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COVID-19 AND SARA SCENARIO ANALYSIS OF RESOURCE ADEQUACY JUNE-DECEMBER 2020

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1. INTRODUCTION

LCG Consulting performed analysis of ERCOT for the second half of 2020, June through December, using market simulations with LCG's UPLAN Network Power Model. Resource adequacy analysis for the region is critical during extreme summer loading conditions as the reserves have tightened because of recent retirements. On top of this, the COVID-19 pandemic, and the society's response to it, are continuing to cause observed impacts to the power system and market.

For this report, LCG built scenarios to investigate compromised generation capacity during the summer, as well as modeling modified load and fuel price due to the COVID-19 pandemic. These sensitivity cases were assessed for resource adequacy to see if peak demand is served. This report further identifies strained conditions that might shift expected energy prices, Operating Reserve Demand Curve (ORDC), Peaker Net Margin (PNM), and congestion.

- Scenario 1 or Base Case: Summer SARA capacity
- Scenario 2: Lower peak and energy demand

Scenario 1 assumes reduced generation capacity in summer, from June to September, based on the pre-COVID-10 ERCOT 2020 summer SARA report. Scenario 2 uses ERCOT's COVID-19 load forecast which is based on information provided by Moody's Analytics in the April economic forecast. For each of these scenarios, LCG used its UPLAN hourly model to simulate the second half of 2020. UPLAN's robust performance has withstood decades of benchmarking and validation in the ERCOT system. . For more details on modeling with UPLAN, see the appendix.

2. SCENARIO MODELING & METHODOLOGY

The nodal market simulations were performed using LCG's proprietary UPLAN Network Power Model (NPM) and PLATO-ERCOT data model at the hourly dispatch level. UPLAN authentically replicates the engineering protocols and market procedures of a system operator.

The study uses the SSWG Summer Peak Power Flow Case for 2020, published December 2019 by ERCOT SSWG group for the transmission network. Generation expansion and retirement assumptions are based on ERCOT publications. In addition, ERCOT publications and other public and private data sources provided electricity demand and transmission network topology assumptions including transmission upgrades, list of contingencies analyzed, list of monitored elements, interface definitions and limits.

LCG's 2020 ERCOT hourly load shapes are based on hourly weather zone load profiles from the 2013 weather year published by ERCOT's Regional Transmission Plan (RTP) Group and modified monthly peak forecasts for each weather zone based on the 50-50 load forecast published by ERCOT in January 2020. Electricity market modeling incorporated almost 900 generators, including existing facilities – based on the ERCOT Capacity Demand and Reserves report – and future units that have a Standard Generation Interconnection Agreement – using ERCOT Monthly System Planning reports and LCG assumptions. LCG produces proprietary natural gas price forecasts, as well as sub-bituminous and lignite coal prices, with data from EIA's 2019 Annual Energy Outlook.

Scenario 1 or Base Case: Summer SARA capacity

In this base case, the peak demand forecast is 77,064 MW, reflecting normal weather conditions based on ERCOT 50/50 demand forecast, which assumes 50% probability of being under or over the actual peak. LCG distributed this load across ERCOT proportional to the nodal Load Distribution Factors (LDFs) published with ERCOT's Steady State Working Group (SSWG) network for 2020. The total resource capacity is 86,907 MW.

Figure 1 shows the installed capacity by fuel type, and Figure 2 shows the installed capacity by load zone.

Scenario 2: COVID-19 decreased load

This scenario assumes decreased peak load and energy, which results from both reduced morning load and reduced overall load in other hours. The changes in load and energy are based on ERCOT's load forecast, which uses Moody's Analytics in the April economic forecast. Natural gas price is also reduced by 10%. Other parameters remain the same as in Scenario 1.

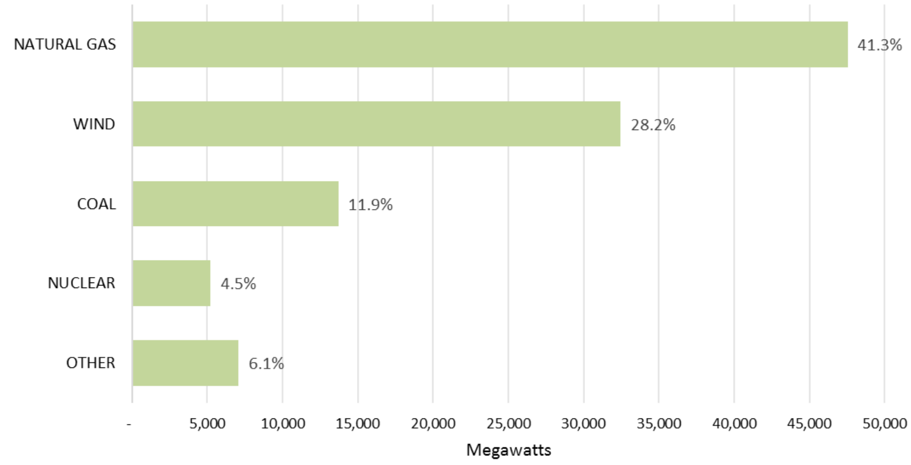

Figure 1 – Installed Capacity by Fuel Type, ERCOT, 2020

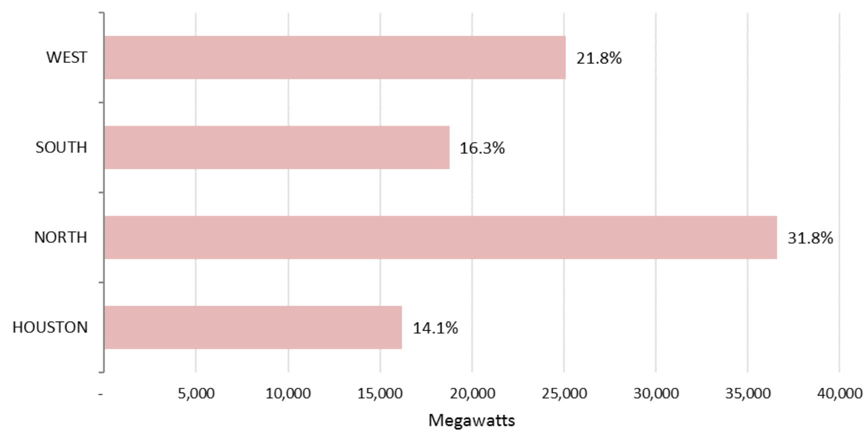

Figure 2 – Installed Capacity by Zone, ERCOT, 2020

3. SIMULATION RESULTS

3.1 Prices

Load zone prices are lower under the modified, COVID-19 case, as a result of lower load and fuel price. The simple monthly average zonal price between June and December decreases by about 10% for Houston, North and South. The change is most significant in the West zone, where the price decreases by 20% under the COVID-19 conditions, which is due to the congestion that would happen under the base scenario. Average load zone prices for both scenarios are shown below in Figure 3.

Figure 3 – Average Load-Weighted Zonal Prices by Scenario – June-December 2020 ($/MWh)

Similar to the zonal price, trading hub prices also decrease due to COVID-19 impacts; in the four trading hubs, prices decrease about 10%.

Trading hub price results by scenario are shown below in Figure 4.

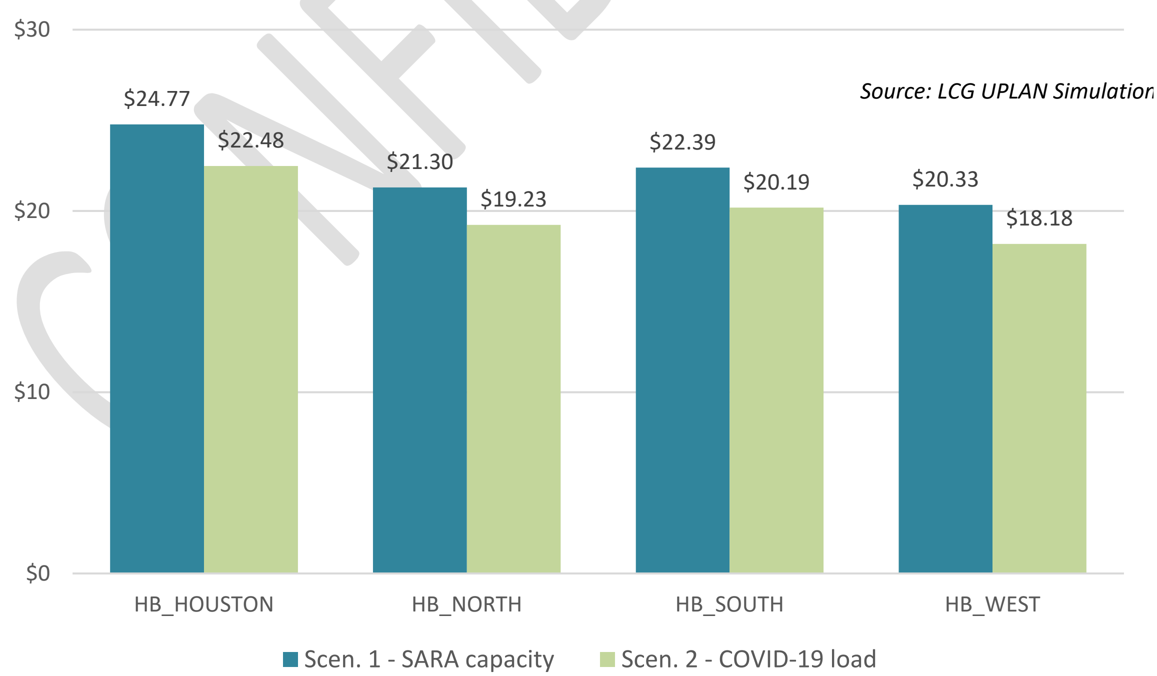

Figure 4 – Average Trading Hub Prices by Scenario – June-December 2020 ($/MWh)

Figure 5 shows the system-wide price duration curve by scenario for the top 100 hours in second half of 2020. Here it can be seen that during high price hours, the prices in the COVID-19 scenario are much lower. This change could be the effect of lowered peak demand and lower fuel price working together under the COVID-19 scenario.

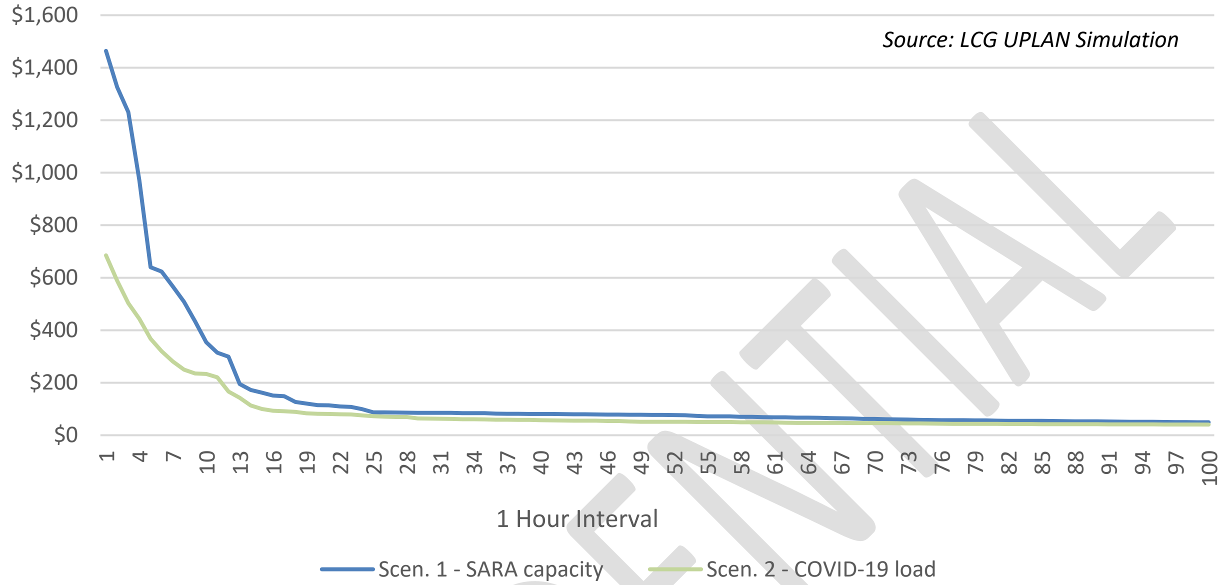

Figure 5 – System-Wide Price Duration Curve - Top 100 Hours – June-December 2020 ($/MWh) [1]

As expected, the ORDC price adder increases in the extreme scenarios due to lower operating reserves. The base case, where the generation capacity is limited during summer months, shows higher ORDC price adders. Hourly average Operating Reserve Price Adder is presented in Table 1 and the duration curve is shown in Figure 6 for the highest 100 hours of the second half of the year.

Table 1 Average Hourly ORDC Adder ($/MWh)

Hour	Base Case	COVID-19
1	$0.24	$0.00
2	$0.26	$0.01
3	$0.00	$0.00

[1] Value includes ORDC price adder

4	$0.00	$0.00
5	$0.00	$0.02
6	$0.00	$0.00
7	$0.05	$0.00
8	$0.26	$0.01
9	$0.03	$0.00
10	$0.01	$0.00
11	$0.05	$0.10
12	$0.02	$0.00
13	$0.12	$0.18
14	$3.77	$3.22
15	$10.93	$6.04
16	$12.88	$4.97
17	$12.47	$5.72
18	$8.58	$3.15
19	$0.50	$0.31
20	$0.62	$1.05
21	$0.21	$0.20
22	$0.01	$0.02
23	$0.00	$0.01
24	$0.00	$0.00
Average	**$2.12**	**$1.04**

Source: LCG UPLAN Simulation

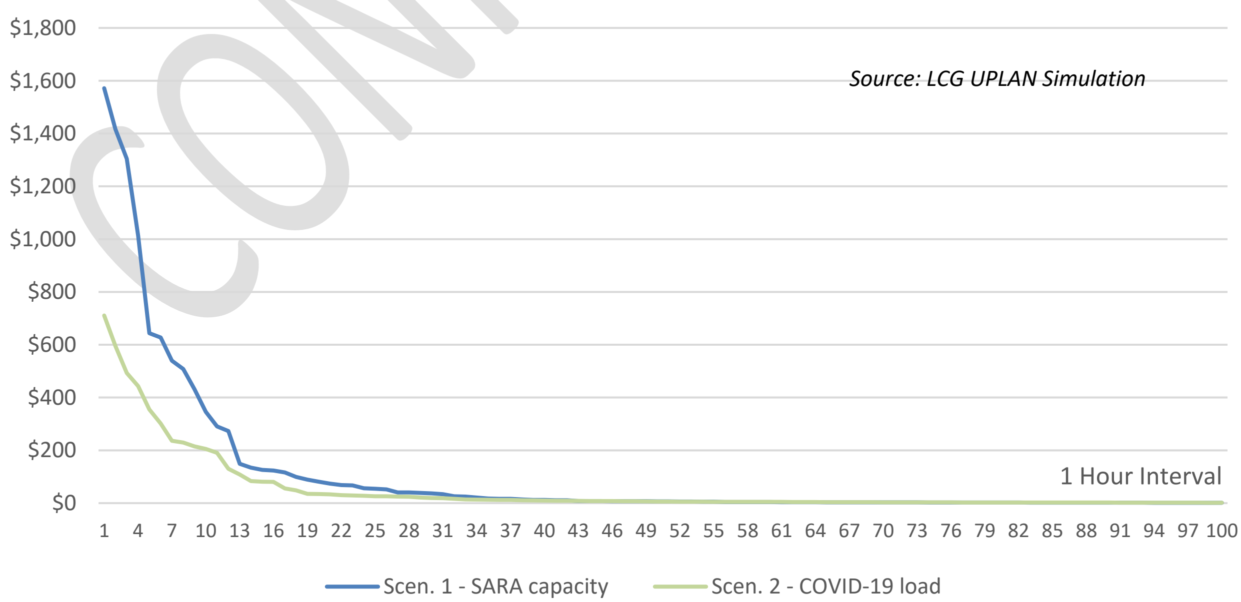

Figure 6 – Operating Reserve Price Adder Duration Curve - Top 100 hours – June-December 2020 ($/MWh)

LCG's simulation shows that the Peaker Net Margin (PNM), which also serves as a simplified measure of the annual net revenue of a peaking unit, is lower in the COVID-19 scenario. In the Base Case, the cumulative PNM value (June through December) is $30,845. During the same period, the margin is $22,141 in the COVID-19 case. Simulation results show that peakers gain the most in August (Figure 7).

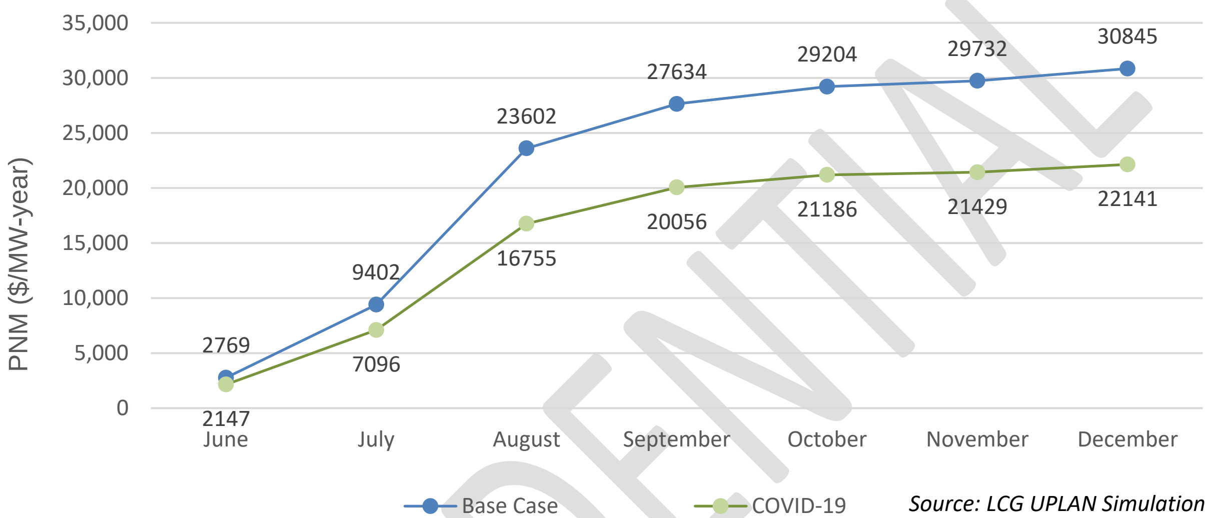

Figure 7 – ERCOT-wide Cumulative Peaker Net Margin

3.2 Generation

Natural gas is increasingly dominant in the ERCOT generation mix, and this trend appears in both cases. Both scenarios see a similar fuel mix, with natural gas accounting for more than 53% of generation. Under COVID-19 impacts, there is a substitution effect from coal to natural gas, due to the price decrease for natural gas, while generation from other fuel types are not affected much. Generation by fuel type for all scenarios are given below in Figure 8.

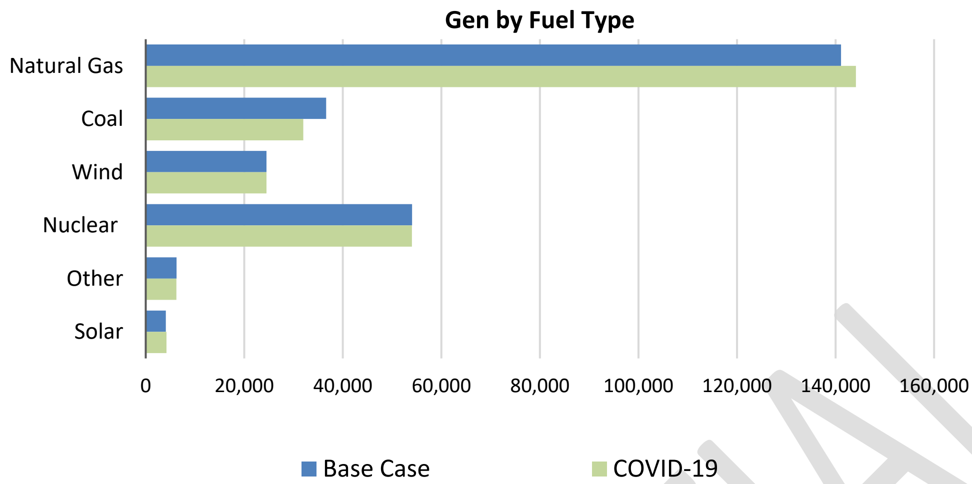

Figure 8 – Generation (GWh) by Fuel and Fuel Mix by Scenario – June-December 2020

3.3 Congestion

The COVID-19 case shows a slightly different picture of transmission congestion. Congestion rents for selected major constraints are shown below in Table 2. The COVID-19 scenario yields a lower congestion rent and this effect is localized.

Table 2– Selected Major Constraints and congestion rent (M$)

Monitored Line	Zone	Base Case	COVID-19
STPWAP39_1	South to Houston	$54	$58
HAMILT_MAVERI1_1	South	$51	$51
N_TO_H	North to South	$44	$34
NEDIN_138L	South	$43	$28
BURNS_RIOHONDO_1	South	$40	$34
6265__A	North	$35	$36
656T656_1	LCRA	$35	$35

Source: LCG UPLAN Simulation

4. CONCLUSION

Under expected conditions, the ERCOT region will see sufficient installed generating capacity to serve peak demands during the summer 2020. The risk of insufficient capacity is lower under the conditions of lowered energy demand scenario due to the COVID-19 pandemic. To drill down into a more comprehensive dataset, this report can be customized upon request to include additional details such as generator performance, hourly LMPs, transmission congestion, and other information of interest.

Under the scenarios explored here, ERCOT sees lower prices due to decreased load and fuel price from COVID-19 impacts. Due to congestion in the West zone under the business-as-usual scenario, the price in the West zone is most sensitive to a decrease in peak load and energy demand. The generation mix mainly shows a substitution effect from coal to natural gas, due to the decrease in natural gas prices. Strained conditions have noteworthy localized effects, as the COVID-19 scenario relieves some significant system transmission constraints, which correspondingly affect the prices.

APPENDIX 1. THE UPLAN NETWORK POWER MODEL

For this study, LCG used its UPLAN model along with its PLATO data model for the ERCOT market simulations. Our proprietary model provides a rich, integrated representation of physical features of the electric generators, loads and transmission, financial characteristics, and system operation specific to the ERCOT system. UPLAN simulations provide a realistic projection of what is going to happen physically and financially throughout a region. Such a realistic projection is useful for assessing the engineering, economic, and financial implications of spatial and temporal changes in operations, reliability, production costs, and resources.

UPLAN is a full network model designed for electricity market simulation. It replicates the engineering protocols and market procedures of any operator. UPLAN also captures the commercial activities, such as bidding, trading, hedging, and contracting of all players in a restructured power market. The model performs marginal cost or bid-based energy and ancillary service procurement, congestion management, full-fledged contingency analysis with Security-Constrained Unit Commitment (SCUC) and Security-Constrained Economic Dispatch (SCED) similar to those used by ERCOT, and dispatch can be at hourly or sub-hourly intervals. In this study UPLAN employed dispatch at five-minute intervals because of the large number of renewables in ERCOT. The model considers each generator's constraints individually, such as unit capacity range, as well as minimum up and down times. The incremental change in load and intermittent generation can be modeled in three ways: a) linear energy preserving interpolation, b) average, and c) energy preserving transformation with volatility. UPLAN sub-hourly model produces realistic results when volatility of intermittent generation and ramping is expected to have a large effect on generation and utilization of storage units. For example, in the case of volatile renewables, the system needs to accommodate system fluctuations with storage and other fast acting generators.

UPLAN has been used extensively to simulate the ERCOT competitive energy market. It has been benchmarked by a number of market participants, including the ERCOT ISO. UPLAN produces information on the hourly operation of generators, hourly balancing prices, and resulting generator energy, as well as ancillary service revenues, costs, and net income while respecting transmission and other constraints. UPLAN provides a consistent, structured framework as well as detailed quantitative inputs and results required to evaluate the full implications of different fundamental drivers and market participant decisions.

APPENDIX 2. PLATO DATA MODEL VALIDATION WITH PERFECTVISION

LCG's PLATO data model is a large-scale resource database, which contains the most recent available data for electric plants, loads, assets, transmission, and operations for all the utilities and independent power producers (IPPs) in North America. Data can be retrieved at any level of grouping such as organization, region, area, state, or council as categorized by the North American Electric Reliability Council (NERC). The PLATO-ERCOT Data Model was used for this study and includes more than 3 million pieces of data covering approximately 800 generators, 7000 electrical buses, 9000 transmission lines, and 8000 contingencies. The data model contains wind profiles for each wind unit in the ERCOT territory.

PerfectVision is a rule-based artificial intelligence program developed by LCG, which performs extensive validation of the PLATO data model and determines whether the data model satisfies the expectations of UPLAN Network Power Model and grid protocols. PerfectVision currently contains more than 100 automated tests, validating the accuracy, consistency and inter-relationship of millions input variables that make up the PLATO data. For example, the program verifies the consistency of each generator with their technology type, heat rate, emission and other engineering characteristics and competitive behavior in relationship with other generators in the system. The fuel model, emissions and other environmental characteristics are also compared with known or expected performance of both traditional and renewable technologies. This data is tagged to units modularly when used in conjunction with UPLAN, so profiles can be seamlessly adjusted on any single unit or any group of units, with that group being defined in any way the user prefers.

In addition, PerfectVision validates bus-level loads and their representation conform to chronological, environmental and grid characteristics. The program assesses whether the transmission system is consistent with grid specifications and the ability to deliver generation to the load without undue congestion. It also verifies that price formation follows the expected LMP patterns with respect to time of day and seasonal variation.

APPENDIX 3. ABOUT LCG CONSULTING

LCG Consulting, based in Los Altos, California, is a widely-recognized leader in electricity market modeling and software development. Since it was founding in 1978 in Silicon Valley, LCG has played a leadership role in providing the utility industry with specialized software and consulting services in the areas of electric and gas deregulation. The company's most popular, best-in-class offerings, UPLAN and PLATO, are in widespread use by market participants worldwide. Our clients include an extensive range of public and private electric utilities, independent system operators, generation asset developers, electricity traders, power marketers, federal and state agencies, and a number of energy research institutes across the United States and abroad, including the United States Energy Information Administration. We specialize in energy model development for electricity markets, economic analysis of transmission and generation assets, tariff design and risk assessment.

LCG has more than 30 years of experience in the electric and gas utility industry. Over that period, LCG has conducted thousands of studies on electricity market forecasting and electricity industry restructuring in the United States and abroad. The company developed and supported models for all aspects of short- and long-term planning for many types of clients, including private and public energy companies, courts, investors, and ratepayers. LCG is one of the first companies to research the implications of competitive pricing and marketing and develop models to analyze competitive power markets.

LCG's professional staff, knowledgeable in utility restructuring and market design, offers a variety of consulting services to our clients including:

- Renewable technology and power storage integration analyses
- Economic valuation of generation and transmission resources over short– and long-term planning horizons
- Transmission analysis, CRR valuation, tariff design
- Congestion and curtailment risk analyses
- Forecasts of energy and ancillary service prices

Our popular web site energyonline.com is a rich source of current electricity market information.