Presentation of the Energy Master Plan

Independence Power & Light

Project No. 103983

August 27, 2018

Agenda

- Energy Master Plan Highlights
- Industry Overview and Trends
- Utility Planning Requirements
- Condition Assessment
- Technology Assessment and Third-Party Resources
- Economic Analysis
- Conclusions & Recommendations

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- **Energy Master Plan Highlights**
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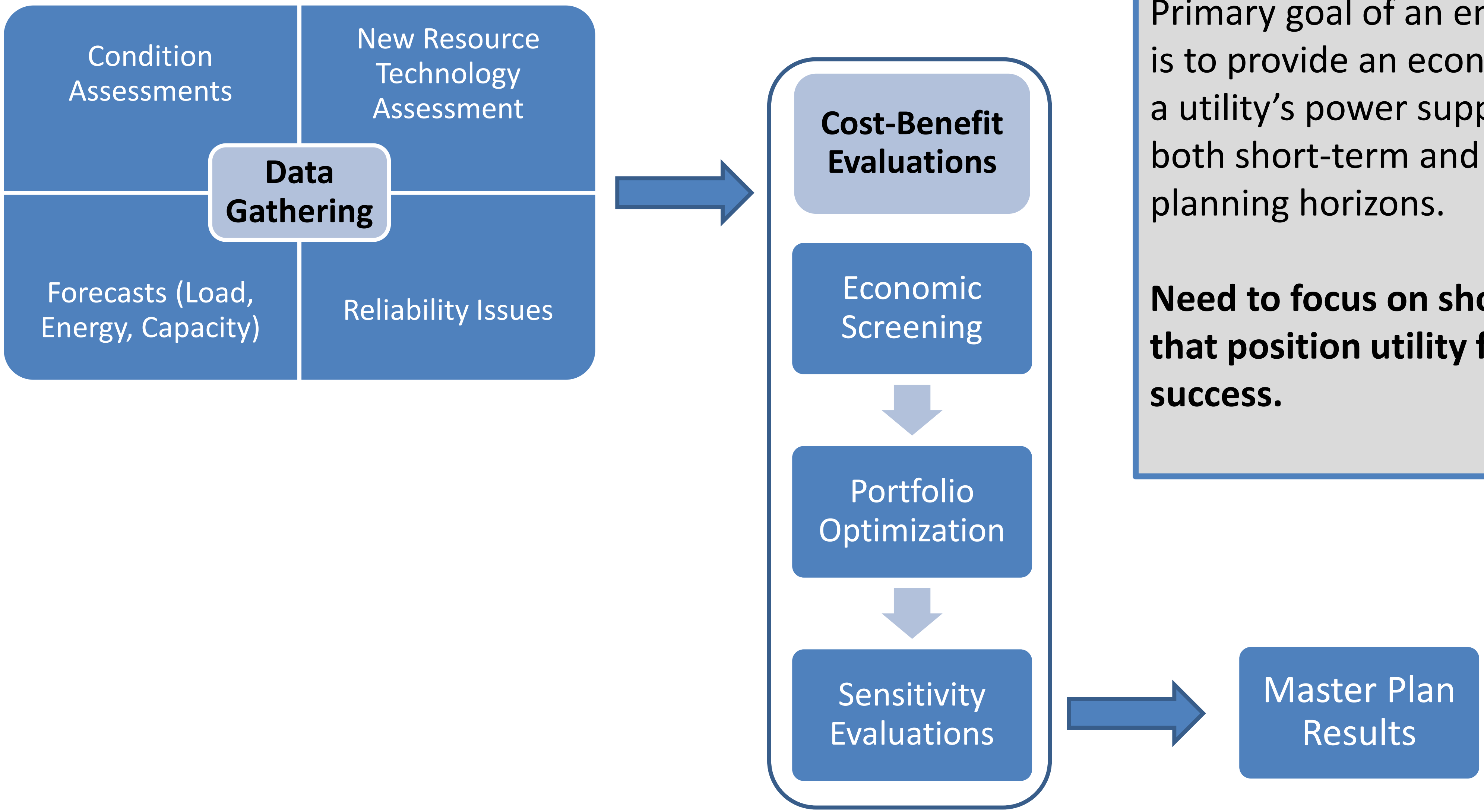
What is an energy master plan?



Primary goal of an energy master plan is to provide an economic evaluation of a utility's power supply portfolio over both short-term and long-term planning horizons.

Need to focus on short-term decisions that position utility for long-term success.

Energy Master Plan Highlights

- Within the electric utility industry, older, inefficient steam plants are higher cost. This is true for Blue Valley. There are less expensive resources available.
- IPL's combustion turbines are aging, but still provide low cost capacity, on-system reliability, and allow IPL to utilize the SPP energy market.
- IPL's fixed costs for power production are above the industry average. IPL should continue to evaluate methods for reducing fixed costs associated with power production.
- IPL's existing power supply portfolio provides sufficient energy, IPL's need will be focused on replacing capacity due to retirements.

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Industry Overview and Trends

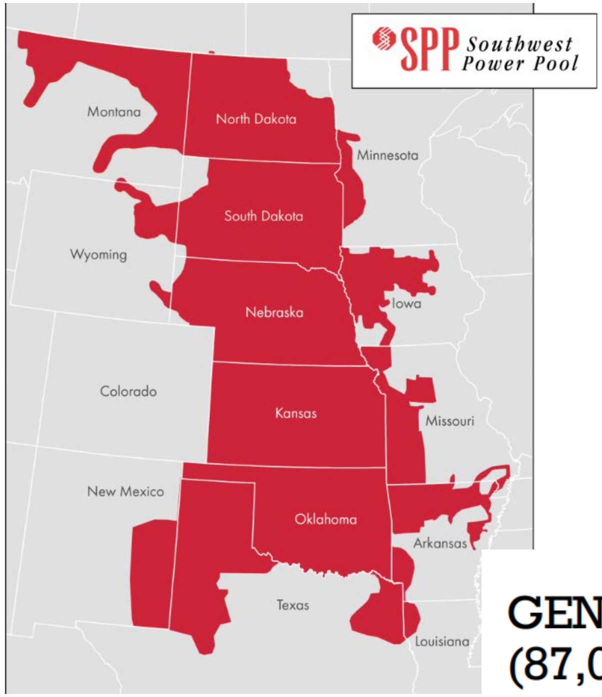
- Many coal-fired power plants have retired, more expected
- Natural gas prices are low, expected to remain low
- Relatively low overall load growth across the U.S.
- Increasing amounts of renewable power, especially wind in the Midwest
- Wholesale electricity prices remain low
- Increased interest in “firm” capacity due to:
  - Retirement of coal-fired power plants
  - Polar Vortex in 2014
  - Bomb Cyclone in 2018
  - Greater dependence on natural gas resources

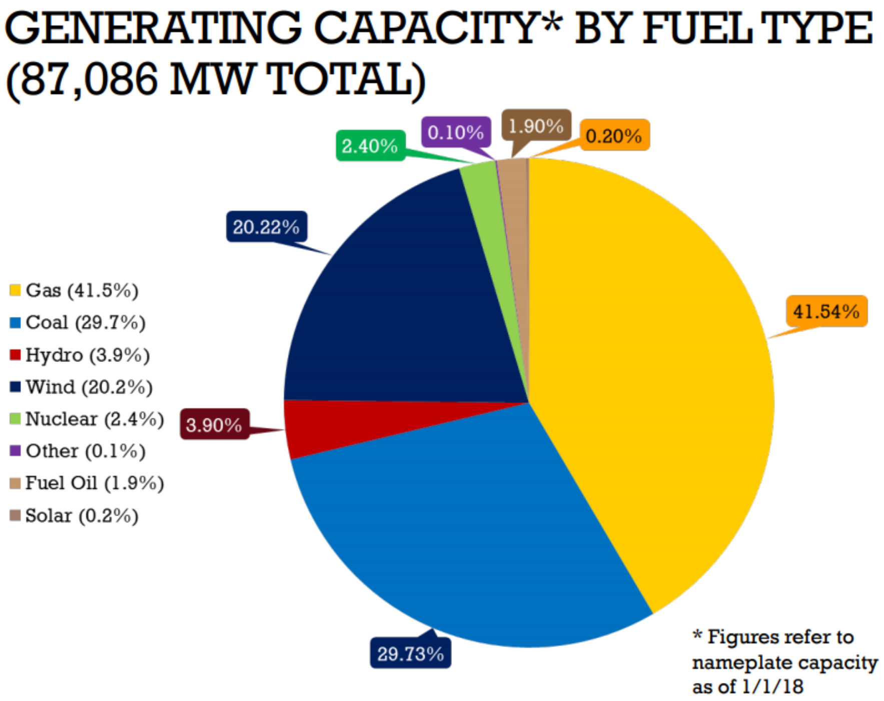
IPL Overview and Trends

- Overall, load is lower compared to historical
- Reduced reliance on coal-fired generation
- Changes since last Master Plan completed in November 2011
  - SPP Integrated Market implemented March 2014
  - Converted Blue Valley units from coal to natural gas (retired coal-fired operations) in 2015
  - Retirement of Missouri City Power Plant in 2016 (38 MW of coal-fired generation)

Southwest Power Pool

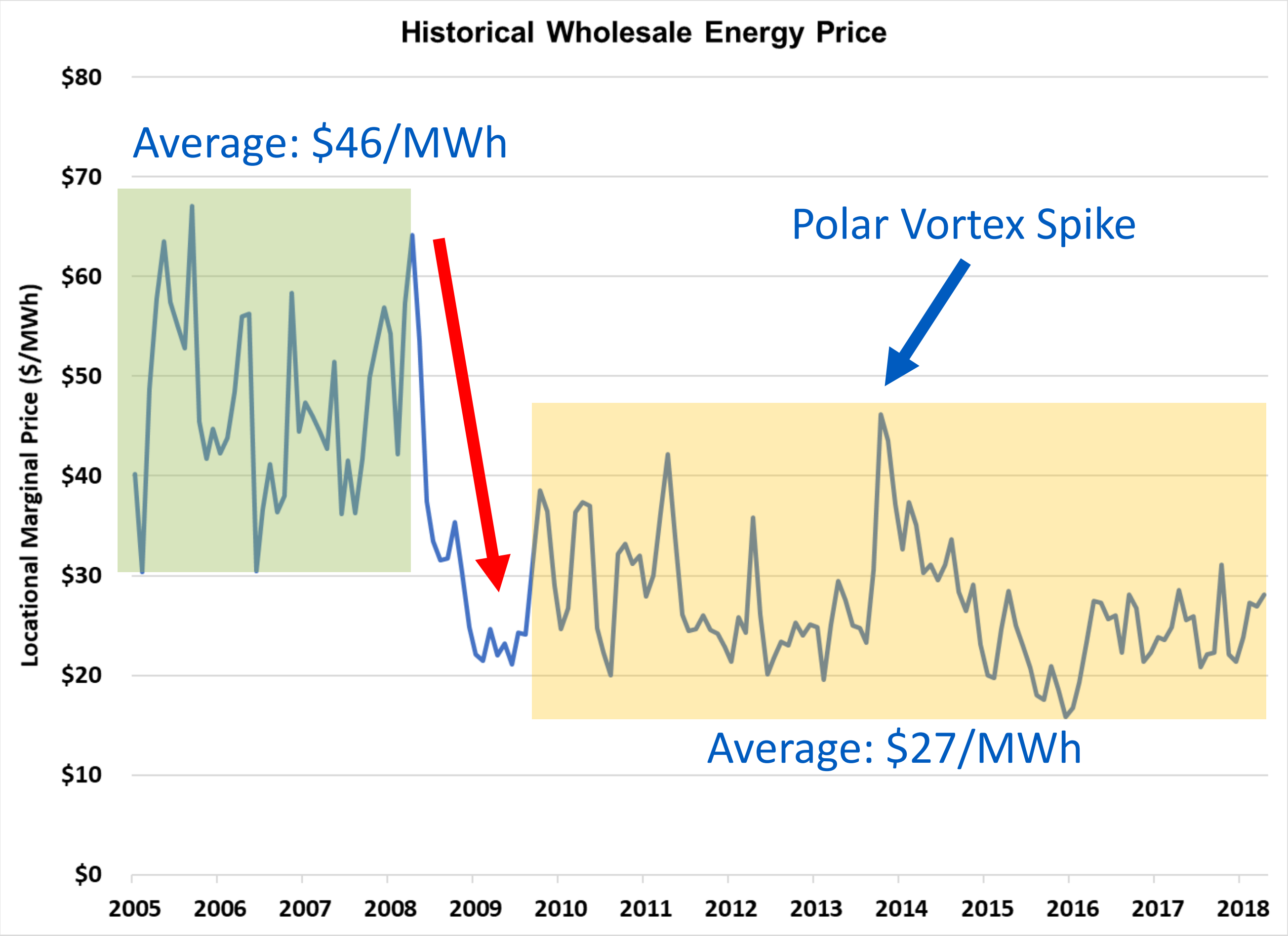
- SPP statistics (2017):
  - Peak summer load: ~51,000 MW
  - Resources: ~87,000 MW
  - Wind capacity: ~17,000 MW
  - Energy: ~246,000 GWh
- IPL is a market participant
  - SPP provides source of energy
  - Opportunity for energy sales from generating units
- IPL statistics:
  - Peak summer load: 280 to 290 MW
  - Energy: ~1,100 GWh





Wholesale Energy Market Prices (2005-2018)

- Prior to 2009, market energy prices significantly higher than today
  - Recession reduces demand
  - Natural gas fracking lowers fuel price
  - Energy efficiency increases
  - Increased renewables
- Post 2009, market energy prices have been lower



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Pillars of Utility Mission Statement

- Low cost energy
- Reliable energy
- Safe energy
- Environmentally compliant energy

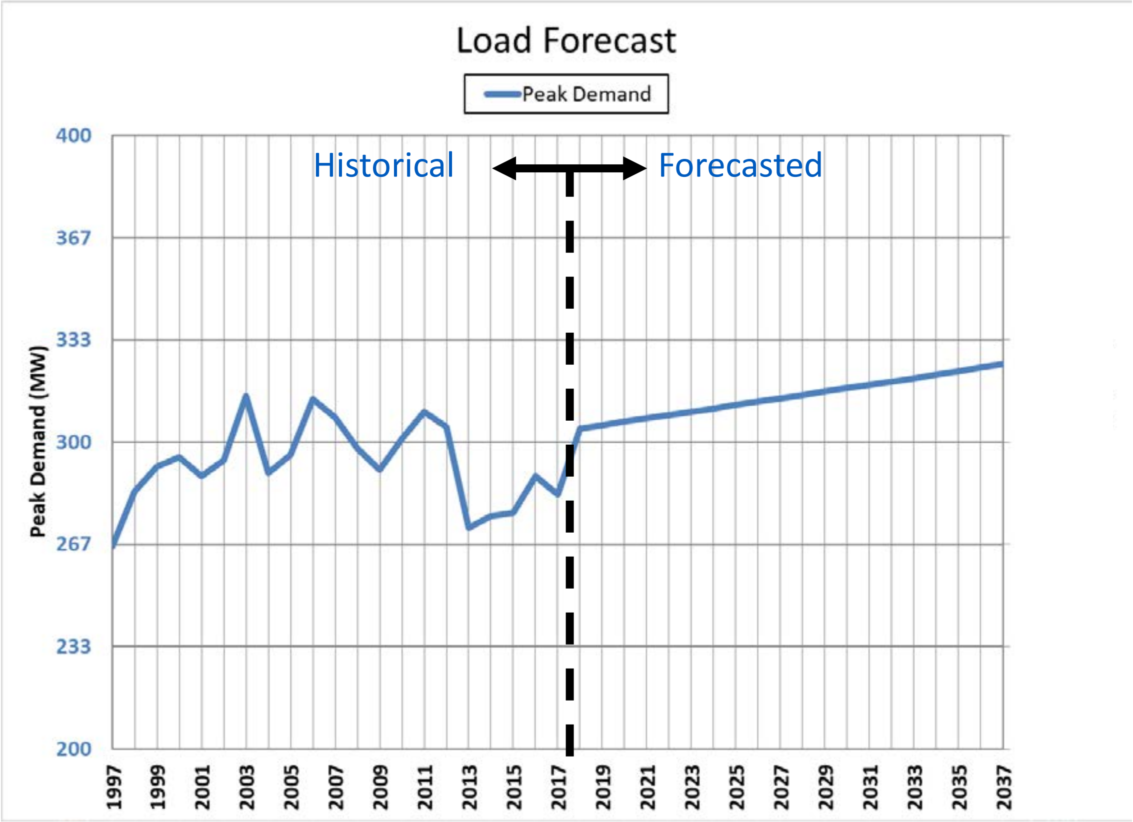
IPL's Obligations

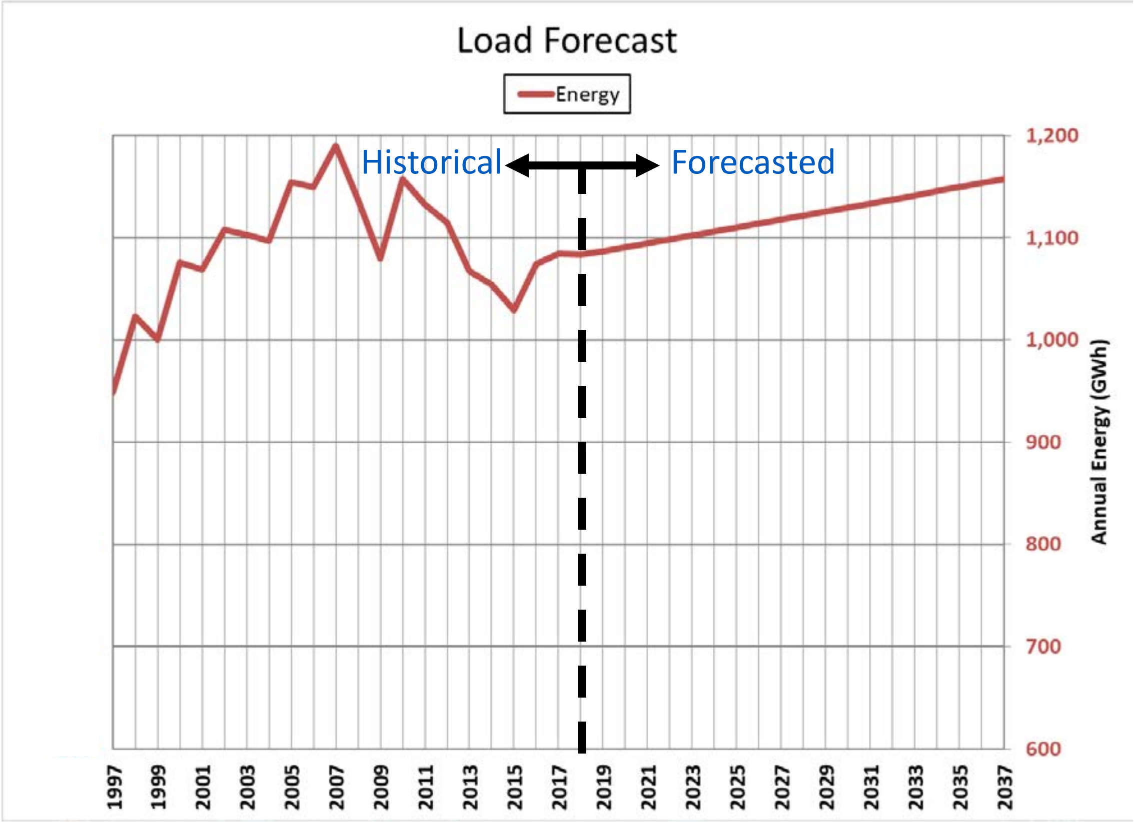
- Provide sufficient capacity (MW) to meet demand
  - SPP sets capacity requirement based on IPL's load forecast
  - Capacity comes from units that IPL builds, contracts through bi-lateral agreement, or demand side management
  - Capacity typically has to be dispatchable, renewables are intermittent and don't provide significant capacity
- Provide sufficient energy (MWh) to meet customers' needs
  - Electrical energy comes form units that IPL builds, contracts, net metering, conservation, or SPP market
- Energy must be compliant with regulations
  - Renewable and solar mandates
  - Environmental regulations
- IPL voluntarily meets Missouri's Renewable Portfolio Standards (Prop C)
  - Renewable energy of 15% throughout planning horizon
  - Solar energy of 0.3% throughout planning horizon

Load and Energy Forecasting

- SPP requires an annual forecast from utilities
- Econometric forecasting
  - Statistically links energy consumption to key variables like electricity and fuel prices, customer income, commercial and industrial activity, weather, etc.
- IPL forecast and planning variables include:
  - Anticipated large industrial or commercial developments that may increase load
  - Potential for customer-owned renewable generation
  - Conservation and load control programs
  - Weather normalization

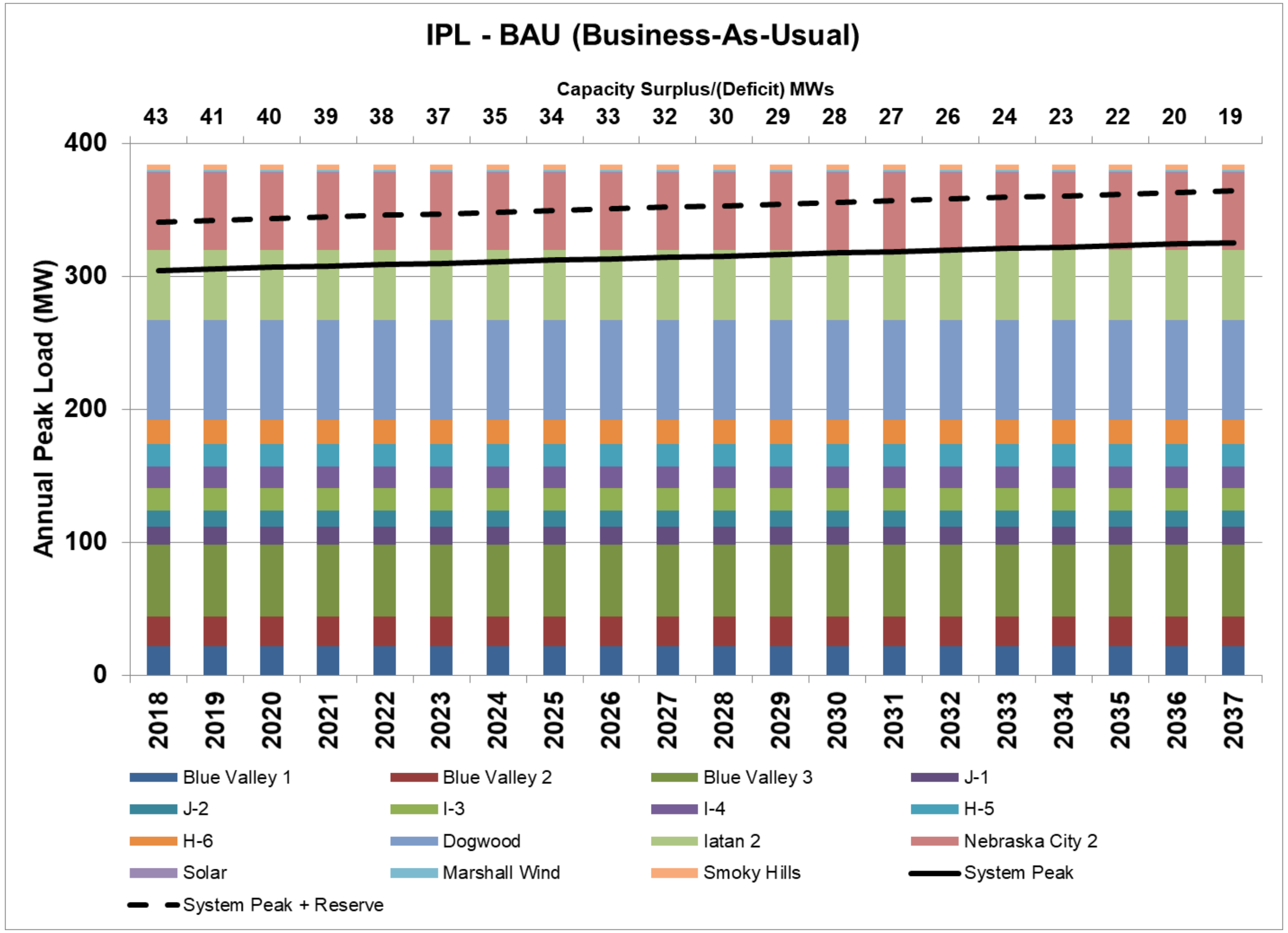
Annual Load Forecast of Energy and Demand



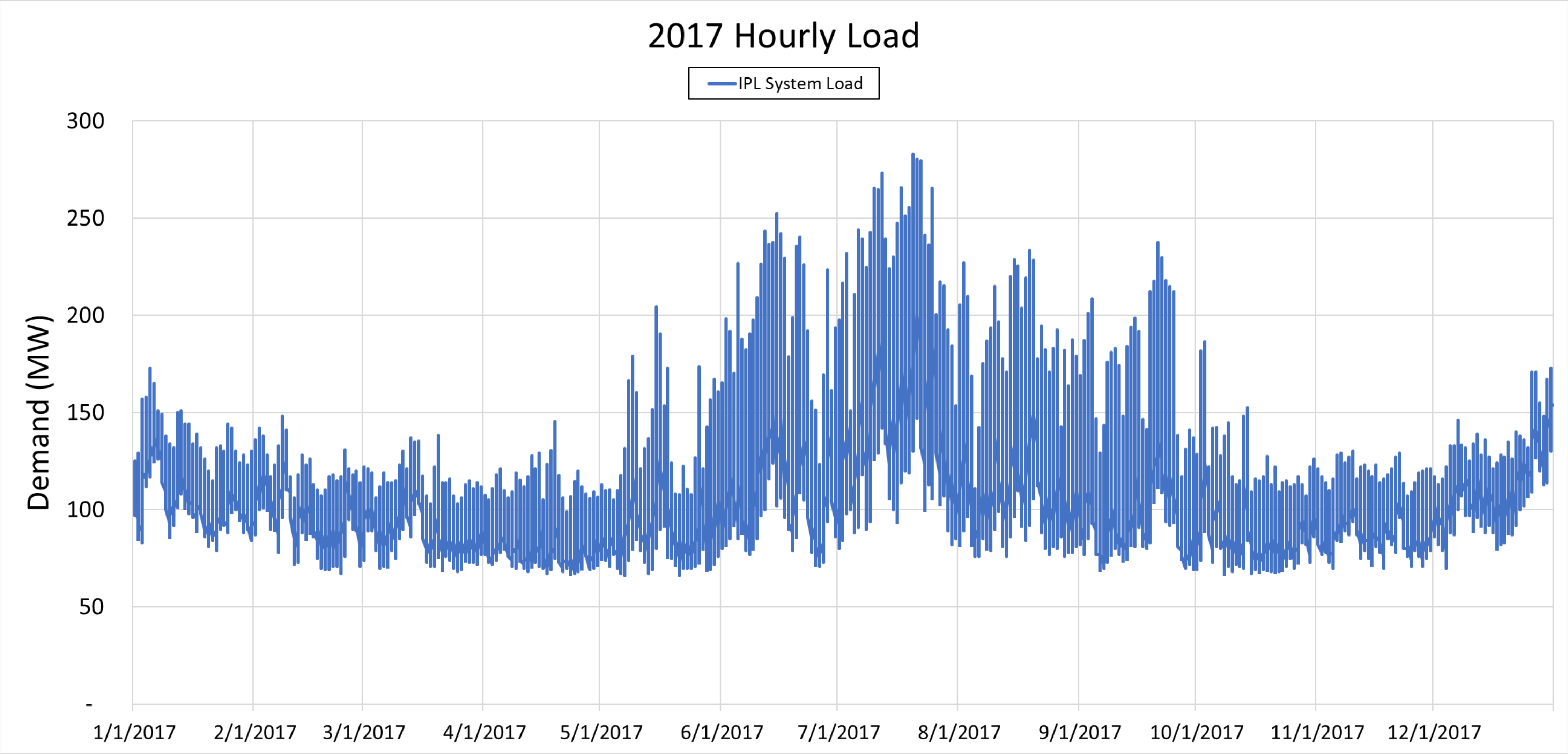


Balance of Loads & Resources (BLR)

- SPP requires utilities to have capacity reserves of approximately 12% in excess of demand
- IPL must secure enough "firm" capacity to meet its demand plus reserve requirements
- Renewables do not get full credit due to intermittency (i.e. non-firm)
  - Wind receives 5%
  - Solar receives 10%
  - Dependent on actual

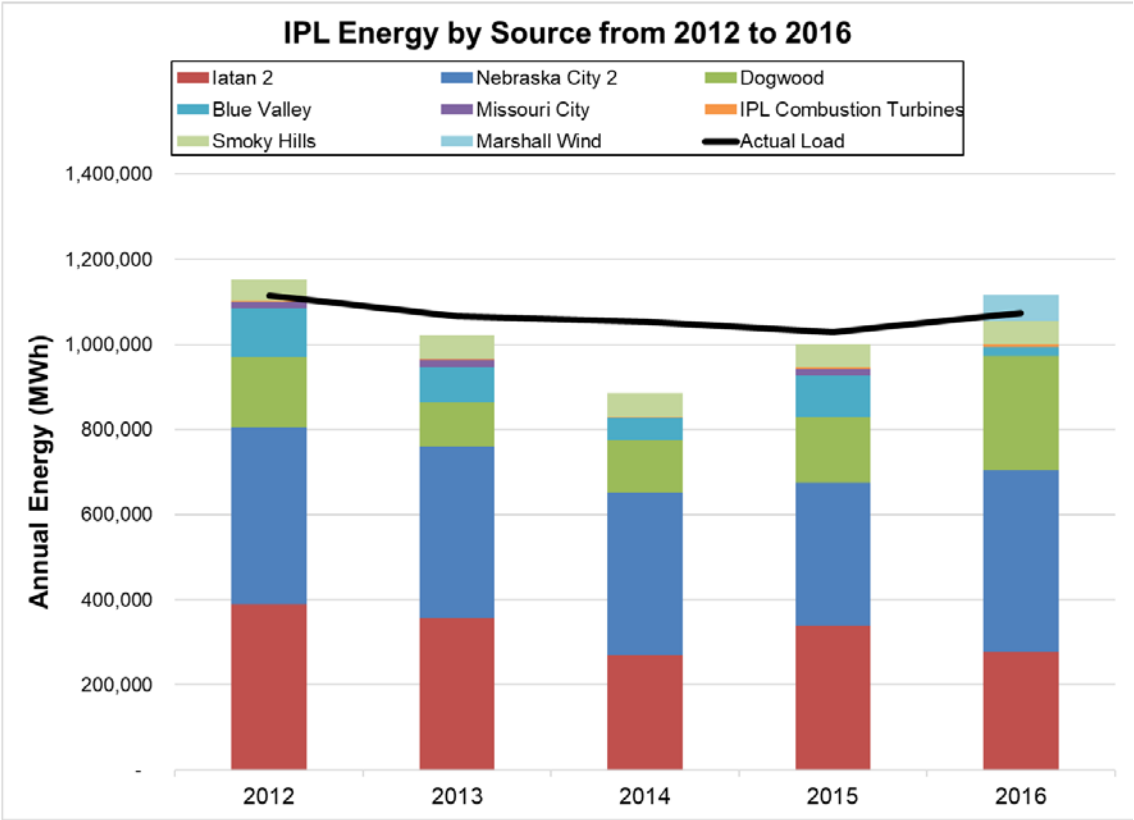


Hourly Load Example



IPL's Historical Energy Supply

- Historically, IPL has supplied nearly all of its energy requirements from existing resources or contracts
- Market supplied energy when resources were offline
- New solar resource will start providing more energy



Key Components of the Energy Master Plan

- Condition assessment of IPL's power plants
- Review of existing power supply resources (contracts/plants)
- Technology assessment of new resources available to IPL
- Identify power supply options available to IPL
- Review of transmission reliability of IPL's system
- Economic cost-benefit evaluation

Objective: Determine the "best" mix of resources that provides safe, reliable, environmentally compliant, low cost capacity and energy to IPL's customers.

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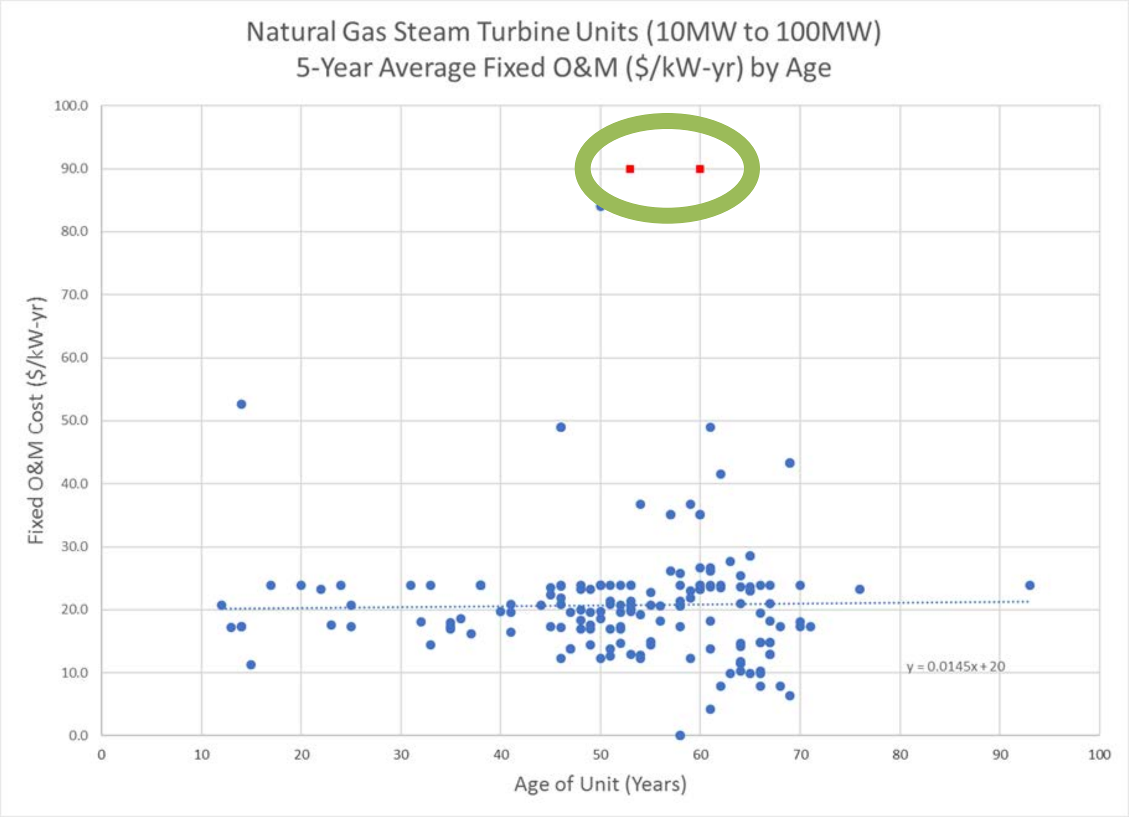
Condition Assessment

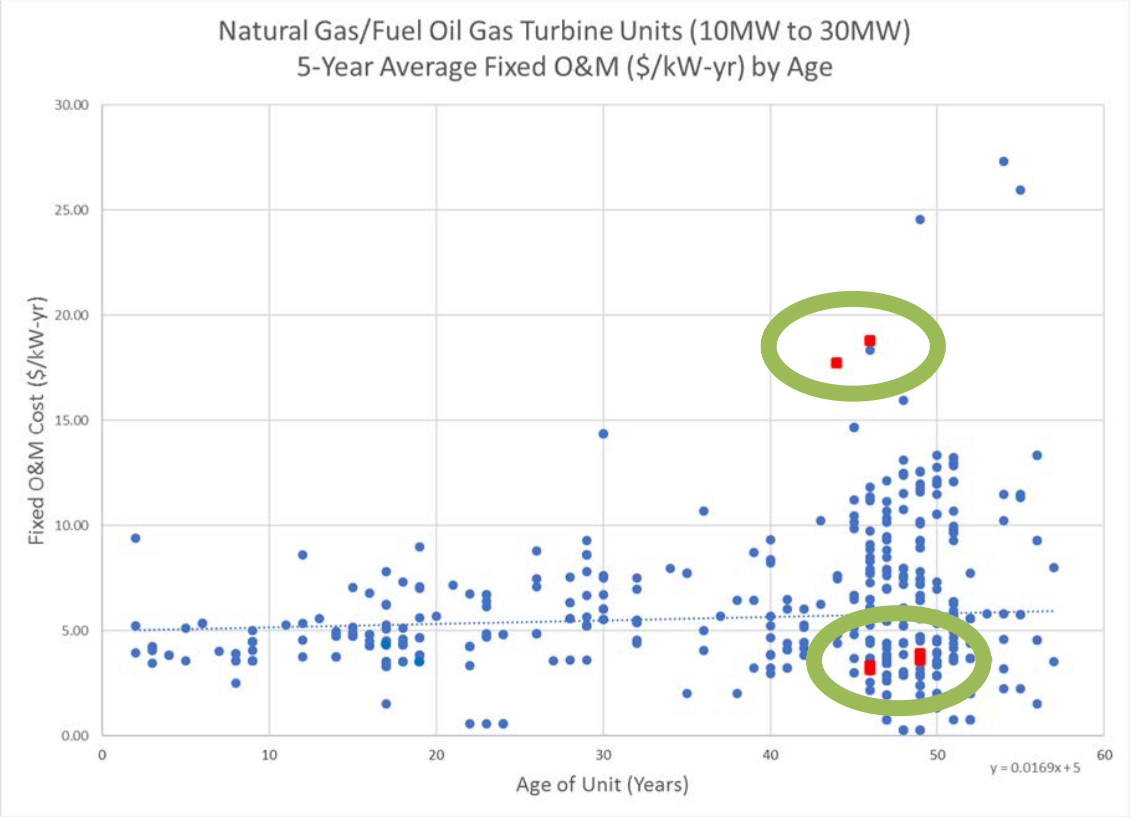
- Objective: Assess the condition of the facilities and determine costs for continued operation over a variety of operating horizons
  - Reviewed documentation and physical inspection
  - Interviewed plant staff regarding plant issues
  - Recent inspection reports and maintenance records
  - Generation and reliability data
  - Historical maintenance and capital expenditures
- Developed cost estimates for continued operation of Blue Valley and the combustion turbines over operating horizons of 5-years, 10-years, and 20-years

Operation & Maintenance Cost Benchmarking

Blue Valley Units

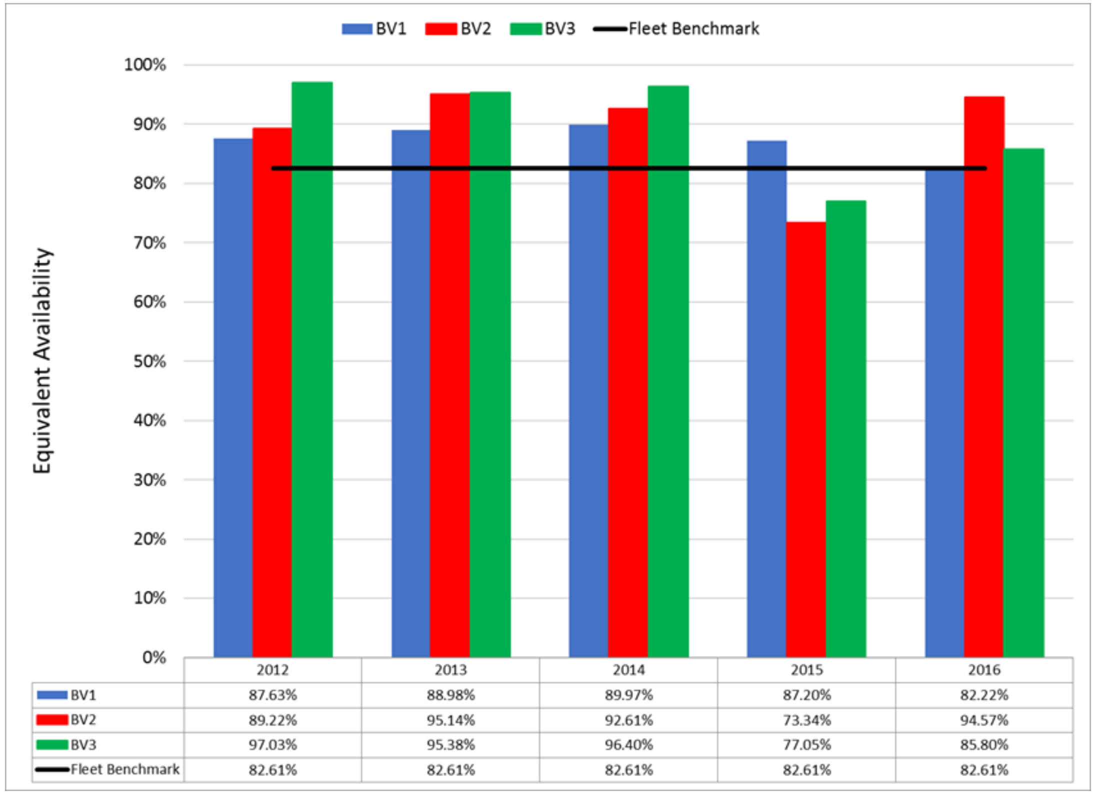


Combustion Turbines



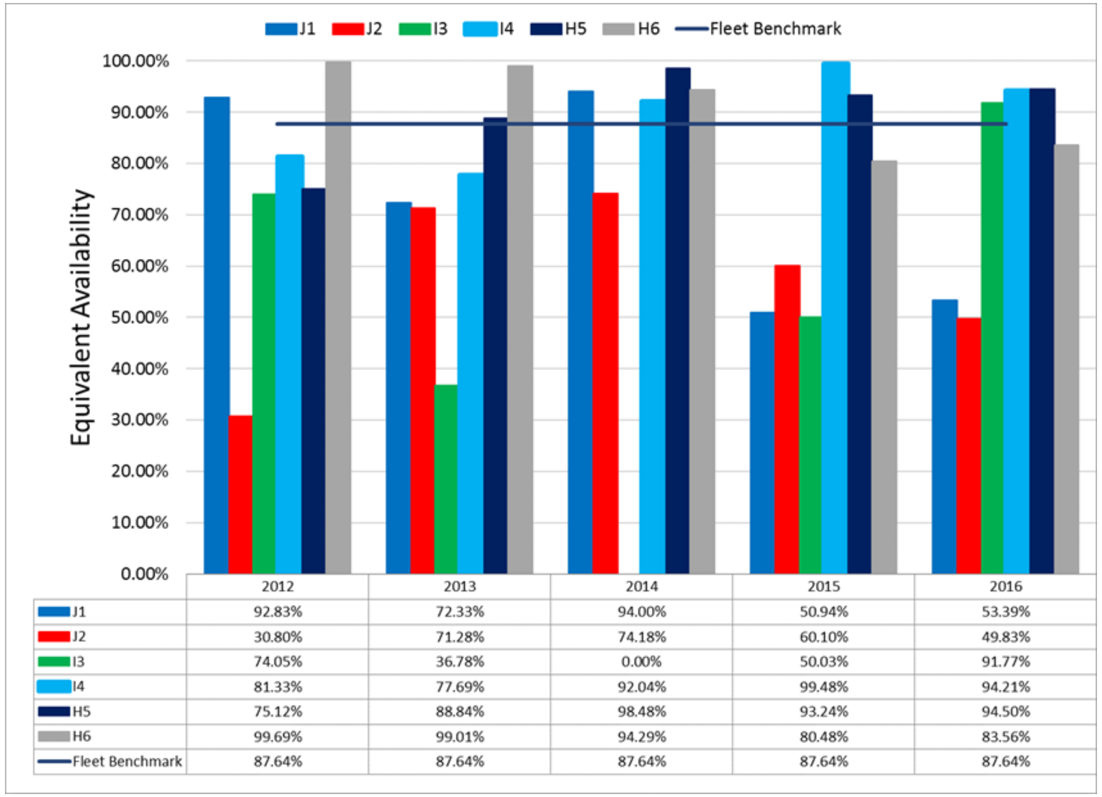
Reliability Benchmarking – Availability

Blue Valley Units



	2012	2013	2014	2015	2016
BV1	87.63%	88.98%	89.97%	87.20%	82.22%
BV2	89.22%	95.14%	92.61%	73.34%	94.57%
BV3	97.03%	95.38%	96.40%	77.05%	85.80%
Fleet Benchmark	82.61%	82.61%	82.61%	82.61%	82.61%

Combustion Turbines



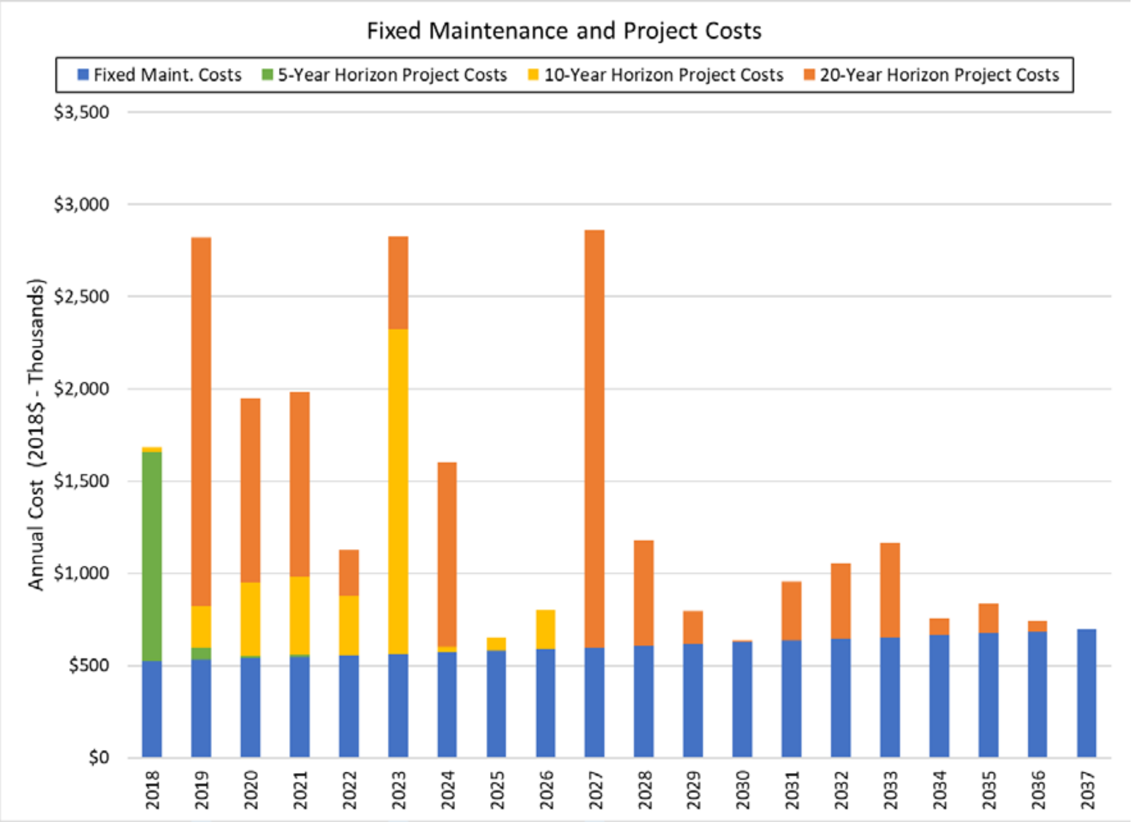
	2012	2013	2014	2015	2016
J1	92.83%	72.33%	94.00%	50.94%	53.39%
J2	30.80%	71.28%	74.18%	60.10%	49.83%
I3	74.05%	36.78%	0.00%	50.03%	91.77%
I4	81.33%	77.69%	92.04%	99.48%	94.21%
H5	75.12%	88.84%	98.48%	93.24%	94.50%
H6	99.69%	99.01%	94.29%	80.48%	83.56%
Fleet Benchmark	87.64%	87.64%	87.64%	87.64%	87.64%

Condition Assessment Results

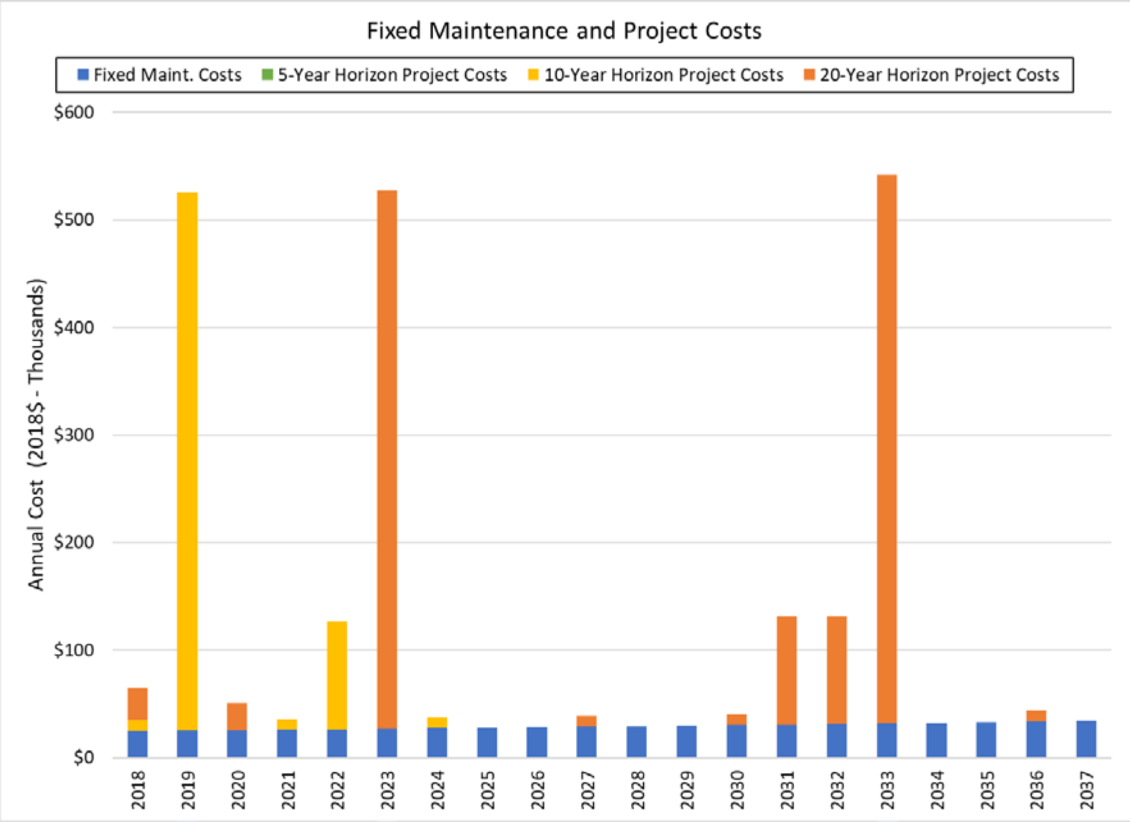
- Blue Valley
  - The units appear to have been maintained at, or exceeding, typical industry standards since they were put in service.
  - Even with availability remaining high, the units have experienced a significant increase in forced outage rates (worse reliability) over the past two years.
  - The facility has significantly higher baseline fixed O&M costs when compared to similar natural gas-fired STG units.
  - Many of the major components and equipment for the units will need to be repaired or replaced to provide reliable operation over the next 20 years.
- Combustion Turbines
  - The units appear to have been maintained at, or exceeding, typical industry standards since they were put in service.
  - The reliability of the units is significantly less (worse) than the peer benchmark due in large part to instrumentation issues (Substation H has performed better than the other units).
  - Many of the major components and equipment for the units will need to be repaired or replaced to provide reliable operation over the next 20 years.

Condition Assessment Cost Estimate Example

Blue Valley Unit 1



Combustion Turbine J1



Power Plant Staffing Review

- Objective: Assess IPL's staffing levels for power production and conduct a benchmark review against the industry
- Reviewed organizational chart for power plant operations and maintenance staff
- Benchmarked against similar facilities and utilities
- Considered alternative IPL portfolios
  - Business-as-Usual operation for Blue Valley and combustion turbines
  - Retired Blue Valley and continue to operate combustion turbines

Power Plant Staffing Review

- IPL's power production staffing has historically been above average for similar facilities and utilities
- IPL has begun reducing fixed O&M costs through natural attrition
- Two alternatives developed
  - No power plant retirements
  - Shutdown Blue Valley, but combustion turbines are in operation
- Overall observations
  - Through recent efforts, staffing levels now reflect benchmark recommendations based on current plant conditions (assuming no power plant retirements).
  - IPL should continue to evaluate staffing levels for power production, and when possible try to naturally reduce costs through attrition, job-sharing, or role-shifting, especially if power plant retirements occur.

Power Plant Staffing Benchmarking

	Independence Power & Light		Benchmark Units										Future Options for IPL	
Technology	**Org Chart 1**	**Org Chart 2**	**Plant Benchmark 1**	**Plant Benchmark 2**	**Plant Benchmark 3**	**Plant Benchmark 4**	**Plant Benchmark 5**	**Plant Benchmark 6**	**Utility Benchmark 7**	**Utility Benchmark 8**	**Utility Benchmark 9**	**Benchmark Average**	**STG/CTG Operation**	**CTG Only Operation**
No. of STG Units	3	3	1	2	1	1	4	1	3	3	1	2	1 to 3	0
No. of CTG units	6	6	0	0	0	0	0	0	2	4	1	0	1 to 6	1 to 6+
Size (MW)	200 MW	200 MW	750 MW	2 x 400 MW	80 MW	100 MW	1,600 MW	250 MW	300 MW	475 MW	79 MW	-	200 MW	100 MW
Age (years)	53 to 60 years	53 to 60 years	40+ years	40+ years	50+ years	5 years	39 to 56 years	20+ years	30 to 50 years	15 to 60 years	35 to 45 years	-	53 to 60 years	40+ years
Staffing/Positions														
Production Manager	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Plant Admin	1	1	1	1	2	2	1	1	1	1	1	1	1	1
Plant Engineer	3	1	1	2	1	1	3	1	3	4	0	2	2	1
Plant Specialist (Data/Engineering Aide)	1	1	0	0	0	0	0	0	0	3	0	0	0	0
Maintenance Planner	0	0	1	1	0	1	2	0	0	1	0	1	1	1
Operations/Maintenance Superintendent	0	1	1	0	0	0	1	0	0	1	0	0	0	1
Operations Superintendent	2	1	0	1	1	1	0	1	5	0	4	1	1	0
Operations Supervisor	5	5	4	4	0	0	0	5	1	1	4	2	5	0
Operations - CRO (III)	6	5	4	5	4	4	5	5	0	7	4	4	5	4
Operations - I/II	18	12	8	12	8	12	12	15	16	11	8	11	12	4
Maintenance Superintendent	1	1	1	1	1	1	1	1	4	0	1	1	1	0
Maintenance Supervisor	4	3	0	0	2	0	2	2	1	2	1	1	0	0
Maintenance - Mechanics/Journeyman/Welders	22	10	2	4	16	4	8	5	8	2	11	7	7	4
Maintenance - Instruments/Controls/Electricians	8	8	3	4	5	3	8	5	3	4	3	4	5	4
I&C Supervisor	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Store Room Superintendent	1	1	0	0	0	0	0	1	0	0	0	0	0	0
Store Room Clerk	2	2	1	1	0	1	1	1	0	1	0	1	1	1
Safety Specialist	1	1	1	1	1	0	0	1	0	0	0	0	1	1
Lab Tech	1	1	0	0	0	0	2	2	1	0	1	1	1	0
Fuel Handling Supervisor	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Fuel Handling Worker	0	4	0	0	0	0	0	0	0	0	0	0	0	0
Total	**77**	**60**	**29**	**38**	**42**	**31**	**47**	**47**	**45**	**40**	**39**	**40**	**44**	**23**

Note: Actual positions may vary due to various reasons such as personnel skill sets or equipment needs

Power Plant Staffing Scenarios

Staffing Scenario	No. of Power Plant Staff	2019 Power Production Labor Costs ($)
Business-as-Usual (no plant retirements)	60	$9.3 million
Reduced staff with no power production retirements (see Note 1 below)	44	$6.8 million
Retire Blue Valley, combustion turbines are operational	23	$3.6 million

Note 1: During these planning efforts, IPL has reduced power production staffing to the reduced staffing levels described above through attrition and internal transfers.

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New Resource Technology Assessment

- Burns & McDonnell conducted a new resource technology assessment
- Estimates the installation capital costs, operation and maintenance costs, and performance (i.e. fuel consumption) for a variety of resources, including:
  - Natural gas-fired (peaking, combined cycle)
  - Renewables
  - Energy storage
- Consider resources that could be wholly owned and operated by IPL and units that IPL may be able to participate in as a third-party
- Cost that were developed are used within the economic evaluation

New Natural Gas Power Plant Characteristics

Technology	Capacity (MW)	Heat Rate (Btu/kWh)	Capital Cost ($/kW)
Aeroderivative	40 - 100	~9,200	~$1,700
Frame Combustion Turbines (F-Class, H-Class, G-Class)	200 - 300	~9,800	~$600
Reciprocating Engines	Variable (9 - 18 MW increments)[1]	~8,300	$1,300-$1,800[2]
Combined Cycle Gas Turbines (F-Class, H-Class, G-Class)	600-1,200	~6,700	$1,000-$1,300

(1) These plants can be built with any number of 9 to 18 MW engine blocks.

(2) Range is based on estimates for plants with capacity between 36 MW and 108 MW.

Summary of Gas-Fired Resources

Technology	Advantages	Disadvantages
Gas-Fired Resources		
Aeroderivative	• Flexible operation (ability to quickly turn-on/off in response to market signals) • More efficient than large frame units • Ability for on-system installation	• High fuel gas pressure • Higher capital cost compared to other peaking resources on $/kW basis
F-Class	• Lowest cost peaking resource on a $/kW basis • Flexible compared to CCGT, but slightly less than Aeroderivative and reciprocating engines • Ability for on-system installation	• High fuel gas pressure • Large capacity on a single shaft • Less flexible compared to aeroderivatives and reciprocating engines • Higher heat rate compared to aeroderivative turbines
Reciprocating Engines	• Most flexible gas-fired resource (ability to quickly turn-on/off in response to market signals) • Low fuel gas pressure • Shaft diversification (9-18MW) • Ability for on-system installation	• Higher capital cost compared to F-Class or CCGT technology on a $/kW basis
CCGT	• Most efficient gas-fired technology • Lower capital cost due to economies of scale on a $/kW basis	• Lacks flexibility compared to other gas-fired technologies • Must be one of potentially several pseudo-owners of a large unit • Most likely located off-system

Summary of Renewable Resources

Technology	Advantages	Disadvantages
Renewables		
Local Wind (Jackson County, Missouri)	• Reduced transmission congestion	• No Production Tax Credit or Interconnection Tax Credit (need taxable partner) • Uneconomical compared to resources available in nearby regions • Wind farms cannot be easily integrated into residential, commercial, or industrial areas
Regional Wind (Kansas, Oklahoma)	• Economically justifiable • Production Tax Credit through PPA • Large wind farms reduce the overall cost of the technology	• IPL is not the operator of the wind farms • Potential congestion costs
Local Solar	• Increased to renewable energy production for utility portfolio	• Lack of solar resource availability in Midwest • Higher cost of energy compared to regional wind

Summary of Energy Storage Resources

Technology	Advantages	Disadvantages
Storage		
Flow Battery	• Scalable technology in development • Higher cycling life compared to conventional batteries • Offsets electric peak loads	• Technology is not entirely mature currently • Required operation of ancillary equipment
Conventional Battery (Lead Acid and Lithium Ion)	• Low capital costs • Responsive to changes in grid demand • Offsets electric peak loads	• Life is dependent on cycling and discharge rates, potentially 5 to 10 years for high cycling utilization • High maintenance cost • Materials used are associated with being high toxicity
High Temperature	• High discharge rates • Life expected to be around 15 years • Offsets electric peak loads	• Energy requirement to maintain liquid electrolytes • Technology is still being developed for utility level applications • Uneconomically compared to other storage technologies
Pumped Hydro	• Large reservoir of storage energy • Offsets electric peak loads	• Geology required for water storage • Environmental impacts to surrounding areas • High capital costs
Compressed Air Energy Storage ("CAES")	• Large reservoir of storage energy • Offsets electric peak loads	• Specific geology required for compressed air storage (not ideal for limestone mines) • High capital costs

Other Resource Alternatives

- All-requirements or partial-requirements contracts
- Purchase of additional Dogwood ownership
- Short-term market capacity purchases
- Power purchase agreement from unsolicited proposal for reciprocating engines

Transmission System Reliability

- The North American Electric Reliability Corporation (NERC), in cooperation with the ISOs, is responsible for establishing a highly reliable and secure bulk power system.
- NERC has specific policies, procedures, and requirements for ISOs and utilities.
- Reliability of N – 1: The transmission system must meet a minimum requirement of maintaining full operating capability with the loss of one (1) key element.
  - IPL can meet N – 1 obligations with no on-system generation.
- Historically, IPL has operated its system with a reliability of N – 2 without shedding load, mainly through having on-system generation. Power plant retirements could impact that.
- Burns & McDonnell evaluated transmission system upgrades required to maintain N – 2 reliability (without shedding load) in the event power plant retirements occur.

Transmission System Reliability Results

Retirement Scenario	Transmission Upgrade Costs (Approximate)
Retire Blue Valley only (combustion turbines remain in operation)	$800,000
Retire and replace Blue Valley with new generation, Retire combustion turbines	$19.5 million
Retire all on-system generation with no new on-system generation installed	$36.5 million

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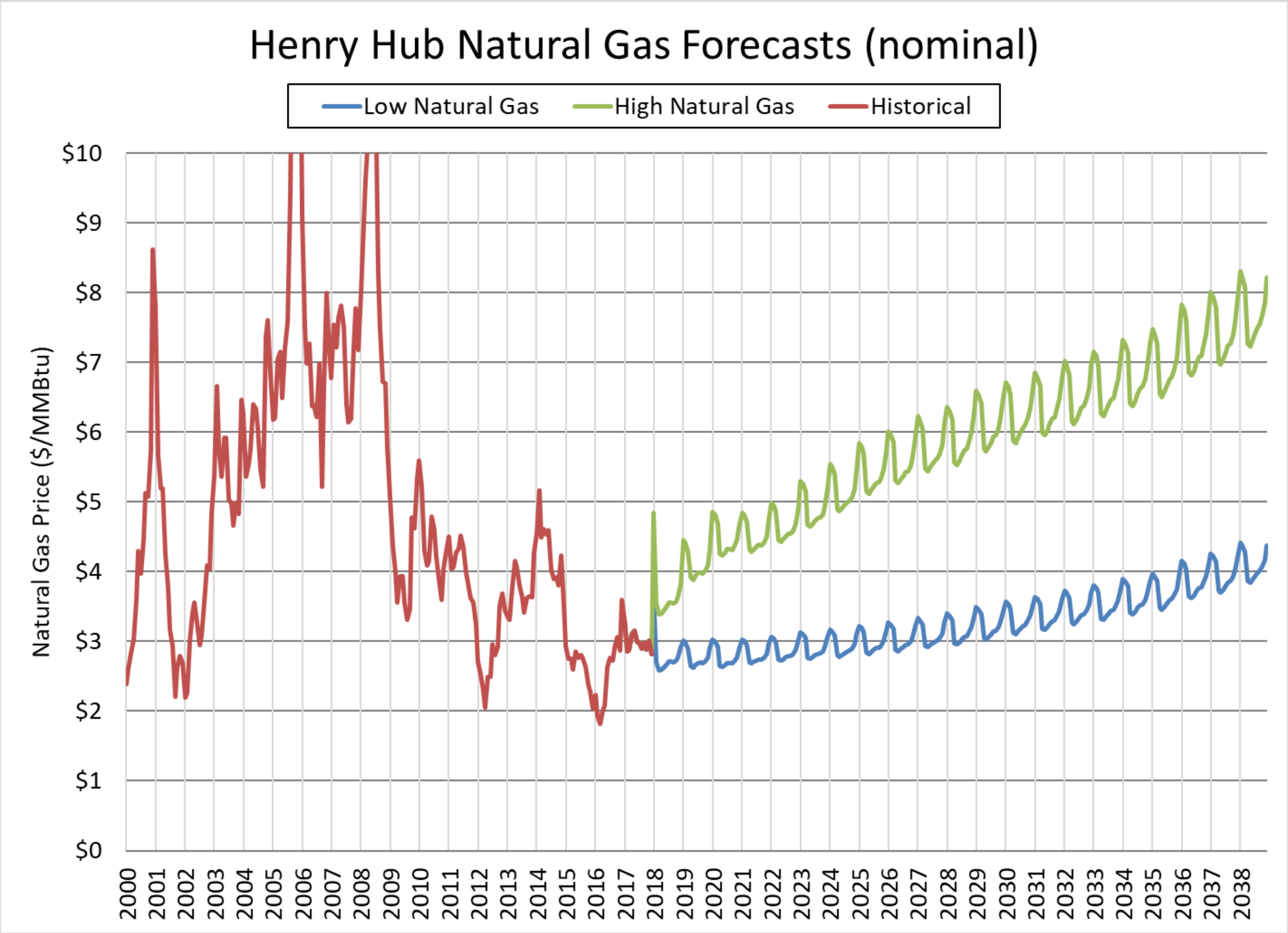
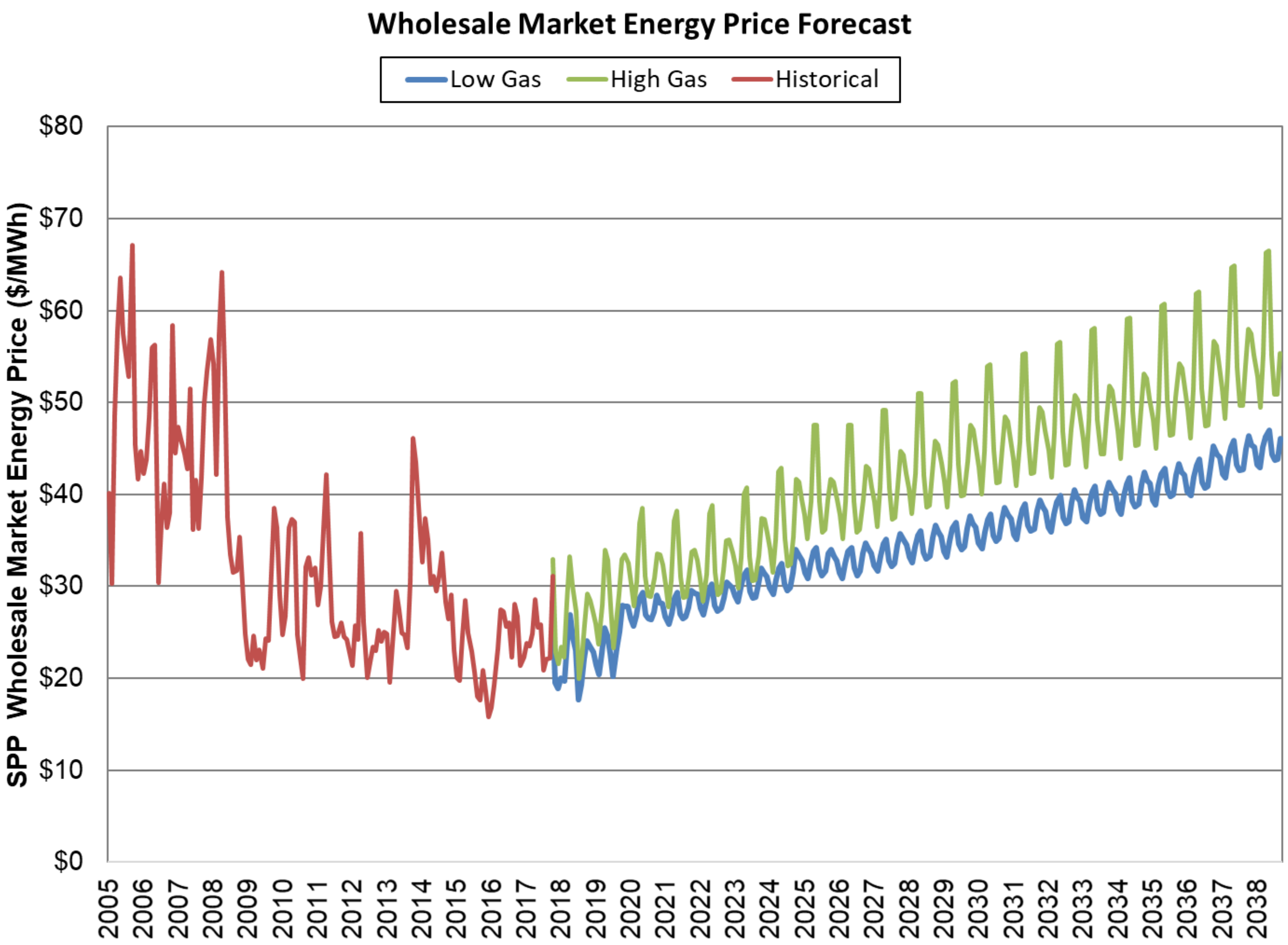
Economic Evaluation

- Objective: Assess the cost-benefits of individual resources to determine how IPL's overall energy supply portfolio can meet customers needs both short-term and long-term
- Utilize costs for resources as described previously
- Develop forecasts for fuel and market energy prices
- Perform economic screening of alternatives to narrow down resource options for more granular evaluation

Natural Gas Forecast Assumptions



SPP Market Energy Forecast Assumption



Financial Assumptions

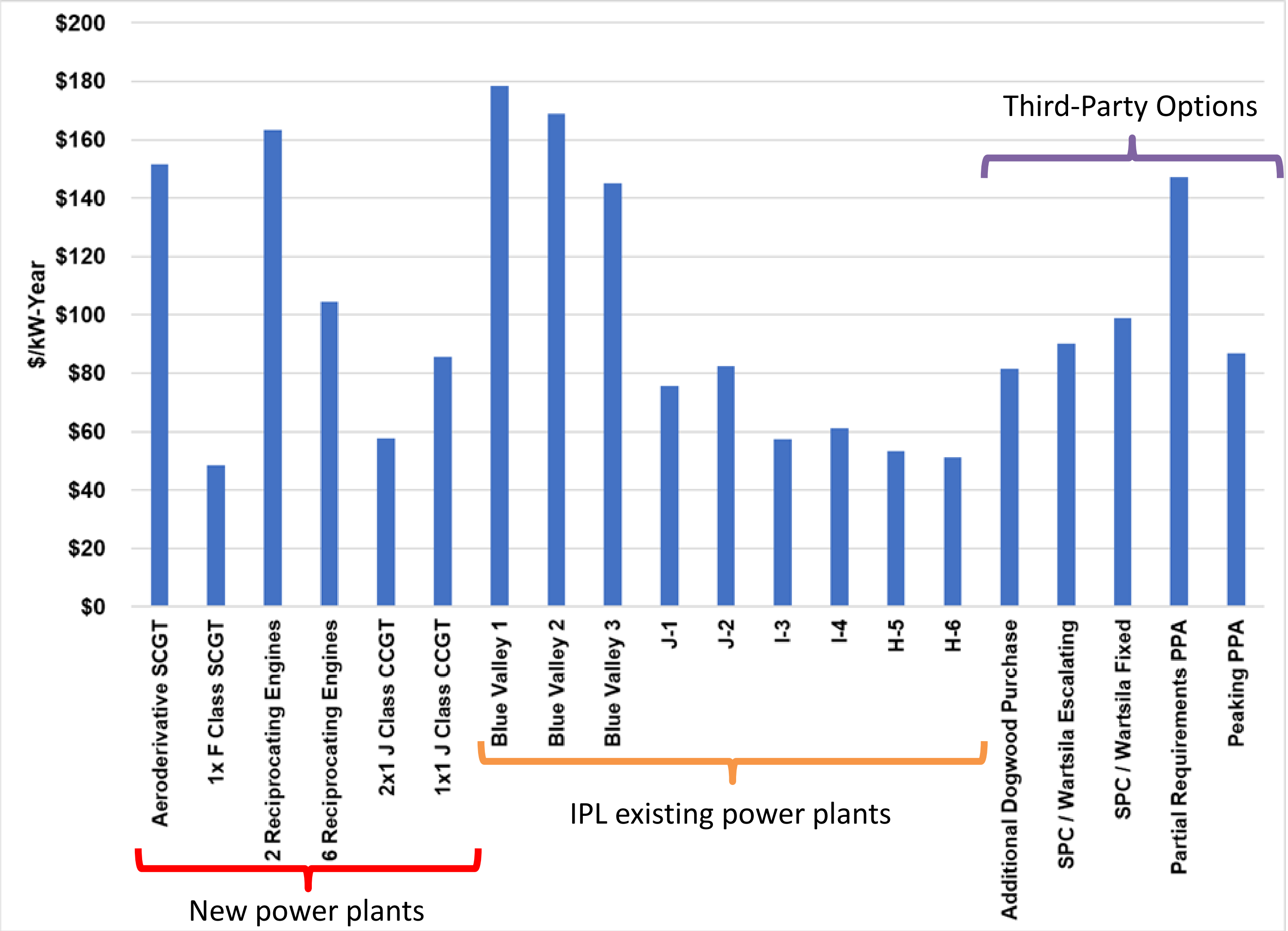
- 20-year planning horizon (2019-2038)
- Interest rate 5%
- Financing term 30 years (20 years for Dogwood)
- General inflation 2.5%
- Discount rate 5%

Economic Evaluation – Levelized Cost of Capacity (LCOC)

- Screening tool used for evaluation of numerous options
- LCOC includes:
  - Fixed expenses
  - Variable expenses
  - Fuel costs
  - Debt service expenses
  - Credit for market revenue

Economic Evaluation – Levelized Cost of Capacity Results

- Blue Valley units are expensive
- Existing combustion turbines are a low cost resource
- Dogwood and Peaking PPA appear attractive
- Several technologies eliminated from further consideration due to costs or reliance on others to develop



Economic Evaluation – Portfolio Optimization

- Utilized pre-screened alternatives and existing resources to determine optimized portfolio
- Sophisticated software that simulates the power generation resources interaction with the SPP market over a 20-year horizon.
- Determines the “low cost” combination of resources to meet IPL’s requirements for capacity and energy
- Considers power plant retirements and additions as cost effective and necessary to meet capacity and energy requirements

Economic Evaluation – Portfolio Optimization

- Three common paths developed within the portfolio optimization
  - Business-as-Usual with no retirements
  - Retire Blue Valley
  - Retire Blue Valley and the combustion turbines
- Each path had unique capacity additions to account for requirements

Portfolio Optimization – Business-as-Usual

	Path 1	Path 2
Path *Labor*	**Business As Usual** *Existing Staff*	**Business As Usual** *Benchmark Staff*
2019		
2020		
2021		
2022		
2023		
2024		
2025		
2026		
2027		
2028		
2029		
2030		
2031		
2032		
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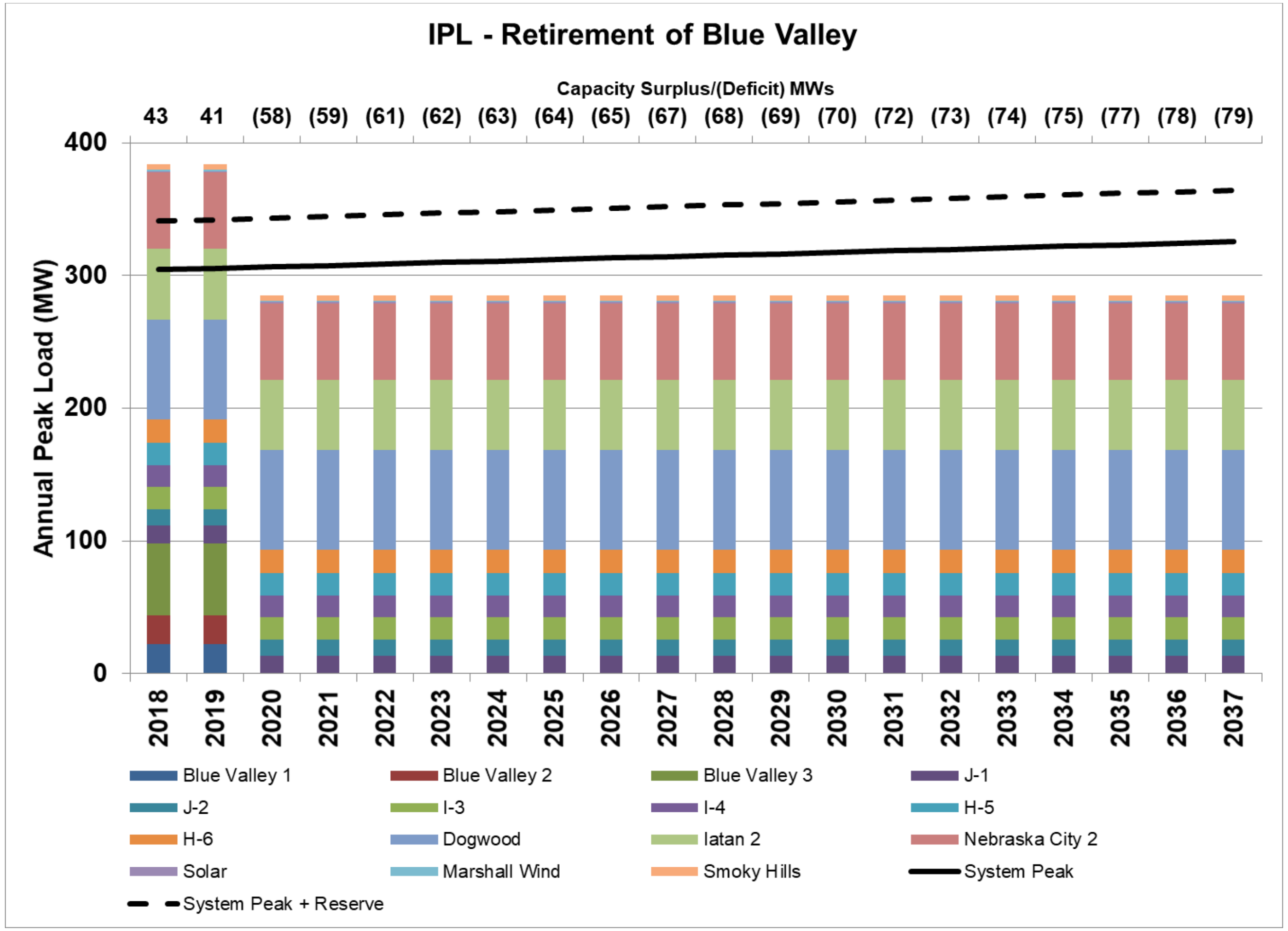
2037		
2038		

Balance of Loads & Resources – Retire Blue Valley



Portfolio Optimization – Retire Blue Valley

	Path 3	Path 4	Path 5	Path 6	Path 7
Path *Labor*	**Retire BV** *CT Only Staff*	**Retire BV** *CT Only Staff*	**Retire BV** *CT Only Staff*	**Retire BV** *CT Only Staff*	**Retire BV** *CT Only Staff*
2019	**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**
2020	60 MW Capacity	**25 MW Dogwood** 35 MW Capacity	**50 MW Dogwood** 10 MW Capacity	60 MW Capacity	**50 MW Dogwood** 10 MW Capacity
2021	60 MW Capacity	35 MW Capacity	10 MW Capacity	60 MW Capacity	10 MW Capacity
2022	65 MW Capacity	40 MW Capacity	15 MW Capacity	65 MW Capacity	15 MW Capacity
2023	65 MW Capacity	40 MW Capacity	15 MW Capacity	65 MW Capacity	15 MW Capacity **Retire 33 MW SUB I**
2024	65 MW Capacity	40 MW Capacity	15 MW Capacity	**110 MW 6xRecips**	**37 MW 2xRecips** 10 MW Capacity
2025	65 MW Capacity	40 MW Capacity	15 MW Capacity		15 MW Capacity
2026	70 MW Capacity	45 MW Capacity	20 MW Capacity		15 MW Capacity
2027	70 MW Capacity	45 MW Capacity	20 MW Capacity		15 MW Capacity
2028	70 MW Capacity	45 MW Capacity	20 MW Capacity		15 MW Capacity
2029	70 MW Capacity	45 MW Capacity	20 MW Capacity		20 MW Capacity
2030	75 MW Capacity	50 MW Capacity	25 MW Capacity		20 MW Capacity
2031	75 MW Capacity	50 MW Capacity	25 MW Capacity		20 MW Capacity
2032	75 MW Capacity	50 MW Capacity	25 MW Capacity		20 MW Capacity
2033	75 MW Capacity	50 MW Capacity	25 MW Capacity		25 MW Capacity
2034	80 MW Capacity	55 MW Capacity	30 MW Capacity		25 MW Capacity
2035	80 MW Capacity	55 MW Capacity	30 MW Capacity		25 MW Capacity
2036	80 MW Capacity	55 MW Capacity	30 MW Capacity		25 MW Capacity
2037	80 MW Capacity	55 MW Capacity	30 MW Capacity		30 MW Capacity
2038	85 MW Capacity	60 MW Capacity	35 MW Capacity		30 MW Capacity

Portfolio Optimization – Retire All On-System Generation

	Path 8	Path 9	Path 10	Path 11	Path 12	Path 13
Path *Labor*	**Retire BV & CTs** *CT Only Staff*	**Retire BV & CTs** *CT Only Staff*	**Retire BV & CTs** *CT Only Staff*	**Retire BV & CTs** *CT Only Staff*	**Retire BV & Staggered CT Retirement** *CT Only Staff*	**Retire BV & Staggered CT Retirement** *CT Only Staff*
2019	**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**
2020	**50 MW Dogwood** 10 MW Capacity	60 MW Capacity	**25 MW Dogwood** 35 MW Capacity	**50 MW Dogwood** 10 MW Capacity	60 MW Capacity	60 MW Capacity
2021	10 MW Capacity	60 MW Capacity	35 MW Capacity	10 MW Capacity	60 MW Capacity	60 MW Capacity
2022	15 MW Capacity	65 MW Capacity	40 MW Capacity	15 MW Capacity	65 MW Capacity	65 MW Capacity
2023	15 MW Capacity **Retire 94 MW CTs**	65 MW Capacity **Retire 94 MW CTs**	40 MW Capacity **Retire 94 MW CTs**	15 MW Capacity **Retire 94 MW CTs**	65 MW Capacity **Retire One CT Plant**	65 MW Capacity **Retire One CT Plant**
2024	110 MW Capacity	**110 MW 6xRecips** 50 MW Capacity	**110 MW 6xRecips** 25 MW Capacity	**37 MW 2xRecips** 70 MW Capacity	**37 MW 2xRecips** 65 MW Capacity	100 MW Capacity
2025	110 MW Capacity	50 MW Capacity	25 MW Capacity	75 MW Capacity	65 MW Capacity	100 MW Capacity
2026	110 MW Capacity	50 MW Capacity	25 MW Capacity	75 MW Capacity	65 MW Capacity	105 MW Capacity
2027	115 MW Capacity	55 MW Capacity	30 MW Capacity	75 MW Capacity	65 MW Capacity	105 MW Capacity
2028	115 MW Capacity	55 MW Capacity	30 MW Capacity	75 MW Capacity	70 MW Capacity **Retire One CT Plant**	105 MW Capacity **Retire One CT Plant**
2029	115 MW Capacity	55 MW Capacity	30 MW Capacity	80 MW Capacity	**37 MW 2xRecips** 65 MW Capacity	140 MW Capacity
2030	115 MW Capacity	55 MW Capacity	30 MW Capacity	80 MW Capacity	65 MW Capacity	140 MW Capacity
2031	120 MW Capacity	60 MW Capacity	35 MW Capacity	80 MW Capacity	70 MW Capacity	140 MW Capacity
2032	120 MW Capacity	60 MW Capacity	35 MW Capacity	80 MW Capacity	70 MW Capacity	145 MW Capacity
2033	120 MW Capacity	60 MW Capacity	35 MW Capacity	85 MW Capacity	70 MW Capacity **Retire One CT Plant**	145 MW Capacity **Retire One CT Plant**
2034	120 MW Capacity	60 MW Capacity	35 MW Capacity	85 MW Capacity	**37 MW 2xRecips** 60 MW Capacity	170 MW Capacity
2035	125 MW Capacity	65 MW Capacity	40 MW Capacity	85 MW Capacity	65 MW Capacity	175 MW Capacity
2036	125 MW Capacity	65 MW Capacity	40 MW Capacity	85 MW Capacity	65 MW Capacity	175 MW Capacity
2037	125 MW Capacity	65 MW Capacity	40 MW Capacity	90 MW Capacity	65 MW Capacity	175 MW Capacity
2038	125 MW Capacity	65 MW Capacity	40 MW Capacity	90 MW Capacity	65 MW Capacity	175 MW Capacity

Economic Evaluation – Portfolio Optimization Results

Independence Power & Light - 2018 Energy Master Plan Low Natural Gas and Market Prices													
	Path 1	**Path 2**	**Path 3**	**Path 4**	**Path 5**	**Path 6**	**Path 7**	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**	**Path 13**
Path *Labor*	**Business As Usual** *Existing Staff*	**Business As Usual** *Benchmark Staff*	**Retire BV** *CT Only Staff*	**Retire BV** *CT Only Staff*	**Retire BV** *CT Only Staff*	**Retire BV** *CT Only Staff*	**Retire BV** *CT Only Staff*	**Retire BV & CTs** *CT Only Staff*	**Retire BV & CTs** *CT Only Staff*	**Retire BV & CTs** *CT Only Staff*	**Retire BV & CTs** *CT Only Staff*	**Retire BV & Staggered CT Retirement** *CT Only Staff*	**Retire BV & Staggered CT Retirement** *CT Only Staff*
2019			**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**	**Retire 98 MW BV**
2020			60 MW Capacity	**25 MW Dogwood** 35 MW Capacity	**50 MW Dogwood** 10 MW Capacity	60 MW Capacity	**50 MW Dogwood** 10 MW Capacity	**50 MW Dogwood** 10 MW Capacity	60 MW Capacity	**25 MW Dogwood** 35 MW Capacity	**50 MW Dogwood** 10 MW Capacity	60 MW Capacity	60 MW Capacity
2021			60 MW Capacity	35 MW Capacity	10 MW Capacity	60 MW Capacity	10 MW Capacity	10 MW Capacity	60 MW Capacity	35 MW Capacity	10 MW Capacity	60 MW Capacity	60 MW Capacity
2022			65 MW Capacity	40 MW Capacity	15 MW Capacity	65 MW Capacity	15 MW Capacity	15 MW Capacity	65 MW Capacity	40 MW Capacity	15 MW Capacity	65 MW Capacity	65 MW Capacity
2023			65 MW Capacity	40 MW Capacity	15 MW Capacity	65 MW Capacity	15 MW Capacity **Retire 33 MW SUB I**	15 MW Capacity **Retire 94 MW CTs**	65 MW Capacity **Retire 94 MW CTs**	40 MW Capacity **Retire 94 MW CTs**	15 MW Capacity **Retire 94 MW CTs**	65 MW Capacity **Retire One CT Plant**	65 MW Capacity **Retire One CT Plant**
2024			65 MW Capacity	40 MW Capacity	15 MW Capacity	**110 MW 6xRecips**	**37 MW 2xRecips** 10 MW Capacity	110 MW Capacity	**110 MW 6xRecips** 50 MW Capacity	**110 MW 6xRecips** 25 MW Capacity	**37 MW 2xRecips** 70 MW Capacity	**37 MW 2xRecips** 65 MW Capacity	100 MW Capacity
2025			65 MW Capacity	40 MW Capacity	15 MW Capacity		15 MW Capacity	110 MW Capacity	50 MW Capacity	25 MW Capacity	75 MW Capacity	65 MW Capacity	100 MW Capacity
2026			70 MW Capacity	45 MW Capacity	20 MW Capacity		15 MW Capacity	110 MW Capacity	50 MW Capacity	25 MW Capacity	75 MW Capacity	65 MW Capacity	105 MW Capacity
2027			70 MW Capacity	45 MW Capacity	20 MW Capacity		15 MW Capacity	115 MW Capacity	55 MW Capacity	30 MW Capacity	75 MW Capacity	65 MW Capacity	105 MW Capacity
2028			70 MW Capacity	45 MW Capacity	20 MW Capacity		15 MW Capacity	115 MW Capacity	55 MW Capacity	30 MW Capacity	75 MW Capacity	70 MW Capacity **Retire One CT Plant**	105 MW Capacity **Retire One CT Plant**
2029			70 MW Capacity	45 MW Capacity	20 MW Capacity		20 MW Capacity	115 MW Capacity	55 MW Capacity	30 MW Capacity	80 MW Capacity	**37 MW 2xRecips** 65 MW Capacity	140 MW Capacity
2030			75 MW Capacity	50 MW Capacity	25 MW Capacity		20 MW Capacity	115 MW Capacity	55 MW Capacity	30 MW Capacity	80 MW Capacity	65 MW Capacity	140 MW Capacity
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2032			75 MW Capacity	50 MW Capacity	25 MW Capacity		20 MW Capacity	120 MW Capacity	60 MW Capacity	35 MW Capacity	80 MW Capacity	70 MW Capacity	145 MW Capacity
2033			75 MW Capacity	50 MW Capacity	25 MW Capacity		25 MW Capacity	120 MW Capacity	60 MW Capacity	35 MW Capacity	85 MW Capacity	70 MW Capacity **Retire One CT Plant**	145 MW Capacity **Retire One CT Plant**
2034			80 MW Capacity	55 MW Capacity	30 MW Capacity		25 MW Capacity	120 MW Capacity	60 MW Capacity	35 MW Capacity	85 MW Capacity	**37 MW 2xRecips** 60 MW Capacity	170 MW Capacity
2035			80 MW Capacity	55 MW Capacity	30 MW Capacity		25 MW Capacity	125 MW Capacity	65 MW Capacity	40 MW Capacity	85 MW Capacity	65 MW Capacity	175 MW Capacity
2036			80 MW Capacity	55 MW Capacity	30 MW Capacity		25 MW Capacity	125 MW Capacity	65 MW Capacity	40 MW Capacity	85 MW Capacity	65 MW Capacity	175 MW Capacity
2037			80 MW Capacity	55 MW Capacity	30 MW Capacity		30 MW Capacity	125 MW Capacity	65 MW Capacity	40 MW Capacity	90 MW Capacity	65 MW Capacity	175 MW Capacity
2038			85 MW Capacity	60 MW Capacity	35 MW Capacity		30 MW Capacity	125 MW Capacity	65 MW Capacity	40 MW Capacity	90 MW Capacity	65 MW Capacity	175 MW Capacity

Economic Evaluation – Portfolio Optimization Results

Independence Power & Light - 2018 Energy Master Plan
Low Natural Gas and Market Prices

Path *Labor*	Path 1 Business As Usual *Existing Staff*	Path 2 Business As Usual *Benchmark Staff*	Path 3 Retire BV *CT Only Staff*	Path 4 Retire BV *CT Only Staff*	Path 5 Retire BV *CT Only Staff*	Path 6 Retire BV *CT Only Staff*	Path 7 Retire BV *CT Only Staff*	Path 8 Retire BV & CTs *CT Only Staff*	Path 9 Retire BV & CTs *CT Only Staff*	Path 10 Retire BV & CTs *CT Only Staff*	Path 11 Retire BV & CTs *CT Only Staff*	Path 12 Retire BV & Staggered CT Retirement *CT Only Staff*	Path 13 Retire BV & Staggered CT Retirement *CT Only Staff*
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2020			60 MW Capacity	**25 MW Dogwood** 35 MW Capacity	**50 MW Dogwood** 10 MW Capacity	60 MW Capacity	**50 MW Dogwood** 10 MW Capacity	**50 MW Dogwood** 10 MW Capacity	60 MW Capacity	**25 MW Dogwood** 35 MW Capacity	**50 MW Dogwood** 10 MW Capacity	60 MW Capacity	60 MW Capacity
2021			60 MW Capacity	35 MW Capacity	10 MW Capacity	60 MW Capacity	10 MW Capacity	10 MW Capacity	60 MW Capacity	35 MW Capacity	10 MW Capacity	60 MW Capacity	60 MW Capacity
2022			65 MW Capacity	40 MW Capacity	15 MW Capacity	65 MW Capacity	15 MW Capacity	15 MW Capacity	65 MW Capacity	40 MW Capacity	15 MW Capacity	65 MW Capacity	65 MW Capacity
2023			65 MW Capacity	40 MW Capacity	15 MW Capacity	65 MW Capacity	15 MW Capacity **Retire 33 MW SUB I**	15 MW Capacity **Retire 94 MW CTs**	65 MW Capacity **Retire 94 MW CTs**	40 MW Capacity **Retire 94 MW CTs**	15 MW Capacity **Retire 94 MW CTs**	65 MW Capacity **Retire One CT Plant**	65 MW Capacity **Retire One CT Plant**
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2026			70 MW Capacity	45 MW Capacity	20 MW Capacity		15 MW Capacity	110 MW Capacity	50 MW Capacity	25 MW Capacity	75 MW Capacity	65 MW Capacity	105 MW Capacity
2027			70 MW Capacity	45 MW Capacity	20 MW Capacity		15 MW Capacity	115 MW Capacity	55 MW Capacity	30 MW Capacity	75 MW Capacity	65 MW Capacity	105 MW Capacity
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2032			75 MW Capacity	50 MW Capacity	25 MW Capacity		20 MW Capacity	120 MW Capacity	60 MW Capacity	35 MW Capacity	80 MW Capacity	70 MW Capacity	145 MW Capacity
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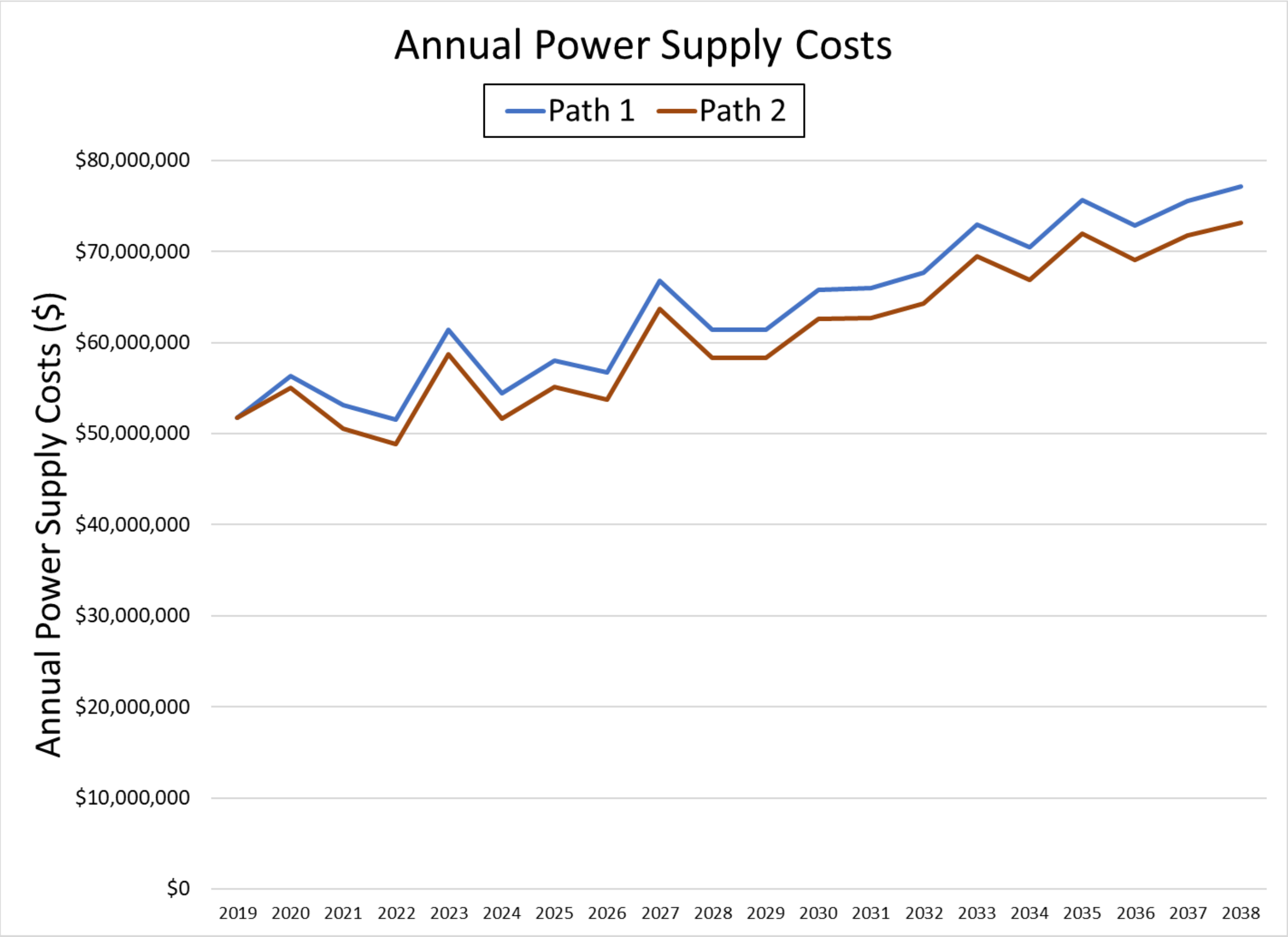
2036			80 MW Capacity	55 MW Capacity	30 MW Capacity		25 MW Capacity	125 MW Capacity	65 MW Capacity	40 MW Capacity	85 MW Capacity	65 MW Capacity	175 MW Capacity
2037			80 MW Capacity	55 MW Capacity	30 MW Capacity		30 MW Capacity	125 MW Capacity	65 MW Capacity	40 MW Capacity	90 MW Capacity	65 MW Capacity	175 MW Capacity
2038			85 MW Capacity	60 MW Capacity	35 MW Capacity		30 MW Capacity	125 MW Capacity	65 MW Capacity	40 MW Capacity	90 MW Capacity	65 MW Capacity	175 MW Capacity
NPV	$769,113,800	$734,755,200	$691,153,300	$674,704,900	$658,254,000	$741,773,500	$696,000,500	$702,592,000	$747,846,100	$731,397,800	$720,516,900	$768,220,600	$720,326,800
Delta $	$110,859,800	$76,501,200	$32,899,300	$16,450,900	$0	$83,519,500	$37,746,500	$44,338,000	$89,592,100	$73,143,800	$62,262,900	$109,966,600	$62,072,800
Delta %	16.84%	11.62%	5.00%	2.50%	0.00%	12.69%	5.73%	6.74%	13.61%	11.11%	9.46%	16.71%	9.43%
Transmission ($)	$0	$0	$800,000	$800,000	$800,000	$800,000	$800,000	$36,500,000	$19,500,000	$19,500,000	$800,000	$800,000	$36,500,000
NPV w/ Transmission	$769,113,800	$734,755,200	$691,953,300	$675,504,900	$659,054,000	$742,573,500	$696,800,500	$739,092,000	$767,346,100	$750,897,800	$721,316,900	$769,020,600	$756,826,800
Delta $	$110,059,800	$75,701,200	$32,899,300	$16,450,900	$0	$83,519,500	$37,746,500	$80,038,000	$108,292,100	$91,843,800	$62,262,900	$109,966,600	$97,772,800
Delta %	16.70%	11.49%	4.99%	2.50%	0.00%	12.67%	5.73%	12.14%	16.43%	13.94%	9.45%	16.69%	14.84%

Economic Evaluation – Annual Power Supply Costs

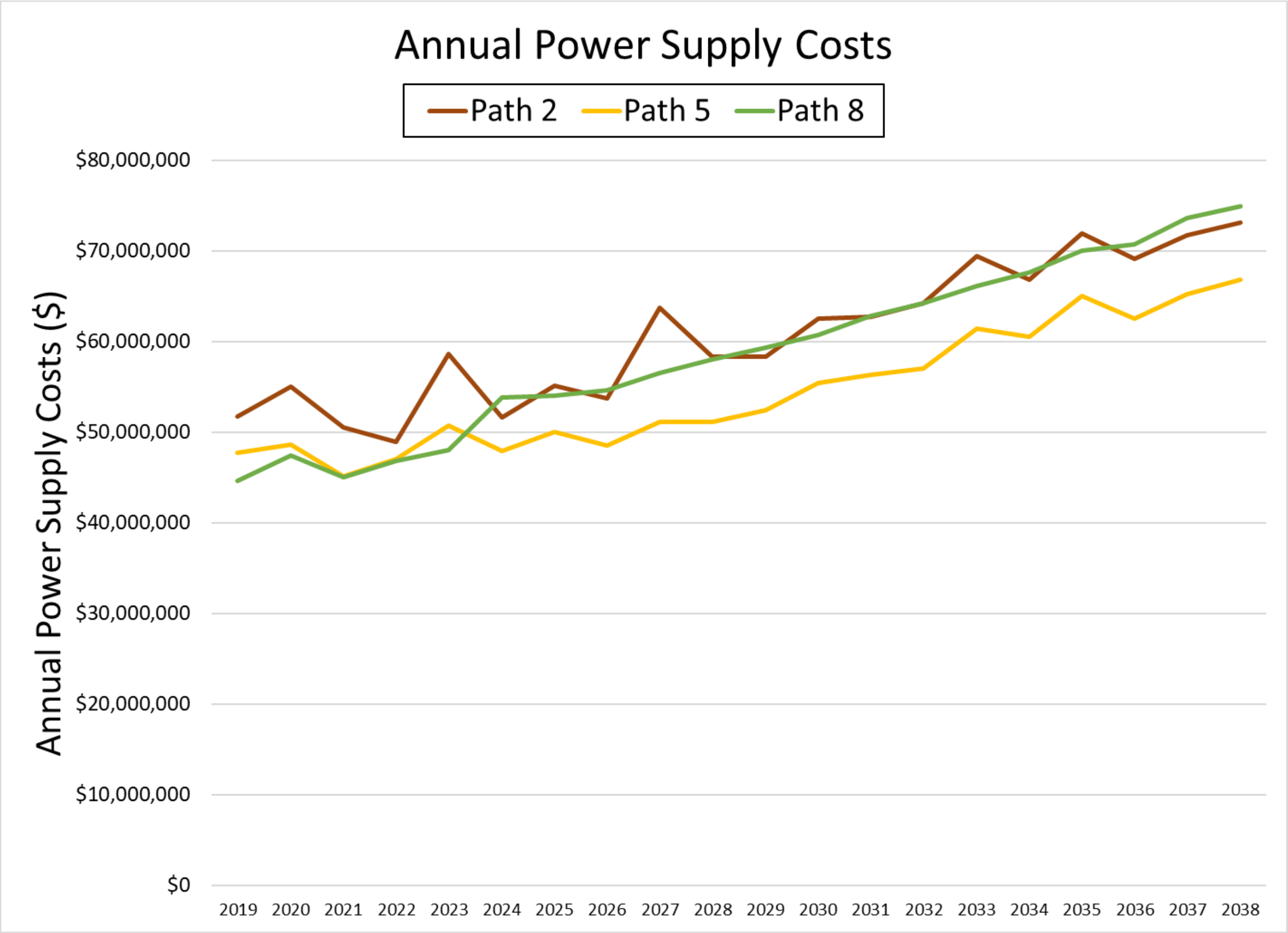
- Path 1: Business-as-Usual has the highest annual power supply costs
- Path 2: Business-as-Usual lower costs with reduced labor

With recent efforts of shifting staff and natural attrition, IPL has reduced staffing levels consistent with Path 2



Economic Evaluation – Annual Power Supply Costs

- Path 2: Business-as-Usual has the highest annual power supply costs
- Path 5: Retiring Blue Valley reduces the annual power supply costs
  - O&M costs are lower (reduced labor from 44 to 23 staff positions)
- Path 8: Continued operation of the combustion turbines is lower than retiring the combustion turbines

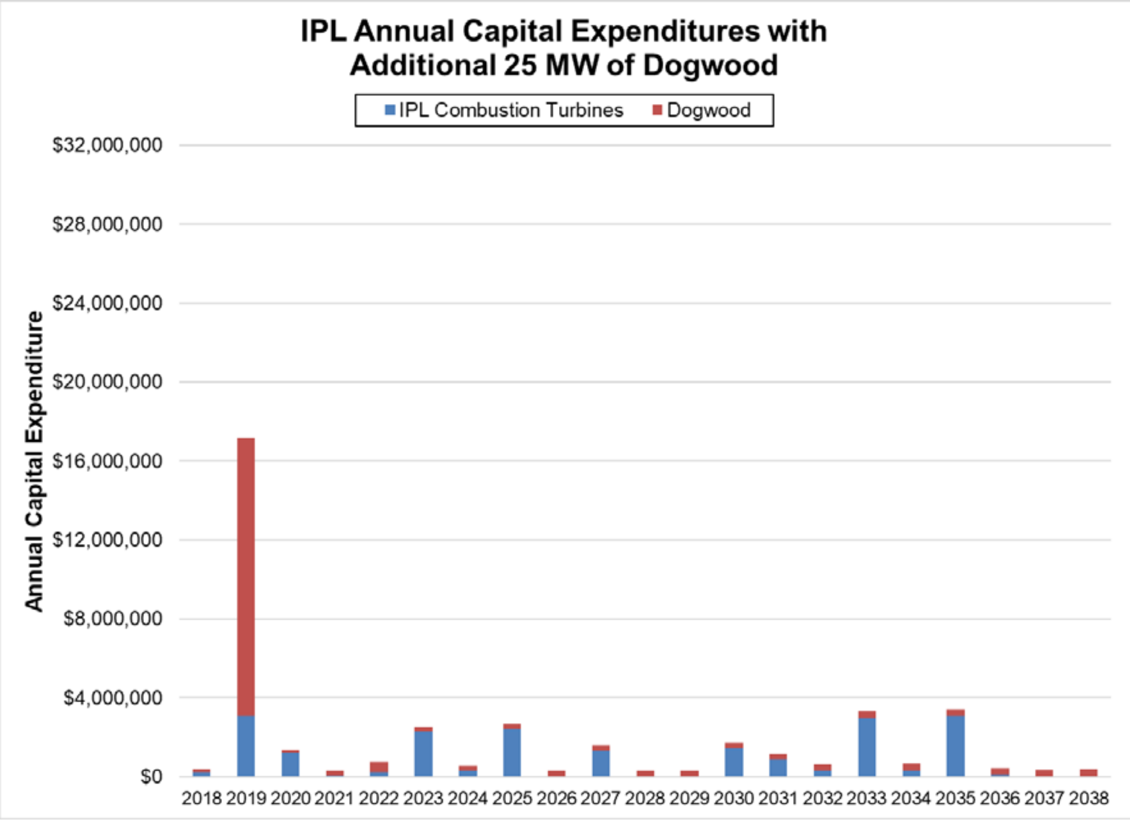


Economic Evaluation – Portfolio Optimization Conclusions

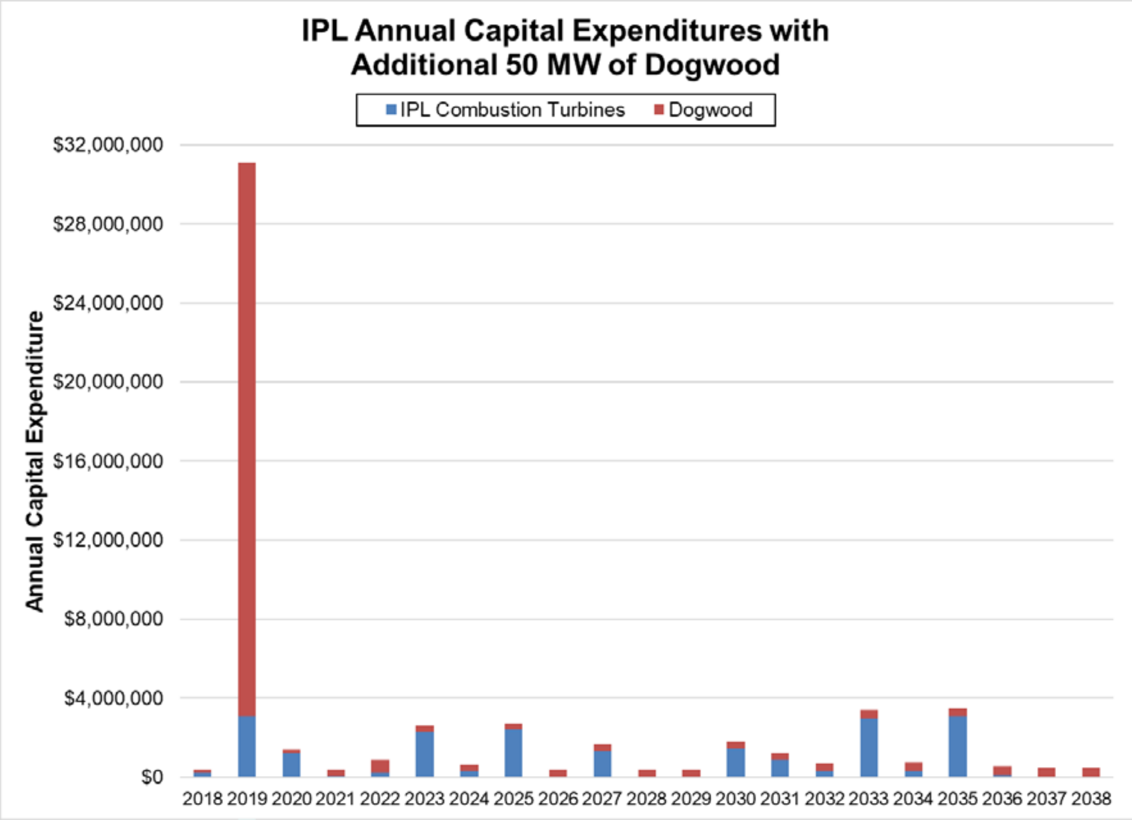
- Power supply results indicate the following:
  - Retirement of Blue Valley, with reduced O&M costs incurred by IPL, lower the power supply costs
  - Continued operation of the combustion turbines provides a lower cost option for both capacity requirements and on-system generation
  - Dogwood and market capacity purchases are lower cost options for replacing capacity requirements (i.e. potential third-party contracts)
  - The addition of on-system resources (i.e. reciprocating engines) to replace combustion turbines is higher cost than continuing to operate the combustion turbines
  - Sensitivity evaluation for variances in gas prices, energy prices, and load do not materially change the paths

Economic Evaluation – Annual Capital Expense

Additional 25 MW of Dogwood



Additional 50 MW of Dogwood



Agenda

- Energy Master Plan Highlights
- Industry Overview and Trends
- Utility Planning Requirements
- Condition Assessment
- Technology Assessment and Third-Party Resources
- Economic Analysis
- **Conclusions & Recommendations**

Conclusions

- Condition assessment
  - IPL's existing units have operated reliably in the past, however the overall O&M costs are higher than industry benchmarks
  - As the units age, O&M and capital investment will be required to maintain reliability
- The Blue Valley units are higher cost than other power supply alternatives
- IPL's combustion turbines provide low cost capacity, even with investments
- New on-system replacement alternatives are generally higher cost than new off-system alternatives
- IPL has sufficient energy under control through contracts, if Blue Valley units are retired IPL will need capacity, but not necessarily energy

Conclusions

- IPL is meeting renewable goals through wind contracts and solar project
- If all on-system generation is retired, IPL will shift from N – 2 reliability to N – 1 reliability without transmission infrastructure investment
  - IPL may be required to shed load in order to comply with N – 2 policies
- Additional Dogwood ownership and other third-party capacity opportunities appear to be the lowest cost power supply options
- Replacing a combustion turbine with a new reciprocating engine plant is more costly than continued operation of the combustion turbine, but it will provide more reliability and experience with a new technology

Recommendations

- If Blue Valley is designated for retirement, IPL needs to conduct the following:
  - Select a retirement date for Blue Valley (depends on replacement options)
  - Provide a minimum of 180 days notice to SPP
  - Develop closure plan for the facility including decommissioning/demolition activities
  - Evaluate power production staffing with steam generation retired
- Combustion turbines
  - Continue to maintain combustion turbines as they provide low cost capacity
  - Consider more regular test runs for the combustion turbines to troubleshoot reliability concerns
  - Consider permitting adjustments to alleviate operating risks
  - Re-evaluate combustion turbines in next master plan

Recommendations

- Begin process for conducting a power supply request for proposals
  - RFP should focus on low cost capacity resources, not necessarily energy
  - A combination of resources should be considered:
    - Contracts vs. ownership
    - Short-term (1-2 years), mid-term (3-6 years), and long-term (7+ years)
  - IPL needs capacity resources to meet SPP capacity obligations
  - Process may take 6 to 12 months
    - Some resources may need firm transmission delivery and/or require longer lead times
  - Use results of power supply RFP to compare against additional Dogwood investment
- Continue to evaluate existing combustion turbines sites for re-purposing with reciprocating engines
  - Site and constructability assessments
  - Detailed capital cost estimates
  - Permitting assessments

Considerations Moving Forward

- Evaluate impacts within the Electric Rate Study
- Consider short-term decisions to allow flexibility for future options
- Capital expenditures deployed today may limit future opportunities
- Significant amount of capacity in a single resource
- Mix of resources to account for variability in load forecast
- Position IPL to be able to maintain on-system power generation for both economics and reliability

CREATE AMAZING.