Village Clean-Heating *Transition Sandbox*

Coal-to-X Household-Level Clean Heating Transition Simulation Sandbox

GUO HANG · SCPKU

RESEARCH QUESTION · HOOK & GAP

Less pollution, but still unaffordable — which path?

A PUBLIC DEBATE

Is clean heating good?

Regional stats dominate; household income, housing, and heating costs differ.

B THIS STUDY

Which coal-to-X route fits this household?

Interactive comparison of gas / heat-pump routes, with compliance and subsidy shocks.

POLICY SUCCESS CAN COEXIST WITH HOUSEHOLD AFFORDABILITY PRESSURE.

SCOPE

Converted and unconverted clean-heating farmers in North China; students and other interested public users.

HYPOTHESES

H1 Farmers can find a coal-to-X path that fits their own household. H2 Students and other users improve their understanding after using the sandbox.

CONTEXT · WHY THIS MATTERS

Clean heating is not only an environmental question.

RELATED RESEARCH FIELDS

Rural energy transition · clean heating policy · energy affordability · environmental governance

SITUATION

Since 2016, many rural households in North China shifted from coal to cleaner heating.

IMPORTANCE

Cleaner air can come with higher winter bills; village-level choices must fit diverse household budgets.

WHY ORDINARY READERS SHOULD CARE

Heating is a basic need. The sandbox makes the trade-off between clean air, cost, and practical village choices easier to see.

RESEARCH PROGRESS · GAP · CONTRIBUTION

Evidence is strong. Decision support is still thin.

RESEARCH PROGRESS

Previous studies show clear pollution and carbon benefits, while policy simulation can connect household behavior with larger outcomes.

Liu et al. · Yuan et al. · Wang

LIMITATIONS

Affordability, infrastructure, fiscal pressure, price risk and coal rebound are recognized, but most work remains regional or policy-level.

Few tools compare gas, electricity, heat pumps and insulation from household inputs.

MY CONTRIBUTION

I turn the policy problem into an interactive village-level sandbox using income, house size, heating cost and affordability pressure.

The question shifts from “Is clean heating good?” to “Which coal-to-X path fits this village?”

METHOD · ARTIFACT + DESIGN

Five-turn simulation + pre/post surveys + AI analysis

www.clean-heating-simulator.com

01
Profile
Identity · income / heating cost

02
Status / compliance
Coal or prepare transition

03
Technology route
Gas / ground-source / air-source HP

04
Income / saving
Pick one of three strategies

05
Subsidy phase-out
Terminal outcome + survey

SAMPLE TARGET
20+ participants
Students + rural users + public URL

IDENTITY GROUPS
4 types
Student / Converted / Unconverted / Other

DATA STORAGE
Supabase
Anonymous UUID · surveys + AI analysis

DATA ANALYSIS PLAN

Sample stratification by identity · data cleaning & duplicate checks · pre/post survey comparison · subgroup patterns · route/outcome coding · descriptive statistics first

DESCRIPTIVE RESULTS · SURVEY + AI ANALYSIS

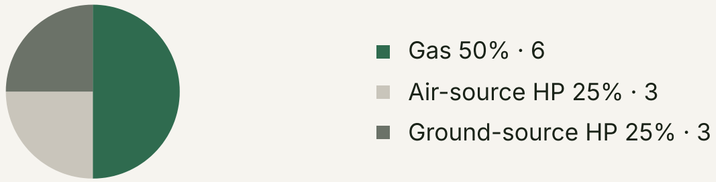
Four early signals from completed surveys

PRE / POST UNDERSTANDING · N=14

+1.50

11/14 improved · largest shift among students

FARMER ROUTE CHOICE · TURN 3 · N=12



Helped some participating farmers find a suitable path

RECOMMENDATION · N=21

17/21

Most would recommend the sandbox

AI DEBRIEF · N=21

17/21

Rated helpful · 4 want clearer explanations

VALID SESSIONS

28

A+B pool

COMPLETED SURVEY

21

primary sample

TAKEAWAY

Awareness gain + positive reception; farmer-path claims remain formative.

PRIOR WORK VS. THIS STUDY · PRACTICAL IMPLICATIONS

From regional evidence to household-level decisions.

DIFFERENCE FROM PRIOR WORK

Earlier studies mainly prove pollution, carbon, and affordability at regional or policy level.

This sandbox links household inputs with turn-by-turn route choices and terminal outcomes, so the question becomes which coal-to-X path fits this household, not only whether clean heating is good.

PRACTICAL IMPLICATIONS

The sandbox turns abstract policy trade-offs into decisions that households can try before they commit.

Future farmers can preview the coal-to-X path that best fits their own household before switching. Village governments can then aggregate these household inputs and choices to select the most appropriate plan for the whole village.

CONCLUSION · THREE QUESTIONS

No single best route; fit depends on the household.

The conclusion is organized around the three defense questions: answer, limitations, and next research.

1 · HOW DO THE RESULTS ANSWER THE RESEARCH QUESTION?

Compared with traditional explanation formats, the interactive game website promoted stronger understanding of clean-heating trade-offs.

It also helped participating farmers identify the most suitable coal-to-X pathway for their own household conditions, rather than treating clean heating as one universal route.

2 · WHAT ARE THE LIMITATIONS?

The collected data are still limited and exploratory.

The sample is small: 28 completed runs, 12 farmer route choices, and 14 paired pre/post surveys. Users were self-selected, and simulation outcomes are not observed long-term adoption.

3 · WHAT FUTURE RESEARCH COMES NEXT?

The next step is to extend the sandbox to other environmental problems.

I also hope to add government and enterprise roles, so the simulation can model strategic interactions among households, public policy, and market actors.

REFERENCES · BIBLIOGRAPHY

Sources cited in this study.

[1]Li, X., Yang, F., & Zhou, X. (2025). Research on the current situation and strategies of scattered coal governance in China.
China Coal, 51(02), 149–157. https://doi.org/10.19880/j.cnki.ccm.2025.02.017.

[2]Liu, J., Li, Z., Zhu, Y., Ma, X., Wang, G., Ning, Z., ... & Han, B. (2025). Temporal variations and sources of PM2.5-bound PAHs in rural Baoding during coal-to-gas conversion.
Research of Environmental Sciences, 38(09), 1929–1938. https://doi.org/10.13198/j.issn.1001-6929.2025.07.13.

[3]Ma, X., Wang, Z., & Wang, J. Artificial intelligence plus public policy research: A multi-agent simulation method driven by artificial general intelligence (AGI+MAS).
E-Government, 1–12.

[4]Qin, Q., & Qiu, C. (2026). Future heating pathway choices from the coal-to-gas controversy.
Energy, (03), 34–36.

[5]Wang, G., & Gao, D. (2023). Research progress and methodological implications of agent-based modeling in public policy simulation.
Journal of Public Management, 20(02), 116–127+173. https://doi.org/10.16149/j.cnki.23-1523.20230314.003.

[6]Yuan, X., Liu, W., Li, R., & Li, P. (2025). Research on carbon emission reduction methodology for clean heating in rural areas of Hebei Province.
Energy Conservation, 44(04), 111–114.

[7]Zhai, Y., & Li, S. (2023). Review and prospect of clean heating renovation in northern rural areas of China.
China Energy and Environmental Protection, 45(10), 194–200. https://doi.org/10.19389/j.cnki.1003-0506.2023.10.029.

[8]Ministry of Ecology and Environment of the People's Republic of China. (2011). Guidelines for the preparation of provincial greenhouse gas inventories (Trial).
Department of Climate Change, National Development and Reform Commission.

[9]Department of Climate Change, Ministry of Ecology and Environment of the People's Republic of China. (2020). 2019 baseline emission factors for regional power grids in China.
Ministry of Ecology and Environment.

[10]China Academy of Building Research. (2025). Grading standard for operational carbon emissions of rural buildings (Standard No. T/CECS XXX-2025).
China Architecture & Building Press.

Q & A

Thank you *Questions welcome*

Village Clean-Heating Transition Sandbox

DEMO

www.clean-heating-simulator.com

INSTRUCTOR

Lawted Wu

COURSE

SCPKU