Entergy Arkansas, Inc.
2018 Integrated Resource Plan




Entergy

Follow-Up Materials
June 18, 2018
entergy-arkansas.com/IRP

Follow-up Materials to the 2018 IRP Stakeholder Meeting

The following information is provided as a supplement to the information presented during the June 6th Stakeholder Meeting and in response to stakeholder questions and feedback received.

Responses are grouped by category as presented and discussed during the Stakeholder Meeting.

Any additional requests for information may be sent to EAI at EAIIRP@entergy.com.

2018 Integrated Resource Plan

FOLLOW-UP MATERIALS - RESPONSE SET 1

Operations Planning

- Please provide actual capacity factors for existing gas generating resources by type.

Unit	Type	2015	2016	2017
Lake Catherine Unit 4	Legacy Gas	3.5%	7.2%	2.0%
Ouachita Unit 1	CCGT	60.3%	58.9%	70.7%
Ouachita Unit 2	CCGT	78.3%	58.6%	55.0%
Hot Spring Unit 1	CCGT	46.9%	55.8%	64.6%
Union Unit 2	CCGT	N/A	62.6%	35.6%

- Please verify that EAI's generation units are bid into the MISO market and no unit is self-scheduled.
  - Yes, EAI's generation units are bid into the MISO market.

- If units are self-scheduled, please the units, age, current capacity factors, heat rates, fuel type, and operational costs in a $/MWh value.
  - Not applicable; refer to prior response.

Operations Planning

- **Please describe the quantity of energy and capacity that supplies EAI's native load versus that which supplies other purchasers in the MISO market (e.g., exported), and where that energy or capacity is consumed.**
  - As a MISO Market Participant, EAI offers its energy and capacity resources into the MISO energy and capacity markets. As shown on slide 12, EAI currently has more capacity than is needed to serve its forecasted peak load plus reserves and in 2017, more than 75% of energy generated by EAI's resources was needed to supply native load. EAI does not have data detailing where energy supplied to the MISO market was consumed.

Transmission Planning

- How can you quantify a weak system versus a strong system?
  - While this issue is not part of the IRP analysis, generally speaking, a "weak system" has thermal or voltage issues in a base case situation and may have stability issues when a disturbance occurs. A "strong system" is usually free of thermal constraints or low voltage issues and does not usually have stability issues.

- Many benefits of energy storage occur on a sub-hourly basis (e.g. frequency regulation, voltage support, etc.). Please explain how EAI plans to model sub-hourly benefits of energy storage systems.
  - The Transmission Reliability and AURORA models evaluate at the hourly level. Any evaluations of specific battery energy storage options would consider all potential benefits.

Transmission Planning

- Please provide metrics for IBR's and inertia-based resources regarding: frequency response, voltage support, and black-start capability.
  - Transmission planning does not provide metrics for Inverter Based Resources or inertia based resources. This would not affect the results of the IRP.

- Please provide metrics for "weak" versus "strong" system and current analysis of the system on the weak/strong spectrum.
  - Transmission planning does not have a current analysis of weak/strong spectrum in this context. This would not affect the results of the IRP.

Transmission Planning

- **Please provide an anticipated timeline regarding when the current system would become "weak".**
  - The IRP results would not derive a timeline. One of Transmission Planning's goals is to maintain and construct "strong" transmission systems. While this issue is not part of the IRP analysis, it was discussed during the Stakeholder Meeting as a potential future issue and is something that EAI is aware of and monitoring.

- **Please provide a timeline for when the system will become "devoid of inertia."**
  - No timeline available from Transmission. While this issue is not part of the IRP analysis, it was discussed during the Stakeholder Meeting as a potential future issue and is something that EAI is aware of and monitoring.

Transmission Planning

- Please provide analysis regarding wind turbines and energy storage flywheels inertia.
  - Transmission currently does not analyze wind turbine or energy storage flywheel inertia.

- What are Entergy's thoughts on distribution system planning in the IRP process in the context of Non-Wires Alternatives?
  - Entergy currently utilizes distribution planning throughout its normal planning processes. Non-wires alternatives are currently being investigated by our Distribution Planning Department.

Transmission Planning

- What transmission use case will be used in IRP modeling and will modeling be sub-hourly?
  - The scope of the IRP does not include transmission and reliability. That is primarily handled through the MISO Transmission Planning process; however, EAI will consider battery storage on a case-by-case basis.

Demand-side Management

- Slide 42 reports actual Energy Savings (kWh) and Demand Reduction (kW) for the years 2016-2018. Please explain the large difference between the 2017 and 2018 actual Demand Reduction Values relative to the difference between the corresponding values of Energy Savings.
  - The "Actual" table on Slide 42 contains an error for 2016 and 2017. The Demand Reduction (kW) row should read 92,496 for 2016 and 104,412 for 2017. Refer to the following slide for a corrected table.
  - Also note that the 2018 values included in the "Actual" table reflect forecasted values from the most recent three-year plan.

Demand-side Management

	Projected		
	2016	2017	2018
Energy Savings (KWH)*	260,304,000	260,304,000	260,306,000
Demand Reduction (KW)*	100,200	100,200	110,700
DR Budget	$7,163,000	$6,588,000	$7,210,000
DSM Budget	$58,801,000	$59,871,000	$59,261,000
Total Budget	$65,964,000	$66,459,000	$66,471,000
Actual Spend			
Percent of Sales (Evaluated)	1.27%	1.27%	1.27%
Total Resource Cost Ratio	2.3	2.3	2.3
	Actual		
	2016	**2017**	**2018**
Energy Savings (KWH)*	253,289,913	264,991,920	260,268,000
Demand Reduction (KW)*	92,496	104,412	130,600
DR Budget	$7,855,090	$6,267,837	$6,279,000
DSM Budget	$58,108,627	$55,766,930	$56,533,000
Total Budget	$65,963,717	$62,034,767	$62,812,000
Actual Spend	$60,270,107	$57,115,534	
Percent of Sales (Evaluated)	1.57%	1.49%	1.80%
Total Resource Cost Ratio	2.5	3.8	1.8

* The savings in the table above do not include T&D adjustment

Demand-side Management

- Slide 51 states that in the Reference Case EE programs are expected to save ~260 GWh per year. What is the corresponding amount of expected equivalent capacity (MW) savings per year?
  - Approximately 53MW per year in the Reference Case load forecast.

- Slide 51 states that in the Reference Case EE programs are expected to save ~260 GWh per year. What is the corresponding amount of expected program expenditures per year?
  - EAI is currently evaluating its EE program plan for the referenced period. As APSC mandated savings targets and final program design are still pending, EAI does not currently feel comfortable releasing an estimate of annual program cost. Please refer to slides 39 and 41 for recent program expenditures.

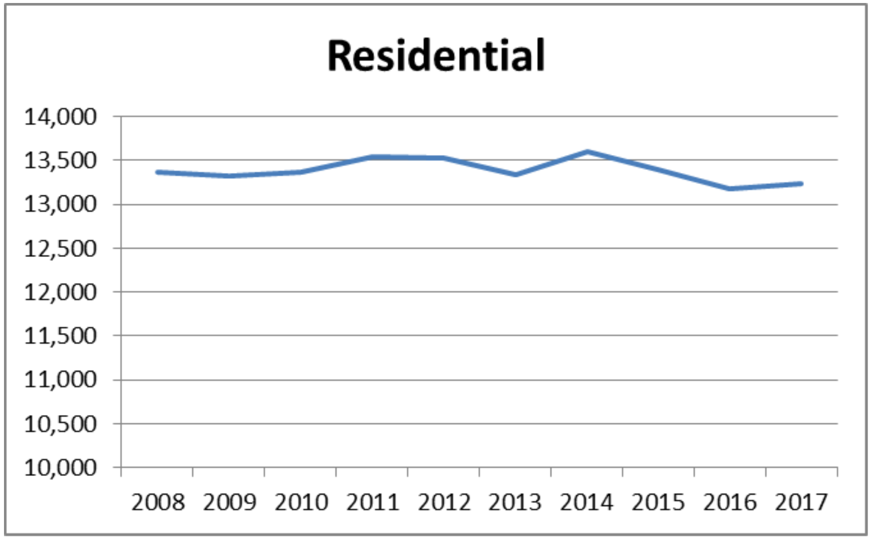
Sales and Load Forecasting

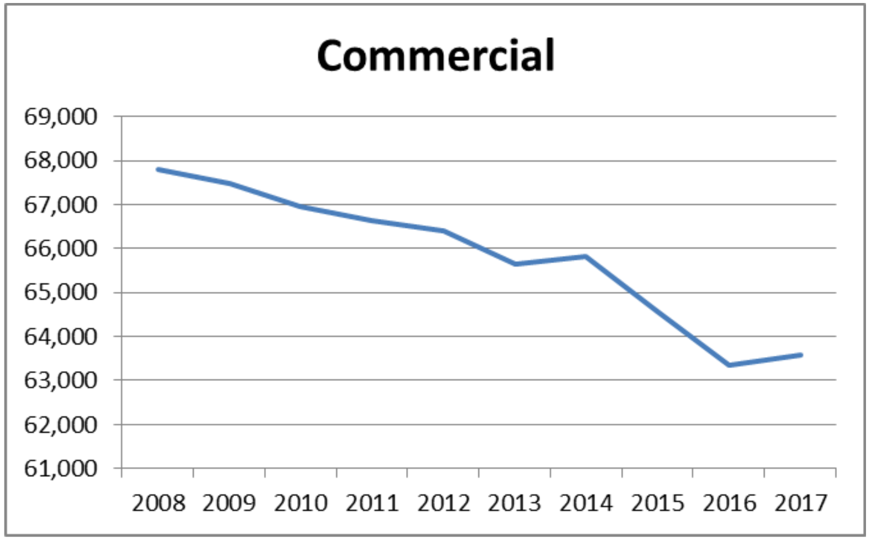
- Please provide historical ten-year trends in customer usage (UPC).
    - Refer to the table below as well as to the charts on the following slide:

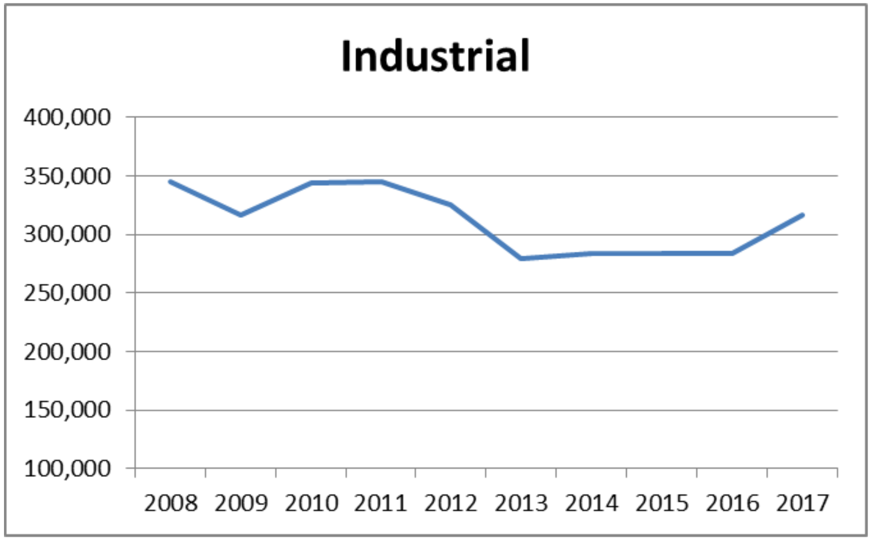
Weather Normalized Average Use per Customer
Amounts in Annual kWh

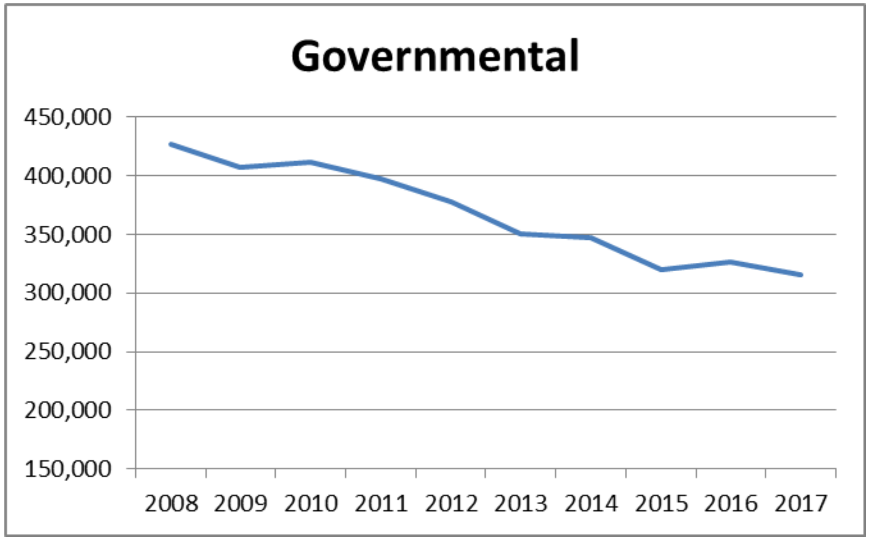
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Residential	13,361	13,323	13,360	13,539	13,533	13,337	13,595	13,402	13,183	13,239
Commercial	67,793	67,467	66,953	66,633	66,403	65,658	65,823	64,563	63,349	63,580
Industrial	344,684	316,923	343,699	344,523	325,205	279,727	283,728	283,461	284,067	316,714
Governmental	426,400	406,914	411,067	397,222	377,344	350,885	346,851	319,946	326,535	315,561

Sales and Load Forecasting









Sales and Load Forecasting

- What is the assumption around EVs in the sales/load forecasts?
  - The sales forecast includes an assumed level of additional energy consumption resulting from the adoption of electric vehicles (EVs) over time. The inputs are based on expected growth in electricity consumption due to EVs in the U.S. reaching 30,000GWh by 2025 and reaching 300,000GWh by 2040. Entergy's service area has nearly the lowest adoption rates for EVs, about 0.33% of the national average. Using those numbers in conjunction with the existing numbers of EVs in each Entergy jurisdiction from 2014 as an allocator results in an expectation of about 75GWh of sales growth from EVs by 2025. For Entergy Arkansas, there were 4GWh added for 2020, 16GWh for 2025, 39GWh added by 2030, and almost 89GWh added by 2035, with incremental amounts in the in-between years.
  - At the time of the development of the IRP load forecasts, this incremental consumption due to EVs was allocated 80%/20% to residential and commercial load, respectively, and the normal residential and commercial load shapes were applied to this energy. Future forecasts will likely include an EV-specific load shape based on the expected consumption profile of that load.

Sales and Load Forecasting

- Please explain expected load growth in industrial customer class.
  - The forecasted industrial growth from the reference case is expected primarily from specific large industrial customers. The growth is expected across multiple customer segments including Primary Metals, Wood Products, Pulp and Paper, and Food Products. Most of those are new customers on the EAI system. There is little growth expected from existing industrial customers.

- Please explain load growth anticipated from 2019-2021.
  - The load growth shown on slide 52 in the Reference Scenario is primarily from the industrial customer class and is due largely to the ramping of a single customer.

Sales and Load Forecasting

- Can EAI provide any information on the assumptions for industrial growth in 2021? (e.g. customer information)
  - While this assumption is based on input from specific industrial customers, EAI is unable to provide confidential customer information.

Generation Technology Assessment

- **Will EAI model carbon capture & sequestration for all new natural gas facilities?**
  - EAI is not planning to model carbon capture & sequestration for new natural gas facilities. Costs associated with carbon emissions are captured through the three CO_2 price forecasts included in the scenarios.

Generation Technology Assessment

- Can EAI provide justification for why it is not modeling flywheels and pumped storage?
  - Generally speaking, flywheels are not well-suited for peak shaving or renewable integration applications as they are limited in terms of capacity size and discharge duration. Flywheels are more well-suited for frequency regulation, the revenues for which are not included in the AURORA model.
  - Pumped hydro is well-suited for bulk energy storage applications and is a mature technology. However, the combination of a large land requirement and proper site elevation make it a highly site-specific deployment option.
  - Battery storage is recognized by EAI as an emerging technology that can serve a peak shaving and/or renewable integration role, is not site-specific, and is expected to continue to decline in cost. For these reasons, battery storage was modeled in lieu of flywheels, pumped hydro, or other energy storage alternatives.

Generation Technology Assessment

- Please explain the disparity in fixed O&M costs between different gas resources. Why is the 501J so much higher than the RICE?
  - The variable O&M (VOM) figures includes consumables and long-term service agreement (e.g. inspection and major maintenance milestones) costs, expressed on a per MWh basis according to an expected capacity factor. RICE engines are expected to operate significantly more (30% as opposed to 10% capacity factor) due to the heat rate and flexibility benefits of RICEs relative to CTs. Accordingly, the VOM figure will appear higher for CTs on a $/MWh basis even if the total cost is similar. Additionally, turbine-based technologies consume more water than RICEs. This is due, in part, to the inclusion of inlet air conditioning technologies for CTs, which is not present for RICEs.
  - The fixed O&M (FOM)figure is mostly comprised of staffing cost and is expressed on a $/kW-yr basis. Due to the relatively large capacity and similar staffing requirements of a CT vs. a RICE facility, the CT FOM will generally appear lower.

Generation Technology Assessment

- What are the underlying assumptions for capital costs displayed on Slide 70 for gas resources?
  - The capital costs for gas resources are based on estimates from the Electric Power Research Institute (EPRI) and/or informed by cost estimates for recent and ongoing Entergy projects. Capital costs for CCGT and CT technologies have been adjusted to include an adder related to risk around requirements for gas compression.

Generation Technology Assessment

- **Please describe all inputs regarding costs associated with energy storage, including capex, capacity factor and all other cost/pricing and performance metrics on Slide 70.**
  - The capital cost and fixed O&M estimates for energy storage are based on confidential IHS Markit forecast data as of October 25, 2017 for a four hour battery storage project. The efficiency figure is a generic assumption based on expectations of round trip efficiency for Li-ion based battery storage technology. Capacity factor is not calculated for battery storage, as battery storage devices do not produce energy. The logic within AURORA seeks to dispatch the battery once per day based on load signals and renewable output in an effort to flatten the daily load shape.