

### Classification of Mobile Home Energy and Heat Solutions

Patricia Soils, Katsiaryna Varfalameveva, Mark Kear and others								
Solution	Category	Stage	Who should be involved to implement	Description	Potential cost	Benefit	Solution Source	Note
<b>Technical and build solutions</b>								
Skirting	Technical and build solutions	Ready-to-go, need to buy building materials	MH park owner, residents of the MH	Insulate underneath of mobile home. Various materials can be used: vinyl, brick, concrete, metal, plywood, foam and reil rock.	Skirting materials can be found at Lowe's and Home Depot. Price range: \$90-\$300 (per case of vinyl siding).	Reduce heat exposure, maintain temperatures underneath of home.	Summer 2020 Walton Solutions Interns	
Shade Awnings	Technical and build solutions	Ready-to-go, need to buy building materials	MH park owner, residents of the MH	Protect homes and spaces from debris.Versatile, cost eff	No cost estimates provided	Reduces the heat around the house and saves money on AC during the day (energy saving). Angled design helps to compensate for weather conditions and blocks different angles of sunlight depending on the time of the year.	Summer 2020 Walton Solutions Interns	These come in different forms and sized – from double carports to window coverings. We should consider which ones are most effective or that are most worthy of implementation.
Window films & Window Tinting	Technical and build solutions	Ready-to-go, need to buy building materials	MH park owner, residents of the MH	Add films/tint on windows of mobile homes.	No cost estimates provided	Window films prevent heat gain from windows at can reduce the utility costs (if there is less heat gain...less A/C use is required to cool the house...less money is spent on electricity)	Summer 2020 Walton Solutions Interns	
Curtains	Technical and build solutions	Ready-to-go, need to buy building materials	Residents of the MH	Add curtains on windows inside mobile homes.	No cost estimates provided	Preventing heat gain from windows.	Summer 2020 Walton Solutions Interns	
Shutters or other external window covering (e.g. cardboard)	Technical and build solutions	Ready-to-go, need to buy building materials	Residents of the MH			Preventing heat gain from windows.	University of Arizona Collaborators	
LED lights & High efficiency appliances	Technical and build solutions	Ready-to-go, need to buy lights and appliances	MH park owner, residents of the MH	Update and install new appliances in mobilehome parks.	No cost estimates provided	Reduce the amount of heat that is generated from inside the structure and also reduces the energy bill the residents pay.	Summer 2020 Walton Solutions Interns; May 2020 Stakeholder Meeting Participants	
Swamp Coolers	Technical and build solutions	Ready-to-go, need to buy swamp coolers	MH park owner, residents of the MH, utility companies, contractors	Swamp coolers are alternatives to traditional portable air conditioners. However they consume less energy than traditional ACs, and they use natural power of evaporation to cool the atmosphere in low-humidity areas. Evaporative coolers cool outdoor air by passing it over water-saturated pads, causing the water to evaporate into it. The 15°- to 40°F-cooler air is then directed into the home and pushes warmer air out through windows.	Starting from \$170.	Cool down the inside of the mobile home.	Summer 2020 Walton Solutions Interns	
Portable AC	Technical and build solutions	Ready-to-go, need to buy Portable AC units	Residents of the MH	It is known to be cost effective as it has low electricity use. It is portable and compact due to its lightweight feature so it is easy to carry around with you in the house or car if needed. The cooler is also noise free so won't disturb while trying to sleep.	Price ranges from \$30-\$90 –more advanced up to \$150	Cool down the inside of the mobile home.	Summer 2020 Walton Solutions Interns	These might be effective at reducing temperatures, but are very inefficient and may lead to unstatinatable energy bills.
Heat-Pumps (especially Mini Split versions)	Technical and build solutions	Mostly ready to go; Some additional research would be beneficial regarding the suitability and possible effectiveness of these technologies in the PHX region and/or specific housing units; Heat pumps would need to be purchased	Residents of the MH w/ possible assistance from utilities and/or Corporation Commission; ASU could help with research related to the effectiveness and most appropriate applications of this technology	<a href="#">Heat-pumps are alternatives to traditional Air Conditioning units. The main advantages of mini splits are their small size and flexibility for zoning or heating, and cooling individual rooms.Ductless mini-split systems are easier to install than some other types of space conditioning systems.Mini splits have no ducts, so they avoid the energy losses associated with the ductwork of central forced air systems.</a>  <a href="#">More info at: https://www.energy.gov/energysaver/heat-pump-systems/ductless-mini-split-heat-pumps</a>	No cost estimates provided; The cost of installing mini splits can be higher than some systems, although lower operating costs and rebates or other financial incentives – offered in some areas – can help offset the initial expense	Cool down the inside of the mobile home. Can provide a feasible (and even advantageous) alternative to Air Conditioners and/or Swamp Coolers	May 2020 Stakeholder Meeting Participant	These can be difficult to mount on MH.
Outdoor Evaporative Cooling (Misters)	Technical and build solutions	Required some research in terms of implementation for the MHP	MH park owner, residents of the MH, contractors	Water system around mobile homes. Energy and water efficient. Easy professional or cheap DIY install options.	No cost estimates provided	30 degree drop in temperature. Health benefits.	Summer 2020 Walton Solutions Interns	
Air sealing the home	Technical and build solutions	Required some research in terms of implementation for the MHP	MH park owner, residents of the MH, utility companies, contractors	Seal leaks of mobile homes structure by inserting new windows, doors, improving insulation, sealing holes.	No cost estimates provided	Improve insulation which decrease temperture inside mobile homes and can lead to reduced energy costs	Summer 2020 Walton Solutions Interns	

Shade sails	Technical and build solutions	Required some research in terms of implementation for the MHP	MH park owner, residents of the MH, contractors	Shading structures that can be a temporary solution before the solar panels. All structures includes: structure, installation, powder coating, high density polyethylene cover, cable, hardware, anchor bolts and template, rebar cages.	Engineered drawings : \$ 1,100.00 for each structure. Installation: 1) 43' x 45' x 15ft entry height, 4 columns - \$ 26-28K. 2) 42' x 65' x 15' entry height, 4 column hip - \$ 35-37k. 3) 38' x 75' x 15' entry height 4 columns - \$ 37 -39k.	Provide shade	Summer 2020 Walton Solutions Interns		
Reflective Coatings (White coat)	Technical and build solutions	Required some research in terms of implementation for the MHP	MH park owner, residents of the MH, contractors	Special white coating on the mobile home roofs. Weather resistant for year-round versatile use. Eco-friendly.	No cost estimates provided	2-way Indoors heat reduction: Reflect solar energy, Radiate or emit heat away.	Summer 2020 Walton Solutions Interns; May 2020 Stakeholder Meeting Participants		
Small and/or Pop-up Heat Relief Centers within Communities	Technical and build solutions	Further planning/coordination needed	City officials/departments; Non-profit organizations; Community groups; MH park owners; MH residents	distributed or pop-up relief centers could be set up within or nearby communities themselves. This would especially benefit those members of the community who are less mobile, and communities often already have an established common space.	No cost estimates provided	Provide a safe and relatively easily accessible place for MH residents to escape/avoid extreme heat conditions	May 2020 Stakeholder Meeting Participant		
Solar (PV) Canopies	Technical and build solutions	Requires further research	MH park owner, residents of the MH, utility companies, contractors	Solar canopies that provide direct shade to mobile homes and generate power for HVAC equipment.	Approximately \$11k for solar canopy, battery, structure, and HVAC add-ons per mobile home installation.	Provide shade and generate power.	Summer 2020 Walton Solutions Interns	required additional policy development: Cooling fluids can be placed behind PVs to increase efficiency	
External Insulated Finishing or Stucco Systems							University of Arizona Collaborators		
Passive Daytime Radiative Cooling (PDRC)	Technical and build solutions	Requires further research	MH park owner, residents of the MH, contractors	The PDRC coating outlined by Mandal et al. in 2018 ( <a href="https://science.sciencemag.org/content/362/6412/315">https://science.sciencemag.org/content/362/6412/315</a> ) is made by dissolving water and Kynar Flex 2801 by Arkema in acetone. The solution is applied via spray or brush, whereupon the acetone will volatilize, causing the water to phase-separate from the polymer in droplets. When the water evaporates, it should leave behind air voids ranging from 50 nanometers to 10 micrometers. The material should have 50% porosity, and thus a 1:1 volume ratio of water and polymer. Its performance is independent of the surface on which it is applied. The coating should be 300-500 micrometers thick. 96 W/m2 cooling power refers to performance in Phoenix.	Price and material questions can be directed to Anna Johnson (anna.johnson@arkema.com), a Business Dev. Engineer at Arkema.	Reduce heat exposure, decrease temperature of home.	Summer 2020 Walton Solutions Interns		
Site Orientation Optimization for Cooling	Technical and build solutions								
Proximity of structures to each other for shading, ventilation	Technical and build solutions								
<b>'Natural' solutions</b>									
Trees	'Natural' solutions	Ready-to-go, need to buy trees	MH park owners; MH residents; government and/or non-profit programs/subsidies might improve effectiveness	Plant trees throughout mobile home communities to provide additional shade (and possibly evaporative cooling). Landlord and tenant cooperation are needed for trees...landlord has to allow them and tenants have to maintain them.	Mesquite Trees cost ~\$149-1499 for 3-18 year olds	Cooling to individual residents/households via shade, as well as cooling of the overall community. Co-benefits = cooling, air quality, mental health, aesthetic improvements	Summer 2020 Walton Solutions Interns; May 2020 Stakeholder Meeting Participants	Best placement is west and central front yard; Best to avoid canopy overlap and/or blocking of wind corridors; Native mesquites and palo verdes are two of the best species for Arizona	
Replacing pavement/asphalt with soil and plants	'Natural' solutions	Ready-to-go, need to buy plants	MH park owners; MH residents	Where possible (e.g., driveways), replace pavement/asphalt (which absorb and re-emit heat and increase ambient temperatures) with gravel, soil, and/or vegetation	No cost estimates provided	Reduces latent heating and urban heat island effects within MH community	Summer 2020 Walton Solutions Interns		
Green/Living Walls	'Natural' solutions	Close to ready; Research on most effective structure size/orientation/costs/plant species would be helpful	MH park owners; MH residents; ASU could help with research related to the effectiveness and most appropriate applications of this technology	Implement vertical forms of vegetation (e.g., vines) to provide shade (and possibly evaporative cooling) to the MH community. Provides similar benefits to trees, but may be more feasible b/c can be installed without having to dig and/or alter the surface/ground	No cost estimates provided	Cooling to individual residents/households via shade, as well as cooling of the overall community. Co-benefits = cooling, air quality, mental health, aesthetic improvements	May 2020 Stakeholder Meeting Participant		
<b>Policy Related Solutions</b>									
Free/subsidized transportation options to help community members access cooling centers	Policy Related Solutions	Ready-to-go, need to establish protocols	City officials/departments; Non-profit organizations; Community groups; MH residents	Provide regular free/subsidized bus/van service to MH communities in order to help them access existing Cooling Centers	No cost estimates provided	Help MH residents escape/avoid extreme heat conditions	May 2020 Stakeholder Meeting Participant		
Door-to-door wellness checks by government employees and/or community groups	Policy Related Solutions	Ready-to-go, need to establish protocols	City officials/departments; Non-profit organizations; Community groups	Have dedicated groups/teams regularly check-in on vulnerable members of MH communities in order to ensure that they are not unnecessarily exposed to extreme heat conditions and/or accessing helpful resources that are available to them	No cost estimates provided	Helps government officials better understand the state of MH community members; Helps ensure that MH community members can access support/resources if needed	May 2020 Stakeholder Meeting Participant		
Improve the building envelope program, and tailor this program to mobile homes	Policy Related Solutions	Ready-to-go, need to establish protocols/coordinate with utilities	Utilities; Corporation Commission; City officials/departments; Non-profit organizations; Community groups; MH owners and residents	Review (and revise) existing policies/programs aimed at supporting/subsidizing the weatherization and retrofitting of dwellings to make them more energy efficient and less susceptible to extreme heat conditions.	No cost estimates provided	Help MH residents retrofit their dwellings via improved weatherization/insulation in order to increase energy efficiency (and energy bill savings) as well as reduce indoor temperatures during extreme heat conditions	May 2020 Stakeholder Meeting Participant	It was implied by the workshop participants that there are already some existing programs through the utilities. However, MH do not currently appear to be eligible for these programs and/or these programs are under-utilized in MH communities	

Outreach/education programs with Mobile Home Communities	Policy Related Solutions	Close to ready, materials need to be collected/created; outreach plan/protocols need to be established	City officials/departments; Non-profit organizations; Community groups; Universities MH residents	Outreach/education should focus on: 1) existing resources for mitigating the impacts of extreme heat (e.g., cooling centers, personal actions, assistance programs, etc.) and 2) overview of tenants rights in relation to the utilities and landowners (e.g., utility shutoff rules). Communication needs to be bilingual. Outreach/education programs could be led by	No cost estimates provided	Help MH residents better understand some of the risks they face and some of the strategies/resources available to them to manage these risks	May 2020 Stakeholder Meeting Participant	Could also apply to Equity Efforts & Social/Community Programs Category
Revise/update utility assistance programs/policies to reclassify "mobile."	Policy Related Solutions	Close to ready; Changes to legislation/policy needed	Utilities; Corporation Commission; City officials/departments; State legislature; Non-profit organizations; Community groups	Policies could be modified to reclassify "mobile." Just because a home has axles/wheels does not necessarily mean that it is mobile, but classifying it as such makes it ineligible for certain grants/policies. Mhs do not currently appear to be eligible for many utility assistance programs that can help them with reducing their utility burden and/or subsidize helpful technologies/retrofits. Through modifications to existing policies/regulations, these "loop holes" can be addressed/rectified	No cost estimates provided	The appropriate changes/additions to current policy can help MH residents reduce their utility costs and/or reduce their exposure to extreme heat via improvements/retrofits to their dwellings.	May 2020 Stakeholder Meeting Participant	
Draft statewide legislation that institutes utility shutoff protections	Policy Related Solutions	Close to ready; Changes to legislation/policy needed	Utilities; Corporation Commission; City officials/departments; State legislature; Non-profit organizations; Community groups	Legislation that would prohibit the utilities from cutting off service to certain residents (e.g., vulnerable members in MH communities) during extreme heat conditions	No cost estimates provided	MH residents that are particularly vulnerable can afford to keep running their air conditioners (or other cooling technologies) and avoid being exposed to dangerous indoor temperatures	May 2020 Stakeholder Meeting Participant	e.g., in places like Minnesota, heat cannot be shut off for specific constituents under certain conditions
Develop/increase shade via zoning requirements	Policy Related Solutions	Further analysis/research needed	City officials/departments; Non-profit organizations; Community groups	Enact zoning laws that require developers/communities/neighborhoods to have a certain amount of shading	No cost estimates provided	Help encourage the implementation of trees and other shade structures in order to reduce extreme heat conditions at the community/neighborhood scale	May 2020 Stakeholder Meeting Participant	
Create policies/financial incentives that facilitate the creation of resident owned cooperative housing	Policy Related Solutions	Further analysis/research needed; Community education & organization needed; policy changes likely needed	Utilities; Corporation Commission; City officials/departments; State legislature; Non-profit organizations; Community groups; MH owners and residents	Provide a pathway to land ownership for MH residents in order to avoid some of the complications and/or misalignment of incentives that exist when one entity owns the land and the residents lease their plots and/or dwellings from this entity.	No cost estimates provided	Provides more agency/ability for MH residents to modify their communities (e.g., plant trees without having to coordinate with the land owner; install solar PV systems, etc.) and manage utility costs (any utility costs savings accrued from retrofits would pass to the residents rather than to the owners)	May 2020 Stakeholder Meeting Participant	
Utility Conversion Program	Policy Related Solutions	Requires further analysis/research	Utilities; Corporation Commission; City officials/departments; State legislature; Non-profit organizations; Community groups; MH owners and residents	Modify electric meter system to be submetered at the individual dwelling level rather than master metered at the community level	No cost estimates provided	Each MH resident would gain much more insight into and control over their electricity use, any utility costs savings accrued from retrofits would pass to the residents rather than to the owners	Summer 2020 Walton Solutions Interns	
Energy-Efficiency Standards and Requirements								
Home-Improvement Loans								
<b>Equity Efforts &amp; Social/Community Programs</b>								
Social Infrastructure & Community Engagement	Equity Efforts & Social/Community Programs	Ready-to-go, need to develop approach	City officials/departments; Non-profit organizations; Community groups; Universities; MH residents	Programs and resources to support and enhance interaction/cohesion within MH communities. Possible ways to bring residents together include bingo nights, art nights, game nights, small classes held at a central location - could be a resident's home, an on sight community center, or a local library or park. Well maintained social infrastructure facilitates community engagement by simply providing welcoming and convenient places for people to congregate.	No cost estimates provided	Social infrastructure and community engagement have been found to be key factors in building adaptive capacity and minimizing impacts of hazards like extreme heat (e.g., Getting out and about and having people at home to recognize the early symptoms of heat related illnesses made an incredible difference in the survival rate of Chicago residents during 1995 heat wave)	Summer 2020 Walton Solutions Interns	For social infrastructure to save lives during hot phoenix summers, residents must frequently use these places and avoid isolation (that might be difficult during the pandemic though). As Klinenberg noticed, culturally, some residents are more likely to engage socially while others are not. Overcoming this barrier proves to be a difficult task.  Additional ways to boost community involvement is through programs set up through colleges for students to lead classes and earn credits/volunteer/internship hours by teaching art classes or classes at community centers in mobile parks.  Common barriers to community engagement are: physical and mental health factors, socioeconomic status, a lack of incentive, a lack of

Heat Resilient Community Center	Equity Efforts & Social/Community Programs	Ready-to-go, need to develop approach	City officials/departments; Non-profit organizations; Community groups; Universities; MH residents; MH park owners	The community center incorporates solutions that increase social connectedness and heat resiliency. Some things that increase social connectedness are vegetable garden, outdoor cooking area, social events, playground, and seating. Shaded areas with misters, aluminum benches, shaded houses, and vegetation, instead of asphalt, increase heat resilience.	No cost estimates provided	Provides a variety of mechanisms for reducing exposure to extreme heat (e.g. shade, evaporative cooling, etc.), as well as increase social infrastructure and community cohesion (see above)	Summer 2020 Walton Solutions Interns	
Put some information into an AARP bulletin to raise awareness	Equity Efforts & Social/Community Programs	Ready-to-go,	AARP; Community groups; MH residents; MH park owners	Partner with AARP to ensure that vulnerable members of the mobile home communities (i.e., elderly, fixed/low income) are receiving pertinent information about their risks to extreme heat, as well as resources/support/solutions available to them to mitigate their risks...AARP could also be a very powerful in lobbying for impactful change to regulations/legislation (e.g., utility shut-off ban; utility subsidies, etc.)	No cost estimates provided	Help MH residents better understand some of the risks they face and some of the strategies/resources available to them to manage these risks	May 2020 Stakeholder Meeting Participant	
Early detection warning system to notify friends, family, caretakers, etc. when a home is getting too hot	Equity Efforts & Social/Community Programs	Close to ready; specific protocols and technologies need to be established	City officials/departments; Non-profit organizations; Community groups; Universities; MH residents; MH park owners	Monitoring and communication systems that alerts MH residents to upcoming/existing dangerous heat conditions within their homes and/or communities, as well as action steps/directions for minimizing dangers	No cost estimates provided	Help MH residents become more aware when particularly dangerous heat conditions exist within their homes/communities. Provides information/instructions about what the residents can do and/or what resources are available to them to minimize their risks	May 2020 Stakeholder Meeting Participant	
Educate public health officials and emergency responders about special vulnerability in mobile homes.	Equity Efforts & Social/Community Programs	Close to ready, materials need to be collected/created; outreach plan/protocols need to be established	Health officials; Healthcare providers; City officials/departments; Non-profit organizations; Community groups; Universities	Provide information about the unique vulnerabilities that MH residents have to extreme heat; Provide information about the disproportionate health impacts that extreme heat has on MH communities; Develop policies/protocols for giving extra care/attention to MH communities during extreme heat events	No cost estimates provided	Help MH residents receive more tailored (and hopefully more timely) assistance/care/treatment during extreme heat events	May 2020 Stakeholder Meeting Participant	
Mutual aid networks (or neighborhood associations, etc)							University of Arizona Collaborators	
<b>Maladaptions?</b>							Schmidt Futures Study	
							University of Arizona Collaborators	