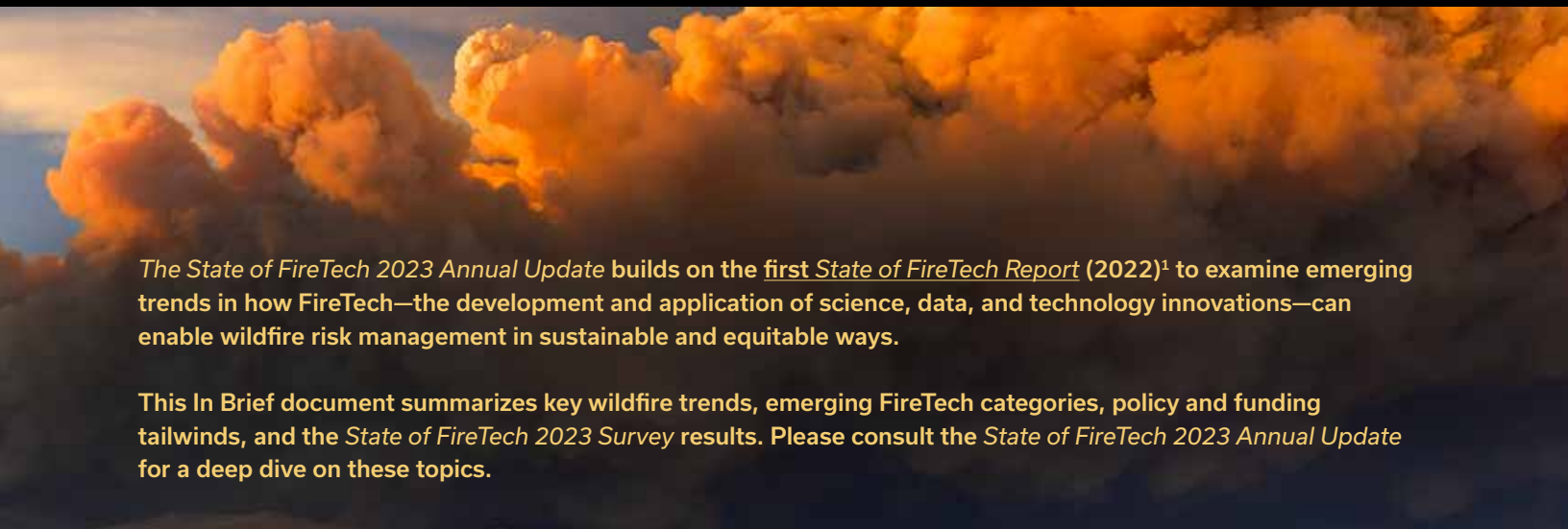
THE STATE OF FIRETECH

2023 ANNUAL UPDATE IN BRIEF



The State of FireTech 2023 Annual Update **builds on the first** *State of FireTech Report* **(2022)[1] to examine emerging trends in how FireTech—the development and application of science, data, and technology innovations—can enable wildfire risk management in sustainable and equitable ways.**

This In Brief document summarizes key wildfire trends, emerging FireTech categories, policy and funding tailwinds, and the *State of FireTech 2023 Survey* **results. Please consult the** *State of FireTech 2023 Annual Update* **for a deep dive on these topics.**

Key Trends

In *Section I—Year in Review, the State of FireTech 2023 Annual Update* identifies three key trends that will increasingly influence the future of innovation and investments in wildfire risk management:

- Changing fire regimes in the WUI will need better methods to identify 'fires that matter'[2],
- Increasingly urban impacts of fires highlight the need to prioritize 'mitigations that matter'[3],
- Smoke exposure and toxicity will require better smoke management to save lives[4].

Wildfire disasters worldwide, and especially from Canada's long burning wildfires, contributed to skyrocketing emissions of over 400 megatons in 2023[5]. This trend is likely to continue. Climate change and land use change are projected to make wildfires more frequent and intense, with a global increase of extreme fires of up to 14% by 2030, 30% by the end of 2050, and 50% by 2100[6].

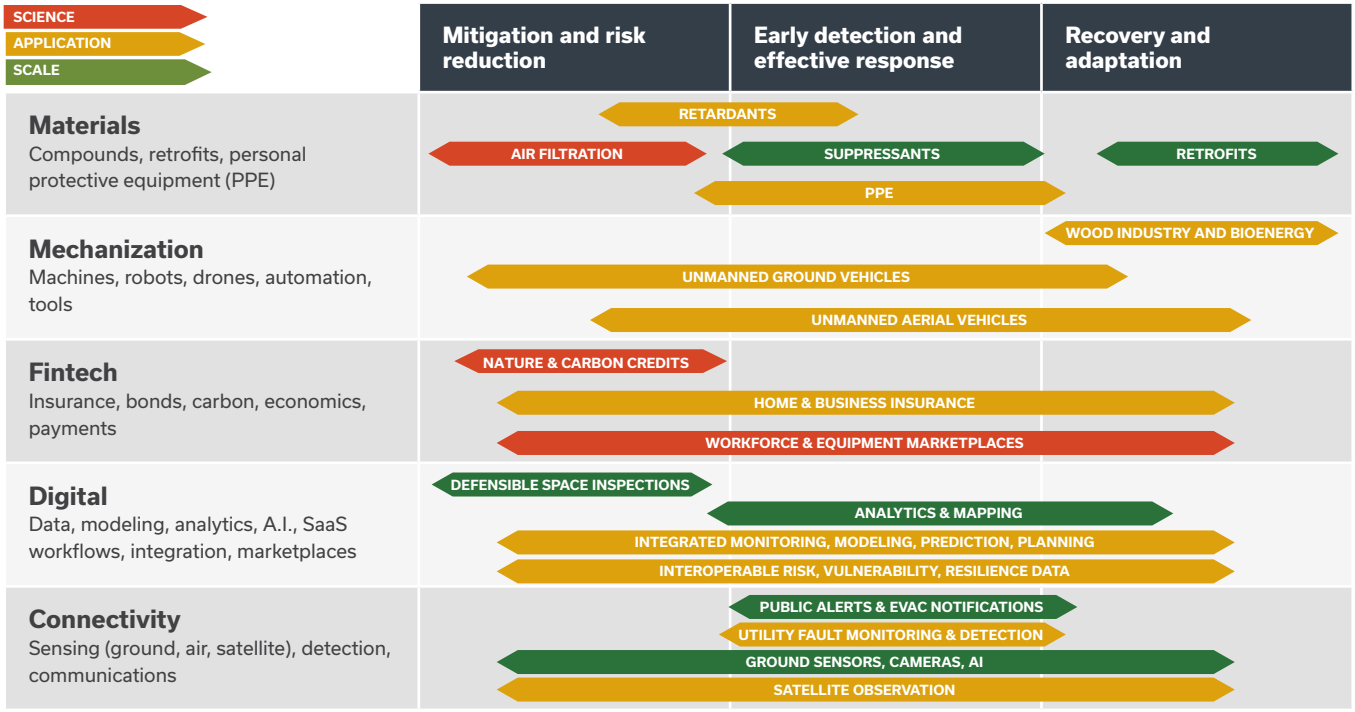
The August 2023 Maui fires in Hawaii reiterate a trend that was observed in the 2017 Thomas fire in California and the 2021 Marshall Fire in Colorado: wildfires are increasingly urban and suburban[7]. This trend is likely to worsen. In the United States alone, an estimated 87.6 million people will live in cities by 2050[8] literally lending more fuel for larger urban conflagrations[9]. The United States' wildfire risk in the near future will be primarily from grassland and shrubland fires[10].

In addition to the growing economic cost[11], wildfires also cause chronic public health impacts due to smoke exposure. 27 times more people now experience heavy smoke exposure than a decade ago[12]. Recent data also shows that mortality is greater from wildfire smoke toxicity than flame exposure[13]. Wildfire smoke impacts are inequitable and disproportionately affect outdoor workers, unhoused people, children, older adults, and people with pre-existing medical conditions. Smoke research in the United States links wildfire smoke with stalled or reversed air quality improvements for 30 states since 2016, with the worst effects in western states[14].

Research and policy analysis now underline the importance of focusing wildfire mitigation efforts in and around the built environment, including through the implementation of appropriate mechanical fuel treatments, prescribed fire, zoning and land use planning, and building codes for home hardening. While mitigation is increasingly a funding priority, mitigation and risk reduction innovations are currently among the least developed and hence, least funded in FireTech[15].

Emerging FireTech Categories

In the context of these key trends, *The State of FireTech 2023 Annual Update* identifies five emerging categories of FireTech—Connectivity, Digital, Fintech, Mechanization, and Materials (see Figure below).



State of FireTech applications for wildfire risk management (2023)

This framework represents dynamic and co-dependent technology trends and will remain open to iterations and adaptations.

CONNECTIVITY

includes technology that assists with sensing, early detection, and communications. It can include sensor networks (satellite, aerial, ground) and the Internet of Things (IoT) applications for enhanced situational awareness. Enhanced connectivity can generate real-time, precise, and life-saving data for more effective wildfire risk management, for example, through the application of Team Awareness Kits[16].

DIGITAL

broadly refers to all data collection, validation, and sharing systems relating to wildfire hazard, exposure, vulnerability, loss, damage, risk, and resilience data. It includes data integration, modeling, analytics, A.I., cloud-based Software as a Service (SaaS) workflows, marketplaces, and intelligent systems to augment end-to-end wildfire risk management mapping, workflows, and information systems, including gamifying learning and trainings. Digitization has been foundational for the development and application of mechanization, financial, and material technologies.

FINTECH

is an emerging category that includes insurance, bonds, carbon economics, and increasingly, payment platforms. The first State of FireTech Report (2022) acknowledged that digitization, mechanization, and material technologies in FireTech are being increasingly used in conjunction with related advances in fintech, such as insurance, crypto, and carbon markets, including pricing insurance offerings and guiding public-private investments. Given growing interest in the deployment of financial solutions in wildfire risk management, the 2023 Annual Update acknowledges fintech as a new FireTech category.

MECHANIZATION

broadly refers to robotics and automation, represented by the development and application of bionics, assistive and collaborative bots, and ground-based and aerial unmanned systems to augment emergency management response and assist fire crews with real-time risk assessment, mitigation, early detection and response, and recovery. Learning from advances in humanitarian tech and disaster tech at large, the most popular kind of robots currently being deployed in FireTech are unmanned aerial vehicles or drones with increasing potential being demonstrated by mechanized solutions including remote operated ground vehicles for more efficient vegetation management.

MATERIALS

include a range of chemicals and compounds, such as suppressants and retardants, as well as engineering, structural retrofits, and tools, and equipment. Perhaps the earliest kind of FireTech materials that have been in use for at least 80 years are foam-based fire suppressants. More recently, material technology has expanded to include a range of organic compounds for use as retardants and ignition agents. These kinds of material technologies are not just being applied in fire response but also for prescribed burns and mitigation actions in wildland-urban interface (WUI) communities. This category also includes building materials and retrofits such as vents, screens, and roofs that allow homeowners to retrofit and 'harden' structures for improved fire defense and smoke protection. While some air filtration systems have been successfully piloted, including weather stripping, DIY box filtration fans, and creating clean rooms with air purifiers, scaling affordable structural air filtration systems largely remains a white space.

Progress in the development and application of FireTech solutions can be assessed along the following broad and overlapping stages:

1. Research and development: prove the science and test methodology across contexts

2. Pilots and operationalizing: demonstrate applications for community wellbeing and ecosystem resilience

3. Achieving scale: through partnerships across new geographies and verticals

Policy and Funding Tailwinds

The State of FireTech 2023 Annual Update also provides an overview of policy developments and funding tailwinds for science, data, and technology, with a focus on the United States. Data shows why there is a continued need for investment and innovation in wildfire mitigation, resilience, and adaptation.

In 2021, the Infrastructure Investment and Jobs Act (IIJA) created the federal Wildland Fire Mitigation and Management Commission[17]. The Commission was charged with making recommendations to improve federal policies related to the prevention, mitigation, suppression, and management of wildland fires in the United States, and the rehabilitation of land devastated by wildland fires.

Among the core themes of the Commission's final recommendations is a call for greater coordination, interoperability, and collaboration, including for science, data, and technology. Read here for more on how the Commission's recommendations relate to FireTech applications[18].

Following from such policy recommendations, FireTech is poised for a strategic boost from unprecedented government funding in the United States[19], and philanthropies and corporates are leaning in.

In 2023, 37 funders from the Wildfire Resilience Funders Network[20] collectively reported about $85 million in grantmaking budget for wildfire-related efforts for 2023, with a slight increase in budgets expected over the next 3-5 years. In this sample, FireTech is represented in at least 28% of funder's budgets but longitudinal trends in technology and innovation related grantmaking remain to be seen.

Significantly, in 2023, the Gordon and Betty Moore Foundation announced a $110 million, six year investment as part of the first of two planned phases for its recently launched Wildfire Resilience Initiative[21].

Aligned with federal priorities, the Moore initiative is focused on securing healthy ecosystems and resilient communities through three key strategies:

- **Early-fire interventions** that reduce the threat of extreme wildfire and enable beneficial fire through improved and integrated early detection, assessment, and response
- **Pre-fire community interventions** that decrease communities' fire disaster risk through implemented mitigations
- **Pre-fire ecosystem interventions** that reduce ecosystem vulnerability through improved stewardship

These key strategies are supported by three cross-cutting strategies: developing a deeper understanding, creating enabling conditions, and operationalizing measurement and evaluation.

In private capital, the first exclusively FireTech focused VC firm—Convective Capital[22]—raised 35 million and invested in 11 FireTech startups in 2022-2023. These portfolio companies are developing FireTech solutions across all areas of wildfire risk management— mitigation and risk reduction, early detection and response, and recovery and adaptation. Aligned with the National Cohesive Wildland Fire Management Strategy goals[23],

Convective Capital's investment thesis has developed along the following categories: resilient landscapes (see BurnBot[24], Treeswift[25], Instinct[26] and Overstory[27]), fire adapted communities (see Delos[28], XBuild[29], and Fire Aside[30]), and early detection and response (see WindBorne[31], Pano[32], Rain[33], and Gridware[34]). According to Convective Capital's estimates as of early 2023, over 275 FireTech companies are operating across 25 countries and have together raised about $1.9 billion.

These companies are most concentrated in wildfire response (103 companies), followed by landscape resilience (73 companies), community risk mitigation (60+ companies), and enabling technologies such as connectivity and drones (4+ companies).

FireTech trends must also be read within the context of market sentiment for climate tech investments, which have seen an overall decline over the past five years, but relative to all start-up investment, climate tech has seen an increased share in recent years[35].

Adaptation solutions remain a significant blind spot[36] within climate tech. Enter FireTech and this picture could be changing.

The insurance sector is leaning in to wildfire risk mitigation[37] and venture capital is exploring how new technologies can safely scale the use of prescribed burns, which will likely create new markets for adaptation[38]. However, successful adaptation remains a policy and research challenge for FireTech.

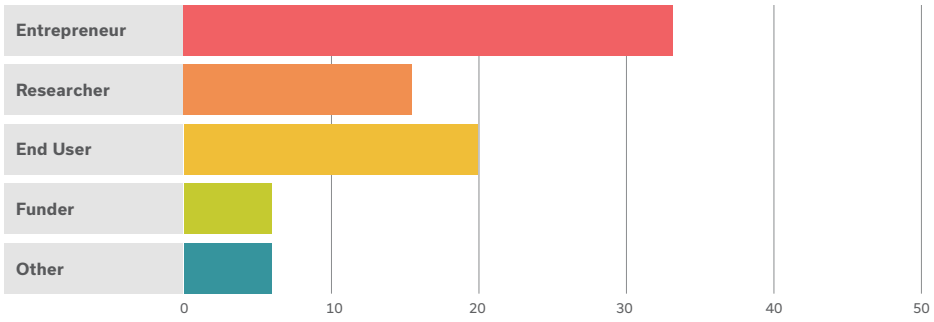
Next steps include scaling up cost-effective investments in physical protection to reduce wildfire losses, ensuring well-functioning insurance markets to absorb risk that cannot be cost-effectively mitigated, and addressing disparities in pre-fire protections and post-fire recovery for socially vulnerable and marginalized populations[39].

State of FireTech 2023 Survey Results

The State of FireTech 2023 Annual Update's Section II—State of FireTech 2023 Survey, presents findings from the inaugural State of FireTech Survey. This survey was designed with the acknowledgement that FireTech engages diverse people and institutions across sectors and scales of activity—including entrepreneurs, researchers, end users, and funders.

Survey respondents who did not identify with any of these four categories were encouraged to share more about their work under 'Other'. Understanding the experiences and sentiments of these diverse and emerging FireTech communities will be important to develop a robust understanding of the kinds of investments and capacities required to build responsive technology solutions for wildfire risk management across geographies.

The survey received a total of 80 responses across the four main categories, see Figure 2 below. However, there were overlaps reported across the categories. Of the total respondents, 12 marked themselves as reporting against 2 or more categories, most often a combination of 'entrepreneur' and 'researcher', and 'entrepreneur' and 'end user' resulting in a total of 26 incomplete responses, a majority in the researcher and end user categories.

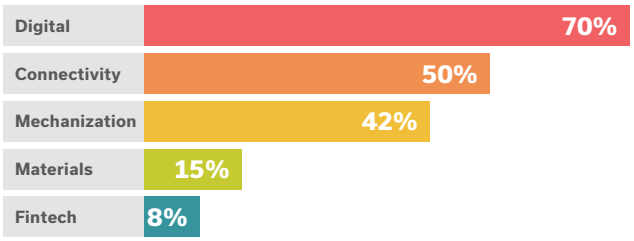


Survey participation categories

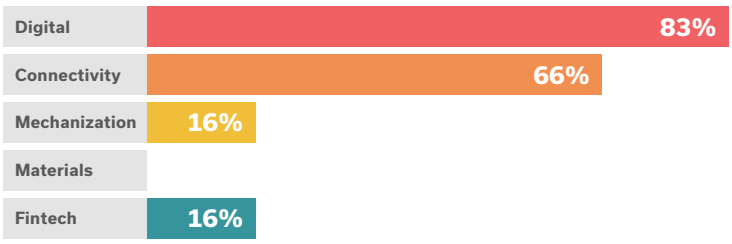
Key findings include:

- General misalignment between innovation trends, end user needs, and funding priorities. For example, see below, a comparison of the main types of FireTech solutions being developed, applied, and funded; and the key areas of focus being addressed in wildfire risk management.
- Entrepreneurs report challenges with gaining access to agile and relevant funding, conducting pilots and testing with end users, and scaling technology adoption in new markets and geographies.
- End users report challenges with assessing the relevance and usefulness of new technology products, securing funding, procurement, and effectively integrating new technology across agency data and program silos.
- Funders report challenges with not finding enough operators, lack of return on investment, growing markets in geographies and verticals, lack of scaled adoption by potential end users, as well as a lack of government capacities and infrastructure to effectively distribute funding.

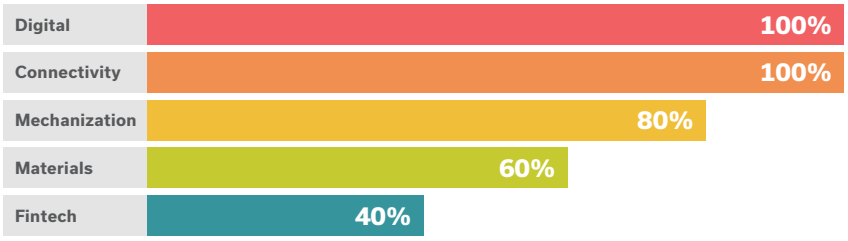
Comparing types of FireTech solutions developed, applied, and funded



Entrepreneurs
In terms of types of solutions developed and applied by entrepreneurs, about half of the respondents self-identified under two or more categories, often associated with digital and connectivity, and materials, and mechanization.

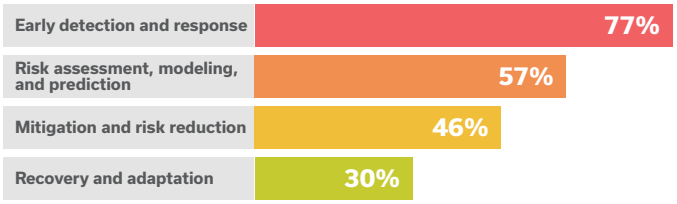


End users
If current funding and capacity barriers are addressed, most respondents in the end user category report wanting to further explore Mechanization solutions.

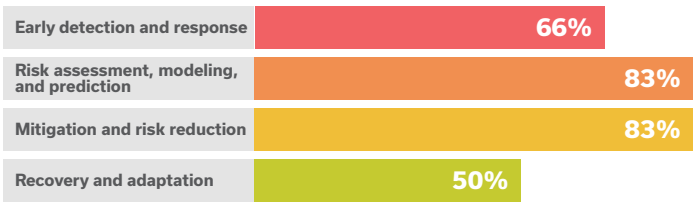


Funders
All funders reported a focus on digital and connectivity, followed by mechanization, materials, and Fintech. In addition, one funder reported a focus on human resources training and capacity development.

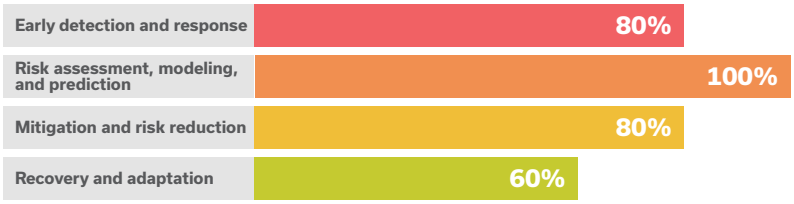
Comparing areas of focus



Entrepreneurs
Most respondents in the entrepreneur category report developing 'early detection and response' technologies.



End users
However, most respondents in the end user category report a focus on adopting 'risk assessment, modeling, and prediction' and 'mitigation and risk reduction' technologies.



Funders
All respondents in the funder category report a focus on funding 'risk assessment, modeling, and prediction' technologies.

Read in the context of global wildfire trends, current FireTech trends reiterate the need to bring greater investments in proactive risk reduction, mitigation, and adaptation innovations that can enable resilient landscapes, fire adapted communities, and safe and effective wildfire response management. In addition to a continued focus on improving early detection and enhancing risk assessment methodologies, it is now clear that scaling the implementation of wildfire mitigation and adaptation actions will be critical to contain future losses and damages[40].

FireTech in the News: 2023 Highlights

In 2023, critical and ongoing debates in popular media reflected on the extent to which new technology can seemingly 'solve' the wildfire crisis in the absence of system-wide engagement, including with 'Indigenous technology' (see here[41]) and the insurance sector (see here[42]).

These debates are leading to more nuanced discussions within industry about the potential of crowdsourcing and co-creating technology for public benefit (see for example, Watch Duty here[43]) as well as learning from traditional and historic land management practices (see for example, BurnBot here[44]).

Such emerging industry best practices[45] acknowledge that to be effective and equitable, wildfire management technology will need to be developed, deployed, and scaled in ways that learn from with traditional, cultural, and local environmental knowledge and land management practices within shared governance frameworks[46].

Convenings such as the Red Sky Summit (held on 29 November, 2023, in Alameda, CA), among others, could help facilitate regular and open conversations about responsible innovation as well as create greater alignment on FireTech priorities and outcomes among diverse stakeholders.

Some highlights of U.S. media coverage in 2023:

- Quartz: FireTech: A match for Silicon Valley (March 2023)
- TED: The growing megafire crisis - and how to contain it (April 2023)
- SF Chronicle: This is the robot that is scorching California's fire-prone landscape (July 2023)
- Bay City News: PG&E seeks solutions at Innovation Summit (July 2023)
- Fast Company: AI wildfire detectors, controlled burn robots: Inside the future of FireTech and the VC making it happen (July 2023)
- CNN: Convective Capital Backs FireTech Firms (Aug 2023)
- Forbes: Startups Think They Can Beat Wildfires, But Insurance Companies Aren't Buying It Yet (Aug 2023)
- YouTube: Wildfires are out of control. Computer Vision can stop them. (Aug 2023)
- Bloomberg: AI, Robots, and Satellite Sensors Are Helping in the Fight Against Wildfires (Sept 2023)
- WSJ: How Better Tech Could Save Lives in a World of Bigger, Faster, More Devastating Fires (Sept 2023)
- Axios: Wildfire startup Rain raises $9.7M led by DBL (Sept 2023)
- TIME: Best inventions of 2023. Stopping wildfires, ALERTCalifornia and Cal Fire AI Wildfire Detector (Oct 2023)

Endnotes

1 Wildfire Technology Funders Group. 2022. The State of FireTech: Progress, Gaps, Futures. Wonder Labs, CA. https://www.wonder-labs.org/uploads/6/4/2/1/6421555/stateofFireTech_v4_3.pdf

2 Iglesias, V. et al. 2022. Fires that matter: reconceptualizing fire risk to include interactions between humans and the natural environment. Environmental Research Letters 17 045014. Available: https://iopscience.iop.org/article/10.1088/1748-9326/ac5c0c

3 Brinkmann, P. et al. 2022. Catastrophe models for wildfire mitigation: Quantifying credits and benefits to homeowners and communities. CAS Research Paper. Available: https://www.casact.org/sites/default/files/2022-10/RP_Cat_Models_for_Wildfire_Mitigation.pdf?utm_source=AR&utm_medium=Web&utm_campaign=AR

4 Hayden, A. 2023. Save lives by making smoke tracking a core part of wildland fire management. Federation of American Scientists Day One Project. Available: https://fas.org/publication/save-lives-by-making-smoke-tracking-a-core-part-of-wildland-fire-management/

5 Axios 2023. Canada's wildfire emissions skyrocket as fires spread. https://www.axios.com/2023/08/23/canada-wildfires-carbon-emissions

6 UNEP. 2022. Spreading like wildfire: The rising threat of extraordinary landscape fires. Available: https://www.unep.org/news-and-stories/press-release/number-wildfires-rise-50-2100-and-governments-are-not-prepared

7 Scientific American. 2023. Some surprising places are at risk of devastating urban wildfires like Maui's. Available: https://www.scientificamerican.com/article/some-surprising-places-are-at-risk-of-devastating-urban-wildfires-like-mauis/

8 UNDESA. 2015. Population Division 2015 World Urbanization Prospects. Available: https://population.un.org/wup/Publications/Files/WUP2014-Report.pdf

9 Guy Carpenter. 2023. Wildfires are increasingly spreading risk to urban areas. Available: https://www.guycarp.com/insights/2021/11/wildfires-are-increasingly-spreading-risk-to-urban-areas.html

10 The New York Times. 2023. America's new wildfire risk goes beyond forests. Nov 9, 2023. https://www.nytimes.com/2023/11/09/climate/forest-fires-grasslands.html?smid=li-share

11 California Council on Science and Technology. 2022. The costs of wildfire in California. https://ccst.us/reports/the-costs-of-wildfire-in-california/

12 Childs, M.L. et al., 2022. Daily local-level estimates of ambient wildfire smoke PM2.5 for the contiguous US. Available: https://pubs.acs.org/doi/10.1021/acs.est.2c02934

13 Hayden, A. 2023. Save lives by making smoke tracking a core part of wildland fire management. Federation of American Scientists Day One Project. Available: https://fas.org/publication/save-lives-by-making-smoke-tracking-a-core-part-of-wildland-fire-management/

14 Climate Central 2023. Available: https://www.climatecentral.org/graphic/wildfire-smoke-nationwide-health-risk-2023?graphicSet=2023+Record+Wildfire+Pollution&lang=en

15 Headwaters Economics. 2023. Missing the mark: Effectiveness and funding in community wildfire risk reduction. Available: https://headwaterseconomics.org/wp-content/uploads/HE_2023_Missing-the-Mark-Wildfire.pdf

16 Team Awareness Kit https://www.coFireTech.org/feature-projects/team-awareness-kit-tak

17 https://www.usda.gov/topics/disaster-resource-center/wildland-fire/commission

18 Wonder Labs. 2023. Unpacking the Wildland Fire Mitigation and Management Commission's Recommendations for FireTech applications. Available: https://docs.google.com/document/d/1u0k3tRZQSjhBJLNECU0CkVTHuMhYV3N4/edit?usp=sharing&ouid=115712622635844121826&rtpof=true&sd=true

19 Goldman, E. et al., 2022. Visualizing federal funding for wildfire management and response. Available: https://fas.org/publication/visualizing-federal-funding-for-wildfire-management-and-response/

20 Wildfire Resilience Funders Network. https://www.climateresiliencefund.org/wildfire-funders

21 The Gordon and Betty Moore Foundation Wildfire Resilience Initiative: https://www.moore.org/article-detail?newsUrlName=moore-foundation-launches-new-wildfire-resilience-initiative

22 Convective Capital: https://www.convectivecapital.com

23 https://www.forestsandrangelands.gov/strategy/thestrategy.shtml

24 https://burnbot.com

25 https://www.treeswift.com

26 https://instinctenvironmental.com

27 https://www.overstory.com

28 https://www.getdelos.com

29 https://www.x.build

30 https://www.fireaside.com

31 https://windbornesystems.com

32 https://www.pano.ai

33 https://www.rain.aero

34 https://gridware.io

35 PwC. 2023. State of Climate Tech 2023 Investment analysis. https://www.pwc.com/gx/en/issues/esg/state-of-climate-tech-2023-investment.html

36 Semafor. 2023. Climate disasters are revealing a blind spot. https://www.semafor.com/article/08/23/2023/climate-disasters-are-revealing-a-blind-spot

37 CAS Research. 2023. Catastrophe models for wildfire mitigation: Quantifying credits and benefits to homeowners and communities. https://www.casact.org/sites/default/files/2022-10/RP_Cat_Models_for_Wildfire_Mitigation.pdf?utm_source=AR&utm_medium=Web&utm_campaign=AR

38 DBL Partners. 2023. Beyond the burn: How new technologies can grow the use of prescribed burns, creating better land outcomes, peace of mind, and new markets. https://www.dbl.vc/resource/beyond-the-burn/

39 https://drive.google.com/file/d/1G_yp4wugO9fXpgTpJ7DFpnm5OM8JfcQF/view

40 OECD. 2023. Taming wildfires in the context of climate change. Available: https://www.oecd.org/climate-change/wildfires/

41 Vice. 2023. These tech companies think they can 'solve' the wildfire crisis. Available: https://www.vice.com/en/article/ak3kg5/these-tech-companies-think-they-can-solve-the-wildfire-crisis

42 Forbes. Startups think they can beat wildfires but insurance companies aren't buying it yet. Available: https://www.forbes.com/sites/cyrusfarivar/2023/08/16/startups-think-they-can-beat-wildfires-but-insurance-companies-arent-buying-it-yet/?sh=52fbb2db7f6f

43 Watch Duty https://www.watchduty.org/

44 BurnBot https://burnbot.com/

45 Conservation X Labs. Fire Grand Challenge. See: https://conservationxlabs.com/fire

46 It is also important to recognize that Indigenous knowledge and practices are not relics from past millennia but are constantly evolving with changes in climate, vegetation, land use and ownership, and demographic trends. See here for more on this point: Atkinson, A. and Montiel-Molina, C. 2023. Reconnecting fire culture of Aboriginal communities with contemporary risk management. Fire 6 (8), Special Issue Reimagining the Future of Living and Working with Fire. Available: https://www.mdpi.com/2571-6255/6/8/296

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