Introduction
LADWP has built a vast power generation, transmission and distribution system that spans five Western states, and delivers electricity to about 4 million people in Los Angeles via thousands of miles of overhead wires and underground cables. The Power Infrastructure Plan evaluates and prioritizes maintenance and replacement of major power infrastructure components. The plan is budgeted at $4.5 billion through fiscal year 2020.

Overall Objectives
- Proactively prevent or decrease the duration of power outages
- Minimize operational costs
- Reduce repair costs through preventative maintenance

Background
LADWP launched its initial Power Reliability Program after major heat storms in 2006 and 2007 caused widespread and prolonged power outages. The program targeted replacing overloaded transformers and other distribution equipment. Since then, LADWP has seen a 30% reduction in outages.

The current Power Infrastructure Plan was developed in 2013 to encompass generation, transmission, and substation equipment as well as distribution equipment. This is especially important as new energy sources, such as wind and solar, are integrated into an aging infrastructure, and LADWP rebuilds its coastal generating units to eliminate ocean-water cooling. As this power supply transformation unfolds, the Power Infrastructure Plan offers a blueprint to safely improve and maintain future reliability for LADWP’s customers.
Benefits of Proactive Infrastructure Replacement

Planned and sustained infrastructure replacement is both a cost efficient and highly effective approach to maintaining reliability.

This is clearly evident when comparing the outages experienced by customers during the 2007 heat storm with a similar heat storm in 2014, following a period of sustained investment in infrastructure replacement. As a result of planned infrastructure replacement, customer outages lasting over 24 hours were reduced by 99.3% during the 2014 heat storm compared to the 2007 heat storm.

Control Gorge Power Plants

Another example of the benefits of proactive maintenance involves the Control Gorge Power Plant, one of three small hydro plants in the Owens Gorge. Due to funding constraints, LADWP had deferred scheduled maintenance on the plant that was originally budgeted for $10 million. When the plant malfunctioned, a forced outage required the same amount of work but on an emergency basis – at a cost of $60 million. Proactive maintenance would have saved ratepayers approximately $50 million.

Reliability

LADWP’s Power System reliability fares better when compared to most peer utilities in the state. We have seen outage levels decline in terms of duration and frequency over the past few years. However, mild weather has contributed to these improvements and additional investment is necessary to maintain high reliability levels that our customers have relied upon for a century.
Distribution System

LADWP’s distribution infrastructure is the backbone of the city’s power grid and crucial for maintaining neighborhood power reliability. Key components include:

- 321,516 poles
- 1,287,120 crossarms
- 126,000 transformers
- 6,800 miles of overhead distribution lines
- 3,597 miles of underground distribution cables

Key Points:

- There are approximately 45,000 “fix-it” tickets in the queue. These are job orders for permanent repairs on circuits that were initially repaired temporarily to resolve an outage, but need further engineering work, design and construction for long-term reliability.
- The challenges facing our distribution system vary by location. For example, much higher temperatures in the San Fernando Valley area have different effects on transformer performance as a function of age than in the coastal areas.
- Infrared inspections are utilized in overhead and underground distribution system to identify potential failure points.

Key components for asset replacement consist of poles, transformers, and cables. Inspections identify recommended repairs or replacements. Priorities for each component are based on:

- Poles – age and inspections
- Transformers – trouble call log and engineering overload assessments
- Cables – cable type, outage records, and location

Other criteria for prioritization are:

- Annual worst-performing circuits
- Abnormal circuits
- Outage records
- Engineering and field crew feedback

The graph below shows the majority of LADWP poles were installed from the 1940s through 1960s. Of LADWP’s 321,516 poles, over 65% are at least 50 years old. More than 45% are older than 60 years, which is the average lifespan of a pole. To keep up with this aging infrastructure, LADWP needs to increase its investment in repair and replacement of poles along with the other components of the power distribution system.

2014-15 Goals:

- Replace 1,560 poles
- Replace 4,500 crossarms
- Replace 450 transformers
- Replace 38 miles of lead & synthetic cables
- Resolve 5,000 “fix-it” tickets

Long-Term Goals:

- Replace 6,000 poles, 10,000 crossarms, 800 transformers, 60 miles of lead & synthetic cables annually by 2020.
- Ramp up to resolve an additional 5,000 “fix-it” tickets annually to reduce backlog to an acceptable level of 2,000 in 10 years.
Substations
Transformers and circuit breakers are considered the most critical assets within the LADWP Power System’s 21 receiving stations (RS) and 123 distributing stations (DS). Keeping thousands of transformers and circuit breakers functioning at their best is at the heart of substation reliability.

Key components include:
- 70 high side transformers (RS)
- 88 load side transformers (RS)
- 930 local substations transformers (DS)
- 612 substation transmission circuit breakers (RS)
- 1,878 34.5 kV substation circuit breakers (RS and DS)
- 2,406 4.8 kV substation circuit breakers (DS)

Key Points:
- LADWP prioritizes which substation transformers to replace based on specialized tests, including critical location, power factor, dissolved gas tests, and age.
- Priorities for circuit breaker replacement are based on outage history, maintenance record, and location.
- Circuit breakers have a 30-year design life but many are older than that. The median age of substation transmission circuit breakers is 16 years old; the RS circuit breaker median age is 44 years old; and the DS circuit breaker median age is 49 years old, underscoring the need to ramp up investment in replacing critical infrastructure.

2014-15 Goals:
- Replace 4 of 88 load side transformers (RS)
- Replace 4 of 930 local substation transformers (DS)
- Replace 3 of 612 substation transmission circuit breakers (RS)
- Replace 10 of 1,878 34.5 kV circuit breakers (RS and DS)
- Replace 10 of 2,406 4.8 kV circuit breakers (DS)

Long-Term Goals:
- Replace 1 high side transformer (RS), 1 load side transformer (RS), 18 local substation transformers, 6 substation transmission circuit breakers, 20 circuit breakers (RS), 40 circuit breakers (DS) and automate 12 substations annually by 2020.
- Standardize major assets such as transformers and circuit breakers within each substation to allow for easier replacements and training personnel.
- Automate all substations in the next 20 years to improve operational capabilities and communications while reducing costs.
Transmission System

LADWP maintains a vast transmission system, which includes 6,107 miles of overhead and underground transmission circuits spanning five Western states. Of these, LADWP’s wholly-owned and operated in-basin transmission network includes the following key components:

- 3,507 miles of overhead circuits (115 kV to 500 kV)
- 124 miles of underground circuits (138 kV to 230 kV)
  - Includes 17 low pressure oil-filled (LPOF) circuits
- 15,452 towers
- 514 maintenance holes (138 kV)
- 157 maintenance holes (230 kV)
- 1542 joints (138 kV)
  - Includes 31 LPOF cable stop joints

Key Points include:

- Priorities for replacements are based on inspections and outage history.
- Inspection of transmission towers is currently done on a one-year and five-year basis, depending on criticality.
- Existing 230 kV underground circuits have a high degree of reliability for the next 20 years.
- The 138 kV LPOF cable was originally placed in service from 1943 to 1959. These 17 circuits are considered critical for replacement due to increasing outages.
- LADWP is also eliminating the problem of stop joint failures on these circuits by rebuilding the lines with synthetic cable.

2014-15 Goals:

- Replace 1 of 17 circuits of 138 kV LPOF cable identified for replacement at Gramercy-Harbor Line 2.
- Replace 2 of 31 138 kV LPOF cable stop joints identified for replacement.
- Retrofit 10 of 238 maintenance holes identified for upgrading with explosion proof covers.

Long-Term Goals:

- Replace 2 of 17 circuits of 138 kV LPOF cable annually with goal of replacing all by 2026.
- Replace 5 LPOF cable stop joints annually; continue to identify those needing replacement.
- Ramp up to 40 maintenance-hole cover retrofits per year by 2020, with goal of completing the retrofitting with explosion proof covers in 6 years. After FY 2014-15 goals are met, 134 will have been completed, 228 more to be installed, and 152 do not need restraints.
- Put in place a multi-year painting contract for the 1,400 wholly-owned in-basin galvanized steel transmission towers.
- Upgrade the land and marine cable portion of the Pacific DC Intertie by 2017.
Generation

Generation assets are either wholly or jointly owned, providing a diverse portfolio of power that is supplemented by long-term power purchase agreements and spot market purchases. Of this, wholly owned and operated In-Basin generation sources include:

- 24 units of thermal electricity (located at Harbor, Haynes, Scattergood, and Valley Generating Stations)
- 7 units of large hydro electricity (located at Castaic Power Plant)
- 22 units of small hydro electricity (located at 14 individual plants)

Key Points:

- Inspections will determine the need for overhauls or replacements of generating units. Replacements are typically multi-year projects. Priorities on repowering the coastal thermal units are done in consideration of the once-through cooling (OTC) regulatory compliance schedule, which requires LADWP to eliminate the use of ocean-water to cool its 3 coastal power plants.
- Repowering the thermal units for OTC compliance will have the added benefit of modernizing these units, improving efficiency and integration with increased renewable energy being added to LADWP’s power supply portfolio.
- Twenty-two small hydroelectric units are performing beyond their design life of 50 years. The Control Gorge generator ran until it failed. It was removed from service in January 2012 and is currently being refurbished.

2014-15 Goals:
- Replace/overhaul 1 unit of thermal - Scattergood / Unit 1
- Replace/overhaul 1 unit of large hydro - Castaic / Unit 2
- Replace/overhaul 1 unit of small hydro - Franklin / Unit 1

Long-Term Goals:
- Replace/overhaul 4 units of thermal generation, 1 unit of large hydro, 2 units of small hydro annually by 2020.
- Replace 2 generator step-up transformers and 2 generator station transformers annually by 2020.
- Repower Harbor, Haynes, and Scattergood as determined through OTC policy by 2029.
- Complete modernization of all Castaic units by 2017.
- Complete refurbishment work to extend the life of the three Gorge plants for another 30 years.

Once-Through Cooling (OTC) Schedule

LADWP is following a closely choreographed engineering, design and construction plan for meeting the tight schedule to eliminate ocean-water cooling of its 3 coastal power plants. For reliability purposes, no one generating unit can be taken offline until its replacement is ready for commercial operation.

Construction is well underway on the Scattergood Generating Station Unit 3 repowering project. The existing Unit 3 conventional steam plant will be replaced with a highly efficient combined cycle (natural gas and steam) plant and two simple-cycle turbines for fast startup.
LADWP is the nation’s largest municipal electric utility, and supplies over 25 million megawatt-hours each year to approximately 1.4 million electric service connections in Los Angeles as well as 5,000 customer connections in the Owens Valley.

**Infrastructure**

**Transmission**
- 3,507 miles of overhead circuits (AC and DC)
- 124 miles of underground circuits
- 15,452 transmission towers

**Distribution**
- 6,800 miles of 4.8 kV and 34.5 kV overhead lines
- 3,597 miles of 4.8 kV and 34.5 kV underground cables
- 162 distributing stations
- 321,516 poles
- 126,000 transformers

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