MITRE | ADAPT™: New Tool for Decision-makers to Integrate Analyses of Climate-Change Risks, Impacts, and Adaptations for Infrastructure Resilience

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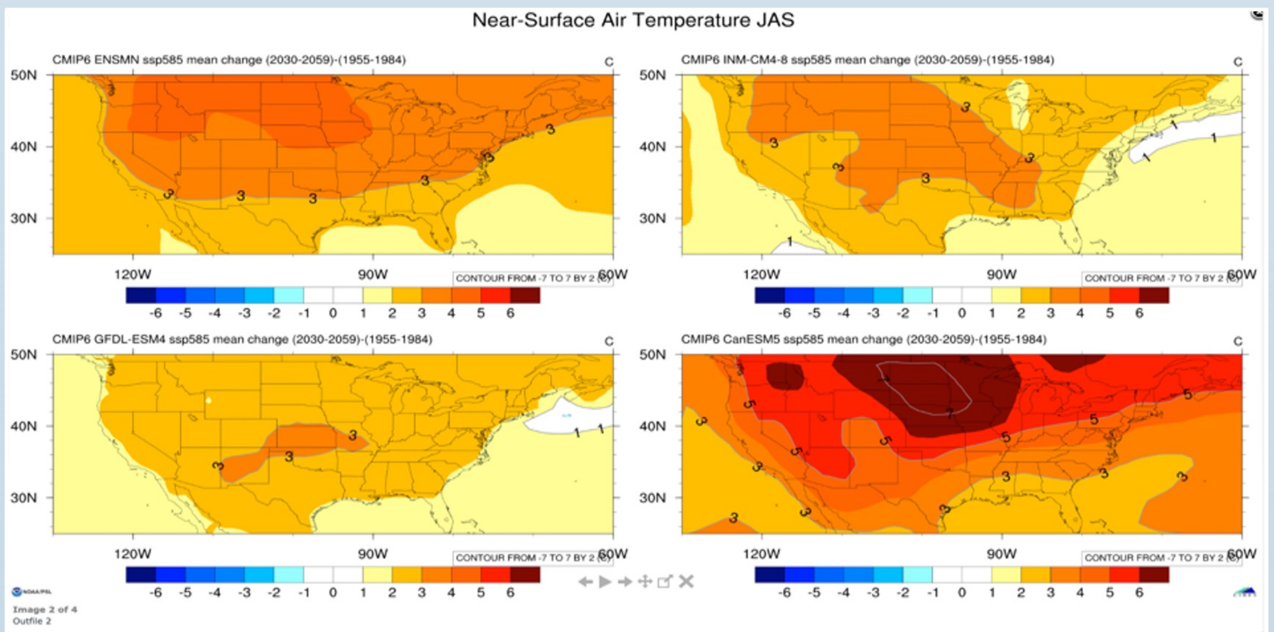
MITRE | SOLVING PROBLEMS FOR A SAFER WORLD®

CLIMATE CHANGE DEEPLY IMPACTS INFRASTRUCTURE

Climate change significantly impacts today's infrastructure, posing a critical challenge for decision-makers as they plan for the future. To address this, there is a pressing need for a data-driven analysis in a myriad of areas: identifying specific climate change hazards, modeling historical and projected future impacts, assessing asset and system vulnerabilities, and determining the effects of adaptation actions.

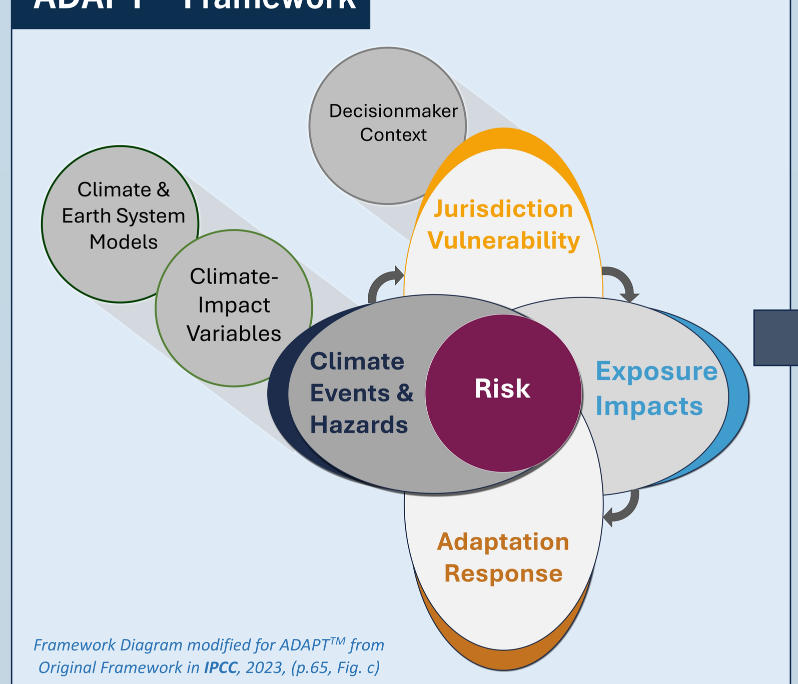


Source: "Variability in Projected North American Mean and Extreme Temperature and Precipitation Trends for the 21st Century: Model-To-Model Differences Versus Internal Variability", 2023

MITRE | ADAPT™ SOLUTION

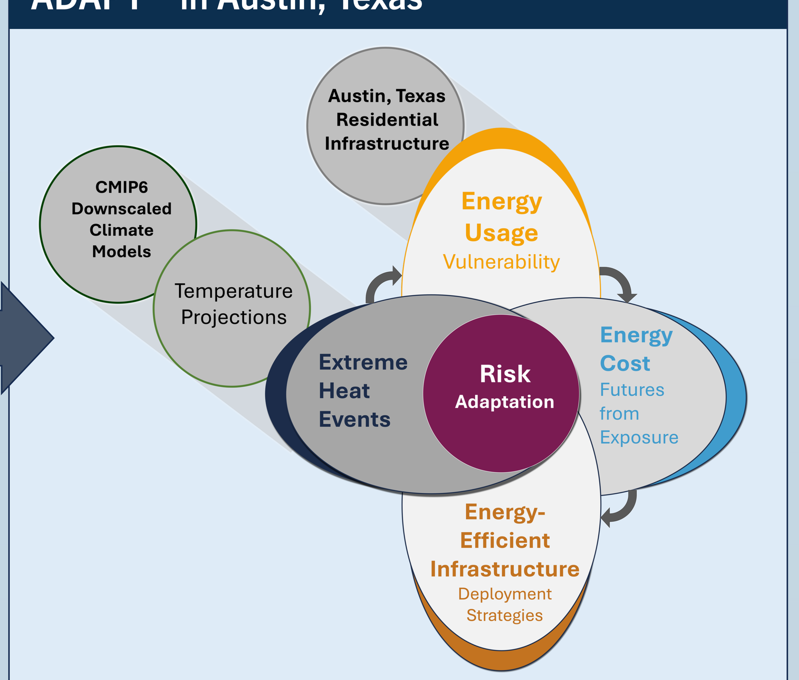
The MITRE ADAPT™ software is designed as an end-to-end decision support tool for users to efficiently integrate analyses of climate-change risks, impacts, and adaptation response option sets for Infrastructure Resilience. The ADAPT framework leverages climate sciences context with machine learning/big data analysis to provide actionable insights, supporting proactive climate adaptation tailored to stakeholder needs.

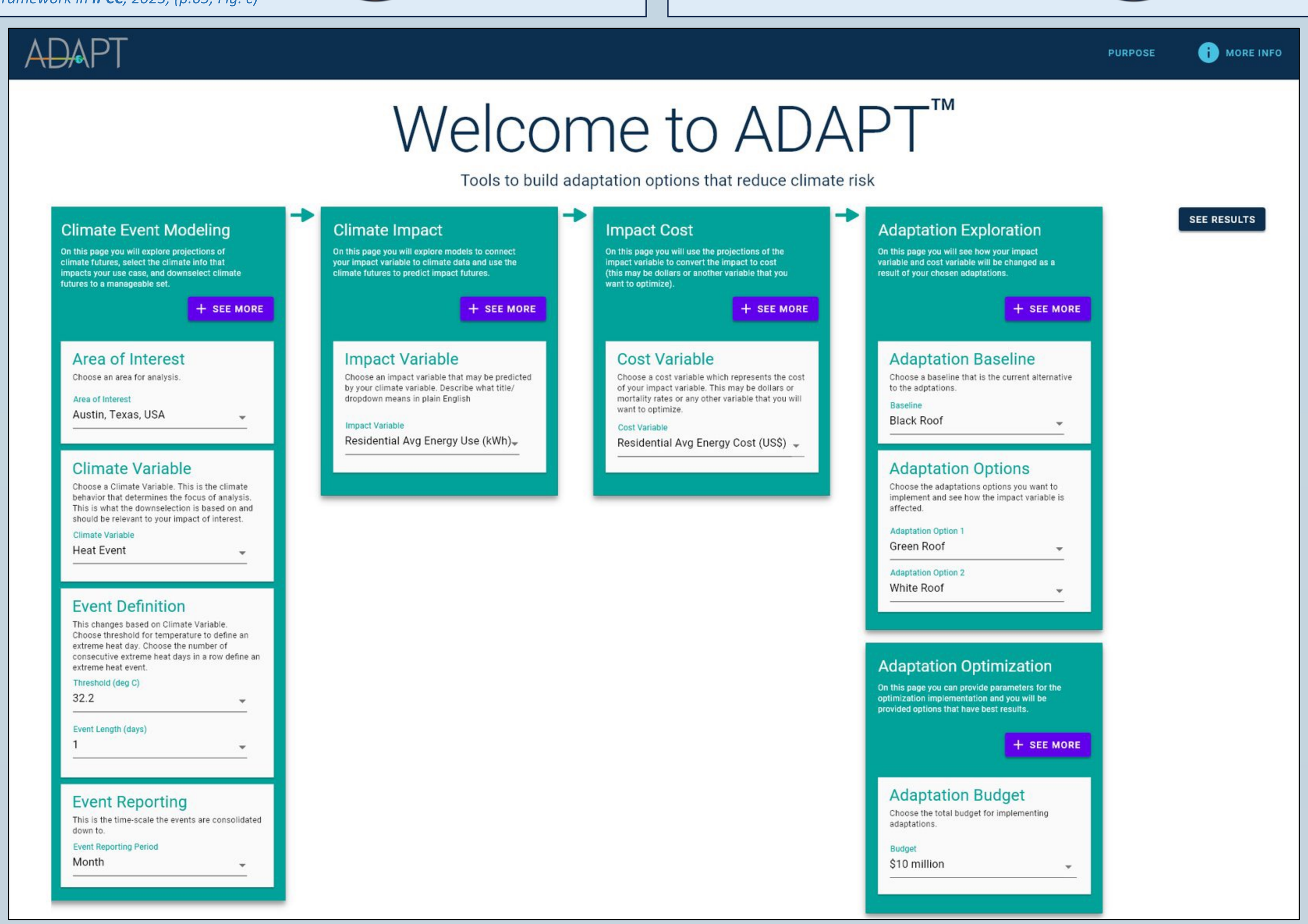
ADAPT™ Framework



Framework Diagram modified for ADAPT™ from Original Framework in IPCC, 2023, (p.65, Fig. c)

ADAPT™ in Austin, Texas





Home Page from Current MITRE | ADAPT™ Application

ADAPT™ WORKFLOW

Step 1: Tailored Climate Model Down-Selection

ADAPT is fitted to utilize the global climate models from the the Coupled Model Intercomparison Project (CMIP). **Our Tailored Climate Model Down-Selection framework is designed to leverage user context targeted for the climate event and region of interest.**

The ADAPT system extracts the CMIP models with the climate variable(s) of interest and employs unsupervised ML clustering via K-Medoids for model down-selection, efficiently **reducing the computational burden and complexity**, whilst provided tailored information for adaptation

Step 2: Vulnerability & Exposure Impacts

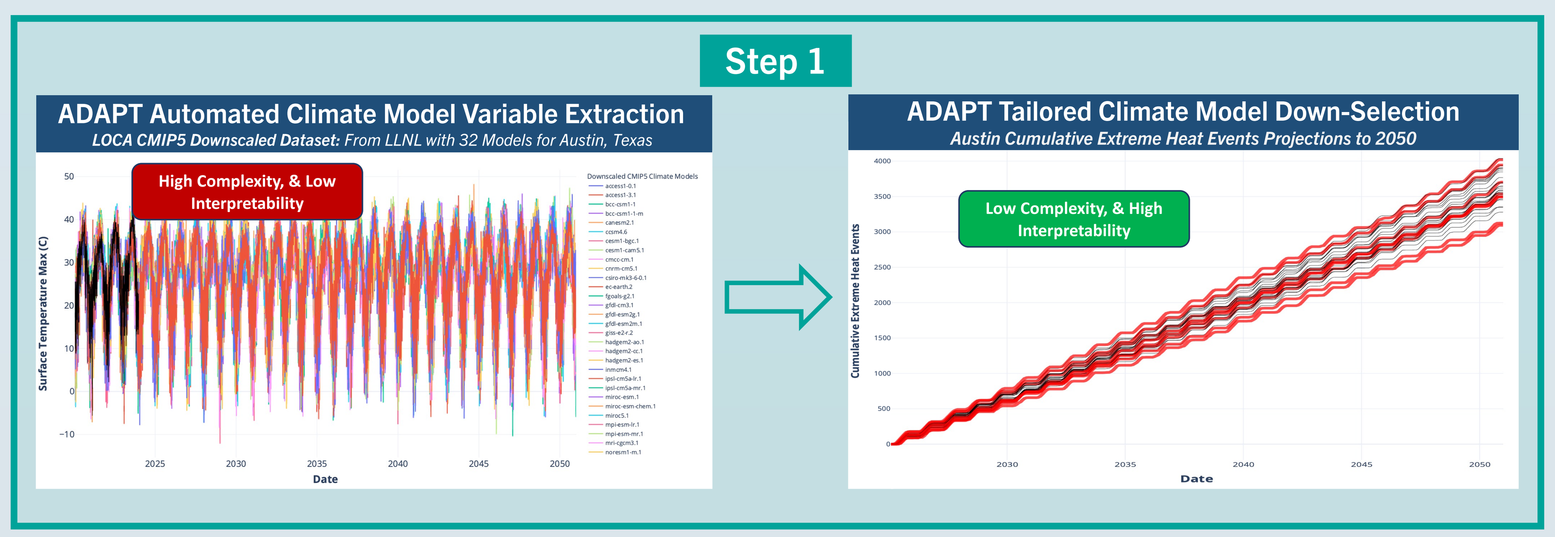
ADAPT works with the user's interests to pinpoint the direct vulnerabilities and exposure impacts of climate change within a decision maker's jurisdiction. It then calculates the associated costs for each exposure impact, enabling strategic decision-making.

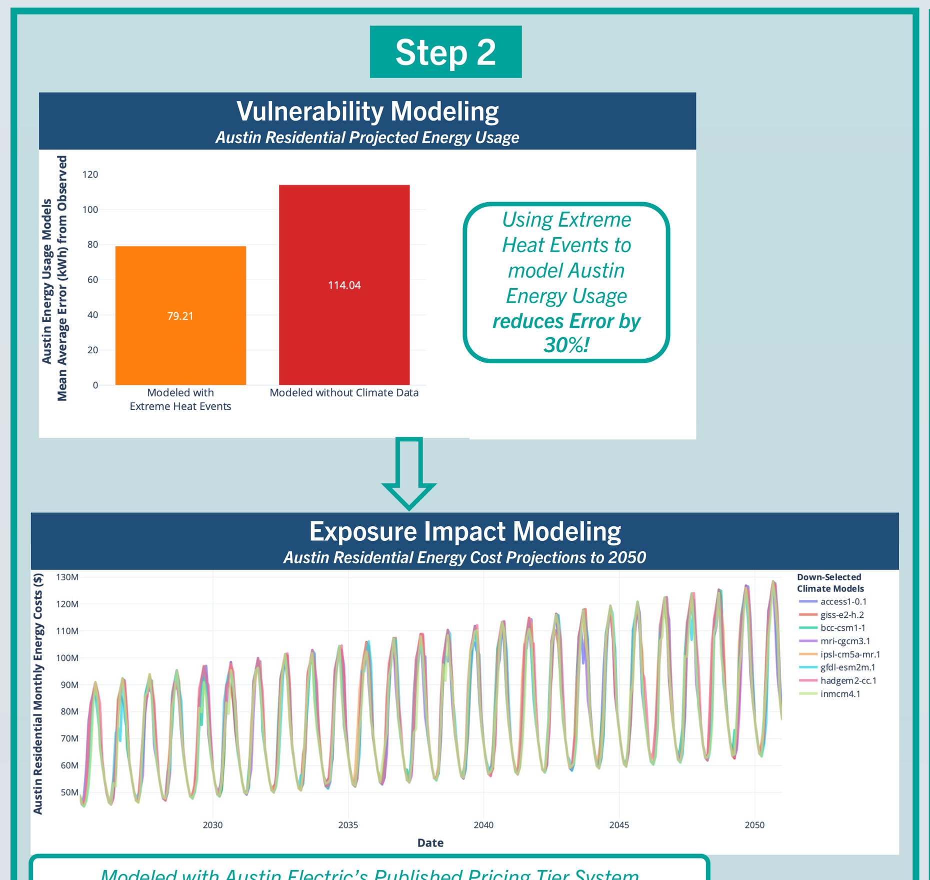
To assess impacts, ADAPT considers various variables per jurisdiction, such as residential energy usage, population projections, and electric charge rate tiers. It then applies a varied cohort of Physics-Based and ML modeling algorithms, like Time Series Auto-Arima Forecasting, to predict future trends of those variables

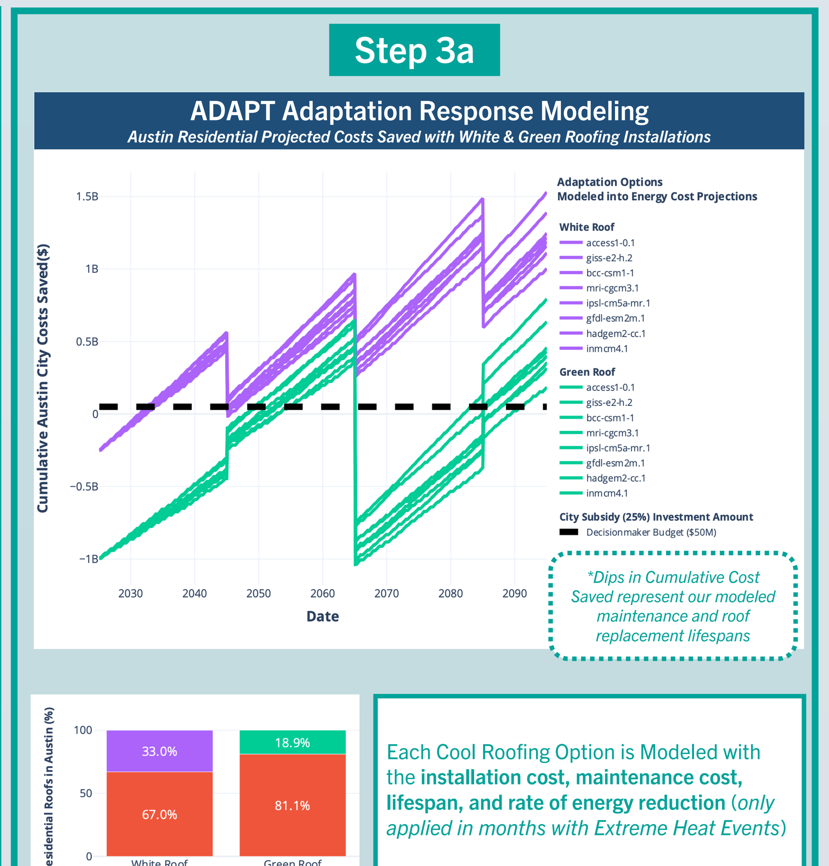
Step 3: Adaptation Responses: Strategies & Option Sets

ADAPT offers the tailored exploration of adaptation options to address predicted climate change impacts while minimizing user target costs. Adaptations are optimized to ensure decision-makers incur the lowest possible impact costs, providing cost-effective solutions to climate events.

Various adaptation strategies are modeled to reduce exposure impacts & vulnerabilities, including energy-efficient white roofing options, installation processes, and associated energy usage costs. ADAPT utilizes multi-objective optimization via element-wise MOOP algorithm, accounting for user constraints to optimize for actionable deployment strategies.







REAL WORLD CASE STUDY: HEAT IN AUSTIN, TEXAS

Step 1: Austin Extreme Heat Projections from Climate Models

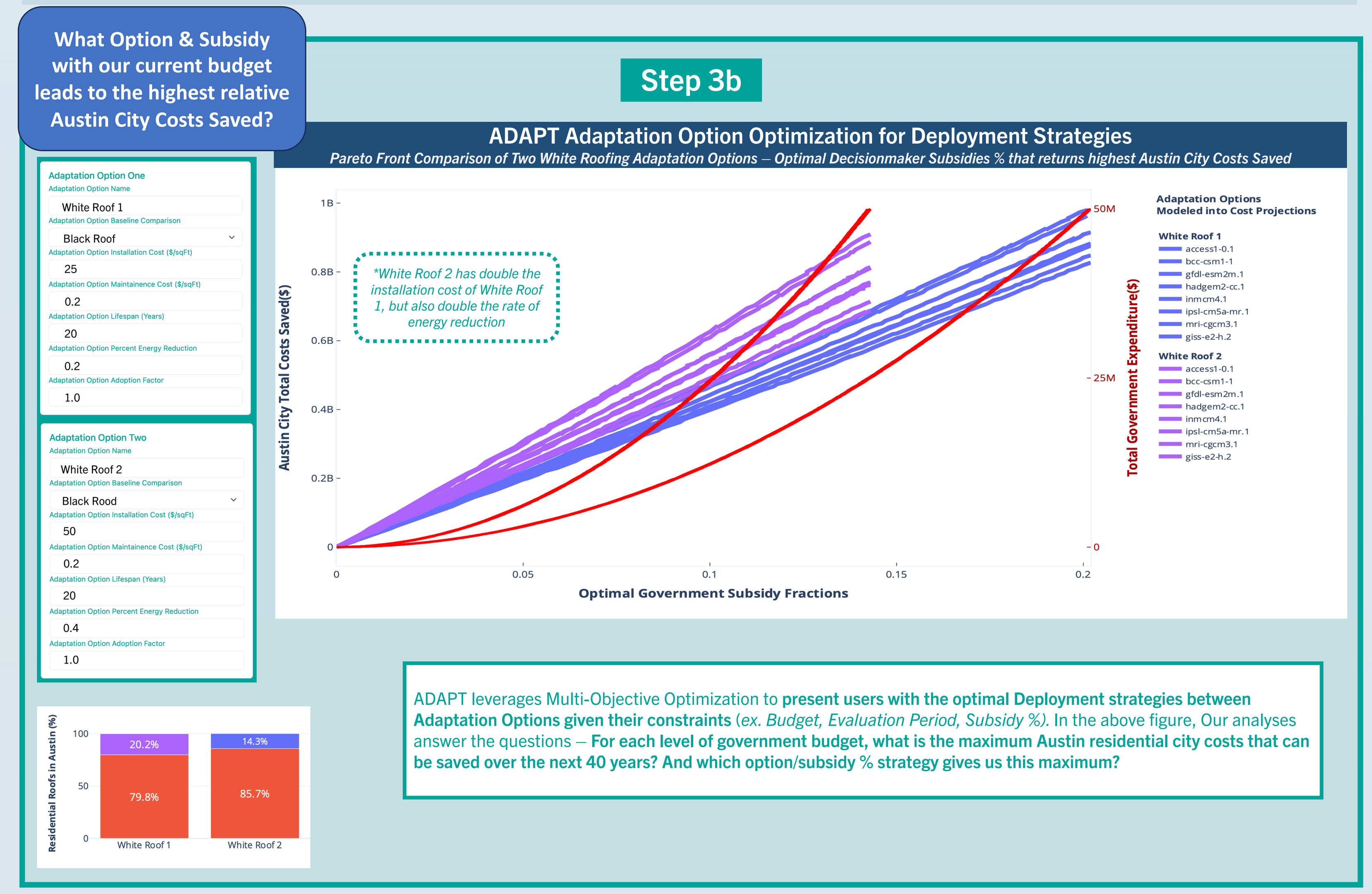
ADAPT organized 32 CMIP5 global climate into 8 representative models for Austin, Texas. **These selected models best represented the variability and range of Extreme Heat Event projections within Austin, Texas until 2099.**

Step 2: Energy Usage Vulnerabilities and Energy Cost Exposure Impacts

The projected extreme heat events were modeled to predict Austin residential energy usage, with a direct correlation. Our modeled energy usage showed a reduction of error when compared to approached not leveraging climate data. Using Austin Electric's cost estimation model, **ADAPT provided insights and figures illustrating the significant impact of extreme heat on Austin's energy consumption and costs.**

Step 3: Energy Efficient Adaptation: Cool Roofing Infrastructure

ADAPT extracted an expansive and tailored adaptation strategy analysis for Austin Energy Efficient Infrastructure: Cool Roofing Options. Our system **modeled detailed parameters of different cool roofing options into the projected energy usage and costs.** With the case study of City Planning officials as the decisionmakers, **ADAPT optimized for which combinations of Cool Roofing and Subsidy % on limited program budgets provided the maximum long-term Austin Residential cost savings.**



ADAPT leverages Multi-Objective Optimization to **present users with the optimal Deployment strategies between Adaptation Options given their constraints** *(ex. Budget, Evaluation Period, Subsidy %)*. In the above figure, Our analyses answer the questions – **For each level of government budget, what is the maximum Austin residential city costs that can be saved over the next 40 years? And which option/subsidy % strategy gives us this maximum?**

CONCLUSION

The ADAPT workflow empowers decision-makers to understand the effects of climate change on their jurisdictions and infrastructure. By leveraging state-of-the-art analytics methodology, ADAPT equips decision-makers with the technology necessary to make strategic infrastructure choices for their jurisdiction.

Our next steps revolve around expanding ADAPT to additional regions. This will further validate its effectiveness in different environments. Furthermore, we are looking to enhance data collection and integration into our system to ensure decision-makers have the most comprehensive information available.