# Results comparative calculation of energy systems

Project name: AKH Wien-Nord

Project number: 0987654

Project part: Anbau Psychyatrie

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*All results are rounded to nearest whole number. The values used for energy-prices represent estimated cost forecasts last updated 2024. A cost spread of around 20% is possible.*

A-1060 Wien, Gumpendorfer Straße 132/1/9
Tel: +43 (0)1/535 21 23; Fax: +43 (0)1/535 21 23 30; E-Mail: office@kppk.at
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# Input values/Energy requirement

| Known input values | |
|---|---|
| Building type | Single family home |
| Heat-load | 5.000 W |
| Household / business electricity demand (HHED/BSB) | 4.000 kWh/a |
| Operating hours | 1.800 h |
| People | 4 |

| Determined energy requirement | |
|---|---|
| Heat-load | 5 kW |
| Cooling-load | 20 kW |
| Annual energy req. hot water | 4.015 kWh/a |
| Annual energy req. room heating | 9.000 kWh/a |
| Annual energy req. electricity (HHED) | 4.000 kWh/a |

| Solar thermal system | |
|---|---|
| Flat plate collector area (FPC) | 20 $m^2$ |
| FPC costs per $m^2$ | 375.75 €/$m^2$ |
| Collector angle | 30 ° |
| Collector orientation ( south-east/west-north ) | 0 ° |
| Horizontal solar radiation | 1084 kWh/$m^2$ |

| Base costs | | | | |
|---|---|---|---|---|
| | Labor price | Base price | Performance price | rcalc.headline_energy_cost_adaption_short |
| Electricity costs | 0,18 €/kWh | 50,52 €/a | | 2,4 % |
| Pellets heating | 335,74 €/t | | | 2,1 % |
| Gas heating | 0,08 €/kWh | 49,71 €/a | | 3,6 % |
| District heating | 0,10 €/kWh | 170,97 €/a | 39,24 €/kW a | 1,3 % |
| **Annual energy price changes** | | | | |
| Imputed interest rate | | | | 2 % |
| Maintenance costs | | | | 1 % |
| Inflation | | | | 2 % |

| Photovoltaic system (PV) | | | | | |
|---|---|---|---|---|---|
| Name | Area | Cost Inst. | Cost | Angel | Align. |
| - | 10 $m^2$ | 800 €/kwp | 67 €/$m^2$ | 30° | 0° |
| **Common values** | | | | | |
| Horizontal solar radiation | | | 1084 kWh/$m^2$ | | |

| $CO_2$ Tax per year within calculation period | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year 1: | 30 €/t | Year 2: | 35 €/t | Year 3: | 40 €/t | Year 4: | 45 €/t | Year 5: | 50 €/t | Year 6: | 55 €/t | Year 7: | 60 €/t | Year 8: | 65 €/t | Year 9: | 70 €/t | Year 10: | 75 €/t |
| Year 11: | 80 €/t | Year 12: | 85 €/t | Year 13: | 90 €/t | Year 14: | 95 €/t | Year 15: | 100 €/t | Year 16: | 105 €/t | Year 17: | 110 €/t | Year 18: | 115 €/t | Year 19: | 120 €/t | Year 20: | 125 €/t |

# System comparison

| System comparison | Gas | District | Air-water * | Geothermal | Pellets |
|---|---|---|---|---|---|
| Subsidy sum | -111 € | - | - | - | - |
| Investment costs | 43.601 € | 31.807 € | 21.989 € | 44.437 € | 23.586 € |
| Energy demand per year (RH + HW) | 9.474 kWh | 13.015 kWh | 3.557 kWh | 2.603 kWh | 13.846 kWh |
| Energy demand per year excl. HHED | 11.326 kWh | 13.015 kWh | 3.557 kWh | 4.452 kWh | 13.846 kWh |
| Electricity requirement per year incl. HHED (grid feed-in) | 4.696 kWh | 4.180 kWh | 6.209 kWh | 7.104 kWh | 4.180 kWh |
| Energy costs in the 1st year | 765 € | 1.606 € | - | - | 930 € |
| Electricity costs in the 1st year (grid feed-in) | 883 € | 792 € | 1.151 € | 1.310 € | 792 € |
| $CO_2$ tax cost in the 1st year | 102 € | 125 € | 42 € | 48 € | 37 € |
| Total $CO_2$ tax cost after 20 years | 5.279 € | 6.458 € | 2.184 € | 2.500 € | 1.923 € |
| Total energy cost after 20 years | 44.192 € | 56.426 € | 29.117 € | 33.133 € | 42.837 € |
| **Total cost after 20 years** | **108.520 €** | **97.321 €** | **62.670 €** | **89.548 €** | **94.328 €** |
| **$CO_2$ equivalent per year** | **3.406 kg** | **4.166 kg** | **1.409 kg** | **1.613 kg** | **1.241 kg** |
| **$CO_2$ equivalent after 20 years** | **73 t** | **84 t** | **32 t** | **37 t** | **26 t** |

* No noise reduction measures are taken into account

*All results are rounded to nearest whole number. The values used for energy-prices represent estimated cost forecasts last updated 2024. A cost spread of around 20% is possible.*

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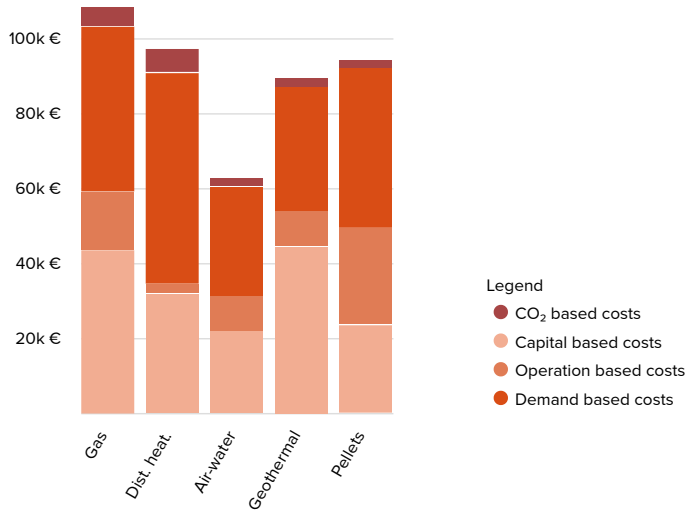
# Total cost comparison

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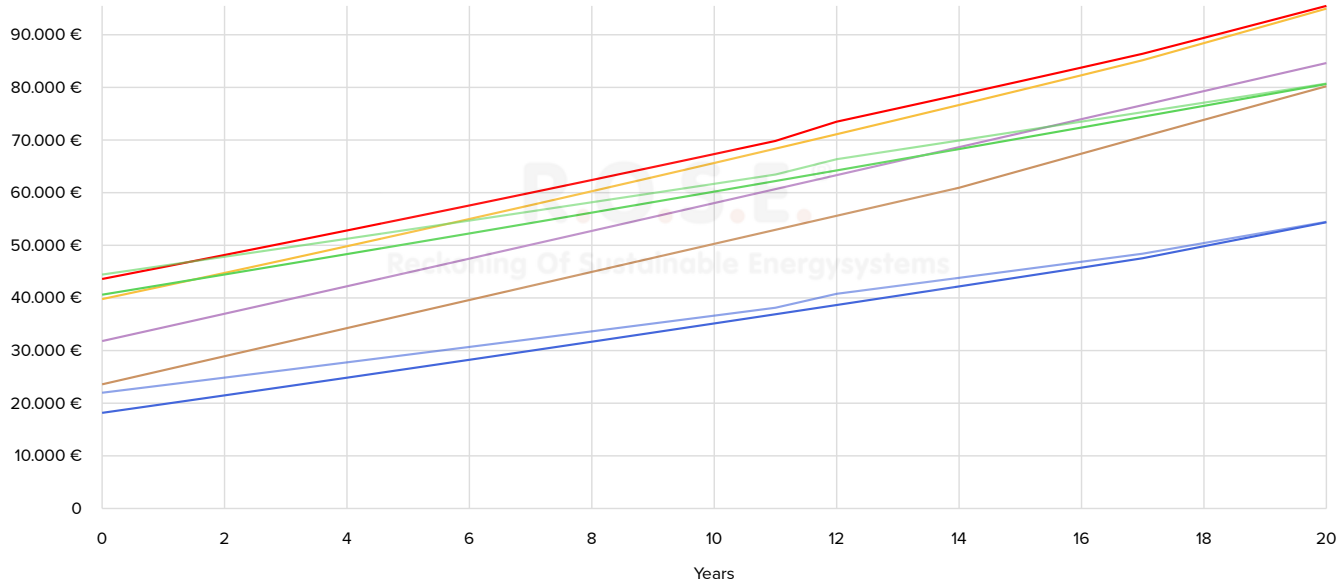
# Amortisation/$CO_2$-Reduction

| Base system | | Total cost after 20 years | $CO_2$ equivalent after 20 years | |
|---|---|---|---|---|
| Gas with PV | | 108.520 € | 73 t | |

| Compare system | Amortization time | Net Value (profit) after 20 years (€) | $CO_2$ reduction (absolute) | $CO_2$ reduction (percent) |
|---|---|---|---|---|
| Gas | 0 Year(s) | 519 € | -3 t | -4 % |
| District | 0 Year(s) | 10.858 € | -11 t | -15 % |
| Air-water | 0 Year(s) | 41.106 € | 38 t | 52 % |
| Air-water with PV | 0 Year(s) | 41.023 € | 41 t | 56 % |
| Geothermal | 0 Year(s) | 14.840 € | 33 t | 45 % |
| Geothermal with PV | 1 Year(s) | 14.757 € | 37 t | 50 % |
| Pellets | 0 Year(s) | 15.267 € | 48 t | 65 % |

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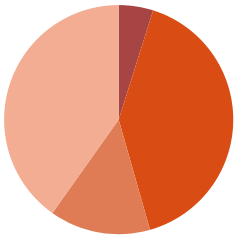
# System data: Gas heating

| Investment costs | | $CO_2$ amount |
|---|---|---|
| Gas burner | 9.576 € | 115 kg |
| Ventilation | 8.000 € | - |
| Installation | 1.200 € | - |
| Connection | 2.375 € | - |
| Buffer storage tank | 1.316 € | 316 kg |
| Drinking water storage tank | 3.615 € | 588 kg |
| Split air conditioner | 6.292 € | 514 kg |
| Modules (PV) | 669 € | 2.811 kg |
| Installation (PV) | 1.707 € | - |
| Inverter (PV) | 1.446 € | included at Modules (PV) |
| Solar thermal | 7.515 € | 983 kg |
| Subsidy sum | -111 € | - |
| **Total** | **43.601 €** | **5.328 kg** |

| Additional information | |
|---|---|
| Power heater | 44 W |
| Auxiliary energy per year (heater) | 79 kWh/a |
| Gas usage per year | 947 $m^3$/a |
| per hour | 1 $m^3$/h |

Cost allocation diagram

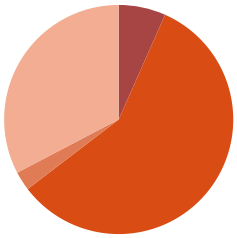


| **Cost allocation** | | |
|---|---|---|
| $CO_2$ based costs | 5.279 € | 5 % |
| Operation based costs | 15.449 € | 14 % |
| Capital based costs | 43.601 € | 40 % |
| Demand based costs | 44.192 € | 41 % |
| **Total** | **108.520 €** | |

# System data: District heating connection

| Investment costs | | $CO_2$ amount |
|---|---|---|
| Transfer station | 3.983 € | 19 kg |
| Installation | 1.200 € | - |
| Connection | 22.000 € | - |
| Buffer storage tank | 1.316 € | 316 kg |
| Drinking water storage tank | 3.307 € | 504 kg |
| Subsidy sum | - | - |
| **Total** | **31.807 €** | **839 kg** |

Cost allocation diagram



| **Cost allocation** | | |
|---|---|---|
| Operation based costs | 2.631 € | 2 % |
| $CO_2$ based costs | 6.458 € | 7 % |
| Capital based costs | 31.807 € | 33 % |
| Demand based costs | 56.426 € | 58 % |
| **Total** | **97.321 €** | |

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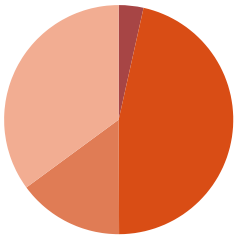
# System data: Air-water heat pump

| Investment costs * | | $CO_2$ amount |
|---|---|---|
| Air-water heat pump | 12.343 € | 162 kg |
| Installation | 1.200 € | - |
| Buffer storage tank | 1.316 € | 316 kg |
| Drinking water storage tank | 3.307 € | 504 kg |
| Modules (PV) | 669 € | 2.811 kg |
| Installation (PV) | 1.707 € | - |
| Inverter (PV) | 1.446 € | included at Modules (PV) |
| Subsidy sum | - | - |
| **Total** | **21.989 €** | **3.793 kg** |

* No noise reduction measures are taken into account

| Additional information | |
|---|---|
| Annual performence factor heat-pump hot-water | 3,8 |
| Annual performence factor heat-pump room-heating | 3,6 |

Cost allocation diagram



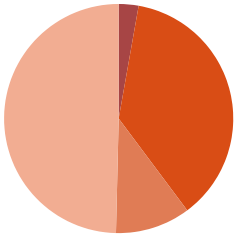
| **Cost allocation** | | |
|---|---|---|
| $CO_2$ based costs | 2.184 € | 3 % |
| Operation based costs | 9.379 € | 15 % |
| Capital based costs | 21.989 € | 35 % |
| Demand based costs | 29.117 € | 47 % |
| **Total** | **62.670 €** | |

# System data: Geothermal heat pump

| Investment costs | | $CO_2$ amount |
|---|---|---|
| Geothermal heat pump | 13.791 € | 471 kg |
| Geothermal probe | 16.000 € | 441 kg |
| Installation | 1.200 € | - |
| Buffer storage tank | 1.316 € | 316 kg |
| Drinking water storage tank | 3.307 € | 504 kg |
| Cost cooling extension | 5.000 € | - |
| Modules (PV) | 669 € | 2.811 kg |
| Installation (PV) | 1.707 € | - |
| Inverter (PV) | 1.446 € | included at Modules (PV) |
| Subsidy sum | - | - |
| **Total** | **44.437 €** | **4.543 kg** |

| Additional information | |
|---|---|
| Annual performance factor heat pump | 5 |
| Spezific extraction performance ground | 30 W/m |
| Drilling cost per $m^2$ | 100 €/m |
| Full drilling depth | 160 m |

Cost allocation diagram



| **Cost allocation** | | |
|---|---|---|
| $CO_2$ based costs | 2.500 € | 3 % |
| Operation based costs | 9.478 € | 10 % |
| Demand based costs | 33.133 € | 37 % |
| Capital based costs | 44.437 € | 50 % |
| **Total** | **89.548 €** | |

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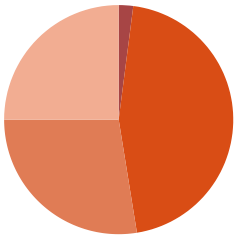
# System data: PelGesamtkostenvergleichlets heating

| Investment costs | | $CO_2$ amount |
|---|---|---|
| Boiler | 11.783 € | 241 kg |
| Storage system | 3.979 € | - |
| Ventilation | 2.000 € | - |
| Installation | 1.200 € | - |
| Buffer storage tank | 1.316 € | 316 kg |
| Drinking water storage tank | 3.307 € | 504 kg |
| Subsidy sum | - | - |
| **Total** | **23.586 €** | **1.061 kg** |

Cost allocation diagram



| Additional information | |
|---|---|
| Auxiliary energy per year | 180 kWh/a |
| Auxiliary power | 100 W |
| Pellets usage per year | 2.769 kg/a |
| Pellets usage per hour | 2 kg/h |

| Cost allocation | | |
|---|---|---|
| $CO_2$ based costs | 1.923 € | 2 % |
| Capital based costs | 23.586 € | 25 % |
| Operation based costs | 25.982 € | 28 % |
| Demand based costs | 42.837 € | 45 % |
| **Total** | **94.328 €** | |

# Result cooling system

Cooling input values

| Common declarations | |
|---|---|
| Operating hours cooling-system | 500 h |
| Height above sea-level | - |
| Density of air | 1,200 kg/m³ |
| Rated indoor temperature | 25 °C |
| Season for calculation | July |
| Rated outside temperature | 30 °C |
| Building orientation | South |

| Indoor cooling-load | |
|---|---|
| Heat emission people | |
| Heat-load through physical exertion | Normal |
| People | 4 |
| Heat emission illumination | |
| Lighting type | Lightbulbs |
| Lighted area (ground plan) | 100 m² |
| Heat dissipation facilities | |
| Number of PC stations | 10 x |
| Number of kitchens | 1 x |
| Number of residential units | 1 x |
| Number of print stations | 2 x |

| Outside cooling-load | |
|---|---|
| Heat-load from external component transfer | |
| Building envelope | 300 m² |
| Heat transfer coefficient | 1.3 |
| Heat-load from outside air | |
| Air exchange rate | 0.5 |
| Gross volume | 100 m³ |
| Ventilated net room volume | 90 m³ |
| Heat-load through radiation from transparent external components | |
| Sunlit transparent area | 50 m² |
| Total transparent area | 100 m³ |
| Glazing | Sheet glass double glazing |
| Sunprotection | External joalousie opening angle 45° |
| Second sunprotection | Inside-curtains-bright |
| Construction and sun protection | Inner sun protection - lightweight construction |

Results cooling extension

| | Gas | District | Air-water | Geothermal* | Pellets |
|---|---|---|---|---|---|
| Cooling-load | 20,38 kW | - | - | 20,38 kW | - |
| Indoor cooling-load | 15.850 W | - | - | 15.850 W | - |
| Outside cooling-load | 4.529 W | - | - | 4.529 W | - |
| Power consumption cooling-system | 3,71 kW | - | - | 3,7 kW | - |
| Electricity demand | 1.852,64 kWh/a | - | - | 1.849,27 kWh/a | - |
| Investment cost | 6.292 € | - | - | 5.000 € | - |

* Delivery system must be tuned for active cooling. Maximum cooling limited via surface delivery system. Note the dew point temperature.

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# Result solar gains

| Seperate photovoltaik systems | | |
|---|---|---|
| **Name of the system** | **System performance** | **Generated electricity per year** |
| | 2 kWp | 2.247 kWh |

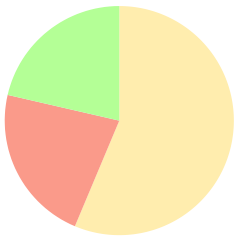
| Result Photovoltaic | | | | | |
|---|---|---|---|---|---|
| | **Gas** | **District** | **Air-water** | **Geothermal** | **Pellets** |
| Annual electricity demand | 5.932 kWh | - | 7.557 kWh | 8.452 kWh | - |
| System performance | 2 kWp | - | 2 kWp | 2 kWp | - |
| Generated electricity per year | 2.247 kWh | - | 2.247 kWh | 2.247 kWh | - |
| Own consumption of electricity per year | 1.236 kWh | - | 1.348 kWh | 1.348 kWh | - |
| Electricity fed in per year | 1.011 kWh | - | 899 kWh | 899 kWh | - |
| Degree of self sufficiency | 21 % | - | 18 % | 16 % | - |
| Self consumption rate | 55 % | - | 60 % | 60 % | - |
| Cost modules | 669 € | - | 669 € | 669 € | - |
| Cost installation | 1.707 € | - | 1.707 € | 1.707 € | - |
| Cost inverter | 1.446 € | - | 1.446 € | 1.446 € | - |
| **Investment Cost** | **3.822 €** | **-** | **3.822 €** | **3.822 €** | **-** |
| **Cost after 20 years** | **5.708 €** | **-** | **5.708 €** | **5.708 €** | **-** |

| Solar thermal | | | | | |
|---|---|---|---|---|---|
| | **Gas** | **District** | **Air-water** | **Geothermal** | **Pellets** |
| Energy | 9.106 kWh | - | - | - | - |
| Subsidy solar thermal system | 111 € | - | - | - | - |
| Cost | 7.515 € | - | - | - | - |

## Annual energy req. with PV

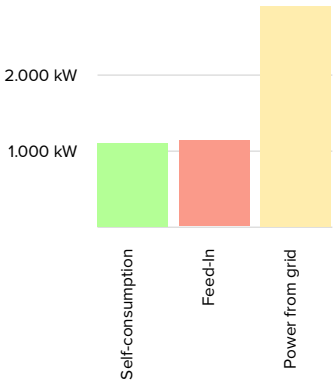
| PV Comparision Inputs | |
|---|---|
| Annual electricity demand | 4.000 kWh |
| Factor PV/Annual energy req. | 0,53 |
| Self consumption | 49 % |
| Feed-In | 51 % |
| Degree of self sufficiency (with battery storage) | 28 % |

Consumption Allocation

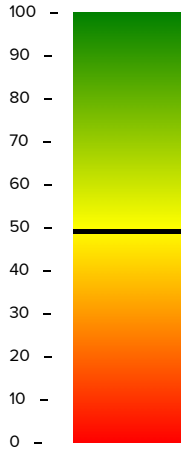


| Parts | | |
|---|---|---|
| Usage Direct | 1.101 kWh | 21 % |
| Feed-In to power grid | 1.146 kWh | 22 % |
| Power from grid | 2.899 kWh | 56 % |

Energy balance




Self consumption rate [%]

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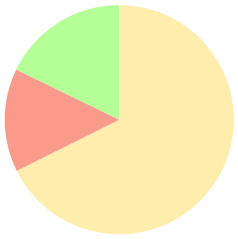
## Gas with PV

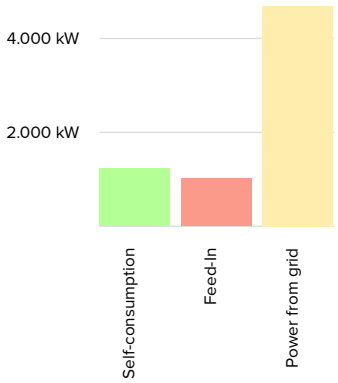
| PV Comparision Inputs | |
|---|---|
| Annual electricity demand | 5.932 kWh |
| Factor PV/Annual energy req. | 0,36 |
| Self consumption | 55 % |
| Feed-In | 45 % |
| Degree of self sufficiency (with battery storage) | 21 % |

Consumption Allocation

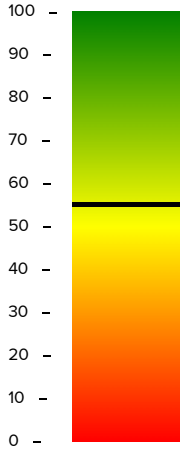


| Parts | | |
|---|---|---|
| Feed-In to power grid | 1.011 kWh | 15 % |
| Usage Direct | 1.236 kWh | 18 % |
| Power from grid | 4.696 kWh | 68 % |

Energy balance



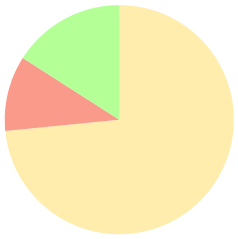

Self consumption rate [%]




## Air-water with PV

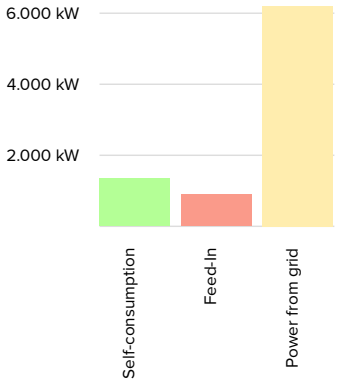
| PV Comparision Inputs | |
|---|---|
| Annual electricity demand | 7.557 kWh |
| Factor PV/Annual energy req. | 0,28 |
| Self consumption | 60 % |
| Feed-In | 40 % |
| Degree of self sufficiency (with battery storage) | 18 % |

Consumption Allocation

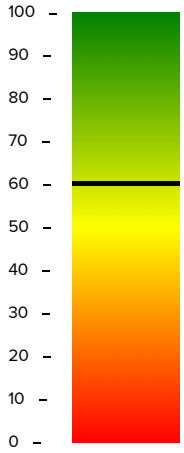


| Parts | | |
|---|---|---|
| Feed-In to power grid | 899 kWh | 11 % |
| Usage Direct | 1.348 kWh | 16 % |
| Power from grid | 6.209 kWh | 73 % |

Energy balance




Self consumption rate [%]



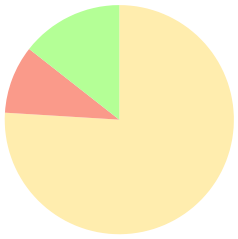

*All results are rounded to nearest whole number. The values used for energy-prices represent estimated cost forecasts last updated 2024. A cost spread of around 20% is possible.*

A-1060 Wien, Gumpendorfer Straße 132/1/9
Tel: +43 (0)1/535 21 23; Fax: +43 (0)1/535 21 23 30; E-Mail: office@kppk.at
www.kppk.at

# Geothermal with PV

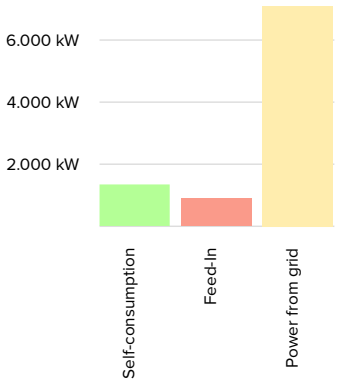
| PV Comparision Inputs | |
|---|---|
| Annual electricity demand | 8.452 kWh |
| Factor PV/Annual energy req. | 0,25 |
| Self consumption | 60 % |
| Feed-In | 40 % |
| Degree of self sufficiency (with battery storage) | 16 % |

Consumption Allocation

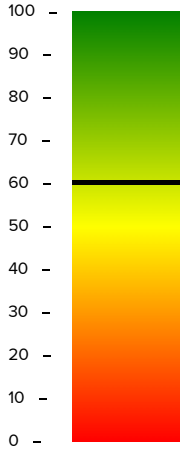


| Parts | | |
|---|---|---|
| Feed-In to power grid | 899 kWh | 10 % |
| Usage Direct | 1.348 kWh | 14 % |
| Power from grid | 7.104 kWh | 76 % |

Energy balance




Self consumption rate [%]

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