

**RESOL®**  
CONTROL TECHNOLOGY

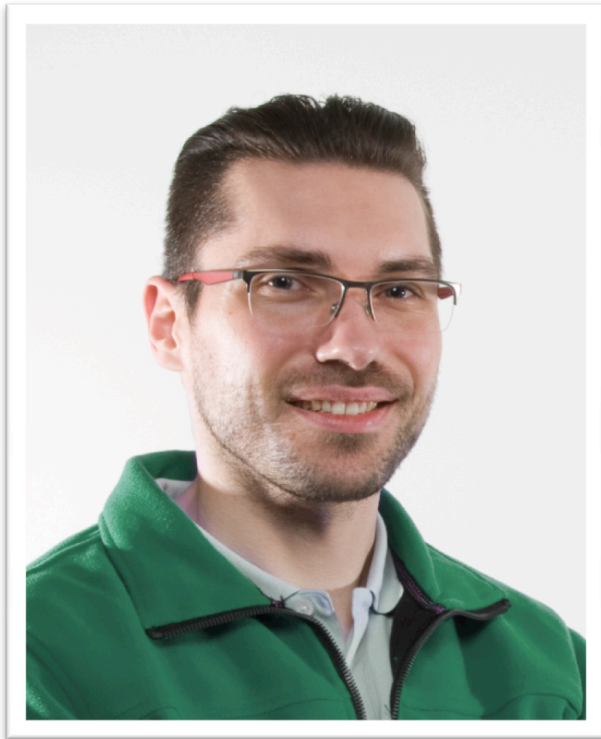


– Your competent partner in solar and heating controllers,  
visualisation and more

# Contents

- Company presentation
- Characteristics
- German Renewable Energy Sources Act (EEG) / price development (feed-in & purchase)
- Possibilities of self-consumption
- Domestic energy flow
- Monetary flow calculation of self-consumption / feed-in
- Optimisation of self-consumption

Welcome!



I am your host today

Tobias Jung

Product Manager

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Phone: +49 (0) 2324 / 96 48 767



## We set standards...

- Modern production technology and a high production depth
- Up to 2000 controllers per day
- 100 % Germany-based production
- State-of-the-art quality assurance technology such as an AOI station, etc.
- TÜV-certified according to ISO 9001





## Our own ideas...

- In-house Research & Development division
- Cooperations with universities and research institutes
- Extensive in-house lab facilities for electromagnetic and hydraulic testing
- Testing of our own as well as, if our customers so wish, third-party products under real-life conditions

# Product overview



- Simple solar controllers
- Controllers for solar and combined systems
- System controllers



- Heating controllers



- DHW exchange controllers



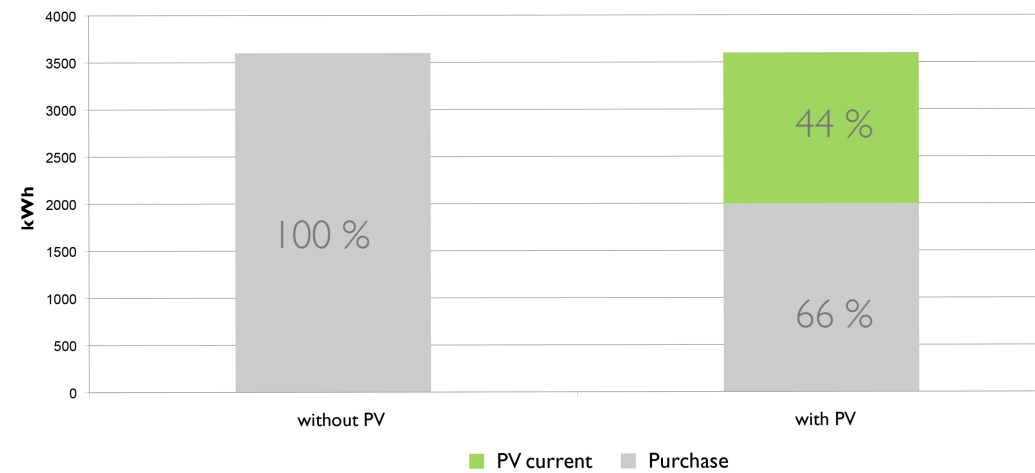
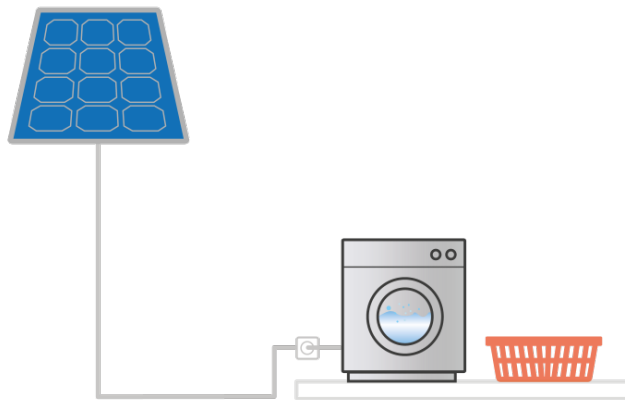
- PV heating



- Accessories

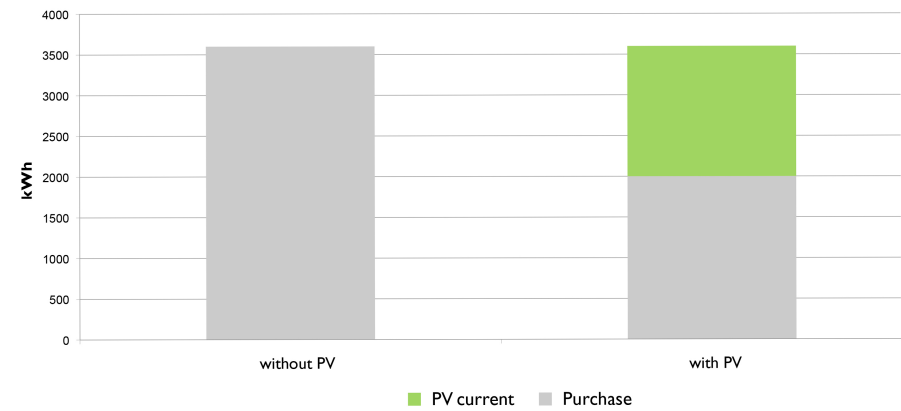
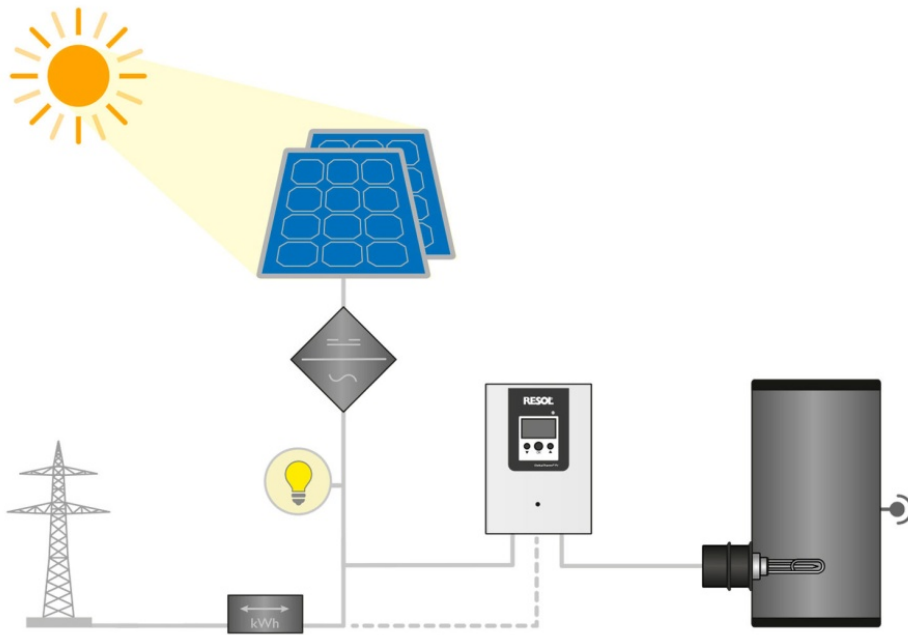
# Self-consumption characteristics

- Self-consumption rate = rate of PV current produced consumed on site.
- Degree of independence = rate of self-consumed PV current in annual consumption.



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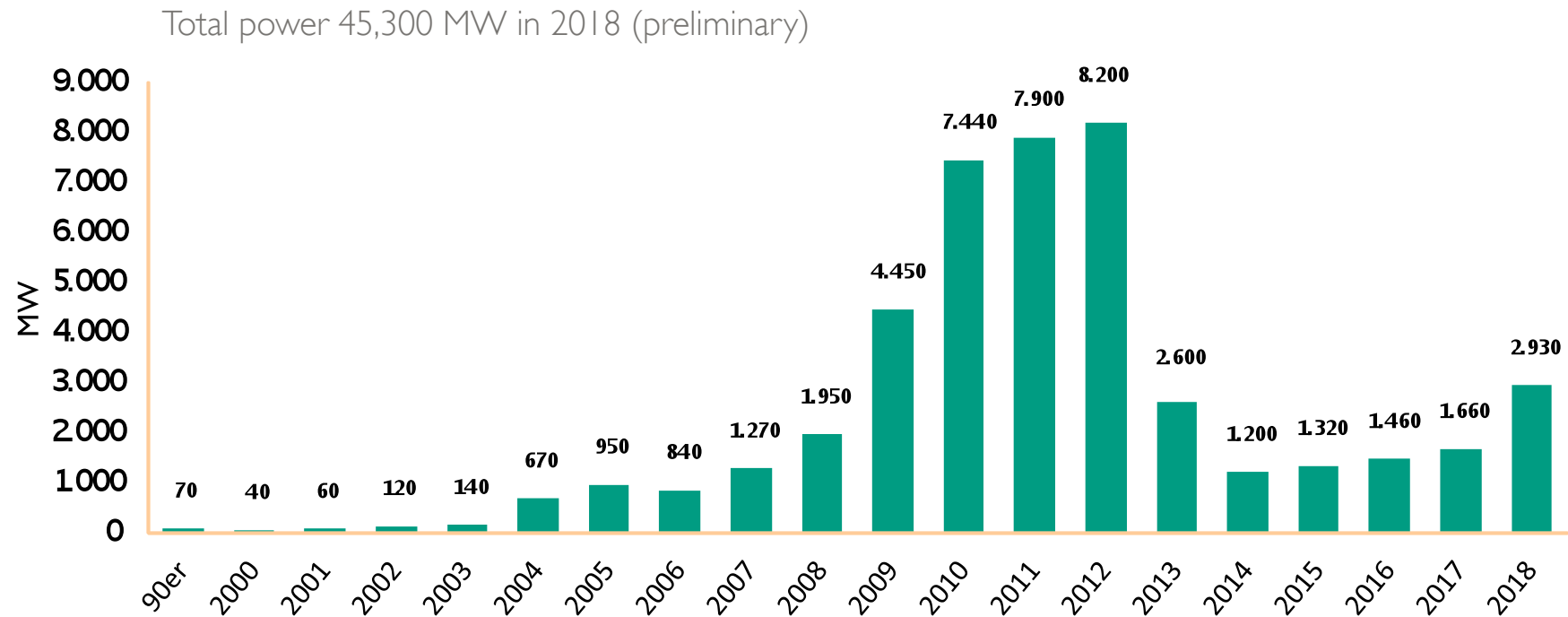




## EEG legal situation after 2020

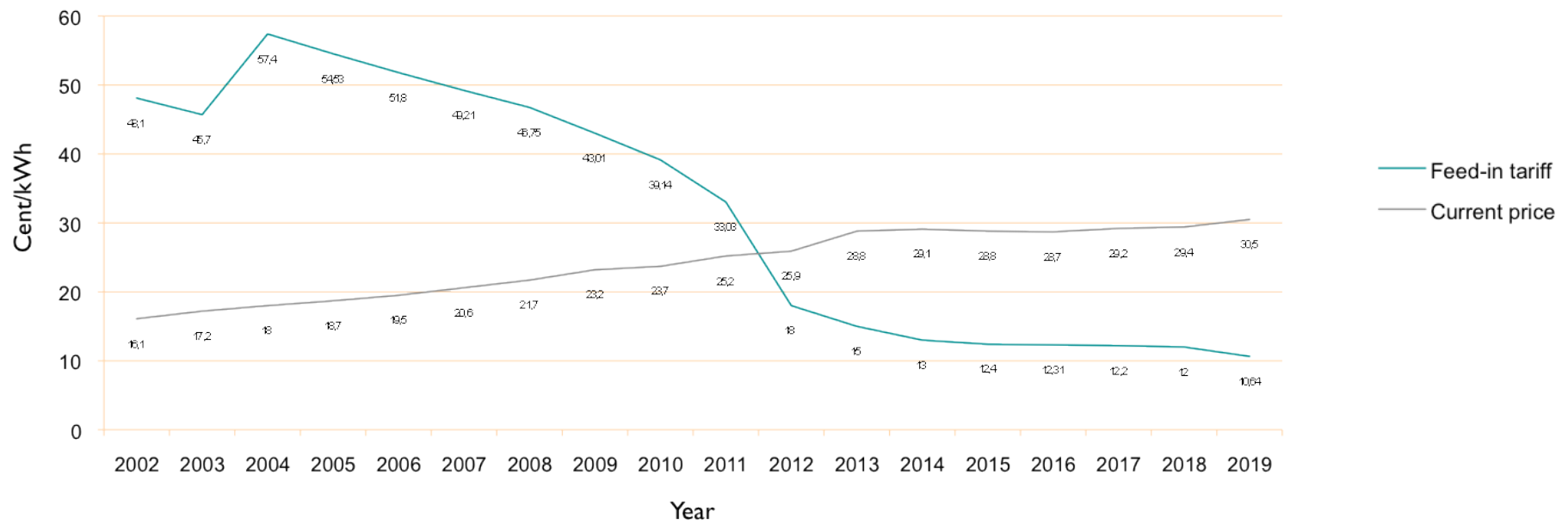
- Obligation to connect the PV system
- Obligation to prior acceptance of the current produced
- No obligation to pay further feed-in tariffs
  
- New systems: no feed-in tariffs paid after the 52 GWp limit has been reached?
- Current state: approx. 46 GWp

# Newly installed PV power in Germany



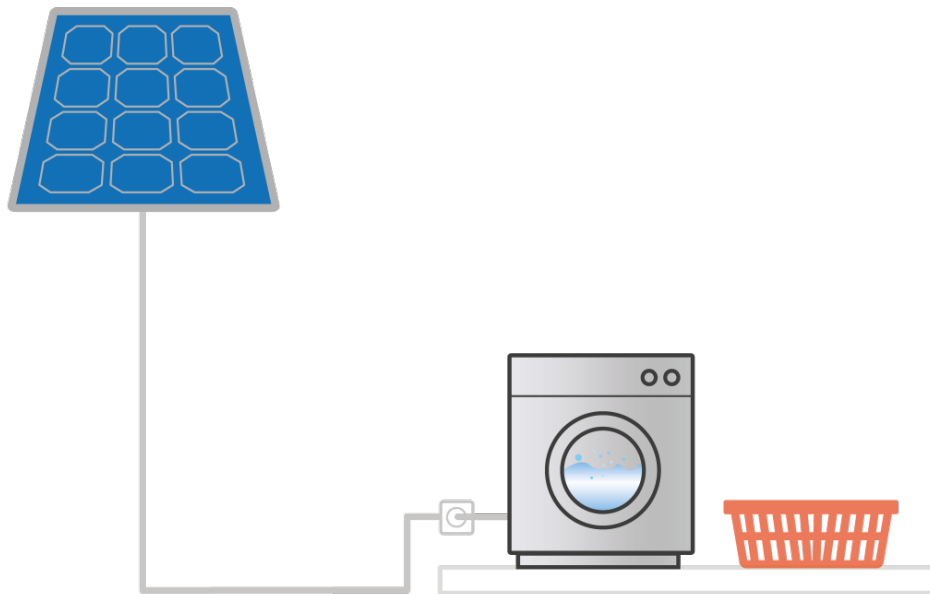
Source: IWR, BMWI, AG Energiebilanzen

# Current price development and EEG feed-in tariffs for rooftop systems

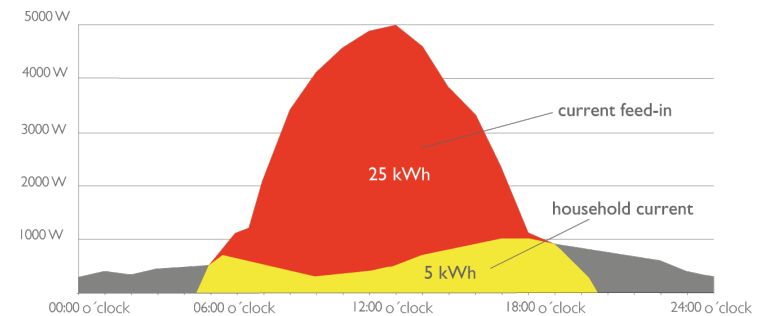


Sources: Stromvergleich.com, EEG

## Direct self-consumption for household current

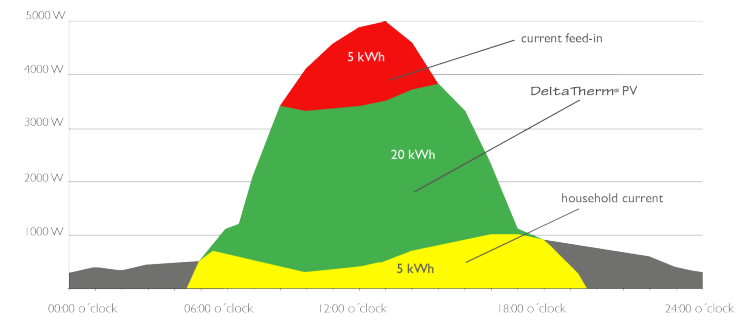
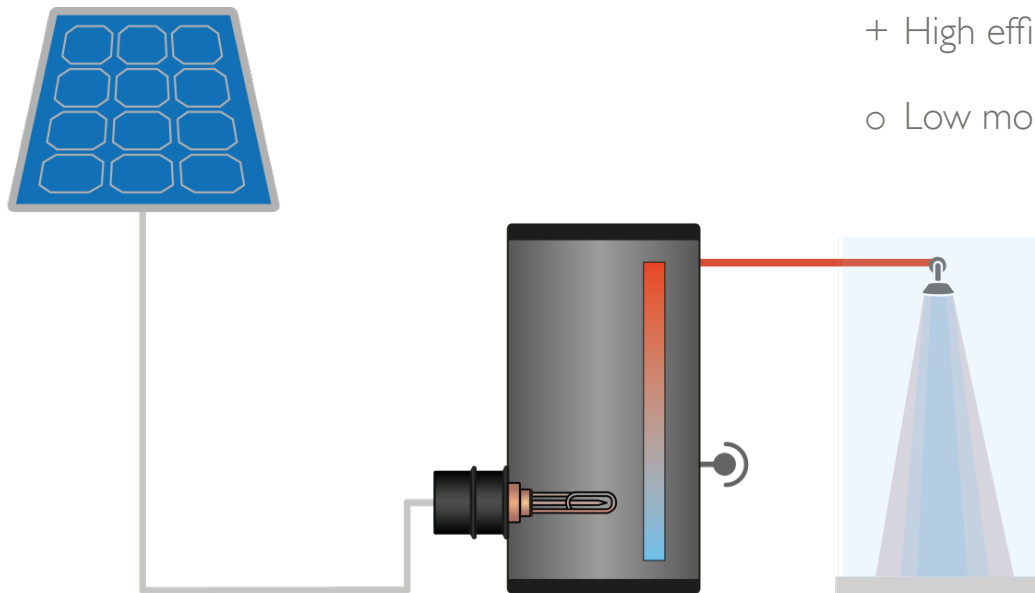


- + No modifications and investments required
- + Production and consumption at the same time
- + High savings potential of 30 cts / kWh
- + Self-consumption rate of approx. 30 %
- + High efficiency
- Adaptation to user behaviour



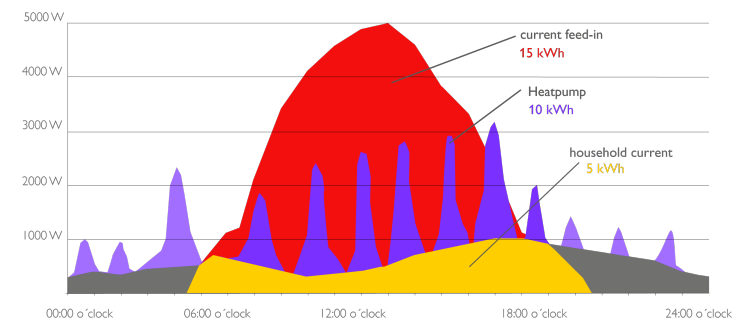
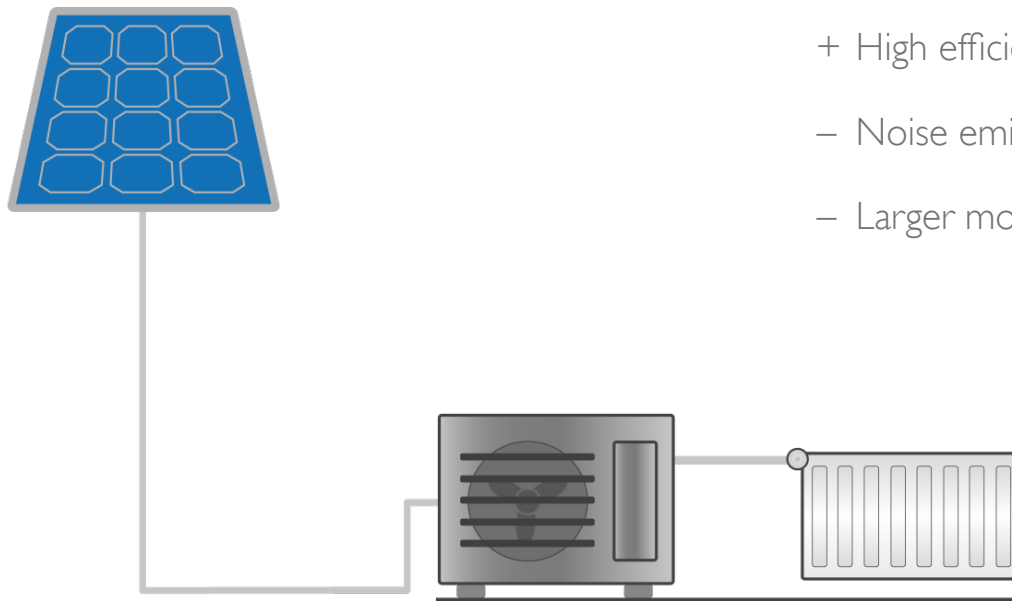
## Direct self-consumption for water heating (Power to Heat)

- + Separation of production and consumption
- + Medium savings potential of 7 cts / kWh (gas / oil)
- + Increase in self-consumption of approx. 30 ... 40 %
- + High efficiency factor of approx. 98 %
- o Low modifications and investments required



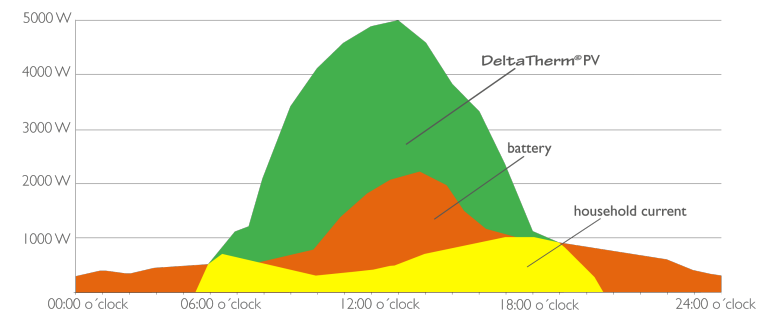
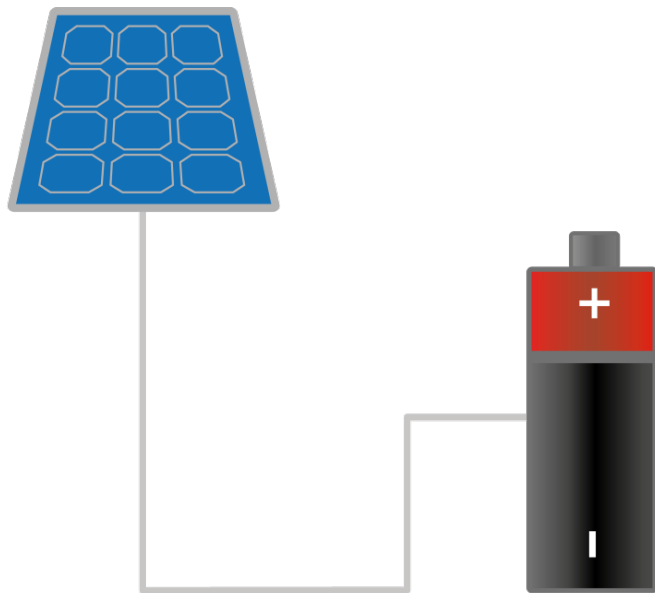
## Direct self-consumption for water heating (heat pump)

- + Separation of production and consumption
- + High savings potential of 30 cts / kWh (current)
- + Increase in self-consumption of approx. 20 %
- + High efficiency
- Noise emission
- Larger modifications and higher investments required

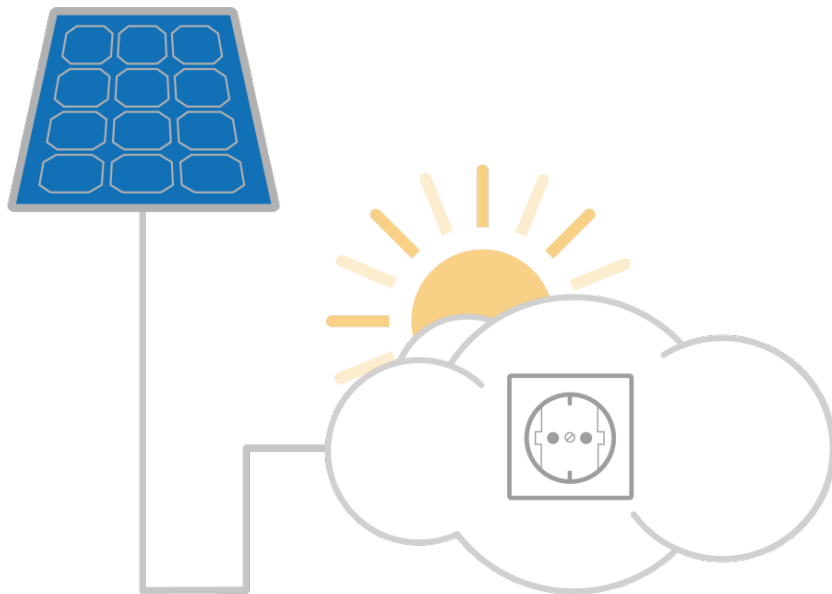


## Direct self-consumption for household current (battery)

- + High savings potential of approx. 30 cts / kWh
- + Increase in self-consumption of approx. 30 ... 40 %
- + Separation of production and consumption
- Charging and discharging: losses of 10 ... 20 %
- Modifications and higher investments required (battery)



## Direct self-consumption via current cloud (battery)

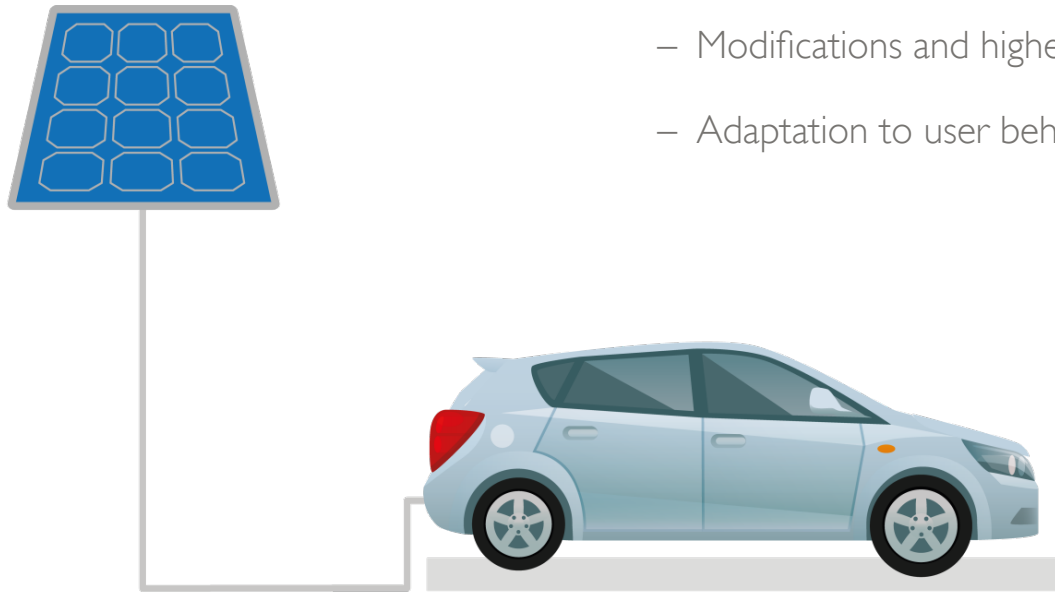


- + High savings potential of approx. 30 cts / kWh
- + Self-consumption of 100 %
- + Separation of production and consumption
- Dependency on the provider
- AC-coupled battery required
- Capacity and access for the provider (peak load current)
- Losses of up to 20 % through grid transmission
- Modifications and higher investments required (battery)

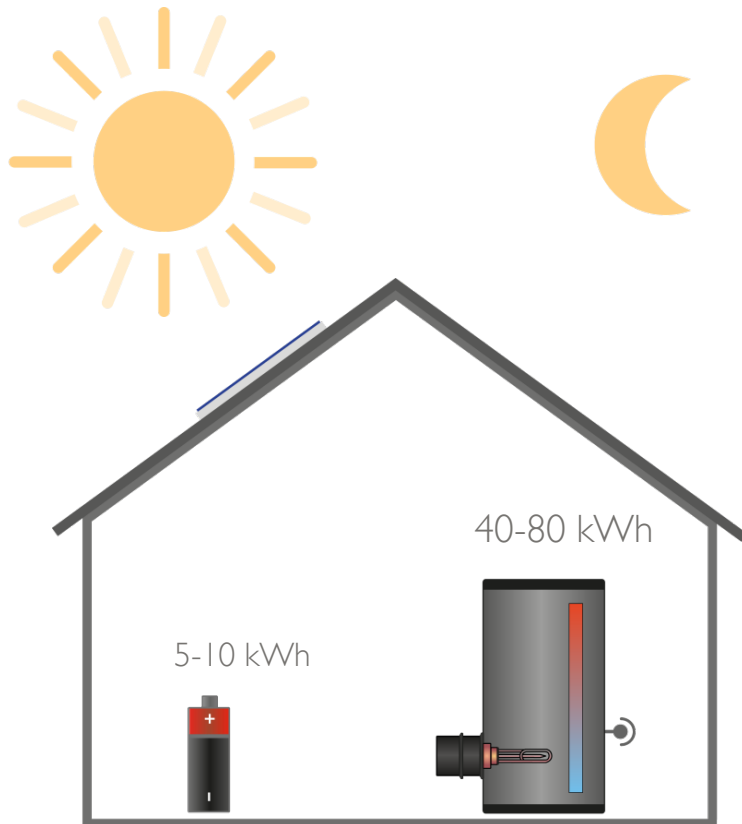


## Direct / indirect self-consumption for mobility

- + High savings potential of 30 cts / kWh
- + Self-consumption of 100 %
- Production and consumption at the same time, or very large battery
- Modifications and higher investments required (battery, wallbox)
- Adaptation to user behaviour

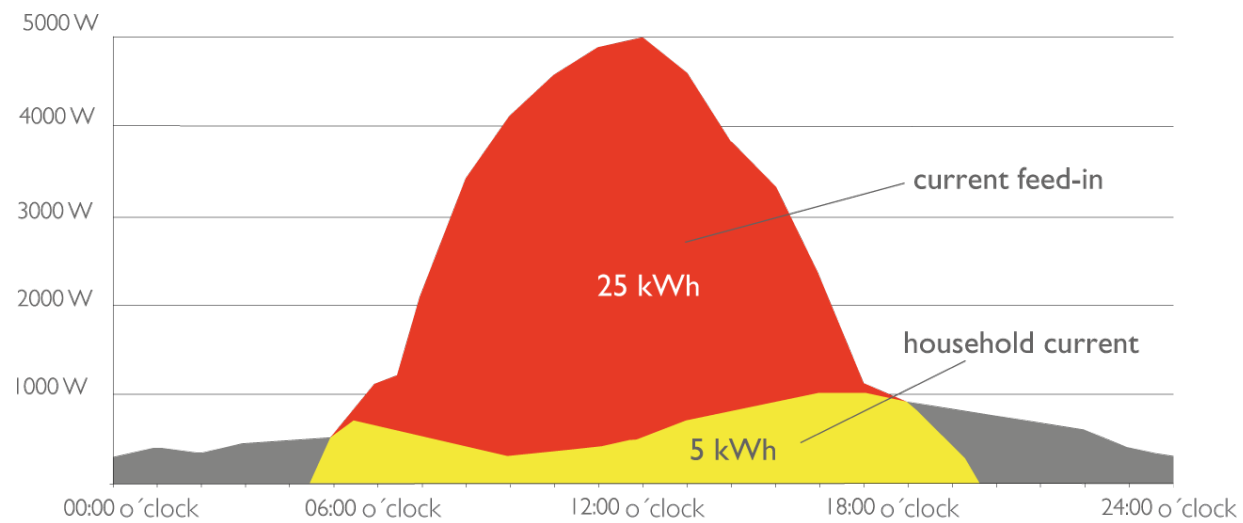


## Comparison between storage capacities



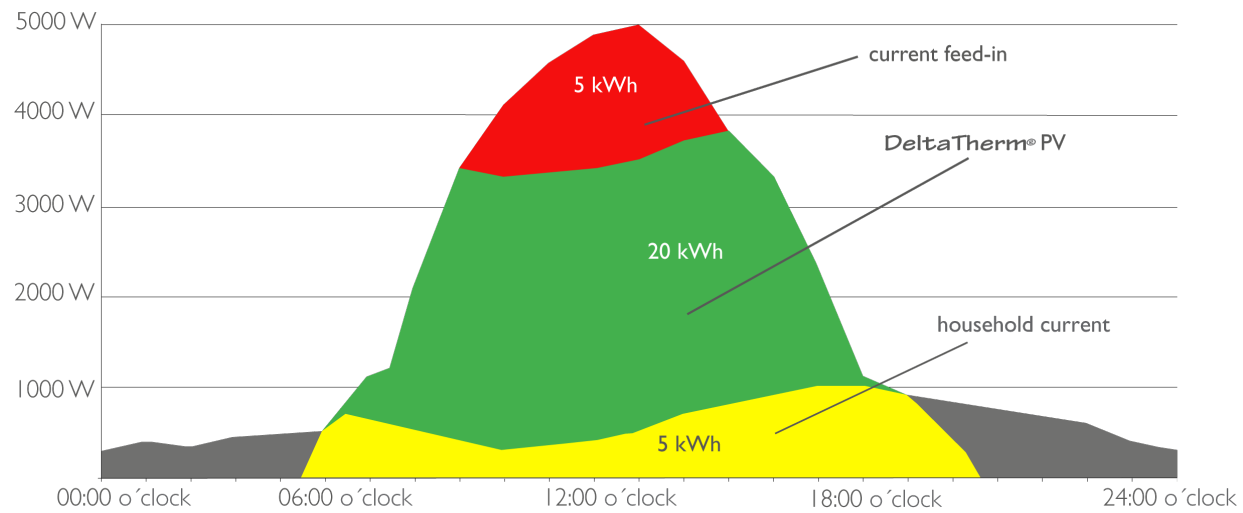
- Water is a cost-effective storage medium
- Water has an unlimited life time cycle and is not flammable
- Water has a high thermal capacity, approx. 80 kWh in 1000 l
- Rule of thumb: approx. 1 kWh per 10 K in 100 l
- Heat storage for several days

# Energy profile of a PV system



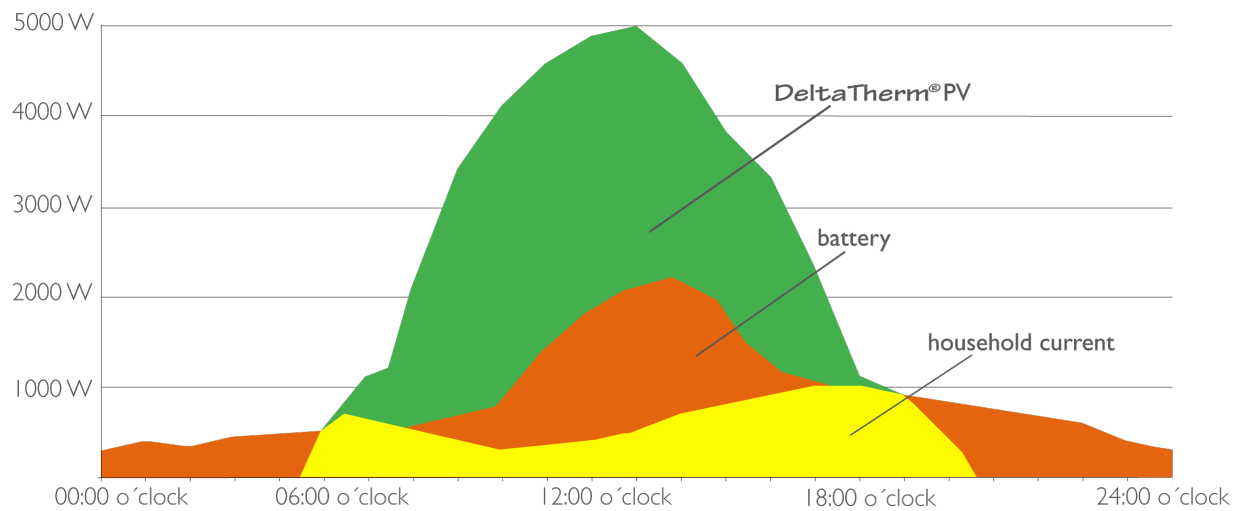
Daily profile of a 5 kWp PV system (example) with direct consumption for household and feed-in

# Energy profile of a PV system



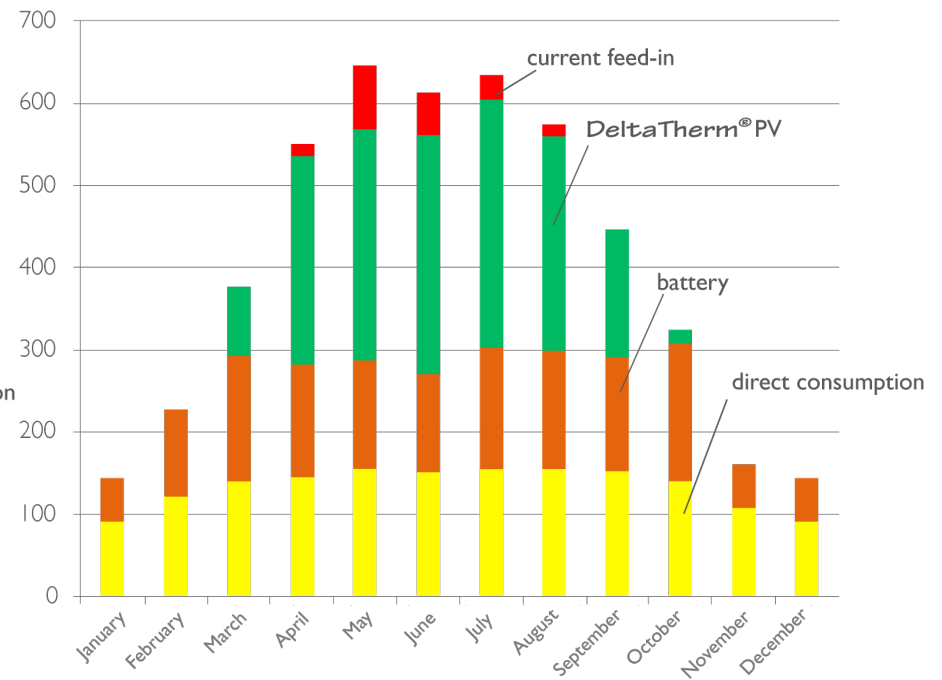
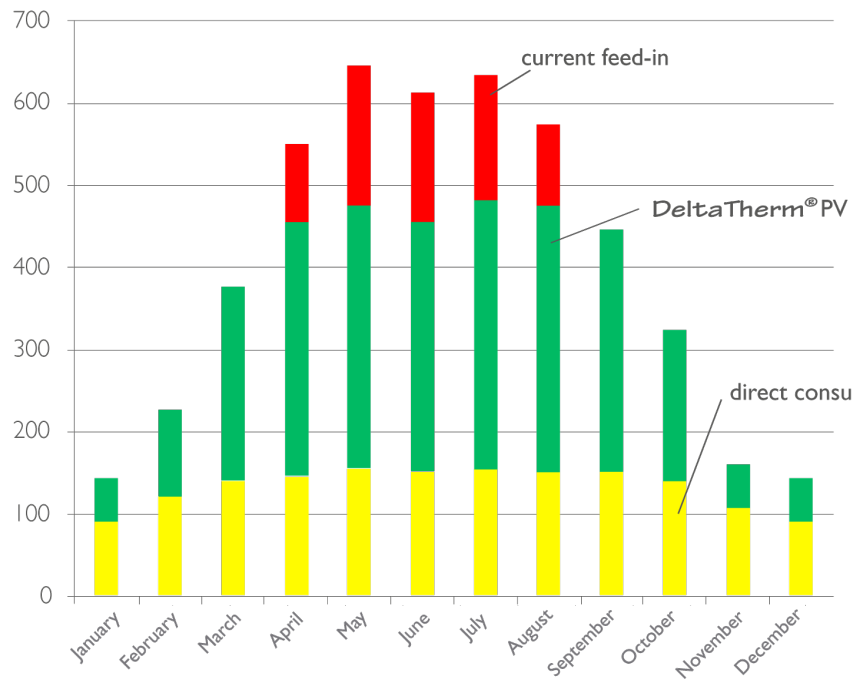
Daily profile of a 5 kWp PV system (example) with heat storage via the DeltaTherm<sup>®</sup> PV controller or the FlowSol<sup>®</sup> E

# Energy profile of a PV system



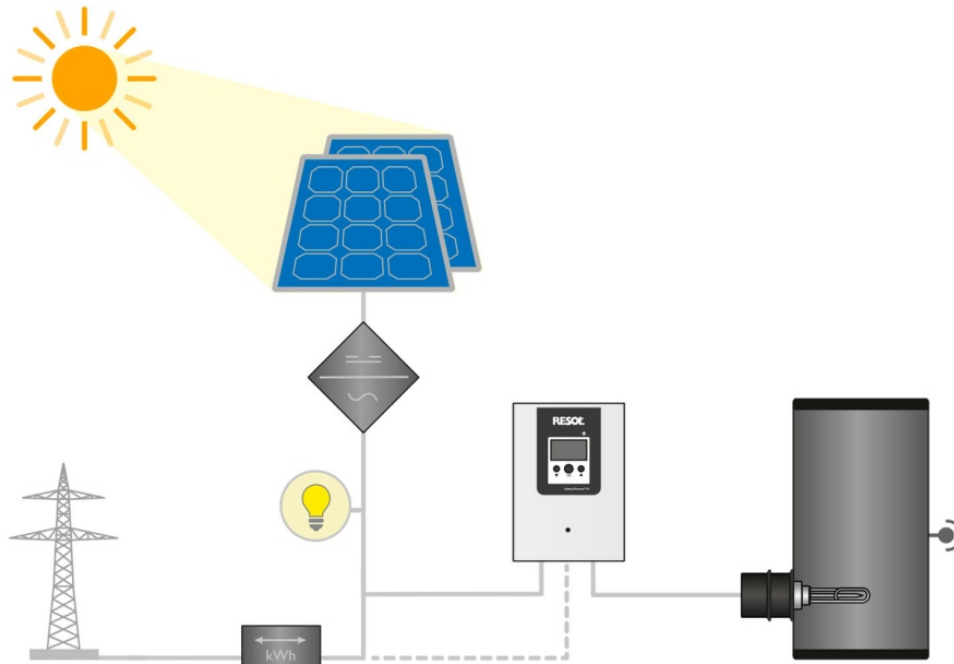
Daily profile of a 5 kWp PV system (example) with heat storage via the DeltaTherm® PV controller or the FlowSol® E and current storage via a 5 kWh battery

# Annual profile self-consumption rate of a 5 kWp PV system



Annual profile of a 5 kWp PV system (example) with heat storage via the DeltaTherm® PV power-to-heat controller or the FlowSol® E with and without current storage in a 5 kWh battery

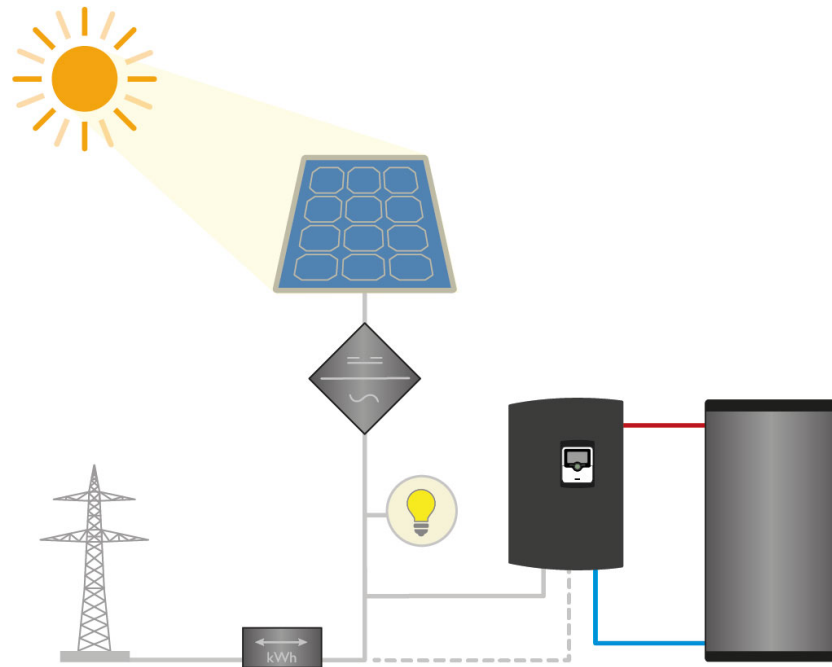
## Function principle of a power-to-heat system



- Household current priority
- Excess current detection
- Redirection to electric heater
- Stepless variable up to 3 kW
- Conversion into thermal energy
- Loading up to maximum store temperature
- Use for hot water (room heating)

PV system with DeltaTherm® PV power-to-heat controller with DeltaTherm® E sensor measuring unit and electromechanical 3 kW immersion heater in a buffer store

## Function principle of a power-to-heat system (external)

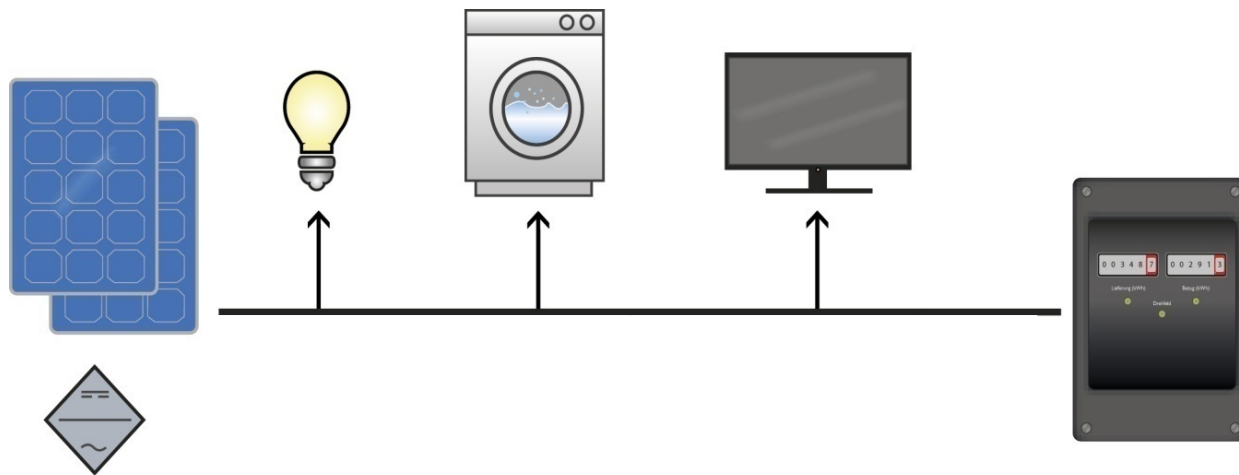


- Household current priority
- Excess current detection
- Redirection to an external electric heater
- Stepless variable to 3 kW
- Conversion into thermal energy
- Generation of a target flow temperature
- Store loading in layers
- Loading to maximum return temperature
- Use for hot water (room heating)

PV system with FlowSol® E electrothermal station with DeltaTherm® E sensor measuring unit connected to a buffer store

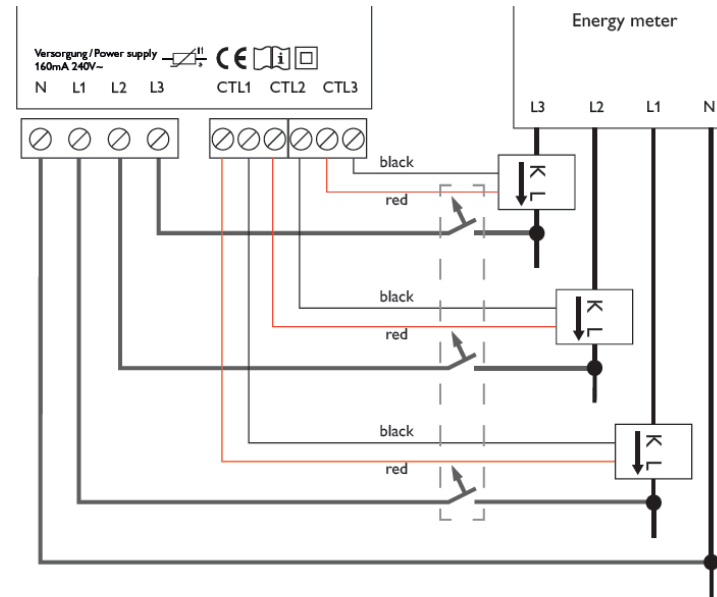
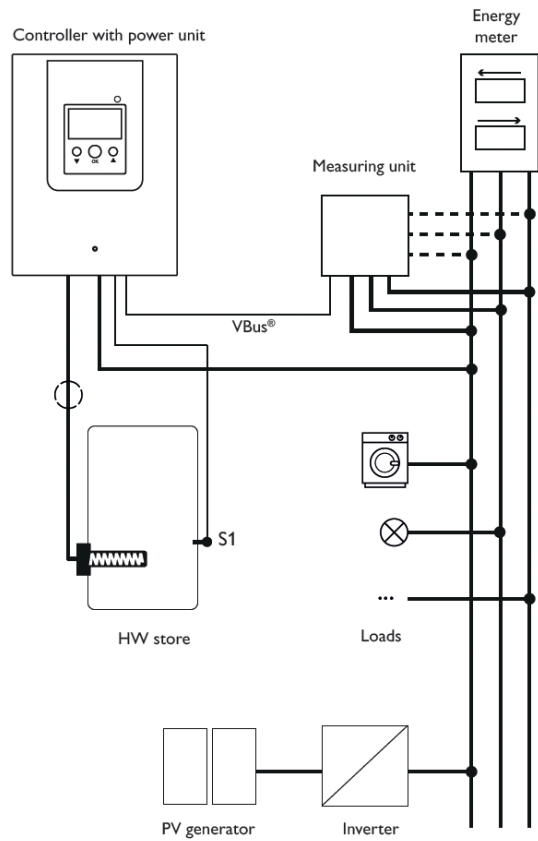


## Integration of a power-to-heat system in the house grid



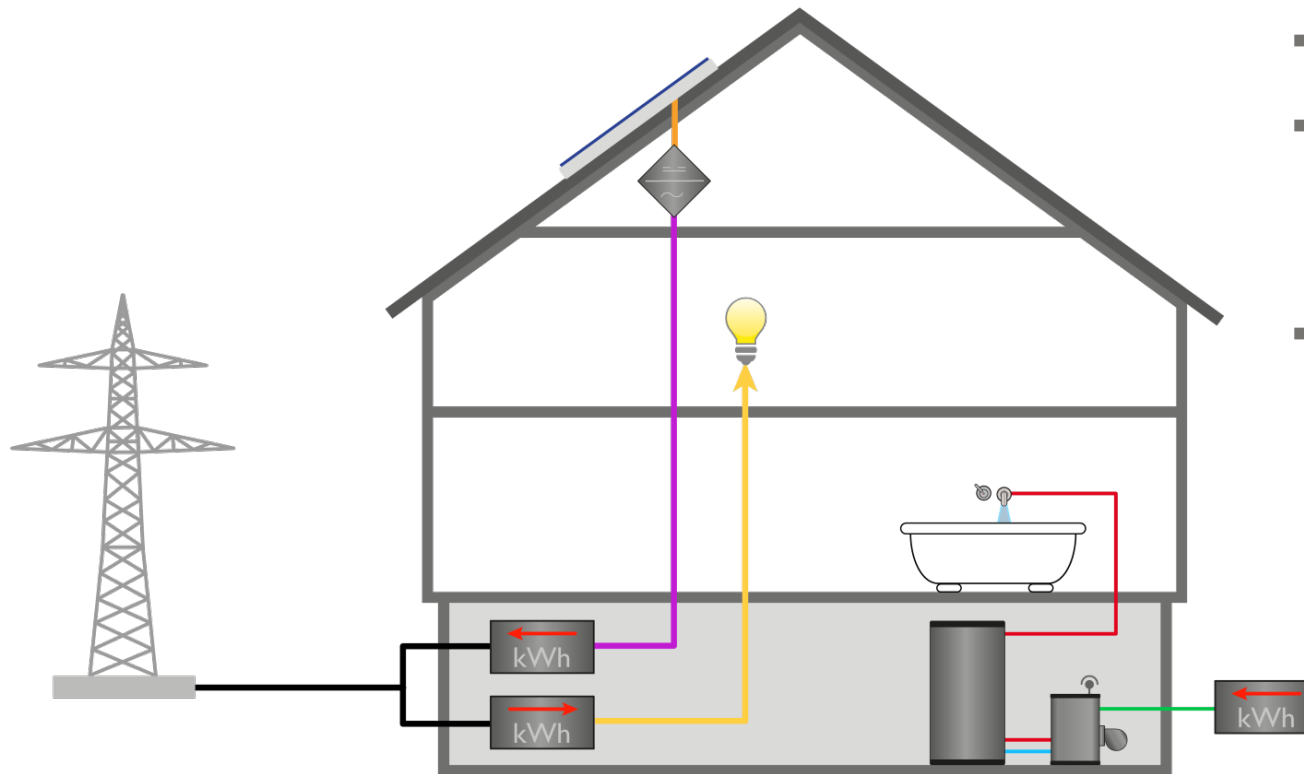
Connection (simplified) of the DeltaTherm® PV power-to-heat controller with DeltaTherm® E sensor measuring unit in the house grid with PV system

# Integration of the DeltaTherm<sup>®</sup> E sensor measuring unit



Connection (simplified) of the DeltaTherm<sup>®</sup> E sensor measuring unit with 3 current sensors directly at the energy meter

## Example: System with feed-in



- PV: 5 kWp; 4,800 kWh/year
- 4-person household:
- Electricity consumption:  
~10 kWh/day  
~3,600 kWh/year
- Hot water production:  
~10kWh/day  
~3,600 kWh/year

## Example: System with feed-in

### Energy costs

Feed-in tariff:  $4,800 \text{ kWh} \times 0.50 \text{ €} = 2,400 \text{ €}$

Electricity purchase:  $3,600 \text{ kWh} \times 0.30 \text{ €} = 1,080 \text{ €}$

Hot water production

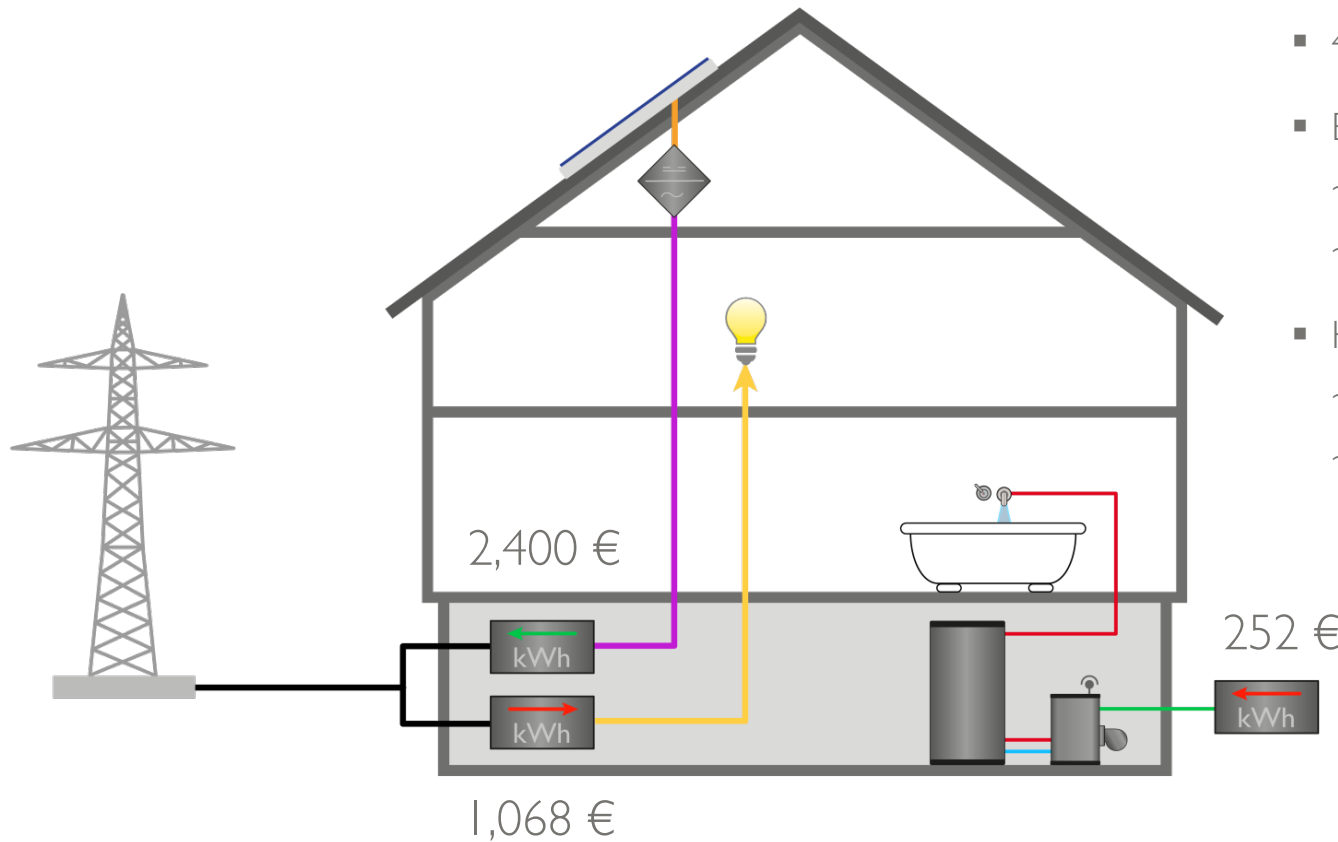
(natural gas approx. 7 cts/kWh):  $3,600 \text{ kWh} \times 0.07 \text{ €} = 252 \text{ €}$

Total energy purchase: 1,332 €

Profit: 1,068 €

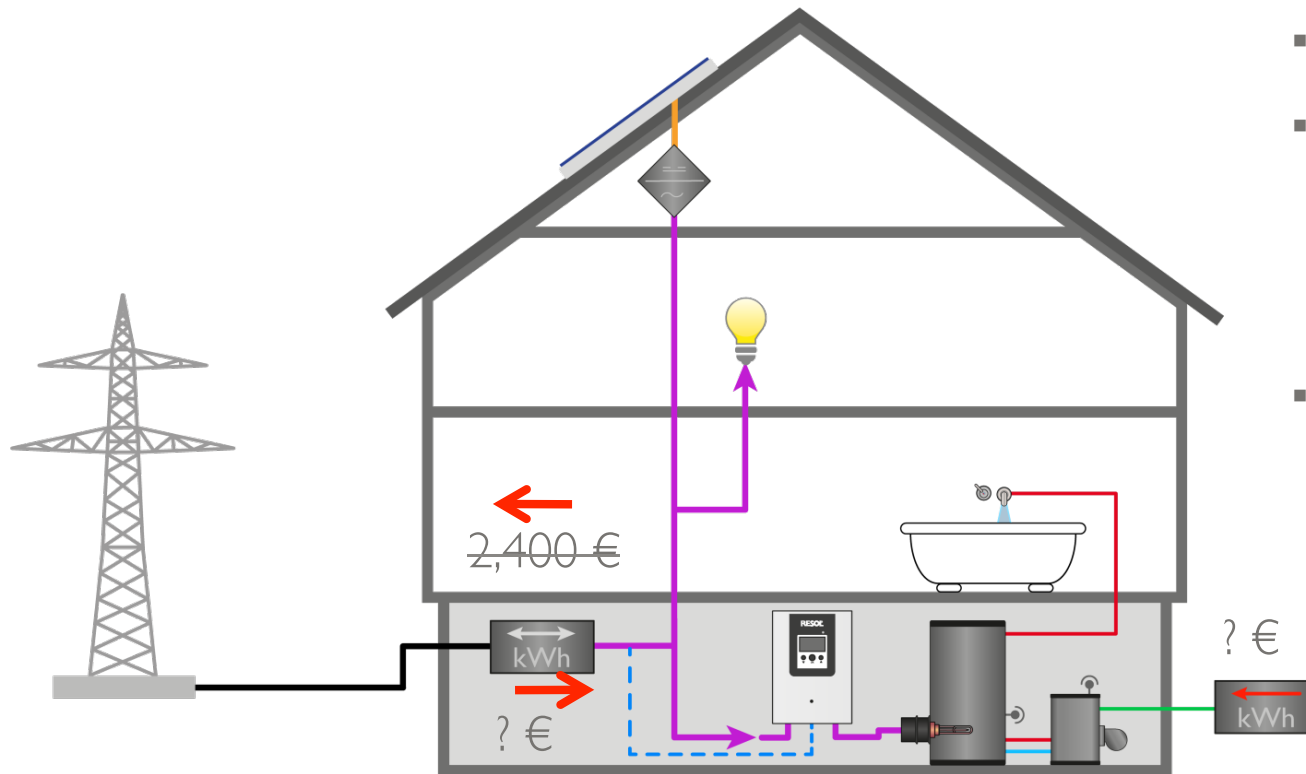
- PV: 5 kWp; 4,800 kWh/year
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## Example: System with feed-in



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~10 kWh/day  
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- Hot water production:  
~10 kWh/day  
~3,600 kWh/year

## Example: Omission of feed-in tariffs



- PV: 5 kWp; 4,800 kWh/year
- 4-person household:
- Electricity consumption:
  - ~ 10 kWh/day
  - ~ 3,600 kWh/year
  - 30 % of the solar yield
- Hot water production:
  - ~ 10 kWh/day
  - ~ 3,600 kWh/year
  - 40 % of the solar yield

## Example: Omission of feed-in tariffs

Self-consumption: Household current approx.  $1,440 \text{ kWh} \times 0.30 \text{ €} = 432 \text{ €}$

Electricity purchase:  $2,160 \text{ kWh} \times 0.30 \text{ €} = 648 \text{ €}$

Excess:  $3,360 \text{ kWh} \times 0 \text{ €} = 0 \text{ €/a}$

Hot water production

Electric  $1,920 \text{ kWh} \times 0.07 \text{ €} = 134 \text{ €}$

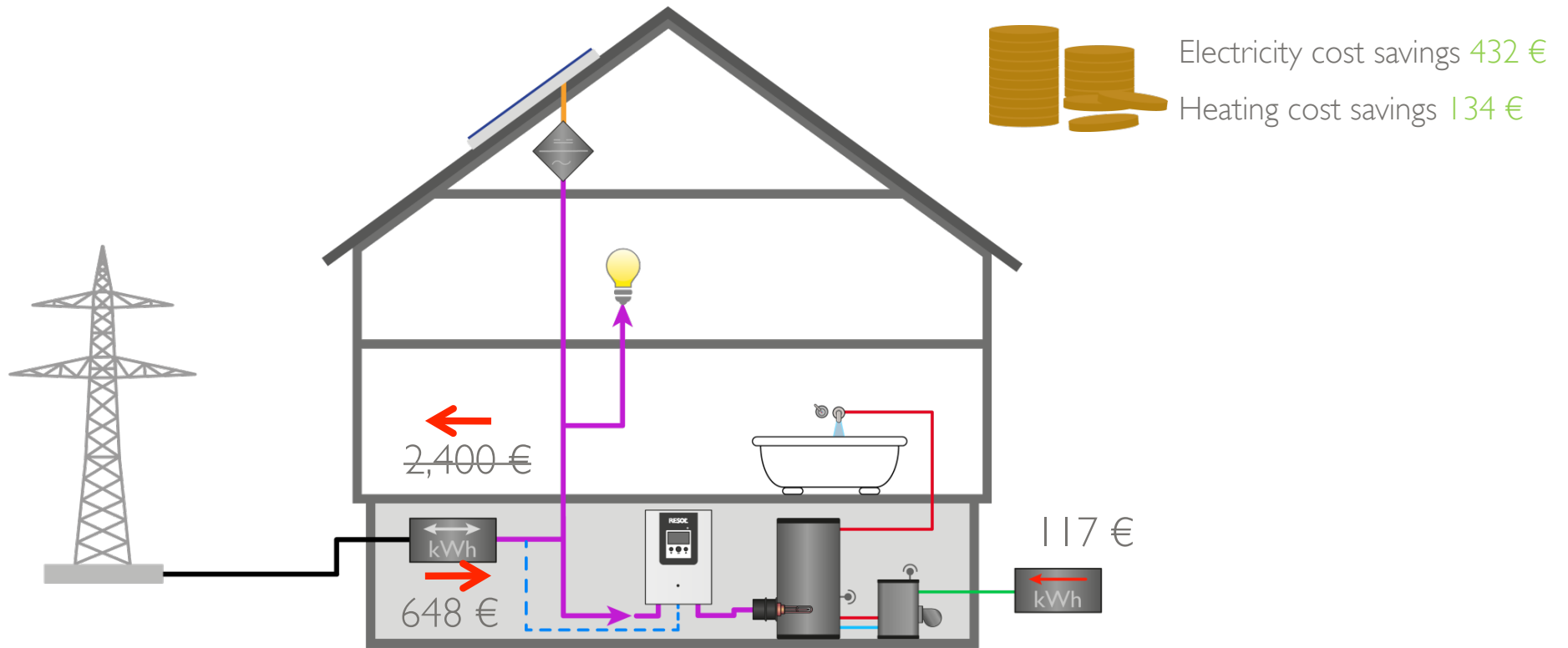
Purchase (natural gas approx. 7 ct/kWh):  $1,680 \text{ kWh} \times 0.07 \text{ €} = 117 \text{ €}$

Total energy purchase: 765 €

Savings:  $1,332 \text{ €} - 765 \text{ €/a} = \underline{567 \text{ €}}$

- PV: 5 kWp; 4,800 kWh/year
- 4-person household:
- Electricity consumption: 3,600 kWh  
30 % of the solar yield  
PV: 1,440 kWh  
Grid: 2,160 kWh
- Hot water production: 3,600 kWh  
40 % of the solar yield  
PV: 1,920 kWh  
Boiler: 1,680 kWh

# Example: Omission of feed-in tariffs





## Functions of the DeltaTherm® PV

- Direct control of an electric immersion heater
- Stepless variable and grid compliant
- Heat production with excess current
- Can be used with all PV systems
- Controller with display and status LED
- RESOL menu system with date and time
- SD card for logging, saving / loading and for firmware updates
- Maximum store temperature, power and reserve are adjustable

Beginning with version 1.02:

- Backup heating with mains current (optional)
- 0-10V control (no measuring unit)

# Contents DeltaTherm® PV



Controller with power unit

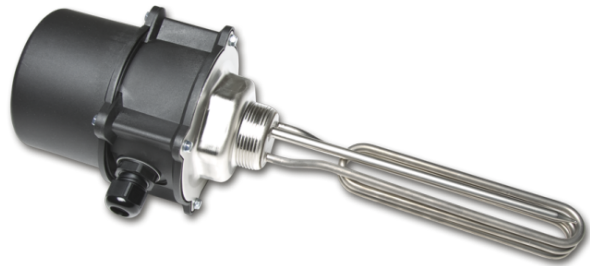


Measuring unit

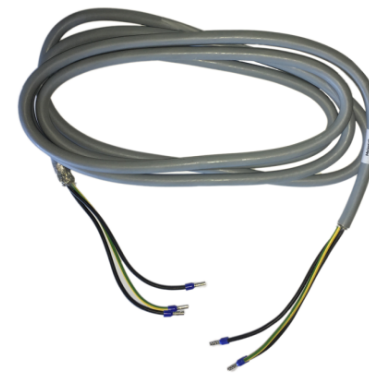


3 current sensors

## Contents Electric immersion heater



Electric immersion heater 3 kW



5 m shielded connection cable 3 x 2.5 mm<sup>2</sup>

# Contents FlowSol® E



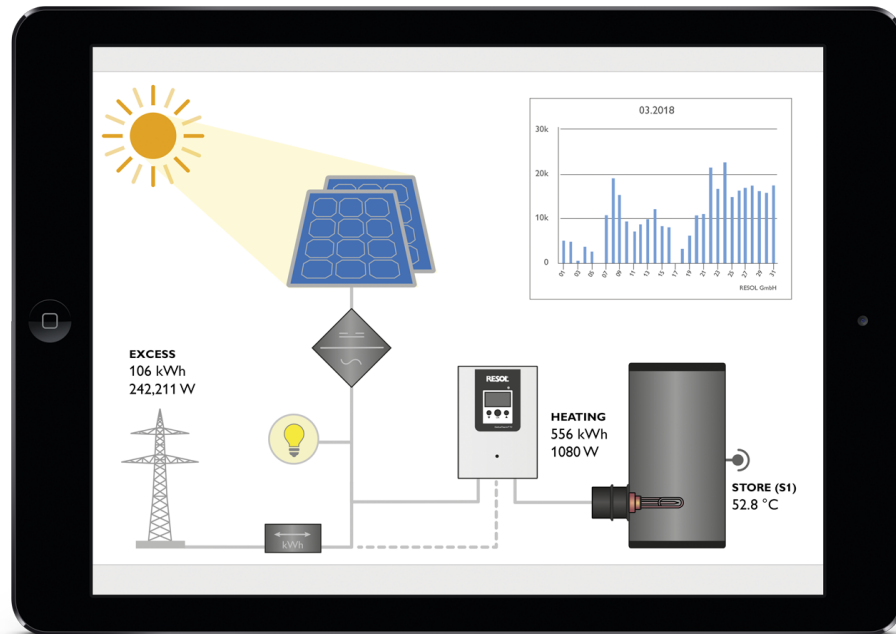
FlowSol® E



Measuring unit 3 current sensors

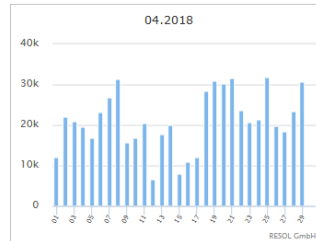
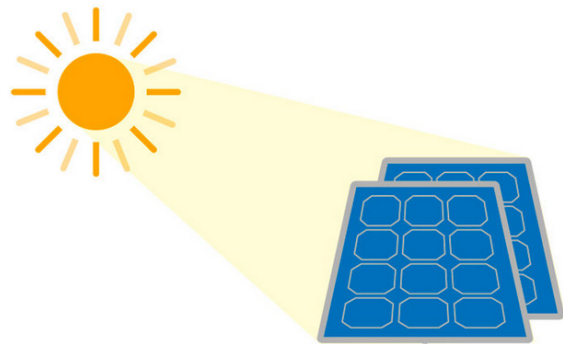


# Visualisation with VBus.net



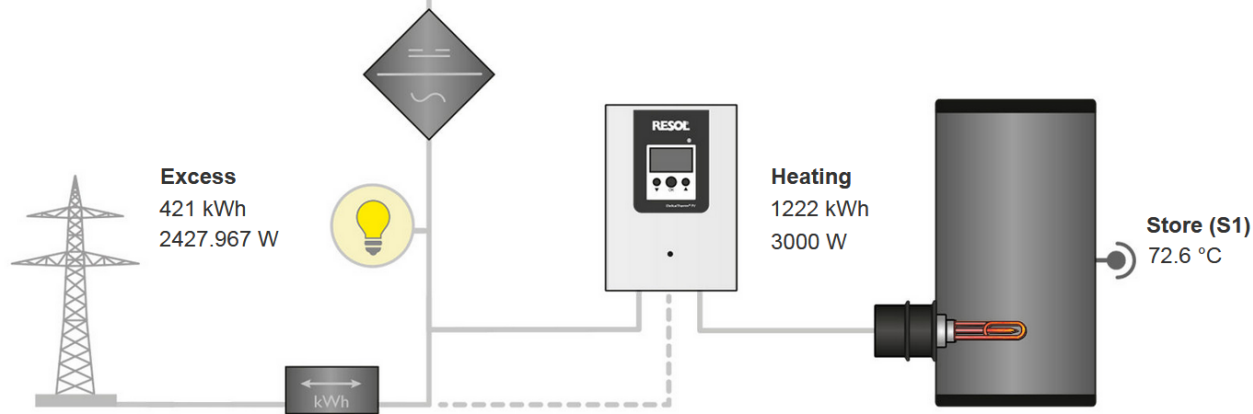
The Internet portal for easy and secure access to your system data

# Visualisation with VBus.net



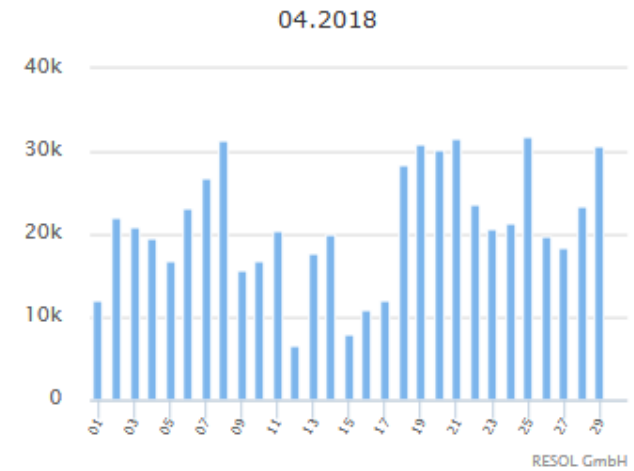
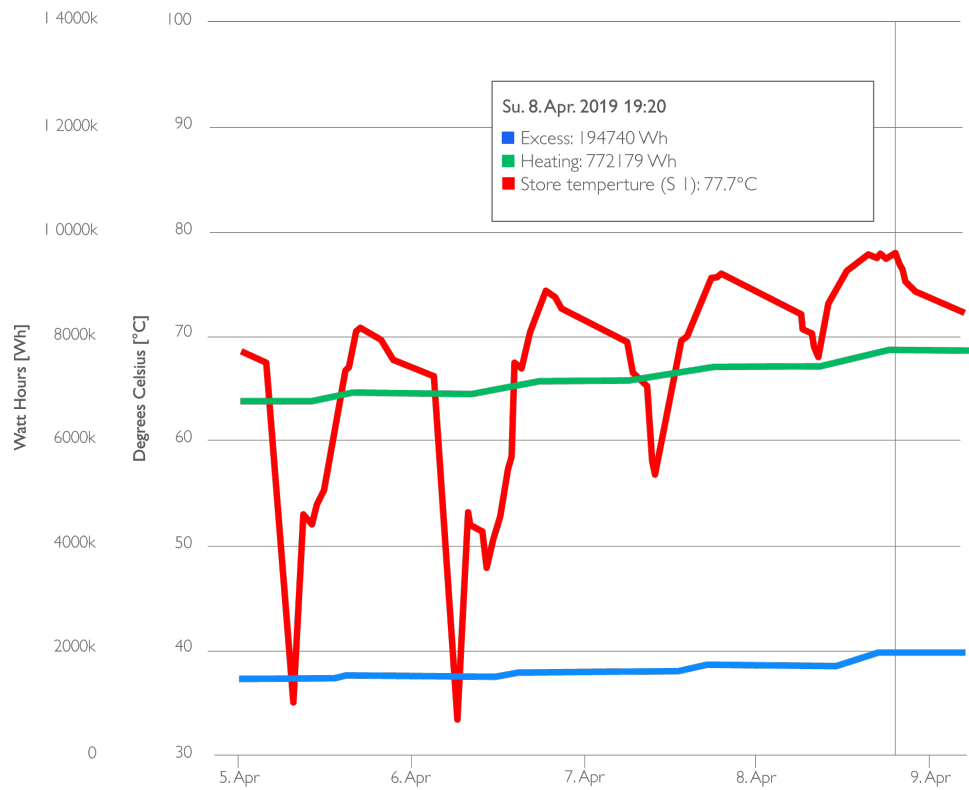
30.04.2018 13:46:25

<b>Location</b>	Austria
<b>PV system</b>	9 kWp East/West
<b>Inverter</b>	7,5 kW
<b>Store</b>	500 Liters



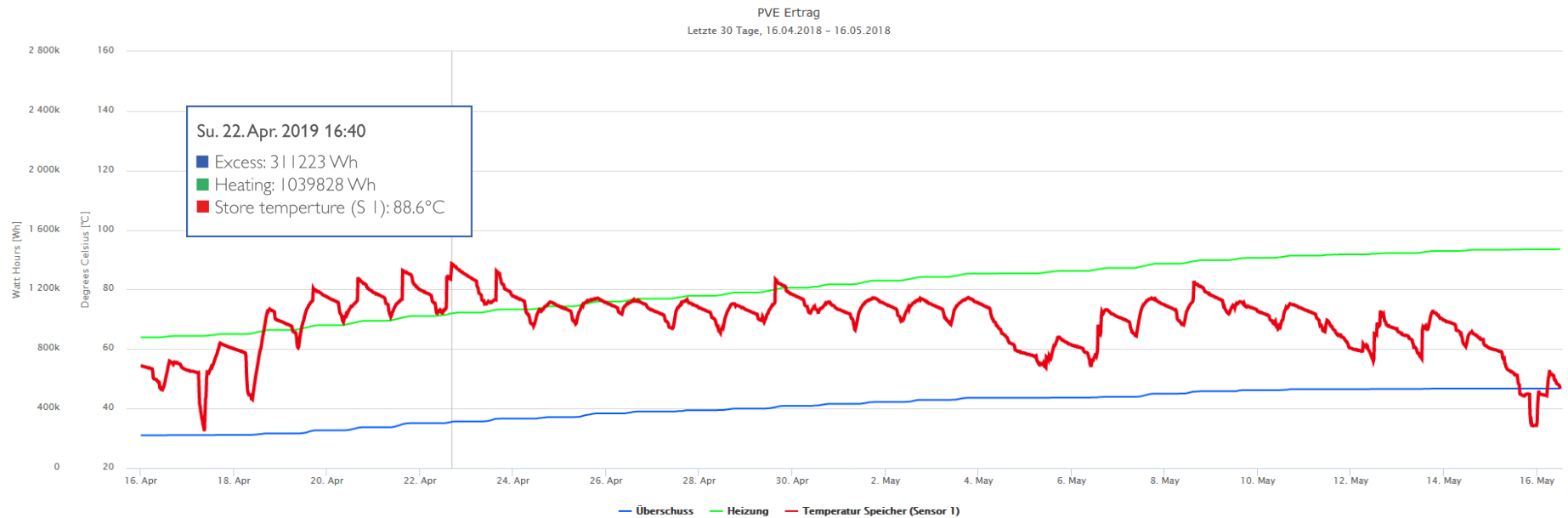
9 kWp PV system (east/west collectors) with 500 l buffer store and DeltaTherm® PV with 3 kW immersion heater, location: Carinthia

# Visualisation with VBus.net



Temperature profile of a 500 l buffer store with a 9 kWp PV system (east/west collectors) and DeltaTherm® PV with 3 kW immersion heater

# Visualisation with VBus.net

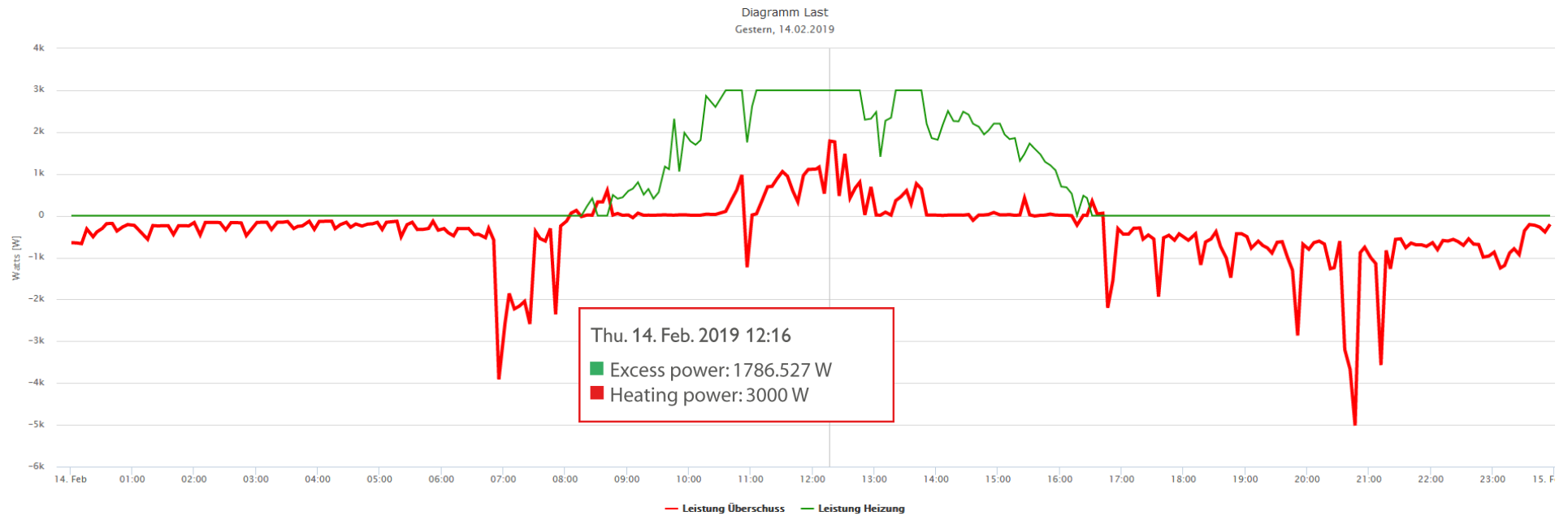


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Temperature profile of a 500 l buffer store with a 9 kWp PV system (east/west collectors) and DeltaTherm® PV with 3 kW immersion heater



# Visualisation with VBus.net



Daily profile heating and excess of a 7 kWp PV system with FlowSol® E, location: Ulm, 17 kWh heating on 14.02.2019

## Power-to-Heat conclusion

- Easy installation
- Suitable for any PV system
- Household current priority
- Increase in self-consumption of PV current
- Stepless variable and grid-compliant, no use of mains current
- Reduction of heating costs, relief of heating system in summer

## Power-to-Heat conclusion

- Water is a cost-effective storage medium with an unlimited life time cycle
- High thermal capacity with heat storage for several days
- Noiseless, low maintenance, no moving parts
- Local energy production and consumption
- Relief of grids

Have you seen it?



The Internet portal for easy and secure access to your system data



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[www.resol.com](http://www.resol.com)