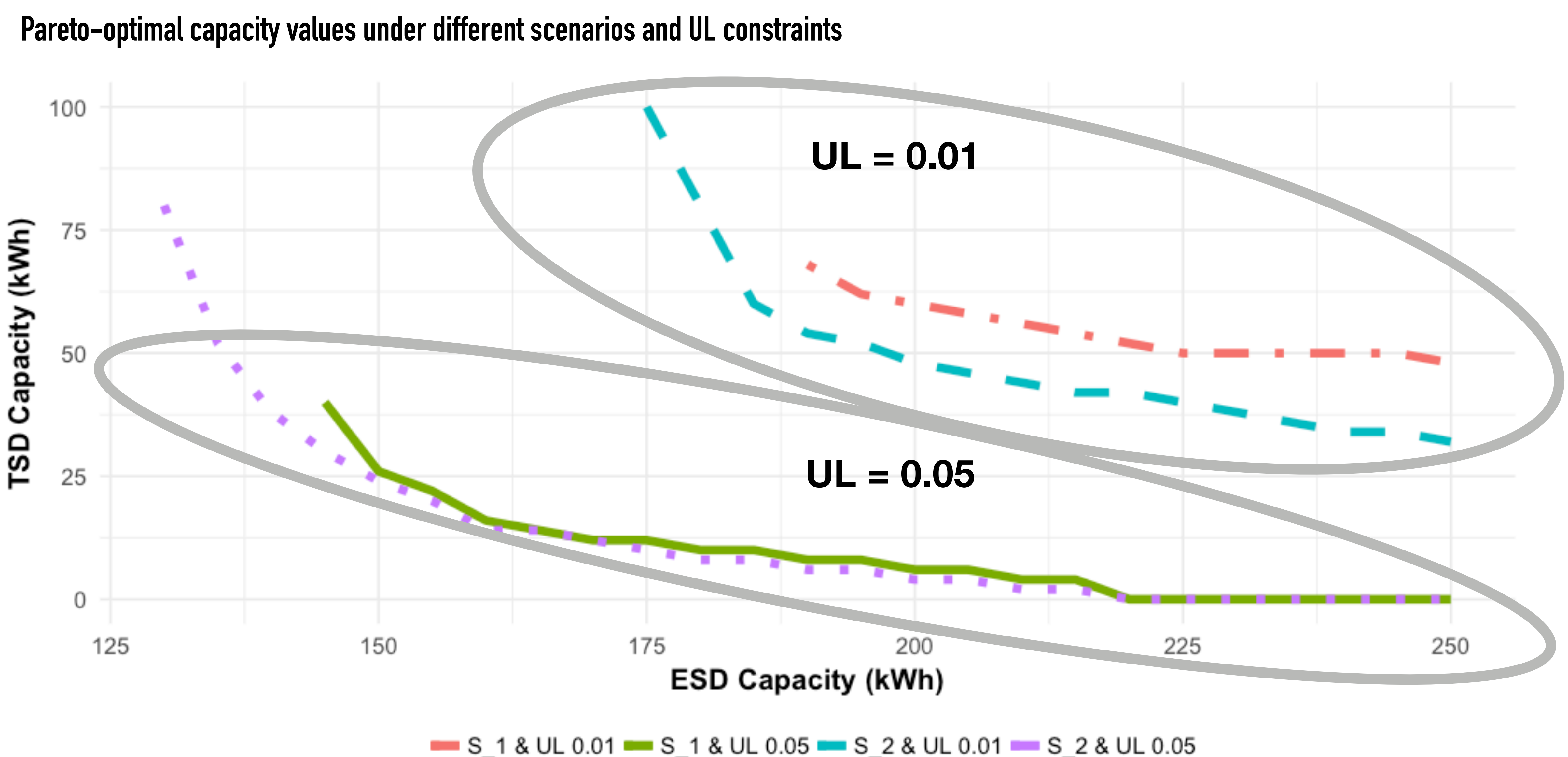
Capacity values

Minimize

- **LOLP**
- **Unmet load**

Optimization metrics

Results - Optimal TSD and ESD Capacity

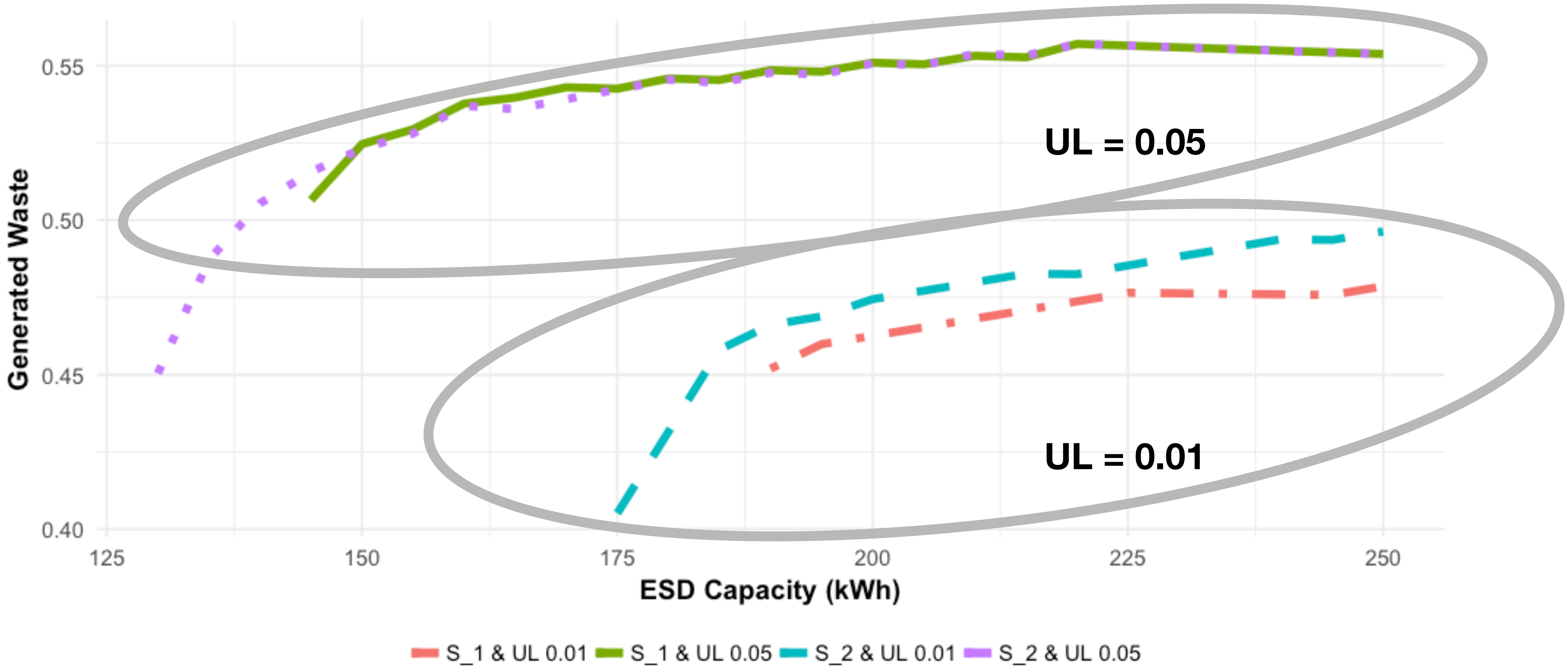


Scenarios

- **Scenario 1:** TSD before ESD
- **Scenario 2:** ESD before TSD

Results – Optimal ESD Capacity and Waste

Generated waste for Pareto-optimal ESD capacity values under different scenarios and UL constraints



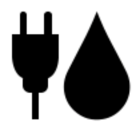
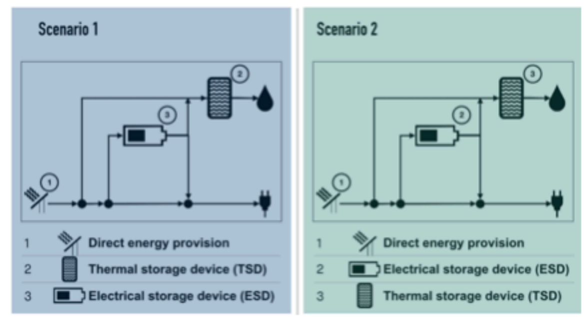
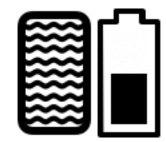
Scenarios

- **Scenario 1:** TSD before ESD
- **Scenario 2:** ESD before TSD

Definitions

- **Generated waste =** total waste / total generation
- **Waste** = generated electricity that cannot be used directly nor stored in ESD or TSD.

Conclusions and Implications

Meet	Consider	Vary	Minimize
			‣ **LOLP** ‣ **Unmet load**
Two types of demand	Two scenarios	Capacity values	Optimization metrics

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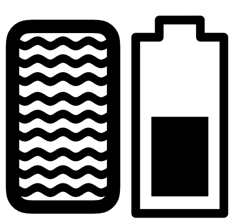

Combination of TSD and ESD is recommended.

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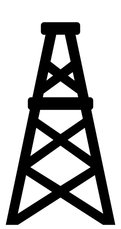
Scenario 2 - ESD before TSD - allows for smaller **storage capacity values** for both unmet load constraints.

- **The effect weakens when strengthening the UL constraint.**



The unmet load constraints result in **a large amount of energy being wasted** (use depending on application).

- **Waste increases when loosening the unmet load constraint.**

Thank you!

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