ADAPTATION & RESILIENCE, CLEANTECH INSIGHTS, RESOURCES & ENVIRONMENTAL MANAGEMENT | 25 JUNE 2024

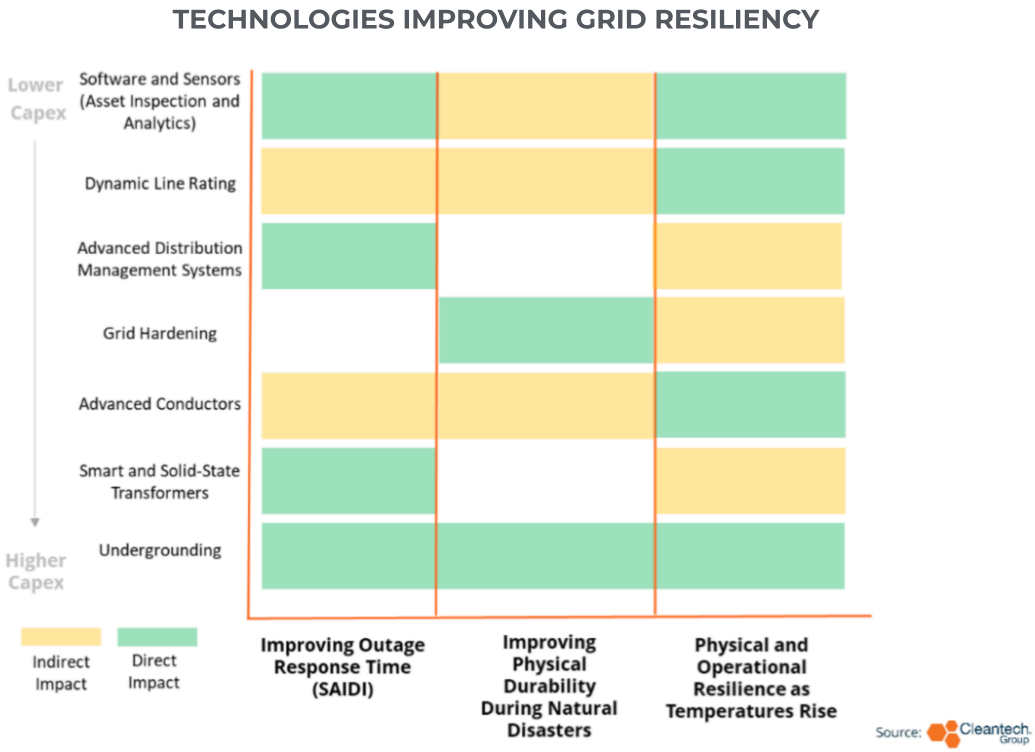
Adaptation & Resilience: Part II

In Part I, I discussed how adaptation remains a side topic in climate and I focused on innovation for wildfires and flooding. Now, let's shift the focus to grid resiliency, droughts, and extreme heat.

Keeping the Lights On: Innovative Solutions for a Resilient Grid

Electricity grids are facing a dual challenge of increasing demand and increasing physical threats. A largely unforeseen increase in the rate of electricity demand growth (as more data centers, electric vehicles come into the system) has created a moving target for deployment of grid transmission and distribution.

Compounding growth challenges are extreme weather events like hurricanes, wildfires, and heat waves that are causing more frequent and severe outages. The answer? More investment in both grid flexibility and strength of assets. While we've seen significant growth in solar, storage, and virtual power plants, these solutions will need the right infrastructure around them. Upgrading transmission and distribution infrastructure to be fit for modern physical threats is crucial.



The good news is, innovation is sparking a wave of promising solutions, not just one silver bullet, but a toolbox of approaches:

- **Drone-Deployed Grid Monitoring:** **Heimdall Power** offers a revolutionary "drop-in" solution. These zero-retrofit devices can be deployed by drone, strengthening grid monitoring without complex installation processes.

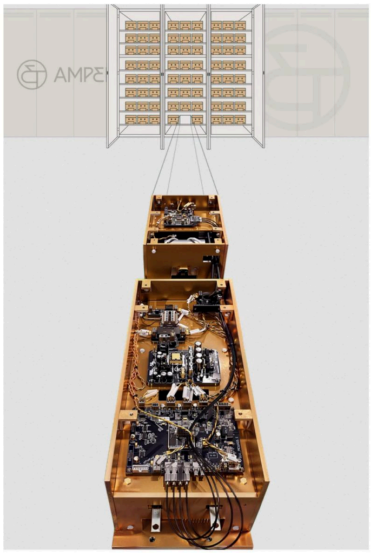
- **Prisma Photonics** takes a different approach to dynamic line rating. The technology uses existing fiber optic cables to provide real-time, granular grid monitoring across long distances. This allows for early detection and response to potential weather-related outages.

Reinventing the Transformer:

- **Ionate** is leveraging AI-powered smart controllers to manage magnetic flows within the transformer with incredible precision. This allows for a more granular and adaptable response to grid fluctuations, leveraging familiar magnetic technology with modern efficiency.

- For decades, transformer technology has remained largely unchanged. **Amperesand**, a Singaporean company, is rethinking the transformer altogether, developing solid-state transformers for modularity of deployment and continuity-of-service in volatile situations. These transformers can isolate loads and prevent faults during weather events, enhancing grid resilience.

AMPERESAND'S SILICON CARBIDE SOLID STATE TRANSFORMERS



Source: Amperesand

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Beyond Efficiency: Droughts Require Large-scale Water Harvesting

Drought is a growing concern worldwide, with many regions, including the U.S., experiencing severe water shortages. The problem? The cost of water often doesn't reflect its true value. Many facilities with high water needs aren't looking for water treatment solutions because they can still get water at low rates. This puts a strain on already limited water resources.

Wastewater and adopting water efficiency technologies, e.g., leak detection and pipe monitoring, should be the first stop to managing water issues. However, the dynamic of growing droughts against the backdrop of global population growth intensifies the need for more water harvesting.

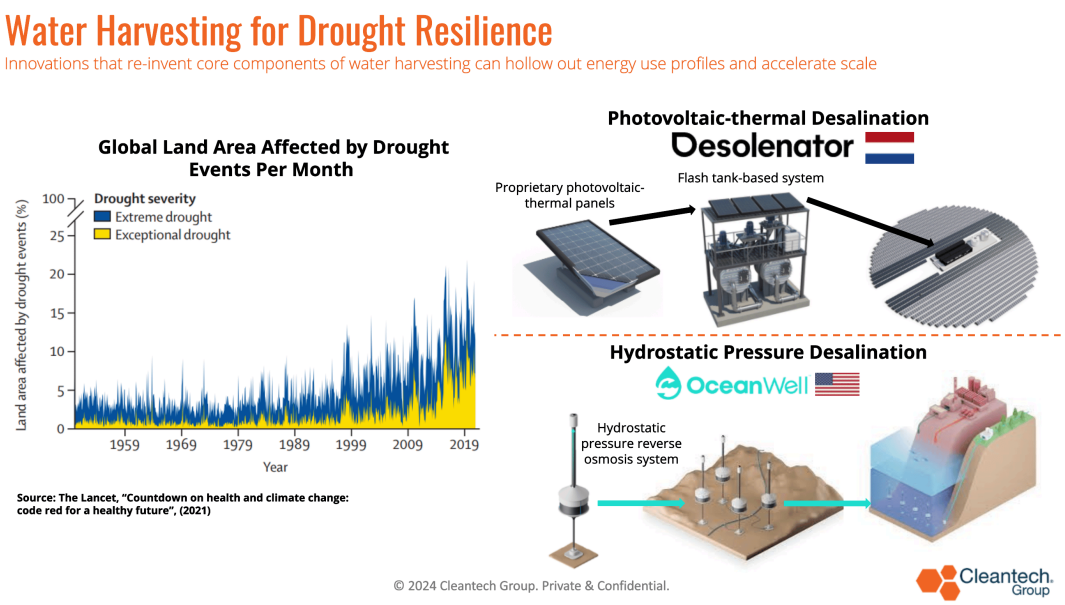
Long challenged by energy intensity issues, desalination may be ready to move into a next generation of scale and efficiency with new technologies aiming to hollow out the energy use profile of operations:

- **Photovoltaic-thermal Systems for Desalination:** Dutch innovator **Desolenator** has developed proprietary solar systems that can supply its desalination operations with solar power, but also harvest heat to feed into the processes. The company is using flash tanks to heat water, in a process that avoids membranes or filters – maximizing the output of the unique photovoltaic-thermal systems by leveraging simple, modular, scalable systems for the desalination process.

- **Wave-Powered Desalination:** **OceanWell** is an example of the power of simple physics in replacing energy sources, placing desalination units on offshore pylons, where wave motion creates hydrostatic power for the desalination operation.

The future of water security requires a multi-pronged approach. While desalination offers promising solutions, it's important to remember that water conservation remains crucial. Industries with high water

consumption, such as agriculture and manufacturing, will need to invest in water-saving technologies to reduce their environmental footprint.



Extreme Heat: The Frontline of the Mitigation-Adaptation Nexus

Air conditioning has become a necessity in many parts of the world, but as the world grapples with increasingly intense heatwaves, traditional systems will struggle to keep pace with the higher temperatures and humidity. Now, indoor cooling will require solutions to keep people safe but also reduce electricity consumption.

Here's where innovation is stepping up to the challenge:

- **Desiccant Cooling:** Those little moisture-absorbing packets you find in new shoes? They're based on desiccant chemicals, which are now being incorporated into air conditioning systems for fast cooling with low energy consumption.

Desiccants remove humidity from the air rapidly, allowing for faster cooling with lower power, and improved reduction of humidity. **Mojave** and **Blue Frontier** are two examples of companies bringing desiccant cooling to rooftop units to drop temperatures and flatten energy profiles in centrally cooled buildings.

- **Vapor-Pumping Materials:** **Adept Materials** is a company developing a revolutionary material with a "vapor-pumping effect." The material can absorb moisture from the air when it's hot and release it when it's cool, essentially regulating humidity. This technology can be integrated into various building materials, from plywood and drywall to paint and primers, offering a wider approach to humidity management.

This technology will play a critical role in upgrading buildings that are not yet due or can't afford a major HVAC overhaul, while also supporting avoidance of humidity damage to buildings — a great example of a technology working at the intersection of climate mitigation, adaptation, health, and economic efficiency.

- **Compact Cooling for Tiny Spaces:** For apartments and other small living spaces, bulky traditional AC units just aren't practical. Evaporative cooling systems offer a solution. These units use the natural cooling power of water evaporation to bring down temperatures quickly. They're compact and don't require hot air discharge, making them ideal for smaller spaces. **Caeli Energy** in France is an early example of consumer-facing innovation in this space.

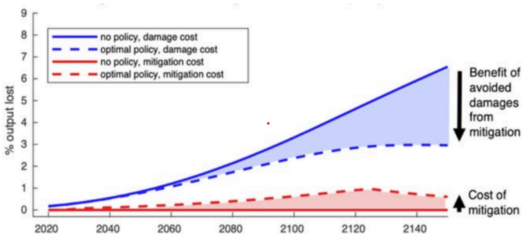
These are just a few examples of the exciting advancements in cooling technology. By embracing innovation and moving beyond traditional methods, we can create cooler, more comfortable living spaces for a warming world.

Adaptation and Mitigation – A Dual Effort, Not a Trade-off

Climate Mitigation is the Best Long-term Form of Adaptation

Mitigation bends the curve, it reduces the cost of adaptation. It brings "solution coupling" innovation into the frame

Cost of Mitigation and Cost of Damages, With and Without Policy



Source: Patrick T Brown et al 2020 Environmental Research Communications 2 095002

- **"Adaptation is more than just adjustment to climate change; adaptation can also drive decarbonization"**
  - High-efficiency cooling cuts heat deaths **and** carbon dioxide emissions
  - Wildfire management curbs destruction **and** nitrous oxide emissions releases
  - Slashing food waste reduces food insecurity **and** methane emissions
- **"If decarbonization is the new industrialization, adaptation is the new modernization."**
  - Even our mildest decarbonization goals are likely out of reach without adaptation
  - Footing the bill for decarbonization is a lot harder when the world is buffeted with hundreds of billions in climate damages each year
  - The longer we wait, the more expensive and less effective adaptation solutions become; concurrently tackling adaptation and decarbonization is critical

Source: Workweek.com, Alex Laplaza et al., Nov 2023, ***Apocalypse now, Adaptation Later***

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Ultimately, there are so many feedback loops involved with deploying both mitigation and adaptation technologies. At a minimum, by investing more in the deployment of mitigation technologies we're going to be able to bend the curve of the costs associated with climate adaptation.

Beyond that, there are many areas where investment in adaptation today starts to bring down the cost of mitigation: high-efficiency cooling avoids human loss from heat but also reduces carbon emissions from energy use; wildfire planning and avoidance reduces physical harm but slows release of a variety of GHG emissions; novel crop inputs support crop resilience and reduce reliance on ammonia-based fertilizers.

We look forward to continuing to examine the adaptation and resilience theme, including its dependence and influence on mitigation themes.