



**BUILDING
INNOVATION** 2018

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Focus of resilience within Building Rating Systems (BRS) LEED 4.0 Review

Sandeep Langar, Ph. D., LEED AP

and

Suchismita Bhattacharjee, Ph. D., Green Assoc.



**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

National Institute of Building Sciences

Provider Number: G168

Session TU2A: Are We Resilient and Sustainable? Evaluation to Make the Case

Date

January 9, 2018





**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

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.

This course is registered with **AIA CES** for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

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





**BUILDING
INNOVATION** 2018

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Course Description

Green Building Rating Systems (BRS) such as LEED aim to alleviate the impacts of the built environment on the ecosystem. At the same time, the effects of the altering climate and recent natural disasters on the built environment, including green buildings, cannot be ignored. The presenter will discuss the goal of a study to ascertain the focus of resilience within the LEED rating system to natural hazards. For the study, the team initially identified 27 disaster types, and of those, shortlisted 14 disaster types. Two filters used to shortlist initially identified disasters: disaster type being natural, and relevance of disaster types to the built environment. The 14 shortlisted disasters were: drought, earthquake, extreme temperatures, fire, flooding, hurricane, severe storm, snow storm, straight-line winds, tornadoes, tsunami, typhoon and winter storm. After shortlisting the disasters, the team used LEED NC V4.0 as a baseline document to analyze how credit requirements within LEED V4.0 enhance building resilience towards the identified disasters. After completing the mapping for each LEED credit to the disasters, the team subjected the results of the mapping to expert reviews. The researchers were also able to identify gaps within the BRS.





**BUILDING
INNOVATION** 2018

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Overview

- Research Purpose
- Background
- Research Question
- Methodology
- Results
- Conclusion



**BUILDING
INNOVATION** 2018

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Purpose of Research

For LEED V4.0

- Ascertain the focus LEED V4.0, at a generalized level, towards enhancing building resilience against identified natural disasters
- Identify credits/prerequisites that enhance building resilience against identified natural disasters



BUILDING INNOVATION 2018

National Institute of BUILDING SCIENCES

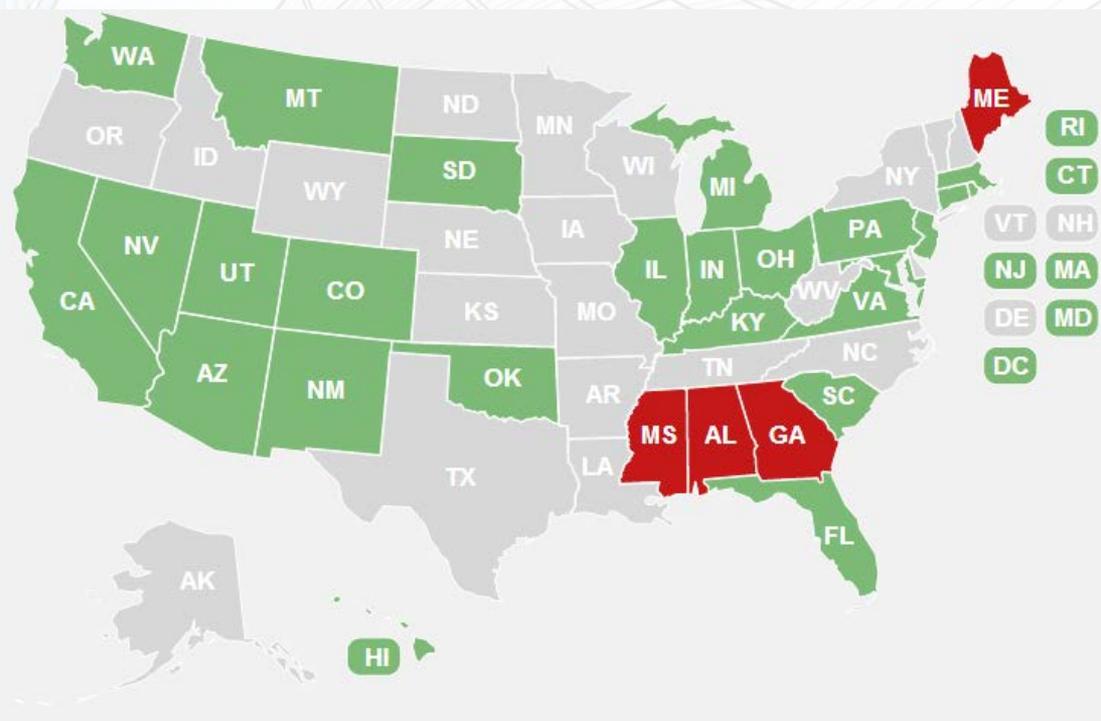
CONFERENCE & EXPO

Background

- Agencies/Cities encouraging/ mandating LEED

Certification:

- GSA
- Phoenix, AZ
- Sacramento, CA
- San Diego, CA
- San Jose, CA
- Denver, CO
- Stamford, CO
- San Francisco, CA



<https://www.gsa.gov/node/78234>; <http://constructiondatacompany.com/map-of-states-with-leed-certification-requirements/#!prettyPhoto>

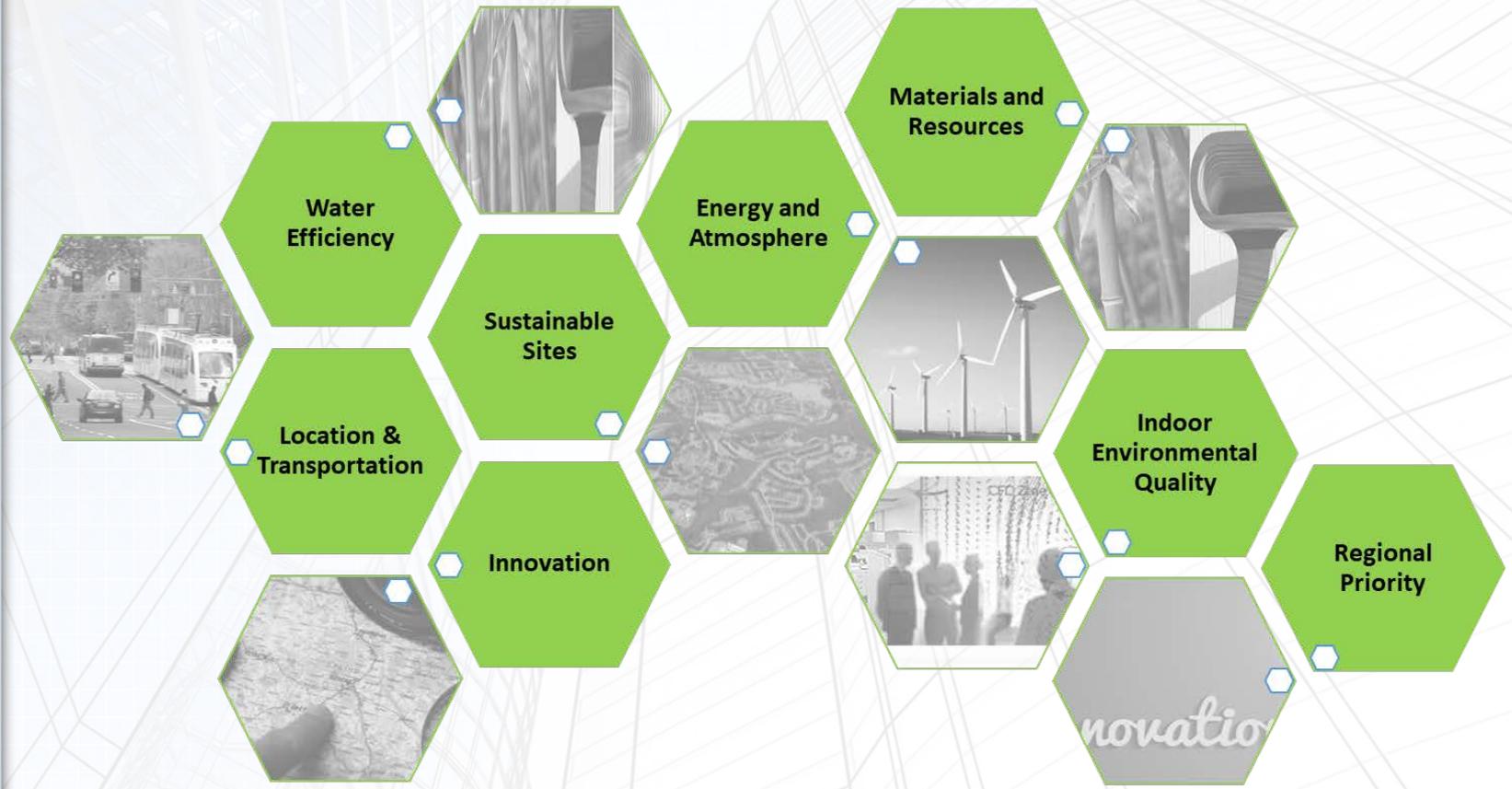


Background- LEED V4.0

BUILDING INNOVATION 2018

National Institute of BUILDING SCIENCES

CONFERENCE & EXPO





**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Climate change impact

- IPCC indicates that change in global climate is resulting in elevated temperatures:
 - Rising sea level
 - Heavier precipitation & storms
 - Tornadoes
 - Hurricanes
 - Cyclones
 - Additional heatwaves
 - Extreme temperatures

(Younger et al., 2008)



BUILDING INNOVATION 2018

National Institute of BUILDING SCIENCES

CONFERENCE & EXPO

Climate change impact

- NOAA'S National Climatic Data Center indicates climate events resulted in a loss of at least \$1 billion in overall damages (Lott & Ross, 2015)

- Between 1995 and 2014:
 - 15,000 extreme weather events
 - 525,000 Casualties
 - 3.0 Trillion USD losses





**BUILDING
INNOVATION** 2018

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Natural Disaster Impact 2016

- For 2016, severe weather impacted 27 states, resulting in a loss of 27 Billion US
- Residential structures incurred a loss of 4 Billion USD, in Louisiana
- Damages worth \$1.5 Billion USD to facilities across North Carolina



(Source: NOAA 2016; Terrell 2016; CBS 2016)



BUILDING INNOVATION 2018

National Institute of BUILDING SCIENCES

CONFERENCE & EXPO

Natural Disasters- 2017

U.S. 2017 Billion-Dollar Weather and Climate Disasters



This map denotes the approximate location for each of the 15 billion-dollar weather and climate disasters that have impacted the United States January through September of 2017, a record pace.

(Source: <https://www.ncdc.noaa.gov/billions/>)



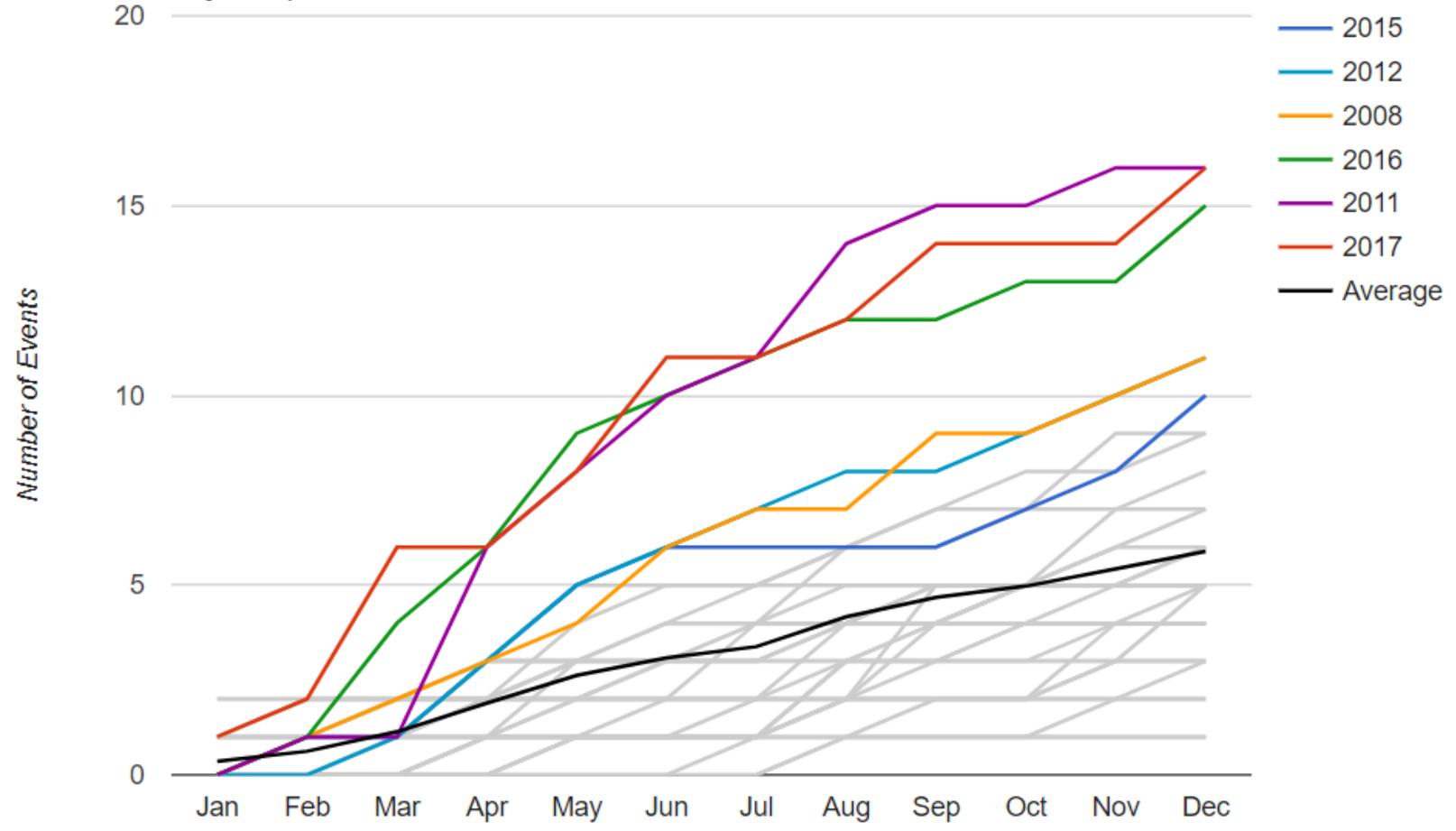
BUILDING INNOVATION 2018

National Institute of BUILDING SCIENCES

CONFERENCE & EXPO

Frequency of natural disasters

1980-2017 Year-to-Date United States Billion-Dollar Disaster Event Frequency (CPI-Adjusted)



(Source: <https://www.ncdc.noaa.gov/billions/>)



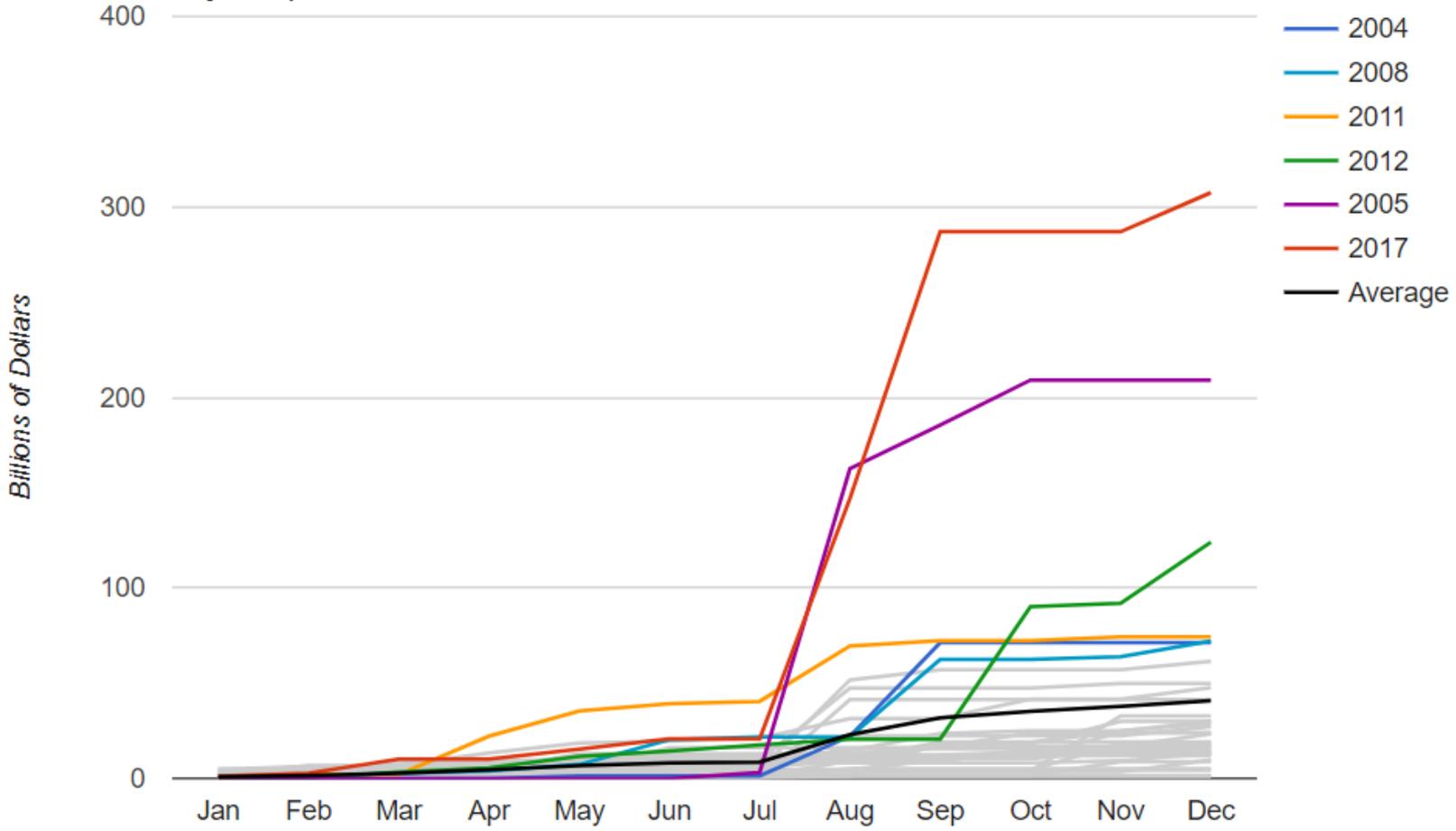
BUILDING INNOVATION 2018

National Institute of BUILDING SCIENCES

CONFERENCE & EXPO

Cost of natural disasters

1980-2017 Year-to-Date United States Billion-Dollar Disaster Event Cost (CPI-Adjusted)



(Source: <https://www.ncdc.noaa.gov/billions/>)

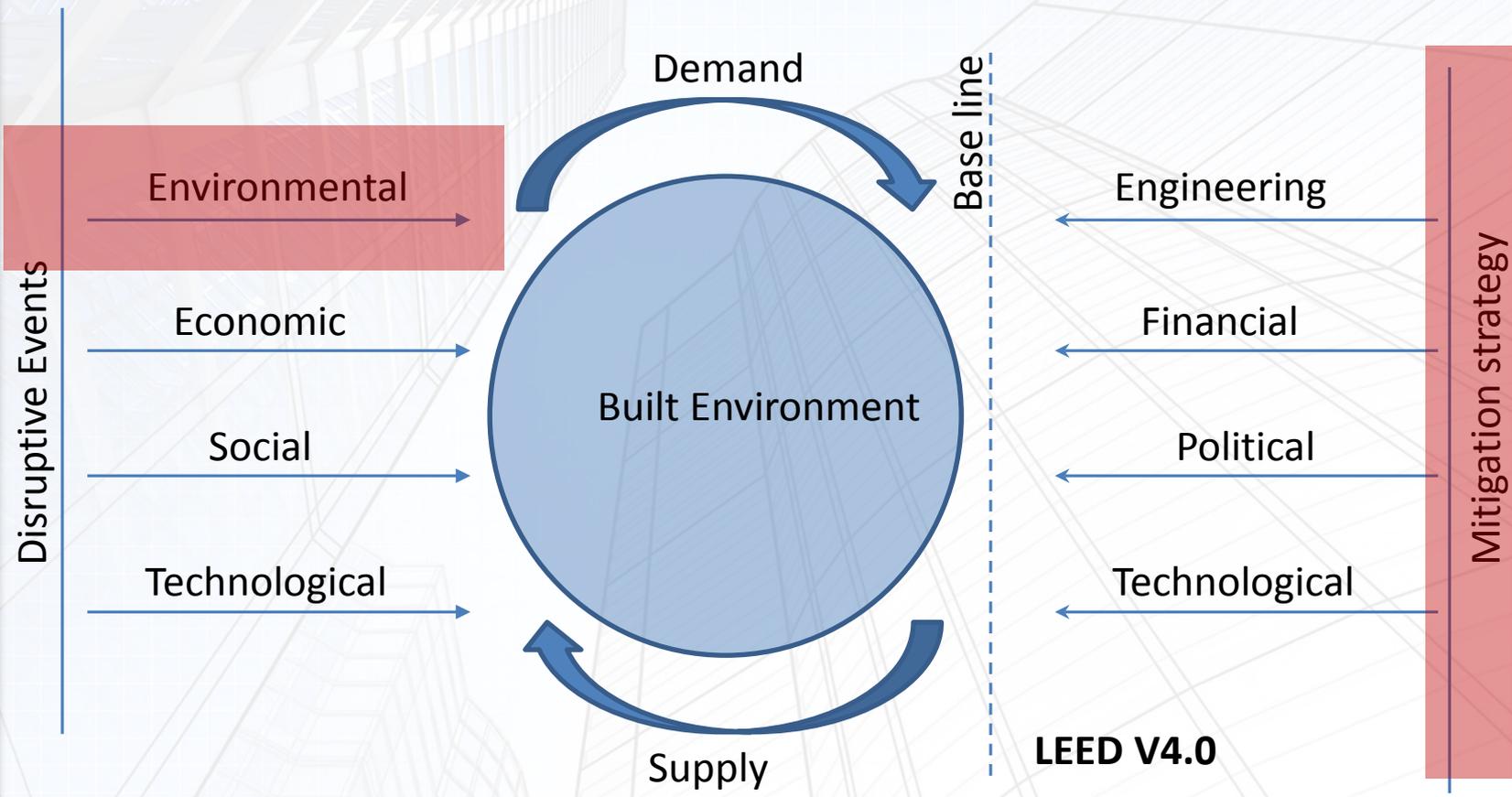


BUILDING INNOVATION 2018

National Institute of BUILDING SCIENCES

CONFERENCE & EXPO

Resilience in Built Environment



(Source Zhao et al. 2015)



BUILDING INNOVATION 2018

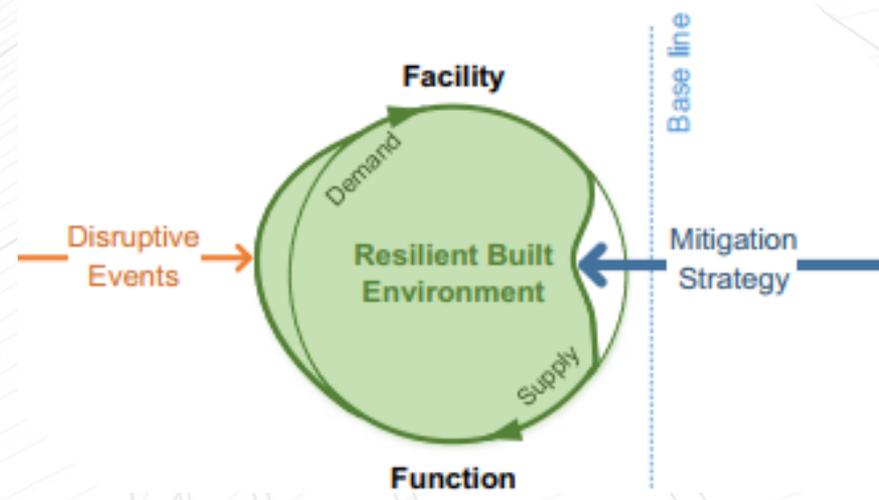
National Institute of BUILDING SCIENCES

CONFERENCE & EXPO

Resilience in Built Environment



Scenario 1: Non-resilient



Scenario 2: Over performance

(Source Zhao et al. 2015)

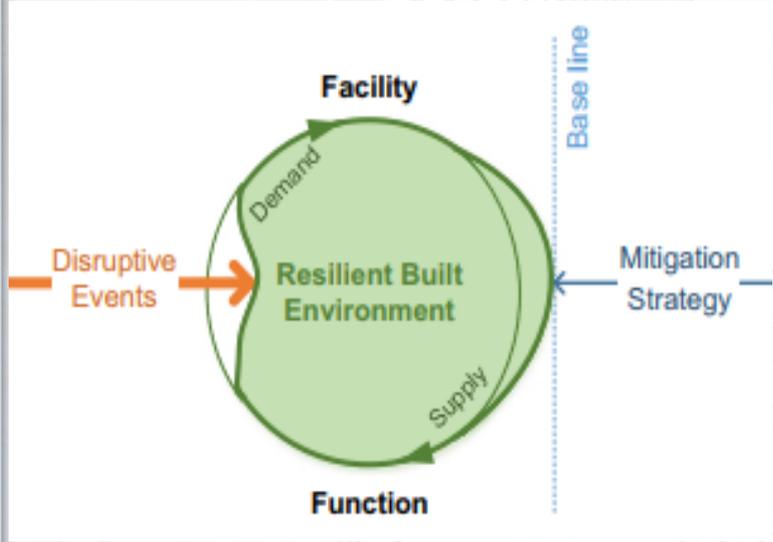


BUILDING INNOVATION 2018

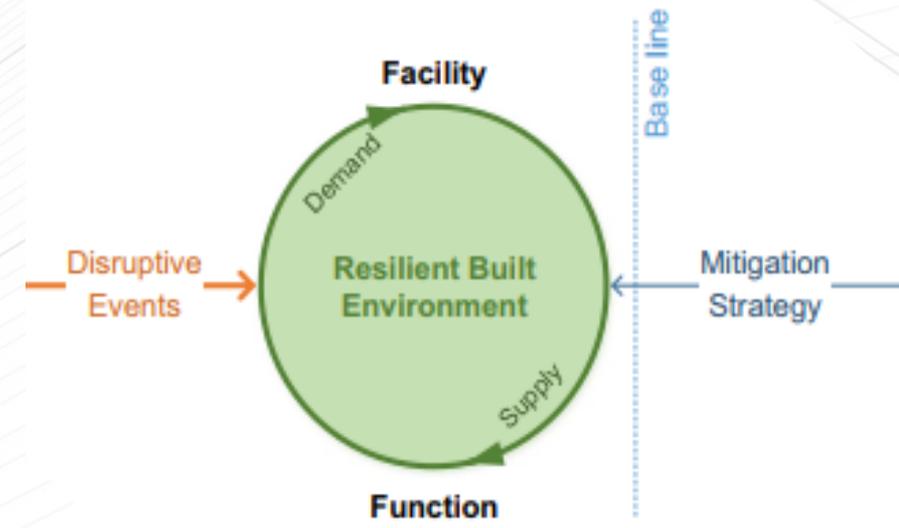
National Institute of BUILDING SCIENCES

CONFERENCE & EXPO

Resilience in Built Environment



Scenario 3: Below performance



Scenario 4: Optimized performance

(Source Zhao et al. 2015)



**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Definition- Resilience

The ability to absorb, adapt, recover quickly from the natural stresses, and be operational and functional

(Richardson et al., 1990).



**BUILDING
INNOVATION** 2018

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Research Question

- How does LEED V4.0 address the issue of resiliency within built environment, with regard to natural disasters?
- What prerequisites/ credits and categories respond most to identified natural disasters?
- What categories are least responsive to natural disasters?



**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Method

- Identify disasters impacting the US (27- FEMA, NOAA)
- Apply filters
 - Natural Disasters
 - Applicable to the built environment
- Shortlist applicable natural disasters
 - 13 Distinct
- Map with LEED V4.0
- Expert review



**BUILDING
INNOVATION** 2018

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Results

- Natural disasters during which buildings are non-operational
 - Fire and earthquake (Extreme conditions)
- Natural disasters during which buildings can be operational
 - Drought
 - Extreme temperatures (heat/cold)
 - Flooding
 - Tornadoes
 - Hurricane/Typhoon- NW Pacific
 - Blizzard
 - Straight-line winds
 - Snow storm
 - Tsunami
 - Winter storm



**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Results: Overview

- 64.8% of the total credits/prerequisites enhance resilience of building against *flooding*
- 63.0% of the total credits/prerequisites enhance resilience of building against *hurricane/typhoon*
- 61.1% of the total credits/prerequisites enhance resilience of building against *tsunami*



**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Results: Overview

- 16.7% of the total credits/prerequisites enhance resilience of building against *earthquake*
- 22.2% of the total credits/prerequisites enhance resilience of building against *fire*
- 42.6% of the total credits/prerequisites enhance resilience of building against *winter storm*



**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Results: Overview

- Credits that have the most potential to enhance building resilience towards identified natural disasters:
 - Integrative Process (*IP*)
 - Indoor Water Use Reduction (Credit + Prerequisite) (*WE*)
 - Building-Level Metering (*WE*)
 - Cooling Tower Water Use (*WE*)
 - Water metering (*WE*)
 - Fundamental Commissioning and Verification (*EA*)
 - Minimum Energy Performance (*EA*)
 - Building-Level Energy Metering (*EA*)



**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Results: Overview

- Credits that have the most potential to enhance building resilience towards identified natural disasters (Contd.):
 - Enhanced Commissioning (*EA*)
 - Optimize Energy Performance (*EA*)
 - Advanced Energy Metering (*EA*)
 - Renewable Energy Production (*EA*)
 - Building Product Disclosure and Optimization - Material Ingredients (*MR*)
 - Minimum Indoor Air Quality Performance (*EQ*)
 - Enhanced Indoor Air Quality Strategies (*EQ*)
 - Low-Emitting Materials (*EQ*)



**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Results: Overview

- Credits that have the most potential to enhance building resilience towards identified natural disasters (Contd.):
 - Thermal Comfort (*EQ*)
 - Interior Lighting (*EQ*)
 - Daylight (*EQ*)
 - Quality Views (*EQ*)
 - **Acoustic Performance (*EQ*)**
 - Innovation (*IN*)
 - Regional Priority (*RP*)



**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Results: Overview

- Credits/Prerequisites the do not enhance building resilience towards identified natural disasters:
 - Green Vehicles (*LT*)
 - Light Pollution Reduction (*SS*)
 - Enhanced Refrigerant Management (*EA*)
 - Green Power and Carbon Offsets (*EA*)
 - Storage and Collection of Recyclables (*MR*)
 - Construction and Demolition Waste Management Planning (*MR*)
 - Building Life-Cycle Impact Reduction (*MR*)



**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Results: Overview

- Credits/Prerequisites the do not enhance building resilience towards identified natural disasters (Contd.):
 - Building Product Disclosure and Optimization - Environmental Product Declarations (*MR*)
 - Building Product Disclosure and Optimization - Sourcing of Raw Materials (*MR*)
 - Construction and Demolition Waste Management (*MR*)
 - Environmental Tobacco Smoke Control (*EQ*)
 - Construction Indoor Air Quality Management Plan (*EQ*)
 - Indoor Air Quality Assessment (*EQ*)



**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Results: Flooding- Major Categories

- Integrative Process
- Sustainable Sites
 - Construction Activity Pollution Prevention
 - Site Assessment
 - Site Development - Protect or Restore Habitat
 - Open Space
 - Rainwater Management
 - Heat Island Reduction
- Innovation
- Regional Priority



**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Results: Flooding- Major Categories

- Water Efficiency
 - Outdoor Water Use Reduction
 - Indoor Water Use Reduction
 - Building-Level Water Metering
 - Outdoor Water Use Reduction
 - Indoor Water Use Reduction
 - Cooling Tower Water Use
 - Water Metering



**BUILDING
INNOVATION** 2018

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Results: Extreme temperature- heat Major Categories

- Integrative Process
- Water Efficiency
 - Indoor Water Use Reduction
 - Building-Level Water Metering
 - Outdoor Water Use Reduction
 - Indoor Water Use Reduction
 - Cooling Tower Water Use
 - Water Metering
- Innovation
- Regional Priority



**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Conclusion

- LEED V 4.0 credit/prerequisites provide opportunities to enhance building resilience
 - Uneven distribution for natural disasters
- Opportunities for improvements in certain categories such as MR
- Performance based credit requirements can be one of the ways that can address the regional issues with natural disasters



**BUILDING
INNOVATION 2018**

National Institute of
BUILDING SCIENCES

CONFERENCE & EXPO

Comments/ Questions

Thank You!!

Dr. Sandeep Langar, LEED AP BD+C, A.M. ASCE

Email: sandeep.langar@utsa.edu