HGA

Climate Adaptation Partnership
UNIVERSITY OF MINNESOTA
Driven to Discover®

Center for Sustainable Building Research
CSBR

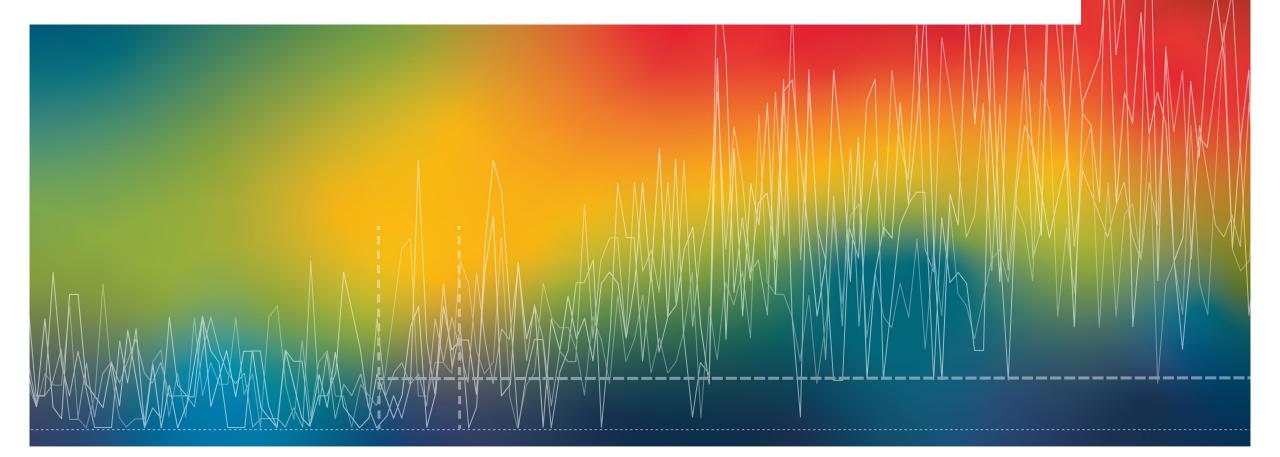# CLIMATE PROJECTIONS
and SB2030

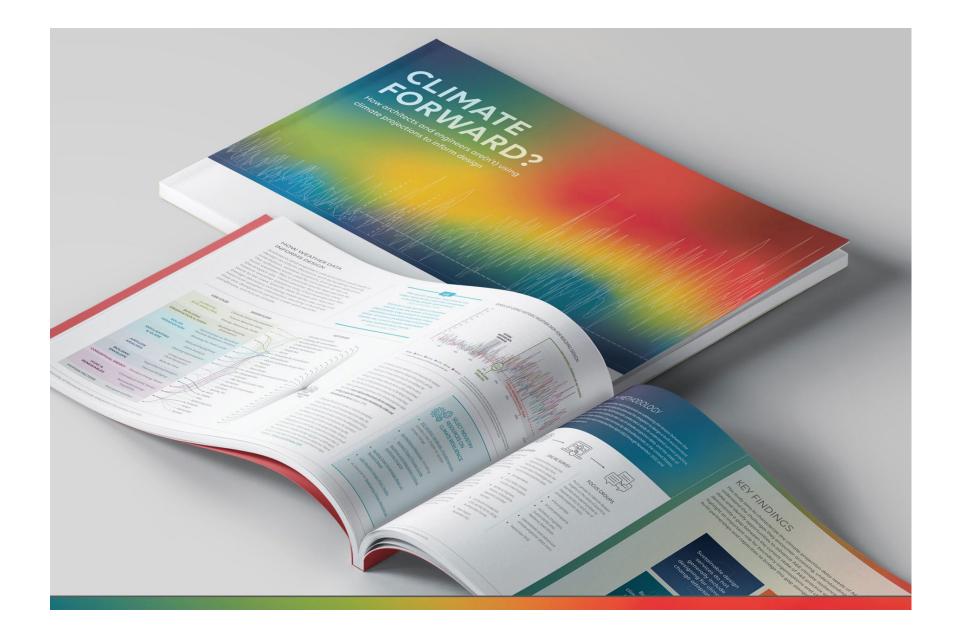# Menti.com
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Presenters

Heidi Roop   University of Minnesota
Climate Adaptation Partnership (MCAP)

Ariane Laxo   HGA

Liz Kutschke   University of Minnesota
Center for Sustainable Building Research

AGENDA

1. CURRENT STATE:
HOW CLIMATE PROJECTION DATA
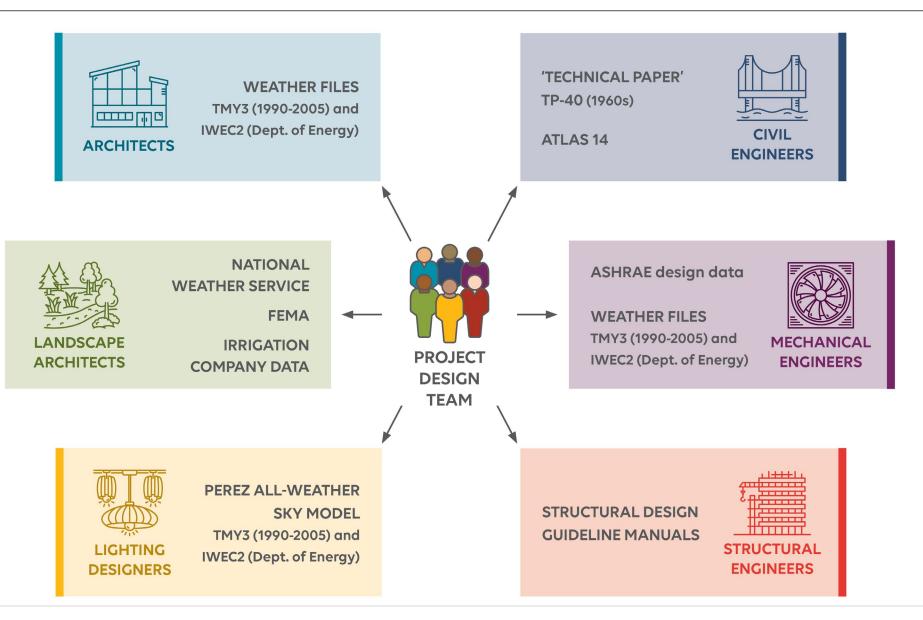IS(N'T) USED IN BUILDING
ARCHITECTURE & ENGINEERING

2. SB2030 & CLIMATE PROJECTION DATA

CURRENT STATE:
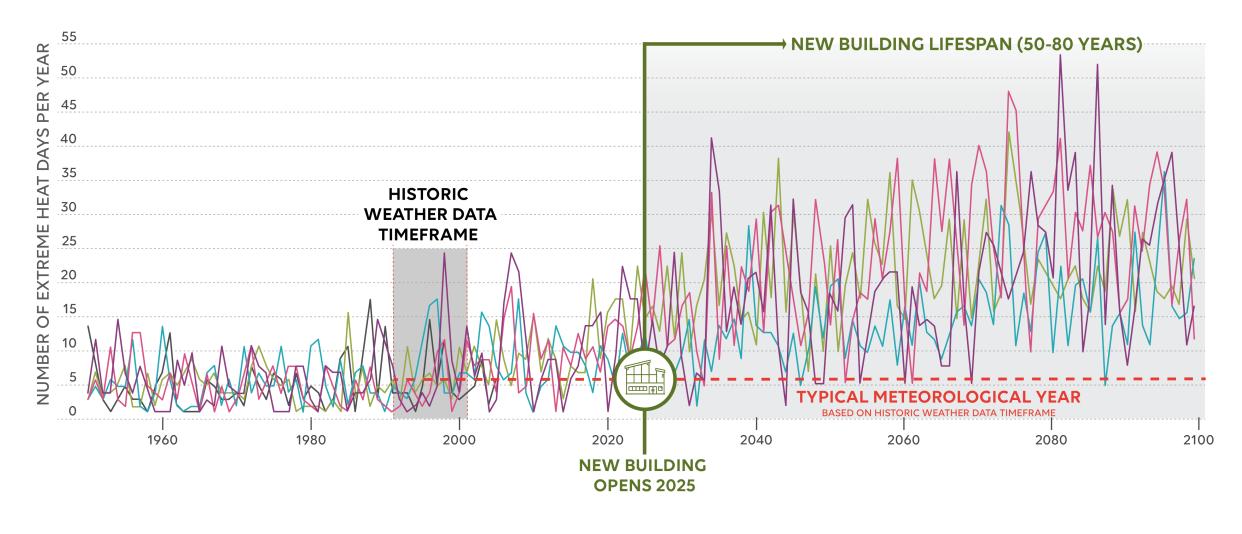# HOW CLIMATE PROJECTION DATA IS(N'T) USED IN BUILDING ARCHITECTURE & ENGINEERING

CLIMATE FORWARD?

How architects and engineers are(n't) using climate projections to inform design

HOW WEATHER DATA INFORMS DESIGN

METHODOLOGY

KEY FINDINGS

USE CASE	WORKFLOW	SOFTWARE

USE CASE

CLIMATE/ SITE ANALYSIS

BUILDING ORIENTATION & FORM

SOLAR IRRADIATION

DAYLIGHTING & GLARE

AIRFLOW ANALYSIS

BUILDING ENVELOPE

CONCEPTUAL ENERGY

HVAC & RENEWABLES

HUMAN FACTORS

WORKFLOW

Climate Data Visualization

Future Weather Data

Energy Sensitivity Study

Building/Massing Orientation

Detrimental vs. Beneficial Facade Radiation Analysis

Shading for Peak Loads

Natural Daylighting

Glare Analysis

Glazing Optimization

Computational Fluid Dynamics

Bulk Air Flow

Hygrothermal Analysis

Thermal Bridging

Shoebox Energy Model

Conceptual HVAC Design

Renewable Energy Feasibility

Occupant Comfort

SOFTWARE

Climate Consultant

LadyBug for Grasshopper

WeatherShift (Arup/Argos Analytics)

CCWorldWeatherGen

Sefaira Architecture

Insight360

IES VE

Honeybee for Grasshopper

ClimateStudio

eQuest Schematic Design Ward

Neotool

ArchSim

Open Studio

Commercial Fenestration (COMFEN)

DesignBuilder

cove.tool

CBE Thermal Comfort Tools

Flometrics

Dragonfly for Grasshopper

CoolVent

Bentley Tas

WUFI

THERM

Flixo

Sefaira Systems

PVWatts

PVSyst

Helioscope

Xendee

WEATHER FILE

WHERE DO A&E PROFESSIONALS GET WEATHER DATA?

ARCHITECTS

WEATHER FILES
TMY3 (1990-2005) and
IWEC2 (Dept. of Energy)

CIVIL ENGINEERS

'TECHNICAL PAPER'
TP-40 (1960s)

ATLAS 14

LANDSCAPE ARCHITECTS

NATIONAL WEATHER SERVICE

FEMA

IRRIGATION COMPANY DATA

PROJECT DESIGN TEAM

MECHANICAL ENGINEERS

ASHRAE design data

WEATHER FILES
TMY3 (1990-2005) and
IWEC2 (Dept. of Energy)

LIGHTING DESIGNERS

PEREZ ALL-WEATHER SKY MODEL
TMY3 (1990-2005) and
IWEC2 (Dept. of Energy)

STRUCTURAL ENGINEERS

STRUCTURAL DESIGN GUIDELINE MANUALS

RISKS OF USING HISTORIC WEATHER DATA FOR BUILDING DESIGN

NUMBER OF EXTREME HEAT DAYS PER YEAR

NEW BUILDING LIFESPAN (50-80 YEARS)

HISTORIC WEATHER DATA TIMEFRAME

NEW BUILDING OPENS 2025

TYPICAL METEOROLOGICAL YEAR
BASED ON HISTORIC WEATHER DATA TIMEFRAME

MODELS: ◼ Observed ━ Warm/Dry ━ Cool/Wet ━ Average ━ Complement

╌╌ Typical meteorological year (TMY) based on historic weather data

Model location: Sacramento, CA with a daily maximum temperature above 103.9 °F and a medium emissions (RCP 4.5) scenario. Source: Cal-Adapt. Data: LOCA Downscaled CMIP5 Climate Projections (Scripps Institution of Oceanography), Gridded Observed Meteorological Data (University of Colorado Boulder), LOCA Derived Products (Geospatial Innovation Facility).

"The words 'weather' and 'climate' are often incorrectly used interchangeably in building design and analysis."
(Rao & Rastogi, 2020)

"Climate is the synthesis of weather events over the whole of a period statistically long enough to establish its statistical ensemble properties (mean value, variation, probabilities of extreme events, etc.) and is largely independent of any instantaneous events."
(Essenwanger, 2001)

RESEARCH METHODOLOGY

LITERATURE REVIEW

- 43 total sources:
  31 peer-reviewed papers
  12 industry sources

- Search terms included: Climate resilience, climate projection data, resilient design, adaptation planning

ONLINE SURVEY

- n = 144

- 27 U.S. States, Canada, and the United Kingdom

- Architects, Engineers, Planners, Sustainability Specialists, and other A&E roles

FOCUS GROUPS

- 4 focus groups, n = 14

- Architects, Engineers, Sustainability and Resiliency Specialists

- Intermediate and advanced climate projection data users

KEY FINDINGS

1 Sustainable design services do not generally include designing for climate change adaptation

2 Few firms are regularly using projections to inform design decisions

3 Barriers to using climate projection data include lack of client requests, data gaps, and lack of expertise

4 Codes, standards, and training are needed

1. SUSTAINABLE DESIGN DOES NOT INCLUDE ADAPTATION

SERVICES OFFERED TO CLIENTS

Respondents could select all services offered by their companies. *n=104*

Service	Count
SUSTAINABLE DESIGN	SELECTED BY **80** RESPONDENTS
THIRD PARTY CERTIFICATIONS	66
BUILDING PERFORMANCE ANALYSIS AND MODELING	65
BUILDING DECARBONIZATION	55
CLIMATE RESILIENCE/ADAPTATION PLANNING/DESIGN	52

SUSTAINABILITY SERVICES	CLIMATE SERVICES
Professional services related to building performance analysis, triple bottom line sustainability, and/or climate change mitigation, typically using historic weather data. *Most often does not factor in the projected climate over the lifespan of the building, landscape, and systems.*	Professional services related to climate change resilience and/or adaptation using climate projection data, factoring in the projected climate over the lifespan of the building, landscape, and systems.

<table>
<tr><td>

- Sustainability planning

- Third-party certifications (ex: LEED, WELL)

- Passive Strategies

- Energy modeling

- Carbon neutral planning

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- Climate vulnerability assessment

- Climate risk assessment

- Climate resilience or adaptation planning

- Infrastructure resilience

- Stress testing the design against climate projections

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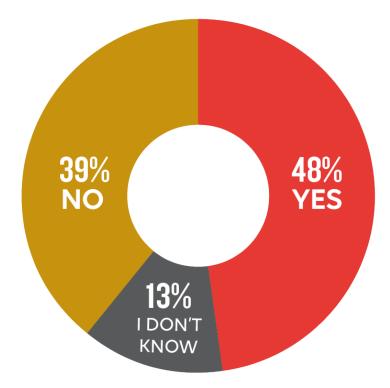# 1. SUSTAINABLE DESIGN DOES NOT INCLUDE ADAPTATION

> ...we're running energy models on every project using historic weather data. So we're making decisions...energy efficiency measurements, based on data that could be wrong.

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2. FEW FIRMS USE CLIMATE PROJECTIONS TO INFORM DESIGN

DOES YOUR ORGANIZATION USE CLIMATE PROJECTION DATA/INFORMATION IN ANY OF ITS WORK/SERVICES? *n=106*

48% YES

39% NO

13% I DON'T KNOW

2. FEW FIRMS USE CLIMATE PROJECTIONS TO INFORM DESIGN

WHAT IS YOUR PERSONAL FAMILIARITY WITH CLIMATE PROJECTION DATA/INFORMATION?

n=106

Not familiar — 7%

I have heard of these but don't know much — 17%

I use climate projections to inform design or planning decisions — 34%

I am familiar with global climate models and projections but do not use them — 21%

I am familiar with regional or local downscaled projections but do not use them — 21%

2. FEW FIRMS USE CLIMATE PROJECTIONS TO INFORM DESIGN
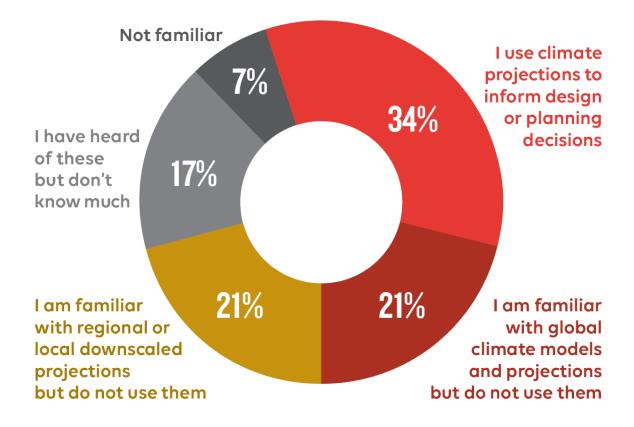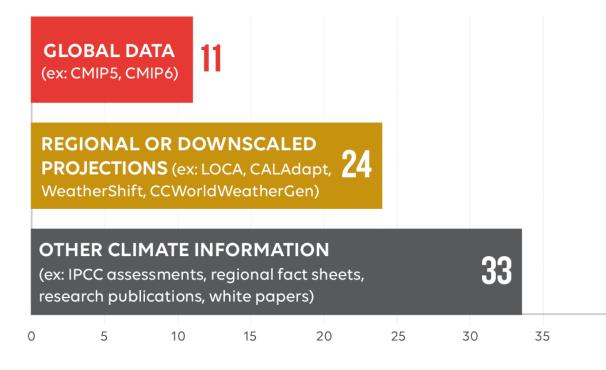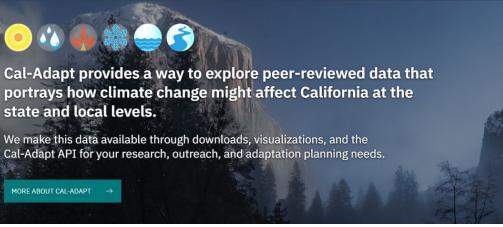
FIGURE 3

WHAT TYPE(S) OF CLIMATE PROJECTION DATA ARE USED?

n=44

GLOBAL DATA (ex: CMIP5, CMIP6) — 11

REGIONAL OR DOWNSCALED PROJECTIONS (ex: LOCA, CALAdapt, WeatherShift, CCWorldWeatherGen) — 24

OTHER CLIMATE INFORMATION (ex: IPCC assessments, regional fact sheets, research publications, white papers) — 33

0 5 10 15 20 25 30 35 40

Cal-Adapt provides a way to explore peer-reviewed data that portrays how climate change might affect California at the state and local levels.

We make this data available through downloads, visualizations, and the Cal-Adapt API for your research, outreach, and adaptation planning needs.

MORE ABOUT CAL-ADAPT →

2. FEW FIRMS USE CLIMATE PROJECTIONS TO INFORM DESIGN

FIGURE 4

HOW ARE CLIMATE PROJECTION DATA BEING USED?

n=44

INFORM CONVERSATIONS WITH CLIENTS about hazards, impacts, and/or risks — **33**

INFORM CLIMATE RISK ASSESSMENTS — **33**

INFORM SITE/BUILDING DESIGN STRATEGIES — **33**

SYSTEM SIZING — **27**

INPUT INTO SUST. ANALYSIS TOOLS — **24**

INPUT INTO ENERGY MODEL — **23**

[We use climate projection data] just to understand...what...changes in heating and cooling loads that we're looking at here...like order of magnitude...understanding that there are high error bars still on a lot of these projections...

KEY FINDINGS

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4 Codes, standards, and training are needed

3. BARRIERS TO USING CLIMATE PROJECTION DATA

BARRIERS TO USING CLIMATE PROJECTION DATA

Respondents could select up to three.

n=87

|	
Our clients aren't asking for climate projection data	**23.5**%
Don't know what products/services are available	**10.3**%
We would need to hire an individual or team to have capacity for these services	**10.3**%
Liability concerns with using climate projection data to inform design decisions	**9.4**%
Data are not in the format(s) used by building analysis/design tools	**8.5**%
Interpreting the output of these products/services (ex: what the data means for design) requires special knowledge that we do not have	**7.9**%
Aware of these products/services, but don't know how to use them	**7.5**%
Using climate projection data/ information is not part of the standard of care	**6.6**%
Other	**8.5**%
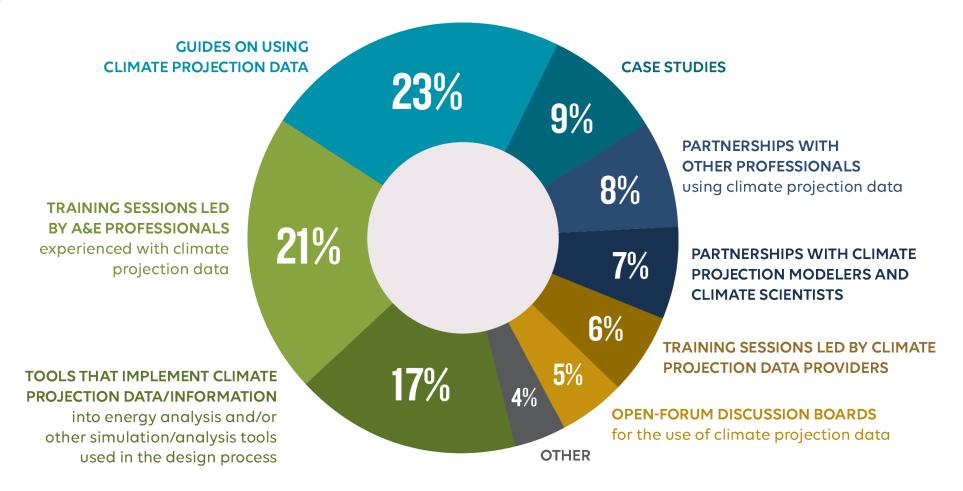
KEY FINDINGS

Sustainable design services do not generally include designing for climate change adaptation

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4. CODES, STANDARDS, AND TRAINING ARE NEEDED

RESOURCES NEEDED TO GROW CLIMATE ADAPTATION EXPERTISE AND SERVICES IN A&E PRACTICE

n=85

GUIDES ON USING CLIMATE PROJECTION DATA — 23%

CASE STUDIES — 9%

PARTNERSHIPS WITH OTHER PROFESSIONALS using climate projection data — 8%

PARTNERSHIPS WITH CLIMATE PROJECTION MODELERS AND CLIMATE SCIENTISTS — 7%

TRAINING SESSIONS LED BY CLIMATE PROJECTION DATA PROVIDERS — 6%

OPEN-FORUM DISCUSSION BOARDS for the use of climate projection data — 5%

OTHER — 4%

TOOLS THAT IMPLEMENT CLIMATE PROJECTION DATA/INFORMATION into energy analysis and/or other simulation/analysis tools used in the design process — 17%

TRAINING SESSIONS LED BY A&E PROFESSIONALS experienced with climate projection data — 21%

SB2030 &
CLIMATE PROJECTION DATA

FUTURE-LOOKING WEATHER FILE CREATION

Current practice uses TMY files which are out of date, based on a limited number of years, and provide annual averages consistent with the long term (past) averages – typical conditions rather than extreme

Our group is testing a new methodology for creating both historic and future weather files to be used when considering resilient design practices and the future of buildings as the climate continues to change
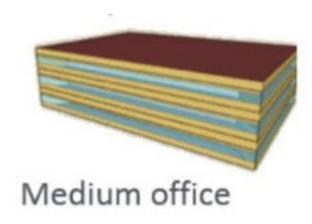
TYPICAL HISTORICAL YEAR FILE
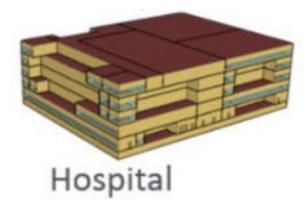
- A TMY-style file assembled from monthly historic data that shows the smallest deviation from historic means for data points listed

- Months selected range from 1995-2013

- TMY3 file will be developed based on existing method

- Typical historic year file will be tested against historic simulations and existing TMY3 file for MSP airport, bias correction will be applied as needed

DATA POINTS
Dry Bulb Temperature
Dew Point Temperature
Relative Humidity
Atmospheric Pressure
Horizontal Infrared Radiation Intensity from Sky
Direct Normal Radiation
Diffuse Horizontal Radiation
Wind Direction
Wind Speed
Present Weather Observation
Present Weather Codes
Snow Depth
Liquid Precipitation Depth

FUTURE REPRESENTATIVE FILES AND PROTOTYPE TESTING

- Fine-scaled global climate projections will be applied to the historic file to create a highly localized future representative file that can be used in energy simulation

- At least two building types will be simulated with historic and future representative files to assess how buildings may perform in the future and what considerations for resilience can and should be made now
  - Medium sized office building, representing externally load driven buildings
  - Large hospital building, representing internally load driven buildings

- Multiple versions of each building will be tested to test how strategies employed for energy efficiency may impact the resilient outcomes of buildings
  - Code baseline
  - Optimized envelope design
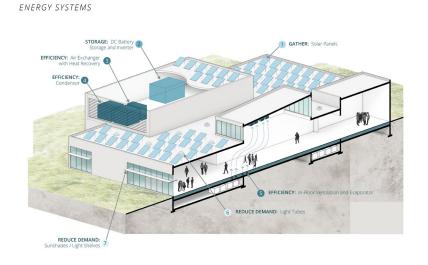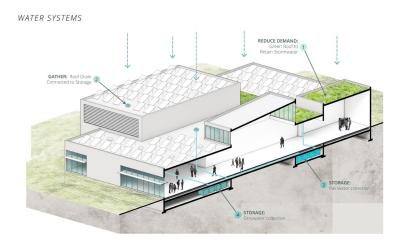 - Optimized mechanical design
  - High performance

Medium office

Hospital

DOE Commercial Prototype Buildings, NREL

FUTURE REPRESENTATIVE FILES AND SB2030

- Goal to create future representative files for all regions of the state that will be integrated into the SB 2030 Energy Standard Tool for project team use to:

  - Set resilience goal(s)

  - Identify resilience measures to support the goal(s)

  - Test building performance in representative future conditions

  - Test impact of strategies for energy efficiency on resilience goals

  - Test impact of strategies for resilience on energy efficiency

- Certain building types and uses may have prescriptive requirements based on modeling study

ENERGY SYSTEMS

WATER SYSTEMS

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