Climate Impact on U.S. Building Energy Use

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THE RGCAM BUILDINGS MODEL
Regional GCAM with 50-state building representation (population, GDP, floorspace…..)
Incorporated the most up-to-date representation from the core GCAM to allow for state level HDD/CDDs.
State HDD/CDDs (CCSM A2 & B1)

Heating Degree Days

Cooling Degree Days

A2

B1
Building Model Calibration in RGCAM

Building Energy Use By Service in 2005
U.S. STATE BUILDING ENERGY USE AND CLIMATE IMPACT
A2 Scenario (Heating & Cooling)

About 13% reduction in 21st century

Decrease: New England (-25%)
Increase: FL (+8%)
B1 Scenario (Heating & Cooling)

About 11% reduction in 21st century

Decrease: New England (-20%)
Increase: None

Building Energy Use with and without Climate Feedback
Impact on Fuel Use (U.S.)

Without Climate Feedback
- +19% elec.
- -17% gas

With Climate Feedback
- +8% elec.
- -10% gas
Impact on Fuel Use (State)

with/without Climate Feedback

-0.40 - 0.50
0.51 - 0.60
0.61 - 0.70
0.71 - 0.80
0.81 - 0.90
0.91 - 1.00
1.01 - 1.10
1.11 - 1.20
1.21 - 1.30
> 1.30

A2

B1
Reduction in building energy use with climate feedback
- 13% in A2 scenarios and 11% in B1 scenario at national level

Climate impact shows large spatial heterogeneity
- -25% (New England) to +8% (FL) in A2 scenario
- -20% (New England) in B1 scenario

Climate change also has a pronounced effect on the fuel use
- Decreasing gas and increasing electricity
Global Buildings and Climate Change Impact

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THE GLOBAL BUILDINGS MODEL
Total Building Energy Demand in Reference Scenario

Residential Buildings (by Fuel)
- heat
- trad biomass
- biomass
- coal
- refined liquids
- gas
- electricity

Residential Buildings (by Region)
- China
- India
- Southeast Asia
- Africa
- Latin America
- Middle East
- Former Soviet Union
- Eastern Europe
- USA
- Western Europe
- Canada
- Australia_NZ
- Japan
- Korea

Commercial Buildings (by Fuel)
- heat
- trad biomass
- biomass
- coal
- refined liquids
- gas
- electricity

Commercial Buildings (by Region)
- China
- India
- Southeast Asia
- Africa
- Latin America
- Middle East
- Former Soviet Union
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- Japan
- Korea
Energy Intensities by Service in Reference Scenario

Space Heating Energy Intensity (Residential)

Space Cooling Energy Intensity (Residential)

Other Energy Intensity (Residential)
The growth in per capita building energy consumption is most pronounced in developing regions.

Traditional biomass and coal phase out from the sector.

Electrification of the buildings sector occurs in all regions with the change most pronounced in developing regions.
CLIMATE IMPACTS ON BUILDINGS ENERGY SYSTEM
Increased cooling leads to increased demand for A/C electricity.

Decreased heating leads to decreased demand for mainly fossil fuels (gas, oil, coal, biomass, and district heat).

Net impact on final energy consumption in the reference case is negative but small (less than 1% globally).

The impact is more modest under abated climate change (550ppm).
Effect of Climate Change on Global Buildings Demand for Fuels (Reference Scenario)
Effect of Climate Change on Building Energy Expenditures (Reference Scenario)

Change in Per Capita Building Energy Expenditure (Effect of Climate Change in Reference Scenario)
WELFARE IMPACT OF CLIMATE CHANGE IN BUILDINGS
Impact on Total Surplus associated with Buildings Services (annual)

- The change in total surplus has strong correlation with the change in total expenditure.
- Regions that are warmer initially would experience the largest welfare cost due to the impact of climate change on buildings via increased expenditures on cooling services.
Impact on Total Surplus associated with Building Services (2005-2095 cumulative)

Change in cumulative surplus 2005-2095 [2005 billion USD]

-6000
-5000
-4000
-3000
-2000
-1000
0
1000
2000
3000
4000
5000
6000

Discount rate

- 2.5%
- 3.0%
- 5.0%
Impacts of Building Energy Codes in China

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Detailed Representation of Chinese Buildings

- 3 building types in each of 4 climate regions (12 sectors in total)
- Variety in socioeconomic development, energy consumption pattern, fuel choice, and climate change
Impact of Building Shell Efficiency Codes in China

- Building shell efficiency codes reduce total energy demand by 14-21%.
- Code scenarios lead to a major decrease in the demand for fossil fuels and a modest decrease in A/C electricity.
- High compliance is essential for any noticeable impact.

![Graph showing Total Building Energy Demand in Alternative Building Energy Code Scenarios and Sensitivity of Year 2095 Average U-factor to the Stringency of the Code](image)
Impact of Building Shell Efficiency Codes in China by Climate Zone

- The impact of the code on energy use intensity is most pronounced in SC and C regions—climate condition matters.
- The impact as expressed by total energy savings is most pronounced in C and HSCW regions—scale matters.
Building Shell Efficiency Codes vs. Carbon Policy

- Economy-wide carbon policy has a limited effect on building energy demand and direct CO₂ emissions (compared to the effect of the codes)
- Carbon policy may not lead to increased electrification as abated climate change reduces the demand for space cooling.

China’s Building Energy Demand in Reference (REF), Carbon Policy (REF/550ppm), Full Shell Efficiency Code (All-Codes), and Full Shell Efficiency Code combined with Carbon Policy (All-Codes/550ppm) Scenarios
THANK YOU!