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Adoption Pathways for Residential Electrification and Efficiency Measures and Impacts in ERCOT

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Energy Affordability Is Top of Mind

34 million U.S. households report trouble paying energy bills. Residential electrification & efficiency measures (REEM) can reduce this strain, yet adoption relies on economics. In ERCOT, there is much interest in understanding REEM's impact on the grid. Previous studies simply assess REEM technologically. By centering REEM's effect on household energy economics we can better understand impacts on the grid.

What Are REEM Adoption's Impacts?

1. **How many homes adopt REEMs over time & how does that change as economic conditions vary?**
2. **How does REEM adoption reshape ERCOTs residential electric demand?**

Using ResStock to Build An Adoption Economics Model for Grid Insights

We represent Texas' 11.4M homes with 30,000 simulated homes. Then we evaluate three REEM packages & layer a net present value (NPV) model onto the results to understand economic-driven adoption under different scenarios.

Package, k	Measures
Efficiency, (k = 1)	Insulation and sealing
Electrification, (k = 2)	Ducted ASHP or ductless MSHP
Eff + Elec, (k = 3)	All

Packages and the REEMs evaluated.

Parameter	Values
Cost Decline (δ)	[0%, 1%, 2%]
Real Discount Rate ($\mathbf{r}$)	[2%, 3.5%, 5%]
Fuel Price Increase ($\mathbf{g}$)	[0%, 1%, 2%]

Key economic parameters.

Steps at time t

1. Cost the upgrades for home i,

$$C_{i,k}(t) = (1-\delta)^t \left[C_{i,k}^{eff} + \left(C_{i,k}^{elec} - C_i^0\right)\left(1 + \left(\frac{1-\delta}{1+r}\right)^{15}\right)\right]$$

2. Calculate changes to energy bills,

$$\Delta B = B_{i,0} - B_{i,k}$$

3. Compute NPV for the home-package-year,

$$NPV_{i,k}(t) = -C_{i,k}(t) + \Delta B_{i,k}(t)(1+g)\cdot\left(\frac{1-\left(\frac{1+g}{1+r}\right)^{30}}{r-g}\right)$$

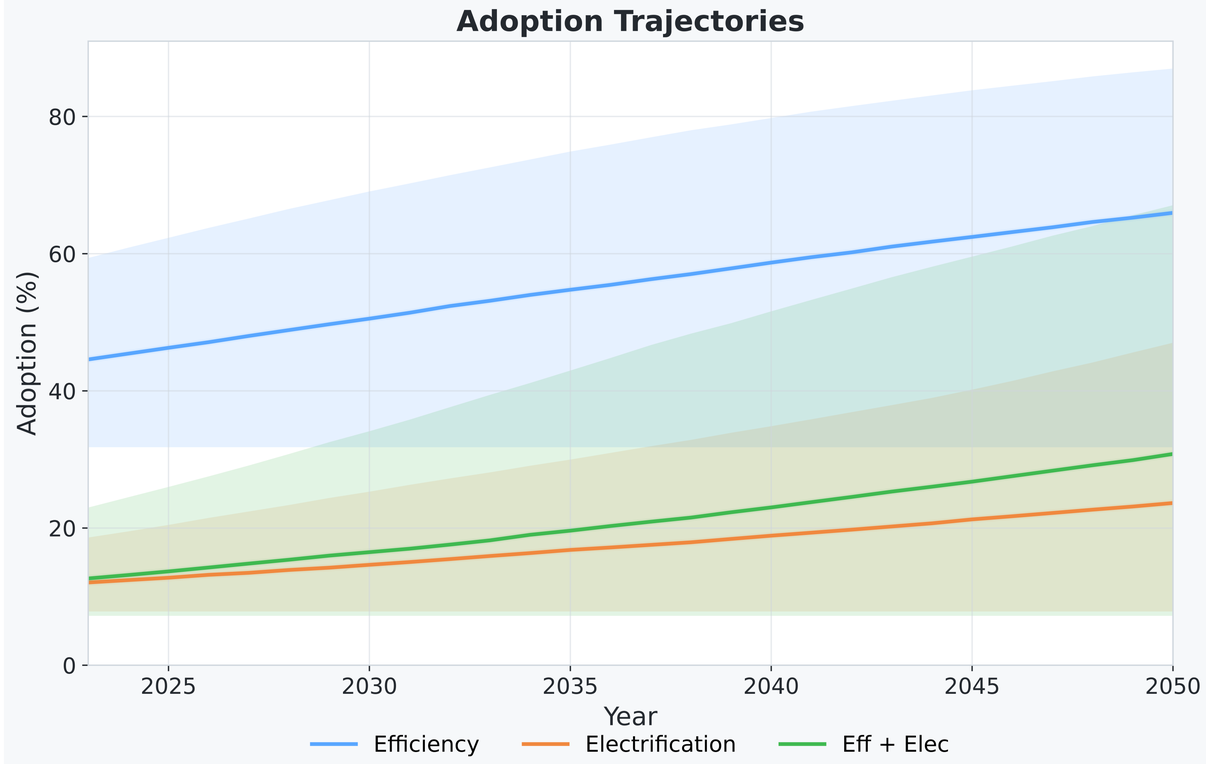
4. Apply NPV adoption rule,

$$t_{i,k}^{*} = \min\{t : NPV_{i,k}(t) > 0\}$$

5. Grow the housing stock.

$$N(t) = (1.017)^t N_0$$

Package Adoption Trajectories Differ

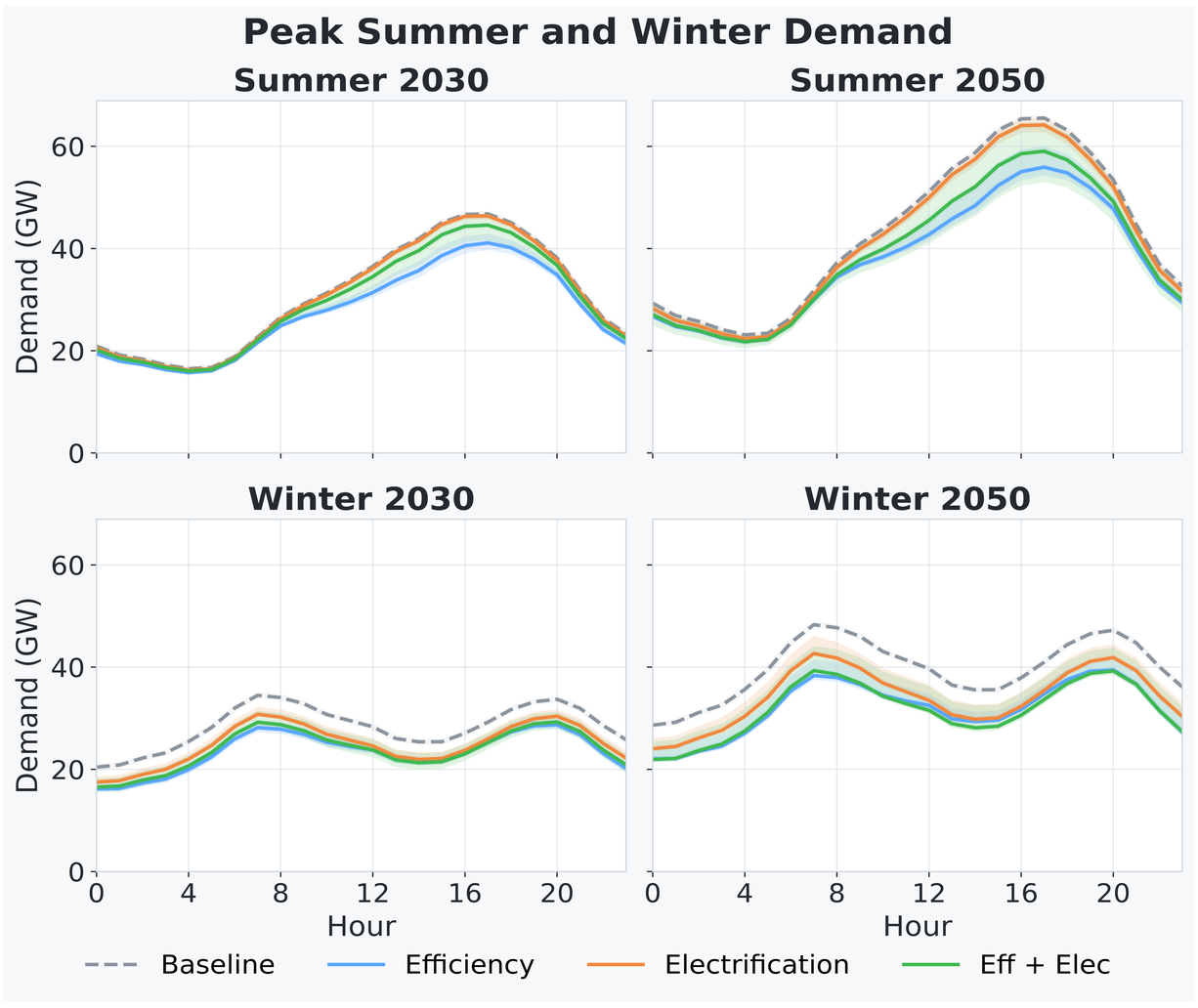


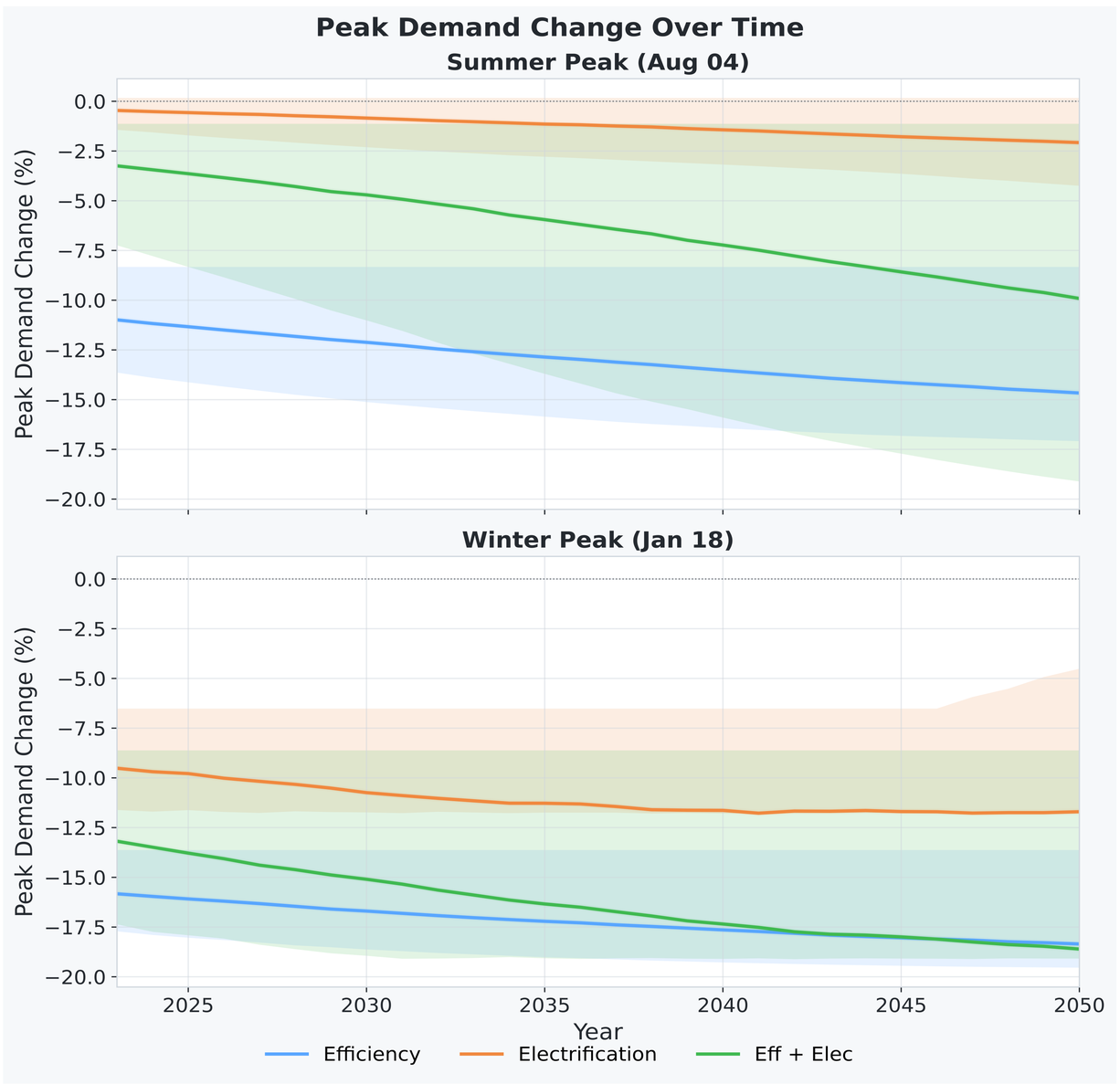
Solid lines show a central estimate; the shaded bands span all parameter combinations.

Results and Analysis for Adopters

Package	Count & Percentage	Average Cost	Average Annual Savings	Average NPV	Average Year of Adoption
Efficiency	**18,712 (66%)**	$5,366	$520	**$3,388**	**2027**
Electrification	6,709 (23.6%)	$11,773	$766	$2,805	2030
Eff + Elec	8,738 (30.8%)	**$18,314**	**$1,120**	$2,876	2032

Takeaway: Despite smaller annual savings, efficiency measures' lower cost leads to overall higher NPV and therefore greater levels of adoption. Results are central estimate.





Takeaway: Studies that evaluate similar packages without consideration for adoption may overstate the impacts of residential electrification technologies. Efficiency packages are more economic, and in many scenarios reduce peak summer and winter demand the most. The sharp increase in winter peak after 2046 is due to a glut of gas heated home adoption.

Scan for references and more information!

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