U.S. GREEN BUILDING COUNCIL

G325

Climate Resilience Strategies for Buildings in New York State: Part 3

USGBCNYU_CRSB3

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May 16, 2019

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Course Description

Although climate has always been a key consideration for the design, construction, and operation of buildings, many professionals assume that future weather conditions will be similar to what was experienced in the past. Increased exposure to climate-related hazards like Hurricane Sandy and 'Snowvember' will require practitioners in New York State to reevaluate their standard practices. Changing climate conditions, including increases in temperature and precipitation, may increase the likelihood of climate hazard events including hurricanes and tropical storms, flooding, severe storms, winter storms, wildfire, sea level rise, heat waves, and pest infestations. Increasing the resilience of buildings in New York State can reduce the negative impacts of these hazards. This last of a three part course, aims to give an overview of climate resilience strategies, while also providing links and references that would allow participants to dig deeper and access more specific information.

This course is approved by the AIA for 1 LU | HSW.

Learning Objectives

At the end of the this course, participants will be able to:

1. Understand the role of insulation, neighborhood development, urban heat island, building ventilation, indoor air quality, passive building systems, active building systems, building operations, potable water systems, reclaimed water systems, and integrated pest management when developing climate resilience strategies during project planning and design in New York State.
2. Explain climate resilience strategy implementation beyond the physical application of a material, technique, or technology; including project planning, occupant health, safety and welfare, costing, and the development of standards, operations, and maintenance.
3. Utilize the information in this course as a tool to assist in the implementation of the covered climate resilience strategies during project planning and design.
4. Understand that all those involved with the building sector, including owners and operators, policy makers, planners, architects, and engineers should play a role in the implementation of climate resilience.

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NEW YORK UPSTATE

Presentation prepared by:

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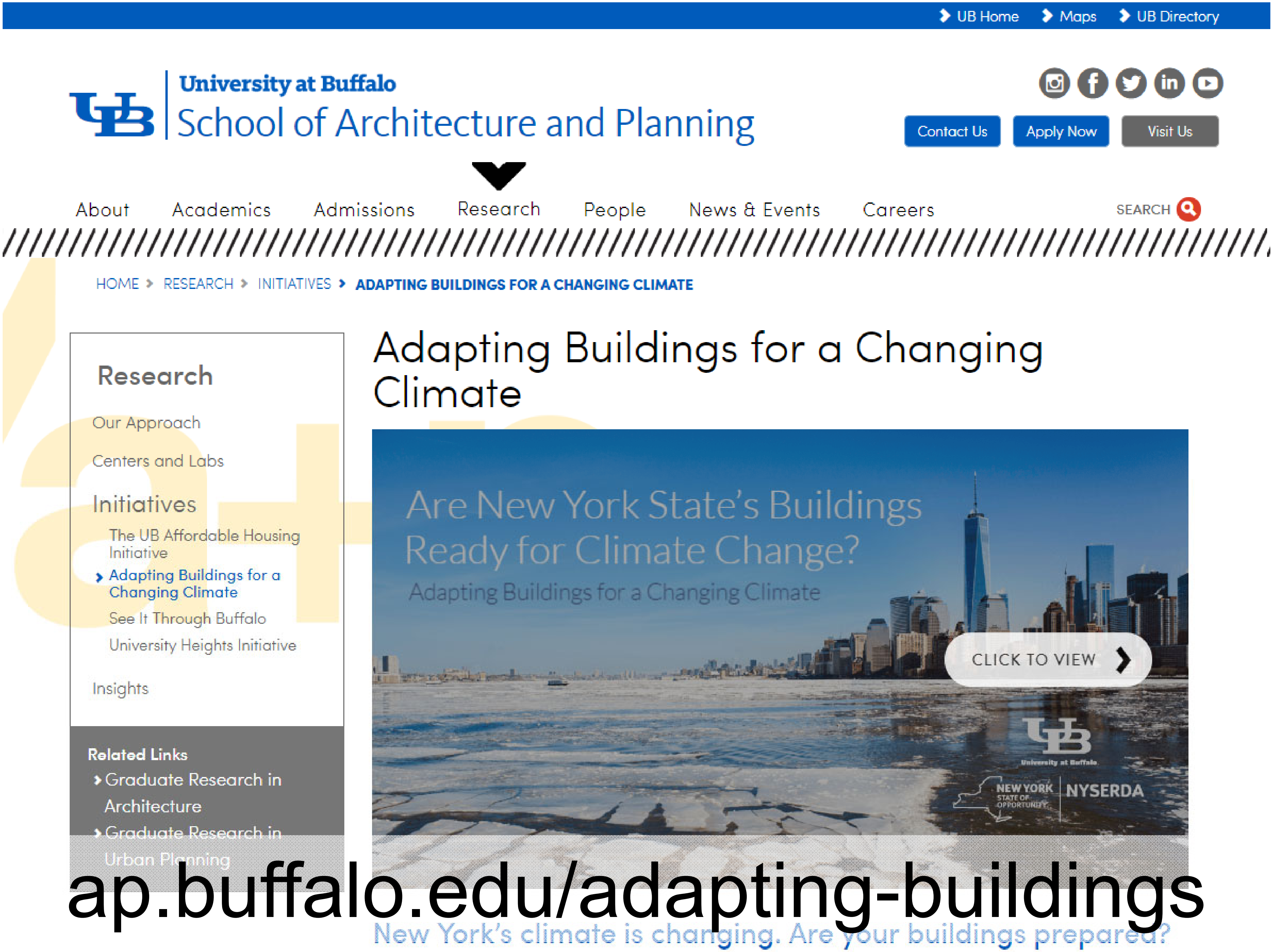

ap.buffalo.edu/adapting-buildings

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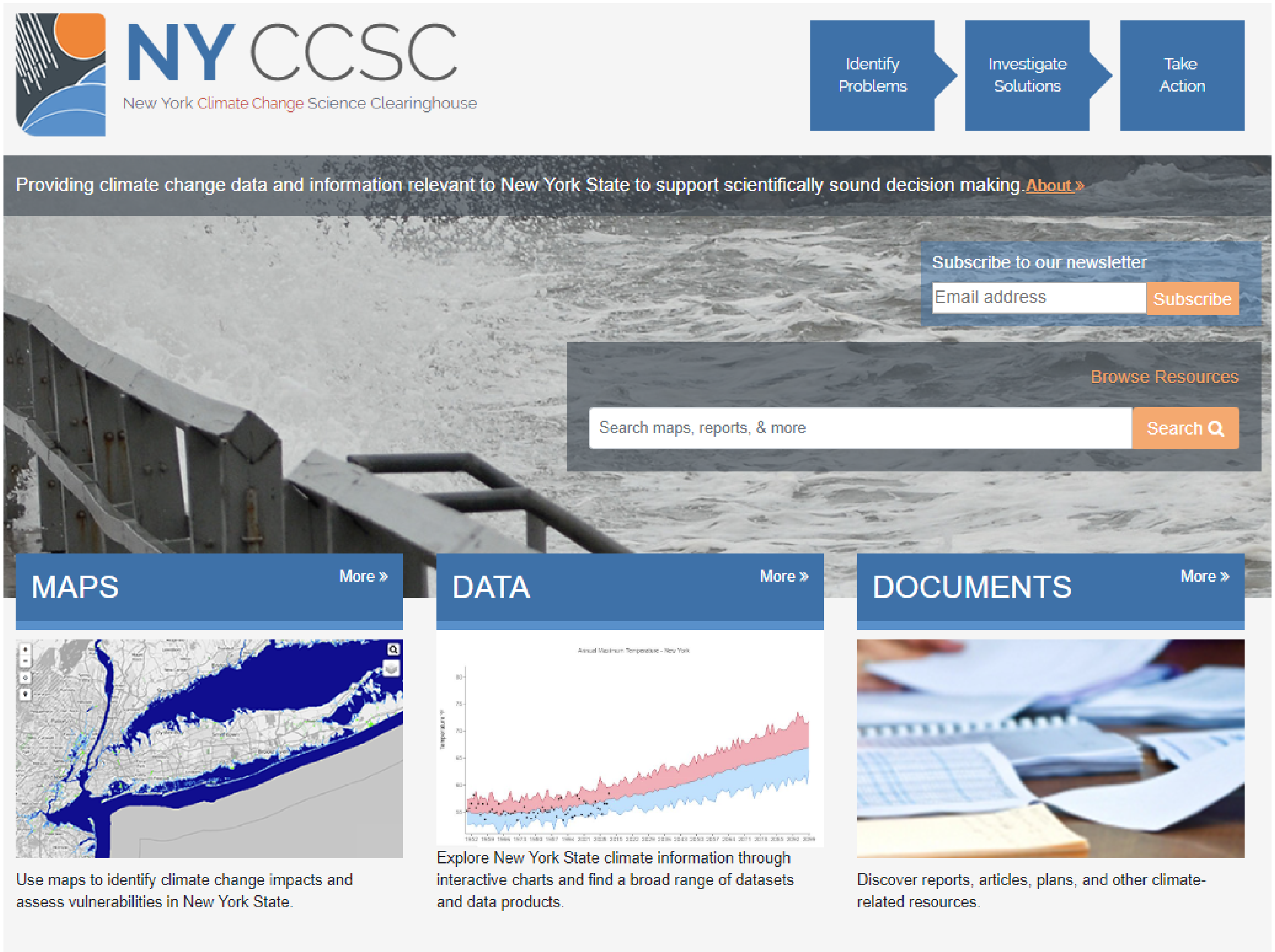
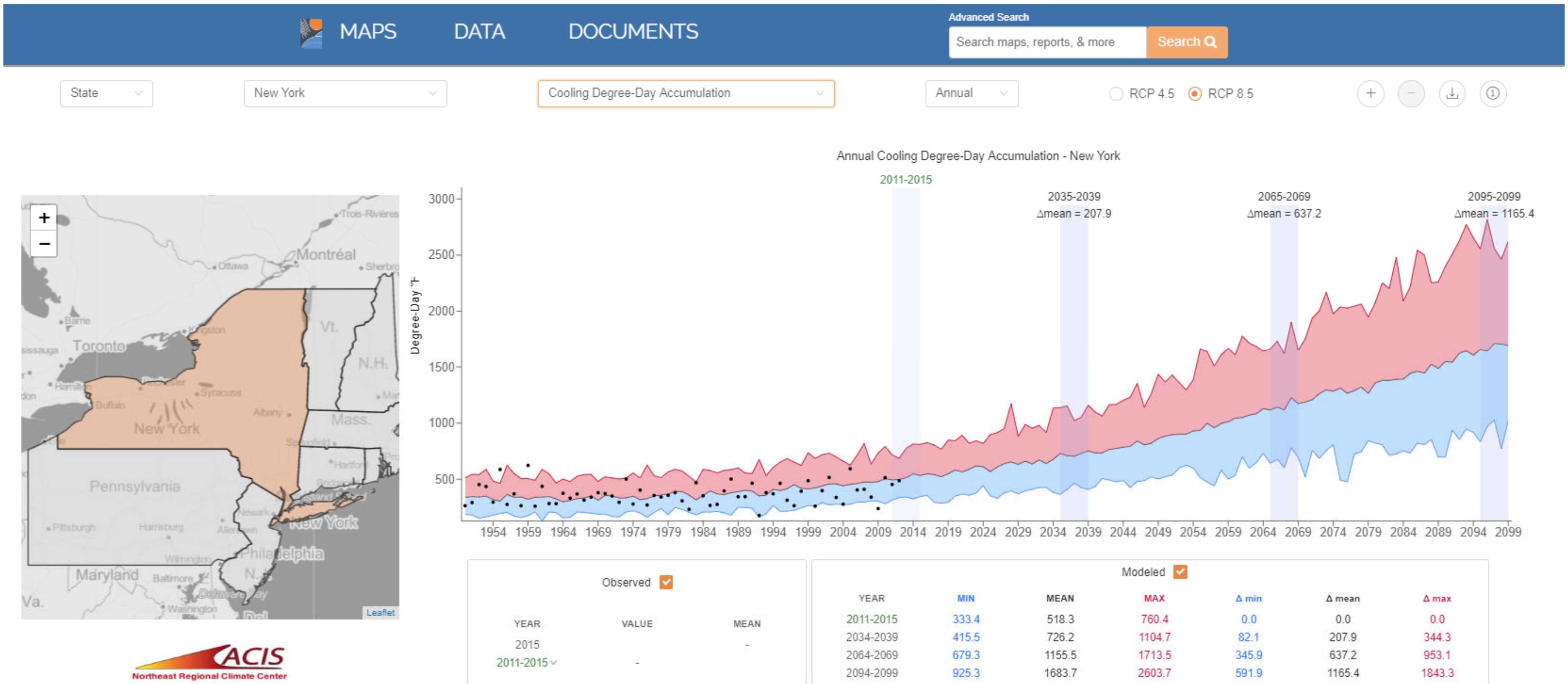
Impacts of Extreme Temperatures

- According to ClimAID, the number of days over 90˚F is projected to increase for every region in the state. Some evidence the number of cold snaps may also increase as the Arctic warms, though this issue requires further research.
- The frequency and duration of heat waves (defined as three or more consecutive days with maximum temperatures at or above 90˚F) are also expected to increase.
- Most heat-related illness and death occurs indoors.
- By 2050, the total heat-related deaths in NYC are projected to be between 204 and 268 per year.
- This could have an annual economic impact of between $1.51 to $1.98 billion in NYC alone.



https://www.nyclimatescience.org/



Observed

YEAR	VALUE	MEAN
2015		-
2011-2015	-	

Modeled

YEAR	MIN	MEAN	MAX	Δ min	Δ mean	Δ max
2011-2015	333.4	518.3	760.4	0.0	0.0	0.0
2034-2039	415.5	726.2	1104.7	82.1	207.9	344.3
2064-2069	679.3	1155.5	1713.5	345.9	637.2	953.1
2094-2099	925.3	1683.7	2603.7	591.9	1165.4	1843.3

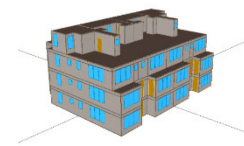
https://www.nyclimatescience.org/

Methodology

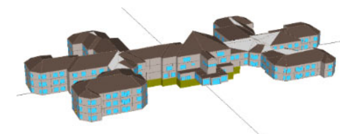
- Based on the Chartered Institution of Building Services Engineers (CIBSE) report “Climate change and the indoor environment: impacts and adaptation” and the NYSERDA New Construction Program (NCP) Simulation Guidelines.
- Models run in eQuest version 3.62 using files originally created by L&S Energy Services for Technical Assistance Studies in Support of the NYSERDA New Construction Program.
- Ran models using Typical Meteorological Year (TMY) data:
  - TMY, 1986 – 2015, 30 years
  - TMY, 2009 – 2015, 6 years
- eXtreme Meteorological Year (XMY) Data:
  - XMY MAX, 2001 – 2015, 15 years
  - XMY MIN, 2001 – 2015, 15 years

<u>Five Case Studies x Seven Climate Zones</u>

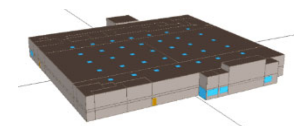
- Low-Rise Residential Building



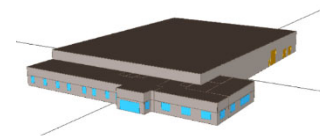
- Multifamily Residential Building



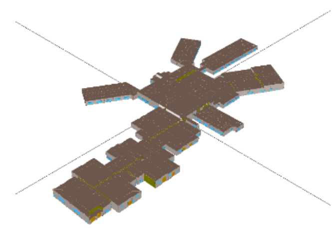
- Commercial Building



- Industrial Building



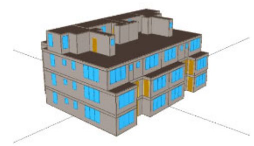
- Educational Building



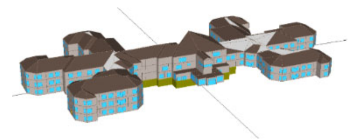
Gilman, Elizabeth K., Nicholas B. Rajkovich, Thomas J. Mulligan, and Brendan Kelly. 2018. *Modeling the Impacts of Climate Change on Building Energy Performance in New York State*. New York State Energy Research and Development Authority (NYSERDA), Albany, New York.

<u>Five Case Studies x Seven Climate Zones</u>

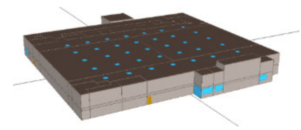
- Low-Rise Residential Building
  (74.6% of statewide floor area)



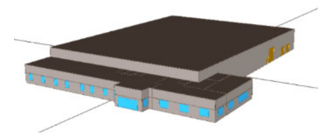
- Multifamily Residential Building
  (13.4% of floor area, 40.1% in NYC & L.I.)



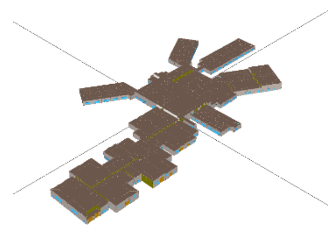
- Commercial Building
  (6.11% of floor area)



- Industrial Building
  (1.72% of floor area)



- Educational Building
  (0.001% of floor area)



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Orientation of the Building

Foundation

Walls and Floors

Envelope (insulation, façade, etc.)

Ductwork and Piping

Roofing

Windows and Doors

Interior Finishes

Mechanical and Electrical Equipment

Appliances

Gilman, Elizabeth K., Nicholas B. Rajkovich, Thomas J. Mulligan, and Brendan Kelly. 2018. *Modeling the Impacts of Climate Change on Building Energy Performance in New York State*. New York State Energy Research and Development Authority (NYSERDA), Albany, New York.

Orientation of the Building (50+ years)

Foundation (50+ years)

Walls and Floors (50+ years)

Envelope (insulation, façade, etc.) (50+ years)

Ductwork and Piping (50 years)

Roofing (10 to 40 years)

Windows and Doors (10 to 30 years)

Interior Finishes (5 to 20 years)

Mechanical and Electrical Equipment (5 to 20 years)

Appliances (5 to 10 years)

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Passive Survivability Definition

"[T]he ability of a building to maintain critical life-support conditions for its occupants if services such as power, heating fuel, or water are lost for an extended period."

- Alex Wilson

https://www.buildinggreen.com/op-ed/passive-survivability

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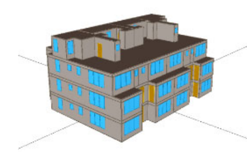
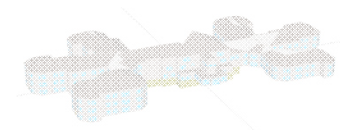
Case Studies

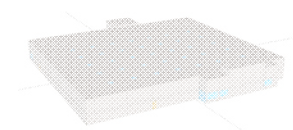
- Low-Rise Residential Building



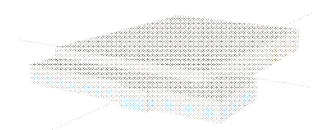
- Multifamily Residential Building



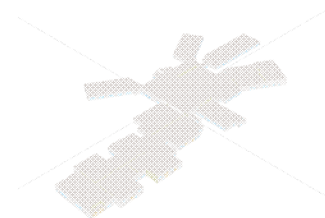
- Commercial Building



- Industrial Building



- Educational Building



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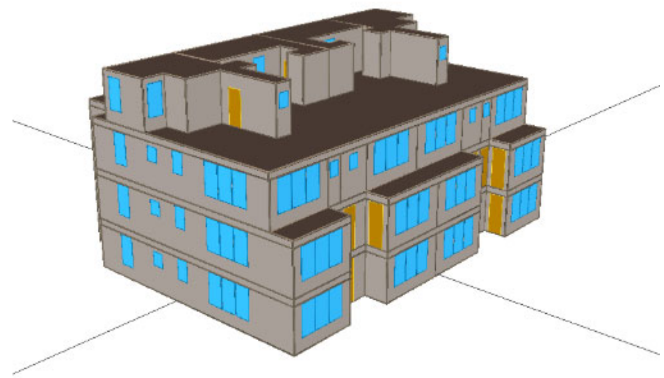
Low-Rise Residential Building



- Approximately 4.75 million residential buildings in New York State
- Represent 90.1% of the total number of buildings in the state and 73.3% of the total value of the building stock
- Externally load dominated
- Model was based on a 12,700 square foot, 12 unit apartment complex built in Brooklyn, New York in 2008.
- Building is a four story, light gauge steel framed structure with a brick veneer finish and a flat roof. The building has a slab on grade foundation.

Gilman, Elizabeth K., Nicholas B. Rajkovich, Thomas J. Mulligan, and Brendan Kelly. 2018. *Modeling the Impacts of Climate Change on Building Energy Performance in New York State*. New York State Energy Research and Development Authority (NYSERDA), Albany, New York.

Energy Conservation Measures

ECMs	Baseline System Description†	Upgraded System Description	EUL (years)	Cost ($)
Improved Insulation	R-20 continuous insulation in the roof.	R-30 continuous insulation in the roof.	50	$4,900
Upgraded Windows	Glazing with a solar heat gain coefficient of 0.50 and a U-value of 0.60.	Glazing with a solar heat gain coefficient of 0.28 and a U-value of 0.30.	30	$26,300
High Albedo Roof	The baseline design includes a dark roof with an absorptance value of 0.7.	The upgrade recommends installing an Energy Star qualified white roof with a absorptance value of 0.3.	20	$20,900
Interior Lighting	Standard efficiency lighting system that meets the Energy Conservation Construction Code maximums on a space by space basis. 1.00 watts/square foot.	Energy efficient fluorescent, compact fluorescent and incandescent lighting. The total lighting intensity of the building was calculated to be 0.47 watts/square foot.	15	$8,400
A/C Equipment	The baseline system consists of apartment split DX furnaces, with a SEER value of 10.	The proposed apartment split DX furnaces have SEER values of 14 for single story apartments and 17.2 for two story apartments.	15	$10,200

†The New York State Energy Conservation Code of 1999 was the baseline used for the analysis.

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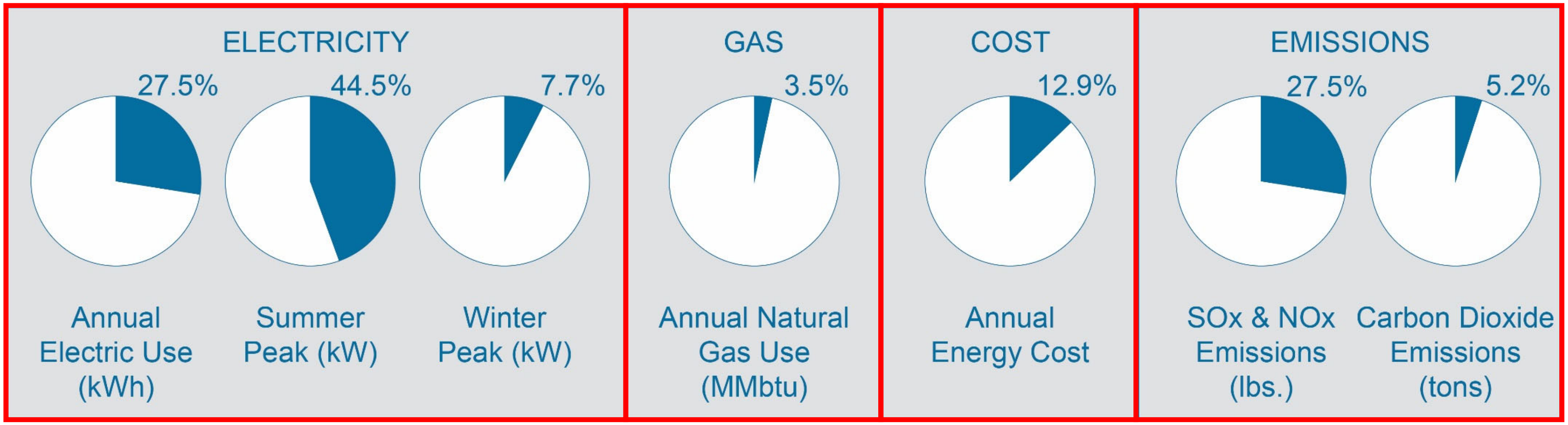
Statewide Energy Use, Demand, Cost, & Emissions Impacts



- Energy Conservation Measures have positive impacts on energy use and cost across the state.
- While each Energy Conservation Measure contributes to enhancing building performance, interior lighting improvements make the biggest difference among each ClimAID Region.

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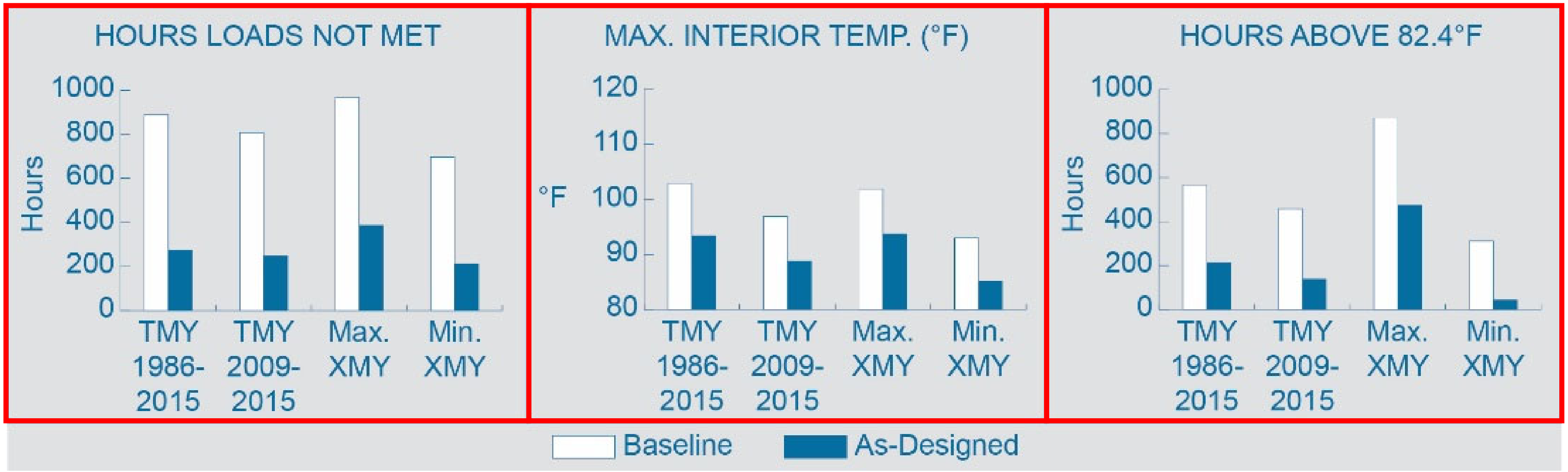
Statewide Climate Resilience Impacts



- All regions showed positive effects in passive survivability from ECMs.
- In every region, there was a greater reduction in the number of hours that the interior temperature exceeded 82.4°F (28°C) between 2009 and 2015 compared to that between 1986 and 2015.

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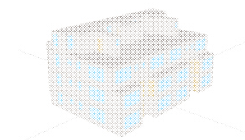
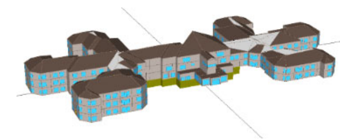
Case Studies

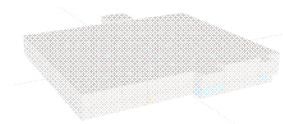
- Low-Rise Residential Building



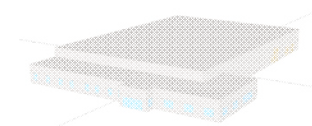
- Multifamily Residential Building



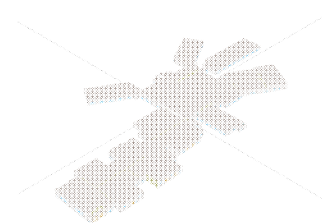
- Commercial Building



- Industrial Building



- Educational Building



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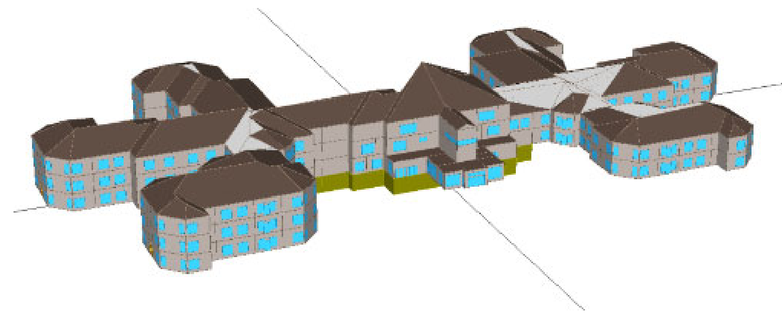
Multifamily Residential Building



- Approximately 705,260 multifamily residential buildings in New York State
- Represent 13.4% of the total number of buildings in the state
- Externally load dominated
- The multifamily residential building energy model was based on a 151,853 square foot in-patient nursing facility in Glenville, New York. The three story building has a steel frame and concrete plank structural system. It functions as both residential, with sleeping, dining, and living areas, and commercial, with common areas and offices.

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Energy Conservation Measures

ECMs	Baseline System Description†	Upgraded System Description	EUL (years)	Cost ($)
High Performance Envelope	R-20 continuous insulation in the roof and R-13 insulation in the walls.	R-40 continuous insulation in the roof and R-26.9 insulation in the walls.	50	$200,900
High Performance Glazing	Glazing with a solar heat gain coefficient of 0.40 and a U-value of 0.55.	Glazing with a solar heat gain coefficient of 0.25 and a U-value of 0.28.	30	$65,800

†The New York State Energy Conservation Code of 1999 was the baseline used for the analysis.

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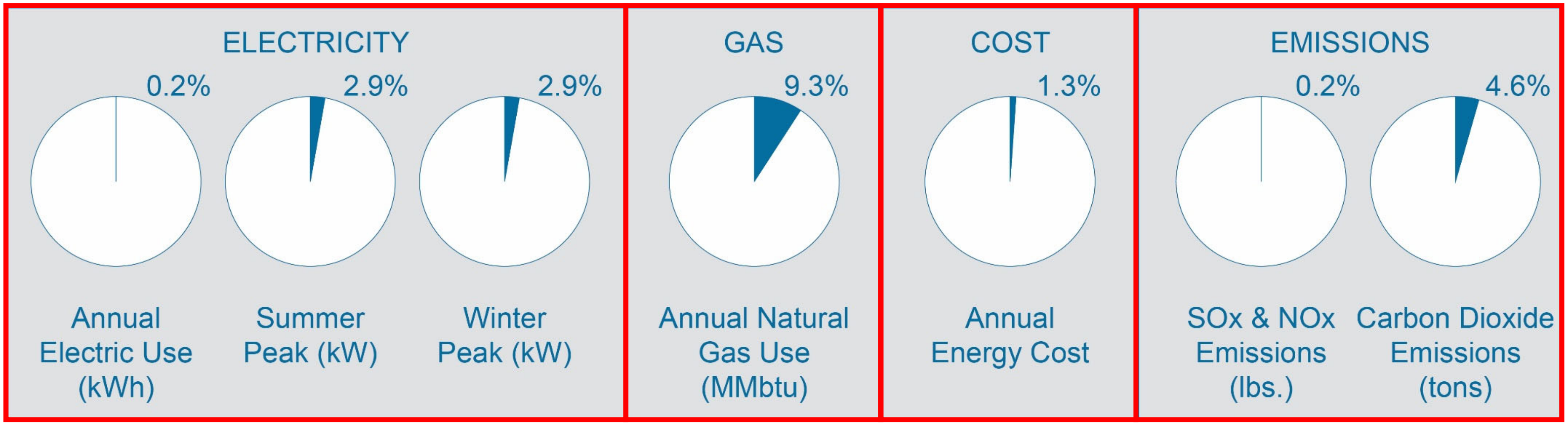
Statewide Energy Use, Demand, Cost, & Emissions Impacts



- Energy Conservation Measures have positive impacts on energy use and cost across the state.
- While each Energy Conservation Measure contributes to enhancing building performance, the addition of high performance glazing made the biggest difference among each ClimAID Region.

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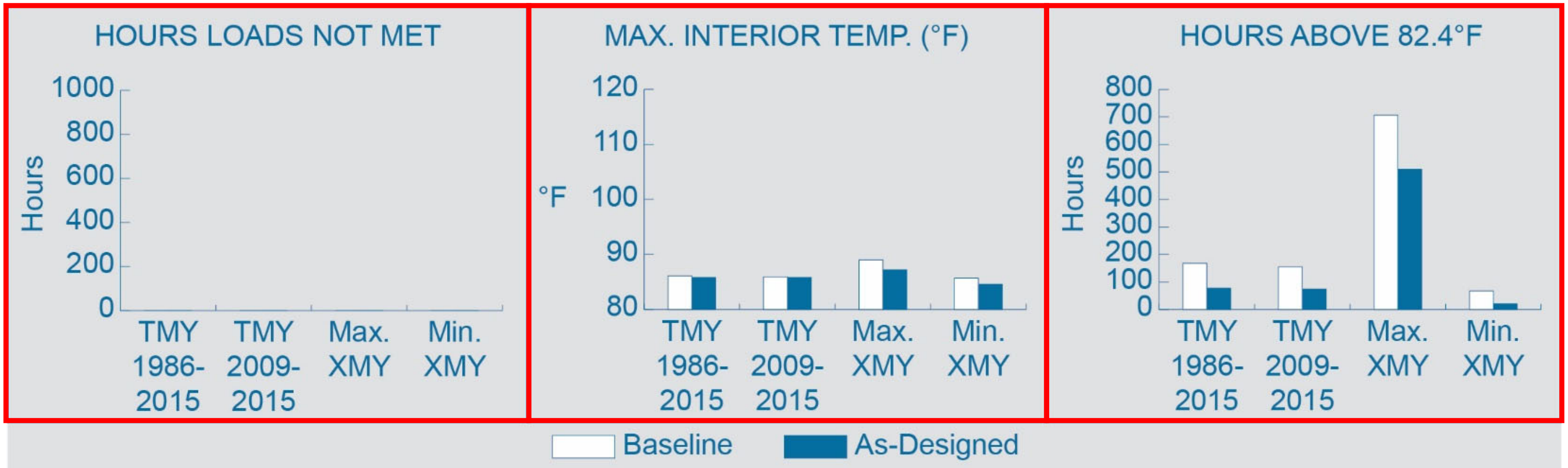
Statewide Climate Resilience Impacts



- All regions showed positive effects in passive survivability from ECMs.
- All regions, except Region 3, saw significant reductions in the number of hours exceeding an interior temperature of 82.4°F, reducing statewide by an average of 43.8%.

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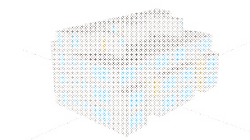
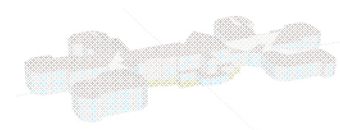
Case Studies

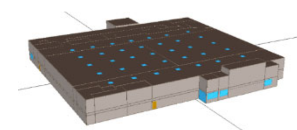
- Low-Rise Residential Building



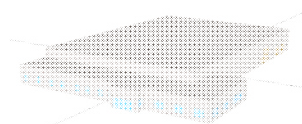
- Multifamily Residential Building



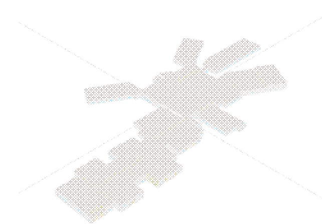
- Commercial Building



- Industrial Building



- Educational Building



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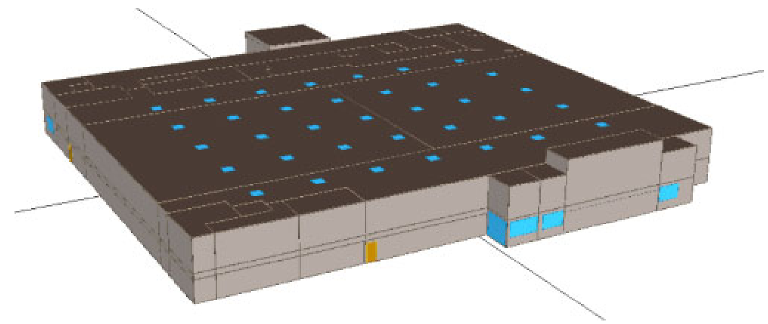
Commercial Building



- Approximately 322,549 commercial buildings in New York State
- Represent 6.11% of the total number of buildings in the state
- Commercial buildings play a crucial role in recovery efforts from climate change and hazards.
- The commercial building energy model was based on a 37,094 square foot supermarket built in Madison, New York in 2009. The single story building uses tilt-up concrete construction for the building shell. The roof consists of a metal frame and a metal deck covered with standard seam roofing.

Gilman, Elizabeth K., Nicholas B. Rajkovich, Thomas J. Mulligan, and Brendan Kelly. 2018. *Modeling the Impacts of Climate Change on Building Energy Performance in New York State*. New York State Energy Research and Development Authority (NYSERDA), Albany, New York.

Energy Conservation Measures

ECMs	Baseline System Description†	Upgraded System Description	EUL (years)	Cost ($)
Above Code Insulation	Steel-framed walls U=0.84, and roofs with insulation entirely above deck U=0.063.	Above code insulation in the exterior walls and roof.	50	$19,600
Daylighting and Lighting Controls	Occupancy sensors in classrooms, conference/meeting rooms, and break rooms. Lighting timers were installed.	Daylighting and lighting controls	30	$5,100
Above Code Glazing	Glazing for all sides has a U-value of 0.57 and a solar heat gain coefficient (SHGC) of 0.49.	Glazing with a U-value of 0.29 and a solar heat gain coefficient (SHGC) of 0.43.	30	$500
Energy Efficient HVAC System	Standard efficiency HVAC system	Energy efficient HVAC system	15	$3,000
Energy Efficient Lighting Design	Standard efficiency lighting fixtures with a LPD of 1.49 w/sf.	High efficiency lighting fixtures with a LPD of 1.09 w/sf.	15	$42,000
Premium Efficiency Motors	Standard efficiency motors	Premium efficiency motors	15	$900

†The New York State Energy Conservation Code of 1999 was the baseline used for the analysis.

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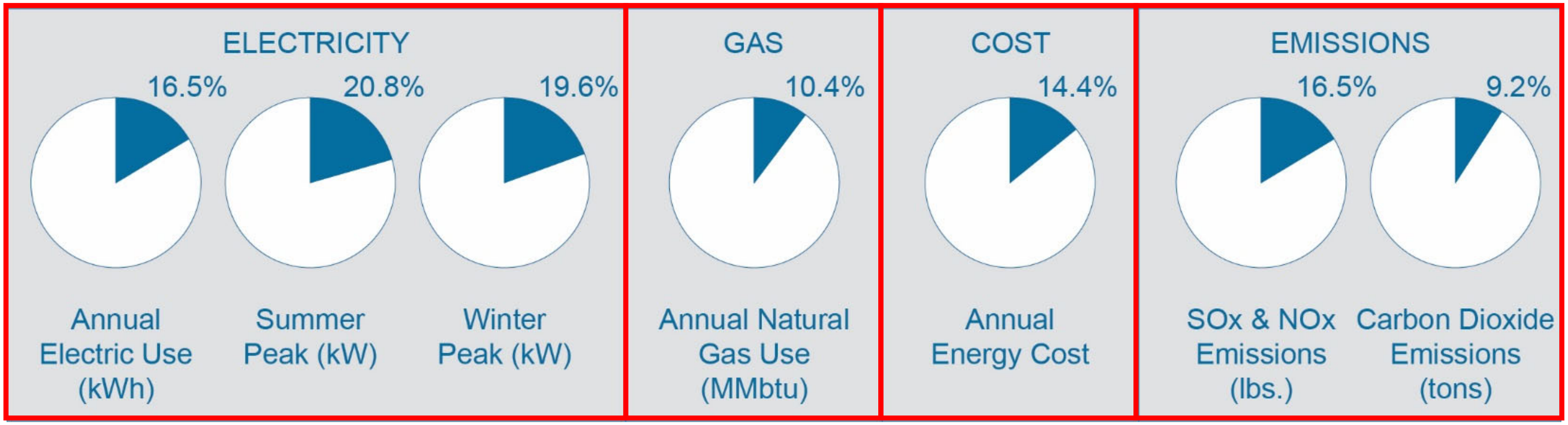
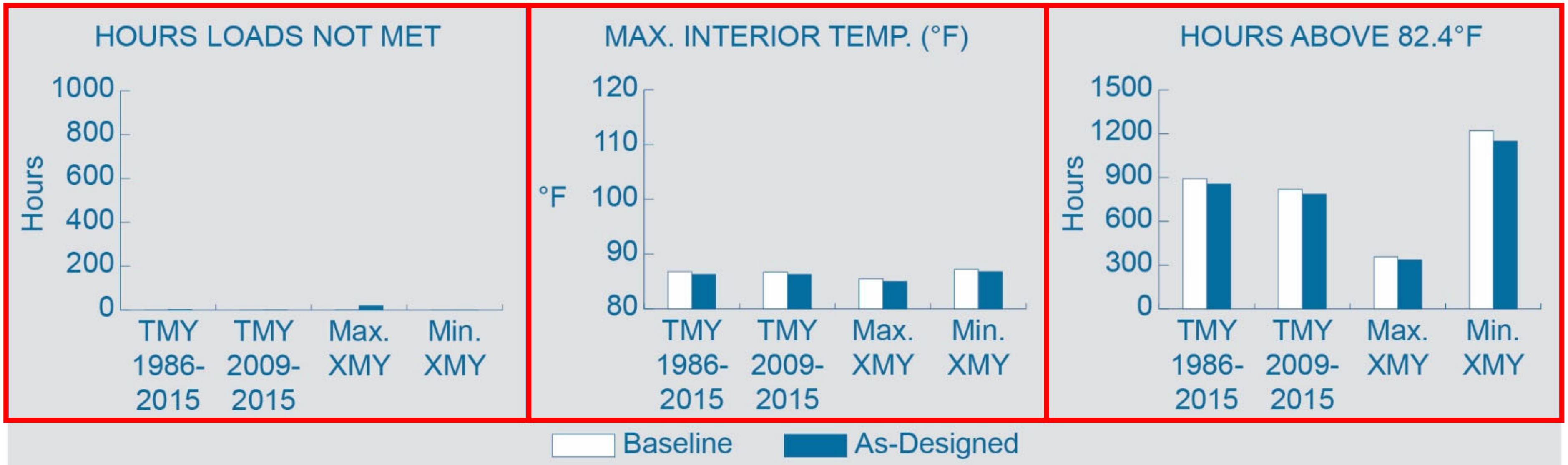
Statewide Energy Use, Demand, Cost, & Emissions Impacts



- Energy Conservation Measures have positive impacts on energy use and cost across the state.
- While each Energy Conservation Measure contributes to enhancing building performance, the addition of an energy efficient lighting design made the biggest difference among each ClimAID Region.

Gilman, Elizabeth K., Nicholas B. Rajkovich, Thomas J. Mulligan, and Brendan Kelly. 2018. *Modeling the Impacts of Climate Change on Building Energy Performance in New York State*. New York State Energy Research and Development Authority (NYSERDA), Albany, New York.

Statewide Climate Resilience Impacts



- All regions showed positive effects in passive survivability from ECMs.
- The number of hours that the interior temperature exceeded 82.4°F decreased statewide by an average of 5.4%. The greatest improvements were seen in the data sets for extreme warm and cold temperatures.

Gilman, Elizabeth K., Nicholas B. Rajkovich, Thomas J. Mulligan, and Brendan Kelly. 2018. *Modeling the Impacts of Climate Change on Building Energy Performance in New York State*. New York State Energy Research and Development Authority (NYSERDA), Albany, New York.

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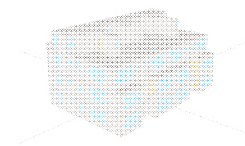
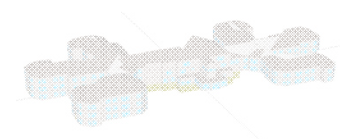
Case Studies

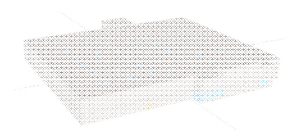
- Low-Rise Residential Building



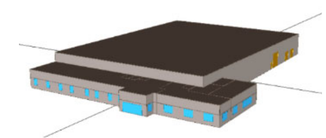
- Multifamily Residential Building



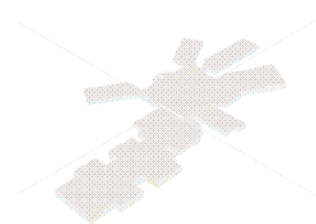
- Commercial Building



- Industrial Building

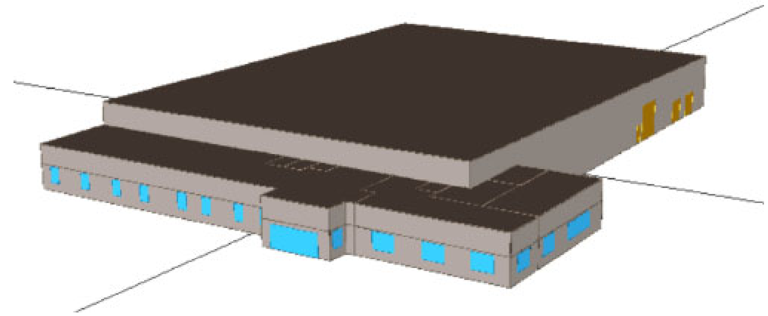


- Educational Building



Gilman, Elizabeth K., Nicholas B. Rajkovich, Thomas J. Mulligan, and Brendan Kelly. 2018. *Modeling the Impacts of Climate Change on Building Energy Performance in New York State*. New York State Energy Research and Development Authority (NYSERDA), Albany, New York.

<u>Industrial Building</u>



- Approximately 90,544 commercial buildings in New York State
- Represent 1.72% of the total number of buildings in the state
- Industrial buildings are a large part of the economy in New York State.
- Improving the energy performance of this building group is critical to increasing the resilience of the building stock.
- The industrial building energy model was based on a single story 36,000 square foot building in Ballston Spa, New York.

Gilman, Elizabeth K., Nicholas B. Rajkovich, Thomas J. Mulligan, and Brendan Kelly. 2018. *Modeling the Impacts of Climate Change on Building Energy Performance in New York State*. New York State Energy Research and Development Authority (NYSERDA), Albany, New York.

Energy Conservation Measures

ECMs	Baseline System Description†	Upgraded System Description	EUL (years)	Cost ($)
Above Code Building Envelope Improvements	R-20 continuous insulation in the roof and R-13 insulation in the walls.	R-30 continuous insulation in the roof and R-31 insulation in the walls.	50	$26,100
Above code Lighting Design	Baseline lighting design uses a total of 56.25 kW.	Improved lighting design uses a total of 29.53 kW.	15	$19,500
HVAC Equipment	Variable Speed Drive of supply fan	Constant speed fans	15	N/A
Occupancy Control of Lighting	Occupancy sensors in classrooms, conference rooms and break rooms per section 9.4.1.2. Controlled wattage = 1.27 kW.	Occupancy sensors in Conference Spc, Women Spc, Men Spc, Server Spc, Shower Spc, Women's Toilet Spc, Men's Toilet Spc. Controlled wattage = 2.96 kW.	15	$2,010
Demand Control of Ventilation	Not required	Static plate, enthalpy	15	N/A
Energy Management and Control	Optimum Start Controls	Optimum Start Controls	15	N/A

†The New York State Energy Conservation Code of 1999 was the baseline used for the analysis.

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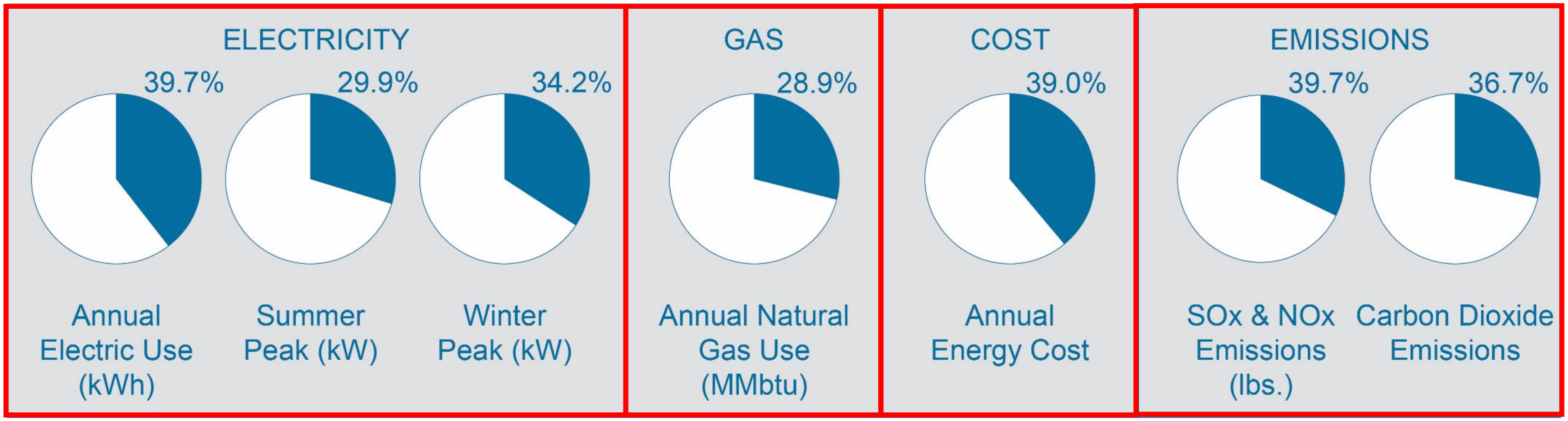
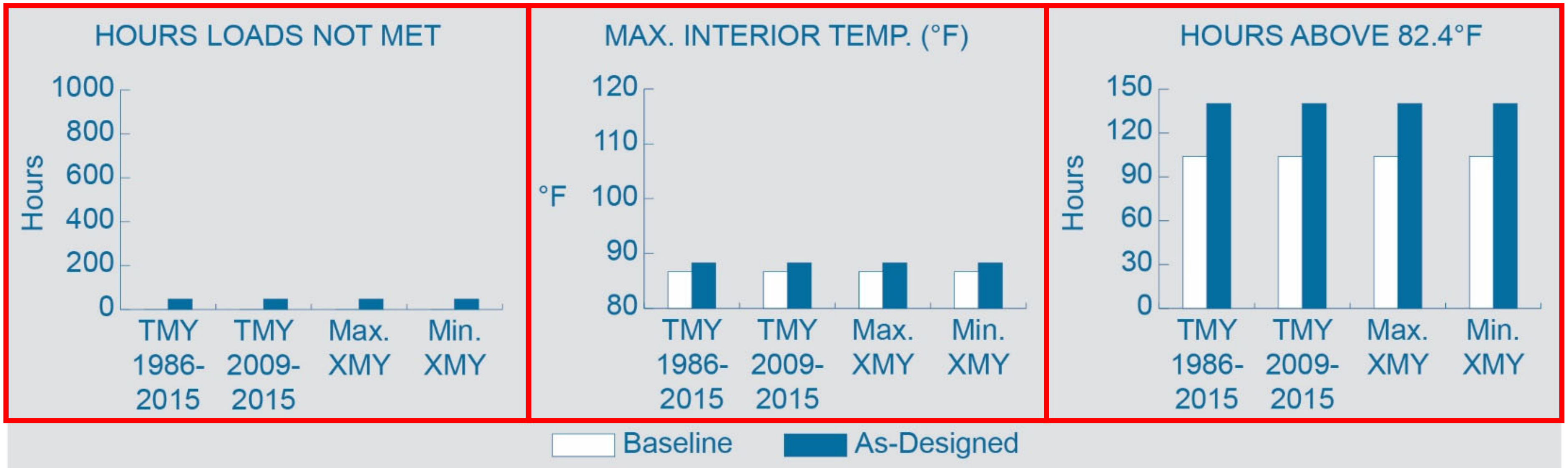
Statewide Energy Use, Demand, Cost, & Emissions Impacts



- Energy Conservation Measures have positive impacts on energy use and cost across the state.
- While each Energy Conservation Measure contributes to enhancing building performance, lighting improvements in uncovered parking areas made the biggest difference among each ClimAID Region.

Gilman, Elizabeth K., Nicholas B. Rajkovich, Thomas J. Mulligan, and Brendan Kelly. 2018. *Modeling the Impacts of Climate Change on Building Energy Performance in New York State*. New York State Energy Research and Development Authority (NYSERDA), Albany, New York.

Statewide Climate Resilience Impacts



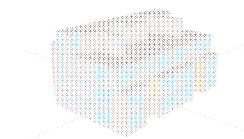
- All regions showed negative effects in passive survivability from ECMs. The maximum interior temperature saw an increase of 1.8%, on average across the state. The number of hours that the interior temperature exceeded 82.4°F increased statewide in all data sets by an average of 34.6%.

Gilman, Elizabeth K., Nicholas B. Rajkovich, Thomas J. Mulligan, and Brendan Kelly. 2018. *Modeling the Impacts of Climate Change on Building Energy Performance in New York State*. New York State Energy Research and Development Authority (NYSERDA), Albany, New York.

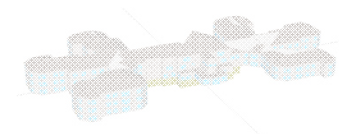
[redacted]

Case Studies

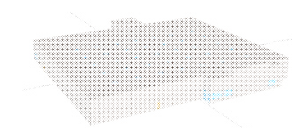
- Low-Rise Residential Building



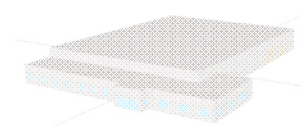
- Multifamily Residential Building



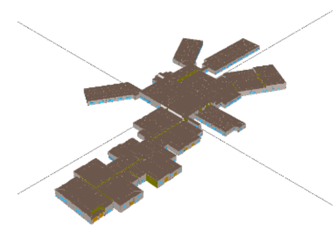
- Commercial Building



- Industrial Building



- Educational Building



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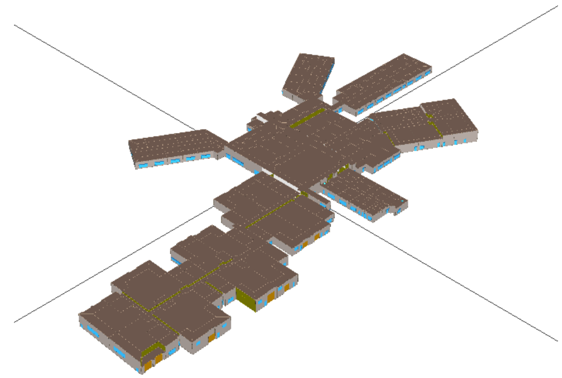
Educational Building



- Approximately 13,944 educational buildings in New York State
- Represent 0.26% of the total number of buildings in the state
- Along with providing communities with spaces for learning, educational buildings often serve as emergency shelters. Because of this, improving the performance of HVAC systems in schools is not only critical to increasing the resiliency of the building stock, but to increasing the resiliency of communities.
- The educational building energy model was based on a 192,000 square foot, single story educational facility built in Auburn, New York in 2007.

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Energy Conservation Measures

ECMs	Baseline System Description†	Upgraded System Description	EUL (years)	Cost ($)
Improved Insulation	Designed to code insulation value for the walls and roof.	Additional insulation in the walls and roof.	50	$34,100
High Efficiency Lighting	A lighting intensity of 0.7 to 2.2 watts per square foot was modeled, depending upon the space type. The baseline lighting averaged 1.38 watts per square foot.	The lighting intensity was calculated using the indoor fixtures as specified in the design drawings. The installed lighting averaged 0.87 watts per square foot.	15	$298,400
VSDs in Pumping Systems	Constant speed on the pumping systems.	Variable speed drivers (VSDs) on pumping systems.	15	$8,300
Lighting Controls	Lighting timers	Occupancy sensors.	15	$16,300
Energy Recovery Units	No energy recovery units.	Energy recovery units.	15	$63,700

†The New York State Energy Conservation Code of 1999 was the baseline used for the analysis.

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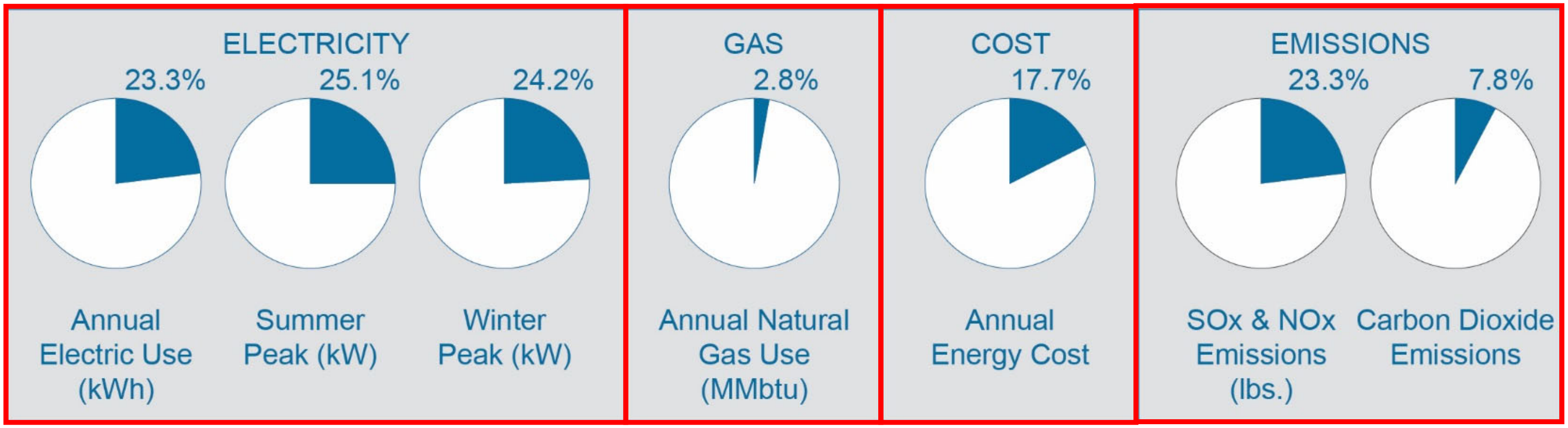
Statewide Energy Use, Demand, Cost, & Emissions Impacts



- Energy Conservation Measures have positive impacts on energy use and cost across the state.
- While each Energy Conservation Measure contributes to enhancing building performance, interior lighting improvements made the biggest difference among each ClimAID Region.

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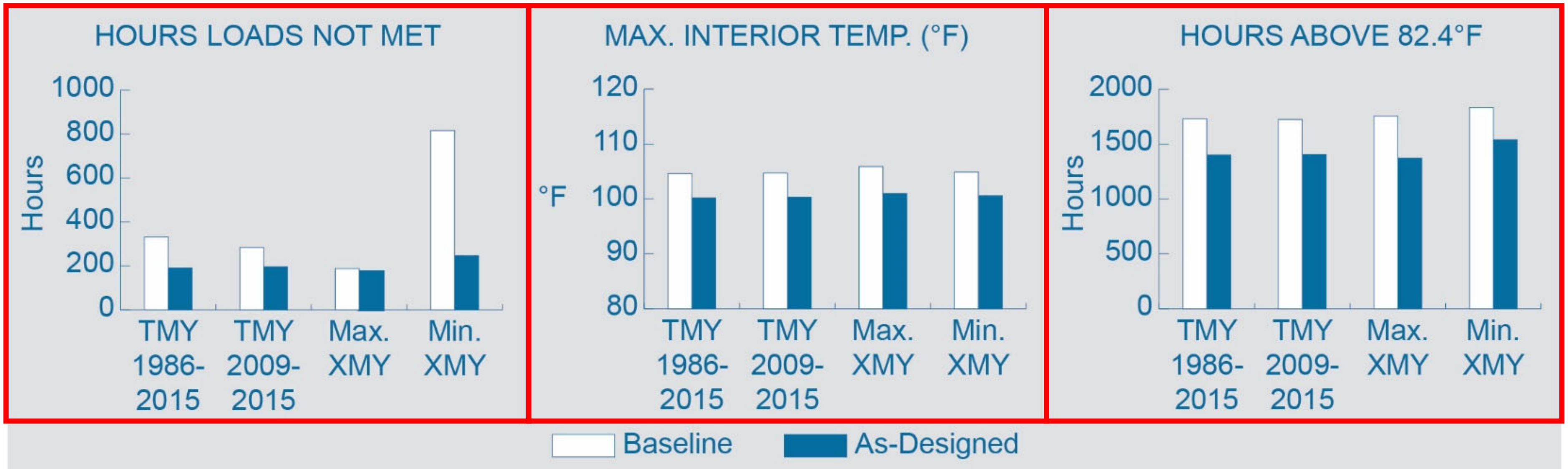
Statewide Climate Resilience Impacts



- All regions showed positive effects in passive survivability from ECMs. The maximum interior temperature saw a reduction of 4.3% on average across the state.
- The number of hours that the interior temperature exceeded 82.4°F were reduced statewide by an average of 18.9%.

Gilman, Elizabeth K., Nicholas B. Rajkovich, Thomas J. Mulligan, and Brendan Kelly. 2018. *Modeling the Impacts of Climate Change on Building Energy Performance in New York State*. New York State Energy Research and Development Authority (NYSERDA), Albany, New York.

[redacted]

Conclusions

- Energy conservation measures and adaptation to climate change can be complementary strategies, though careful attention must be paid to use, occupancy, schedules, etc.
- Improvements to the building envelope can have either positive or negative impacts on exposure to extreme temperatures; ensuring natural ventilation potential is critical for heat waves.
- Better guidance on how to model passive survivability would help design teams; future TMY file development should be part of this process.
- Energy efficiency programs may want to develop new protocols for studies that incorporate health impacts, thermal extremes, and future weather issues.

Future Work

RESILIENCE DOCUMENT	Quality	Air Quality	Seismic Activity	Drought	Wildfires	Pest Infestation	Rising Sea Levels	Flooding	Hurricanes	Severe Storm	Winter Storms	Heatwaves
LEED [Resiliency Pilot Credits]	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉
PEER [Performance Excellence in Electricity Renewal]	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉
RELi [Resilience Action List + Credit Catalog]	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉
ENVISION	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉
B-READY	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉	◉
BRLA [Building Resilience Los Angeles]	◎	◎	●	●	●	○	◎	●	●	●	●	●
ENTERPRISE [Strategies for Multifamily Building Resilience]	○	○	○	○	◎	◎	◎	●	◎	●	●	●
USGBC [Green Building & Climate Resilience]	○	◎	○	●	●	◎	◎	●	●	●	●	●
NIST [Community Resilience Planning Guide]	○	○	●	○	○	○	◎	●	◎	●	●	○
NYSERDA [CC Impacts on New York State's Buildings Sector]	●	●	○	◎	◎	●	●	●	●	●	●	●
BOSTON [Enhancing Resilience in Boston]	○	○	○	○	○	○	●	●	○	○	●	●
NYC [Climate Resiliency Design Guidelines]	○	○	○	○	○	○	●	●	○	○	○	●
FORTIFIED COMMERCIAL [Hail & High wind]	○	○	○	○	○	○	○	○	○	●	●	○
FORTIFIED COMMERCIAL [Hurricane]	○	○	○	○	○	○	○	○	●	○	○	○
FORTIFIED HOME [Hail & High wind]	○	○	○	○	○	○	○	○	○	●	●	○
FORTIFIED HOME [High wind]	○	○	○	○	○	○	○	○	○	●	○	○
FORTIFIED HOME [Hurricanes]	○	○	○	○	○	○	○	○	●	○	○	○
REDi [Resilience-based Earthquake Design Initiative]	○	○	●	○	○	○	○	○	○	○	○	○

MAPS DATA DOCUMENTS

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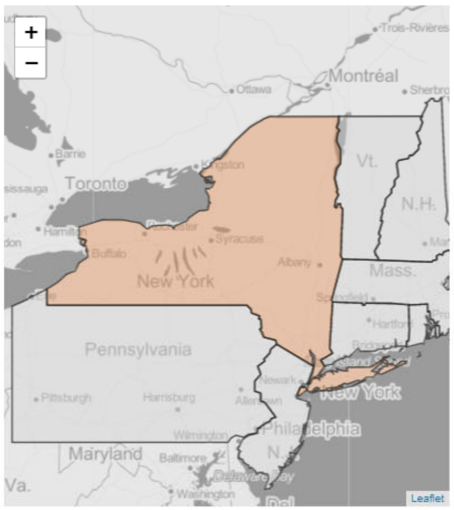
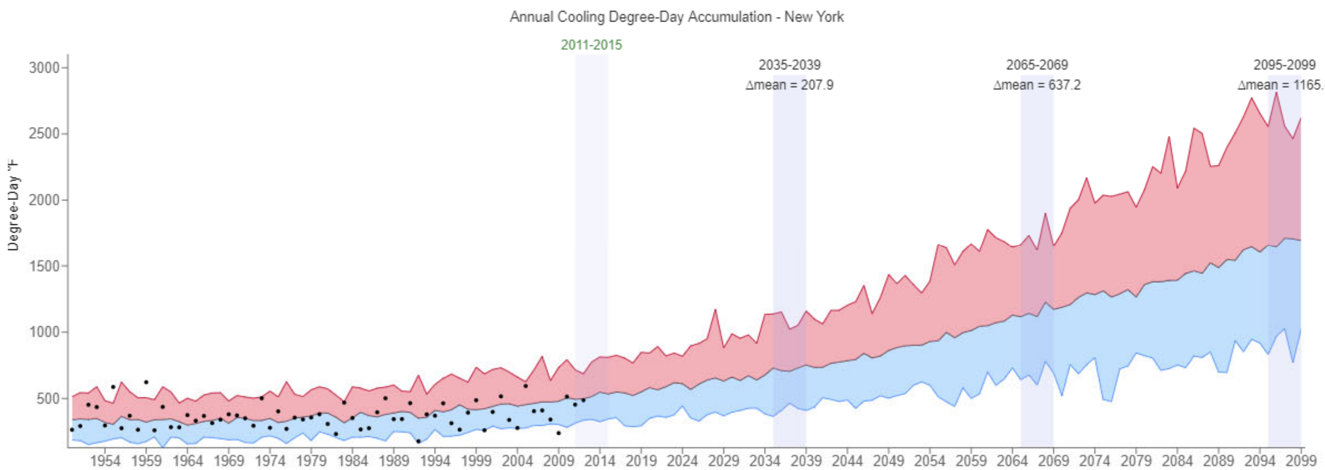
State | New York | Cooling Degree-Day Accumulation | Annual | RCP 4.5 | RCP 8.5





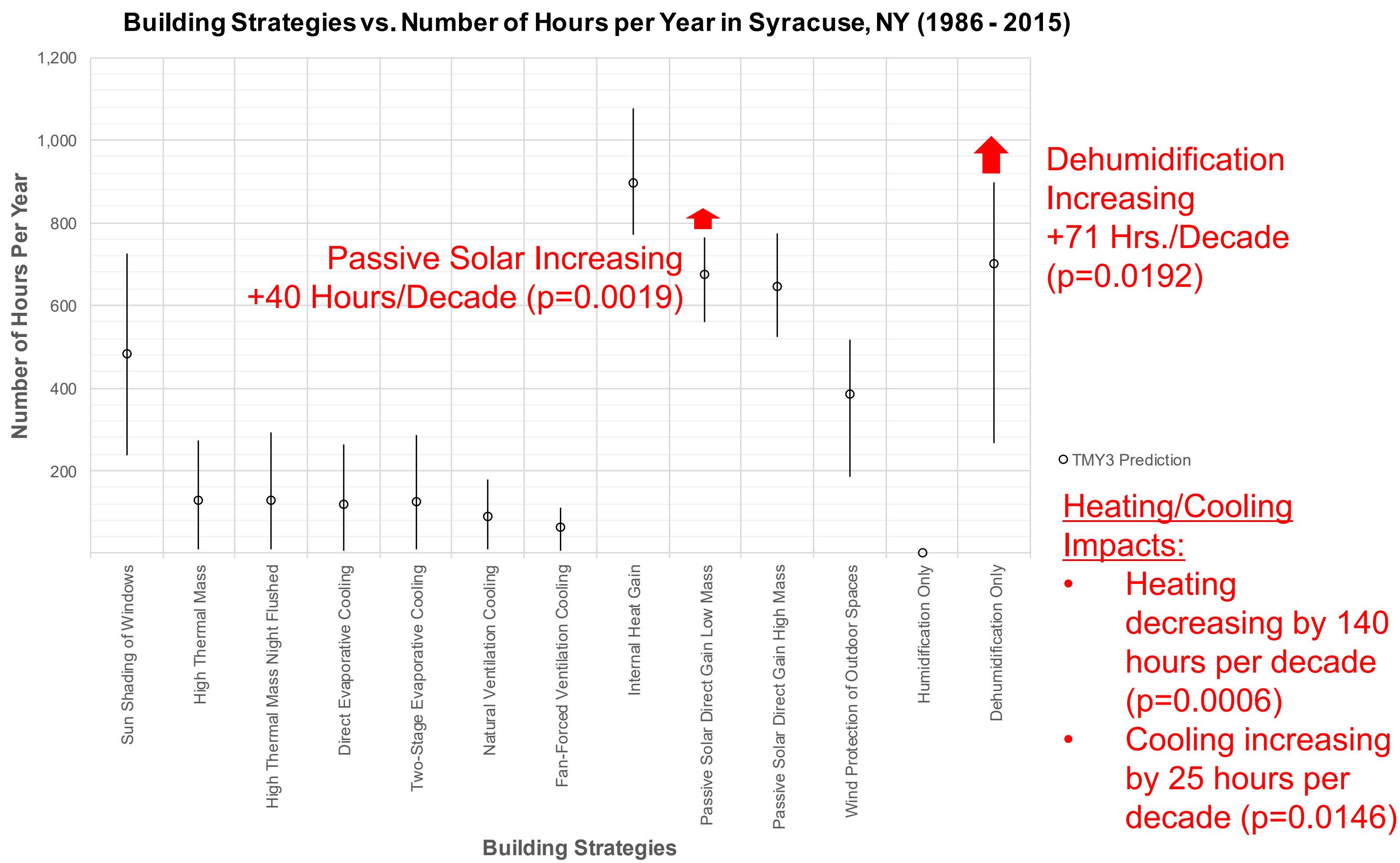
Observed

YEAR	VALUE	MEAN
2015		-
2011-2015	-	

Modeled

YEAR	MIN	MEAN	MAX	Δ min	Δ mean	Δ max
2011-2015	333.4	518.3	760.4	0.0	0.0	0.0
2034-2039	415.5	726.2	1104.7	82.1	207.9	344.3
2064-2069	679.3	1155.5	1713.5	345.9	637.2	953.1
2094-2099	925.3	1683.7	2603.7	591.9	1165.4	1843.3

https://www.nyclimatescience.org/


Building Strategies vs. Number of Hours per Year in Syracuse, NY (1986 - 2015)
Number of Hours Per Year
1,200
1,000
800
600
400
200
Sun Shading of Windows
High Thermal Mass
High Thermal Mass Night Flushed
Direct Evaporative Cooling
Two-Stage Evaporative Cooling
Natural Ventilation Cooling
Fan-Forced Ventilation Cooling
Internal Heat Gain
Passive Solar Direct Gain Low Mass
Passive Solar Direct Gain High Mass
Wind Protection of Outdoor Spaces
Humidification Only
Dehumidification Only
Building Strategies
Passive Solar Increasing
+40 Hours/Decade (p=0.0019)
Dehumidification
Increasing
+71 Hrs./Decade
(p=0.0192)
TMY3 Prediction
Heating/Cooling
Impacts:
• Heating decreasing by 140 hours per decade (p=0.0006)
• Cooling increasing by 25 hours per decade (p=0.0146)

[redacted]

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

U.S. GREEN BUILDING COUNCIL USGBC

NEW YORK UPSTATE

Presentation prepared by:

Nicholas B. Rajkovich, Elizabeth K. Gilman, Hope Forgus, and Thomas J. Mulligan

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Adapting Buildings for a Changing Climate

ap.buffalo.edu/adapting-buildings
ap.buffalo.edu/rajkovich

New York's climate is changing. Are your buildings prepared?

[redacted]