The role of District Heating and Cooling Networks in the future renewable energy system

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Heating and cooling are a global energy challenge

$\approx 50\%$

of global final energy consumption is used for heat

$\approx 40\%$

of energy-related CO_2 emissions are associated with heat

$\approx 30\%$

of global energy demand occurs in buildings

- Residential buildings account for about 70% of total building energy demand.
- Heating dominates cold climates; cooling is growing fastest in hot and emerging economies.

Key message: Heating and cooling are central to the global energy transition.

Source: [1,2]

Networks connect local resources, storage and consumers

$\approx 10\%$
of global building heat is supplied by district heating

$\approx 90\%$
of global district heat is still produced from fossil fuels

What networks can integrate

- industrial and urban waste heat,
- geothermal and solar thermal energy,
- large heat pumps and renewable electricity,
- waste-to-energy and sustainable bioenergy,
- short- and long-term thermal storage.

Networks are not inherently renewable. Their value is the ability to connect diverse sources, flexible storage and concentrated demand.

Source: [3]

Agenda

- Germany's heating sector in a nutshell
- District heating: status quo and outlook
- District cooling: the missing but heavily needed addition?

Germany's energy sector in a nutshell

Spotlight on the building sector

Final energy consumption Germany 2024: 2,249 TWh

Heat dominates consumption

- About 53 % goes to heating applications:
  - Space heating: 616 TWh (27 %)
  - Process heat: 459 TWh (20 %)
  - Hot water: 115 TWh (5 %)

Private households: 625 TWh

- Space heating: 66 %
- Hot water: 16 %
- other applications (process heat/cooling, ICT, lighting ...): 18 %

Key message: Heat supply is the central lever for decarbonizing the German building sector.

Source: [4]

Germany's energy sector in a nutshell

Renewable power... a summer and midday phenomenon

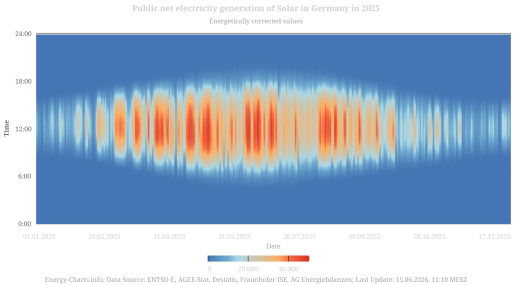


Figure: Solar power generation 2025 by time of day (y) and date (x); red = high feed-in.

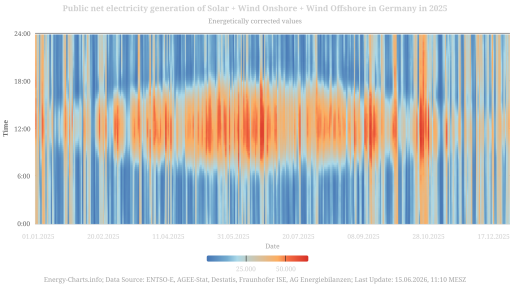


Figure: Generation from solar + wind (on-/offshore) 2025.

Key message: Renewable supply clusters around midday and the summer months, exactly when heat demand is lowest.

Source: [5]

Germany's energy sector in a nutshell

Power prices collapse at summer midday

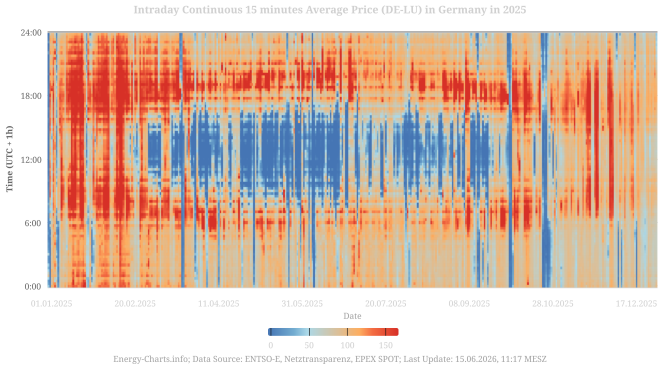


Figure: Intraday power price (DE-LU) 2025 by time of day (y) and date (x); blue = low/negative prices, red = high prices.

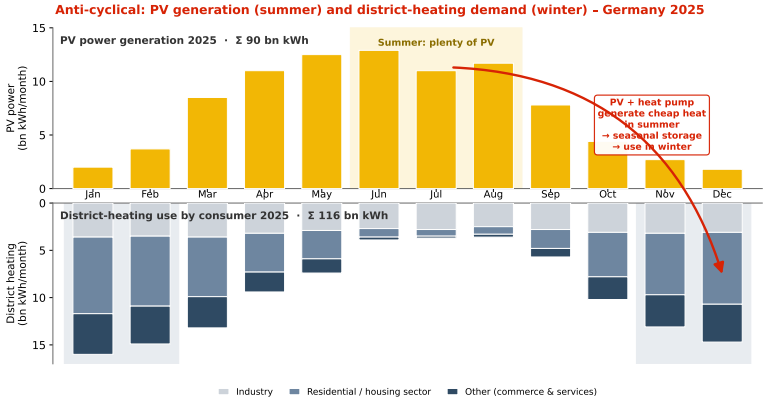
Source: [5]

- Summer midday: PV surplus → low, often negative prices (blue zone)
- Winter and evening hours: expensive (red)
- 2024: more than 450 h with negative exchange prices

Consequence: Cheap energy is available in summer; ideal for generating heat then and storing it seasonally.

District heating: status quo and outlook

Anti-cyclicality of PV generation and heat demand



Data: BDEW, "Die Energieversorgung 2025" (slides 44 & 67); ZSW, Destatis. As of 05–06/2026.

Key message: PV generation (summer) and district-heating demand (winter) peak in different seasons; cheap summer electricity + heat pump produce heat that, stored seasonally, covers the winter demand.

District cooling: the missing but heavily needed addition?

Rising cooling demand in Germany

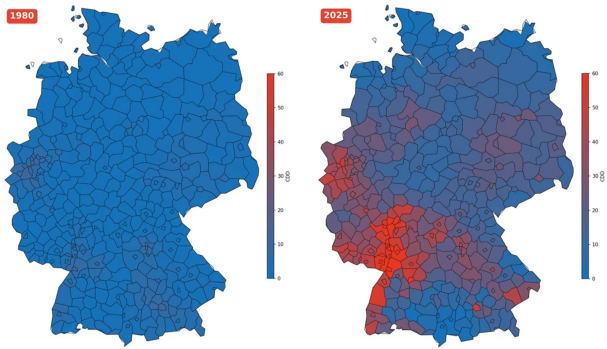


Figure: Cooling Degree Days (CDD) per district compared: 1980 vs. 2025.

- Marked increase in cooling degree days since 1980
- Air-conditioning demand is growing; especially in summer
- The cooling peak coincides with the PV surplus *and* can be covered from cold regenerated in winter

	No.	Length (km)	Energy (TWh)
DH	3,800	38,850	133
DC	30 (+≈80)	86	0.2

Cooling demand for residential buildings (2022): 6 TWh (≈ 20 TWh in 2045*).

Source: [7,8,9]

*2045: own estimate based on an electrical air-conditioning demand of 4.6 TWh, assuming a constant average coefficient of performance of 4.29; no official forecast from the UBA or BMWK.

District cooling: the missing but heavily needed addition?

Cooling is becoming a major driver of electricity demand

2,900 TWh

global electricity demand for space cooling

+50%

growth in cooling electricity demand since 2015

22 → 68 TW

projected global cooling capacity, 2022–2050

- Since 2015, cooling caused about 14% of global electricity-demand growth.
- In many hot-climate countries, space cooling may reach 30–50% of peak electricity load by 2050.
- District cooling networks can reduce electricity demand for cooling by up to 70% compared to decentralized options.

Key message: Cooling is becoming an energy-security and grid-capacity challenge.

Source: [10,11,12]

District cooling is proven where cooling demand is concentrated

(still) a niche in Germany, but not everywhere else

Paris

- more than 100 km of network,
- 401 GWh delivered in 2024,
- Seine water for heat rejection and winter free cooling,
- museums, offices, hospitals and public buildings.

Singapore - Marina Bay

- world's largest fully underground district cooling network,
- up to 35,000 RT of chilled-water production,
- thermal storage and central optimization,
- dense commercial and mixed-use district.

- Central production enables efficient chillers, thermal storage and professional refrigerant management.
- Economic viability depends on demand density, anchor customers and long-term utilisation.

Source: [13,14]

Heating-focused Germany, cooling-focused Laos: shared network opportunities?

Thank you very much for your attention!

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