Green Hydrogen & the Intermountain Power Project

Presented by
Los Angeles Department of Water and Power
SYNOPSIS

With the passage of California Senate Bill 100, the state has mandated a transition to 100% Clean Energy. LADWP is now faced with the challenge of providing clean, zero-carbon, reliable power to its customers by 2045. The INTERMOUNTAIN POWER PROJECT (IPP) will be essential in reaching that goal.
Clean Grid LA
LA100
LA’s 100% Renewable Energy Study

In July 2017, LADWP began a research partnership with the National Renewable Energy Laboratory (NREL) to develop a study that determines the investments needed to achieve a 100% renewable energy portfolio for the City of Los Angeles.
Mayor Garcetti’s Announcement

In February 2019, LA Mayor Eric Garcetti announced his decision to accelerate LADWP’s transition away from fossil fuel generation.

Approximately 1660 MW of natural gas generation must be replaced or offset by 2030.
Clean Grid LA & LA100

**LA100**

Determine investments needed to achieve 100% Renewables

**TARGETS**

100% CLEAN ENERGY BY 2045
CARBON FREE BY 2050

**CLEAN GRID LA**

Replace 1660 MW by 2030

ladwp.com
History of IPP

- Located in Delta, Utah
- Two coal-fired units operating since 1986 with 1,800 MW net capacity
- Two Transmission Systems:
  - STS To Southern California
    2400 MW HVDC System
  - NTS To Utah & Nevada
    - Interconnected to 370MW of Wind Generation
- 35 Project Participants, 6 from Southern California
- Coal Units to be retired by 2025
**Project Scope**

- 840 MW Natural Gas Combined Cycle Facility (reduced from 1,200 MW)
  - Estimated capacity factor = 68%
  - Construction: Start – January 1, 2020
    Completion – July 1, 2025
- 2,400 MW HVDC Converter Station Replacements
  - Additional Transmission support allows integration of renewables
  - Construction: Start – May 1, 2021
    Completion – April 1, 2026

**Project Necessity**

- Required to meet LADWP’s 100% Renewable Goals
- Dispatchable energy required to maintain system reliability
- Less reliance on in-basin natural gas units and Aliso Canyon Storage facility
Unlocking IPP’s Green H₂ Potential
Utah’s Renewable Hub

- IPP sits in a confluence of renewable resources
- Currently interconnected to 370 MW of wind generation
- Secondary Path for existing Geothermal Projects and potential for additional geothermal in the area
- 2,300 MW of current solar interconnection requests in queue
- 1500 MW of Wyoming wind interconnects currently being discussed
Transmission

NORTHERN TRANSMISSION SYSTEM (NTS)
AC System, Bi-directional

SOUTHERN TRANSMISSION SYSTEM (STS)
2,400 MW DC System, Bi-directional
Land and Water

- IPP is located in Delta, UT with over 4,000 acres of land
- Fed by Utah’s Servier River, IPP has secured enough water rights for its original four generating units
Underground Salt Formation

• A “one-of-a-kind” geological feature in the Western US, the underground salt dome in Delta, UT is ideal for storing hydrogen at high pressures

• The caverns are impermeable and “self-healing”
The highly-skilled Operations, Maintenance and Technical Staff of Intermountain Personnel Services Corporation (IPSC) have operated the facility for over 30 years.

With over 350 active employees, IPSC’s technical leadership will be critical to meet the challenges of the changing utility industry.
# Solutions to Green $\text{H}_2$ Challenges

<table>
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<th><strong>GREEN $\text{H}_2$ CHALLENGES</strong></th>
<th><strong>SOLUTIONS AT IPP</strong></th>
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<tr>
<td>Availability of Renewables</td>
<td>IPP is located in a “Renewable Hub” with access to wind and solar energy projects; 2300 MW of renewable interconnections in the queue</td>
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<td>Transmission Resources</td>
<td>With two large, bi-directional AC &amp; DC transmission systems, IPP is able to received and deliver renewable energy</td>
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<tr>
<td>Land and Water Needs</td>
<td>IPP sits on over 4,000 acres of land and has enough secured water rights for four coal units</td>
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<td>Hydrogen Storage and Transportation</td>
<td>Utilizing the underground salt formation allows for on-site storage and alleviates the need to transport hydrogen fuel</td>
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<td>Emerging Technologies</td>
<td>IPSC’s highly trained staff is poised to take on the challenges of the constantly evolving technology</td>
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Hydrogen Projects at IPP

With unique resources at its disposal, IPP represents a first-of-its-kind opportunity for the western energy grid. Any project at IPP will benefit from the availability of renewables, transmission resources, and underground storage capabilities.
The proposed 160 MW Compressed Air Energy Storage (CAES) pilot project has a vision to run 100% hydrogen through its generation expansion process.
Hydrogen-Fired Generation

The new natural-gas fired generators will be capable of burning a hydrogen fuel mix on DAY 1 of commercial operation.
Selected Technology

Request for Proposals were solicited based on performance of manufacturers’ advanced class combined cycle technology.

NEW UNITS WILL BE COMPLIANT WITH SB1368

APPROVED BY CALIFORNIA ENERGY COMMISSION IN NOVEMBER 2018
Required Capabilities

The Request for Proposal outlined requirements for hydrogen capabilities in the new generators:

1. Description of Equipment’s capability to operate fuel blend of up to 20% Hydrogen
2. Detailed plan to develop 100% Hydrogen by 2040
3. Modifications needed all the way through Balance of Plant and value engineering approach to avoid major modification in the future
4. Recommended capability tests to demonstrate 20% Hydrogen burn
Fuel Transportation

- Fuel transportation agreements currently under review with anticipated approval in November 2019
- Minimum firm transportation service of 140,000 Dekatherms/day until 2045
If renewable H₂ is expanded into external fuel supplies, this could significantly affect the amount of IPP-generated H₂ used by the generators.
Gas Flow Diagram

Verification of gas constituents and quality
Hydrogen Storage at IPP

Hydrogen storage is one of IPP’s most unique features. Not only does it alleviate the challenges of hydrogen transportation, it also allows for SEASONAL SHIFTING of renewable energy; taking the otherwise curtailed energy and storing it as fuel.
Hydrogen Storage at IPP By The Numbers

- A typical cavern size at IPP = 4,000,000 barrels
- 1 cavern = 5,512 tons of H2 (operational limit)
- This is equivalent to:
  - 200,000 hydrogen buses
  - 1,000,000 fuel cell cars
  - 14,000 tube trailers used for delivery
- Over 100 caverns can be constructed in the salt dome at IPP

The Empire State Building would fit into a large Magnum Cavern
Hydrogen Storage Potential

The energy storage capabilities at IPP are unique in that they allow for **DAYS** for storage rather than hours compared to today’s Li-ion batteries.

![Table](image)

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<tr>
<th>Generation Capacity (MW)</th>
<th>Stored Generation Capacity (Days*)</th>
<th>Total Generation (MWHrs)</th>
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<tr>
<td>CAES</td>
<td>160</td>
<td>87</td>
</tr>
<tr>
<td>CCGT</td>
<td>840</td>
<td>10</td>
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* Assumes: 100% Hydrogen Fuel, CAES CF=44%, CCGT=50%

**WHEN COMPARED TO THE COMBINED CYCLE GENERATING TURBINE (CCGT) AT 50% CF, THIS IS 84 TIMES THE STORAGE CAPACITY OF A 1,200 MWH BATTERY SYSTEM**
**Production Requirements**

**QUESTION**: Assuming a 30% H2 by volume natural gas fuel mix, how much renewable energy per year is needed to run the 840 MW CCGT?

\[
\begin{align*}
\text{840 MW} & \times (27) 20 \text{ MW Blocks} = 29,920 \text{ tons H2/yr}^* \\
&= 10.7 \text{ tons H2/hr}^{**} \\
\end{align*}
\]

*Assumes production only during spring and autumn (50%)

**Assumes renewable CF of 32%**

538 MW @ 32% CF (2,803 hrs)
Production Requirements

Other Resources Required:
1. Land Required = 27 acres (5 acres per 100 MW electrolyzer block)
2. Water Required = 278 acre-ft/year

Caveats and Assumptions:
1. Curtailed renewable energy used for hydrogen production during Spring and Autumn seasons only (50% of the year)
2. Production rate of 794 lbs H2/yr based on current alkaline electrolyzer technology;
3. Heat rate based on mix of natural gas and H2 (6,844 Btu/kWh)

As the technology progresses, we will have a better idea of what it takes to get to 100% H2 by volume
Hydrogen Timeline

**IPP Milestones**

- **2019**: NGCC & CAES Commence Construction
- **2020**: Begin Fueling NGCCs #1 & #2 w/ Hydrogen Blend
- **2021**: CAES Pilot COD
- **2022**: Expand Electrolyzer Array to Accommodate NGCC
- **2023**: Hydrogen Electrolyzer + Cavern COD
- **2024**: Begin Fueling CAES Pilot W/ 30-50% Hydrogen Blend
- **2025**: Expand Electrolyzer Array to Accommodate NGCC
- **2030**: IPP Retired
- **2035**: IPP Retired
- **2040**: IPP Retired
- **2045**: California SB100 Mandate - 100% Clean Energy by 2045

**Hydrogen Inputs**

- **2022**: 500+ MW PV Solar Interconnected at IPP
- **2023**: 1000-1500 MW WY Wind Interconnected at IPP
- **2024**: NGCC COD
- **2025**: RPS 55%
- **2030**: RPS 60%
- **2035**: RPS 70%
- **2040**: RPS 70%

For more information, visit ladwp.com.
By exploring Green Hydrogen and with the complimentary technologies maturing, the Intermountain Power Project becomes an essential piece of our overall clean energy future.