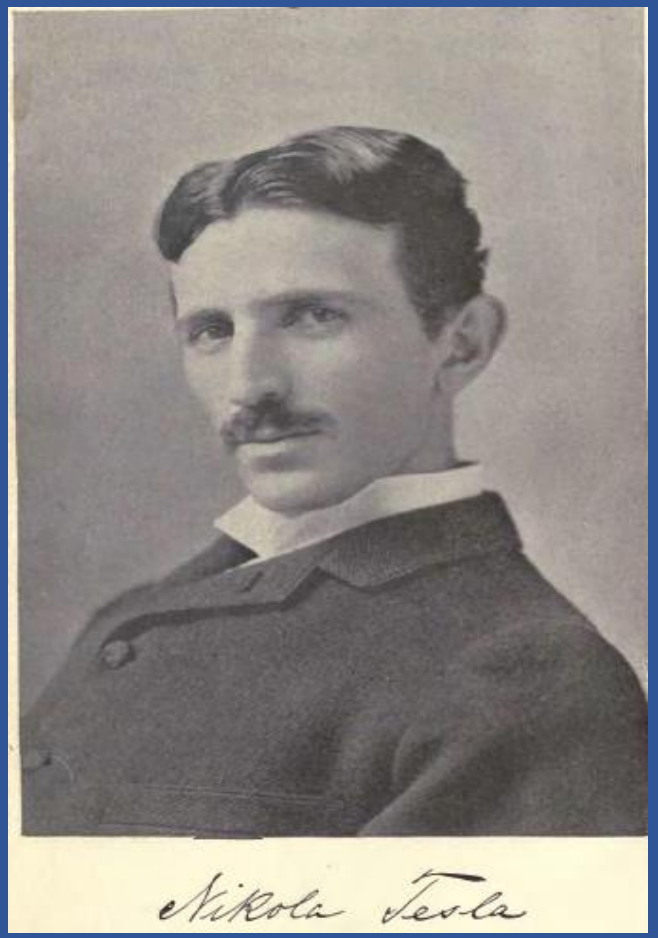
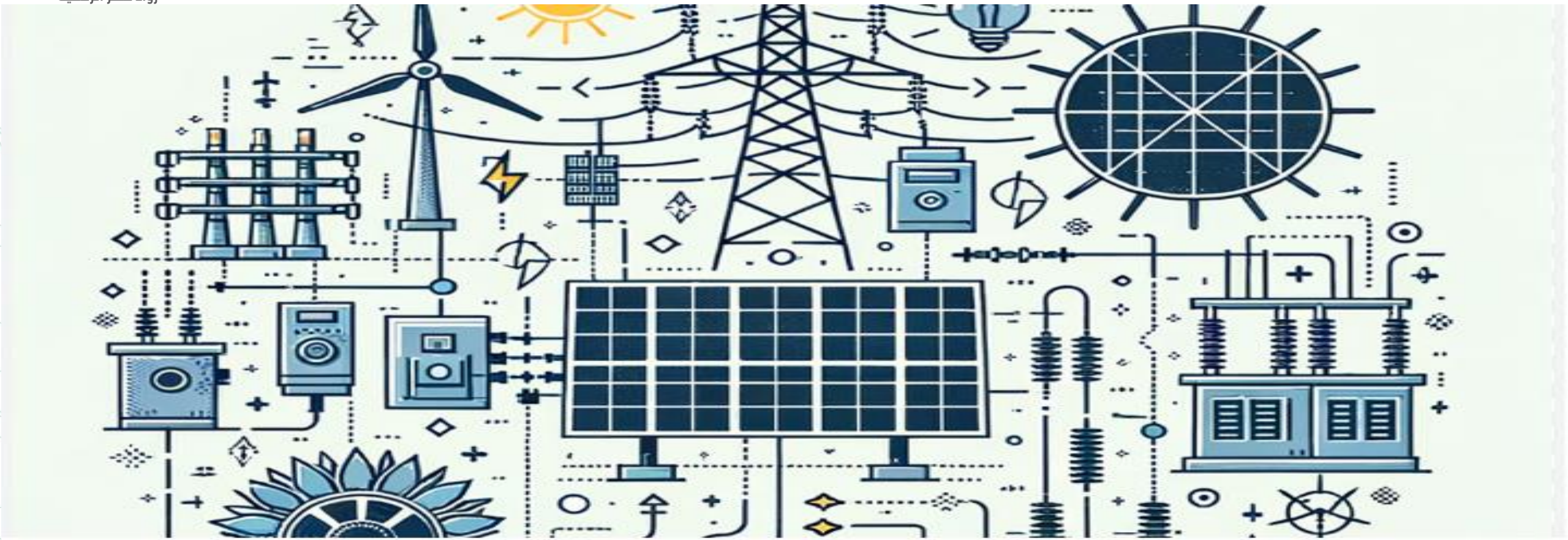


Tessla had a dream, dreams never die



Electric Disturbance Events Analysis

Eng: Omar Saied & Eng: Shaker Sami

Agenda

1- Scope

2- Project 1st phase:

3- Project 2nd phase:

Creating dashboard

4- Project 3rd phase:

Pattern, their impact

5- Project 4th phase:

Insights

6- Project 5th phase:

Suggestions solutions

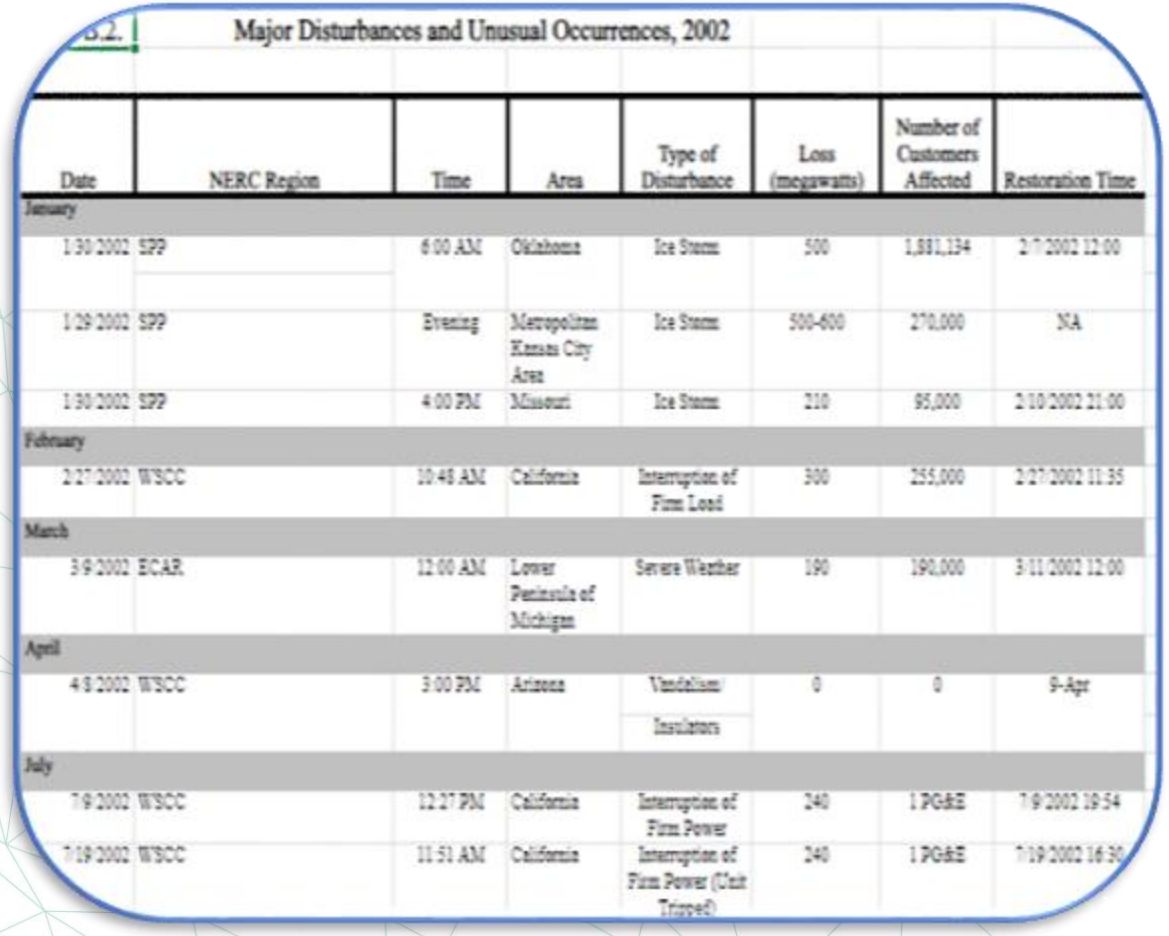
Scope

Data:
Event-level power outage data going back to 2002

Challenges:
We have struggled to make sense of it due to severe issues with the data quality and integrity.

Targets:
1. **consolidate and clean up the raw data**
2. **create a dashboard or report**
3. **understand patterns and trends around outages**
4. **quantify their impact on our communities**
5. **identify possible weak points in the grid.**

Data Samples before cleanings



Major Disturbances and Unusual Occurrences, 2002

Date	NERC Region	Time	Area	Type of Disturbance	Loss (megawatts)	Number of Customers Affected	Restoration Time
January							
1/30/2002	SPP	6:00 AM	Oklahoma	Ice Storm	500	1,881,134	2/7/2002 12:00
1/29/2002	SPP	Evening	Metropolitan Kansas City Area	Ice Storm	500-600	270,000	NA
1/30/2002	SPP	4:00 PM	Missouri	Ice Storm	210	95,000	2/10/2002 21:00
February							
2/27/2002	WSCC	10:48 AM	California	Interruption of Firm Load	300	255,000	2/27/2002 11:35
March							
3/9/2002	ECAR	12:00 AM	Lower Peninsula of Michigan	Severe Weather	190	190,000	3/11/2002 12:00
April							
4/8/2002	WSCC	3:00 PM	Arizona	Vandalism Insulators	0	0	9-Apr
July							
7/9/2002	WSCC	12:27 PM	California	Interruption of Firm Power	240	1 PG&E	7/9/2002 19:54
7/19/2002	WSCC	11:51 AM	California	Interruption of Firm Power (Unit Tripped)	240	1 PG&E	7/19/2002 16:30

Event Type	Area Affected	NERC Region	Alert Criteria	Event Type	Demand Loss (MW)	Number of Customers Affected
January	California: Riverside County;	WECC	Damage or destruction of its Facility that results from actual or suspected intentional human action.	Vandalism	0	0
January	California: Sacramento County;	WECC	Complete loss of monitoring or control capability at its staffed Bulk Electric System control center for 30 continuous minutes or more.	System Operations	0	0
January	Florida: Citrus County;	SERC	Physical attack that could potentially impact electric power system adequacy or reliability; or vandalism which targets components of any security systems	Vandalism	19	2109
January	Texas: Dallas County;	TRE	Damage or destruction of its Facility that results from actual or suspected intentional human action.	Vandalism	0	0
January	New Mexico	WECC	Physical attack that causes major interruptions or impacts to critical infrastructure or to operations	Vandalism	432	0

Data Samples after cleanings

Date Event Began	Time Event Be	NERC Re	Event Typ	Dem	Numb	Date of Restoration	Time of R	Area Affec	Event Year
Saturday, June 2, 2012	7:30:00 AM	WECC	Vandalism	0	0	Saturday, June 2, 2012	11:35:00 AM	California	2012
Thursday, April 25, 2013	4:00:00 PM	WECC	Vandalism	0	0	Friday, April 26, 2013	10:55:00 AM	California	2013
Wednesday, February 4, 2015	11:55:00 AM	WECC	Vandalism	0	0	Wednesday, February 4, 2015	11:56:00 AM	California	2015
Thursday, February 5, 2015	11:20:00 AM	WECC	Vandalism	0	0	Thursday, February 5, 2015	11:21:00 AM	California	2015
Sunday, March 29, 2015	4:26:00 AM	WECC	Vandalism	0	0	Sunday, March 29, 2015	9:21:00 AM	California	2015
Saturday, June 20, 2015	1:52:00 PM	WECC	Vandalism	0	0	Saturday, June 20, 2015	3:30:00 PM	California	2015
Thursday, December 10, 2015	5:55:00 PM	WECC	Vandalism	0	0	Thursday, December 10, 2015	5:56:00 PM	California	2015
Wednesday, November 9, 2016	6:44:00 AM	WECC	Vandalism	0	0	Wednesday, November 9, 2016	7:44:00 AM	California	2016
Saturday, August 5, 2017	1:20:00 PM	WECC	Vandalism	0	0	Saturday, August 5, 2017	2:20:00 PM	California	2017
Monday, March 26, 2018	3:05:00 AM	WECC	Vandalism	0	0	Monday, March 26, 2018	3:35:00 AM	California	2018
Tuesday, April 3, 2018	11:15:00 AM	WECC	Vandalism	0	0	Tuesday, April 3, 2018	11:30:00 AM	California	2018
Tuesday, June 12, 2018	3:00:00 PM	WECC	Vandalism	0	0	Tuesday, June 12, 2018	3:15:00 PM	California	2018
Saturday, June 30, 2018	12:30:00 PM	WECC	Vandalism	0	0	Saturday, June 30, 2018	12:31:00 PM	California	2018
Saturday, August 4, 2018	8:20:00 AM	WECC	Vandalism	0	0	Saturday, August 4, 2018	8:21:00 AM	California	2018
Thursday, August 30, 2018	12:00:00 PM	WECC	Vandalism	0	0	Thursday, August 30, 2018	12:20:00 PM	California	2018

Different Splits

Date	monthn	month	dayn	day	year	quarter	weekn
7/9/1899 12:00:00 AM	7	Jul	1	Sun	1899	Q3	28
7/8/1900 12:00:00 AM	7	Jul	1	Sun	1900	Q3	28
7/7/1901 12:00:00 AM	7	Jul	1	Sun	1901	Q3	28
7/6/1902 12:00:00 AM	7	Jul	1	Sun	1902	Q3	28
7/5/1903 12:00:00 AM	7	Jul	1	Sun	1903	Q3	28
7/3/1904 12:00:00 AM	7	Jul	1	Sun	1904	Q3	28
7/9/1905 12:00:00 AM	7	Jul	1	Sun	1905	Q3	28
7/8/1906 12:00:00 AM	7	Jul	1	Sun	1906	Q3	28
7/7/1907 12:00:00 AM	7	Jul	1	Sun	1907	Q3	28
7/5/1908 12:00:00 AM	7	Jul	1	Sun	1908	Q3	28
7/4/1909 12:00:00 AM	7	Jul	1	Sun	1909	Q3	28
7/3/1910 12:00:00 AM	7	Jul	1	Sun	1910	Q3	28
7/9/1911 12:00:00 AM	7	Jul	1	Sun	1911	Q3	28
7/7/1912 12:00:00 AM	7	Jul	1	Sun	1912	Q3	28
7/6/1913 12:00:00 AM	7	Jul	1	Sun	1913	Q3	

New Measures

```
Event Duration (Hours) =
SUMX(
    'Data Model',
    DATEDIFF(
        'Data Model'[Date Event Began] + TIMEVALUE('Data Model'[Time Event Began]),
        'Data Model'[Date of Restoration] + TIMEVALUE('Data Model'[Time of Restoration]),
        HOUR
    )
)
```

Customer Impact Summary

REGIONAL ANALYSIS

Event Month: April

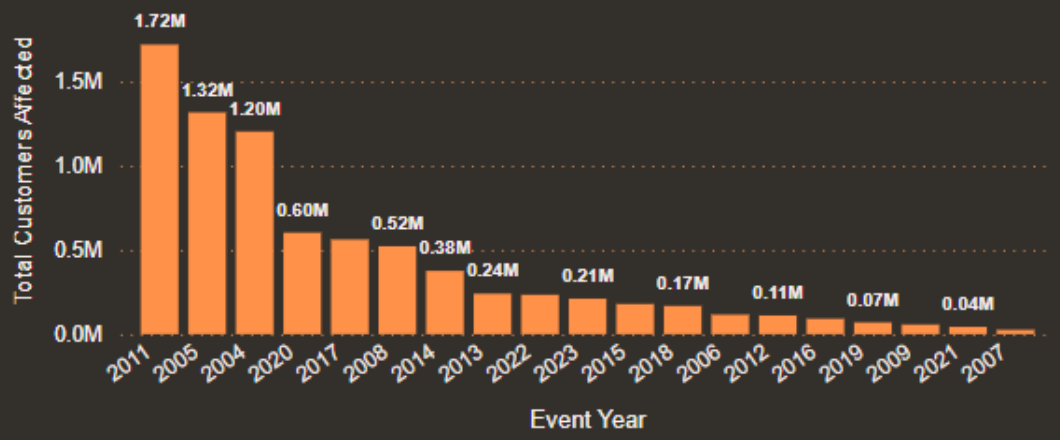
Event Year: 2004

Area Affected: Alabama

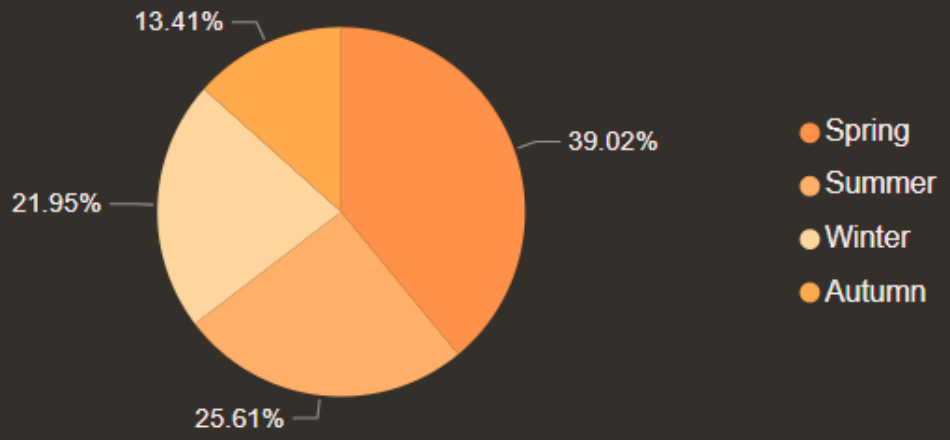
8M
Total Customers Affected

82
Count of Down Time (Days)

Total Customers Affected
by Event Year



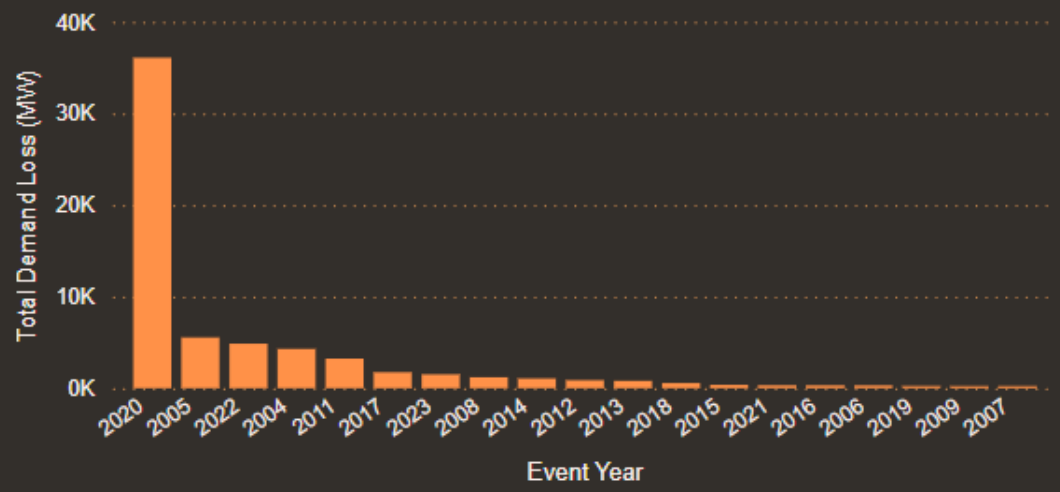
of Events by Season



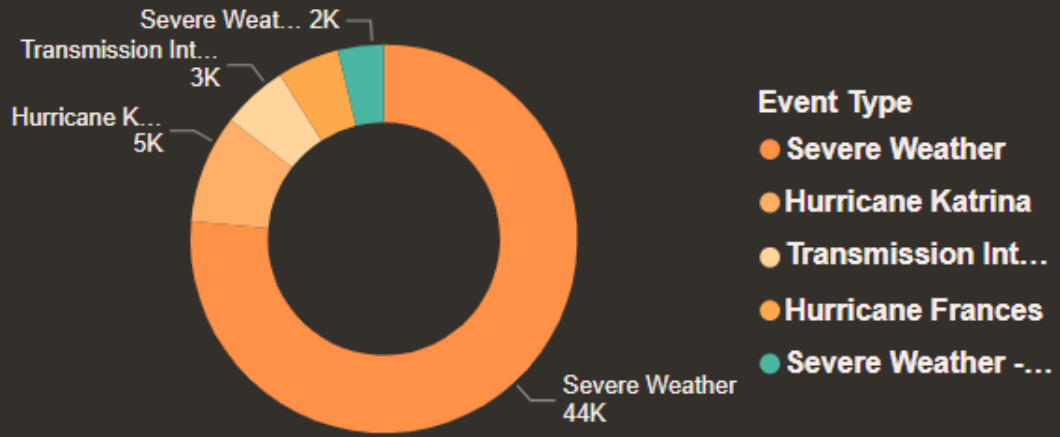
63K
Total Demand Loss (MW)

82
Events

Total Demand Loss (MW)
by Event Year



Top 5 Events Affecting Demand Loss



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Project 2nd phase

An Overview

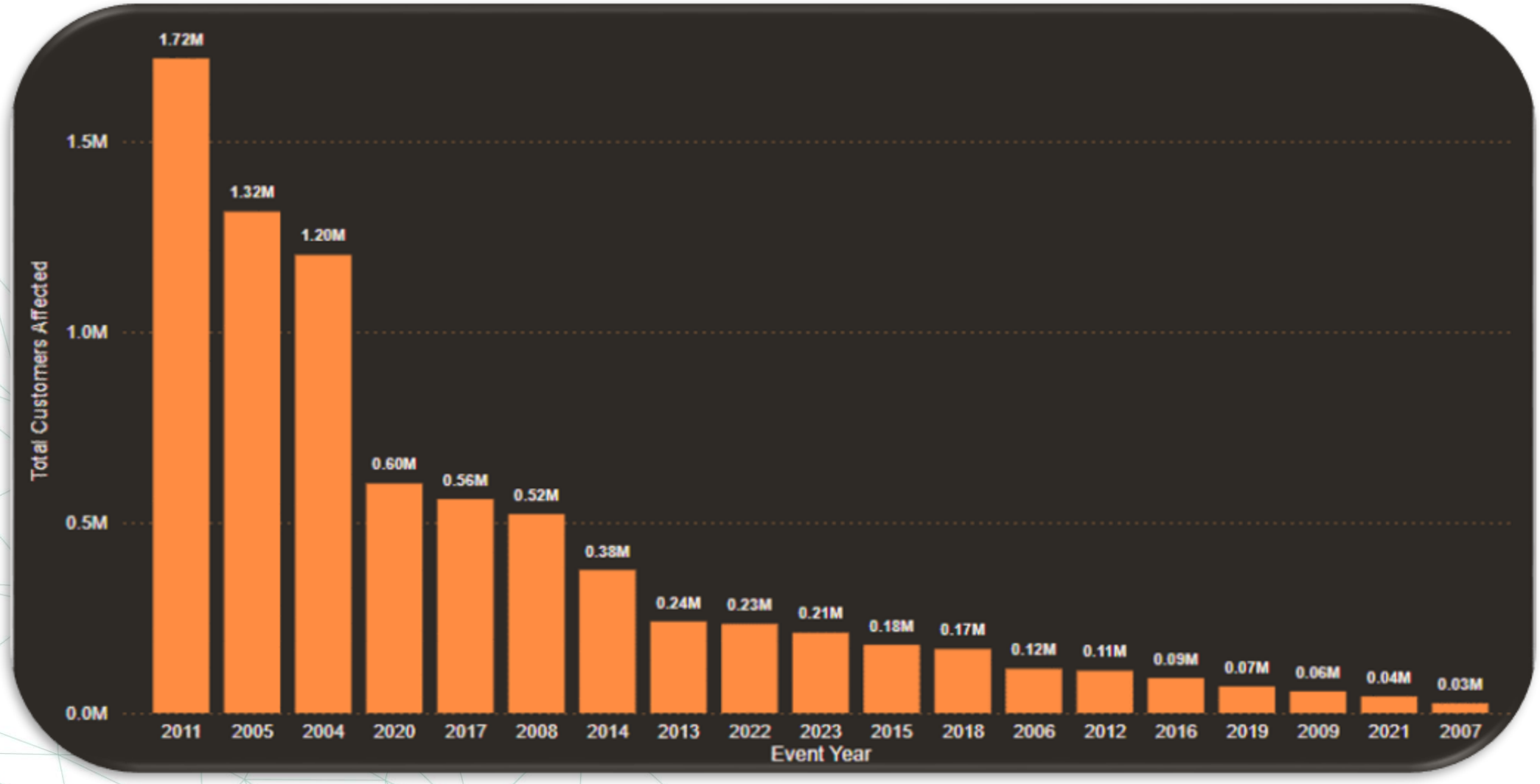
276 M
Total customer Effected

3383 Day
Count of down time

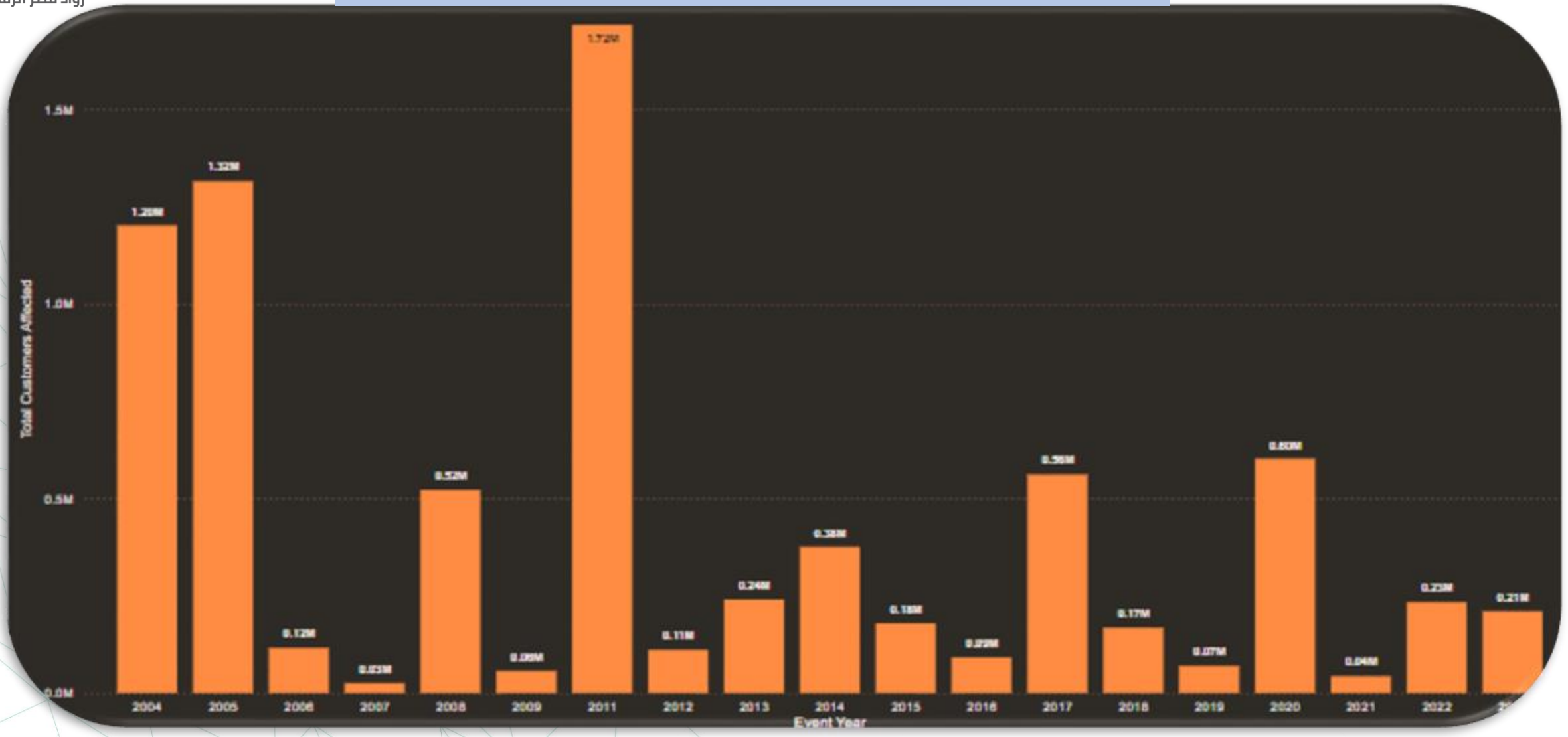
1023 K
Total demand Loss(MW)

3383
Events

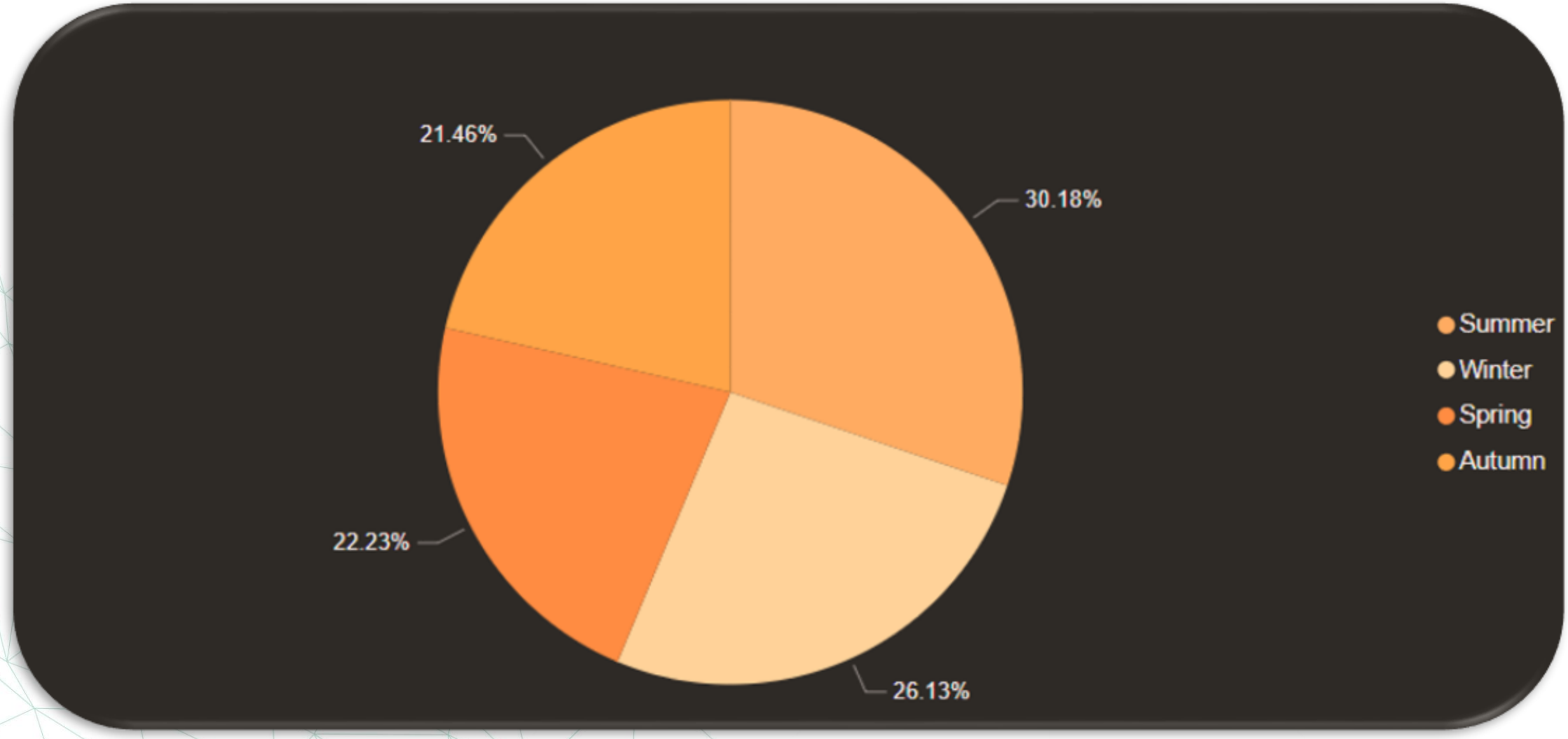
Total customer effected by event year



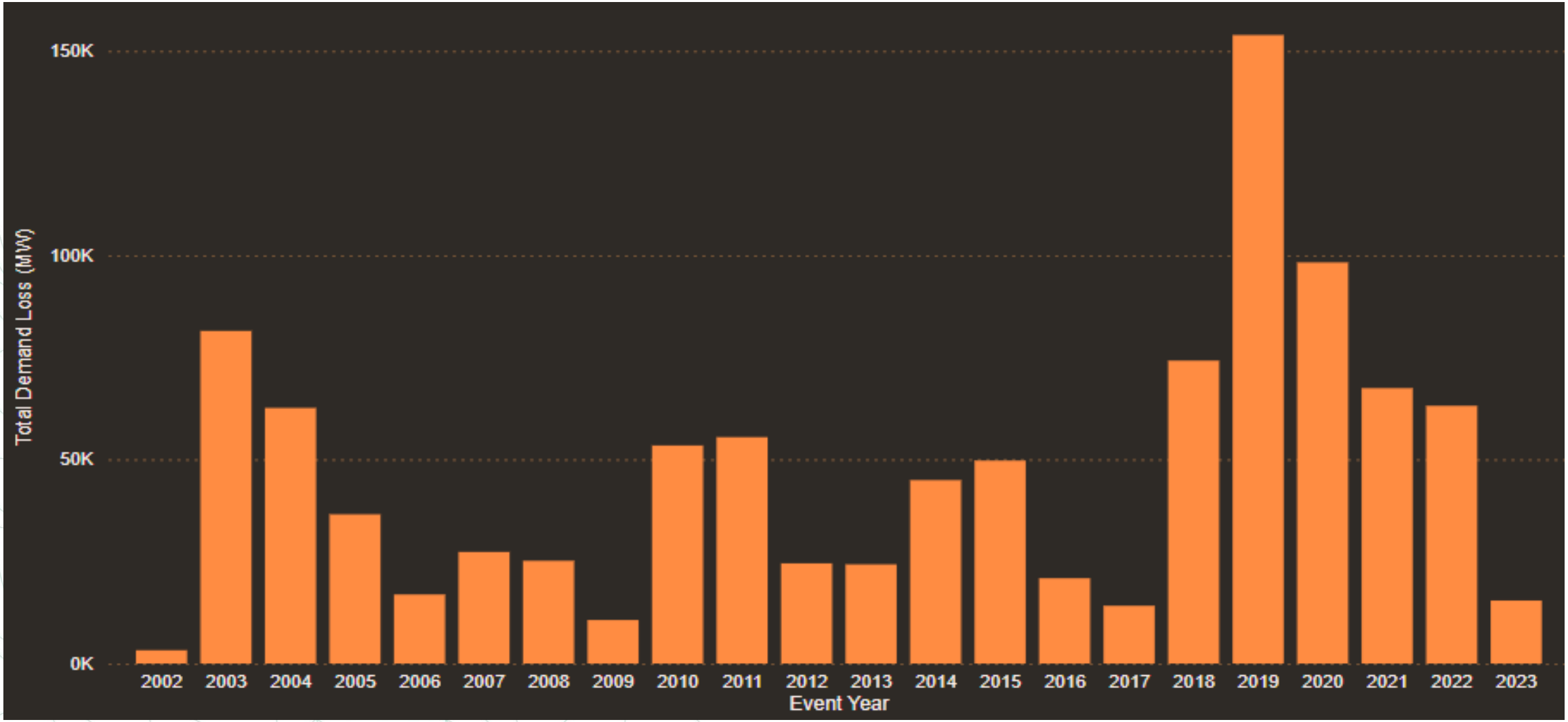
Total customer effected by event year



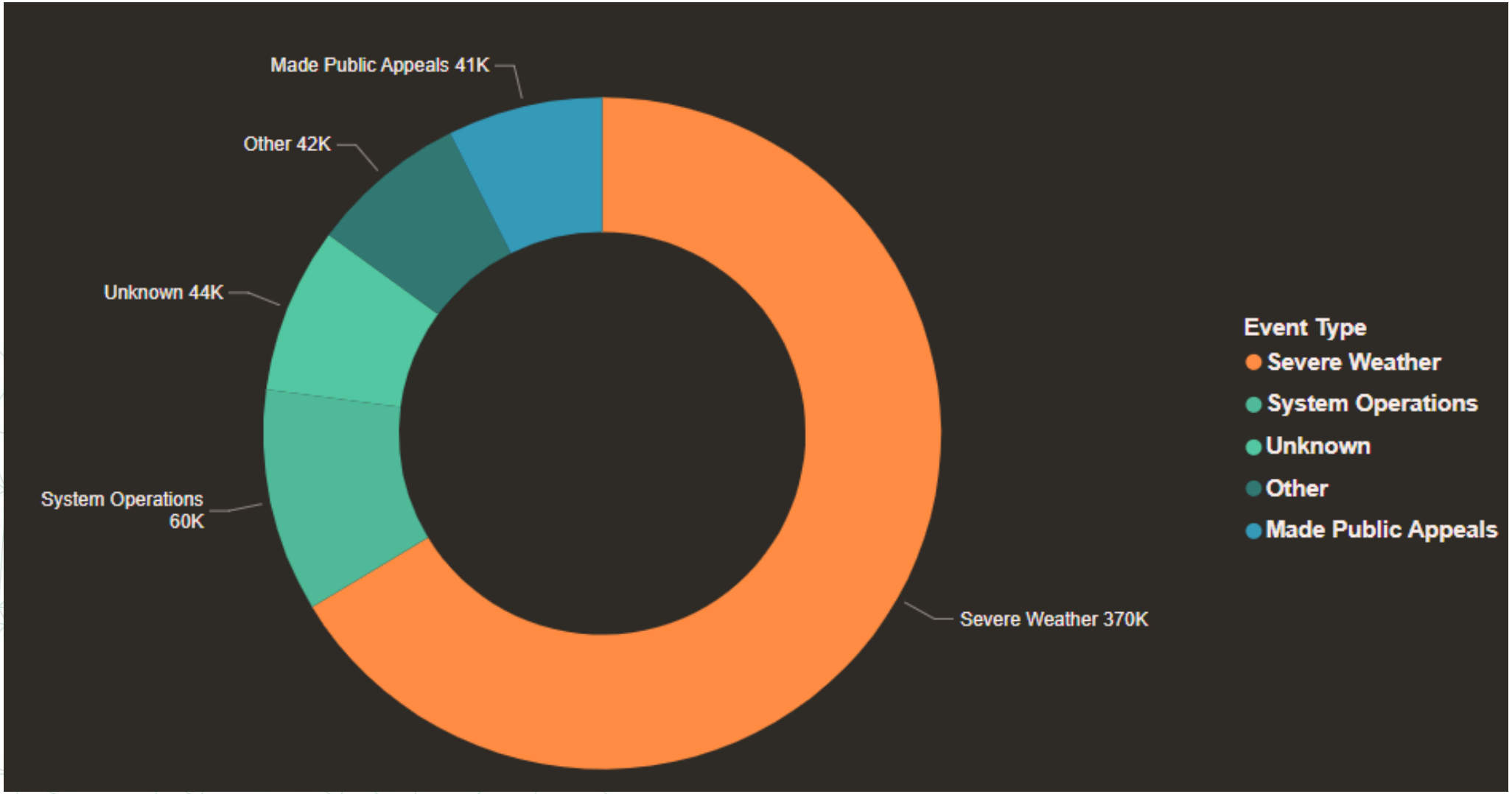
Count of events by season



Total Demand loss per year



Top 5 events effects Demand loss



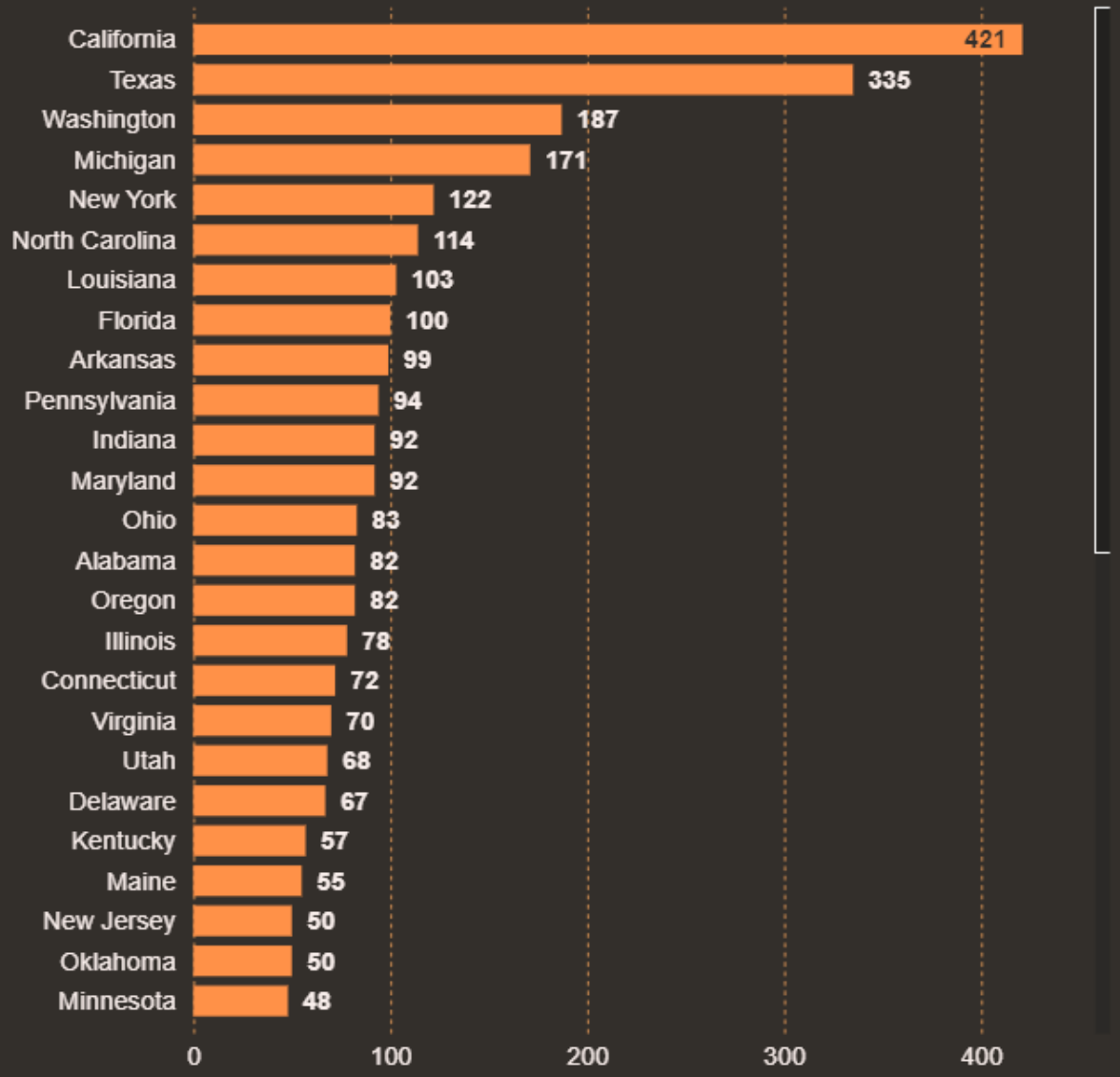
Customer Impact Summary

REGIONAL ANALYSIS

Alabama

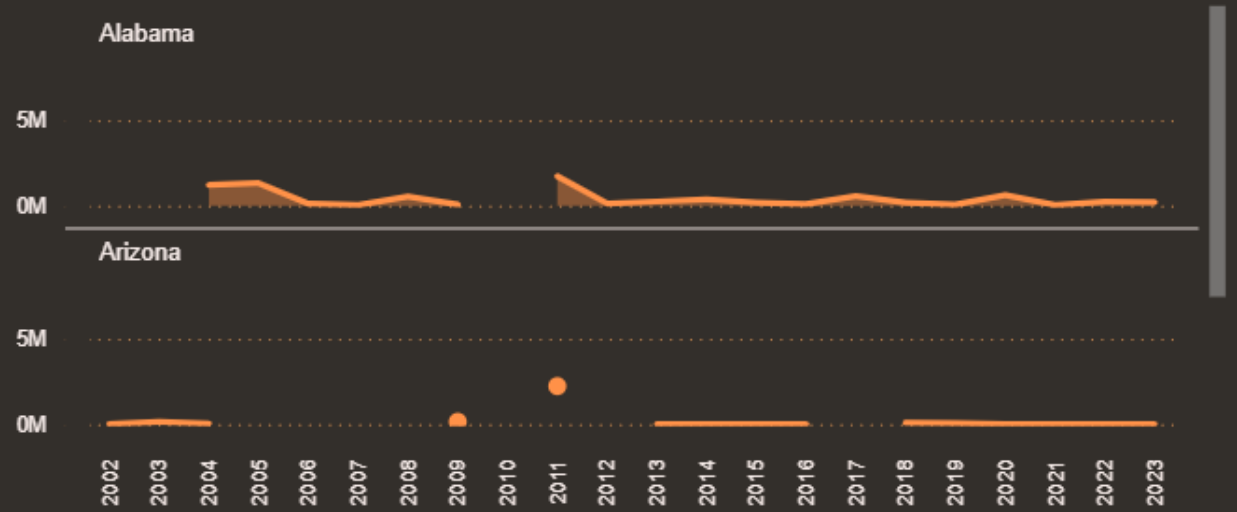
Arizona

#Events by States

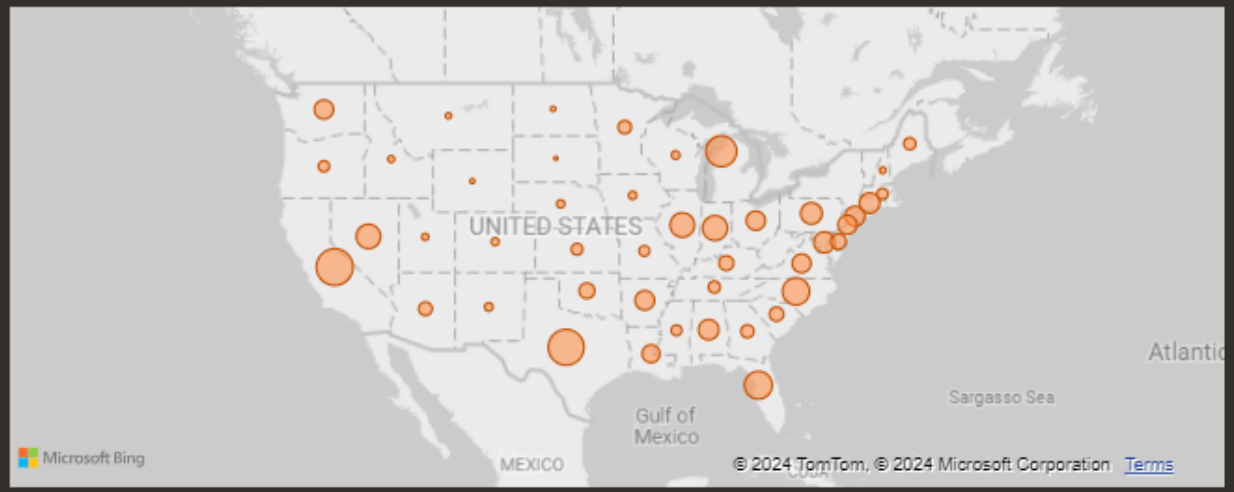


Sum of Number of Customers Affected

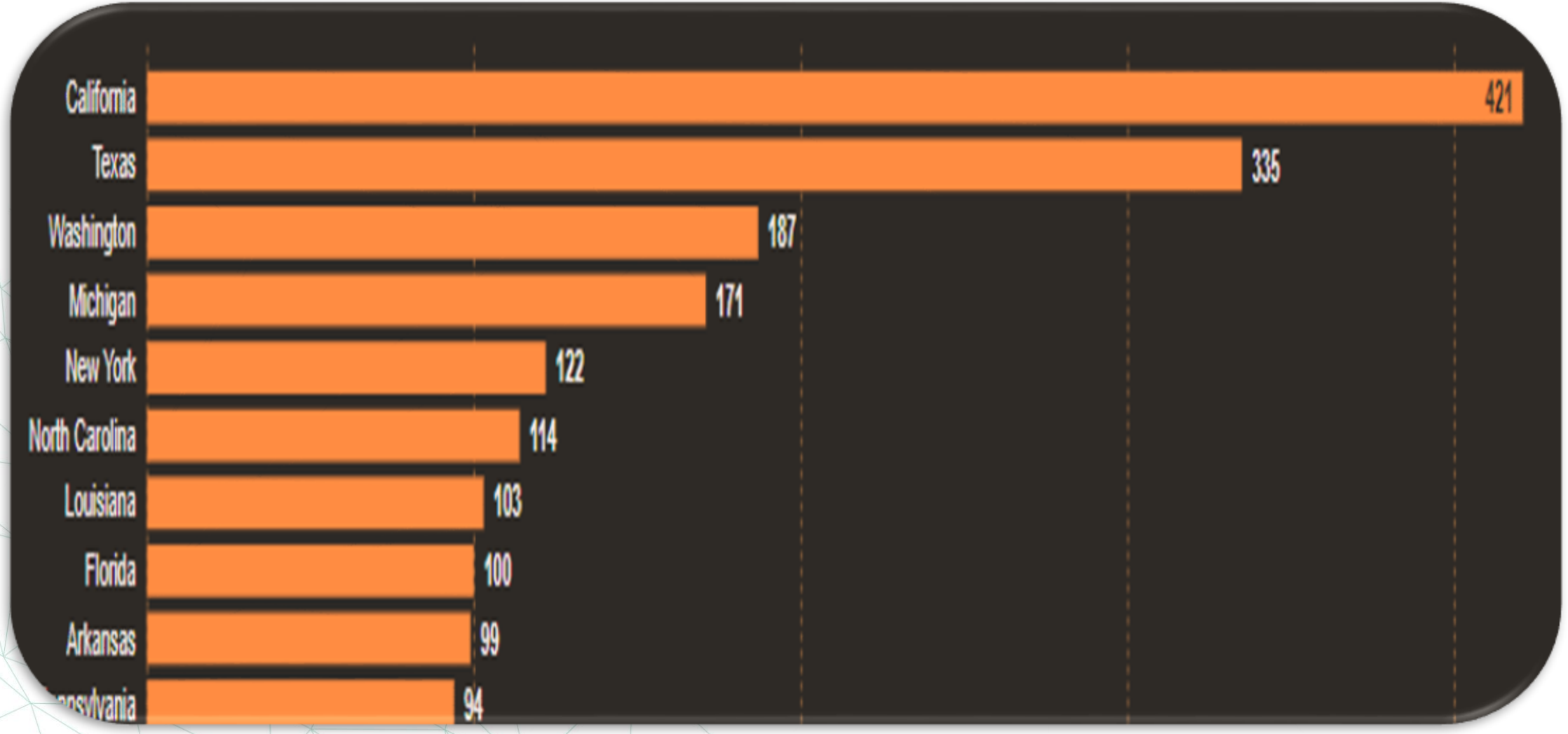
by Event Year and Area Affected



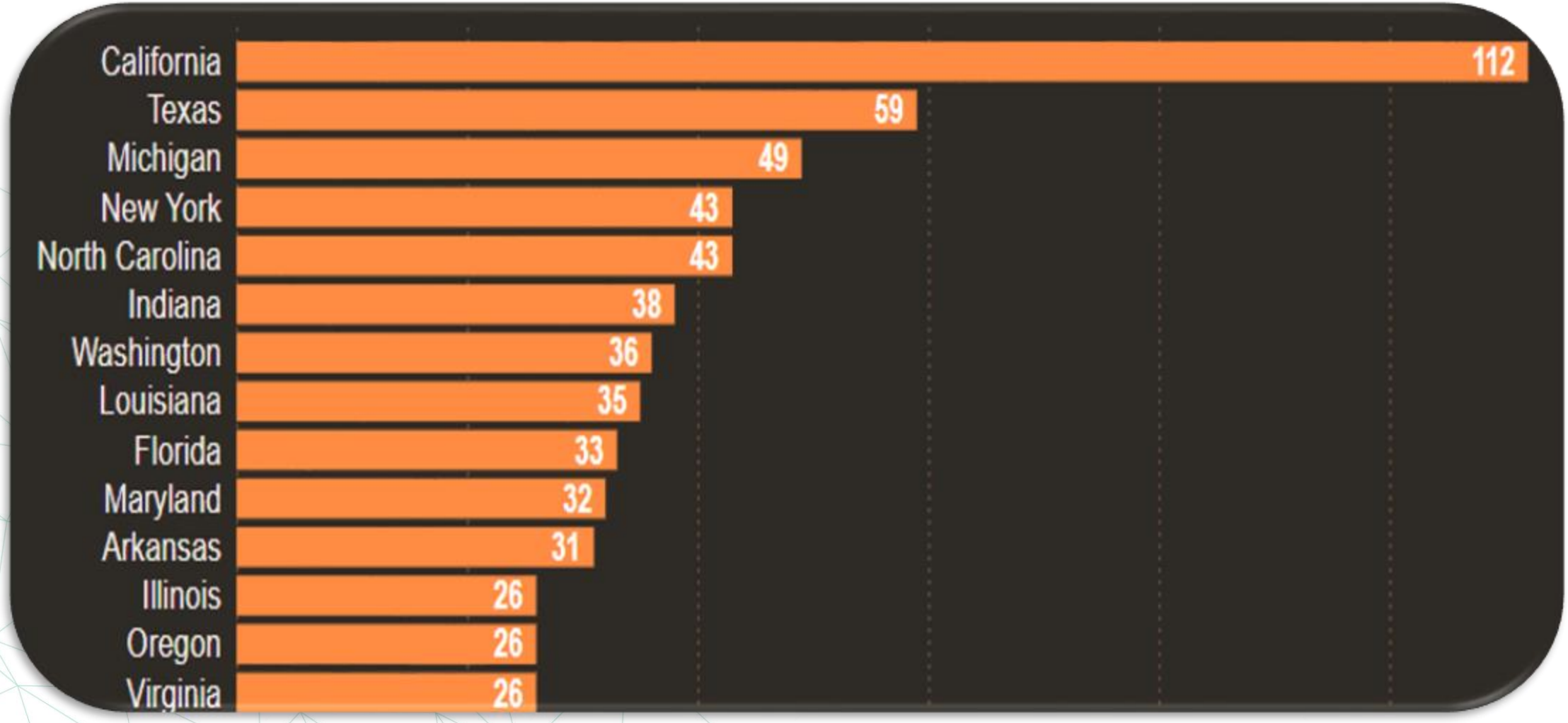
Total Customers Affected by Area Affected



Count of Distinct event type By Area Affected



Count of Distinct event type By Area Affected



Top 16 Area Affected
Total customer effected – Loss of Demand – Count distinct event

rea Affected	Total Customers Affected	Sum of Demand Loss (MW)	Count of Event Type
California	30907671.00	140752	112
Texas	29313135.00	51928	59
Michigan	20764554.00	49404	49
Florida	16524985.00	49058	33
North Carolina	15524925.00	190670	43
Indiana	12756989.00	29267	38
Illinois	12293221.00	6274	26
Nevada	12154448.00	79040	12
Pennsylvania	8954834.00	7651	24
Maryland	8444061.00	19771	32
Connecticut	7917024.00	5095	23
Alabama	7837830.00	63475	24
New York	7363542.00	40894	43
Arkansas	6991268.00	34306	31
Ohio	6698385.00	24395	23
Washington	6682483.00	20002	

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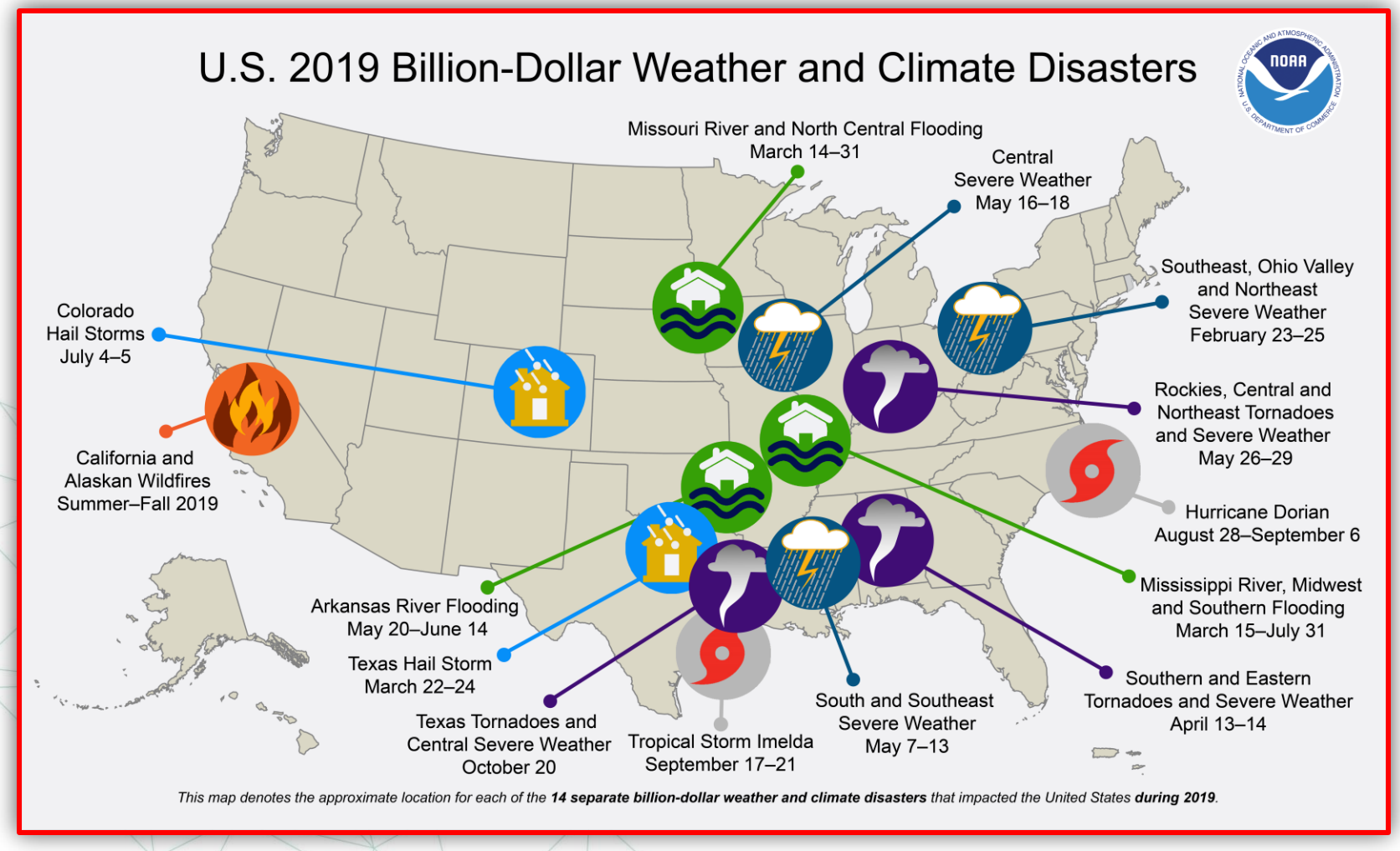
Total customers effected by Area effected

Project 3rd phase

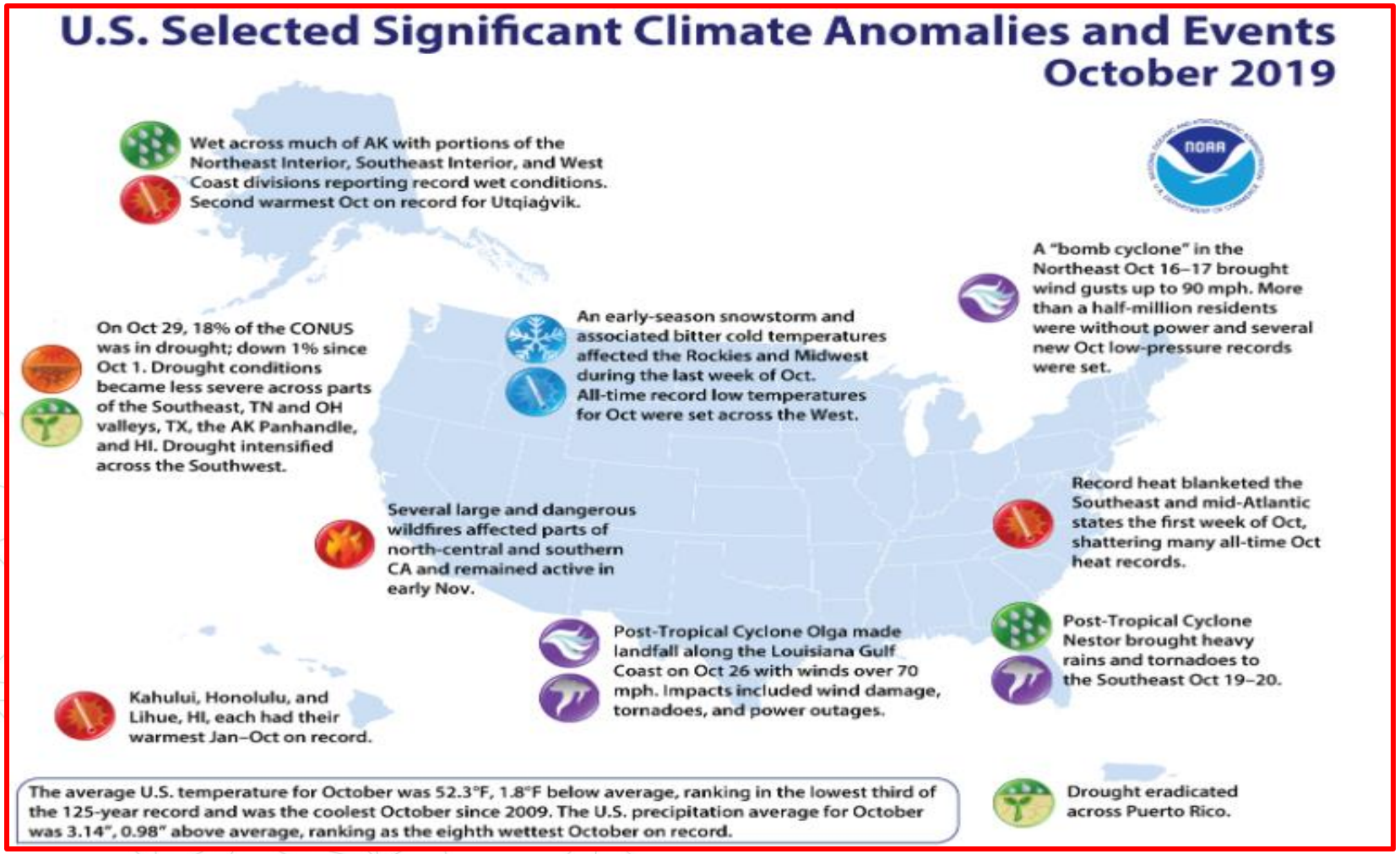
pattern and impaction

Pattern in 2019



https://www.noaa.gov/news/2019-was-2nd-wettest-year-on-record-for-us

Pattern in 2019



https://www.noaa.gov/news/october-2019-was-coolest-in-10-years-as-us-continued-its-wettest-year-to-date

States and their population and total Area

States of the United States of America

Flag, name and postal abbreviation[8]		Cities		Ratification or admission[A]	Population (2020)[10]	Total area[11]		Reps.
		Capital	Largest[12]			mi²	km²	
California	CA	Sacramento	Los Angeles	Sep 9, 1850	39,538,223	163,695	423,967	52
Texas	TX	Austin	Houston	Dec 29, 1845	29,145,505	268,596	695,662	38
Florida	FL	Tallahassee	Jacksonville	Mar 3, 1845	21,538,187	65,758	170,312	28
New York	NY	Albany	New York City	Jul 26, 1788	20,201,249	54,555	141,297	26
Pennsylvania[B]	PA	Harrisburg	Philadelphia	Dec 12, 1787	13,002,700	46,054	119,280	17
Illinois	IL	Springfield	Chicago	Dec 3, 1818	12,812,508	57,914	149,995	17
Ohio	OH	Columbus		Mar 1, 1803	11,799,448	44,826	116,098	15
Georgia	GA	Atlanta		Jan 2, 1788	10,711,908	59,425	153,910	14
North Carolina	NC	Raleigh	Charlotte	Nov 21, 1789	10,439,388	53,819	139,391	14
Michigan	MI	Lansing	Detroit	Jan 26, 1837	10,077,331	96,714	250,487	13
New Jersey	NJ	Trenton	Newark	Dec 18, 1787	9,288,994	8,723	22,591	12
Virginia[B]	VA	Richmond	Virginia Beach	Jun 25, 1788	8,631,393	42,775	110,787	11

https://en.wikipedia.org/wiki/List_of_states_and_territories_of_the_United_States

Project 4th phase

Insights

https://www.google.com/maps/@23.3171309,-93.394609,4z?entry=ttu&g_ep=EgoyMDI0MTEwNS4wIKXMDSoASAFQAw%3D%3D

https://www.google.com/maps/@39.5965859,-97.612684,3402637m/data=!3m1!1e3?entry=ttu&g_ep=EgoyMDI0MTEwNS4wIKXMDSoASAFQAw%3D%3D

1- Top state effects is California with:

total customers affected 31 million,

comes from 112 types of unique events,

total 151 000 Mw demand loss

The reason for that :

its huge area and a great number of populations

Then Texas , Michigan

2- seasons plays mineral role in event count

3- severe weather Plays the key role in event count

4- Costal status is the most effected status

Project 5th phase
Suggested solutions

- 1- Changing the location of main electricity stations.

- 2- Change the design of ways to transfer electricity:
- I will be dependent on the location of the state

- 3- Considering the location of electrical station:
- If the stats is costal or not

- 4- Preparation of severe weather

- 5- Training operational teams
- 6- Social awareness