

# Solar-thermal activation of rear-ventilated facades as a source for heat pump based heat supply systems (Solar-VHF)

Ch. Büttner, E. Frick, F. Giovannetti

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Germany

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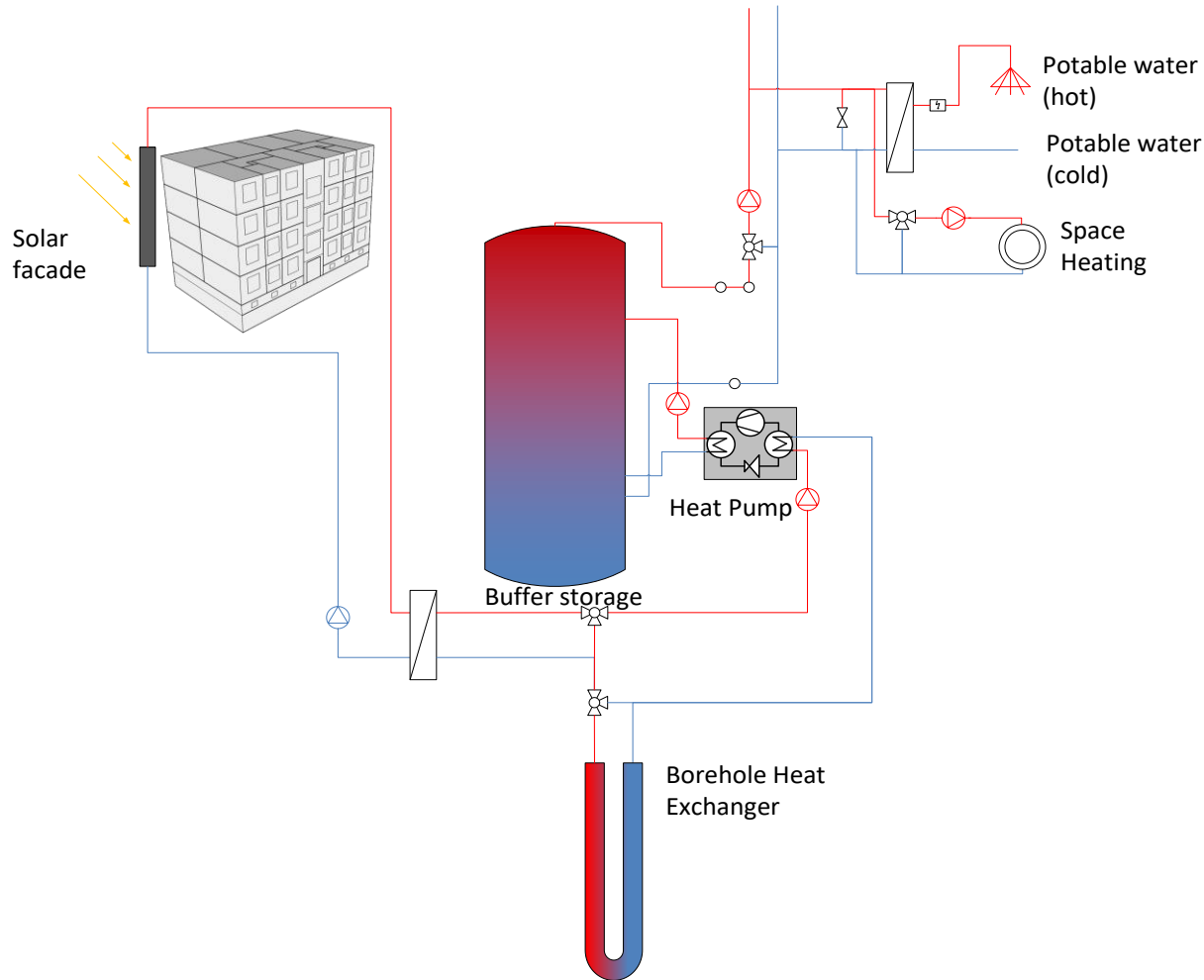
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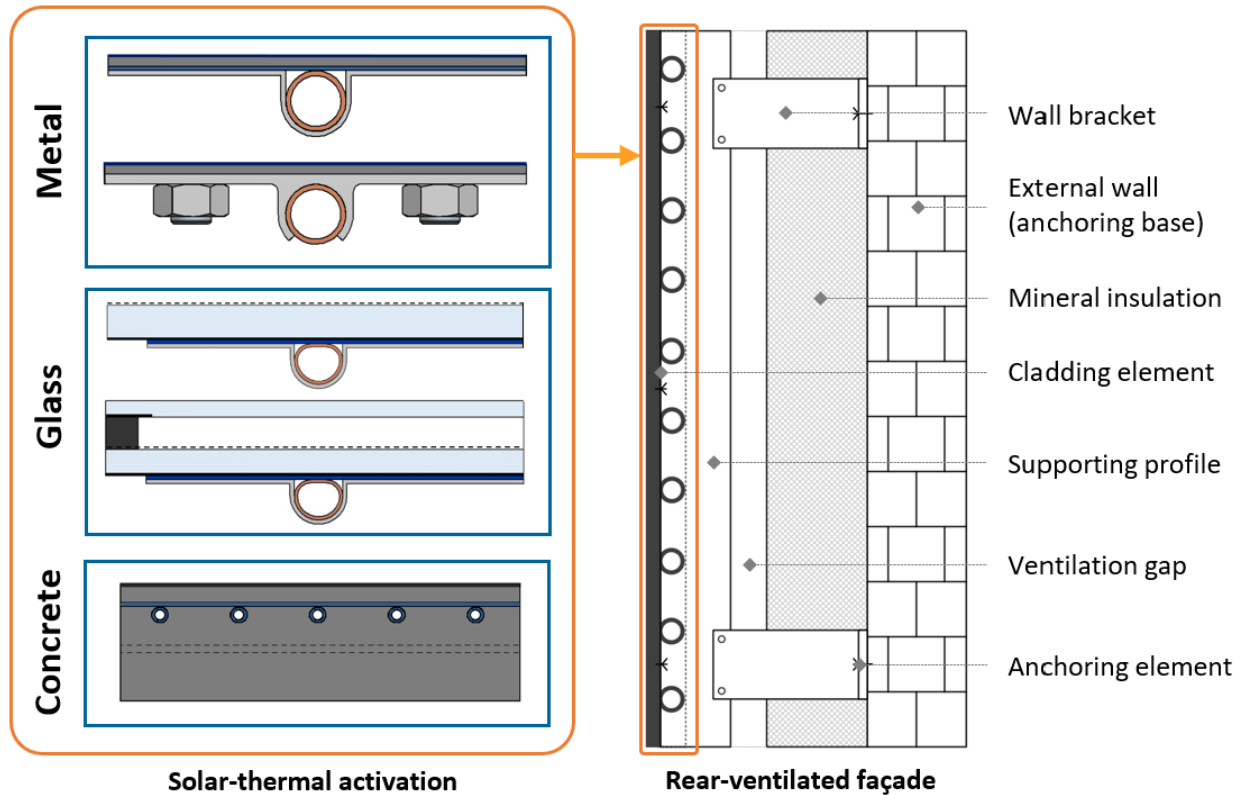
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# Solar-VHF: project goals



- Integration of solar thermal components in facades of multi-family houses
- Invisible integration in rear-ventilated facades
- Facade as heat pump source, direct loading of buffer storage or space heating
- Alternative supply concepts with small borehole heat exchanger or source storage tanks



- Detailed investigation of manufacturing and properties
- Different facade claddings
  - Concrete
  - Metal
  - Glass (unglazed and double glazed)
- Goal:
  - Reduction / replacement of typical sources
  - Use of heat pump under otherwise unusable conditions

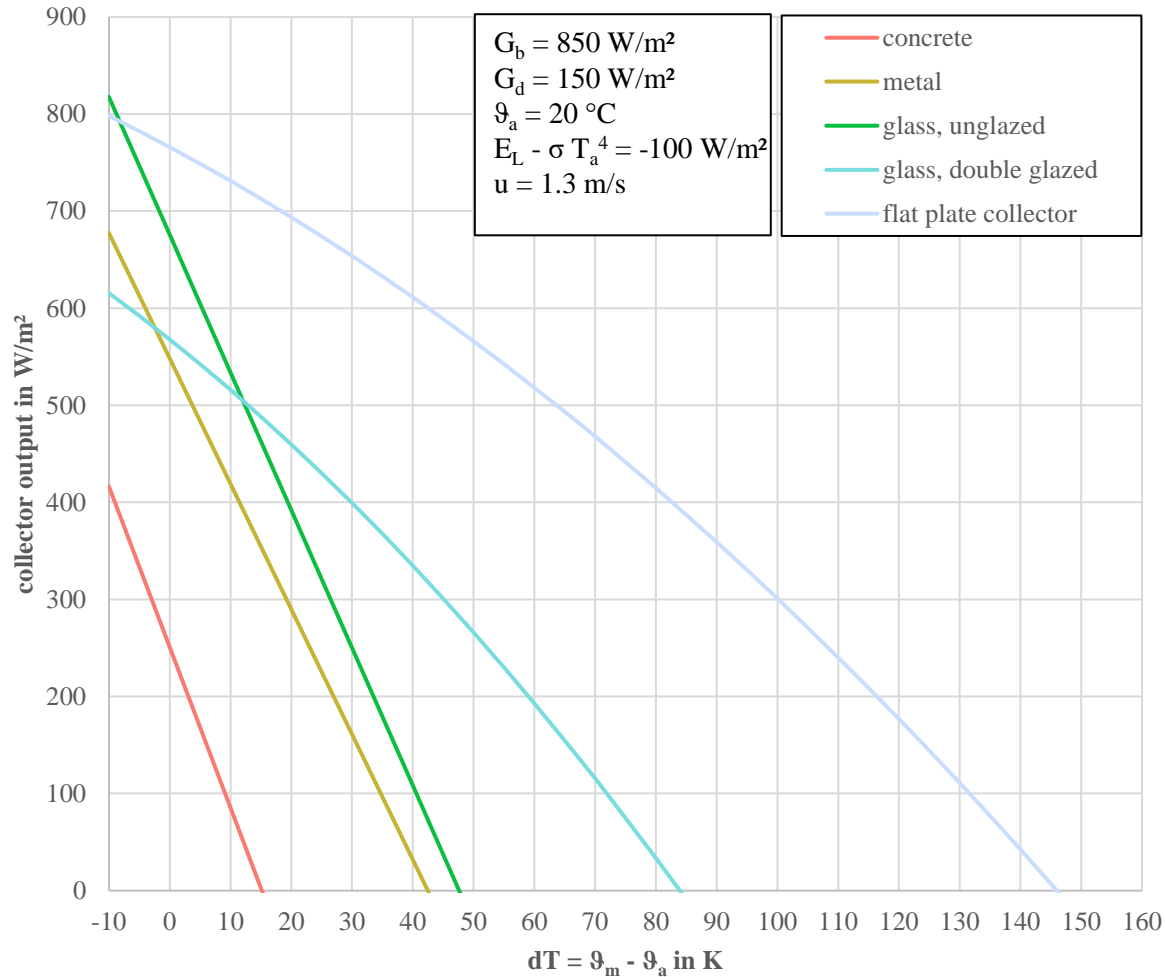


- Laboratory tests on single façade modules
- Different facade claddings
  - Concrete
  - Metal
  - Glass (unglazed and double glazed)
- In-situ experimental tests on large-sized façade prototypes
- Analyze thermal efficiency and reliability



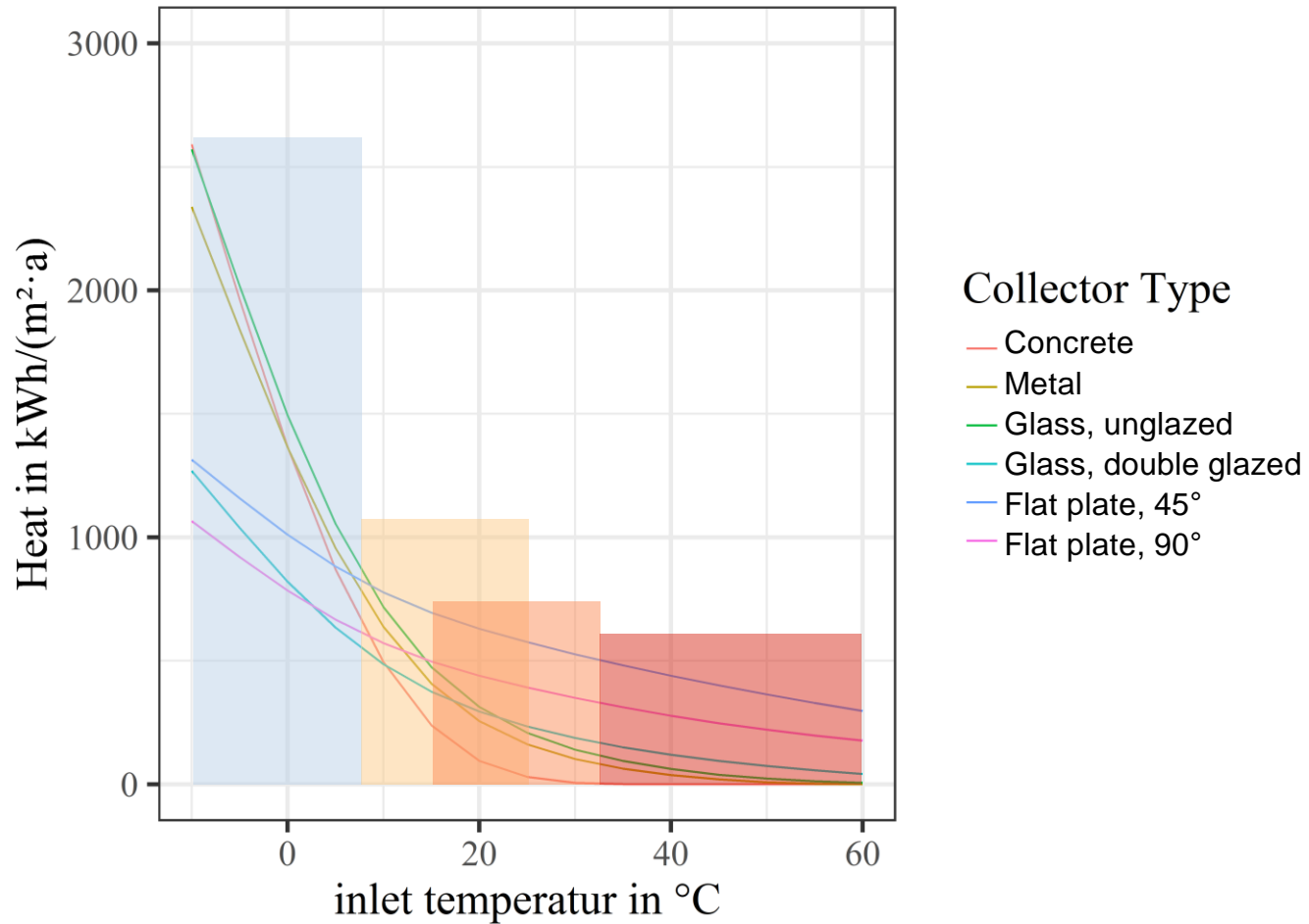
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# Collector output



- Useful power extracted from collector
- Different facade claddings
  - Concrete
  - Metal
  - Glass (unglazed and double glazed)
- Flat plate collector for comparison

# Heat yield: facade and collector



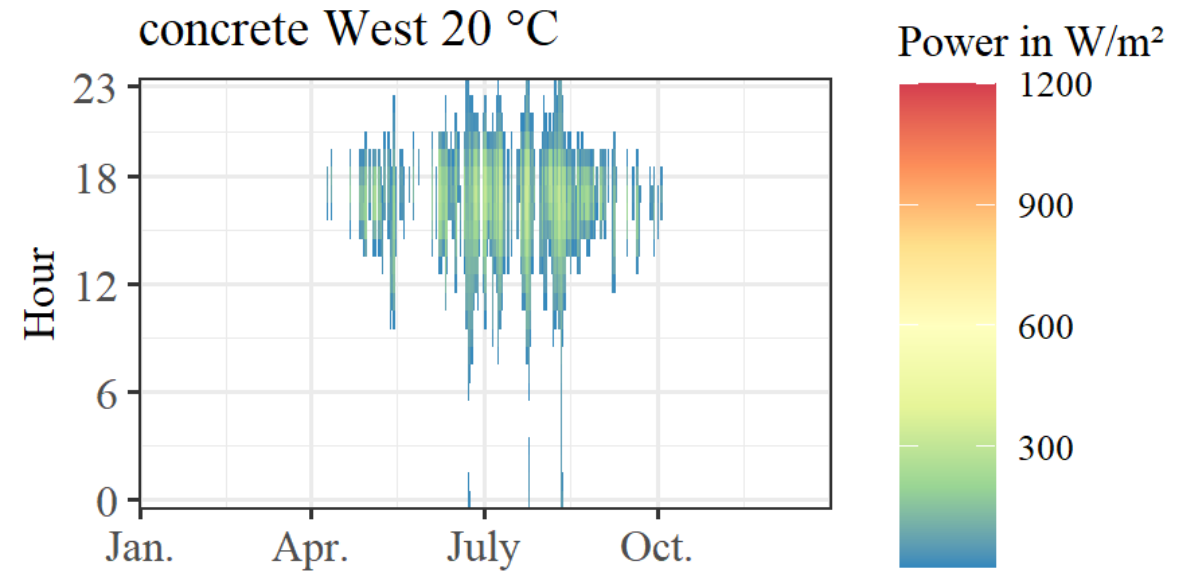
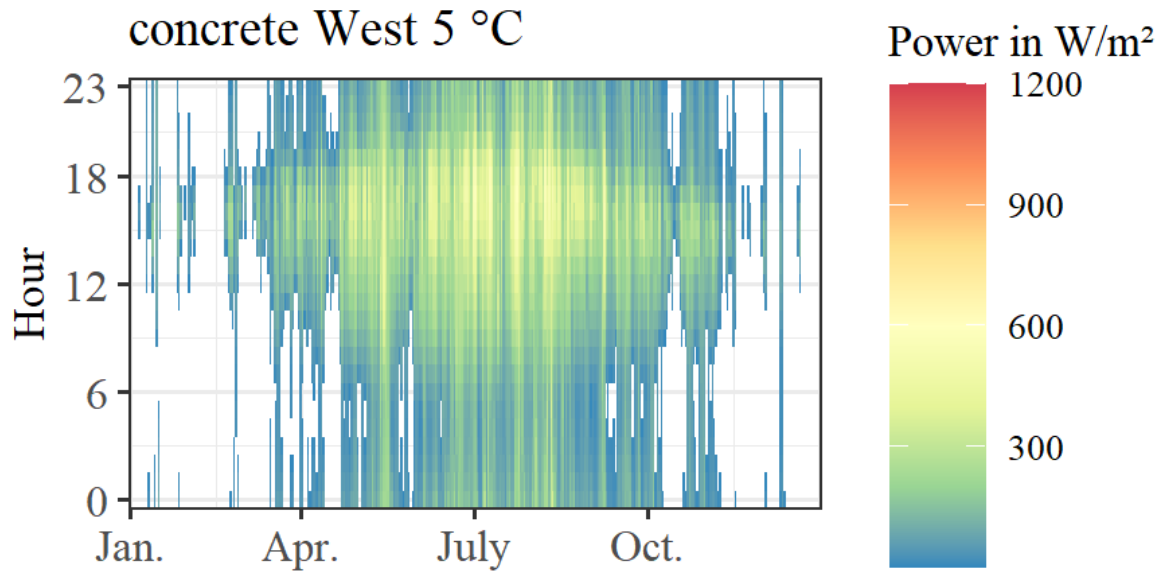
- Heat depending on inlet temperatur
- Different temperature ranges
- Facade: Icing / dew formation
- Heat pump: limits of evaporator side
- Borehole heat exchanger: regeneration
- Buffer storage: direct loading

Orientation: West

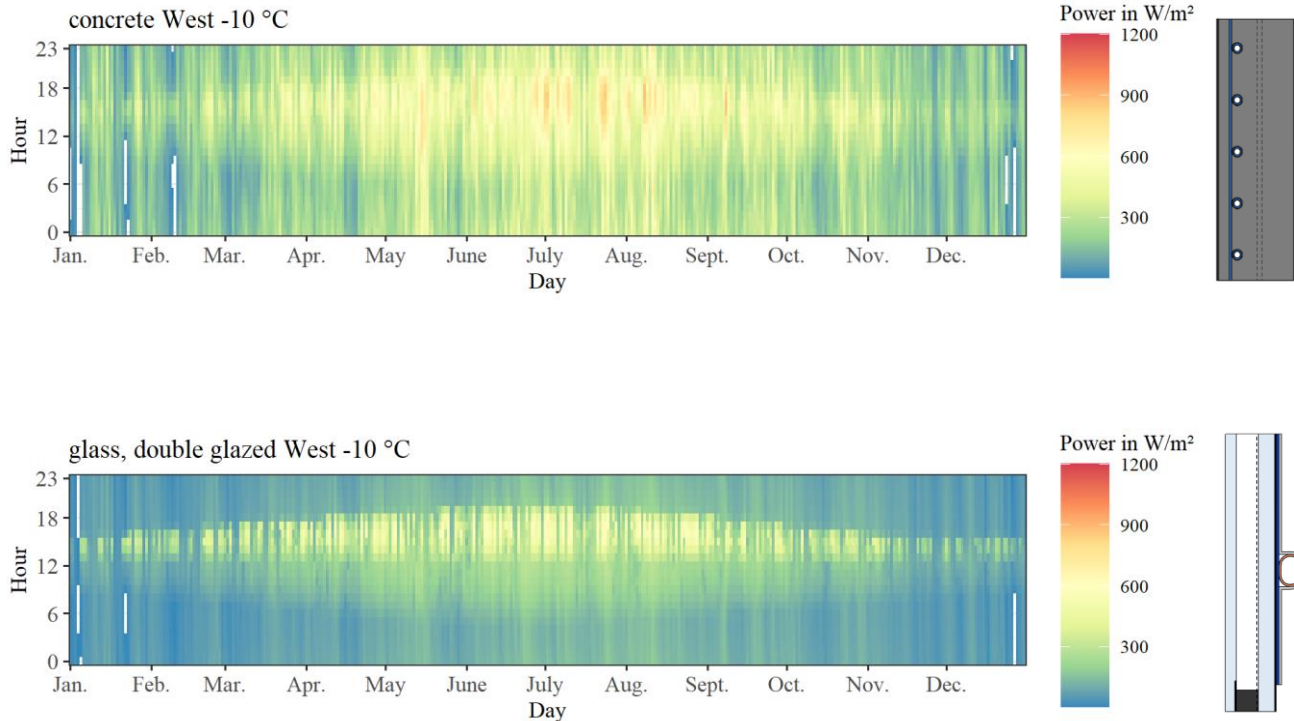
Weather Data: Meteonorm for location Pforzheim, Germany



# Heat Map: power during day and year

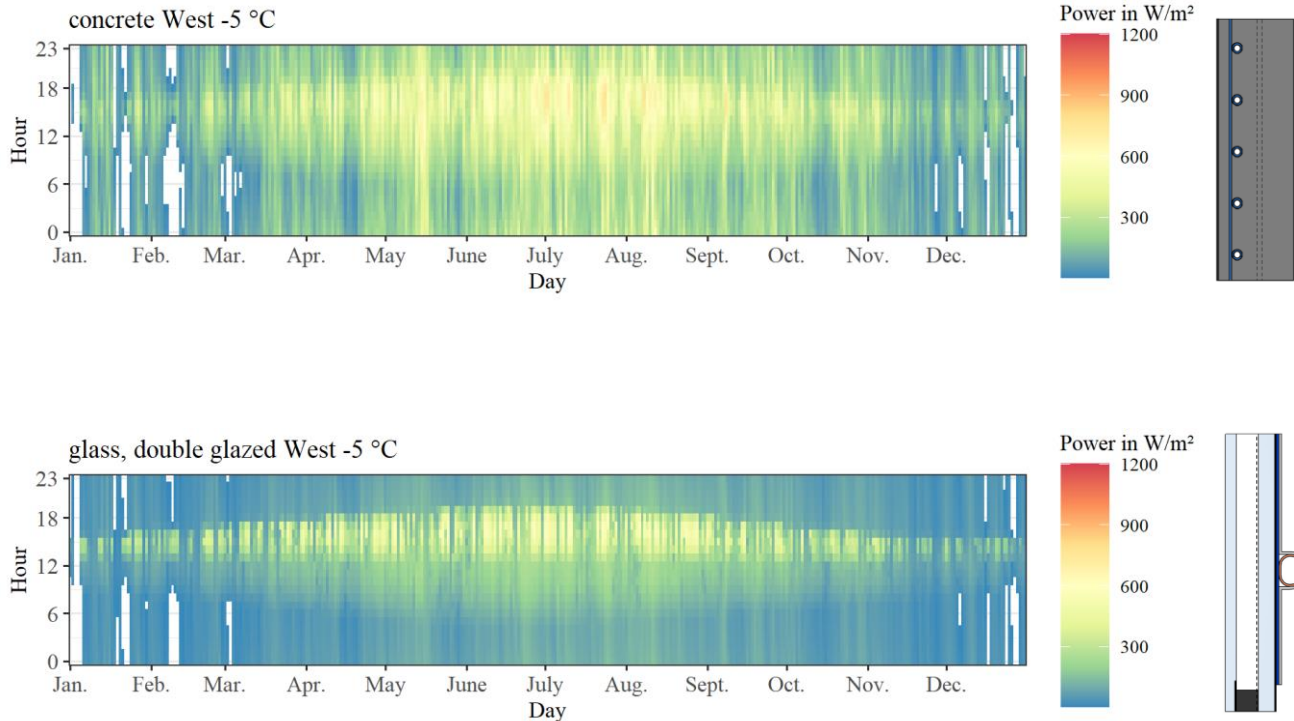


# Heat map: different claddings



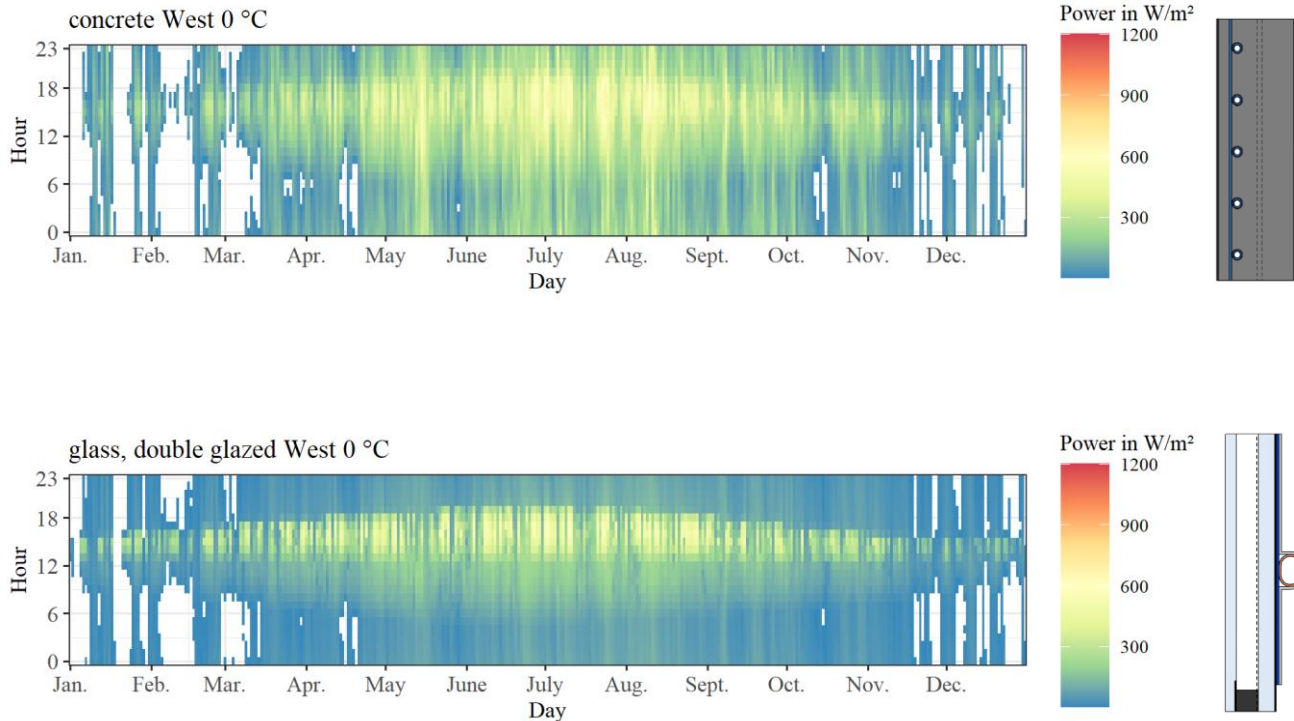
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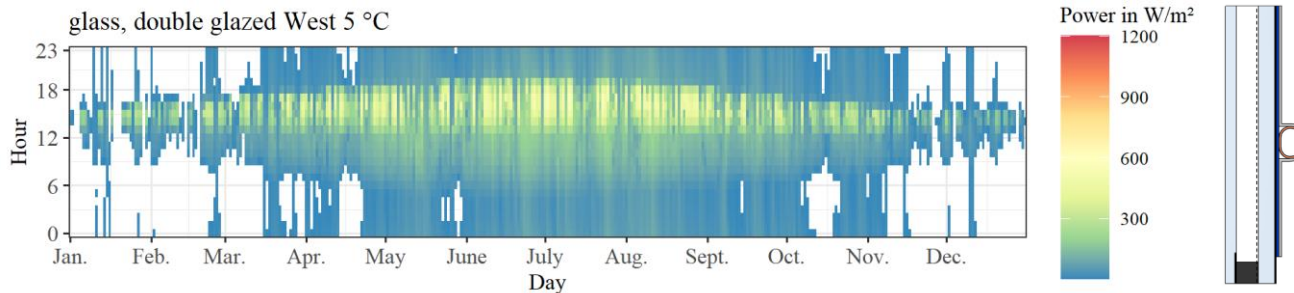
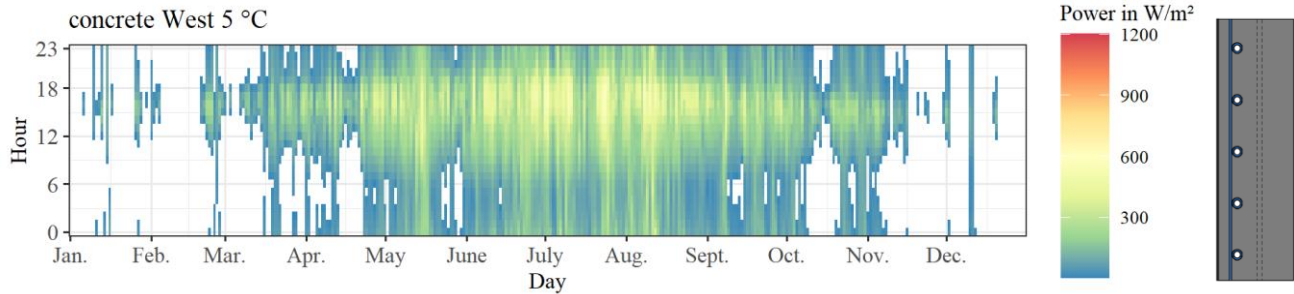
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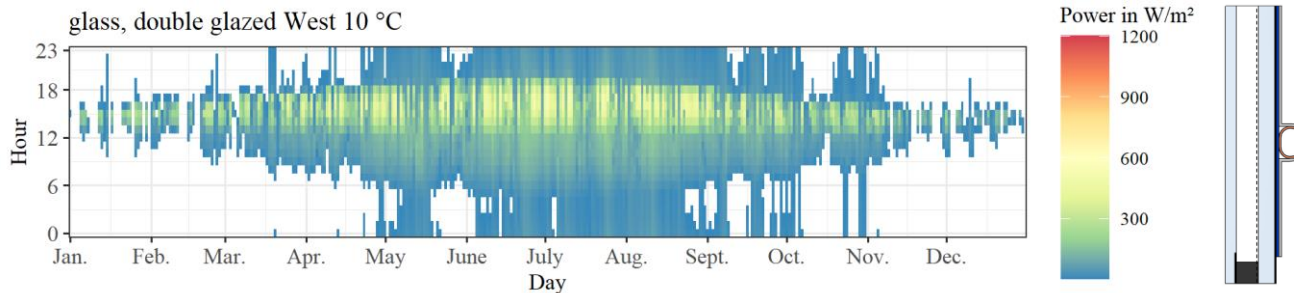
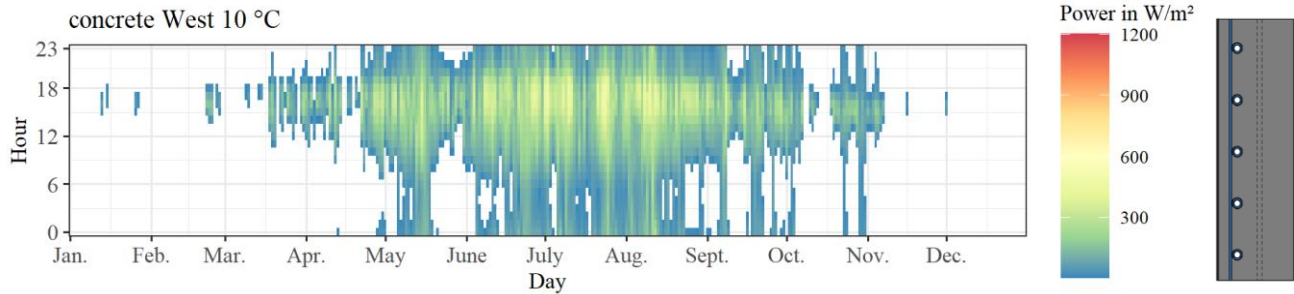
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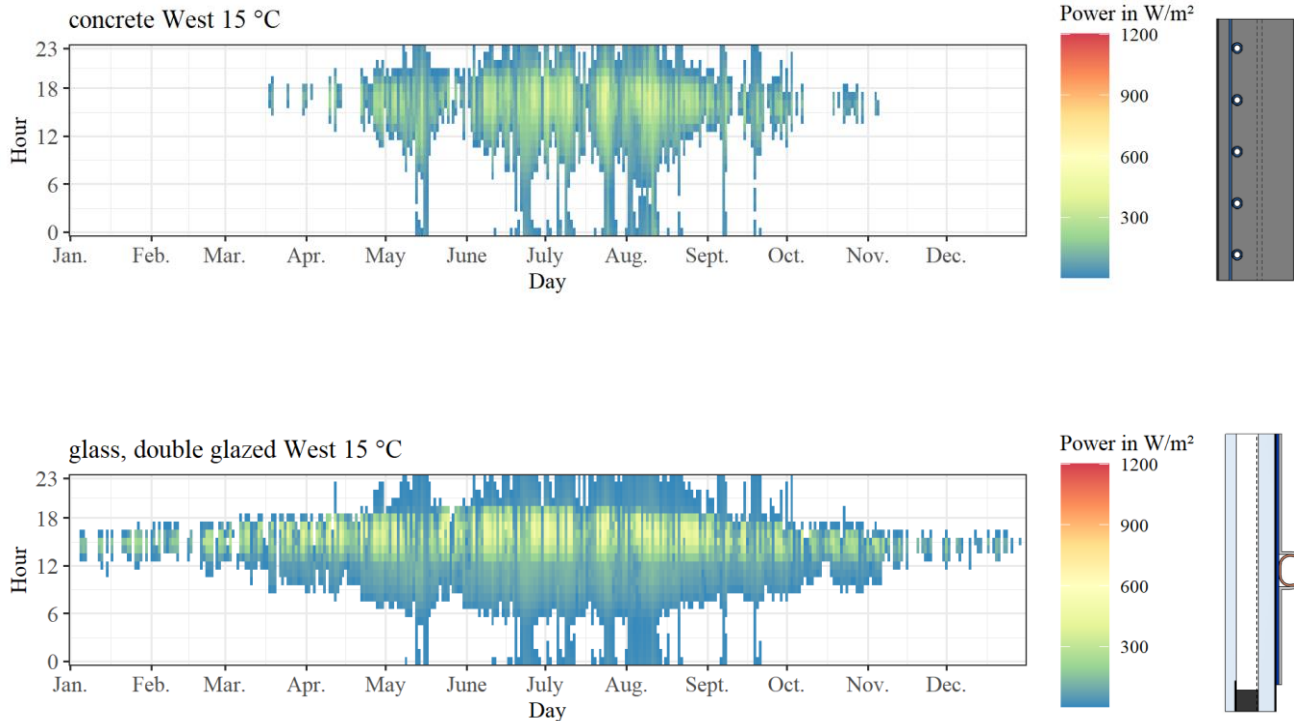
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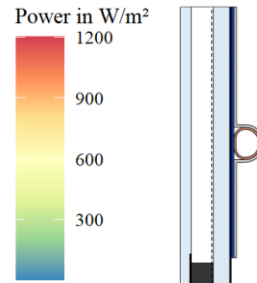
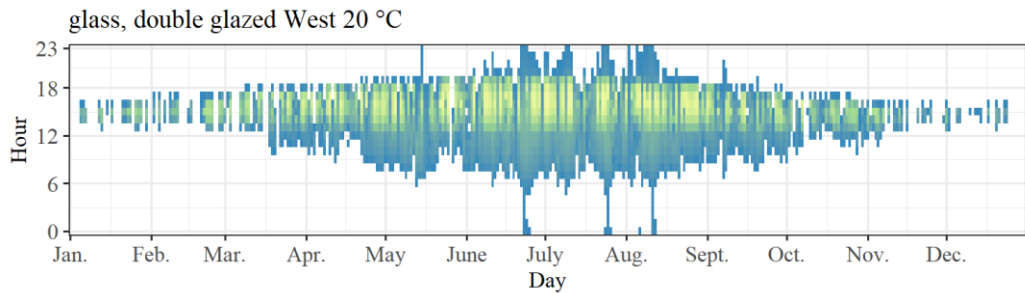
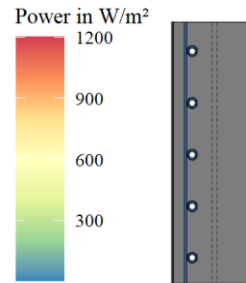
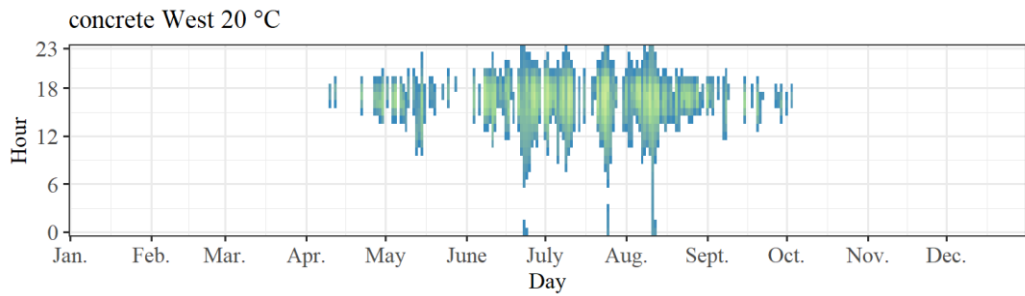
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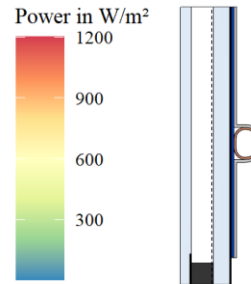
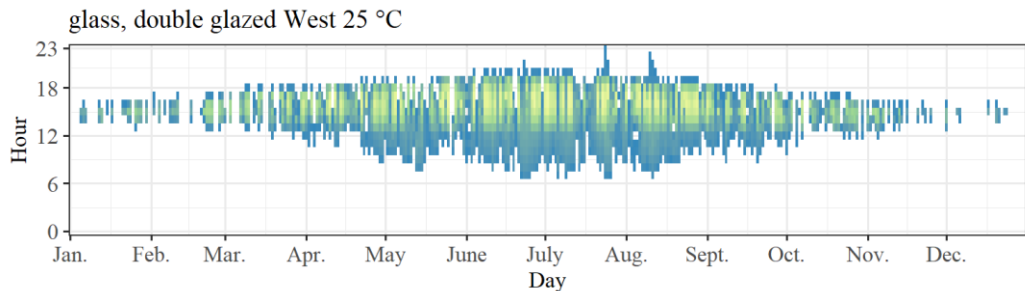
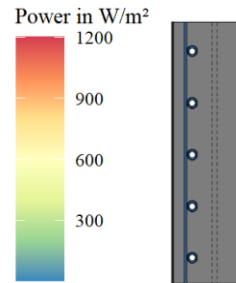
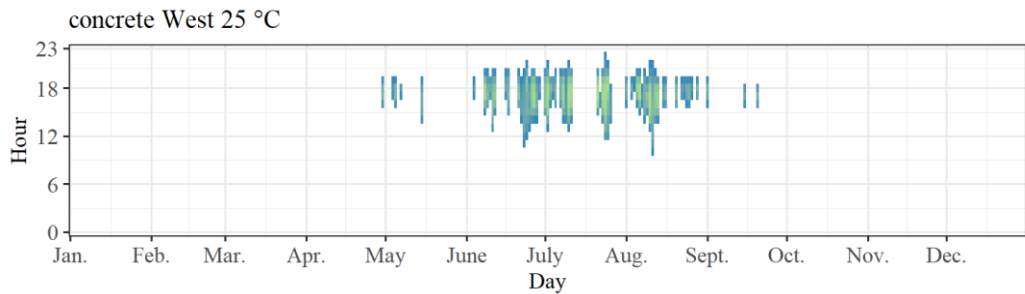
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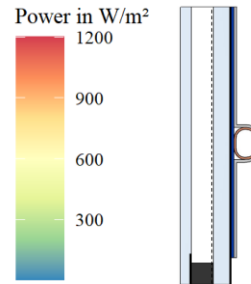
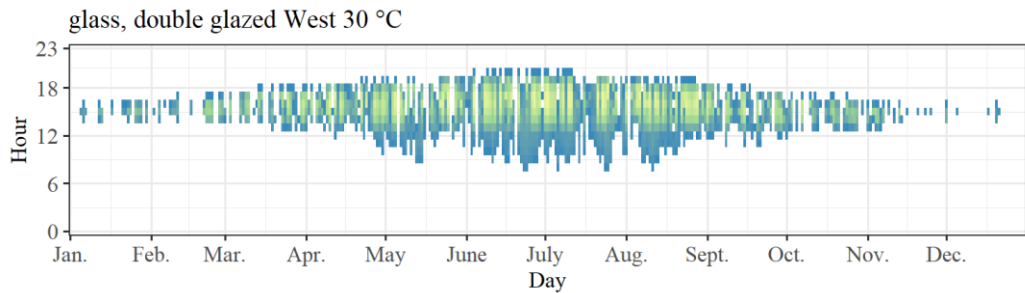
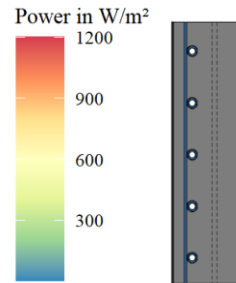
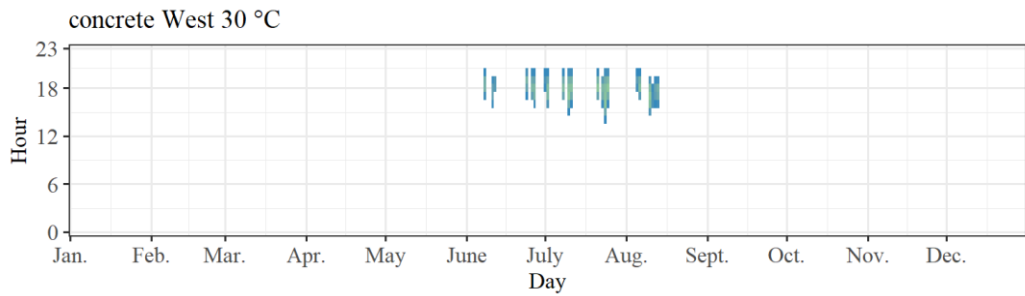


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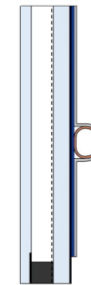
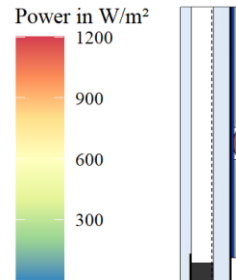
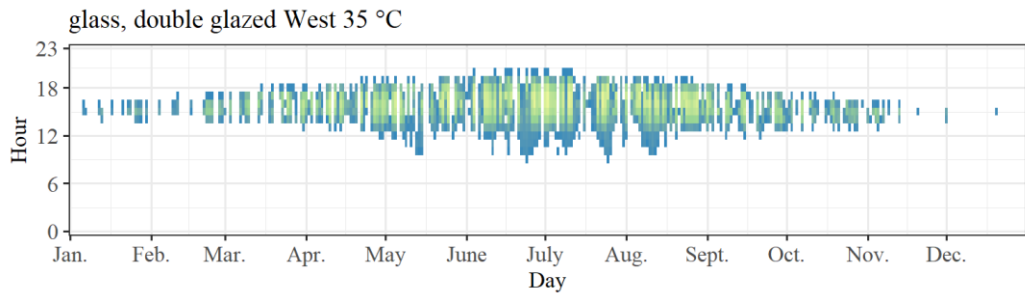
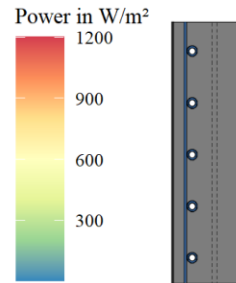
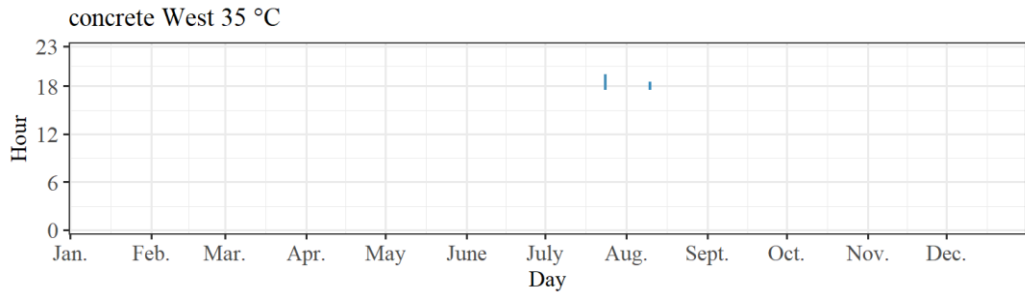
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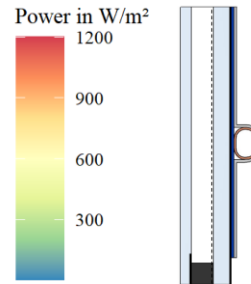
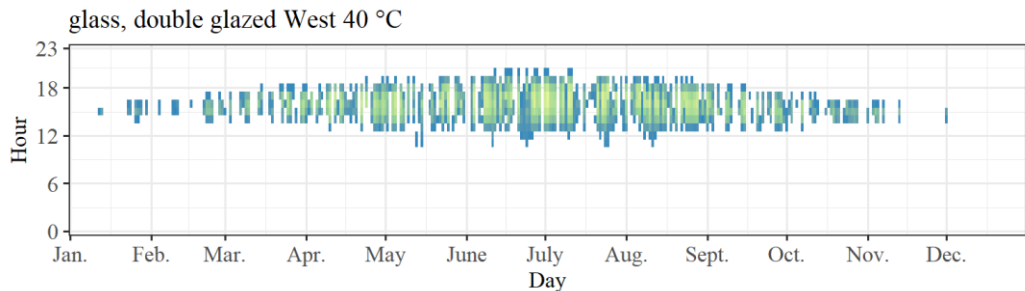
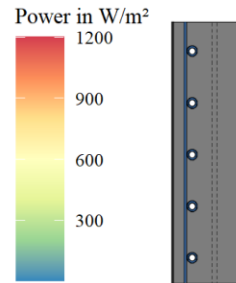
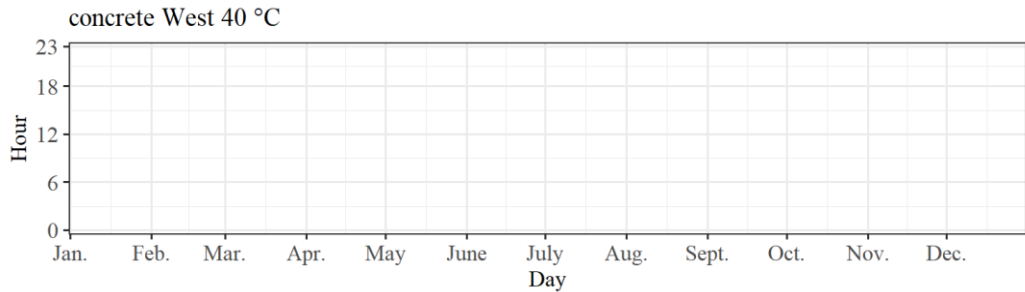
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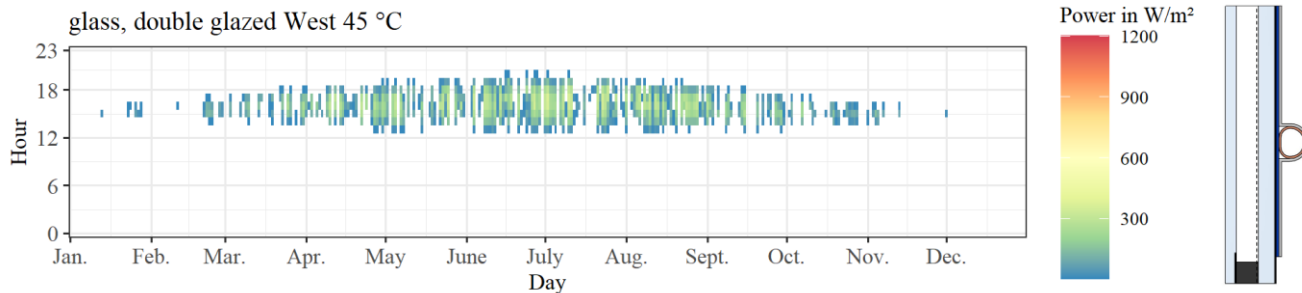
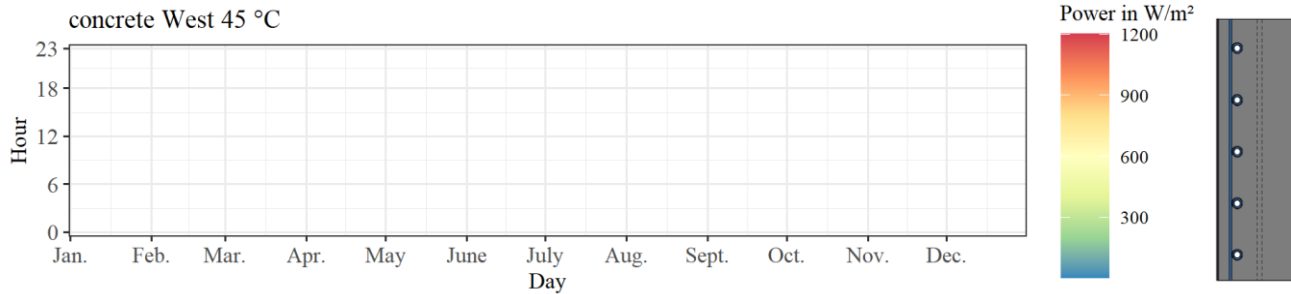
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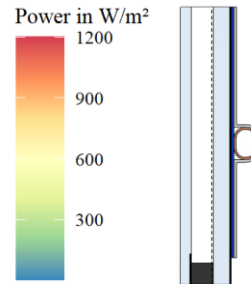
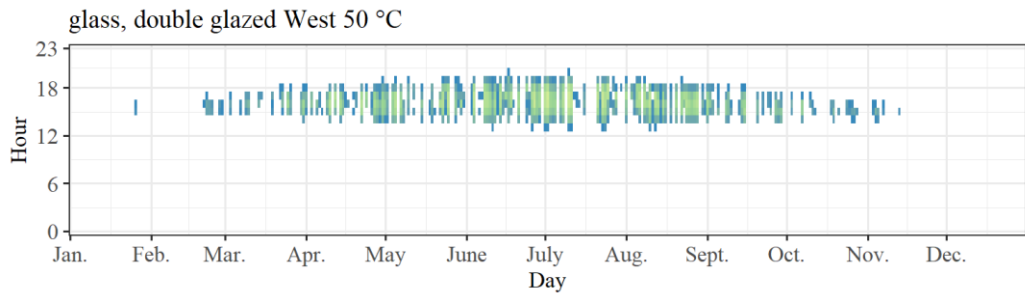
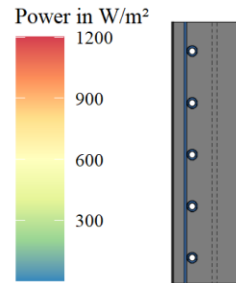
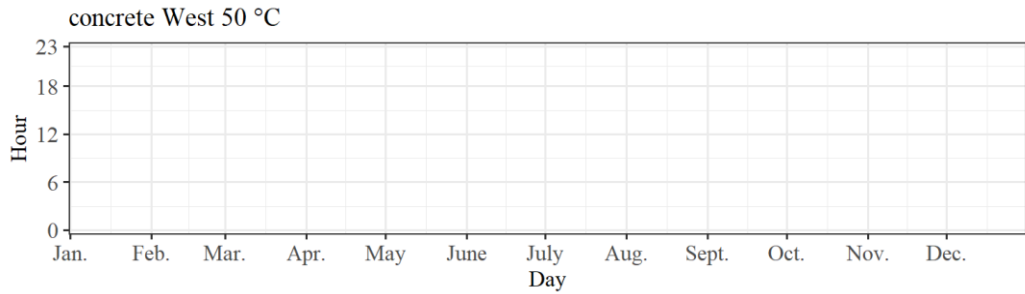
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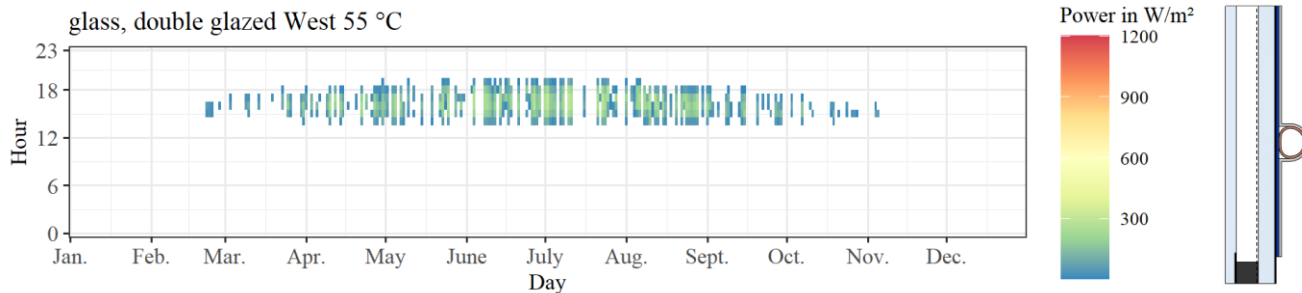
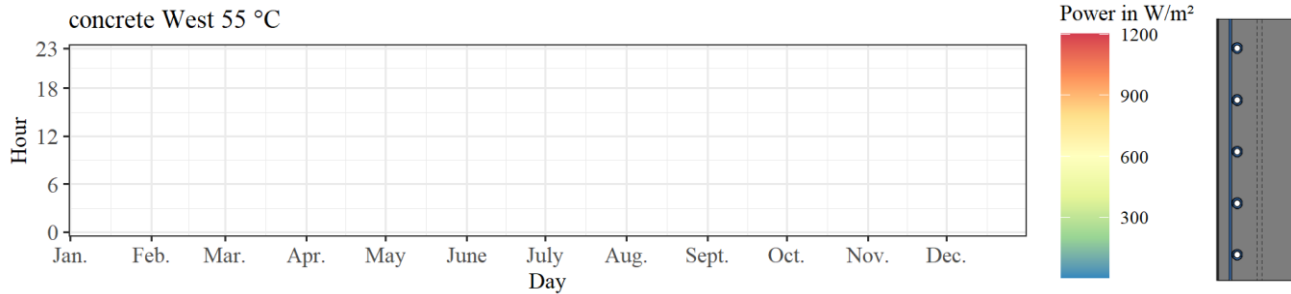
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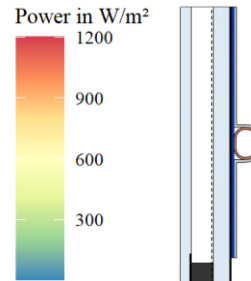
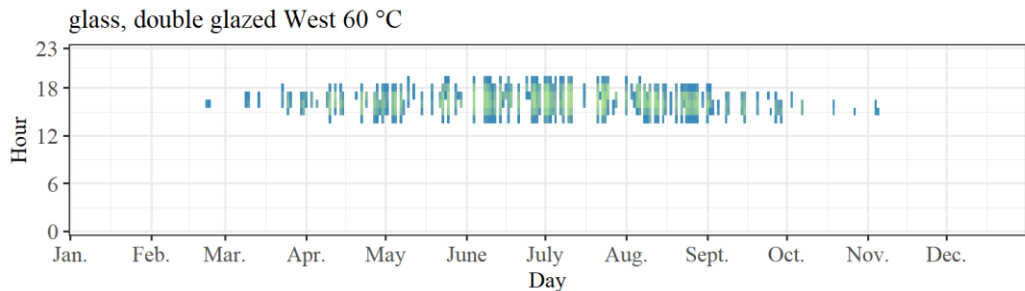
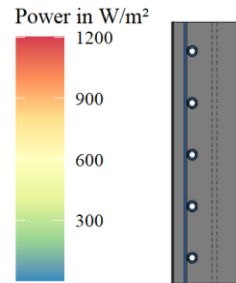
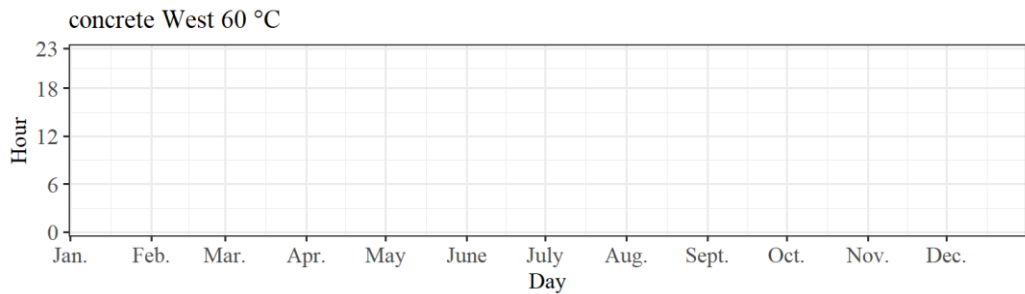
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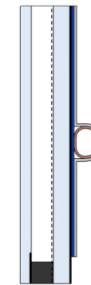
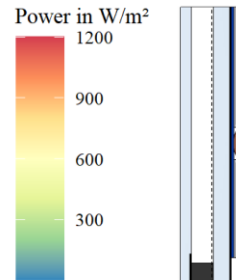
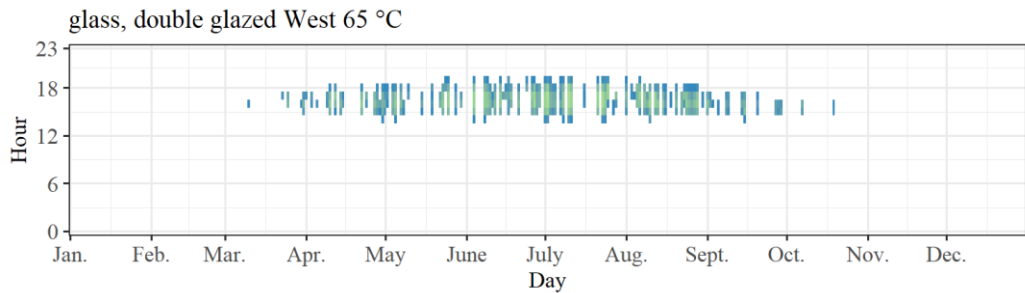
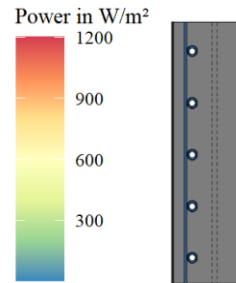
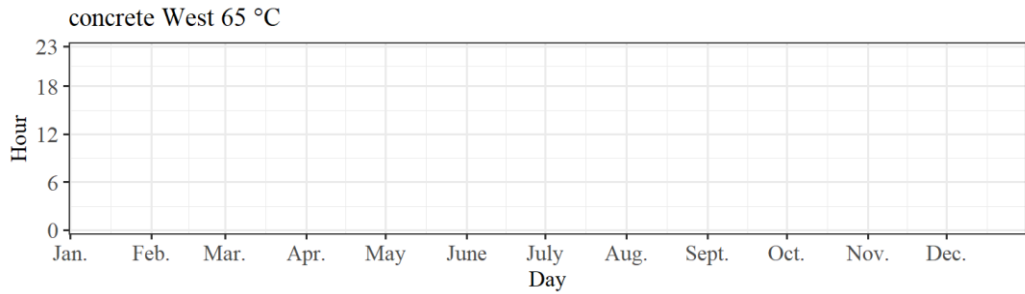
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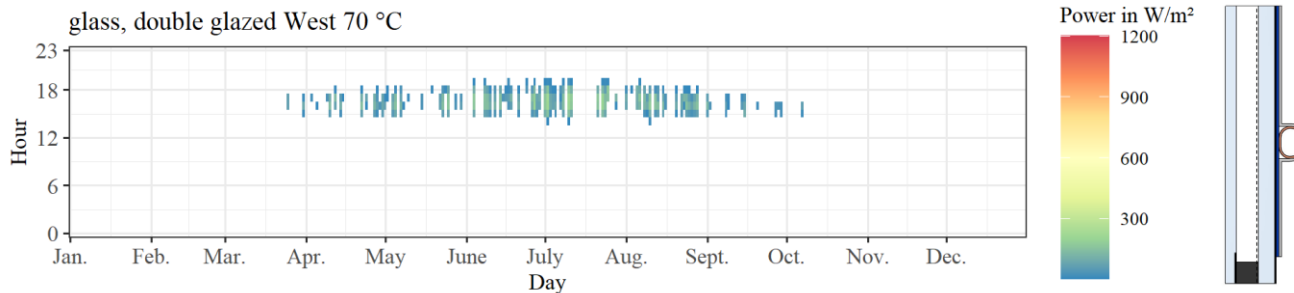
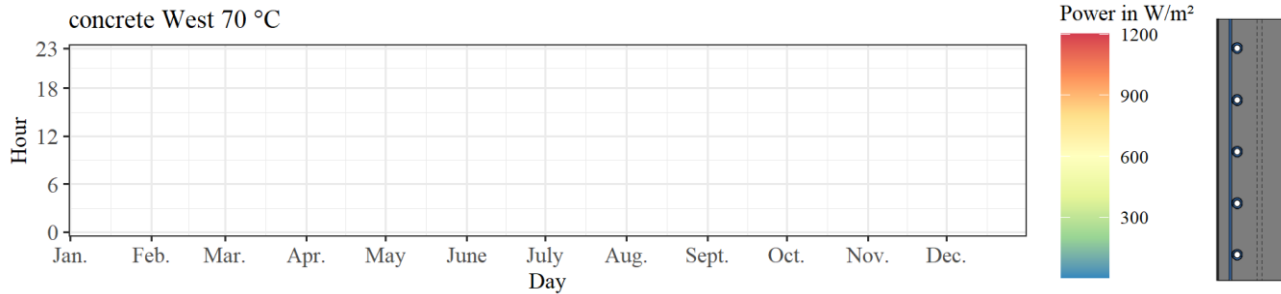


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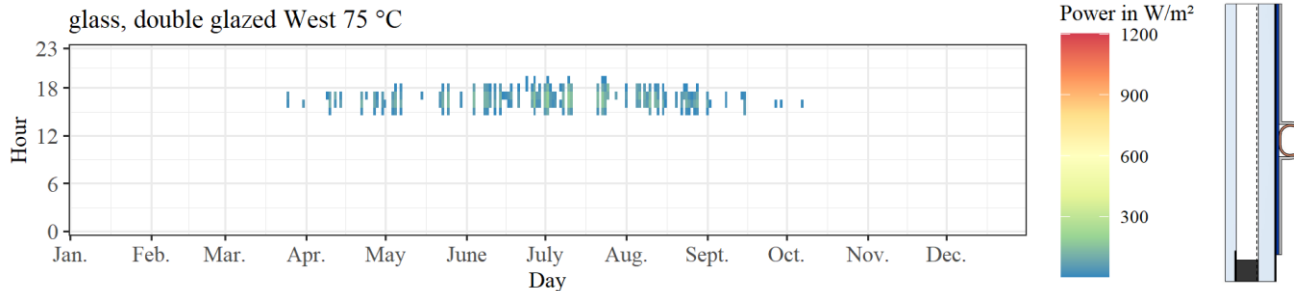
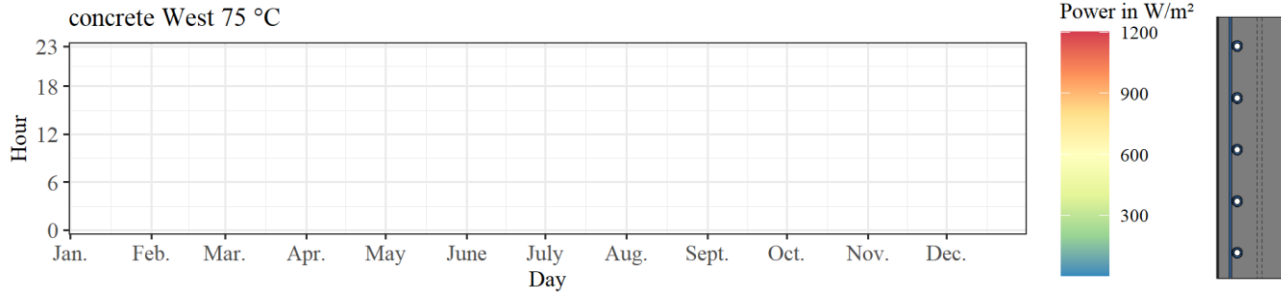
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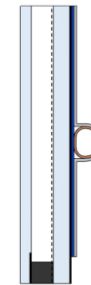
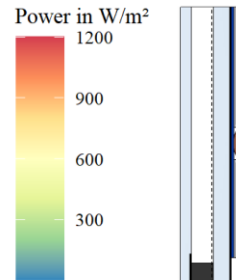
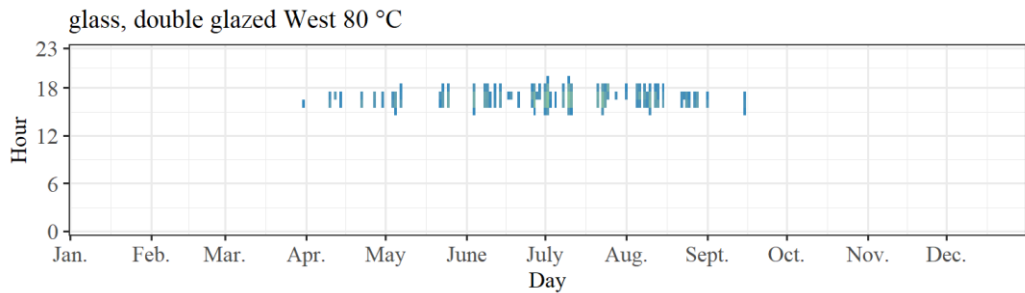
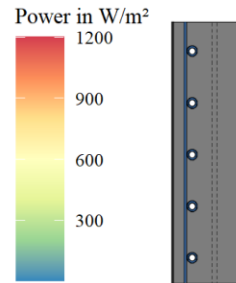
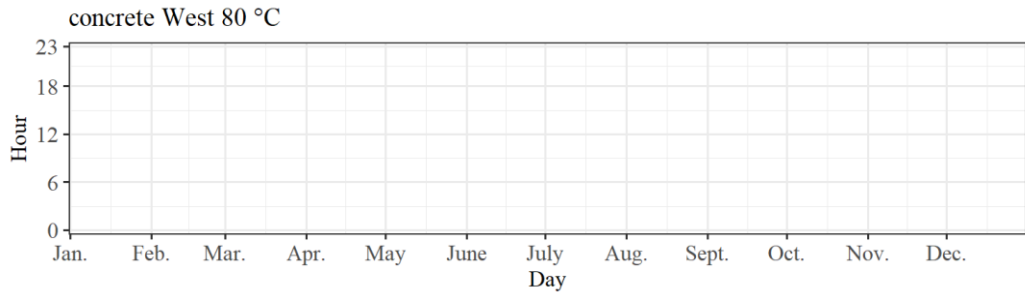
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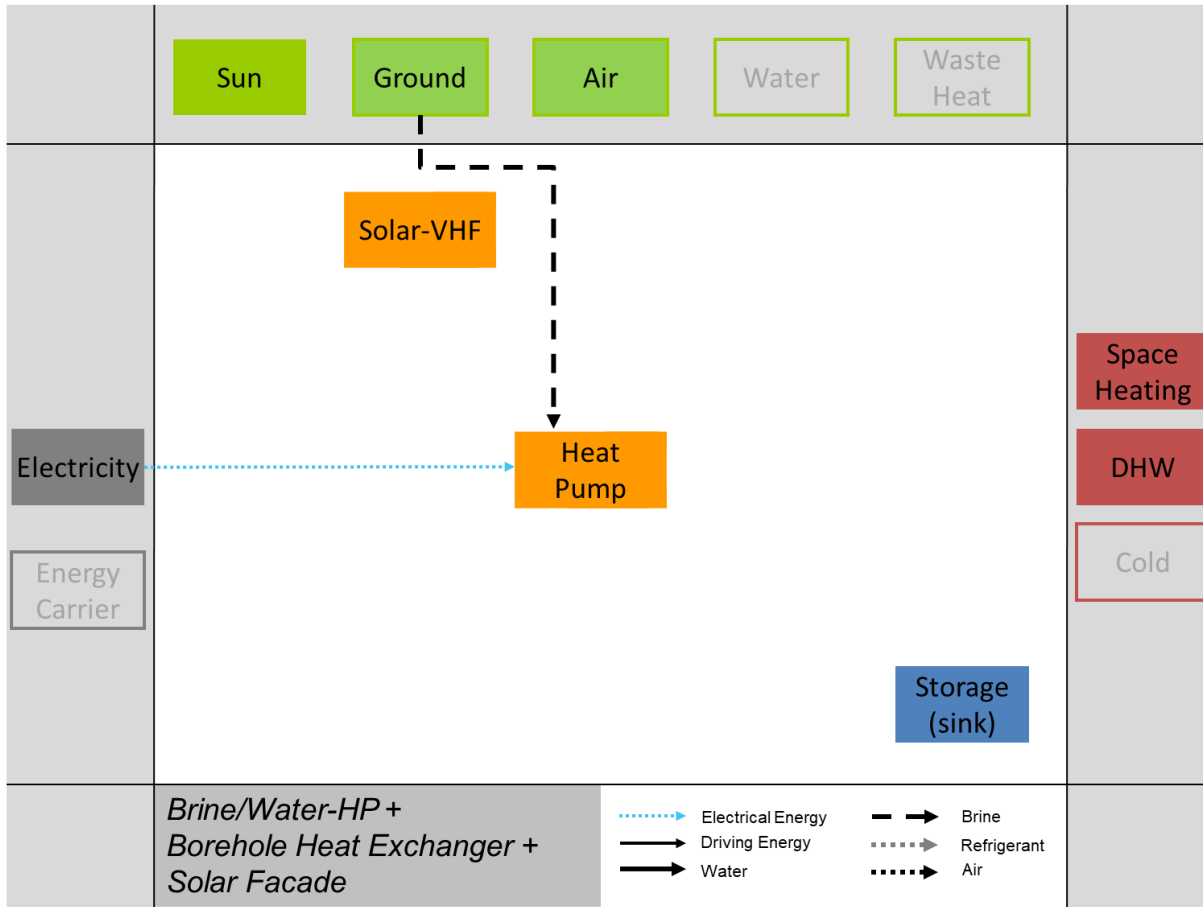
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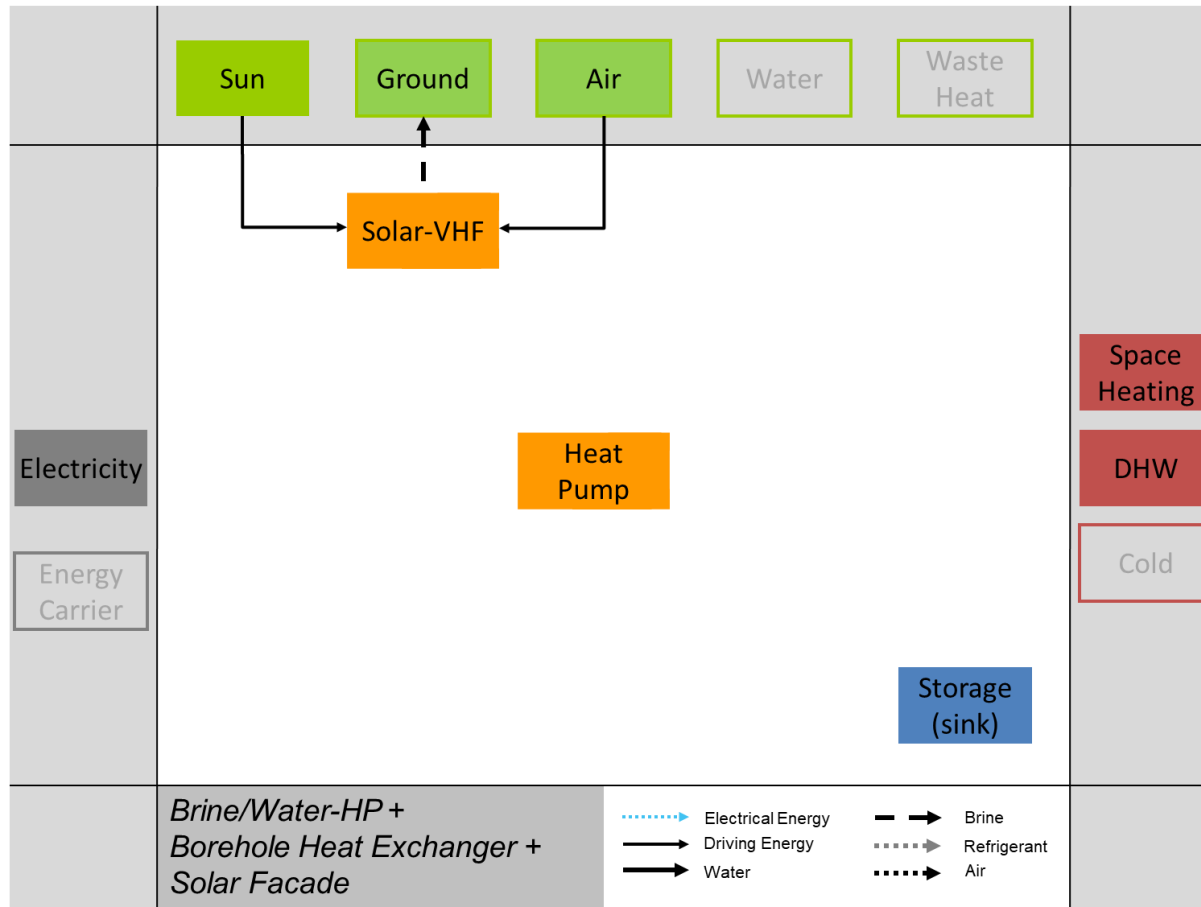
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# Facade as an energy source



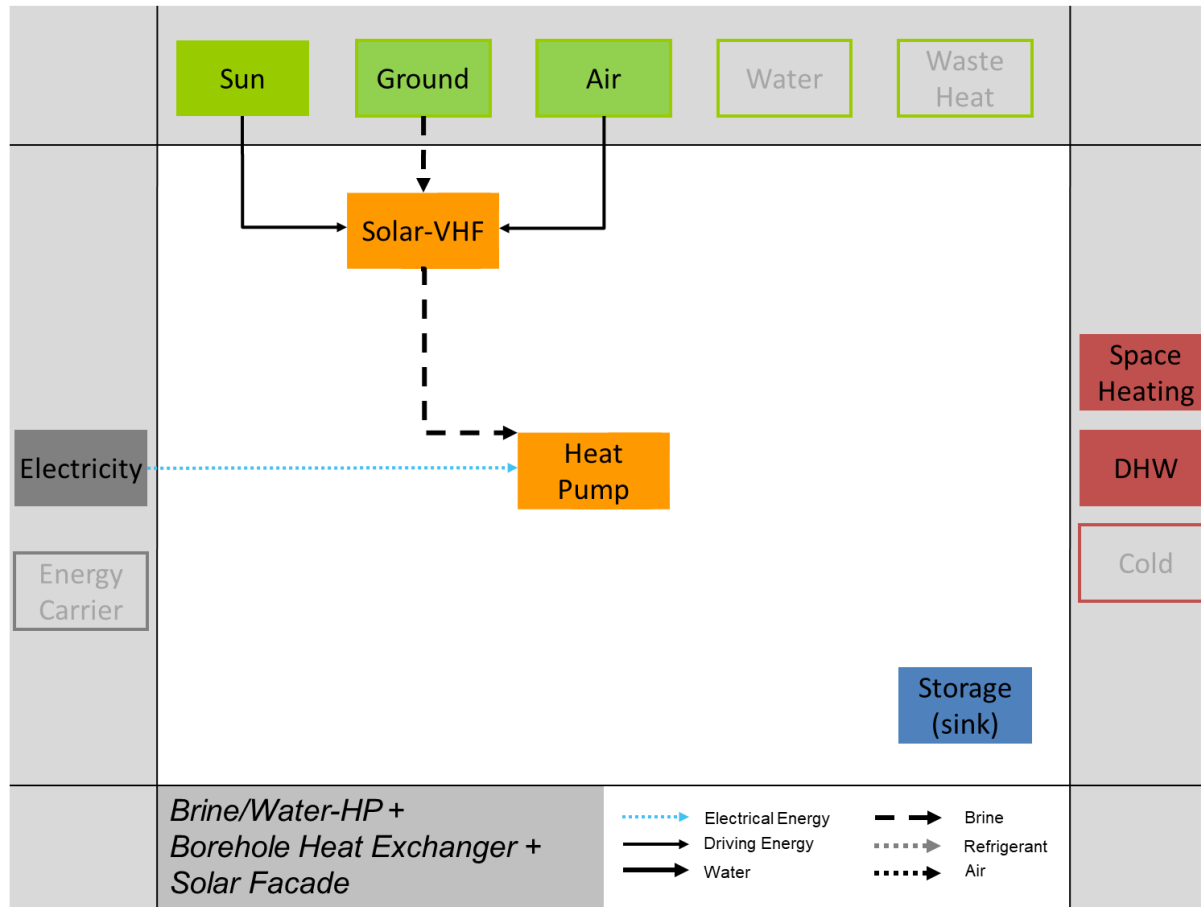
- **BHE -> HP:** borehole heat exchanger (BHE) as source of heat pump

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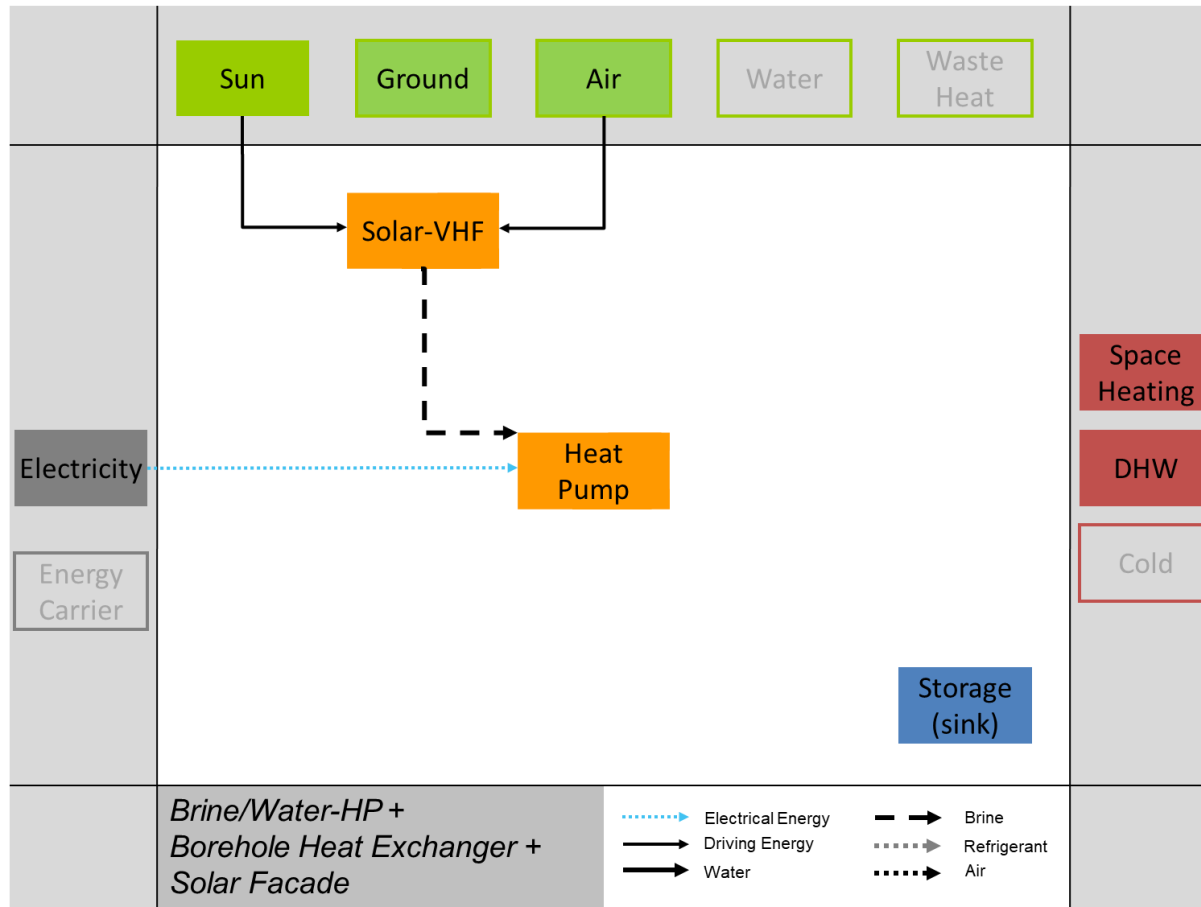
- **BHE -> HP:** borehole heat exchanger (BHE) as source of heat pump
- **SOL -> BHE:** solar façade (SOL) for active regeneration of BHE

# Facade as an energy source



- **BHE -> HP:** borehole heat exchanger (BHE) as source of heat pump
- **SOL -> BHE:** solar façade (SOL) for active regeneration of BHE
- **BHE + SOL -> HP:** Outlet of BHE additionally heated by SOL as source of heat pump (HP)

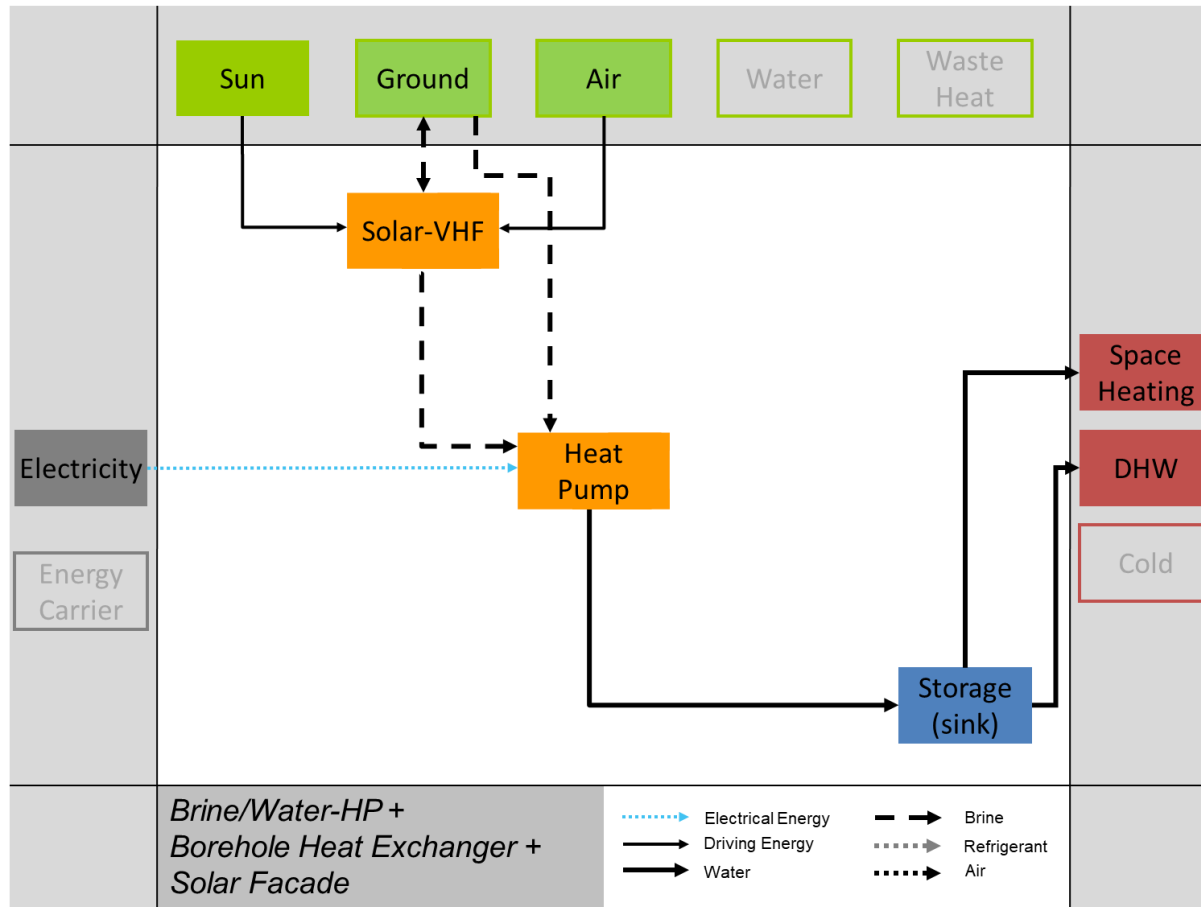
# Facade as an energy source



- **BHE -> HP:** borehole heat exchanger (BHE) as source of heat pump
- **SOL -> BHE:** solar façade (SOL) for active regeneration of BHE
- **BHE + SOL -> HP:** Outlet of BHE additionally heated by SOL as source of heat pump (HP)
- **SOL -> HP:** SOL as source of HP

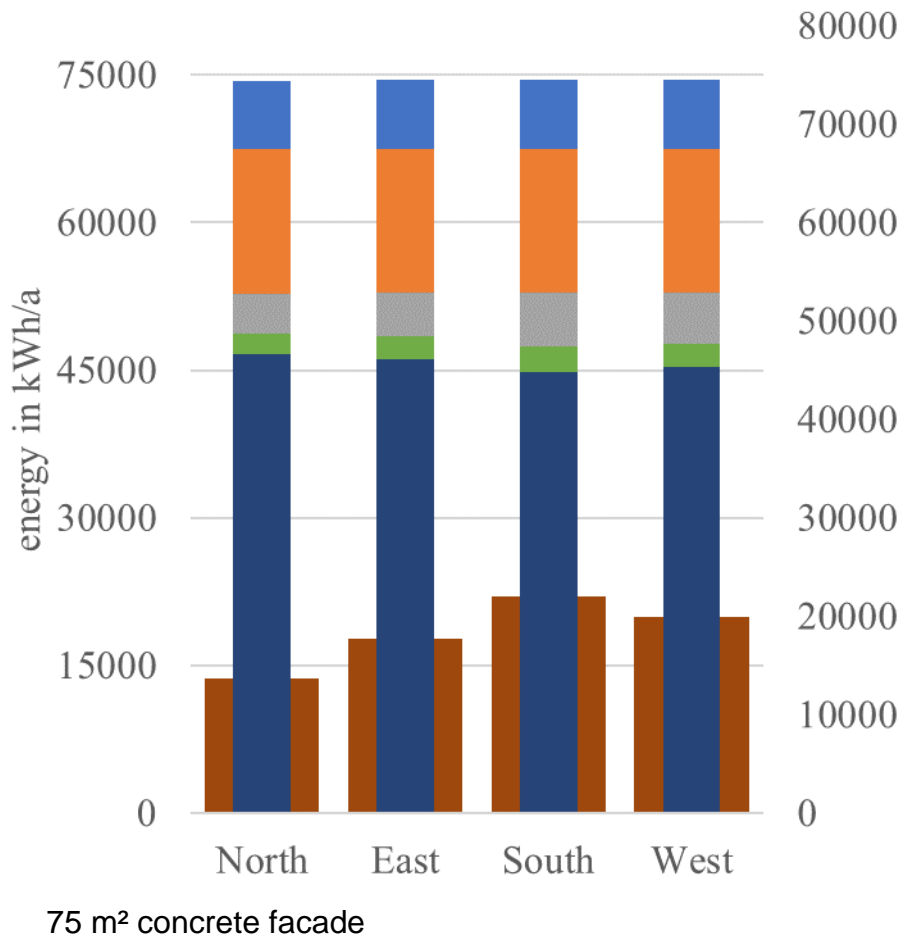


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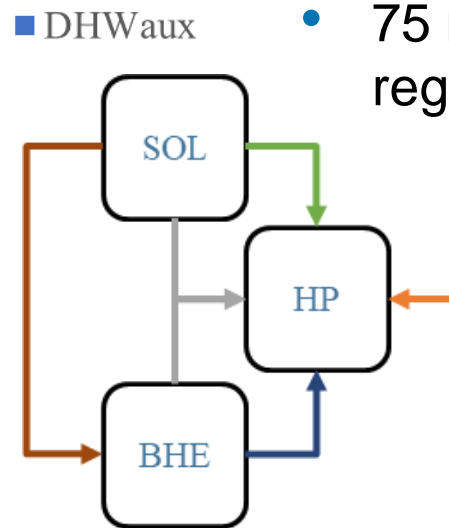


- **BHE -> HP:** borehole heat exchanger (BHE) as source of heat pump
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- **BHE + SOL -> HP:** Outlet of BHE additionally heated by SOL as source of heat pump (HP)
- **SOL -> HP:** SOL as source of HP
- **-> HP:** power consumption of HP compressor

# Results: Orientation for concrete



- Heat demand: SH 52 MWh (38 kWh/(m<sup>2</sup>a)), DHW 20 MWh
- Activation of large continuous south facade often not possible
- East and west facade also suitable
- 75 m<sup>2</sup> concrete facade: ~1/3 of heat extraction regenerated of borehole heat exchanger



- Building envelope as an unused energy source
- Different claddings for different temperature range
- Invisible installation in rear-ventilated facade
- Orientation influences heat generation during day
- Significant contribution to renewable energy in building sector
- Enables use of heat pump for refurbishment and new-build
- Additional source enables otherwise unsuitable projects
- Small concrete façade enables reduction of BHE by 25%
- Currently under construction; ready for occupancy spring 2023

# Acknowledgments



This work was funded by the state of Lower Saxony and the Federal Ministry for Economic Affairs and Climate Action (BMWK) under grant number 03ETW013 (Solar-VHF).

Supported by:



on the basis of a decision  
by the German Bundestag

