

# HOME IMPROVEMENT, WEALTH INEQUALITY, AND THE ENERGY-EFFICIENCY PARADOX

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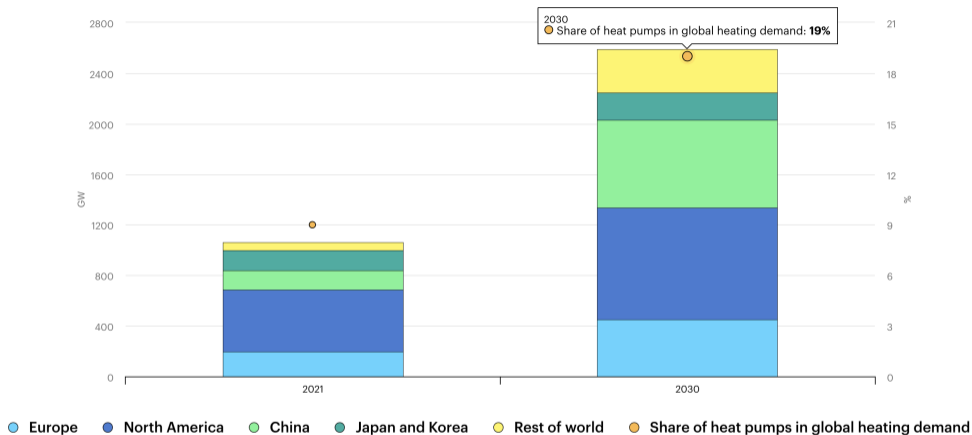
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# NEW EVIDENCE ON GREEN HOME INVESTMENT DECISIONS

- Use two waves of repeated cross-sectional household (HH) survey to document new facts about takeup of energy-efficient home investments in Netherlands:
  1. Higher-income HHs invest more in energy efficiency at both extensive (home purchase) and intensive margins
  2. At least some of this gradient due to **tastes for climate mitigation** rather than purely liquidity constraints, as evidenced by willingness to invest in  $\mathbb{E}[NPV] < 0$  projects
  3. Both types of home investments result in reductions in energy consumption, with savings mainly driven by boiler upgrades
- Descriptive analysis points to an **energy-efficiency “paradox”** (really a tradeoff)
  - ▶ Higher-income HHs emit more carbon, but have less to gain from energy efficient savings as a fraction of their income or wealth
  - ▶ Counterfactuals: **equity-efficiency** tradeoff might (?) be best mitigated by **broad-based green retrofitting** of the housing stock

# LARGE INVESTMENT GAP IF WE ARE TO APPROACH NZE TARGETS



Source: International Energy Agency (IEA): <https://www.iea.org/energy-system/buildings/heat-pumps> (July 29, 2024)

- By 2030, installing **modern building heat pumps** in keeping with current global pledges could offset all CO<sub>2</sub> emissions for all cars in Europe

## COMMENT #1: MORE DIRECT EVIDENCE ON CHANNELS

- Most interesting part of paper is survey evidence on why HHs do green HIs
  - ▶ Capitalization effect: stronger effects for homeowners who benefit from home equity ↑
  - ▶ Liquidity constraints seem to play limited role: renters still make investments
- **To what extent to income and wealth serve as a tag for these motivations?**
  - ▶ Renters have lower incomes on average, but do not gain home equity by doing certain types of investments
  - ▶ Under what conditions are landlords responsible for providing retrofits or paying the utility bills on behalf of tenants?
- **Rather than “controlling” for tastes for living in a green house, what happens if you use motivations as the outcome variable?**
  - ▶ Are richer HHs more driven by intrinsic tastes for greener technologies?
  - ▶ Implications for optimal targeting of green energy subsidies

TABLE F1 – REASONS FOR DOING AND NOT DOING HOME IMPROVEMENTS

VARIABLES	Observations	Mean	Std. Dev.
Necessary due to maintenance (1A)	23,485	0.426	0.494
Investment pays off (1B)	23,485	0.242	0.428
Make the home more pleasant (1C)	23,485	0.204	0.403
Environmental considerations (1D)	23,485	0.064	0.244
Agreed in homeowner's association (1E)	23,485	0.012	0.110
Enhance marketability of the home (1F)	23,485	0.011	0.106
Other reasons (1G)	23,485	0.0401	0.197

**Panel A.** Reasons for undertaking energy efficiency-enhancing home improvements.

*Note:* Based on Dutch survey data (WoON-survey) from 2018.

VARIABLES	Observations	Mean	Std. Dev.
Home is already energy efficient (2A)	11,310	0.384	0.486
Outside of my budget (2B)	11,310	0.167	0.373
Savings are insufficient (2C)	11,310	0.124	0.329
Don't know what the possibilities are (2D)	11,310	0.055	0.227
Don't want to renovate (2E)	11,310	0.069	0.253
Homeowner's association doesn't want this (2F)	11,310	0.020	0.141
Didn't get to it yet (2G)	11,310	0.224	0.417
Planning to move (2H)	11,310	0.060	0.238
Others (2I)	11,310	0.131	0.338

**Panel B.** Reasons for not undertaking energy efficiency-enhancing home improvements.

*Note:* Based on the WoON-survey (2018).

## COMMENT #2: AUTOCORRELATION IN GREEN HI DECISIONS

- History of work done on the property matters for measurement of elasticity of green HIs w.r.t. income due to **serial autocorrelation**
  - ▶ Gillingham & Watten (2024): capitalization of solar into house prices much lower after controlling for other renovations
  - ▶ Bellon, LaPoint, Mazzola, Xu (2024): on top of this, evidence of wealth effects in HI decisions + complementarities in projects
  - ▶ HHs may feel richer due to utility bill savings, making them more likely to invest further
  - ▶ Not clear how this mediates the observed relationship with income, since wealth effect may spur investment in both green and brown projects
- Solution #1: **control for different types of HIs already done on the property**, interacted with the energy efficiency label
- Solution #2: **separate out colinear “treatments”** in regression of energy consumption on home improvement, energy efficiency, heating type [equation 7]

## COMMENT #3: MODEST PROPOSAL TO REDUCE HOUSING SCALES?

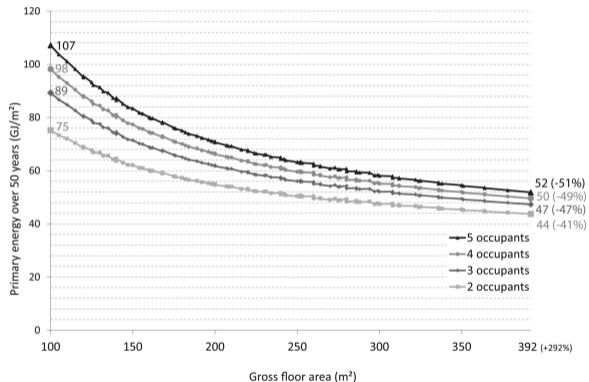
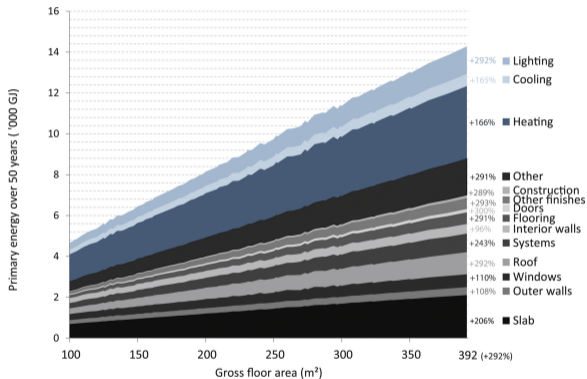
- How much of the carbon emissions to income gradient is driven by the fact that **richer households simply demand more space**?
  - ▶ Run counterfactuals with income  $\beta$  conditional and unconditional on house size
- Scale (i.e. square footage) of housing is a normal good
  - ▶ Children are also a normal good, and space is a complementary input to fertility in household production functions (van Doornik et al. 2024)
  - ▶ Concave relationship between house size and energy usage helps mitigate carbon concentration at higher incomes (Stephan & Crawford, *Energy* 2016)
- Opens the door for plausible, less costly policies related to land use
  - ▶ **Remove minimum lot size regulation**  $\rightarrow$  important in U.S. context
  - ▶  $\implies$  govt. should internalize negative spillover effect of policies aimed to reduce population aging and restore fiscal balance to pension systems

# MODELING THE HOUSING SCALE PROBLEM

- Extensive  $x_{i,t}^1$  margin (purchase of an already greener home) and intensive  $x_{i,t}^2$  (HIs) margin energy-efficient reduction per unit of housing
  - ▶ **Currently modeled as being independent of housing demand  $H_{i,t}$**
- But empirically we have  $x(H_{i,t})$ , with the following structure...
  - ▶  $x^1(\cdot)' > 0; x^1(\cdot)'' < 0$ : larger homes use more energy but are more efficient on a square foot basis, with marginal gains that diminish with size
  - ▶  $x^2(\cdot)' < 0; x^2(\cdot)'' < 0$ : larger homes are already more efficient per unit, so lower value-add from home improvements
- Side note: not obvious that the model needs to be in the main text after the introduction
  - ▶ Describe simulation of income profiles, but move to the appendix?
  - ▶ If keep in the main text, need to make the households' problem more realistic



# EVIDENCE OF CONCAVE RELATIONSHIP BETWEEN HOUSING SCALE AND EMISSIONS



Source: Stephan & Crawford (2016): "The relationship between house size and life cycle energy demand: Implications for energy efficiency regulations for buildings," *Energy*, 116(1): 1158–1171.

## MINOR COMMENTS ON EXPOSITION

- Cut several things – especially robustness checks – and focus on main message
  - ▶ No mention of the paradox or results of counterfactuals in the intro (not until pg. 37)
  - ▶ Long discussions of Netherlands context don't help with external validity concerns
- **Not clear why the IV strategy is necessary for the paper's arguments**
  - ▶ For the policy counterfactuals, really just care about the descriptive relationship between income and green adoption → focus on measurement rather than causality
  - ▶ IV might be useful if trying to establish whether financing constraints bind
    - ★ Exclusion restriction likely fails given effect of marriage/divorce on household size
  - ▶ But many papers already document liquidity constraints matter for green HIs
- **Also not clear why focus on the 2006 survey wave given...**
  1. More precise definition of HIs and energy labels in 2018 survey wave
  2. Attitudes have shifted over the last 15 years in favor of climate change mitigation (Marlon et al. 2022 on the Yale Climate Change Communication Survey)

## SMALL DETAILS FOR AUTHORS TO FIX

- Figure 2: if utility bills are capitalized into rents, then underestimating utility expenditures as a fraction of income
  - ▶ Plot separate distributions for (social housing) renters vs. owners
- Table 8: horizon for present value of energy savings should match HH tenure rather than project lifespan
  - ▶ Median U.S. household moves every 6 years  $\implies$  realized energy savings are lower
  - ▶ Mobility can help explain lack of takeup of green HIs earlier in the life cycle
- If stick with the IV strategy use Montiel Olea & Pflueger (2013) F-stat which is heteroskedasticity and cluster robust and check for individual relevance of instruments
  - ▶ Also, in some specifications relevant source of variation seems to be at municipality  $\times$  renter/owner level, so do two-way clustering of standard errors

# TAKING STOCK: WHAT CAN WE DO TO RESOLVE THE ENERGY-EFFICIENCY VS. EQUITY TRADEOFF?

- Key contribution of the paper is to highlight a new stylized fact about **green housing decisions across the income distribution**
  - ▶ Positive relation between income and green home purchase and home improvement decisions
  - ▶ Gives rise to equity-efficiency tradeoffs standard in public finance
  - ▶ Evidence that under revenue neutrality, a national retrofit campaign would lower carbon emissions and reduce inequality
- **Main suggestion:** trim the paper and focus only on the results which are needed to sharpen policy counterfactuals
  - ▶ Income gradient not just due to liquidity constraints, as emphasized elsewhere
  - ▶ To consider other, perhaps more feasible policy targets, determine **whether income simply proxies for other carbon-emitting behaviors** (e.g. over-consumption of housing, green thumb)



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THANKS!

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