(APWR), and the entire process and steam generation is contained in one, modular vessel. The steam generated in this vessel is then tied to a steam turbine for electric generation.

According to these manufacturers, the benefit of these SMRs is two-fold: the smaller unit size will allow more resource generation flexibility and the modular design will reduce overall project costs while providing increased benefits in the areas of safety, waste management, and the utilization of resources. Due to the design's modularity, most of the fabrication is planned to be done in the manufacturing facility before the vessel is shipped to the site. The goal is to reduce field labor and construction schedule.

This assessment includes the evaluation of a 160 MW SMR facility, based on current designs supported by government grants. Currently, SMRs are considered conceptual in design and are developmental in nature. Several manufacturers have completed conceptual design of these modular units to target lower output and costs, and are in various stages of permitting applications with the Department of Energy. However, there is currently no industry experience with developing this technology outside of the conceptual phase. Therefore, the information provided in this assessment for the SMR option is based on feedback and initial indications from SMR manufacturers.

4.1.1.6 Distributed Generation Technologies

Combined Heat and Power (CHP) technology is used in a variety of applications where host facilities see an efficiency, cost, or reliability advantage from CHP over purchasing power from their utility and meeting their thermal needs through on-site generation. CHP allows the facility to meet all or part of their thermal and electric needs through a single fuel source. A CHP system consists of a prime mover, generator, heat recovery and electrical interconnection. Typical prime movers used in CHP systems include reciprocating internal combustion engines, combustion turbines, microturbines, or fuel cells. A generator coupled to the prime mover produces electric power that serves the host facility's power demand. The hot exhaust from the prime mover is recovered and used to serve the host facility's thermal demand. This can be in the form of steam for process use, building heating, or building cooling in the summer. The electrical distribution system is interconnected to the utility which provides the balance of the facilities electric load and serves as a back-up power source.

CHP plants offer an efficiency benefit compared to simple cycle units of comparable size. In addition to the electrical output, the work from the exhaust energy is also produced with the same amount of inlet fuel.

A Solar turbine was selected as the representative technology for the 5 MW CHP option. Currently Solar turbines have over an 80 percent market share for this size range, and have historically been selected the most frequently for CHP projects utilizing combustion turbine technology as the prime mover. However, other OEMs also provide turbines in this size range that can be competitive. Reciprocating engines are also used in a variety of CHP applications as a substitute to gas turbines. A reciprocating engine offers better simple cycle efficiency, but less exhaust energy for steam production. A reciprocating engine selection may make sense in an application where the facility has higher electrical demand relative to its thermal demand.

4.1.1.7 Integrated Gasification Combined Cycle Technology

The Integrated Gasification Combined Cycle (IGCC) technology produces a low calorific value synthesis gas (syngas) from coal that can be fired in a combined cycle power plant. The gasification process itself is a proven technology used extensively for chemical production of products such as ammonia for fertilizer. Integrating proven gasifier technology with gas turbine combined cycle technology is fairly new and continues to improve with additional project experience. There are currently six IGCC plants that have either been built, are in construction, or are in the development phase within the United States. Summit Power – Texas Clean Energy Project and Hydrogen Energy California are in the development stages, Mississippi Power – Kemper Co. is under construction, and Duke Energy – Edwardsport, Tampa Electric – Polk and Wabash Valley Power – Wabash River have been completed. IGCC is considered beneficial retire in 2035, the final year of the planning horizon, for IRP purposes. One alternate plan (Plan 16) was a "what-if" scenario that examined an earlier retirement date for the Asbury unit in 2022. Since the *assumed* Asbury retirement occurs near the end of the planning horizon, not enough information was available to determine any transmission upgrades as a result of this retirement. No additional transmission upgrade costs were included for the assumed Asbury retirement in this IRP. Empire will continue to consider this issue in its planning models as more details become available.

8.1.5 Impacts of Distributed Generation

> ***(e) Analyze and document the range of potential levels of distributed generation in Empire's service territory for the 20-year planning horizon and the potential impacts of each identified level of distributed generation, and in particular distributed solar generation, on Empire's preferred resource plan. The potential impacts should quantify both the amount of electrical energy the distributed generation is expected to provide to the grid and the amount of electrical energy that the distributed generation customers are expected to consume on site that will offset the amount that the company would normally provide to those customers.***

Empire has made an estimate of the impact of distributed generation, particularly solar, for the 20-year planning horizon (2016-2035) considered in the 2016 IRP. Since the adoption of the Missouri renewable energy standard (RES) until early 2015, Empire had an exemption from the 2% solar requirement of the Missouri RES. On February 10, 2015 the Missouri Supreme Court overruled the solar rebate exemption that was extended to Empire in 2008. Empire's solar rebate tariffs were approved in mid-May 2015 and the first rebates were paid to customers in early June 2015. Prior to the rebate period, Empire had about 37 customer-sited solar photovoltaic (PV) systems in its Missouri service territory and four other solar customers located in other states. At that time, the total installed capacity was about 259.6 kW with an estimated annual energy output of about 340,000 to 387,000 kWh, representing about 0.008 to 0.009% of Missouri retail sales. At the end of 2015, following about six months of paying solar rebates, Empire had about 236 Missouri solar PV customers, representing about 2.6 MW of nameplate capacity with an estimated annual energy output of about 3,400 to 3,870 MWh or about 0.08 to 0.09% of Missouri retail sales. Additionally, at the end of 2015, there were several Missouri solar rebate applicants still in the processing queue. In order to qualify for the rebate level in which they applied, these customers must have their systems operational by June 30, 2016. Therefore, there could be a significant increase in new customer-sited solar PV by the end of June 2016.

When making an estimate of solar's impact on the planning process, the solar incentive levels are a very important factor. In mid-December 2015, the Federal government approved the extension of the 30% solar investment tax credit (ITC) through year 2019. Based on this extension, Empire utilized the solar ITC assumptions of 30% for 2016 through 2019, 26% in 2020, 22% in 2021 and 10% from 2022 through the end of the study period. In addition to the Federal tax incentive, the Empire solar rebate level was an important consideration. Solar rebates are based on a declining rate per watt as shown in the table below. At the time estimates were determined, it was assumed that the declining incentive rate would negatively impact customer participation, which appears to be a valid assumption. Since the time the rebate per watt dropped from $1.00 to $0.50, customer solar applications have slowed considerably.

Application Received on or before December 31st of the Year *	Operation Status Achieved on or before June 30th of the Year	Rebate Rate per Watt
2015	2014	$2.00
2015	2015	$1.50
2015	2016	$1.00
2016-2018	2017-2019	$0.50
2019	2020	$0.25
* Empire started the rebate program in mid-May 2015, but customers may have installed solar PV before that time		

Table 6-77 – Empire Solar Rebate Program

The solar coincident peak and energy impact on the 2016 IRP process was accomplished by a reduction to the demand and energy forecasts. Empire developed the solar forecast through year 2020, the timeframe that Empire's rebate program would be active and Federal incentives are assumed to be decreasing. The period following the rebate program—from 2021 through the end of the study period in 2035—the statistically adjusted end-use (SAE) load forecasting method treated non-incentivized solar PV as an end-use with saturation levels derived from the 2015 EIA Annual Energy Outlook developed by Itron for the West North Central region. Additionally, demand-side solar projects were a demand-side candidate resource screened in the IRP demand-side analysis. However, a customer solar demand-side management (DSM) program was not selected as a cost-effective option by the IRP modeling.

Empire estimated that there would be about 1,000 solar customers by the end of year 2020 as shown in *Table 6-78.*

	NEW Customers at End of Period			CUMULATIVE Customers		
Year	Residential	Non-Res	Total	Residential	Non-Res	Total
2015	255	45	300	255	45	300
2016	184	46	230	439	91	530
2017	135	45	180	574	136	710
2018	84	56	140	658	192	850
2019	50	50	100	708	242	950
2020	22	28	50	730	270	1000
TOTAL	730	270	1000			

Table 6-78 – 2016 IRP Assumed Distributed Generation Solar Customers

The estimated impact on system peak and energy is outlined in *Table 6-79*.

Year	Summer Peak	Winter Peak	Annual NSI (MWh)
2015	3.47	0.37	5442
2016	4.63	0.49	7258
2017	6.76	0.71	10,590
2018	8.62	0.91	13,509
2019	10.22	1.08	16,018
2020	11.30	1.19	17,706

Table 6-79 – 2016 IRP Assumed Solar Impact on Load

Table 6-80 illustrates the current Missouri RES requirement. It is based on a percentage of a utility's Missouri retail sales. The 2% required solar portion, if applied to Empire's Missouri retail sales, would be a 0.1% annual requirement from 2015-2017; a 0.2% annual requirement from 2018-2020; and a 0.3% annual requirement from 2021 onward. In terms of MWh of energy, this would be roughly 4,100 annual MWh from 2015-2017; about 8,300 annual MWh from 2018-2020; and approximately 12,600 annual MWh from 2021 onward adjusted for future growth.

Dates	RES Energy (no less than)
2011-2013	2%
2014-2017	5%
2018-2020	10%
Beginning in 2021	15%
Two (2) percent of the energy requirement from solar	

Table 6-80 – Missouri Renewable Energy Standard

Based on the 2016 IRP assumptions, Empire would meet the 2% RES energy requirement from solar during the entire study period from the rebates paid to customers. It is difficult to estimate the number of customers that will actually install solar PV systems in the future as well as the associated peak and energy impacts of these systems. Estimates will need to be refined as additional information becomes available.

Another type of distributed generation is customer-sited small wind turbines. Currently Empire has only about ten net-metered wind customers. This number has remained relatively static, and no adjustments to the 2016 IRP load forecasts were made for these resources.

8.1.6 Customer Financing for Energy Efficiency Measures

(f) Review the options available to Empire for providing customer financing for energy efficiency measures. Discuss Empire's current, near term (next three years) and long-term activities and plans for providing customer financing for energy efficiency measures.

There are multiple customer financing options for energy efficiency measures/programs. Three common financing options include: