University of Natural Resources and Life Sciences, Vienna
Department of Material Sciences and Process Engineering

Decentralized photovoltaic and electric energy storage systems for autonomous buildings and seasonal base load provision to the grid

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Content

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- Aim of the work
- Methodology
- Profiling and seasonal classification
- Technical results
- Economical results
- Conclusion

Problem & Aim

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Problem

- Solar electricity production is fluctuating
- Challenge for the power grid due to excess energy

Aim

- Design of a Photovoltaic (PV) and Battery Storage System (BSS) to
- cover annual energy demand of a residential building even in winter and
- supply seasonal, uniform energy to the grid

Methodology I

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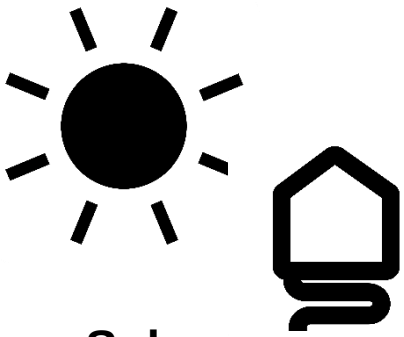

Solar generation

Electricity demand

Scale Up PV system

Methodology II

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Dimensioning of the BSS

Calculation Feed-In share

Cash flow analysis

Methodology IV – Seasonal photovoltaic production profile

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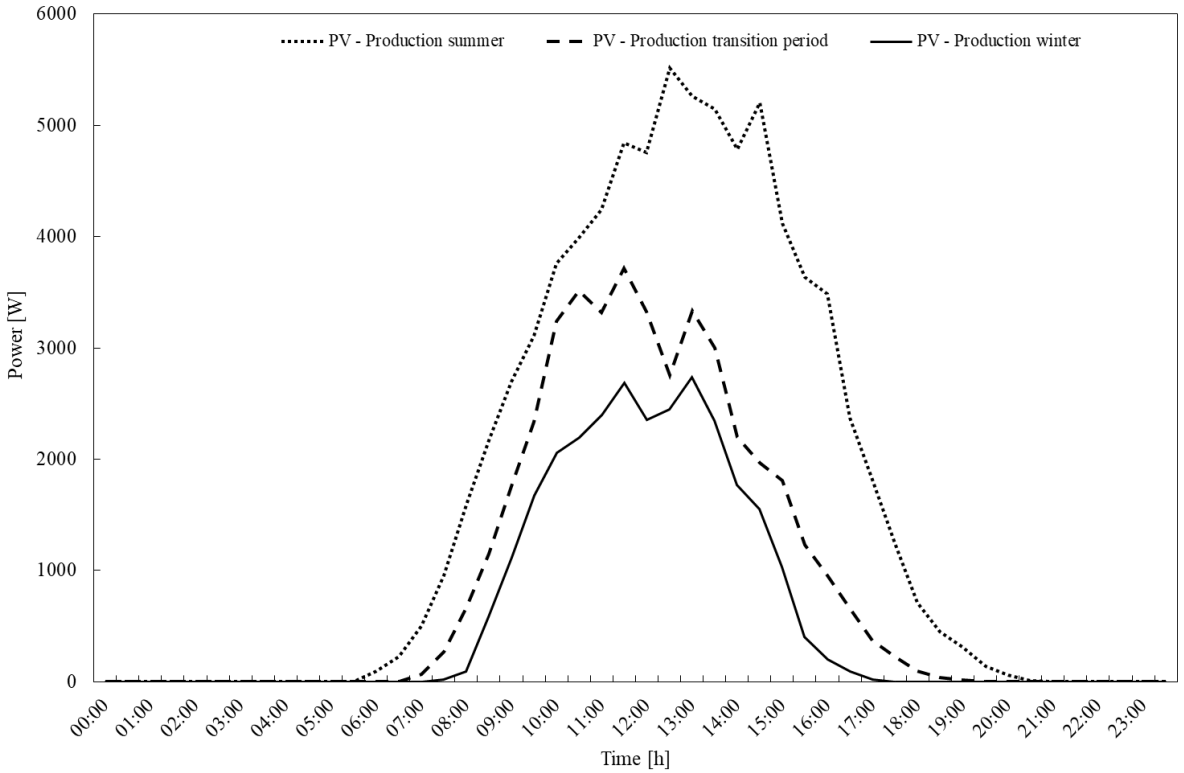

Summer:
April, May, June, July, August, September

Winter:
December, January, February

Transition period:
March, October, November

Methodology V – Seasonal consumption profile of a single family house

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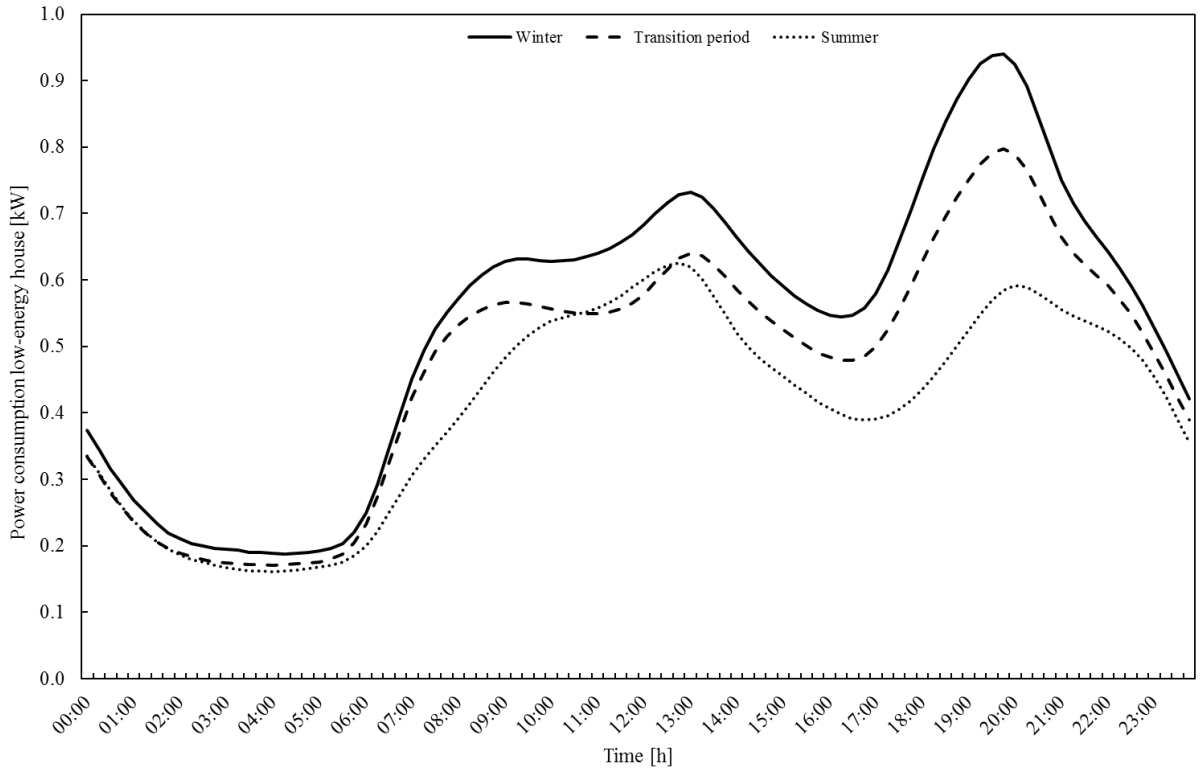

Quelle: BDEW (2017): Bundesverband für Energie- und Wasserwirtschaft e.V., Standardlastprofile 2017

Cash flow – Basic assumptions

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Expenditures		
PV system	1250	EUR/kWp
BSS	200	EUR/kWh
Energy manager	500	EUR
Insurance, maintenance, metering charge	282	EUR/a
Parameters of depreciation		
Depreciation period	10	a
Inflation rate	2	%p.a.
Revenues		
Power purchase tariff	0.206	EUR/kWh
Feed-in tariff	0.058	EUR/kWh

Technical results – System dimensioning

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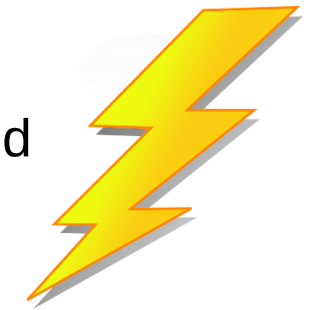
1. Photovoltaic – Design Data

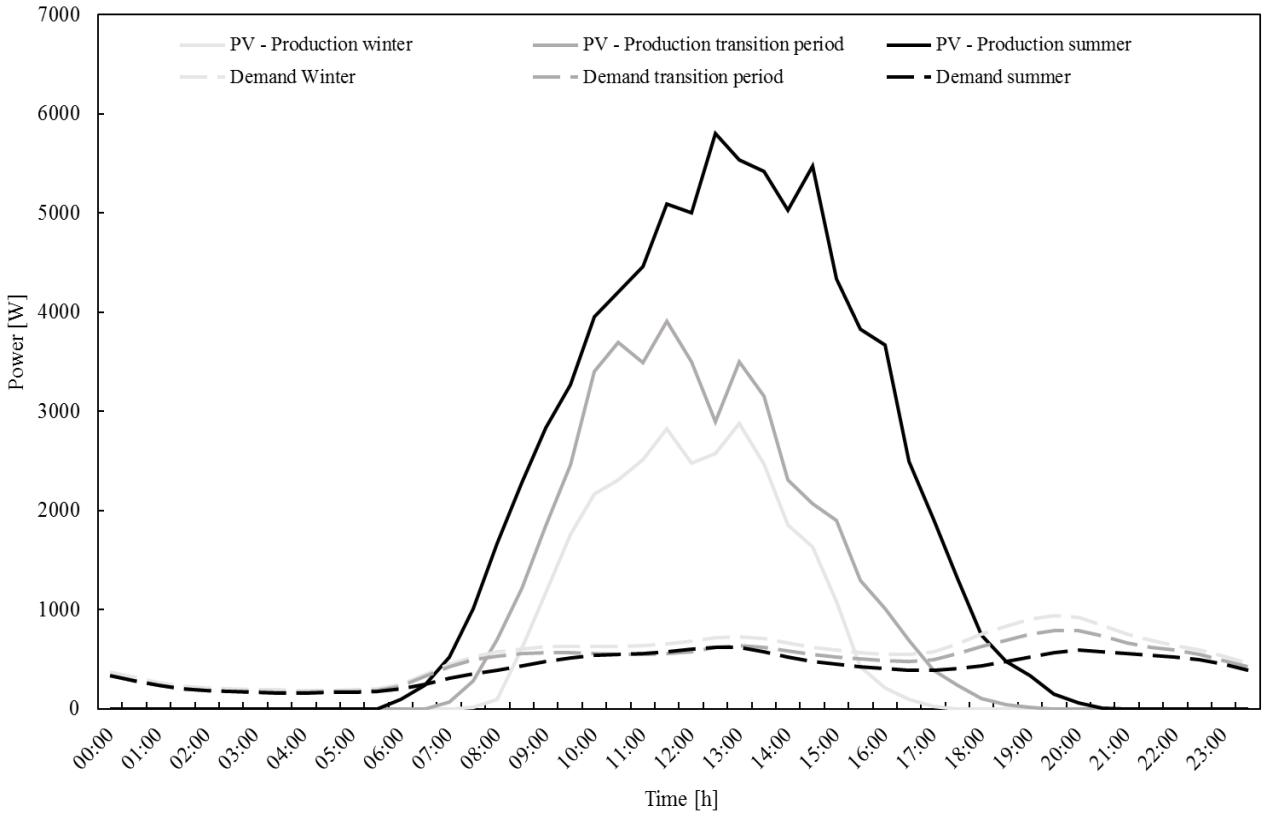
- Data basis: 8.25 kWp PV-system in Eastern Austria
- Comparison of energy consumption and production
- Scale Up of the PV system to cover the energy demand even in winter



2. Battery storage system – Design Data

- Requirement: Storage of the whole produced electricity even in summer
- Dimensioning based on electricity production and consumption in summer

Technical results – Comparison of seasonal energy consumption and production



- **Result PV: 8.7 kWp**
- **Result BSS: 19.8 kWh**

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Technical results – System dimensioning

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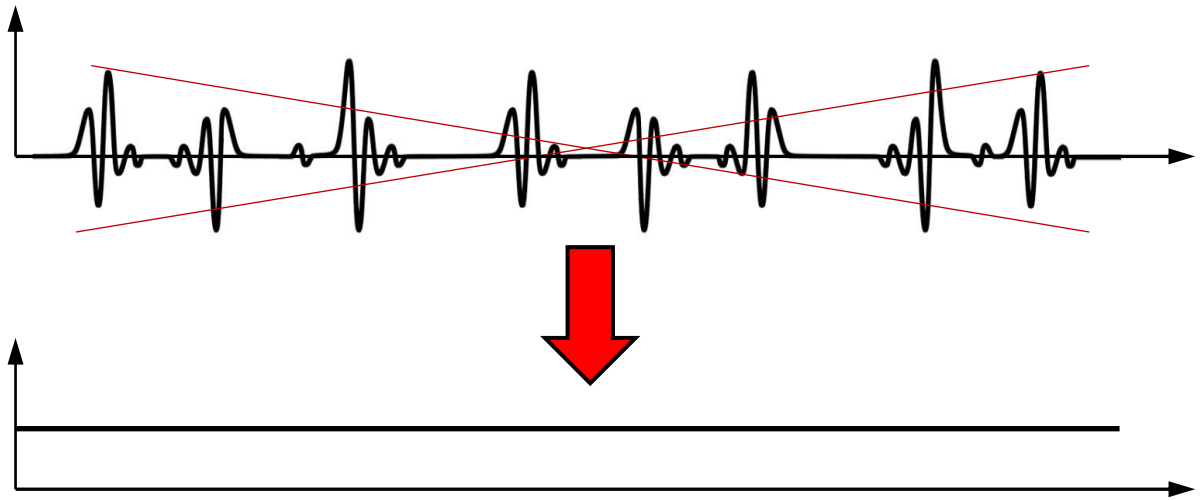
3. Seasonal, uniform supply to the grid

- Excess electricity feed into the grid BUT
- Controlled and uniform
- Requirement: constant grid feed-in for 24 hours



Technical results – Operation of the PV – BSS – system in summer

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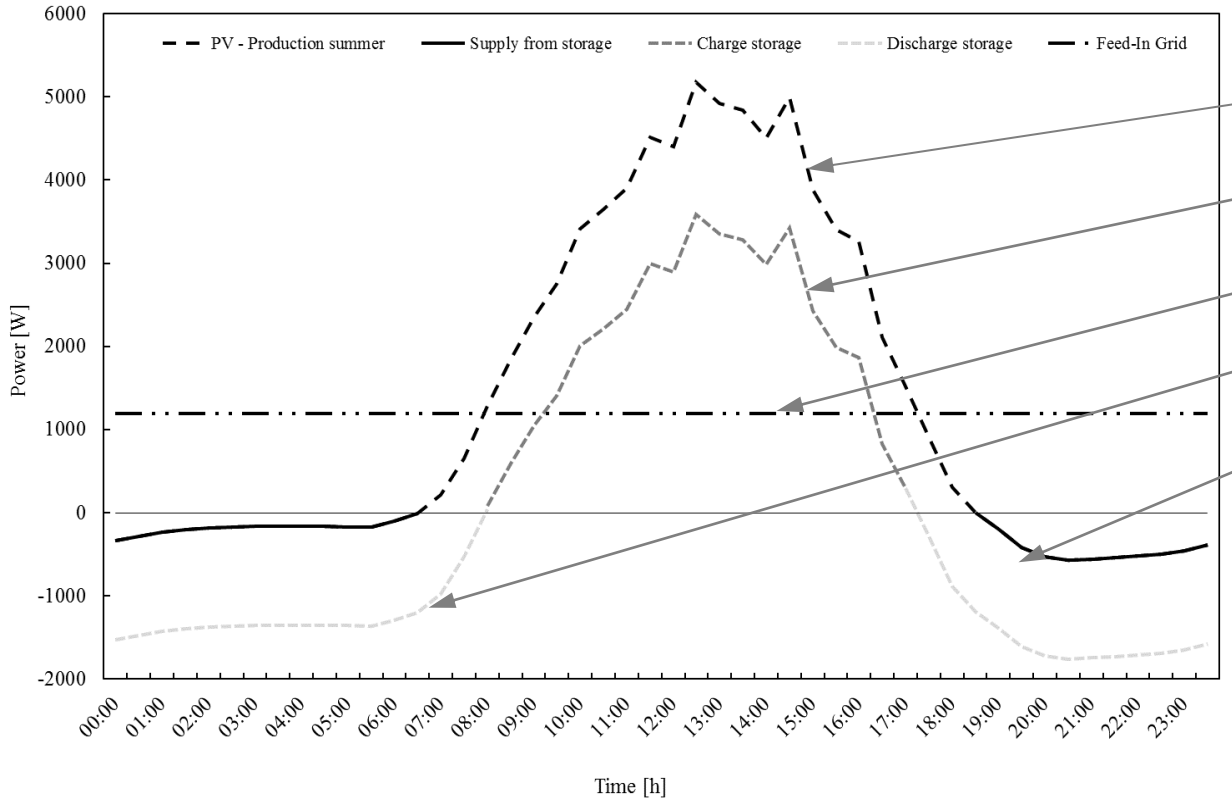

PV – Production

Charging BSS

Feed – In Grid

Discharging BSS

Supply from storage

- **Seasonal**

  Power supply: 1191 W

Technical results – Operation of the PV – BSS – system in transition period

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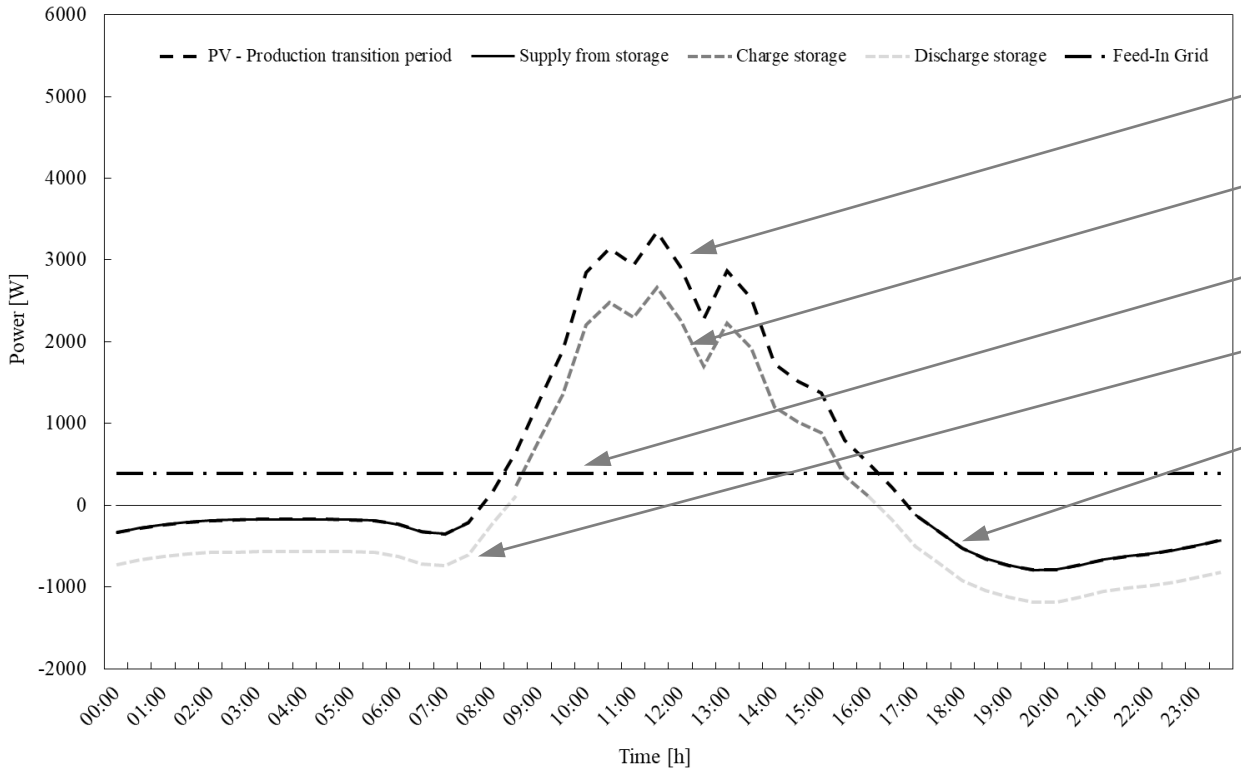

PV – Production

Charging BSS

Feed – In Grid

Discharging BSS

Supply from storage

- **Seasonal**

  Power supply: 392 W

Technical results – Seasonal free storage capacity

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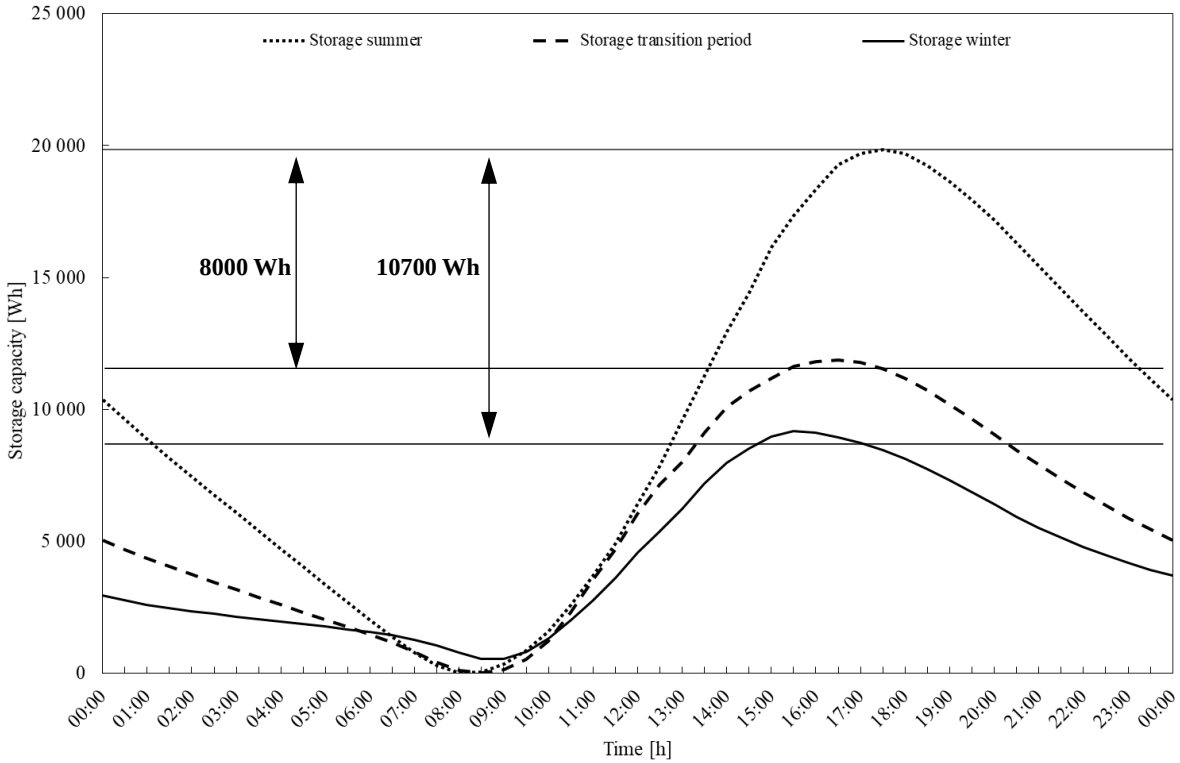

- Storage of excess elecitricity from the grid
- **Transition period: 8000 Wh**
- **Winter: 10700 Wh**

Economic results – Cash flow

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Expenditures				
Investment costs				
PV system	8.7	kWp		
	1250	EUR/kWp	10844	EUR
BSS	19.8	kWh		
	200	EUR/kWh	3968	EUR
Energy Manager			500	EUR
Operation costs				
Maintanance, insurance, counter	282	EUR/a	2845	EUR
	Sum Expenditure		18157	EUR
Revenues				
Supply to the grid	5994	kWh/a		
	348	EUR/a	3512	
Savings power purchase	4000	kWh/a		
	825	EUR/a	8323	EUR
	Sum Revenue		11835	EUR
	Financial gap		**6322**	**EUR**

- **Subsidies are necessary**

Conclusion and Outlook I

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- Single family house:
  - **8.7 kWp** Photovoltaic system
  - **19.8 kWh** Battery storage system
- System covers electricity demand even in winter
- System can profide seasonal base load
  - **Summer:** 1191 W – 5233 kWh
  - **Transition period:** 392 W – 760 kWh
- Free storage capacity

Conclusion and Outlook II

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- After 10 years:
  - Financial gap of 6322 EUR
  - Subsidies are necessary
- **Investment based subsidies**
  - PV: 351 EUR/kWp
  - BSS: 158 EUR/kWh
- **Feed – in tariffs**
  - Only for electricity feed into the grid: 10.55 cents/kWh
  - Whole produced electricity: 5.87 cents/kWh

Conclusion and Outlook III

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- **Not considered:**
  - Subsidies storing from the grid
  - Future increased electricity consumption due to electromobility and P2H
- Political frameworks for funding must be chosen
- Bilateral agreements between prosumer and energy supplier advantageous

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