Climate change, family technology use and the role of technology in promoting climate action

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The known hazards of climate change to families worldwide are many. They negatively impact public health and mortality, local and national economies, resource availability (including supply chain and food delays), create job inequities and more. Particularly vulnerable are those countries whose annual mean temperature is at least 1C higher than pre-industrial levels (UN stats, 2023). At the UN Climate Change Conference COP28 in Dubai last year, UNFCCC (UN Framework on Climate Change) Executive Secretary Simon Stiell said: "Only by working together, harnessing technology and making bold strides towards a new, better and more sustainable world, will we succeed in taming climate change." (UNFCC January 2024). Innovative technologies are deeply embedded in actions put forward in the United Nations SDG 13.

In its broadest sense, technology is the application of scientific knowledge to the practical aims of human life, or to the change and manipulation of the human environment (Britannica). Technological innovations promoting climate action have both direct and indirect impacts on the family. For example, while green building technology can benefit human health by creating indoor environments with fewer pollutants, carbon capture technology that prevents emissions from entering the atmosphere and stores it underground is more indirectly helpful. Families too use technology in ways that have varying degree of climate impact. Driving 'cleaner' cars (e.g., electric vehicles) tangibly reduces carbon emissions. Use of digital technology as it contributes to individual knowledge, attitudes and behaviors related to climate change is more indirectly connected. In the last quarter century, 'technology' has become the shorthand for 'information and communications technology (ICT), 'or digital technology.' While most innovations to abate climate change depend on digital technology to some degree (e.g., data analytics offering predictive modeling of climate disasters; AI [1]), use of ICT by individuals for information on the internet, sharing information with others via communication apps and social media, plays a specific role. The spread of information and particularly mis-information from person to person, and as used by groups and influencers, can have serious impacts on people's beliefs. Climate change efforts do not occur without legislation and policy which is greatly shaped by significant resources and investments, and by cultural values related to social issues (Venghau et al, 2022).

This paper contributes to the UN DESA Expert Group Meeting on Families and Climate Change by briefly reviewing technologies to address climate change that have both direct and indirect impacts on families. As myriad efforts related to global climate change are present - many with the United Nations at its center[2] - policies and programs suggested will selectively address technology use as it influences family life.

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[1] In 2023, the UNFCCC's Technology Mechanism launched an initiative on Artificial Intelligence (AI) for Climate Action (#AI4ClimateAction) whose main focus is on developing countries, notably on least developed countries and small island developing States

[2] The Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN) of the UNFramework Convention on Climate Change

Climate change technology innovations with direct Impact on families

Green buildings in the community

Green buildings in the community benefit families particularly when they are places that individuals spend a significant portion of time (e.g., places of employment and schools).The design and construction of green buildings improves indoor air quality, and easing respiratory conditions. Technologies that contribute to these outcomes include passive design strategies, the use of sustainable materials, energy efficient HVAC (heating, ventilation and cooling) systems, and Building Information Modeling (BIM).. The Center for Green Schools and UNDAUNTEDk-12's observe the investment impacts that protect student health will simultaneously advance student success and address equity. Interestingly families vary in their satisfaction with green building availability. Looking at two regions more positive toward sustainability practices, Khoshbakht and colleagues (2018) identified that those living in Asian countries (e.g., South Korea, China) were more favorable that those in the US and the UK.

Health care improvements that benefit families

Health care offices and buildings that are 'green' offer benefits to workers and patients alike. Renewable energy source technologies in health care include thermal pumps that regulate room temperatures, and solar windows. Smart refrigeration for medicine storage and energy-efficient x-ray technologies help healthcare delivery to be more sustainable and accessible worldwide, particularly in rural areas (Appaji, nd). Improvements that prevent temperature rise help to diminish health effects (Ellerbeck, 2022). And the move to more telehealth service delivery that reduces carbon emissions offers patients efficiency and flexibility in their lives. Digital technologies offer rapid and more accurate diagnosis of sickness (Rahimi-Ardabili, et al, 2022). AI can provide early warning systems for climate-sensitive infectious diseases which enables the prevention of outbreaks by predicting both the location and timing of the disease transmissions.

Technology promotion of climate change with indirect impact

Renewable energy sources

Renewable energy technologies promoting bioenergy, geothermal, hydropower and ocean energy demonstrate potential to benefit families. Bioenergy such as biofuels and biogas are alternate sources of fuels used for heat, transportation and electricity. Geothermal energy from heat stored beneath the Earth's surface is showing strong potential for electricity and heating. In Iceland, for example, 85% of all energy is from renewable sources (25% from geothermal; 75% hydropower) (Mikhaylov, 2020). While other countries are stymied by cost, resources and regulatory challenges, Iceland and Japan, island countries rich in geothermal resources, have passed legislation to maintain renewable energy progress. The social values positive to sustainability in these countries factor into this success (Shortall, & Kharrazi, 2017). Ocean energy includes wave, tidal and ocean thermal energy conversion (OTEC). These technologies are most probable in coastal regions including Europe, North America and Asia. Further research, development and investments are necessary to tap the potential in these natural, existing sources of energy worldwide.

Sustainable Land Management

Sustainable Land Management (SLM) technologies aim to control degradation and enhance productivity. SLM occur at country, regional and global levels (Global Environmental Fund, 2024). A recent report by the UNCCD identified over one hundred technologies applied to land management around the world.[3] As one example, terracing for watersheds in Afghanistan, reshapes unproductive land in to levelled, sloping platforms to create conditions more suitable for cultivation, and prevents accelerated erosion.

Energy efficiency

Families indirectly benefit from when industry (including the tech industry), buildings, transportation and city and regional utility infrastructure deploy technologies that minimize energy consumption and reduce greenhouse gas emissions. Reductions in energy consumption occur through smart grid systems, advanced HVAC systems (heating, ventilation, and air conditioning), LED lighting and the use of energy-efficient appliances. Industry and research groups such as the Exponential Roadmap Initiative promote frameworks for businesses to reduce emissions and capture energy resources (Falk & Roupe, 2023). Similarly, the shift to virtual services and energy efficient technologies in the delivery of medical care to under-resourced areas occurs with reduction of greenhouse gas emissions (Rahimi-Ardabili, et al, 2022). Climate benefits also occur when the power consumption of medical devices and equipment is minimized (Appaji, nd). Yet caution is warranted in anticipating the value that industries offer. The energy consumption required for their operation due to the power needed to run its data centers, data networks, and the like is significant. Peer-reviewed studies estimate tech companies' current share of global greenhouse gas (GHG) emissions probably higher than estimated (closer to 4% rather than 1.8%–2.8% of global GHG emissions).

Carbon Capture and Storage (CCS)

Carbon capture and storage solutions capture CO2 emissions from industrial plants to prevent them from entering the atmosphere (Fischer, 2023). The carbon can then be stored underground or used in further industrial processes. 'BECCS' (bioenergy with carbon capture storage) involves incorporating CO2 capture into biomass-based electricity-generation, in which organic matter such as crops and wood pellets are burned to produce power. Other options include: huge facilities where the carbon is extracted from the air before being stored in the ground; the use of specially treated charcoal (biochar) that locks in carbon; and "enhanced rock weathering" - loosely based on the carbon removal that occurs with natural erosion.'(Fischer, 2023). As one industry example, since 2015, the tech company Ericsson has been planting mangrove saplings in Malaysia that are connected with sensors, enabling real-time monitoring of the mangrove plantation conditions. This has encouraged growth of the plant that stores carbon in their soil and sediment.

Climate Monitoring and Modeling

With rises in global temperatures, shifts in weather systems enhance the possibility of hurricanes, floods and droughts, yet also make their occurrence unpredictable. Digital technologies, including Artificial Intelligence enable monitoring and modeling of climate trends and impacts. Valuable data is provided by remote sensing technologies, weather stations and satellite systems. These data help predict extreme weather events and potential impacts from climate change on communities (Lindhall, 2022).

Climate Adaptation and Resilience

The United Nations Environment Programme (UNEP) is working on a digital ecosystem that will enhance environmental sustainability, prevent pollution and promote climate action. This means

[3] For a listing see https://www.unccd.int/land-and-life/land-management-and-restoration/technologies-approaches/technology-groups

innovative solutions that promote structural transformations for risk assessment, disaster preparedness, and infrastructure planning. Vulnerable areas can be identified through modeling software, and geographic information systems (GIS) and remote sensing contribute to creating strategies to enhance resilience to climate impacts (UNEP, 2022). Sea level and sea temperature elevations are specific areas of attention as these pose a threat to global supply changes and can cause severe storms in tropical parts of the world (Ellerbeck, 2022).

Household technology use impact

Families' own behavior related to technology use have direct impacts on climate change. The United Nations suggests six areas where families can make a difference home energy use, transportation, food, fashion, waste and water. Technology as it plays particular roles in two of these will be highlighted. Promising as these are, adaptation to energy alternatives remains slow. As David Gelles noted in the New York Times (2024), humans tend to be bad at altering their behavior today to address risks tomorrow. This "present bias," as cognitive scientists call it, makes it hard for us, as individuals, to carry out lifestyle changes now to prevent a catastrophe down the road."

Home energy

As noted above, solar and wind power are technological advancements in renewable energy. Reporting on electricity generation over recent years, SEIA (the Solar Energy Industries Association) indicates that the most significant rise is in solar power. While wind power is more commonly deployed at the utility-scale level, there are also households that utilize small-scale wind turbines for onsite electricity generation. According to the U.S. Department of Energy, there were approximately 234,000 small-scale wind turbines installed in the United States as of 2018 (cite). In the US household adoption of solar power has been growing steadily, according to the SEIA. By the end of 2020 there were over 3.5 million residential solar installations. This is somewhat due to the reduced cost of solar panels, federal tax incentives, and state-level policies promoting renewable energy. Globally, Germany is a leader in residential solar power with its feed in tariff and positive policies. Australia, China and India represent some of the other global leaders in residential solar and wind power. In Japan the Fukushima nuclear disaster in 2011 prompted a shift towards renewable energy, leading to a surge in residential solar installations. Continued advancements in technology, supportive policies, and public awareness are expected to further accelerate the deployment of solar and wind power in households worldwide.

Barriers to household solar or wind power use are many. These vary based on location, the regulatory environment, financial considerations and personal preference. Barriers include upfront cost of purchasing and installing systems, the uncertainty of a return on investment, regulatory hurdles (e.g., permitting requirements, zoning restrictions, and homeowners association (HOA) rules), property characteristics (e.g., roof orientation, shading, wind exposure, and available space), perceived complexity of the design and installation, access to other energy sources (e.g., grid electricity or natural gas), and limited knowledge about the benefits, availability, and affordability of solar or wind power systems. Policy, financial incentives and programs that provide technical assistance and education are suggested means to promote families' use of solar and wind energy.

Transportation

Transportation creates the largest source of emissions in American cities (Gelles, 2024). The choice to use electric vehicles (EV) is one effort by families toward lowered emissions, reduced fuel costs and improved air quality. In 2021 a record 7.5 million electric vehicles were sold worldwide; In 2020, one in 25 cars sold was electric; in 2023, it was one in 5. (International Energy Agency (IEA). China, Europe and the United States are countries leading in EV adoption. Factors that also encourage the use include a growing range of EV options across various vehicle types, including passenger cars, enhanced charging infrastructure, advances in battery technology, electric drivetrains, and vehicle connectivity, and policy options. Regulatory measures such as emissions standards and zero-emission vehicle mandates encourage automakers to manufacture ore EVs.

As with solar energy, families also face challenges in using EVs. These include upfront costs, concerns about driving a distance without access to a charging stations, the perceived inconvenience, lack of awareness about EV benefits, and access to home charging. The cost of purchasing an EV is often higher than a traditional internal combustion engine vehicle. Options can also seem limited for certain vehicle segments including SUVs and pick up trucks. Families living in more remote and rural areas are particularly leery about charging access.

Family ICT technology use as indirect impact on climate change

The United Nations Development Programme found that popular support for policies that address climate change is a key factor for countries taking action (UNDP, 2021). UNEP's People's Climate Vote indicated widespread agreement (64%) in the seriousness of climate change, with variation by demographics (e.g, education, age) and location. Research supports that beliefs and attitudes about climate affect voting behavior specific to the issues (Venghau, et al, 2022).

A recent report on SDG progress, however, indicated that global education on climate change has not kept up with youth demand (UNstats, 2024). Thus, alternative sources of information are most likely shaping beliefs. The internet (with 64% of people worldwide having access, Seitz, 2024), and specifically social media (used by 61.5%) are key mechanisms for the transfer of information and opinion and collective awareness about climate change. And other ICT including the popular WhatsApp app with its 2 billion users, email and videoconferencing for communication and newer technologies like AR and VR add to the potential and reach.

According to Jeff Turrentine (2022), writing for the NDRC, *"If the good news is that more and more people are accepting the reality of climate change, despite decades' worth of attempts by fossil fuel interests to mislead us, the bad news is that these same interests have adopted a new tack. Social media is their secret weapon. And our current cultural proclivity for disagreement on nearly everything—including objective reality—is their strategic advantage."*

So, while ICT may be useful in influencing knowledge about climate change, it is also potentially harmful in sharing mis-information and convincing individuals not to support progressive practices or policies. And future perspectives on ICT use predict abandonment from large platforms to smaller, more niche oriented networks (Seitz, 2024). This can deepen particular beliefs and knowledge, and reduce exposure to counter messaging.

Social media's influence on climate change.

Social media platforms including Facebook, X (Twitter), Instagram and TikTok serve as hubs for the dissemination of news articles, scientific reports, videos and personal opinions. Facebook reaches 2 billion users daily, Instagram boasts 2 billion per month, and Twitter has 238 million users daily. (Seitz, 2024). Climate activists and groups mobilize support. Platforms are also used for education to the public about climate change issues. The UN is a significant contributor of climate content on social media (e.g, @unstats, @unsdg). Real time weather events, forest fires, and melting glaciers and more are shared using social media keeping the public informed in the moment about changing conditions. These act as potent visuals of climate impacts and consequences. Social media has also been powerful in galvanizing networks and communities for action, fundraising and promoting policies. Even the United Nations encourages tracking climate change progress with its Act Now app (UN's own Act Now program: https://www.un.org/en/actnow including an app to track efforts).

Misinformation about climate change spread online

At the same time, social media can promote misinformation, further divide people on climate issues, and influence individuals away from constructive action. Gelles 2024) observes, "There's a whole lot of climate misinformation out there, thanks to deniers, special-interest groups and also the numerous people who buy into it not realizing that it's bad information." In a study by Hassan, et al (2023) in Malaysia, misleading and fabricated disinformation about climate change on Twitter was most likely to be spread by politicians, organizations, and anonymous agencies (compared with celebrities academics or other high profile users). Even the United Nations recognizes this possibility with their "Myth Busters" page[4].

The consequences to individuals, families and communities of this misinformation spread are many. It can delay action by individuals and policy makers by creating confusion, complacency and skepticism about the need to address climate change. As evidence of divides that can occur through social media, Falkenburg et al (2022) analyzed Twitter data related to the plurality of views and interaction patterns among ideologically opposed groups between 2014 and 2021 after United Nations Conference of the Parties on Climate Change (COP). According to the authors, a large increase in ideological polarization occurred during COP26, driven by right-wing activity, with messaging of political hypocrisy. Retrepo et al (2021) showed that parenting communities were subject to powerful misinformation that pulled them closer to communities with extreme views, despite efforts by Facebook to monitor and post accurate information. Indeed efforts by social media platform administrators traditionally are ineffective at combatting misinformation.

Climate change policy and program action recommendations

The IEA (2023) specifically observes that measures that triple renewable energy capacity, double the pact of energy efficiency, enhance electrification and diminish methane emissions from fossil fuel operations as key to climate solutions. Rather than continuing to treat areas separately, many policy recommendations for climate action assert comprehensive, collaborative infrastructure efforts globally (e.g., Mallinoux, et al, 2023; UNFCC, 2024, 2023). Within any "comprehensive management system" that Gouge et al (2023) promote for environmental health, innovative technologies are involved such as those briefly reviewed here - both as drivers of the component climate actions and as data approaches that underscore "continuous monitoring and maintenance".

Financing climate change technology innovation research, development and implementation is a universal policy recommendation. Related to families' adoption of EV, the IEA reports that a number of countries have introduced purchase subsidies, tax incentives and rebates.
Similarly, financing support to community buildings toward green technology enable cash strapped school districts to implement change. More broadly, at the UN Climate Change Conference COP28 in Dubai, a key component of the UAE consensus of the Paris Agreement was a technology implementation program to strengthen support in particular to developing countries. This agreement is supported in part by the Financial Mechanism (UNFCC, nd).

As previously noted, the UN TEC and CTCN promote further development of Artificial Intelligence as a significant response to climate action, echoing others (Gaffney, et al, 2023; UNFCC, 2024). Diversification and Inclusion are critical in TEC and CTCN's efforts. At COP28, the groups introduced a global pool of female experts in the area of climate change technologies (the Gender and Climate Technology Expert Roster). They also co-convened multi-stakeholder with the Local Communities and Indigenous Peoples' Platform that advanced the work of technologies in indigenous communities.

And education regarding climate change is an important policy step, and in particular, battling the misinformation about climate impacts and solutions shared through the internet and social media. A

[4] https://www.un.org/en/climatechange/science/mythbusters

multifaceted approach is needed to combat misinformation that involves family, community and industry involvement. Families and schools can help children be more critical of information they see online, encourage fact checking and using trusted sources. Industry solutions - including from the very social media involved like Facebook, Instagram, and Twitter (X) - involve deploying algorithms that limit the reach of 'flagged as false' content or reduce the visibility of accounts known to be misleading. To summarize:

- Technological innovation to address climate change must be part of collaborative and continuous global solutions.
- Financing for technology innovation is critical to advance the research, development and implementation of new strategies. This is particularly important in health care. Financing support to households and localities will encourage the use of more renewable energy sources and greener buildings.
- Policies integrating technology in climate action must keep abreast of future tech, especially the value of AI (artificial intelligence).
- Policy recommendations must also conscientiously include women's contributions to technological innovation and promote collaboration with indigenous areas and those regions vulnerable to the greatest impacts of rising temperatures.
- Education on climate change – including critical thought to identify and dispel misinformation – is essential everywhere. A component of this education is information and communications technology (ICT) which is used to transmit information from person to person, spread misinformation and thus create polarization on climate issues.
- Technology/social media platform companies can be held accountable to do more to combat the spread of misinformation about climate issues.

These recommendations merely skim the surface of the remarkable advances proposed to deploy technology for climate action. Yet progress on all fronts – including public knowledge and perception – is key. And the family in this regard, is both beneficiary of change and catalyst.

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