Global Climate Impact from Hospital Cooling

Prepared by:

KIGALI
COOLING EFFICIENCY PROGRAM

Co-authored by:

Hovland Consulting LLC &
Health Care Without Harm

With input from:

Natural Resources Defense Council

The views contained herein are those of the author(s) and do not necessarily reflect those of NRDC.

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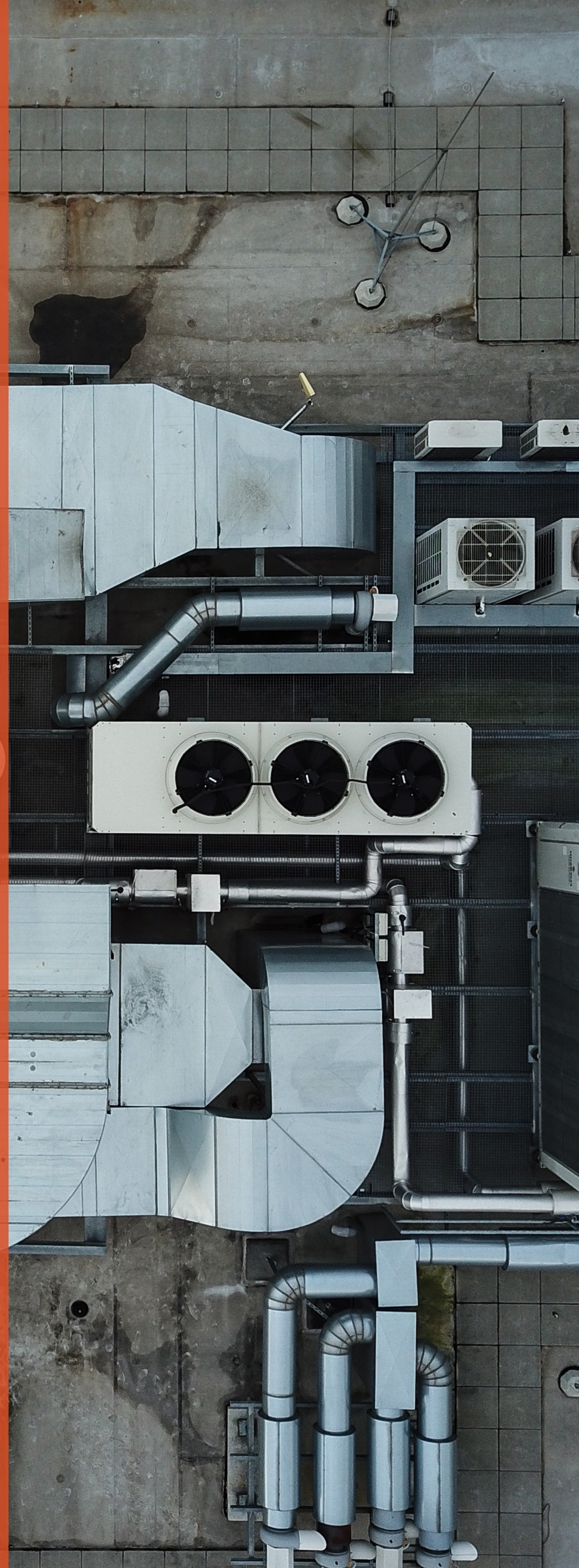


Executive Summary

Cooling is crucial for health. Thermal regulation minimizes heat stress and improves mental function and sleep. Refrigeration prevents spoilage of food, medicines, vaccines and blood. Not surprisingly, hospitals have large demands for cooling for patients and for medical products. Given that hospitals' cooling demand requires large amounts of energy consumption, hospitals are also responsible for greenhouse gas emissions, representing a **significant**[1] **percent of healthcare's climate impact.** Until now however, while there have been select country estimates, there have been no global estimates for the climate impacts of hospital cooling; this brief and the underlying approach estimated the collective climate impact of hospital cooling globally.

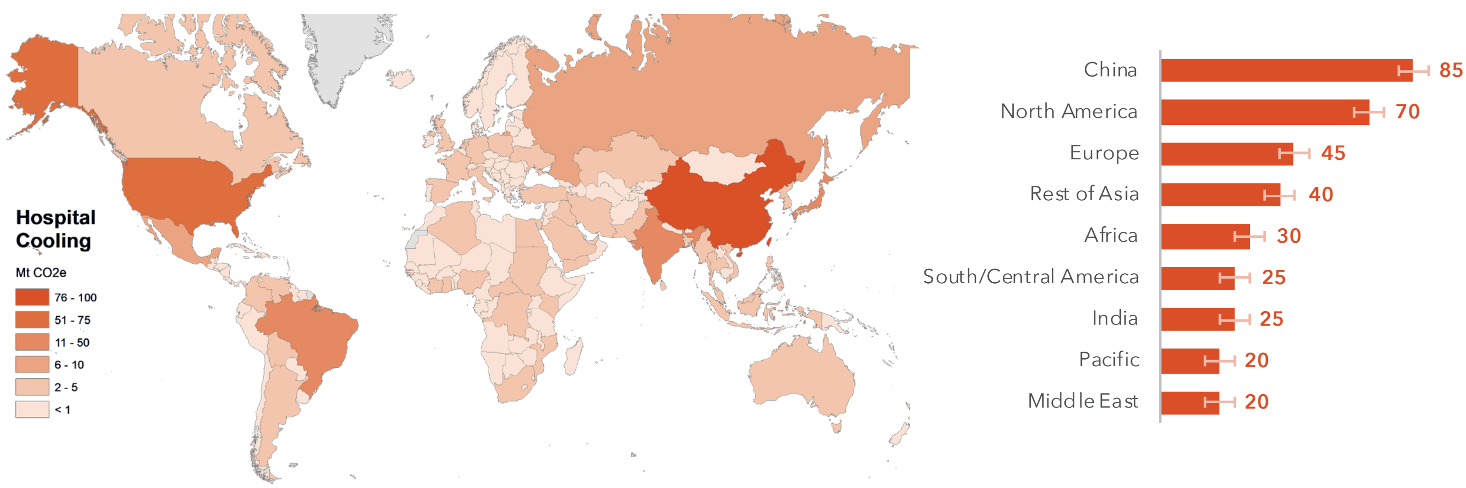
The climate impact from hospital cooling is significant and rising. Globally, roughly 365 Mt CO_2e (+/- 90 Mt) annually comes from hospital cooling. This is equivalent to the emissions from over 75 million cars on the road or 110 coal power plants[2] for an entire year. With increased attention to providing better and more health care and associated increases in spending (particularly in middle income countries), and absent efforts to improve efficiency and/or decarbonize the power grid, compared to present day, annual hospital cooling emissions could **almost quadruple by 2040 (to ~1,360 Mt CO_2e per year**). *Note that we are not modeling the climate impact of harmful F-gases used in cooling, such that the total emissions and potential benefit could be up to twice what is presented here (see the Methodology box).*

> Hospital cooling globally is currently **365 Mt CO_2e per year** but could quadruple by 2040. That's equivalent to emissions from **75+ million cars** and **110 coal power plants.**

Significantly, most of the energy used for cooling in hospitals is to maintain cool ambient temperatures. In the US, space cooling uses the most energy (70 percent for cooling and another 15 percent for

Figure 1: Hospital Cooling CO_2e by Region

Annual Mt CO_2e, current
Plus/minus bars show ½ standard deviation across scenarios



1 In the US, hospital care emissions are roughly 36 percent of total health care emissions, Environmental Impacts of the U.S. Health Care System and Effects on Public Health, Eckelman et al 2016, doi.org/10.1371/journal.pone.0157014

2 E.g., for coal plants producing ~3.3 TWh annually

related ventilation[3]); refrigeration represents roughly 15 percent of the emissions. Looking globally, as estimated through this analysis, the numbers skew even more to keeping rooms cool (~92 percent), with only eight percent for refrigeration.

Our modeling showed that three countries – **China, the US, and India – represent 45 percent of the total hospital cooling CO_2e emissions.** Japan, Brazil, and Mexico add another ten percent collectively. Sixty percent of the climate impact comes from seven countries. Figure 1 shows the map of the most prominent emitters and a summary by major region.

Solutions are readily available to reduce hospital cooling emissions without compromising patient care; in fact, efficient cooling can reduce the cost of providing healthcare. Solutions include: procurement of high efficiency low global-warming potential (GWP)[4] coolant air conditioners, chillers, and refrigerators; designing passive cooling into new and existing buildings to reduce the cooling load; enhancing ventilation and cooling strategies; taking a systems approach to cooling; improving energy management systems; and expanding onsite and offsite use of renewable power. We provide multiple case examples from China to Sudan including hospitals, universities, and entire health ministries that are embracing efficient and low-GWP cooling methods and improving hospital building designs. **Reducing the energy used for hospital cooling and refrigeration by 30 percent could abate ~110 Mt CO_2e per year currently, equivalent to installing 27,400 wind turbines.**[5] **By 2040, the benefit could be almost quadruple.**

Methodology: What is included?

Methods: This knowledge brief is based on **three methods** used to estimate the hospital cooling emissions from each country globally, including bottom-up and top-down approaches: 1) Hospital-derived, adjusted for cooling-degree days and electricity CO_2e intensity, 2) Total CO_2-derived, taking the percent for healthcare/hospital needs and adjusted by cooling-degree days, and 3) Space cooling for services energy-derived, taking the percent of how many services are for hospitals. Full details are in the Appendix. The difficulty in data collection was the prompt for using multiple methodologies in the hope that several converging lines of evidence would strengthen our confidence in the results.

What is included: The estimates **do include CO_2e** emissions that derive from electricity and other sources (such as natural gas) used to run **air conditioners,**[6] energy used for **cooling ventilation,** and electricity used for **refrigeration** (keeping medicines, food, blood, organs, etc. cool). The estimates are grounded in **current** emissions, but we forecast a **rough estimate for total emissions in 2040** extrapolating from projected increases in health spending and population growth (see Appendix for details).

What is not included: The estimates **do not include the non-CO_2 impact of using high global warming potential (GWP) refrigerants** (such as R-22), an important aspect of the Kigali Agreement. Given that efficiency increases are potentially on par with the benefit of phasing down harmful F-gases used in cooling,[7] the **total emissions and potential benefit could be up to twice** what is presented here.

3 Using data from US Energy Information Administration, 2012 data with actual data on 409 inpatient buildings representing ~9,580 inpatient buildings (hospitals). Known ventilation energy usage was distributed to cooling by the percent of cooling energy versus cooling and heating energy (e.g., ventilation is needed to move around cool and warm air), see the Appendix Method 1. https://www.eia.gov/consumption/commercial/data/2012/index.php?view=microdata

4 Typical hydrofluorocarbons used in air conditioners have high GWPs – with thousands of times more warming potential than CO_2 (20- and 100-year high global warming potentials (GWP) https://www.epa.gov/ghgemissions/understanding-global-warming-potentials, http://unfccc.int/ghg_data/items/3825.php). Low GWP units have values ranging from 1-6 (https://www.epa.gov/sites/production/files/2015-09/documents/epa_hfc_residential_light_commercial_ac.pdf)

5 Representing an average US wind turbine of 2 MW, ~3,950 tons CO_2 abated per turbine https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

6 As described in Method 1, direct (scope 1) emissions from natural gas and other cooling (~18% of space cooling energy) are rolled into indirect energy use (via electricity) and yield scope 2 indirect emissions through power grid intensities

7 Phasing down F-gases for cooling could reduce warming by up to 0.5°C by 2100, www.igsd.org/wp-content/uploads/2017/05/HFC-Primer-19May2017.pdf. Using more efficient cooling technology, such as super-efficient air-conditioners, could avoid up to an additional 0.5°C in the same period – savings from a combination of 30% more efficient ACs in combination with low GWP coolants. Lawrence Berkeley National Laboratory. 2015. Benefits of Leapfrogging to Superefficiency and Low-Global-Warming-Potential Refrigerants in Room Air-Conditioning. eta.lbl.gov/sites/default/files/publications/lbnl-1003671.pdf.

Recommendations

We recommend four actions:

1. **Continue to expand the availability and use of highly efficient and low global-warming potential coolant air conditioners, chillers, and refrigerators,** especially using financing that accounts for operational savings (e.g., considers reduced electricity) and procuring in bulk to reduce the price. This applies to both new and replacement units and can be facilitated by procurement standards adopted by ministries of health, hospitals and multilateral funding agencies. Financing options should look at lifecycle costs and consider reduced electricity costs by running efficient units (e.g., by offering attractive interest rates for efficient units or through pay-as-you-save ideas as Smart Joules uses in India). While all countries have potential to lower hospital-related cooling GHGs, action is particularly needed in the countries contributing most to hospital-related cooling emissions, such as China, the US, India, Japan, Brazil, and Mexico.
2. **Improve hospital building design to incorporate passive cooling and ventilation and improved ventilation and cooling strategies.** This can include using cool roof materials, less glass, increasing shading, orienting buildings to take advantage of wind, increased natural ventilation, zone temperature control, and night setbacks. While some of these measures could be implemented in existing hospitals, they are expected to be most cost-effective when introduced in the planning and design of new hospitals.
3. **Take a systems approach to reduce cooling load and capture waste cold, automating where possible and collecting better data that can inform further improvements.** This can mean using intelligent control systems to help properly manage and optimize the amount of energy used for cooling. Additionally, ensure existing units are serviced and maintained to optimize efficiency.[8]
4. **Expand onsite and offsite use of renewable power** within healthcare (for cooling and other needs). This could include hospital-level district cooling that could also help balance variable renewable power.

In the sections that follow, this Knowledge Brief provides an overview of the methods used to estimate hospital cooling emissions, results by country, a brief look at potential solutions, case examples, potential abatement impact, and a conclusion. An appendix provides further details on the three methods behind the CO_2e estimates, data sources, scenarios, and detailed results.

For the full paper, please visit KCEP's website here: https://www.k-cep.org/hospital-cooling-report/.

8 KCEP Knowledge Brief on Optimization, monitoring, and maintenance of cooling technology. http://k-cep.org/wp-content/uploads/2018/03/Optimization-Monitoring-Maintenance-of-Cooling-Technology-v2-subhead....pdf