Demand Response: A "Green" Approach to Addressing Capacity/Transmission Constraints While Empowering Customers

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ABSTRACT

Utilities cannot build new generation or transmission lines fast enough to have adequate capacity to meet increasing peak demand. With the heightened environmental consciousness, Demand Response (DR) Programs (changes in electric usage by customers from their normal consumption in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized), provide customers with a tool to manage their energy consumption, while reducing carbon emissions, and easing generation and transmission constraints. A case study – Meeting Texas' ERCOT Growing Energy [1], is evaluated, to see how consumer energy demand, available capacity, transmission constraints and carbon emissions can be kept in balance.

Keywords: demand response (DR), capacity/transmission constraints, green-house gas emissions, carbon constraints

1 OVERVIEW OF DEMAND RESPONSE (DR)

Demand Response is the proactive management of electric and gas utility loads in order to more efficiently and reliably market, produce, transmit and deliver energy. Applications of demand response are as simple as the Utility interrupting load in response to severe grid transients or supply shortages (direct load control or active demand-side management), or as complex as millions of customers voluntarily reducing their consumption / load in response to price signals (passive demand-side management). With the exception of having to address emergencies, DR is generally used to flatten the demand peaks (see Figure 1). In either case, the Utility must have a communications gateway to either directly control the consumer's loads, or provide a pricing signal to allow the consumer to manage their consumption directly by making the decision when to use appliances / equipment or as input to a home / premise energy management panel which automates these decisions based on initial consumer input / settings. As some confusion often exists in the use of the terms Energy Efficiency, Demand Response and Load Shifting, definitions and examples are provided in Figure 2.

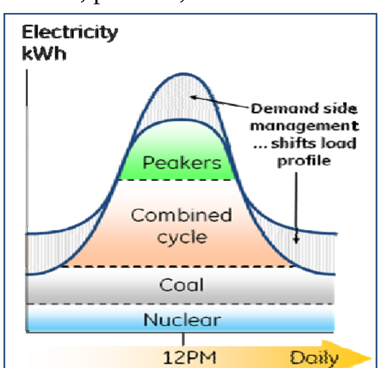

Figure 1: Demand Peak

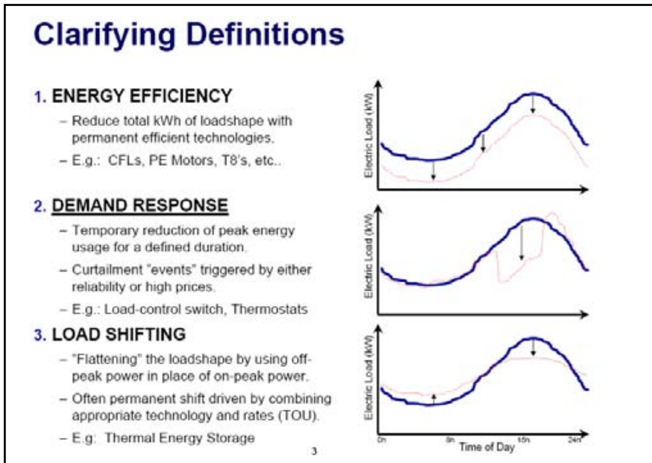

Figure 2: Definitions & Examples
Source: GoodCompany Associates, Robert J. King

Large Commercial and Industrial Customer DR Programs are not new. They have been in-place for 20+ years. This is primarily because the individual loads are larger, requiring fewer controls and automation, in achieving the desired load reduction / shedding. However, as demand has continued to grow, there has been a noticeable shift in the overall makeup and magnitude of the energy demand peak. Residential consumers now make up about 60% of the peak, with unprecedented growth occurring, such as 17% growth in the last three years in the U.S. Mid-Atlantic states. Additional DR will have to come from residential consumers.

2 WHY DEMAND RESPONSE?

So, why is more DR needed? First, it's estimated that electrical demand will grow substantially. According to the Energy Information Administration, the nation needs 50,000 megawatts by 2014 and 258,000 megawatts by 2030, and that need comes atop a projected decline nationally in electricity reserve margins through 2015. Less than half the generation capacity to meet this need is currently being planned. Also, coal has long been the fossil fuel of choice for meeting generation needs.

2.1 Environmental Consciousness

However, with the more recent legislative, regulatory, and societal focus on being environmentally conscious (e.g., carbon constraints, green-house gas (GHG) emissions, global warming), new coal-fired power plants are being turned down / denied approval at an unprecedented rate. This leaves the Utility with few choices to meet this substantial demand growth and the environmental constraints (see Figure 3). Nuclear generation, likely won't be available until 2020. Natural Gas generation, which can be built within a few years, will be used to meet some of this growing energy demand, however, fuel price volatility makes it less favorable fuel choice.

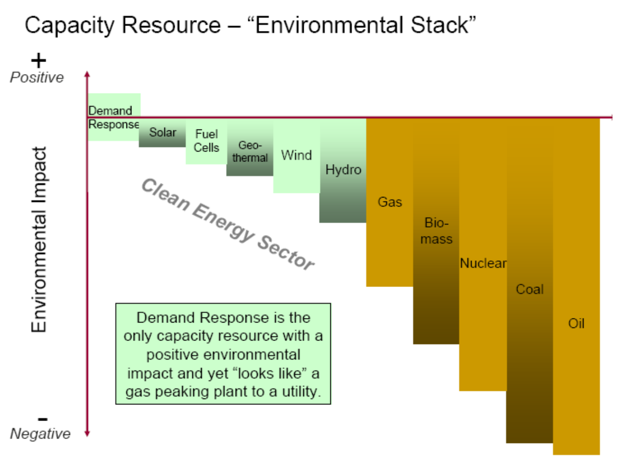

Figure 3: Relative Environmental Impact by Fuel
Source: GoodCompany Associates, Robert J. King

2.2 Transmission Congestion

Second, transmission grid congestion is inhibiting the movement of electrical power from generation sites to where it is needed. Transmission constraints inhibit the ability to move power from areas where excess is available to those areas faced with not having enough power available to meet electricity demand. Grid operators are aware of where these transmission bottlenecks exist. Having to build new lines to increase the transmission capability can take upwards of ten years. Targeting DR in those areas in need of additional power, but under transmission constraints, is an excellent, near-term alternative. Figure 4 shows transmission congestion and potential network upgrades based on a recent ERCOT Competitive Renewable Energy Zones (CREZ) study. Areas enclosed in "red" and numbered indicate areas where capacity exists (west Texas represents substantial wind energy) with the "blue" identifying areas of high demand/consumption. Insufficient transmission capacity

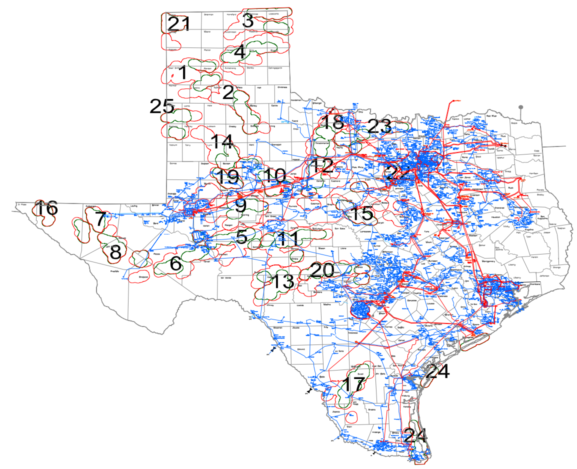

Figure 4: Texas Transmission Constraints
Source: ERCOT CREZ Study

currently exists to move this electrical power from west Texas to where it is needed most.

FERC recently announced the development of national transmission corridors to help reduce the time it takes to build new transmission lines, which presently can take up to 10 years to commission. This makes DR programs very attractive. Through DR, the Utilities can delay or even eliminate the need to build new generation and transmission capacity, which reduces contributions to GHG emissions, can be commissioned within a few years, and provides consumers with more choices.

2.3 How Much Demand Response is needed?

But how much DR is needed to meet the growing demand? The answer to this will primarily depend on accepted / legislated GHG emissions targets and the availability of

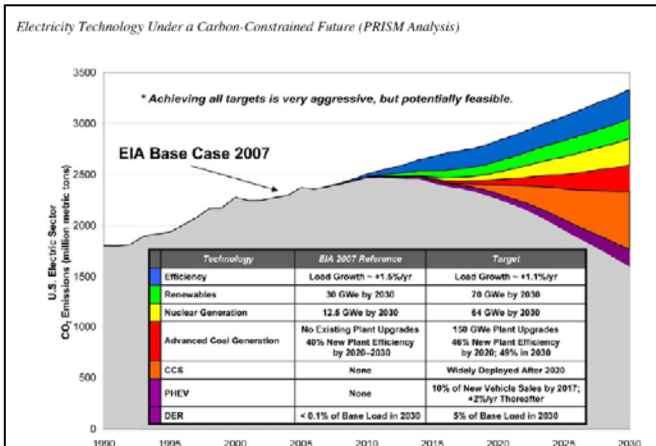

Figure 5: CO_2 Emissions & Technology Deployment
Source: EIA 2007 Annual Energy Outlook

Clean Technology 2009, www.ct-si.org, ISBN 978-1-4398-1787-2

specific new technologies. The Electric Power Research Institute (EPRI) recently completed a study "The Power to Reduce CO_2 Emissions", showing that the aggressive development and deployment of several advanced technologies could reduce U.S. electricity sector CO_2 emissions by roughly 45% by 2030, relative to estimates in the EIA *2007 Annual Energy Outlook* [AEO 2007] Base Case (see Figure 5). Most importantly, the analysis indicates that the rising trend in CO_2 emissions from the U.S. electricity sector can be slowed, stopped and ultimately turned around. Efficiency (DR Programs) is shown to have a significant impact on CO_2 emissions reduction, with the technology being available today. As seen in Figure 5, the amount of DR needed will be highly dependent on the availability and amount of new technology deployed. In addition to technology choices, the issues of program design, rate structure and customer impact will also have a tremendous influence on the success or failure of DR initiatives.

3 CASE STUDY – MEETING TEXAS' ERCOT GROWING ENERGY DEMANDS

In the following case study, ERCOT (Electric Reliability Council of Texas) either directly or through a contracted effort with the American Council for an Energy Efficient Economy (ACEEE), studied how DR Programs could meet their growing energy needs in an environmentally conscious manner.

Over the next 15 years, it is projected that Texas' population growth will continue at an annual rate of 1.7% through 2023, with the state's economy projected to grow at an annual rate of 3.2%. Accompanying this rapid population and economic growth is rapid growth in electricity needs and peak demand. Peak demand growth is the most pressing short-term policy concern in Texas. ERCOT reported that peak demand increased by about 2.5% per year between 1990 and 2006. The current forecast is for peak demand to increase by 2.3% annually from 2007 through 2012. ERCOT has predicted that the state might be without sufficient generation capacity for peak demands beginning in 2009. As a result of Texas' rapidly growing peak electric demand and electricity consumption, ERCOT and electric generating companies have called for the construction of new fossil-fueled and nuclear power plants to meet growing needs. Neither of these, however, is viable for the short-term.

About half of the state's population and a similar share of electricity consumption and peak demand are concentrated in the state's two largest metropolitan regions, Houston/Galveston and Dallas/Fort Worth. These regions are also among the fastest-growing in the state. These regions also face significant environmental challenges, in part because of the concentration of economic activity and population. If the growth in these regions continues, new resources will be needed to meet the surging demand for electricity without worsening their environmental challenges. However, the economic contribution of these metro areas may be limited in the future by growing energy needs and limitations placed on energy production by existing environmental quality conditions. This triple challenge of the economy, environment, and growing energy needs requires new policy solutions if these economic engines are to continue to expand. For continued economic viability in Texas, energy efficiency provides least-cost resources to meet future growth in energy needs while at the same time reducing the impacts of volatile energy prices [1]. Accordingly, energy efficiency improves local air quality by reducing overall energy needs and the use of fossil fuels for electricity generation with their associated emissions.

A recent ACEEE study [2] suggested that, beyond just conventional supply resources, expanded demand-side energy efficiency (including CHP and recycled energy) and onsite renewable resources should be considered as the state develops its near- and long-term energy plans. Energy efficiency, demand response, and onsite renewable energy generation can meet the growing demand for electricity in Texas. Expanded demand response with efficiency and renewable energy resources can meet 107% of growth in summer peak demand in Texas by 2013.

In evaluating the Dallas/Fort Worth (DFW) Metro Area, about 38% of the total electric consumption is residential (see Figure 6), providing significant DR potential in a densely populated area. Oncor (formerly known as TXU Delivery), the transmission and distribution company for the DFW Metro Area, is also in the midst of a broadband-over-power-line (BPL) communications infrastructure rollout to 2.1 million customers in the DFW Metro Area for their advanced metering program. This provides an excellent opportunity to implement a DR Program that can result in significant positive electrical consumption, economic and environmental impacts for the area. The total suite of policies analyzed for this study has the ability to meet 101% of the load growth in the DFW Metro Area over the next 15 years, reducing electricity use by over 24% in 2023 (see Figure 7). The energy efficiency and onsite renewable policies reduce the region's peak summer demand by 23% by 2023. Peak demand can be further reduced through the deployment of expanded demand response programs, which

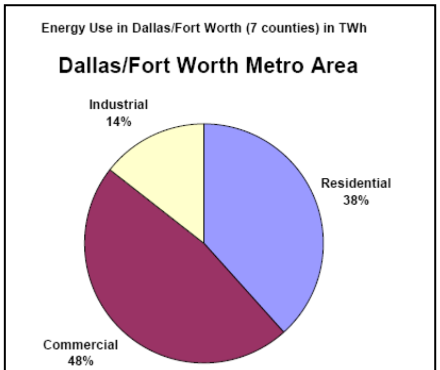

Figure 6: Distribution of Electricity Consumption by End-Use Sector
Source: ACEEE Report E078

provide an additional 14% demand reduction in DFW. Combined, these policies would reduce peak demand in DFW by 38%, or roughly 6,700 MW by 2023.

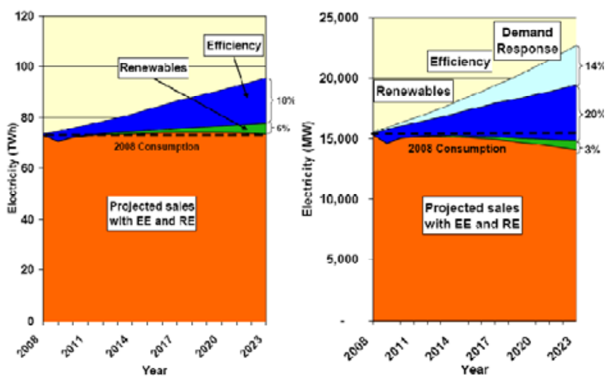

Figure 7: Results for DFW Metro Area
Source: ACEEE Report E078

All energy policies considered in this study can help to meet the growing demand for electricity in the region without further exacerbating existing air pollution problems. It's estimated that the suite of policies could prevent emissions in the region as indicated in Table 1.

Table 1:

Estimate of Avoided Air Emissions Resulting from Expanded Efficiency and Renewable Measures in the DFW Area

Category of Pollutant	2008
SO_2 (thousand short tons)	0.4
NO_x (thousand short tons)	0.2
CO_2 (million metric tons)	0.3

Note: Emissions are based on state average rather than marginal emission rates.

4 SUMMARY

DR is a "fifth fuel", as commonly referred to by Jim Rogers, CEO Duke Energy, and has significant potential to positively contribute to energy consumption, economic, and environmental challenges. As Utilities consider the development and deployment of new generation, DR is the only one that can address the capacity, transmission, and environmental constraints, now. Given all the generation sources (e.g., coal, nuclear, wind), and all the resulting potential environmental impacts from these sources, DR is truly the "greenest". For the case study above, it has the capability to reduce CO_2 emissions in the Dallas – Fort Worth metro area alone, in 2008, by 300,000 metric tons.

REFERENCES

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