2016 State of the Interconnection

WECC

RELIABILITY

The State of the Interconnection presents the most accurate historical data available at the time of publication. All data are subject to revision in future editions of the report and in other WECC documents.

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Introduction

The State of the Interconnection, now in its fifth edition, is a snapshot of evolving trends in the Western Interconnection. The report gathers data from a variety of sources to provide a comprehensive summary of information relevant to the reliability of the Bulk Electric System (BES).

The State of the Interconnection is published annually by the Western Electricity Coordinating Council (WECC). WECC is the Regional Entity with authority delegated from the North American Electric Reliability Corporation (NERC) to assure the reliability of the BES across the entire Western Interconnection.

How to Use This Report

The State of the Interconnection is a reference tool. Its design allows the reader to quickly access information about the Western Interconnection. Colored tabs separate the report into five sections, each describing an element of power system reliability. Sidebars provide additional context and background on issues of particular interest. Explanatory information and citations are found in footnotes at the end of each section.

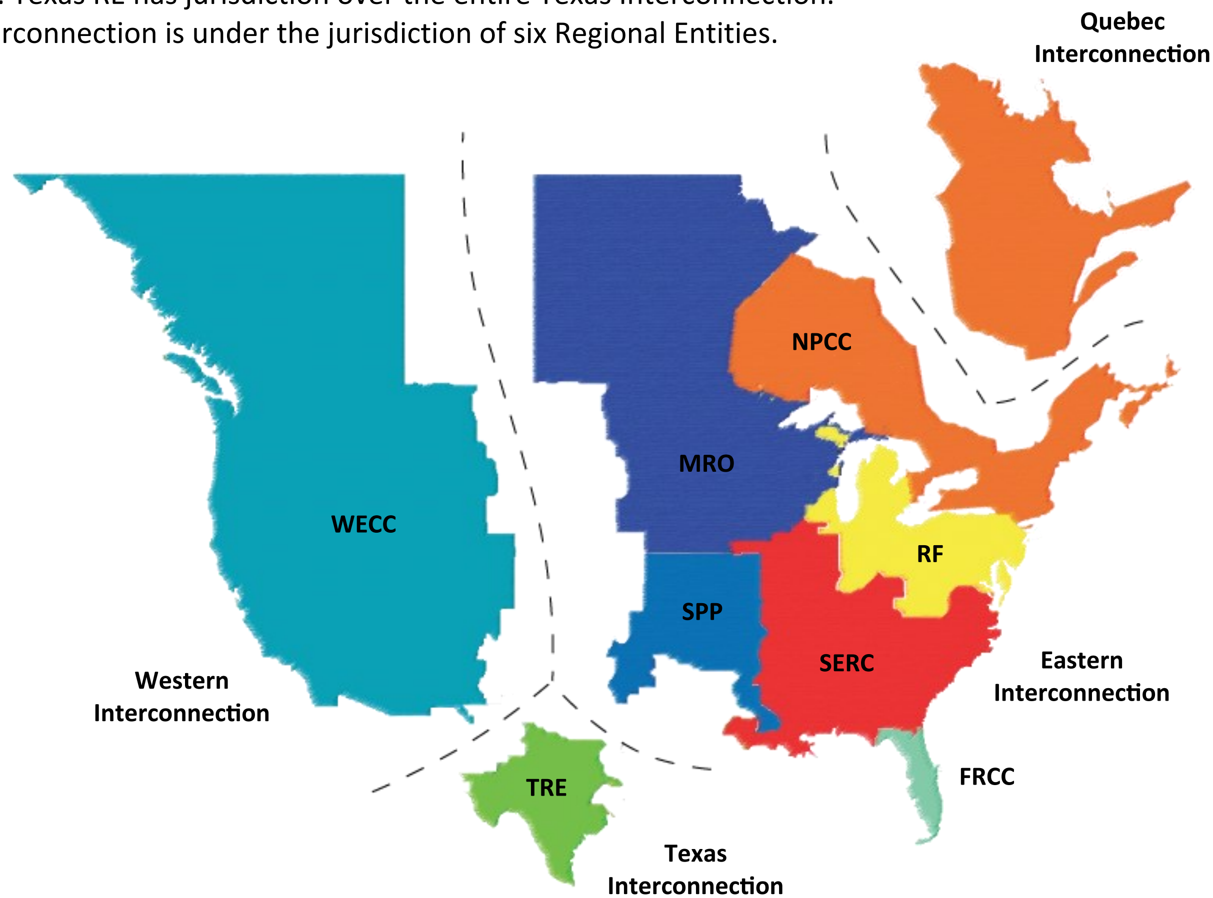
WECC invites feedback on this report from readers. To participate in a survey on the report, visit—

https://www.surveymonkey.com/r/WECCSurvey2016

The North American Interconnections

The Western Interconnection is one of four major electric system networks in North America. Serving a population of over 80 million, the Interconnection spans more than 1.8 million square miles in all or part of 14 states, the Canadian provinces of British Columbia and Alberta, and the northern portion of Baja California in Mexico. The Western Interconnection differs from the other Interconnections in a number of ways.

The responsibility for assuring BES reliability across North America is delegated to eight Regional Entities. WECC has jurisdiction over the entire Western Interconnection. Texas RE has jurisdiction over the entire Texas Interconnection. The Eastern Interconnection is under the jurisdiction of six Regional Entities.



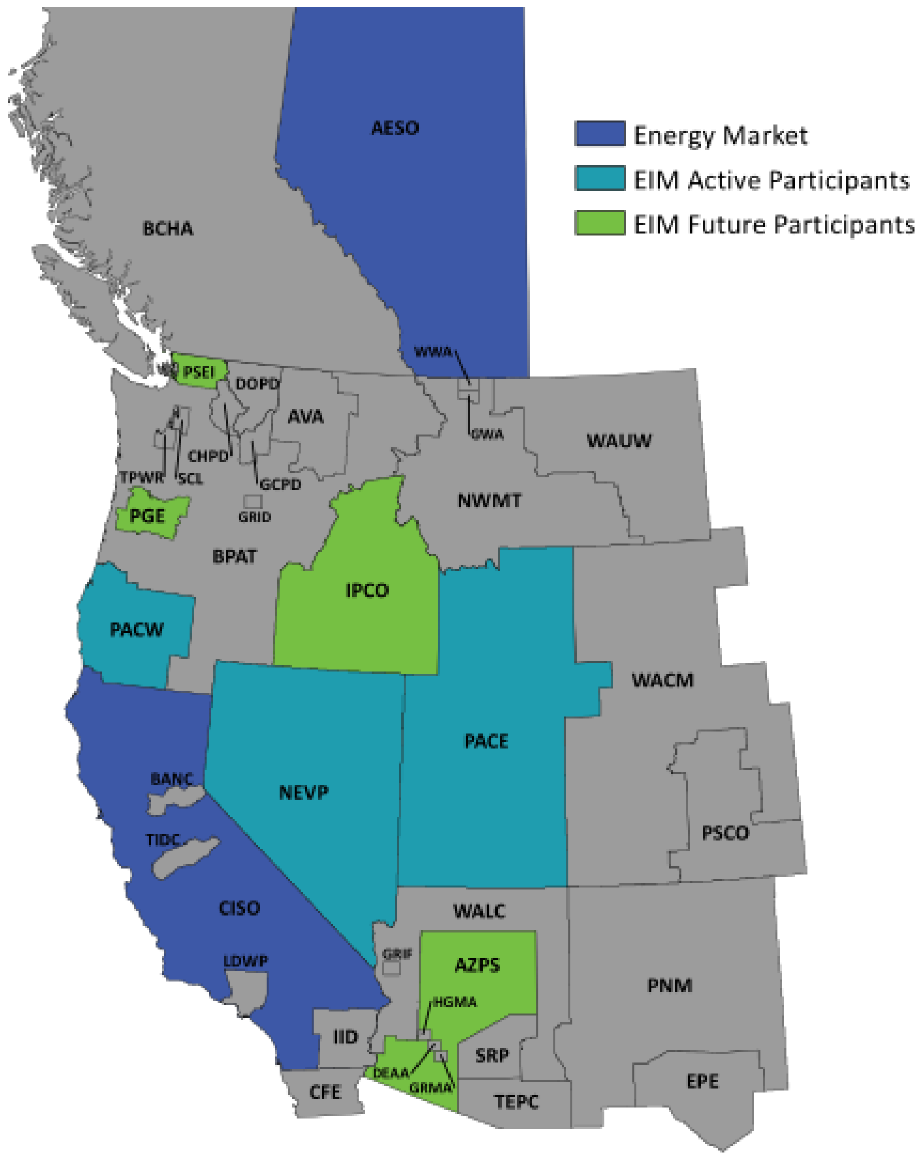
The Western Interconnection

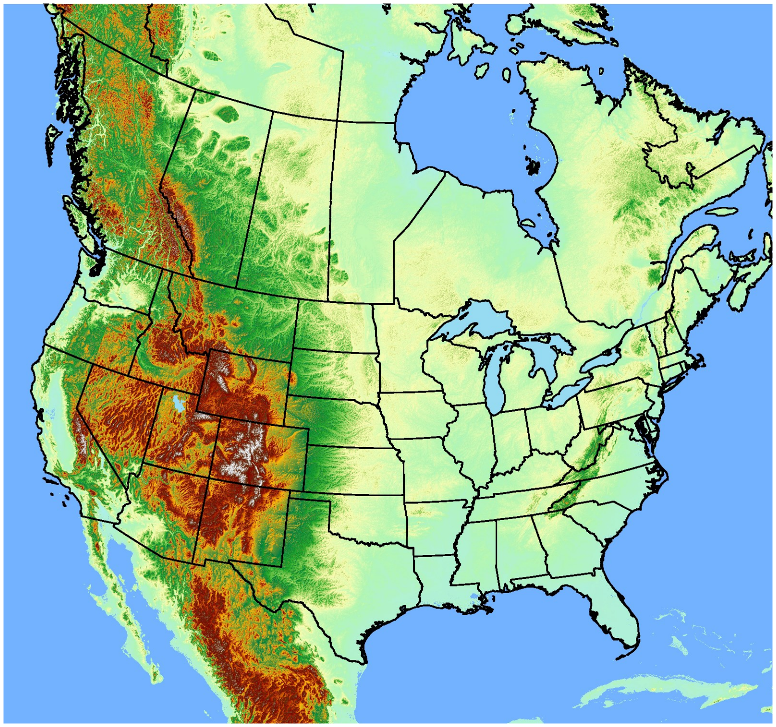
There are 38 functional Balancing Authorities (BA) in the Western Interconnection, seven of which are generation-only BAs.

The West has two full energy markets, one operated by the Alberta Electric System Operator (AESO) and one by the California ISO (CISO). CISO also operates an Energy Imbalance Market (EIM). Participation in the EIM has increased since its inception in 2014.

> *The Western Interconnection has two Reliability Coordinators (RC), compared with 13 in the Eastern Interconnection. Peak Reliability is the RC for most of the Western Interconnection; AESO provides their own RC services.*

Balancing Authorities of the Western Interconnection





Geography and Climate

The Western Interconnection is diverse in climate, topography and terrain. It experiences weather extremes that impact how the system is operated. For instance, daily temperature swings of over 50°F occur throughout much of the West.

The region holds several weather-related records for the United States, including:

» Five of the 10 states with the lowest minimum temperature records, and the four states with the highest maximum temperature records

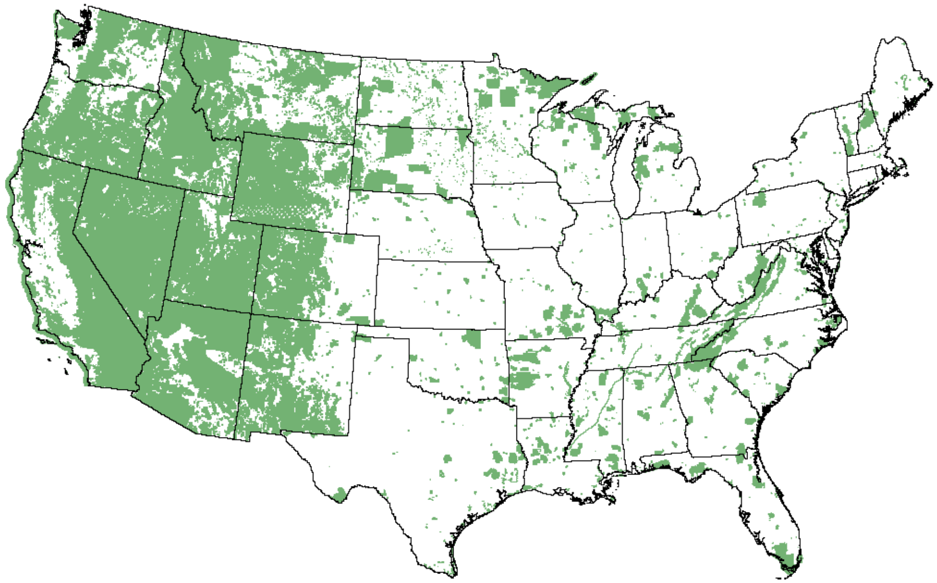
» The 10 driest and five of the 10 snowiest locations

» The 10 sunniest and six of the 10 cloudiest locations

» Both the most and least humid locations[1]

Increasing variability in climate contributes to a wide number of issues that put stress on energy infrastructure including wildfires, drought and high electricity demand. Resources like wind, solar, hydro and, to some extent, natural gas are impacted by weather and climate patterns. Changes in climate, coupled with increases in these resources, pose short- and long-term planning and operational challenges.

Federally Owned Lands of the United States[2]



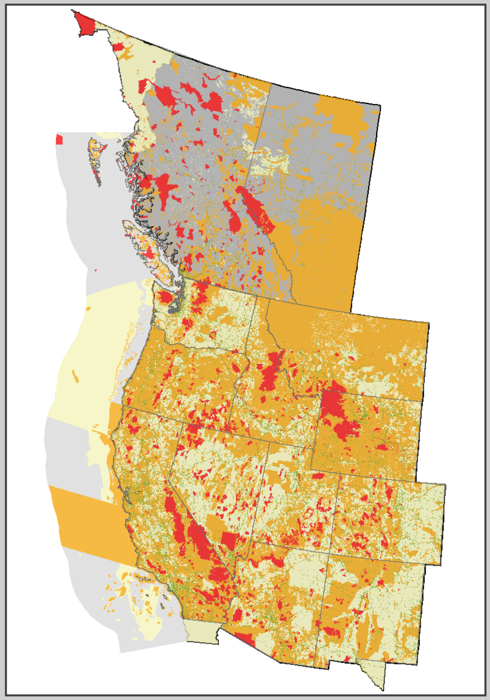
Land Use and Environment

A large part of the Western Interconnection is public land. This, coupled with a range of environmental considerations, presents challenges when planning the system, including:

» Protection of vulnerable species, habitats and vegetation

» Preservation of game rangeland, migration corridors and critical rivers and streams

» Cultural considerations, including National Parks and Monuments, Native American tribal lands, and sacred sites



Environmental Risk

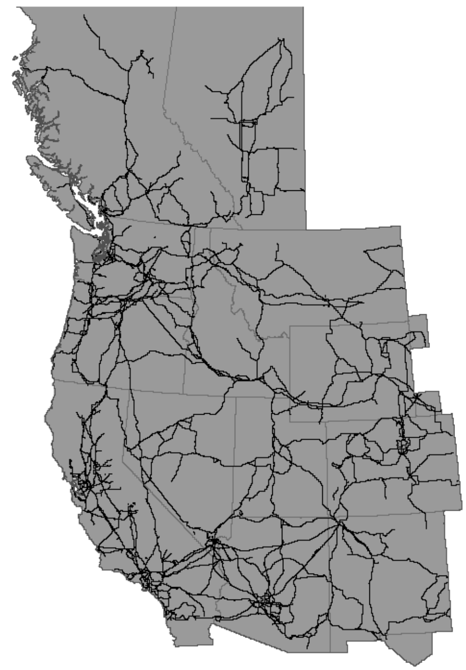
The West is home to nearly 250 animal and over 270 plant species that are threatened or endangered.[3] System planners must ensure new infrastructure does not disrupt critical habitats.

WECC classifies areas in the West into four environmental risk categories, ranging from those with least risk of environmental or cultural resource sensitivities and constraints (green), through those with low-to-moderate (yellow) and high risk (orange), to areas presently precluded from development by law or regulation (red).[4]

TRANSMISSION

The Western Interconnection is made up of approximately 121,200 circuit-miles of transmission that carries power long distances from remote areas where generation resources are located to load located primarily along the West Coast. Electricity flows south and west in a "doughnut" pattern, contrasting with the spider-web configuration in the East.

Major Transmission Lines of the Western Interconnection



Circuit-Miles by Interconnection[5]

	Miles	*Percent*
Eastern	273,140	63%
Western	121,200	28%
Texas	21,300	5%
Quebec	17,200	4%

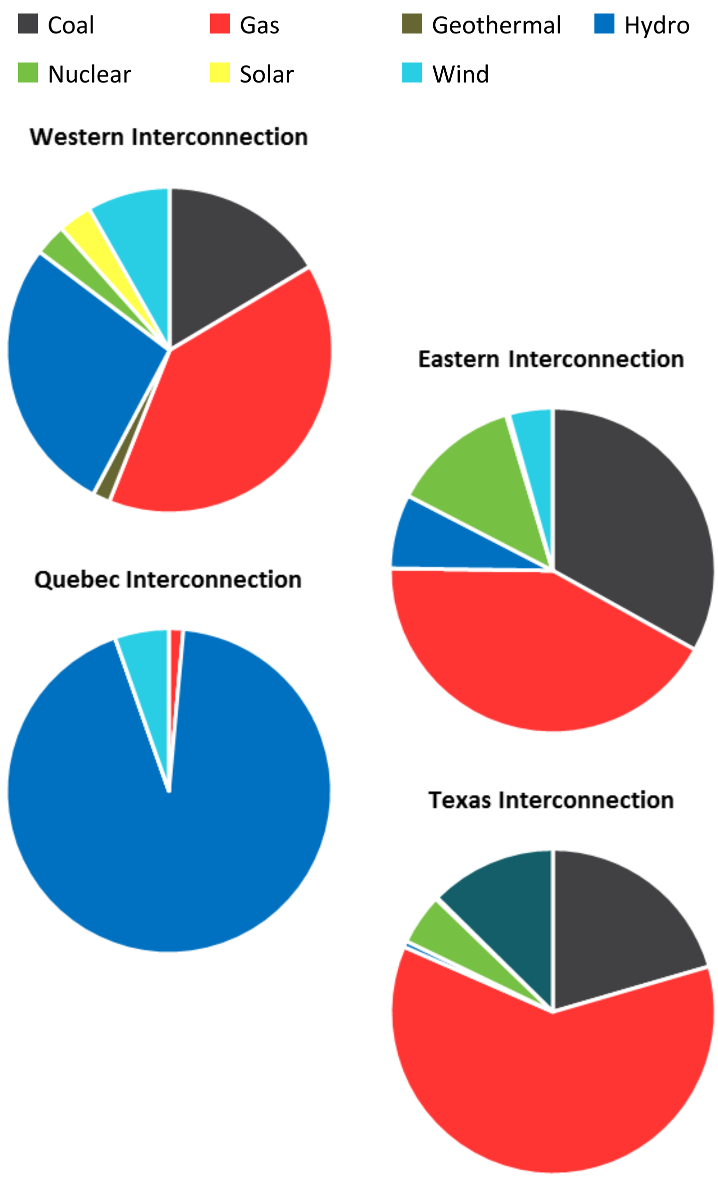
Compared to the densely populated East, the Western Interconnection is characterized by vast distances between centers of generation and load, except along the coast, where the majority of load in the Interconnection is located.

Resource Portfolio

The West has a diverse mix of resources, including large amounts of hydro and renewable resources. The Western Interconnection relies less on coal and nuclear resources than the Eastern Interconnection. The roughly 265,000 MW of generation capacity in the Western Interconnection make up approximately 20 percent of all capacity in the United States and Canada. However, the Interconnection has 35 percent of all wind and solar capacity, and 40 percent of all hydro capacity.

> *Like the Texas and Eastern Interconnections, the West's reliance on natural gas generation is heavy and growing. Entities in all three interconnections are facing challenges at the interface of these two industries. As reliance on natural gas continues to grow, so will these challenges.*

Installed Capacity by Resource Type[6]



[1] National Centers for Environmental Information, National Oceanic and Atmospheric Administration
[2] The National Map, US Geologic Survey
[3] Environmental Conservation Online System, U.S. Fish & Wildlife Service
[4] Environmental Data Viewer, WECC
[5] Transmission Availability Data System, NERC
[6] U.S. Energy Information Administration; Statistics Canada

Contents

Events & Outages

- Protection System Misoperations
- Events
- Loss-of-Load Events
- Generation Outages
- Transmission Outages

2015 in Brief

Protection System Misoperations: 301

Events Reported: 100

Unplanned Generation Outages: 9,363

Unplanned Transmission Outages: 2,428

While major outages of the BES are rare, minor events and outages are a common occurrence in a system as complex as the Western Interconnection. Many factors contribute to outages, including:

» the multitude of elements required to operate the system,

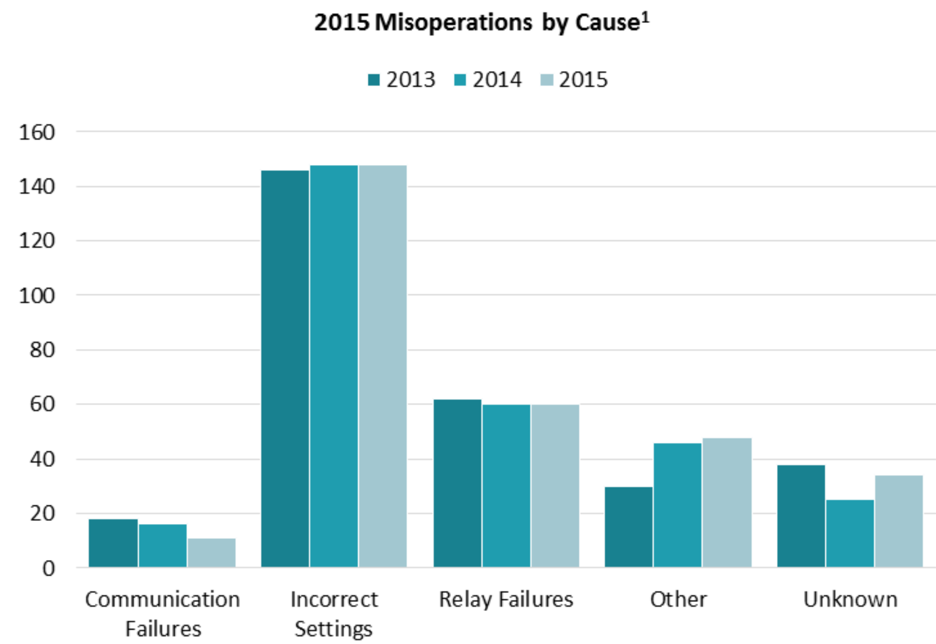
» the line exposure resulting from serving such a vast geographical area, and

» the complex array of protection systems and devices in the Interconnection.

This section provides information about misoperations of protection systems, reported events and unplanned outages of generation and transmission elements. This section only describes events and outages in the United States.

Protection System Misoperations

A misoperation can be either the failure of a protection system to successfully operate as intended or an unnecessary operation. In 2015 there were 301 protection system misoperations, up from 295 in 2014.



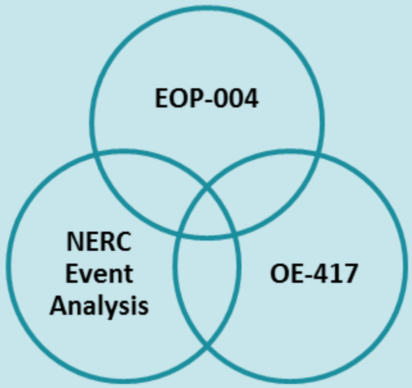
Misoperations Due to Incorrect Settings

Historically, half of all misoperations are caused by incorrect settings. Best practices can reduce the number of these misoperations.

» Requiring both new and experienced engineers and technicians to participate in training before new relay models are introduced ensures they are familiar with the equipment and helps reduce errors.

» Peer review of relay settings during the design phase identifies errors before the settings are implemented. Review is especially important when the settings are complex or the relay engineer is inexperienced.

» Performing fault studies before new facilities are put in service and periodically thereafter, as well as when facilities are retired, will allow entities to identify setting changes necessary to accommodate system configurations.



Event Reporting

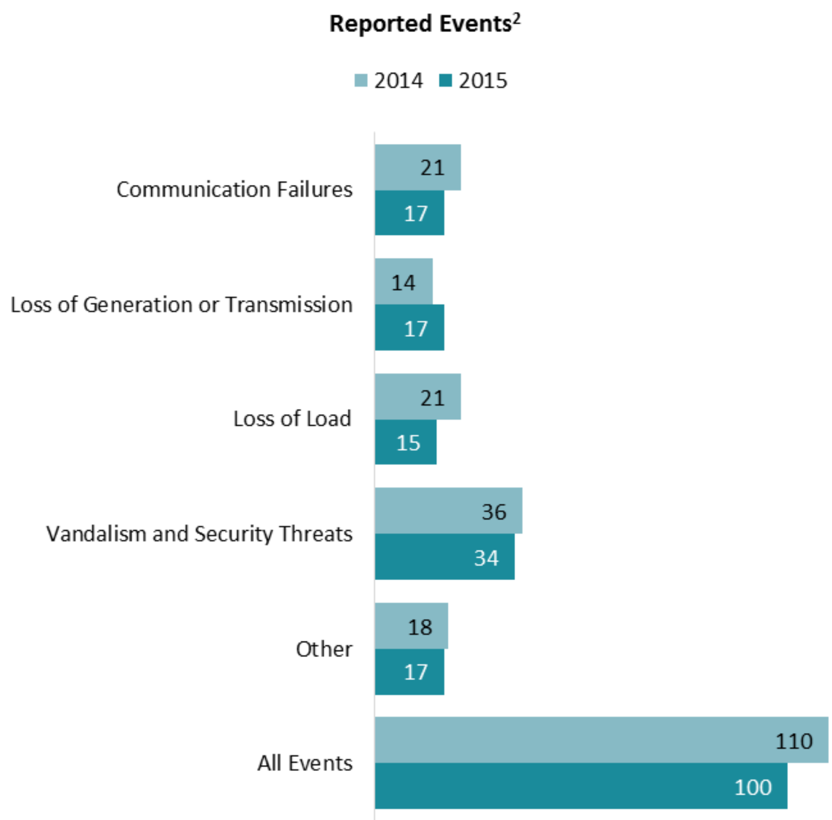
The 2016 State of the Interconnection describes information about events from three sources. Duplicate reports from multiple sources are excluded here.

- » NERC Reliability Standard EOP-004 requires entities to report events to their Regional Entity according to criteria established in the standard.
- » The Department of Energy requires entities to file Form OE-417 when an event meets defined thresholds.
- » Through NERC's Event Analysis Process, entities voluntarily collaborate with NERC and their Regional Entity to review and learn from events in a non-punitive setting.

Events

There were 100 unique events reported to WECC in 2015, down from 110 in 2014. These incidents and disturbances ranged from copper theft at a substation to the loss of 1,200 MW of firm load during a severe storm.

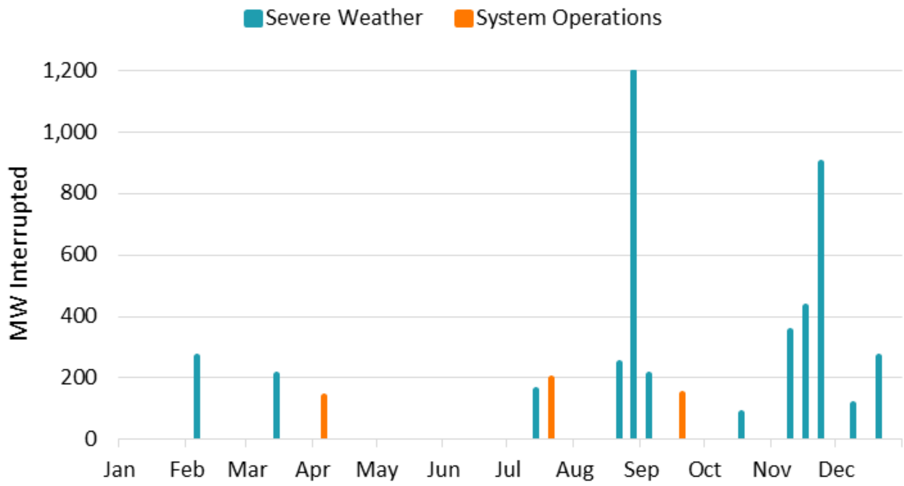
Reportable events are events that meet specific criteria, such as a certain amount of load lost or a certain number of customers affected. Events are reported through multiple channels, each with its own criteria.



Loss-of-Load Events

There were 15 reportable loss-of-load events reported to WECC in 2015. Not all disturbances resulting in the loss of load are considered reportable loss-of-load events. Criteria for reporting loss-of-load events vary by source and circumstance.[3]

2015 Loss-of-Load Events by Cause[4]



A majority of reported loss-of-load events in 2015 were caused by severe weather. Severe weather-related events typically coincide with periods of high demand in late summer and early winter, when the system is most stressed. This is an important consideration for system planners and operators.

Vandalism and Security Threats

Many of the events reported to WECC in 2015 were incidences of vandalism or security threats.

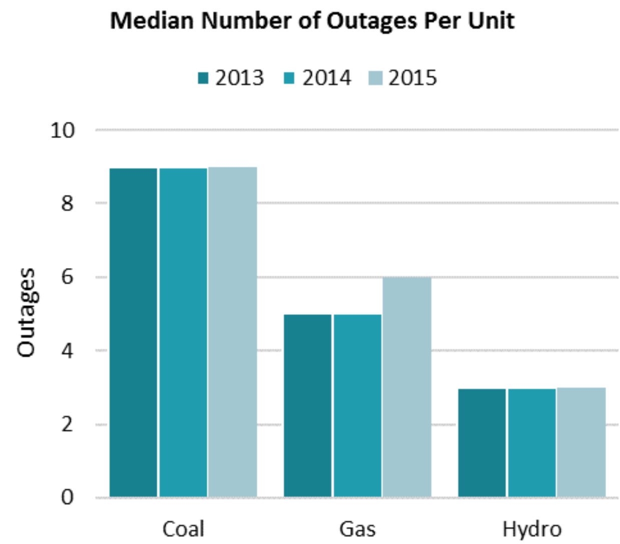
Only two were known to be sabotage—deliberate damage to a facility with intent to undermine the performance of the electrical system.

None of the 34 reported events resulted in significant operational disruption.

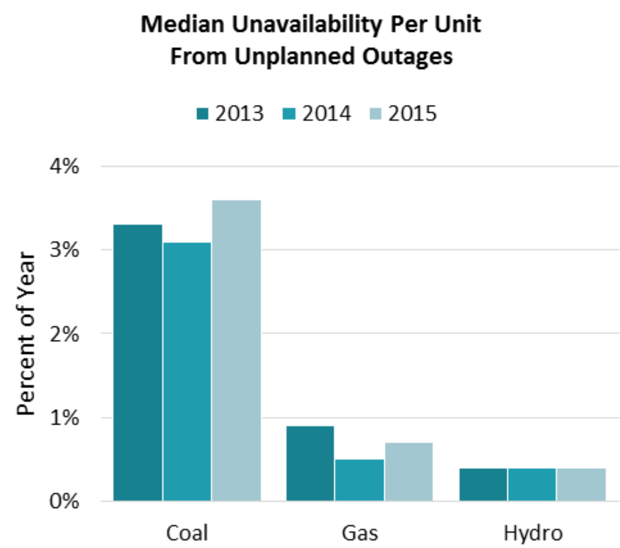
Generation Outages

NERC's Generating Availability Data System (GADS) is used to collect information about outages of conventional generating units 20 MW and above. Collection of information about outages of wind units will be phased in beginning in 2017. Development of a plan to collect solar outage information is underway, with implementation expected to begin in 2018.

There were 9,363 outages of conventional generating units in 2015, up 11 percent from 2014.



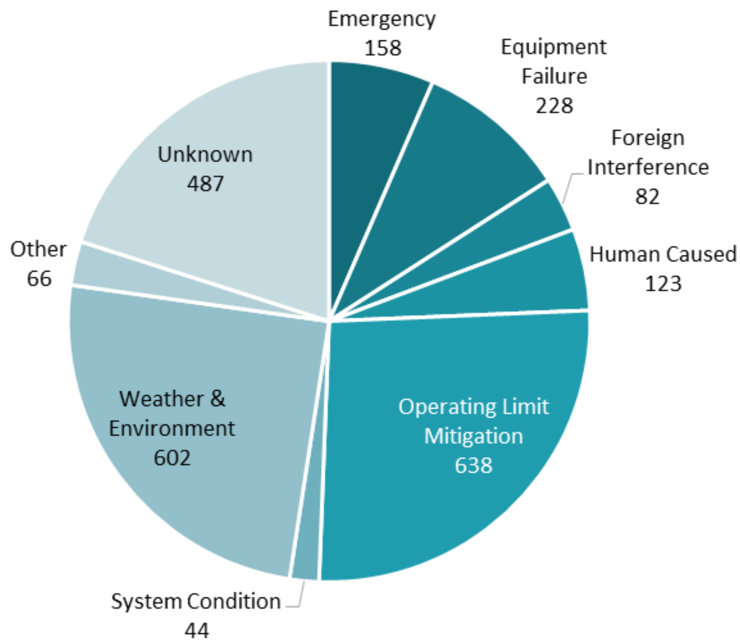
> *There are several reasons that coal units experience a higher forced outage rate than gas or hydro units. These include the age of the typical coal plant, the complexity of these plants, and approaches to maintenance.*

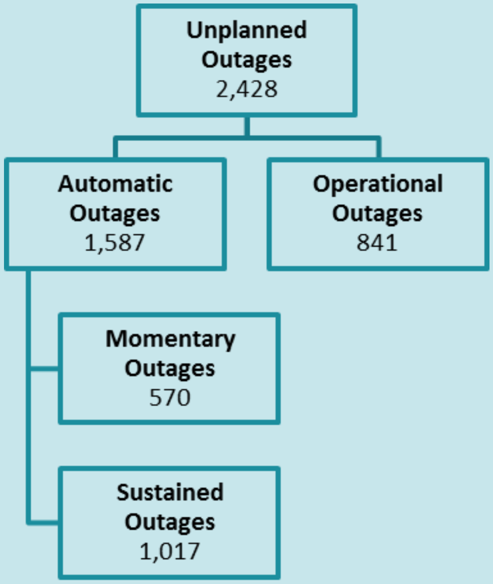


TRANSMISSION OUTAGES

NERC's Transmission Availability Data System (TADS) is used to collect information about outages of transmission equipment. In 2015 there were 2,428 unplanned transmission outages, up 6 percent from 2014.[5] The number of outages of unknown cause has remained steady over the last three years. Of the 487 in 2015, 248 lasted more than one minute. It is important to understand entity practices around identifying the causes of outages to ensure critical outages are addressed.

2015 Unplanned Transmission Outages by Initiating Cause





Transmission Outage Categories

Unplanned outages are divided into automatic outages, initiated by an automatic switching mechanism, and operational outages, initiated manually. The majority of operational outages are for operating limit mitigation.

Automatic outages are further divided into momentary outages, lasting less than one minute, and sustained outages, lasting one minute or more.

[1] Misoperations categories:

- **Communication Failures**: Malfunction of communication systems associated with a protection scheme
- **Incorrect Settings**: Engineering errors by the system owner
- **Relay Failures**: Failed equipment, or improper operation of a relay
- **Other**: Includes problems in the AC inputs and DC controls of a protection systems

[2] Event categories:

- **Communication Failures:** Loss of monitoring and control capability that affects an entity's ability to make operating decisions
- **Loss of Load:** Sustained loss of firm load above defined thresholds
- **Loss of Generation or Transmission:** Loss of generation above defined thresholds or loss of transmission elements due to a common disturbance, without loss of load
- **Vandalism and Security Threats:** Vandalism of or other damage to BES equipment and other security threats, including theft that degrades normal operations or suspicious activity near electric facilities
- **Other:** Includes fuel supply shortages and public appeals to reduce demand

[3] Minimum losses range from 100 to 300 MW.

[4] Peak demand interrupted was estimated for some loss-of-load events.

[5] This report excludes outages of sub-100 kV equipment.

LOAD

» Energy Consumption

» Peak Demand

» Rooftop Solar

Load

The Western Interconnection has a diverse load composition. The majority is concentrated along the West Coast, with pockets in the Southwest and Rocky Mountains. The Northwest is winter-peaking, while other areas are summer-peaking.

2015 in Brief

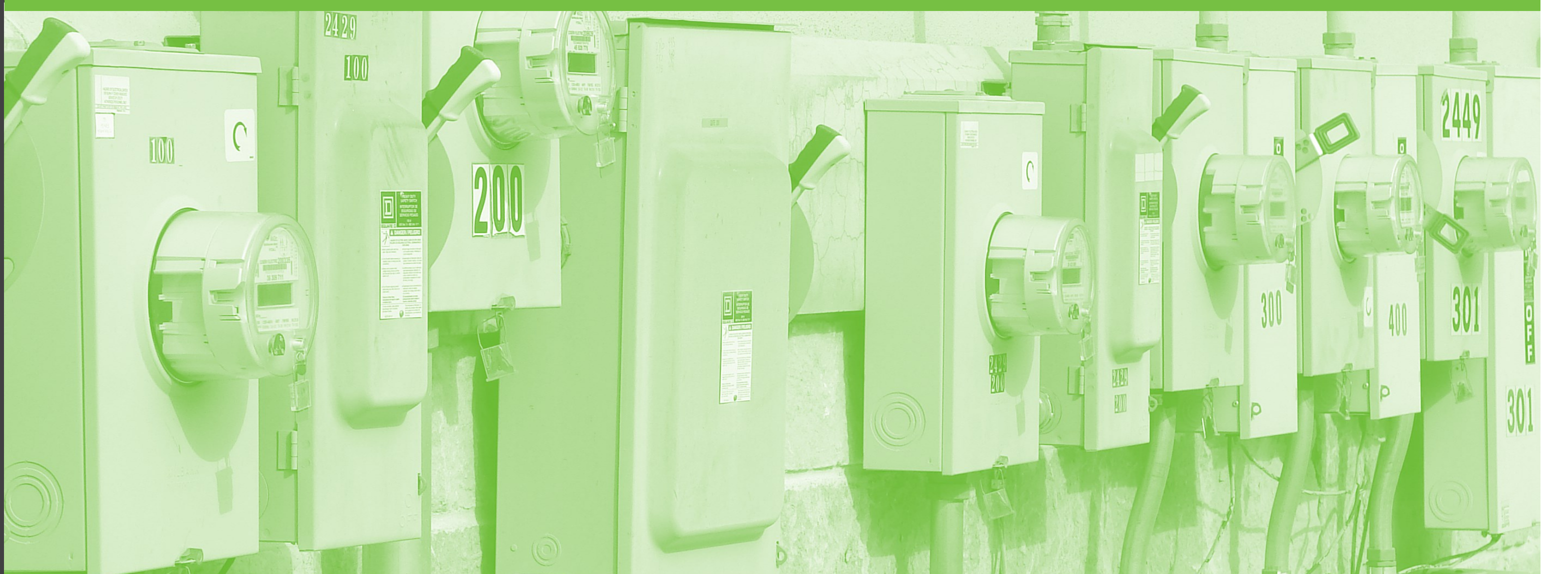
Summer Peak Demand: 150,700 MW

2014-15 Winter Peak Demand: 126,200 MW

Energy Consumption: 883,600 GWh

Over the last several years, annual energy consumption has changed in response to various factors driving demand. These include fluctuations in weather patterns and economic conditions.

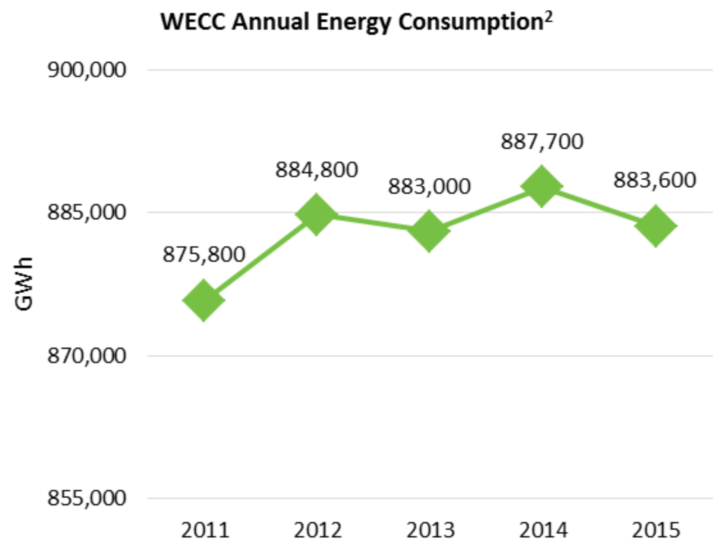
This section describes energy consumption, peak demand and the growing penetration of rooftop solar.



Energy Consumption

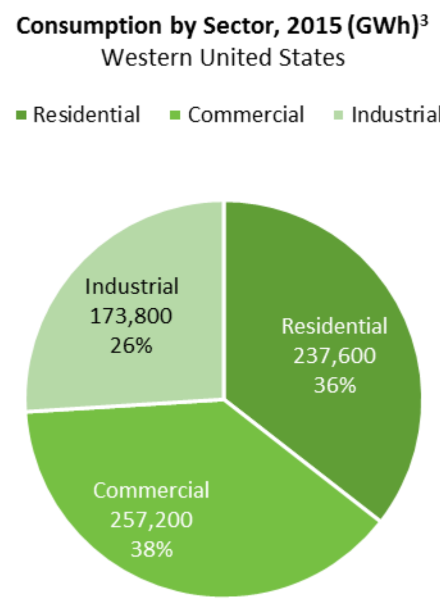
2015 was the second warmest year on record for the contiguous United States and the 19th consecutive year with above-normal temperatures.[1]

The first six months of the year were especially warm across the West, resulting in decreased demand during the winter months. Even though summer peak demand in 2015 was 2 percent higher than in 2014, less electricity was consumed during the year overall.



Consumption by Sector

The breakdown of electricity consumption by sector remains relatively unchanged over time. An increase in residential demand associated with a warm spring was offset by decreases in industrial and commercial demand.

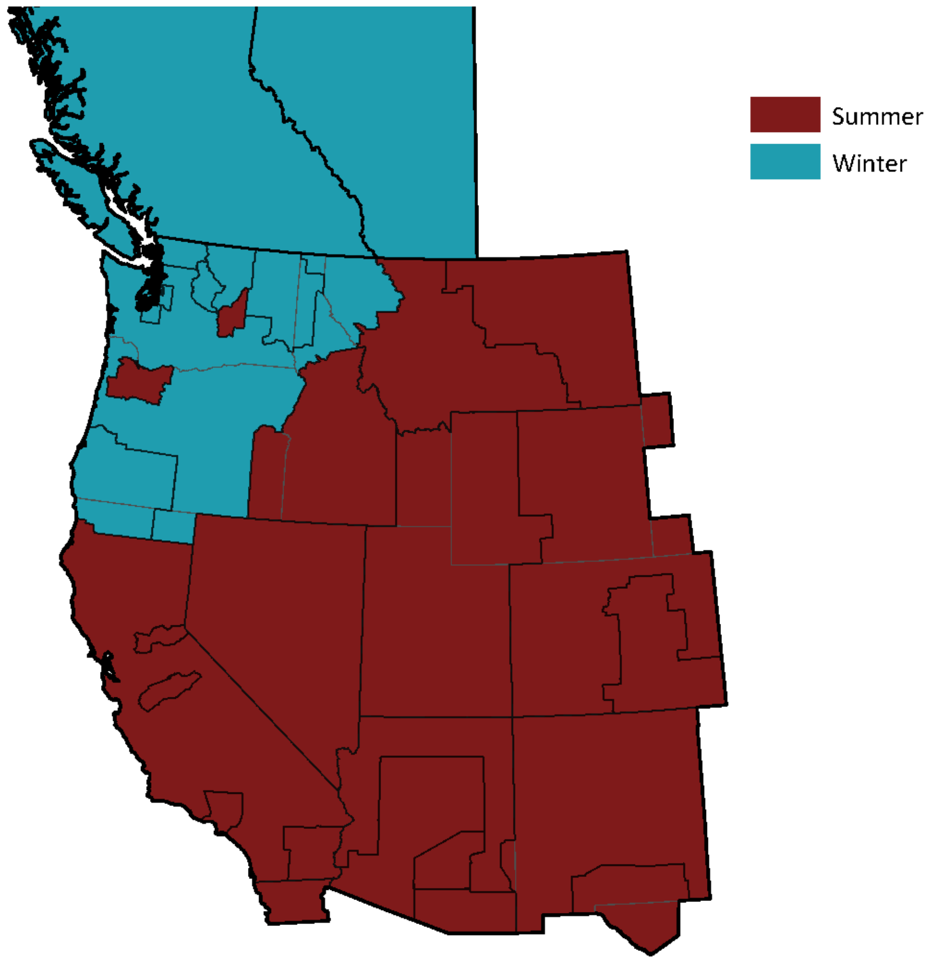


Peak Demand

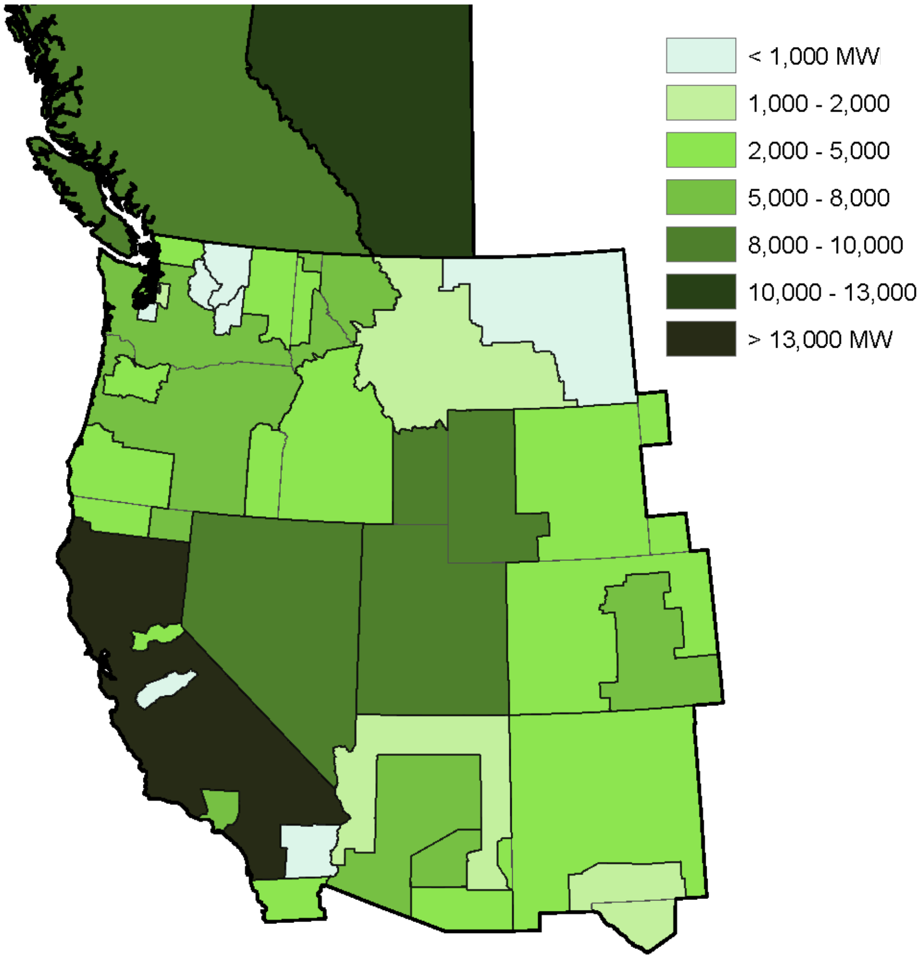
The Western Interconnection covers a large geographic region with diverse weather and temperature conditions. Different areas within the region peak at different times of year.

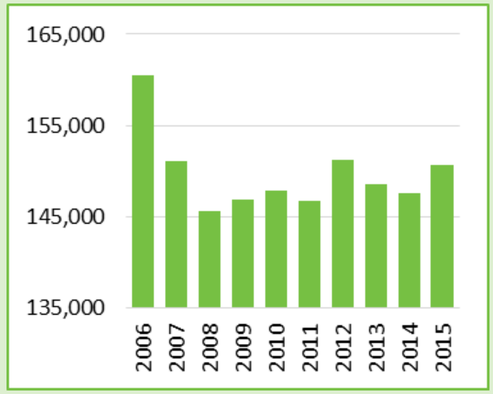
The Western Interconnection as a whole experiences peak demand in the summer, but areas in the Pacific Northwest peak in the winter. This diversity allows the Northwest to export large amounts of electricity to California and the Southwest during the summer, when demand is lower in the Northwest.

Typical Peak Season by Balancing Authority Area



2015 Non-Coincident Peak Demand by Balancing Authority Area[4]

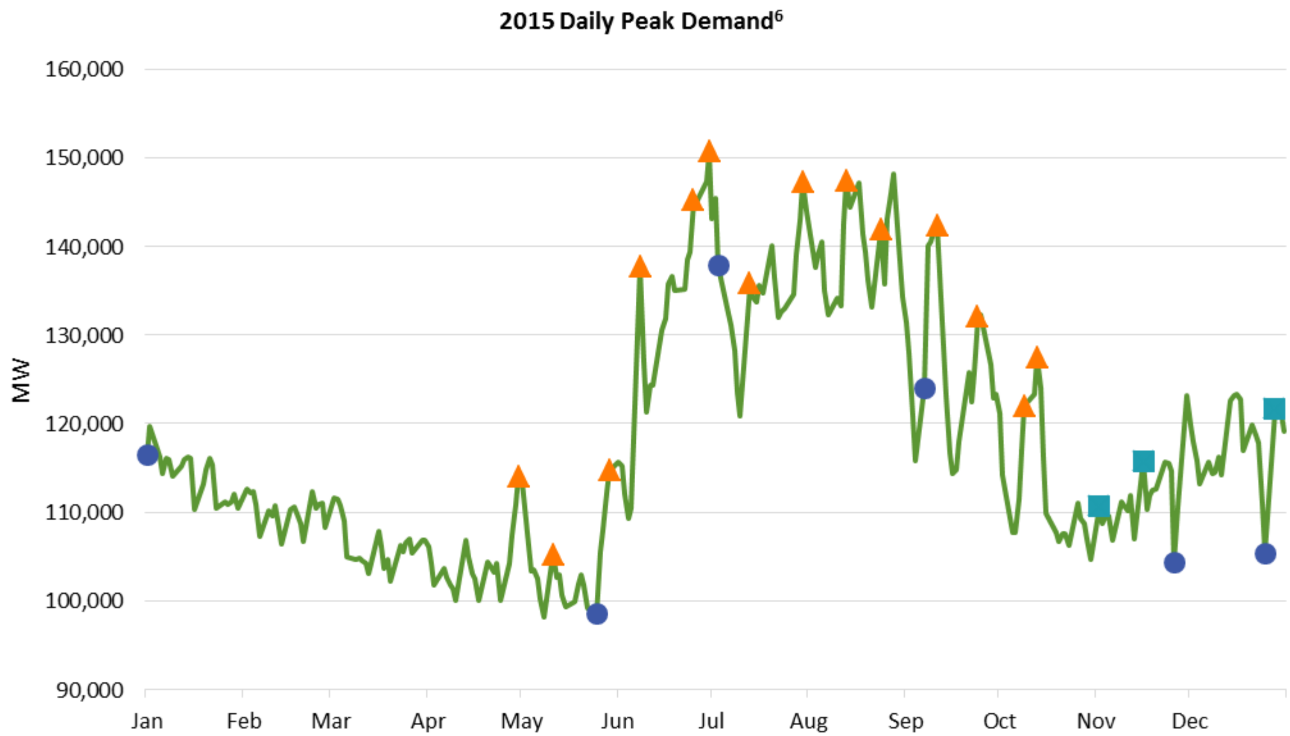




WECC Coincident Peak

Many factors drive peak demand, including sustained periods of hot weather. The 2015 WECC coincident peak occurred on June 30 as a result of an earlier-than-usual heatwave across the Interconnection.[5] West-wide hot weather was a major driver of the WECC all-time high peak demand in 2006.

The economy also affects demand. Peak demand in 2008 was more than 5,000 MW lower than in the year before, in part due to adverse economic conditions.



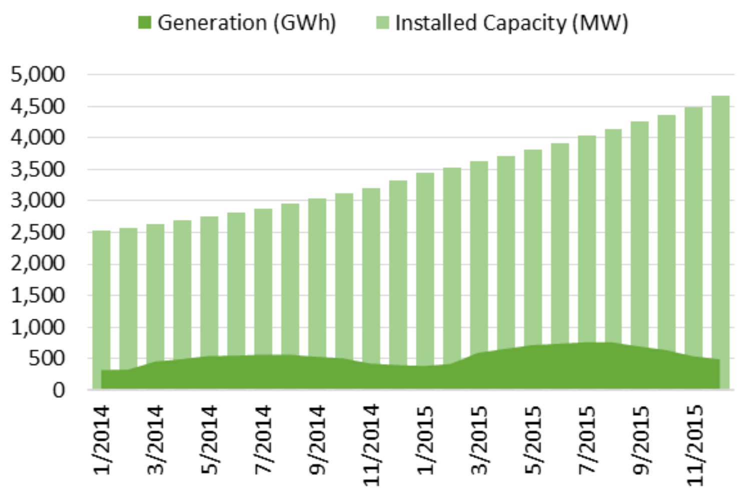
- ▲ Periods of warm weather significantly increase demand for electricity, primarily for air conditioning. June was the warmest on record in five Western states, and the second-warmest in the United States.
- ■ Storms and freezes cause spikes in demand in the winter months. One cold snap in the Southwest increased demand in the area by 25 percent above the week before.
- ● Some holidays are associated with observable decreases in demand. Peak demand is historically 9 percent lower on Thanksgiving and 6 percent lower on Christmas than the day before.

ROOFTOP SOLAR

Installed capacity of rooftop solar in the Western Interconnection has increased by 85 percent over the last two years. Capacity has grown linearly, averaging a net increase of 115 MW per month during 2015.

The majority of this growth is in California, where lots of sun, electricity prices and incentives make rooftop solar a viable option for a large number of consumers. Other states may see a similar impact if economic, environmental, technical and policy factors make rooftop solar more cost effective.

Rooftop Solar[7]



Increases in rooftop solar create operational challenges because it is behind-the-meter generation. It cannot be measured or dispatched by system operators, but its variability must be balanced by other resources.

Rooftop Solar Installed Capacity
December 2015

California	3,391 MW
Arizona	642 MW
Colorado	255 MW
Nevada	129 MW
Oregon	75 MW
New Mexico	74 MW
Utah	51 MW
Washington	49 MW
Montana	6 MW
Idaho	5 MW
Wyoming	2 MW
Total	4,679 MW

[1] State of the Climate, National Oceanic and Atmospheric Administration

[2] 2016 LAR Data Request, WECC

[3] Electric Power Monthly, US Energy Information Administration (EIA)

[4] 2016 LAR Data Request, WECC. Non-coincident peak refers to a local maximum in demand within a given Balancing Authority Area alone, without regard to demand in the rest of the Interconnection.

[5] Coincident peak refers to a local maximum in demand across the Interconnection as a whole.

[6] 2016 LAR Data Request, WECC

[7] Form EIA-826, EIA

GENERATION

Generation

The Western Interconnection is comprised of a varied mix of generation resources, distinct by geographic area. This section contains information about generation in the West, in terms of both the resource portfolio and net generation. This section also describes the generation additions and retirements and consumption of natural gas.

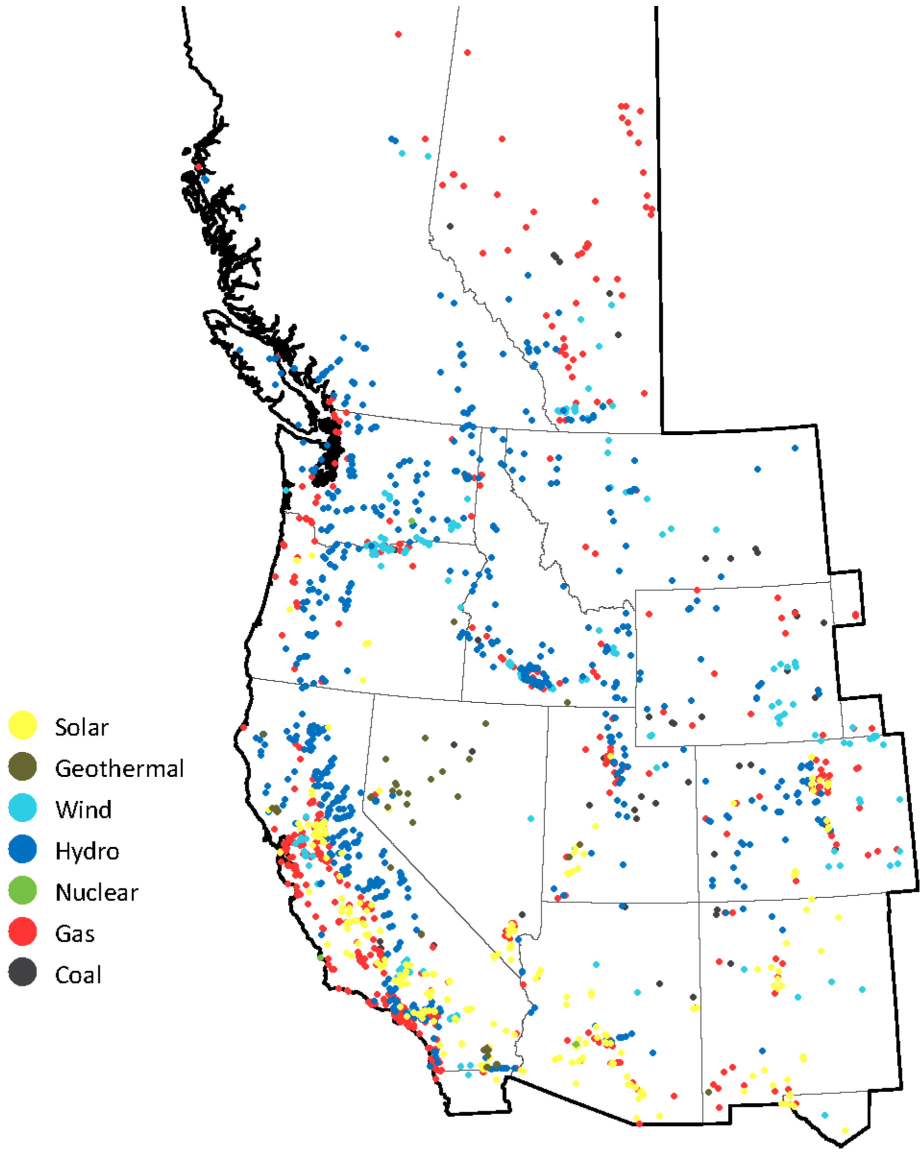
2015 in Brief

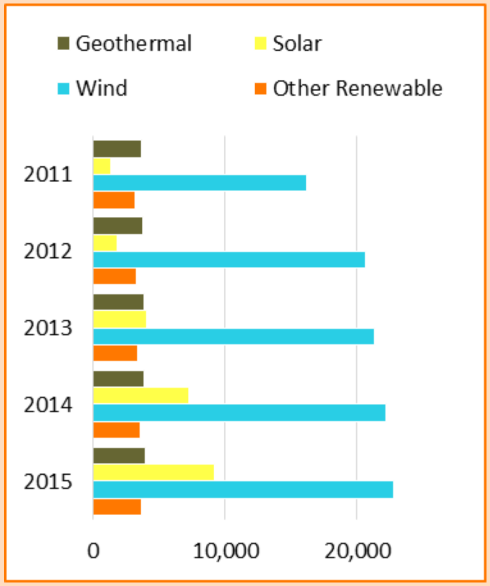
Nameplate Capacity: 265,000 MW

Net Generation

- **from Fossil Fuels:** 500,300 GWh
- **from Hydro:** 196,600 GWh
- **from Nuclear:** 60,200 GWh
- **from Renewables:** 83,400 GWh

2014 Utility-Scale Generating Resources[1]





Growth of Renewable Resources

Over the last five years, growth of wind capacity has begun to stabilize, while growth of utility-scale solar capacity has increased.

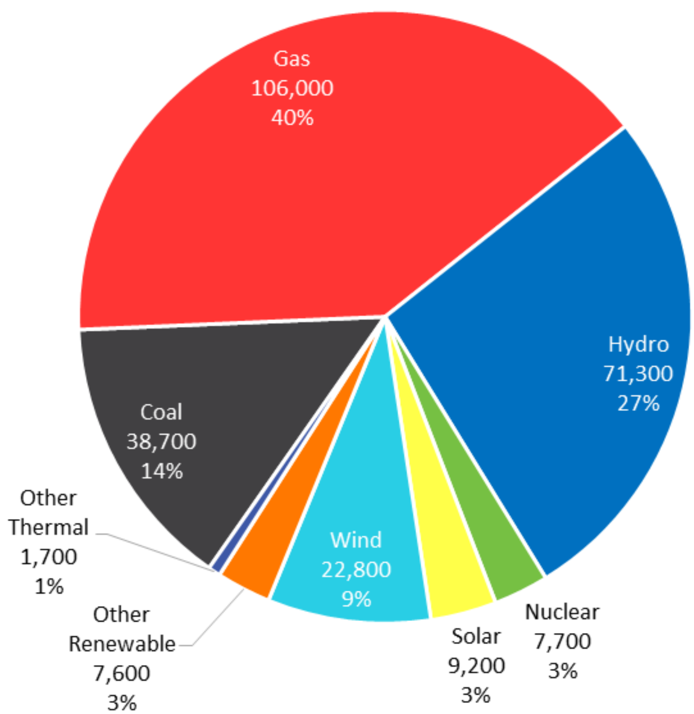
The number of new solar installations added each year has remained relatively unchanged since 2011. However, advances in solar technology have significantly increased their capacity. The average new installation in 2015 had more than four times the capacity of the average installation in 2011.

Resource Portfolio

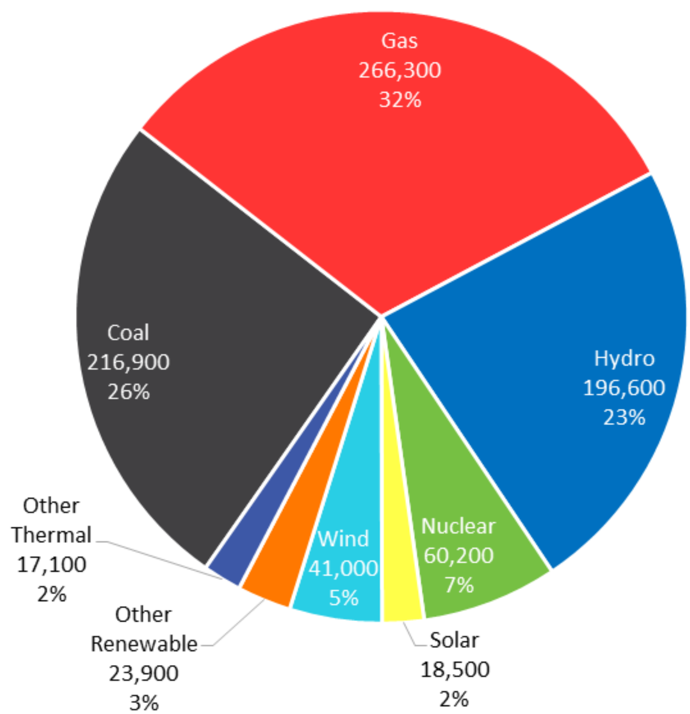
In 2015 the combined nameplate capacity of all utility-scale resources in the Western Interconnection was 265,000 MW.

Depending on the resource type, there can be a significant difference between nameplate capacity and the capacity actually available at any given time. The amount of electricity generated by a unit can be limited by operational decisions, environmental and system conditions, political and economic considerations, the efficiency of the technology, and the availability and quality of fuel.

2015 Nameplate Capacity (MW)[2]



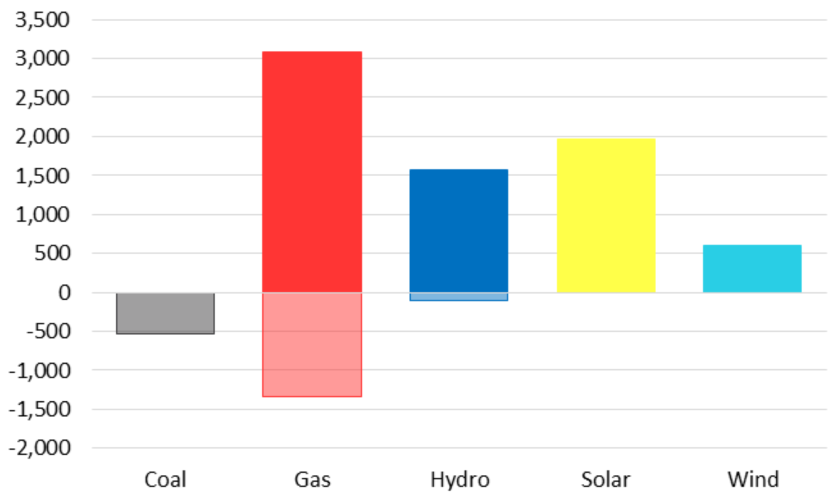
2015 Net Generation (GWh)[3]



Additions and Retirements

The resource mix of the Western Interconnection is undergoing a significant change. Environmental regulations and an aging fleet contribute to changes in coal capacity. Renewable portfolio standards help drive development of wind and solar resources. Increased reliance on natural gas is changing how the gas and electric systems are operated.

2015 Generation Additions and Retirements (MW)[4]



Essential Reliability Services

Changes to the resource portfolio are altering the operational characteristics of the Interconnection. They lead to several challenges, including ensuring the resource portfolio provides sufficient voltage and frequency support and ramping capability to balance generation and load. Without these Essential Reliability Services (ERS), the grid cannot be operated reliably.

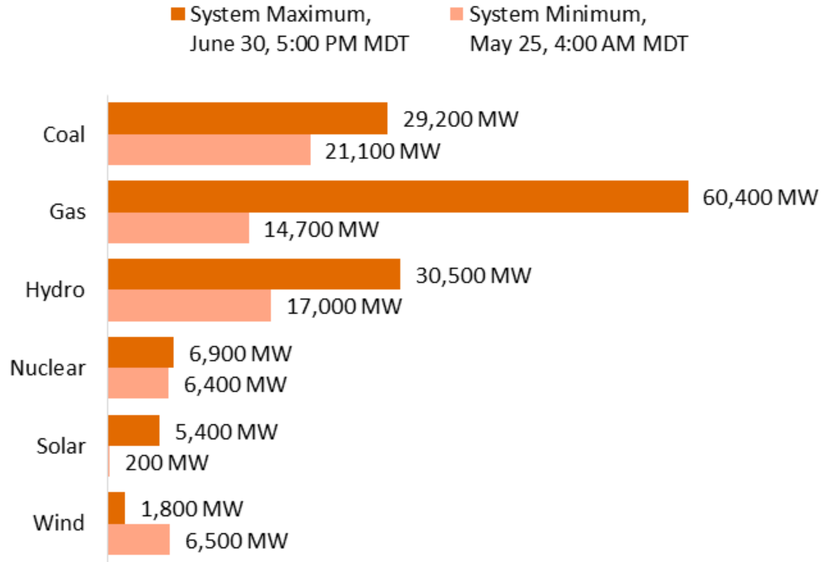
As variable generation is added to the system, more ERS are needed. Sufficient resources with the flexibility to respond to sudden changes in generation and demand strengthen the grid. These services are needed both Interconnection-wide and locally.

NET GENERATION

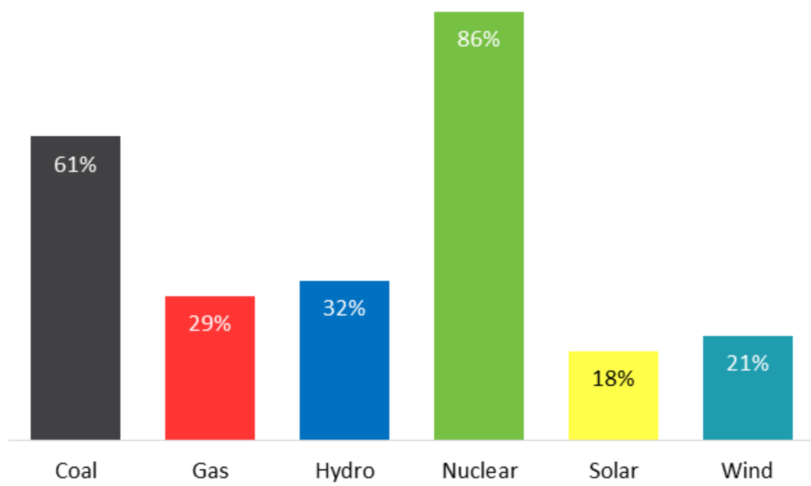
The vast majority of generation on the system comes from coal, gas and hydro. This is the case at both system maximum and minimum generation.

Capacity factors vary greatly depending on the type of generator. Coal and nuclear units have a high capacity factor, while generation from wind and solar units is limited by weather conditions and the amount of sunlight available. Capacity factors for gas and hydro vary, since they can be used for reserves due to their ability to quickly respond to system need.

2015 Net Generation at System Extremes[5]



2015 Estimated Capacity Factors[6]



2015 Net Generation by State/Province (GWh)[7]

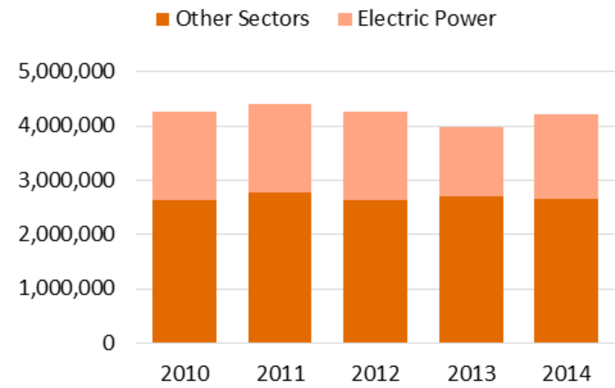
	Coal	*Gas*	*Hydro*	*Nuclear*	*Solar[8]*	*Wind*	*Other*	*Total*
Arizona	37,200	33,700	6,500	32,500	2,800	400	100	113,200
California	-	103,300	13,900	18,500	12,600	12,200	20,300	180,800
Colorado	31,500	11,800	1,500	-	300	7,400	-	52,300
Idaho	-	3,700	8,200	-	-	2,500	300	14,700
Montana	16,300	800	9,700	-	-	2,000	700	29,500
Nevada	2,700	28,100	2,300	-	1,500	300	3,600	38,500
New Mexico	20,400	9,400	100	-	600	2,100	100	32,700
Oregon	2,400	16,000	32,300	-	-	6,700	700	58,100
Utah	31,600	7,600	600	-	-	600	600	41,000
Washington	5,000	12,800	74,300	8,200	-	7,100	1,100	108,500
Wyoming	42,700	0	900	-	-	3,800	-	47,400
Alberta	39,300	16,000	1,700	-	-	4,100	600	61,700
British Columbia	-	900	60,700	-	-	1,200	3,600	66,400
Baja California (WECC)	-	9,000	-	-	-	-	3,900	12,900

Natural Gas

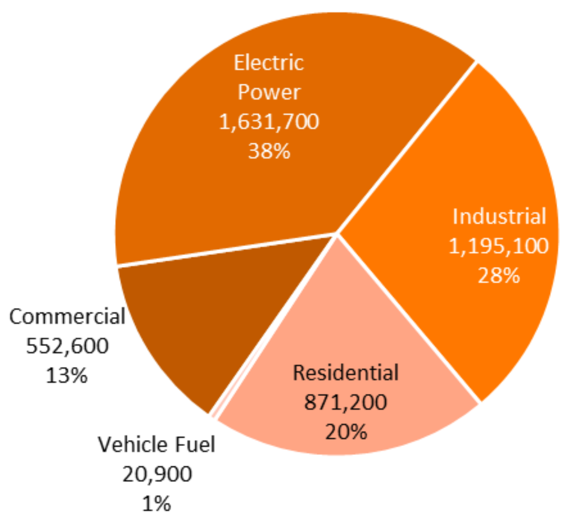
Demand for natural gas in the electric power sector has fluctuated widely, while demand in other sectors has remained relatively steady. Electric power demand for natural gas has varied by an average of 10 percent each year since 2010.

More than half (59,900 MW) of natural gas generating capacity is from combined-cycle units, which typically provide base-load generation. There are also 29,200 MW of combustion-turbine units installed. These units are often used to meet peak load and to follow variable generation, like wind and solar. Twenty percent of combustion-turbine capacity can switch between gas and oil.

Natural Gas Consumption by Sector (MMcf)[9]



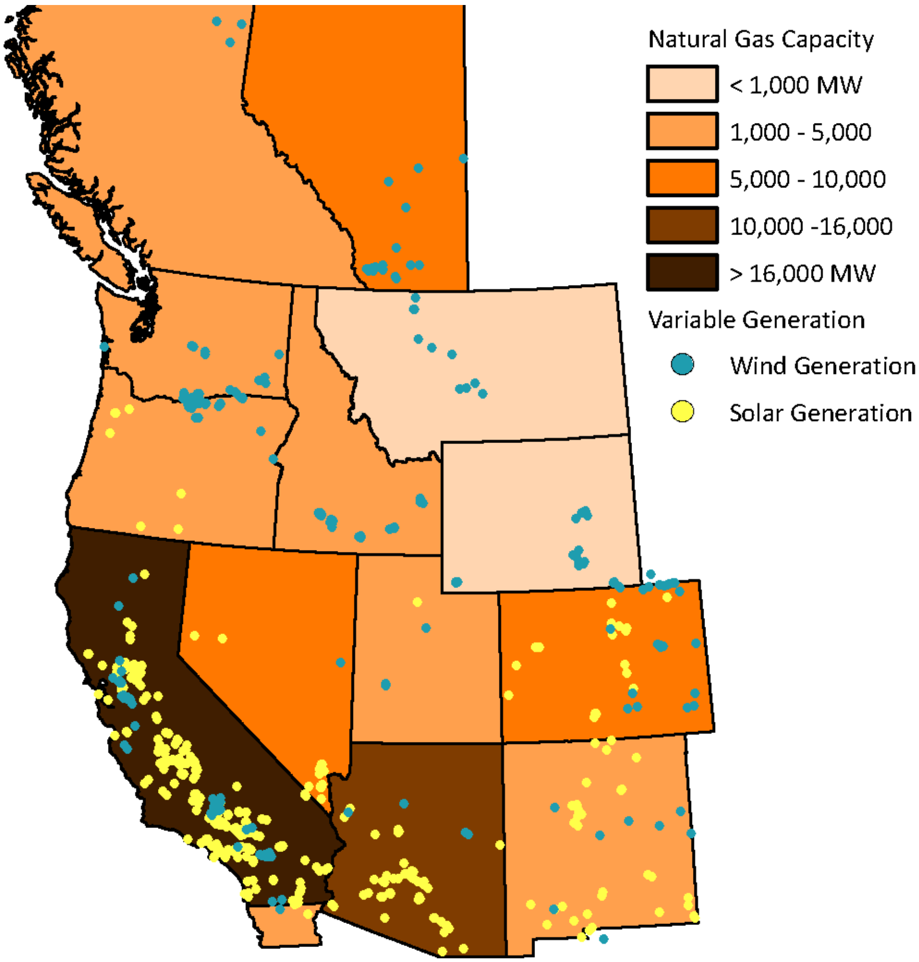
2014 Natural Gas Consumption (MMcf)[10]



Natural Gas Capacity by Technology

	Nameplate Capacity[11]	*Avg. Capacity Factor*[12]
Combined Cycle	59,900 MW	56%
Combustion Turbine	29,200 MW	7%
Steam Turbine	15,700 MW	12%
Other	1,300 MW	-
Total	106,000 MW	29%[13]

2014 Natural Gas and Variable Generation[14]



The greatest increase in gas generation capacity has been in California. The state relies heavily on generation from gas to balance an increasing amount of variable generation. California's gas system includes a network of storage fields that are relied on to meet the needs of the electric system, as well as natural gas consumption.

Aliso Canyon Gas-Electric Coordination

In October 2015, a gas leak was discovered at the Aliso Canyon natural gas storage facility in Southern California. Aliso Canyon is a critical component of the gas system in the Los Angeles Basin. The facility not only provides gas to customers and power plants, it also provides the gas system pressure regulation necessary for ramping gas plants to balance variable generation.

Aliso Canyon is one of the largest natural gas storage facilities in the United States, with 86 billion cubic feet (Bcf) of working gas storage capacity. Currently, there are only 15 Bcf of working gas stored in Aliso Canyon. It is uncertain when gas can be injected into the facility again because the facility is undergoing leak and safety inspections. Loss of this facility will have operational implications possibly resulting in electric power curtailments. The Aliso Canyon situation demonstrates how electric reliability is impacted by a growing dependence on natural gas.

[1] 2015 LAR Request, WECC

[2] 2016 LAR Request, WECC

[3] Peak Reliability

[4] 2016 LAR Request, WECC

[5] Peak Reliability

[6] Peak Reliability

[7] Form EIA-923, EIA; 2016 LAR Request, WECC

[8] Includes only utility-scale installations

[9] Natural Gas Monthly, EIA

[10] Natural Gas Monthly, EIA

[11] Form EIA-860, EIA

[12] Electric Power Monthly, EIA

[13] Peak Reliability

[14] Form EIA-860, EIA; 2016 LAR Request, WECC

TRANSMISSION

- Path Flow
- Net Interchange
- SOL Exceedance

TRANSMISSION

The Western Interconnection is characterized by long transmission lines connecting remote generation to load centers. Around 121,200 circuit-miles of transmission lines cross the Western Interconnection.

This section contains information about the structure and use of this complex transmission system, including the flow on WECC paths and the incidence of System Operating Limit (SOL) exceedances.

2015 in Brief

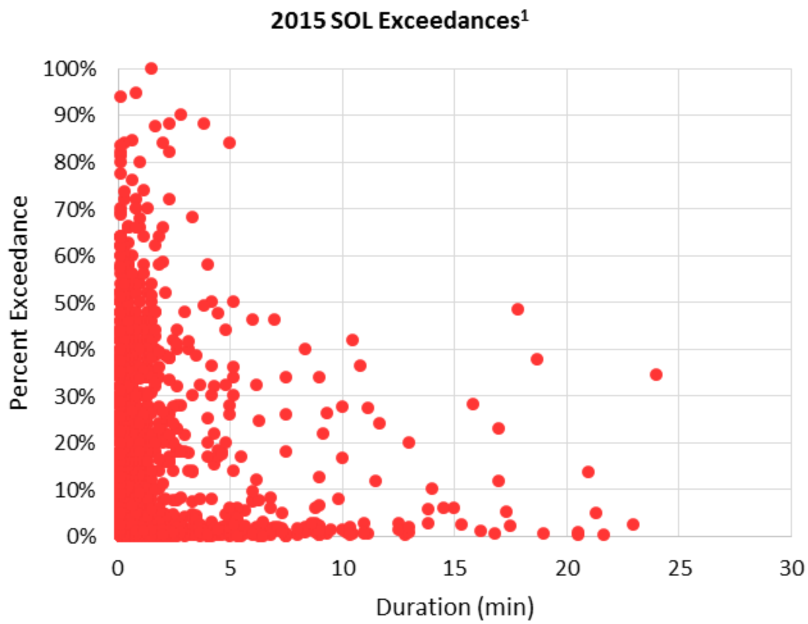
Transmission Miles: 121,200

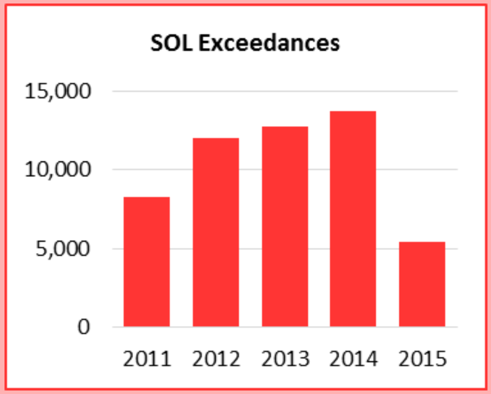
WECC Paths: 66

SOL Exceedances: 5,396

SOL Exceedance

On any given path, SOLs change to reflect system conditions. Instances where flows on a transmission path exceed the SOL are relatively rare. In 2015 there were 5,396 SOL exceedances, representing on average 1 percent of the year. Half of exceedances lasted less than 10 seconds, with another 30 percent lasting less than one minute.





Reduction in SOL Exceedance

There was a 60 percent reduction in the number of SOL exceedances in 2015 from the previous year. There are several explanations for this reduction:

- An increase in the number of high-voltage elements in the Pacific Northwest and Canada has decreased how often limits are temporarily lowered.
- More local generation, milder winter weather, and changing economic conditions have reduced interchange between areas.
- The methodology for developing SOLs is periodically revised by Peak Reliability, in cooperation with industry experts.

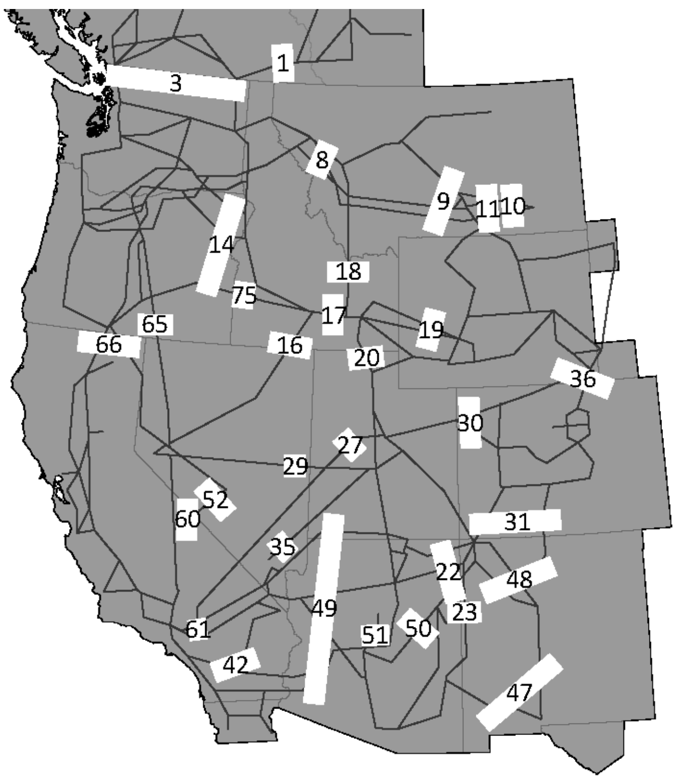
Path Flow and Net Interchange

Key transmission lines in the Western Interconnection are grouped into 66 numbered paths for planning and operational purposes.

One measure of congestion on WECC paths is the U75 metric, which measures the percent of time the flow on the path is above 75 percent of the path's operating limit.

A low U75 does not necessarily indicate a path is underutilized. Inversely, a high U75 does not necessarily indicate congestion. Many factors determine operating limits.

Major WECC Paths

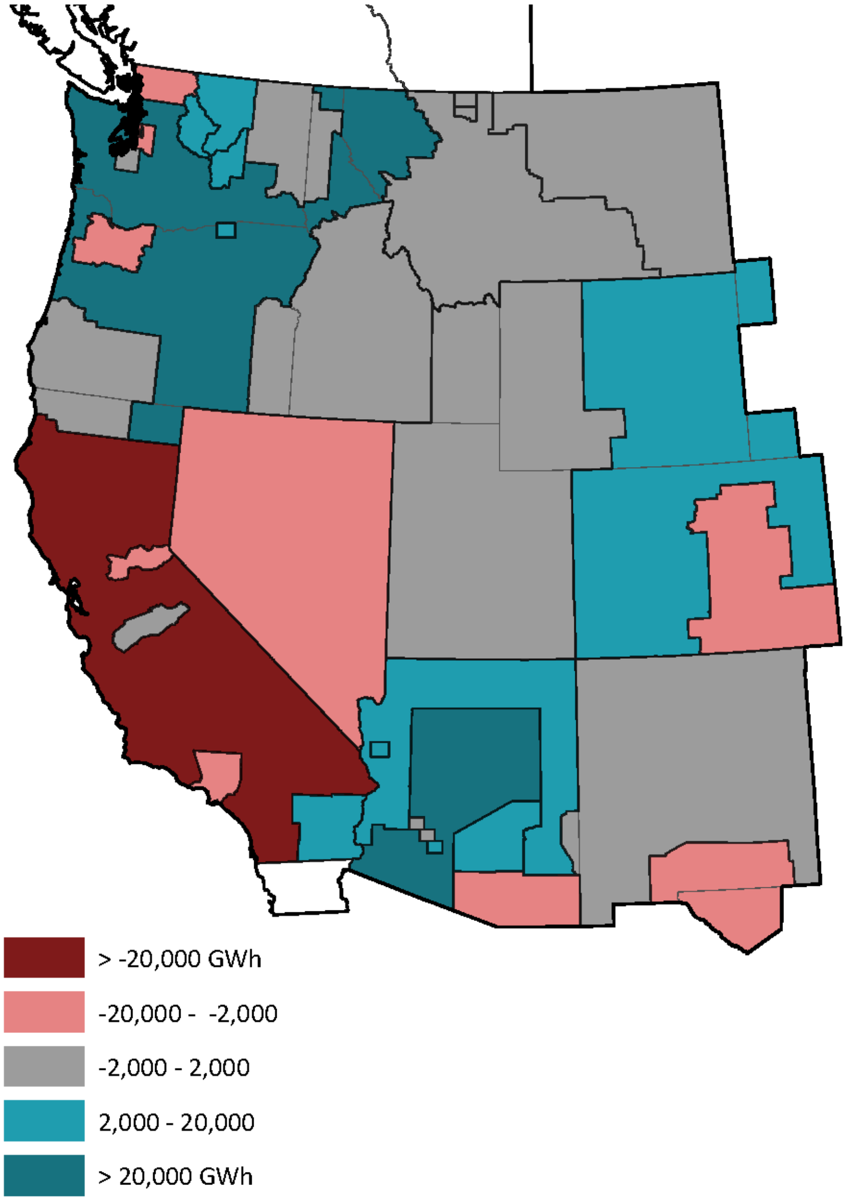


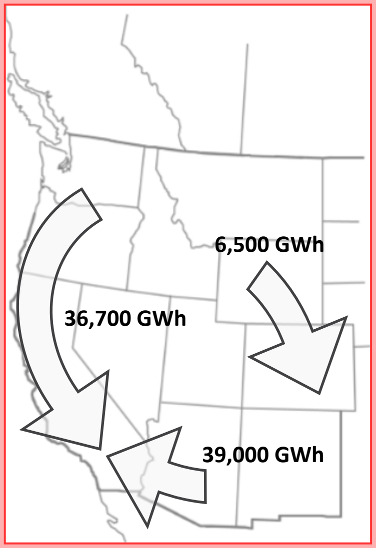
2015 Path Flow[2]

Path	*U75*	*Path*	*U75*
Path 1	3%	Path 35	7%
Path 3	16%	Path 36	36%
Path 8	9%	Path 42	4%
Path 9	6%	Path 47	11%
Path 10	35%	Path 48	27%
Path 11	25%	Path 49	0%
Path 14	1%	Path 50	0%
Path 16	0%	Path 51	0%
Path 17	0%	Path 52	1%
Path 18	22%	Path 60	0%
Path 19	38%	Path 61	0%
Path 20	1%	Path 65	24%
Path 22	0%	Path 66	41%
Path 23	0%	Path 75	0%
Path 27	27%	Path 76	0%
Path 29	0%	Path 78	1%
Path 30	6%	Path 79	2%
Path 31	2%	Path 83	3%

Some paths (e.g., Path 10, Path 19) were built to carry electricity from large plants. High levels of flow are not unusual for these paths.

2014 Net Interchange by Balancing Authority Area[3]





Net Interchange

Regional variation in seasonal demand and an abundance of generation capacity in the Pacific Northwest and Southwest, combined with high demand in California, cause electricity to flow in a "doughnut" pattern.

In 2014, California imported 75,400 GWh, more than a quarter of its internal demand for the year. This was nearly evenly split between imports from the Northwest and the Southwest.

[1] Peak Reliability

[2] Peak Reliability

[3] Form FERC-714, Federal Energy Regulatory Commission. Positive interchange indicates a net export of electricity; negative interchange indicates a net import.

OVERSIGHT

OVERSIGHT

Through the Compliance Monitoring and Enforcement Program (CMEP), WECC and NERC assure the reliability of the BES by holding entities in the Western Interconnection accountable for compliance with Reliability Standards. WECC also recommends owners and operators of the BES in the Interconnection for registration with NERC for oversight purposes.

2015 in Brief

Registered Entities (US): 350

International Entities: 34

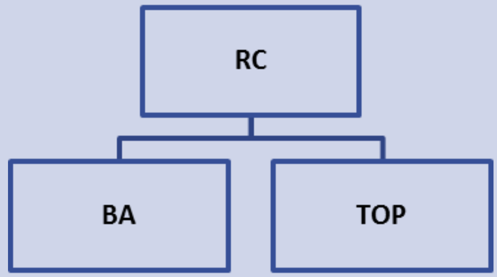
Violations (US): 174[1]

Registration

Approximately 25 percent of all Registered Entities in the United States are under WECC's jurisdiction. There are 350 U.S. entities registered with NERC through WECC. There are also 34 international entities for which WECC provides certain oversight services.

NERC Entity Registration
As of January 8, 2016

	WECC	*United States*	*WECC %*
Generator Owner	235	914	26%
Generator Operator	229	863	27%
Distribution Provider	87	401	22%
Transmission Owner	76	317	24%
Resource Planner	54	174	31%
Transmission Operator	50	177	28%
Transmission Planner	44	178	25%
Balancing Authority	34	105	32%
Transmission Service Provider	34	80	43%
Planning Authority	31	71	44%
DP-UFLS	6	36	17%
Reserve Sharing Group	3	14	21%
Reliability Coordinator	1	15	7%
Registered Entities	350	1,413	25%



Reliability Functions

NERC registers entities according to Reliability Functions. RCs, BAs and TOPs are particularly critical to the reliable operation of the BES and must be certified by NERC.

Reliability Coordinators (RC) have the authority to prevent or mitigate operational emergencies in both next-day analysis and real-time operations.

Balancing Authorities (BA) balance load and generation within their footprint and maintain interconnection frequency.

Transmission Operators (TOP) direct the operations of their local transmission system.

Compliance Assessments

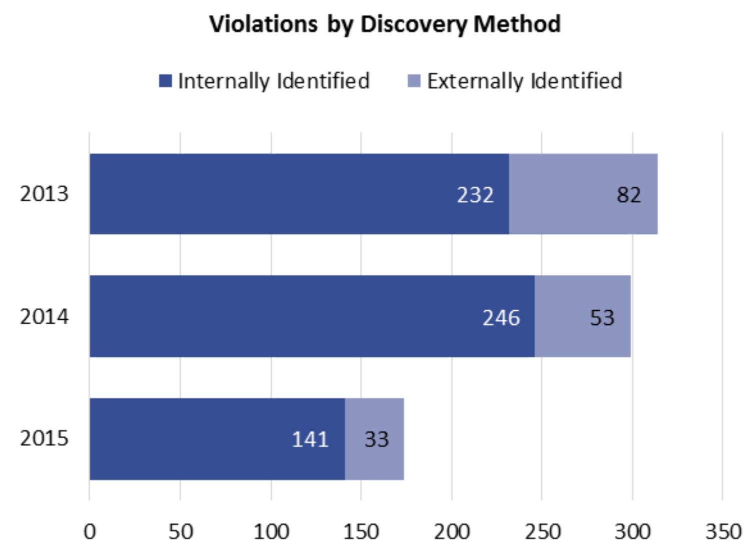
WECC encourages Registered Entities to perform a Compliance Assessment (CA) in response to all system events. Through the CA process, Entities systematically evaluate their own compliance performance, self-report potential non-compliance and address reliability issues.

These Entities demonstrate the effectiveness of their internal controls and their commitment to a culture of compliance. This may result in a reduced level and frequency of compliance monitoring activities.

Regional Risk Assessment

The ERO Enterprise Compliance Monitoring and Enforcement Implementation Plan (CMEP IP) provides a framework for risk-based entity oversight. When identifying the scope of an audit, WECC also considers regional and local risks, as well as the Registered Entity's characteristics.

In 2015 WECC audited an average of 11 percent of the requirements applicable to each Entity. This reduced the administrative burden for the audited Entities and increased focus on risk mitigation.



The total number of violations reported to or discovered by WECC decreased each year since 2012. At the same time, the percentage of violations internally identified by entities has increased. These are positive indicators of the industry's reliability culture.

VIOLATIONS

Potential violations of Reliability Standards in 2015 were discovered through audits conducted by WECC, self-reported by the entity, or reported when an entity self-certified its compliance.

WECC audited 44 entities in 2015. This includes 23 audits covering Critical Infrastructure Protection standards and 43 audits covering Operations & Planning standards.

Violations by Standard Family

Family	*2013*	*2014*	*2015*
Operations & Planning[2]	119	112	91
Critical Infrastructure Protection	195	187	83[3]
All Standards	314	299	174

Historically, violations have been dominated by "zero-tolerance" standards that focus attention on administrative processes instead of reliability risk. Violations of these standards are expected to decrease with the implementation of risk-based concepts.

[1] This report excludes dismissed violations. Data is as of April 30, 2016.

[2] Operations & Planning standards include all but the CIP family.

[3] In 2015, WECC focused on outreach and education in advance of the CIP V5 effective date.

Photo credits: (Page 2) Sonneveld, F. [Untitled picture of transmission lines]. Retrieved April 27, 2016 from https://unsplash.com/photos/q6n8nIrDQHE; (Page 10) Tribble, D.R. (2012). Electric meter boxes 4625 [Online image]. Retrieved April 27, 2016 from https://commons.wikimedia.org/wiki/File:Electric-meter-boxes-4625.jpg; (Page 18) Martin, R. (2007). Generators inside the Hoover Dam [Online image]. Retrieved April 27, 2016 from https://commons.wikimedia.org/wiki/File:Hoover_Dam_generators.jpg; (Page 28) [Untitled picture of transmission lines at sunset]. Retrieved April 27, 2016 from https://www.pexels.com/photo/dawn-twilight-dusk-electricity-917/; (Page 34) Leaflet (2004). Green mountain wind farm fluvanna 2004 [Online image]. Retrieved April 27, 2016 from https://commons.wikimedia.org/wiki/File:GreenMountainWindFarm_Fluvanna_2004.jpg

Acknowledgements

WECC would like to thank Peak Reliability for providing much of the data presented in this report. WECC would also like to thank the individuals who participated in the State of the Interconnection Focus Group. Their feedback helped shape this year's report.

Kristie Cocco, Manager, NERC Regulatory Compliance
Arizona Public Service Company

Gary DeShazo, Director, Regional Coordination
California Independent System Operator

Linda Jacobson-Quinn, Regulatory Compliance Manager
Farmington Electric Utility System

Milorad Papic, System Planning Engineer
Idaho Power Company

David Till, Senior Manager, Performance Analysis Department
North American Electric Reliability Corporation

James Leigh-Kendall, Director of Reliability Compliance & Coordination
Sacramento Municipal Utility District

Travis Tate, Reliability Specialist
SERC Reliability Corporation

John Martinsen, Senior Manager of Reliability Compliance and Regional Transmission
Snohomish County Public Utility District No. 1

Chris Haley, Engineering Associate III
Southwest Power Pool

Leland McMillan, Manager—NERC Compliance
Talen Energy

Texas Reliability Entity

Bob Easton, VP of Transmission Services for CRSP, DSW & RMR
Western Area Power Administration

Western Electricity Coordinating Council
155 North 400 West, Suite 200
Salt Lake City, Utah 84103
http://www.wecc.biz