Executive Summary

From milligrams to megatons:
A climate and nature assessment
of ten key health products

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Disclaimer

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Executive Summary

The risks associated with climate change and degradation of nature pose grave threats to global public health, and affordable, sustainable solutions have not yet been fully developed. It is becoming increasingly imperative for organizations in global public health to meet four objectives:

- **Climate resilience.** Climate change has been identified as the greatest threat to human health of the twenty-first century.[1] It is expected to worsen a range of medical conditions, including vector-borne diseases, other infectious diseases and maternal and child health. Additionally, disasters will become more frequent and severe, imperiling the capacity of healthcare systems to provide accessible services. Vulnerable populations in Low- and Middle-Income Countries (LMICs) will be disproportionately affected. Unless value chains and health products are climate-proofed – made resilient to these shifts – the United Nations' Sustainable Development Goal 3 (SDG3), which is meant to ensure "good health and well-being," will be much more difficult to accomplish.[2]
- **Decarbonization.** As the source of 4.6 percent of global emissions[3], health value chains contribute significantly to climate change. Rapid decarbonization of the sector is thus required to meet the Paris Agreement's objectives on warming.
- **Nature positivity.** As with climate change, the degradation of the natural environment affects public health. Environmental pollution poses a major risk to health (for example, air pollution leads to 7 million deaths per year[4]), and health value chains have significant effects on the environment through water use, wastewater discharges, and generation of plastic waste.[5] By making health value chains "nature-positive" – that is, helping to build nature's resilience and restoring it to 2020 levels – actors can avoid unintended, detrimental effects on health and align with global commitments to conserve biodiversity.[6]
- **Affordability.** To ensure widespread access to life-saving treatments, measures taken to meet sustainability objectives must simultaneously assure affordable healthcare. At present, however, little information is available on the potential trade-offs between cost and sustainability, and how those trade-offs can be managed.[7]

1 https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019; https://www.paho.org/en/topics/climate-change-and-health.

2 https://documents1.worldbank.org/curated/en/322251495434571418/pdf/113572-WP-PUBLIC-FINAL-WBG-Climate-smart-Healthcare-002.pdf.

3 Romanello et al., Lancet Countdown, The 2023 report of the Lancet Countdown on health and climate change.

4 https://www.who.int/news/item/22-09-2021-new-who-global-air-quality-guidelines-aim-to-save-millions-of-lives-from-air-pollution.

5 https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(20)30121-2/fulltext.

6 https://www.unep.org/news-and-stories/story/cop15-ends-landmark-biodiversity-agreement#:~:text=The%20GBF%20consists%20of%20four,to%20people%20are%20valued%2C%20maintained.

7 https://noharm-global.org/sites/default/files/documents-files/5961/HealthCaresClimateFootprint_092319.pdf.

These imperatives are particularly essential for health products supply chains, as these are highly complex and global, depend on many physical assets, processes and routes, are known to represent over 70% of healthcare's emissions[8], and are central to the provision of equitable access to health.

This report describes some of the key sustainability issues affecting health value chains of ten health products, and charts a path toward managing them. Its contribution is threefold. First, the report assesses greenhouse gas emissions, effects on nature, and the climate risks associated with ten strategic products in global public health that are critical in the fight against HIV, Tuberculosis, Malaria, for women and children's health and when dealing with global emergencies in LMICs. This assessment is conducted along the whole supply chain, from raw material acquisition to waste disposal. Second, it sets out an agenda of actions that will mitigate detrimental effects and risks, with a focus on maintaining affordability. Finally, the analysis is presented in a framework that can be applied to other health value chains in accordance with leading standards for risk assessment and disclosure.[9] Figure 1 below introduces the value chains that are the focus of this study.

8 Romanello et al., Lancet Countdown, The 2023 report of the Lancet Countdown on health and climate change.

9 TNFD website; Official Journal of the European Union (2022) Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022.

Figure 1. 10 priority health products have been selected based on relevance for & representativeness of the Unitaid portfolio and disease space

Archetypes	Typical products	Focus products
Small molecule medicines	Oral medications Injectable medicines	Heat stable Carbetocin Long-acting injectable Cabotegravir Dolutegravir-based first line regimen Bedaquiline, Pretomanid, and Linezolid (BPaL) Artemisinin-based combination therapy
Rapid diagnostics	Lateral Flow Assay products (Rapid tests)	HIV Self-Testing
Point-of-Care diagnostics	Point-of-Care PCR testing platforms	Point-of-Care PCR platform for MTB test
Integrated diagnostic platform	Lab-based PCR testing platform	High-throughput PCR platform
Vector control products	Insecticide-based vector control products	Long Lasting Insecticide- treated Net (dual active ingredient nets)
Others	Production of medical oxygen	Pressure swing adsorption oxygen generating plant (PSA O_2 plant)

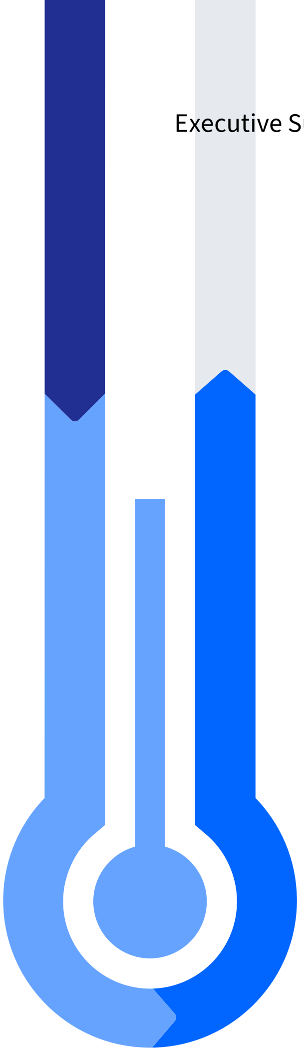
Women & Children's health
HIV & Co-infections
Tuberculosis
Respond to Global Health Emergencies
Malaria

Figure 2. While many factors have been accounted for in the calculation of emissions, it is useful to summarize them as a product of emissions intensity, consumption per patient and patient demand

High Medium Low

Products	Product Emission Factor by weight, $kgCO_2e/kg$	Consumption per patient-year, kg/patient	Total GHG emission per patient-year, $kgCO_2e$/patient	Patient demand[1] in 2030, M	Total GHG emission, $ktCO_2e$
Heat-stable Carbetocin	7.4	0.03	0.2	17	4
Long-acting Cabotegravir	9.7	0.2	2	21	11
Dolutegravir-based regimen[2]	64.4	1.3	83	32	2,657
B-PaL regimen[3]	57.4	0.7	41	0.1	2
Artemisinin-based combination therapy	6.9	0.04	0.3	480	103
HIV Self-Testing	9.4	0.1	0.9	30	27
Point-of-Care PCR testing platform	4.3	0.1	0.3	30	10
High-throughput real time platform for HIV-1 PCR test	3.1	0.1	0.4	31	14
Long-Lasting Insecticide-treated Nets	7.5	0.1	0.7	115	506
Pressure swing adsorption oxygen generating plant	0.2 kg $CO_2e/m3$	$101m^3$	17	854 M m^3	147
					~ 3,480

1. The Dolutegravir-based regimen includes three drugs: Tenofovir, Lamivudine, and Dolutegravir.
2. Assumptions for patients treated: 3.5 injections of LA Cab per person/year; 1 HS Carbetocin injection per patient/year; DTG 1 tablet per day; 1 cycle of malaria per patient/year; 1 regimen of B-Pal regimen per patient/year; 10 liters per minute of oxygen for 1 week per patient/year. 1 net for 2 people for 3 years.
3. The B-PaL regimen includes three drugs: Bedaquiline, Pretomanid, and Linezolid.



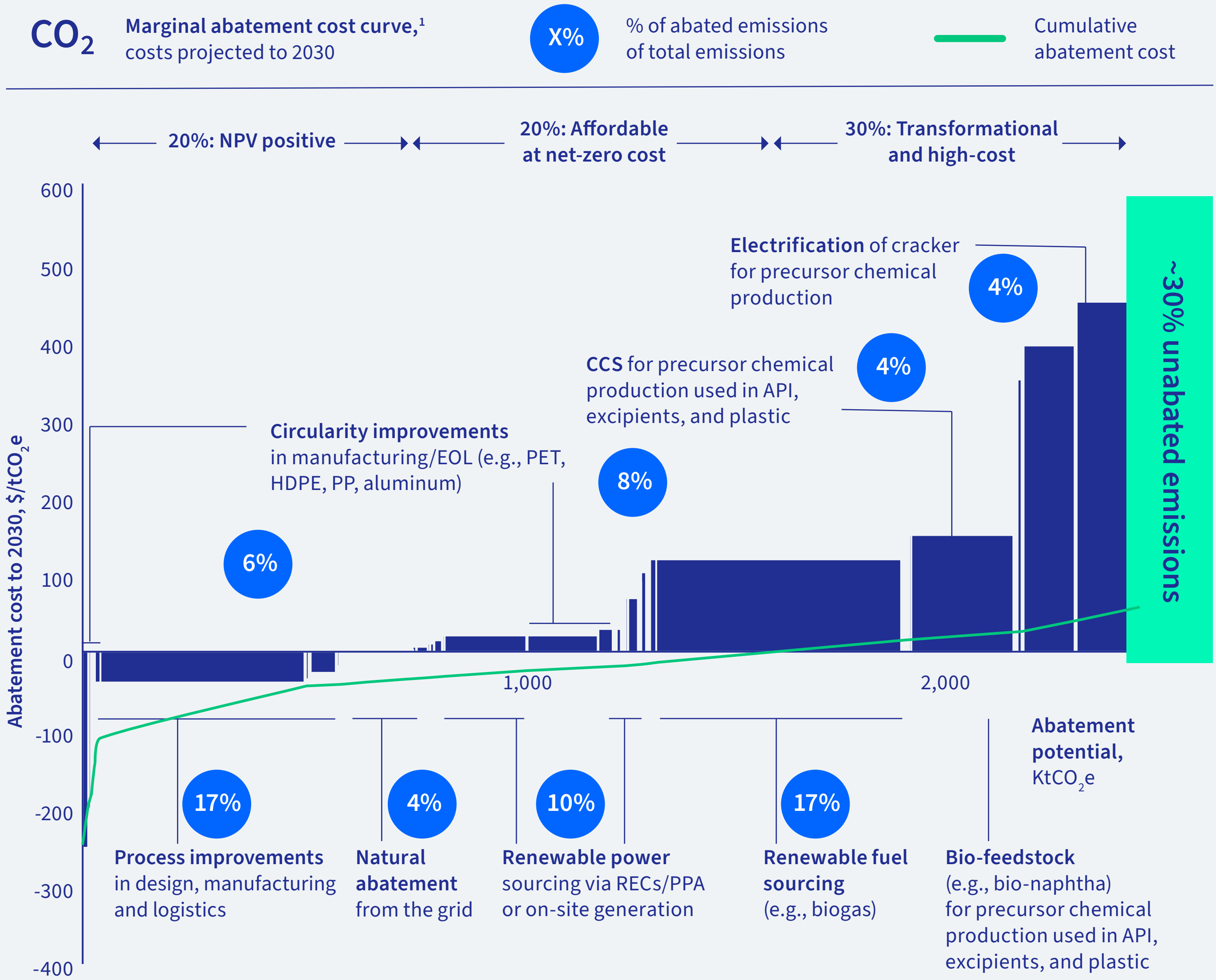
Emissions

Despite being usually small in size and weight, health products can be associated with significant footprints, as Figure 2 highlights. This is largely driven by the presence of components that are highly energy intensive to produce, such as Active Pharmaceutical Ingredient (API) in medicines and plastics in diagnostics, the frequent or continuous product use for each patient or individual, and large demand worldwide (up to hundreds of millions of beneficiaries). Dolutegravir-based HIV treatment exemplifies this: despite a daily dose expressed in milligrams of active pharmaceutical ingredient, the analysis estimates that by 2030 it will contribute 2.7 megatons of GHG emissions annually worldwide, due to a particularly emissive set of APIs, the need for daily treatment and a demand expected to reach 30 million People Living with HIV by 2030. The second largest footprint of the 10 products are dual active ingredient LLINs, which are distributed in very large quantities, and where most emissions come from the manufacturing of 57,500 tons of plastic annually. At the other end of the spectrum, heat-stable Carbetocin requires much smaller quantities of an active ingredient that is simpler to manufacture – resulting in a much smaller footprint. The central scenario of this study projects limited use of air freight in value chains, and as a result emissions from transportation are only 1% of the total. If all marine transport were displaced by air freight, transport emissions would rise to 17% of the total.

Forty percent of emissions can be abated without increasing overall costs. As Figure 3 highlights, 70 percent of emissions can realistically be abated by 2030 – of which 40 percent of the total can be removed at cumulative net-zero cost. The remaining 30 percent would increase product costs. Energy efficiency measures and the use of renewable energy can yield savings across the whole portfolio, especially in medicines, while contributing significant abatement (27 percent across the portfolio). The adoption of high-quality recycled PET (rPET) could reduce emissions per net at a cost of $0.2 to $0.3 per net.[10]

10 This is based on an assumption that the plastic component cost in bed net is around $1/net using virgin PET and a projection that high-quality rPET (comparable in mechanical strength to virgin PET) costs 20–30% more than virgin PET in 2030, similar to the observed average premium from 2020–23.

Figure 3. 40% of GHG could be abated without increasing overall costs



1. Shows a non-exhaustive list of abatement levers. Abatement costs are computed as the difference in levelized costs of production between 'from' and 'to' technologies from 2022 to 2030.

Note: All GHG abatement levers cost are assumed as the difference between cost of current technology vs. decarbonization lever net of any benefits. It does not account for any green premium that certain players may choose to apply.

Source: Expert interview, IEA, Mission Possible Partnership.

Nature

The impact on nature from waste materials is notably problematic for health value chains. These effects are a concern across the sector and are likely to be particularly challenging in settings with limited resources for waste management. While medicines tend to have impacts upstream at the point of manufacturing, nature impacts from devices is more concentrated downstream through the creation of waste products.

- **Medicine manufacturing processes generate large volumes of harmful waste that require treatment.** This waste can include the toxic solvents used to make APIs (e.g., ~400kg of solvents used to create 1kg of DTG API) as well as the APIs themselves, which can cause anti-microbial resistance in the natural environment. While a detailed analysis of waste management practices in the selected value chains was not possible, there is evidence that waste products are not fully treated in regions where production is concentrated. The resulting effects on public health are already significant and could become more severe as discharges accumulate.
- **Downstream effects result from generation of waste products in settings without waste management resources.** Dual AI LLINs alone are projected to create 57,500 tons of plastic waste by 2030. The expansion of "decentralized" products and delivery models – for example through self-testing – means that waste must increasingly be managed within communities rather than in health facilities.

Solutions to manage discharges exist but their costs and feasibility remain untested. Investments include specialist filters for APIs and infrastructure for recycling or treating waste, while lower cost community waste management models or 'product as a service' arrangements with equipment suppliers are promising but untested at scale in target countries.

Green chemistry processes can alleviate damage to nature from synthetic medicines and save costs. While solutions that focus on managing discharges typically require investment, green chemistry approaches can reduce costs, nature damage and emissions by limiting the volume and toxicity of inputs. For TB treatments, initial pilots of green-chemistry practices have already cut raw material use by more than 50 percent[11]. Expanding the application of these approaches to a wider portfolio of treatments could potentially mitigate detrimental effects on nature and enhance affordability. As capacity is ramped up globally and expanded across regions, there is an opportunity to implement such approaches as it is typically more cost-effective to adopt a new manufacturing process at the time of construction.

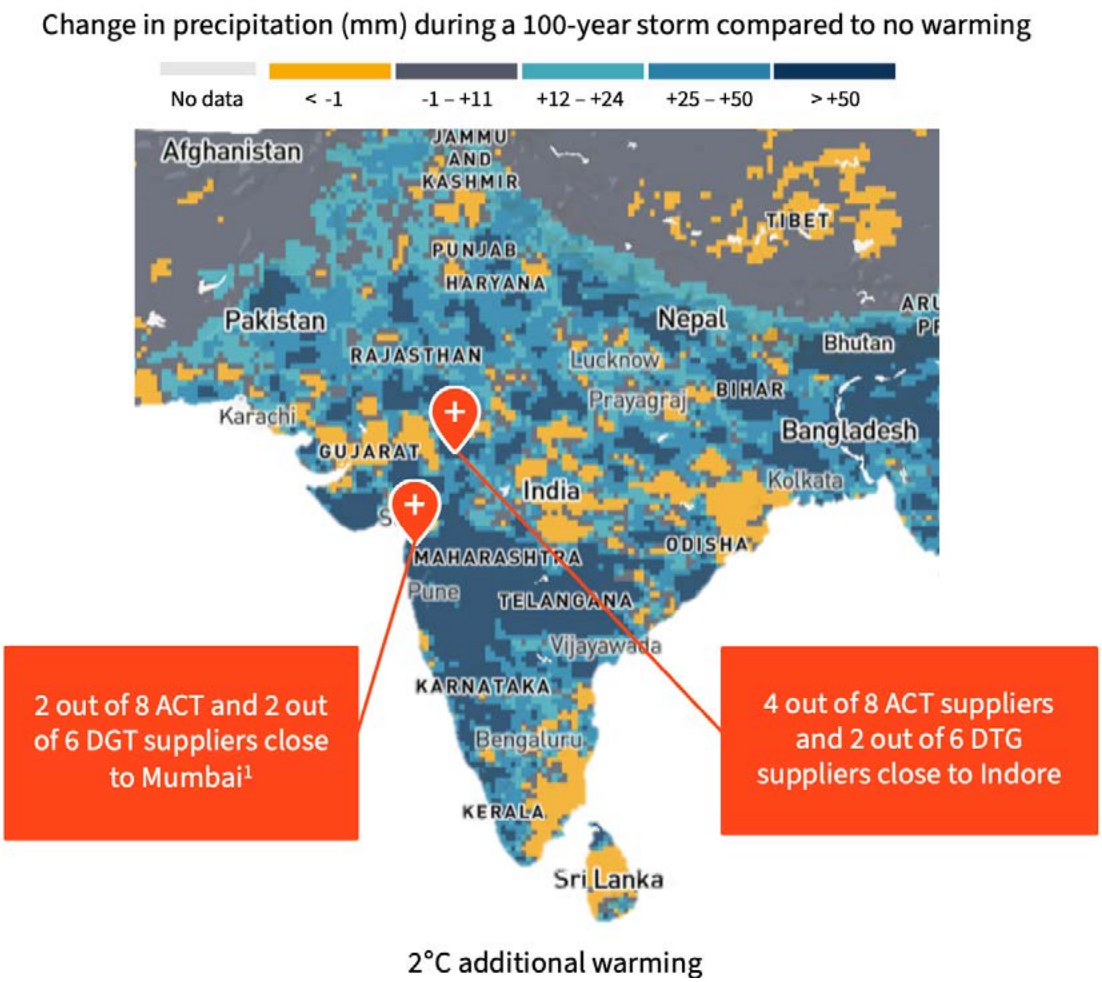
11 M4ALL Institute.

Resilience

Upstream climate risks are growing and can threaten health products' availability where value chains are concentrated in clusters. Value chains in all sectors are exposed to increasing risks of outages due to extreme events such as flooding or wildfire. As many health value chains have developed around regional 'clusters', there is a risk that a single extreme event could disrupt a substantial portion of supply.

Within the portfolio of products under review, as Figure 4 highlights, DTG and ACT manufacturers are clustered in flood exposed regions of India. Avoiding the risk of supply outages can involve a range of measures, from strengthening assets along the supply chain to increasing stockpiling; regionalization of value chains can also contribute to resilience provided output can be flexibly exported.

Figure 4. Elevated flood risk upstream due to regional concentration, and severe hazard related disruptions downstream



1. Firms are be counted twice if they have multiple locations.

Sources: Expert interviews, Probable Futures, Supply Chain Dive, Times of India, World Health Organization.

Downstream risks can create acute pressure on healthcare, though best practice disaster management and resilient health systems can mitigate this. The 2022 Pakistan floods affected healthcare needs and the ability of systems to manage them: for example, bednet distribution was affected at a point when mosquitos could spread very rapidly, leading to a fourfold increase in malaria cases [ref: "It was just the perfect storm for malaria" – Pakistan responds to surge in cases following the 2022 floods (who.int)]. Emergency management frameworks, including guidance from the World Health Organization (WHO)[12], can be more widely adopted to mitigate impacts without incurring significant investment costs. Greater heat stability of products and temperature control of value chain can also mitigate the risk of lost efficacy in the context of growing extreme heat.

Framework for action

To encourage the implementation of these levers within health value chains, partners across the public health ecosystem can take catalysing steps towards making health products more "climate-smart": less carbon emissive, less harmful to nature, more resilient and responsive to climate and nature risks, and locally adapted with regards to evolving needs from health systems and communities. Several common pathways emerge across groups of key levers:

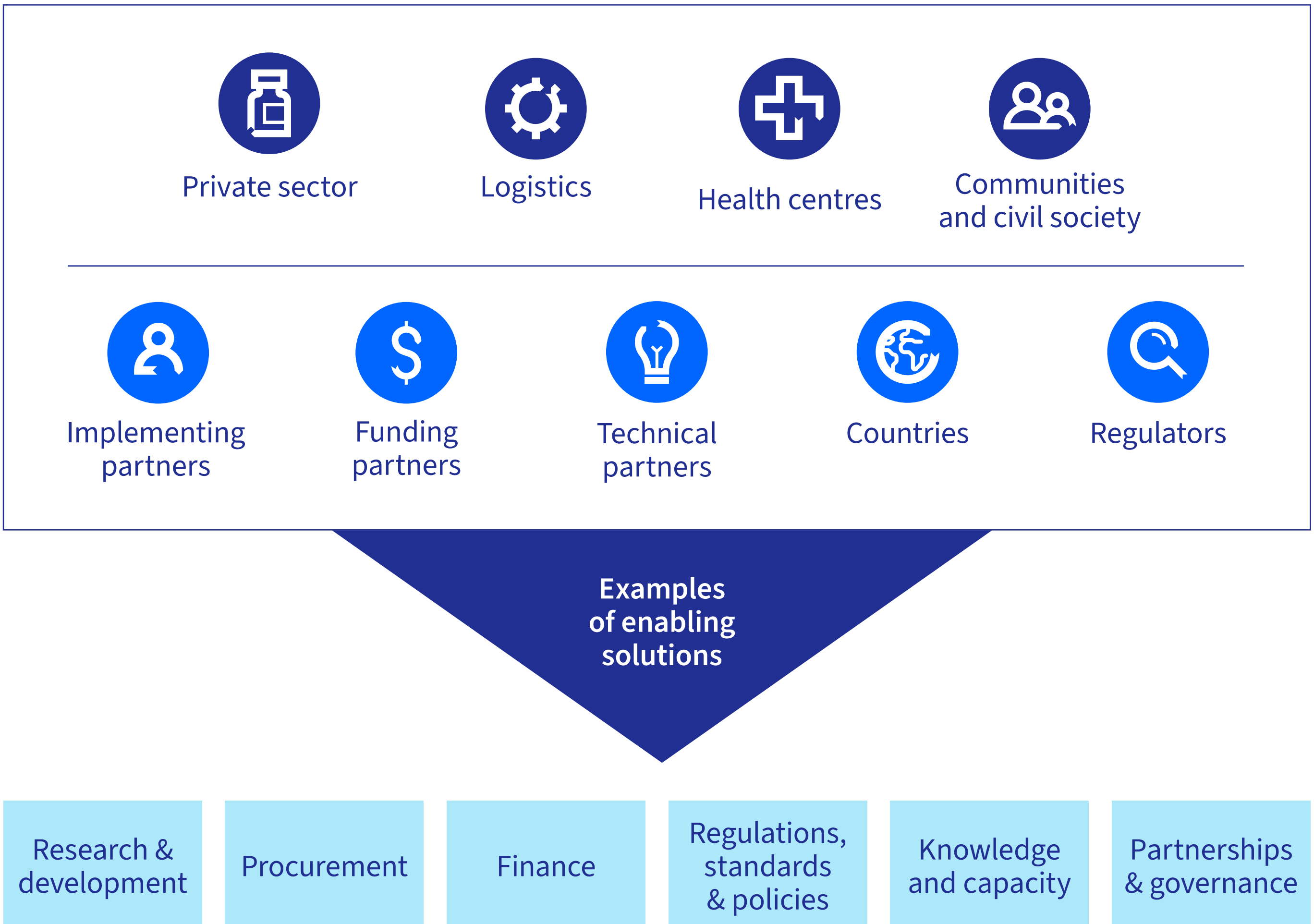
- **For upstream processes such as energy efficiency or pharmaceutical wastewater treatment**, multiple challenges need to be overcome in order to support implementation of more advanced processes. This includes generating and disseminating evidence on costs, feasibility and emissions, creating the right incentives through policies, regulations and standards, procurement practices and market-based approaches, enabling access to finance, and increased research on more sustainable technologies such as green chemistry.
- **For upstream inputs such as renewable energy and recycled materials**, barriers are more likely to be related to cost or the accessibility of sustainable inputs. This requires funders to provide incentives for value chain actors to bear these costs.
- **For product design efficiencies**, the challenge is to orchestrate a shift from one norm of production to another more sustainable benchmark, in a way that is economically viable and maintains affordability. Further evidence could support a switch to new designs (e.g., confirming bed nets remain stable when bulk packaged).
- **For management of waste within health centers and at community level**, challenges include a lack of evidence on the most effective approaches, and a lack of funding and capacity to implement them. Procurement models that combine capital and operational support, underpinned by sufficient funding and capacity building, and efforts to study new waste management models, can ensure such approaches are increasingly deployed.

12 World Health Organization, Operational framework for building climate resilient and low carbon health systems, 9 November 2023.

- **To support resilient access to products,** barriers center more on information on risks (e.g. geospatial exposures to physical risks), and best practices. Improvements in tools and metrics for assessing resilience of health products supply chains, supported by capacity building efforts, can empower practitioners to do more. Further research on the efficacy of climate risk management practices in health systems could support better targeted responses.

All of these interventions require partnerships to drive progress towards climate-smart health products. As value chains expand rapidly over the course of this decade, cost-effective progress requires an alignment on priorities and supporting funding, standards, practices and policies. Only strong partnerships across the ecosystem can deliver this.

Figure 5. Critical enablers and solutions across the partner ecosystem



Source: Unitaid.

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