Interoperability of Demand Response Resources Demonstration in NY

Final Technical Report

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Principal Investigator: Andre Wellington, Project Manager, Smart Grid Implementation Group

Recipient: Consolidated Edison Company of New York, Inc.
Team members: Innoventive Power and Verizon Communications

Consolidated Edison Company of New York, Inc.
Taxpayer ID Number: 13-5009340
Organizational DUNS: 00-698-2359
4 Irving Place
New York, NY 10003

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Disclaimer

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1. Executive Summary

The Interoperability of Demand Response Resources Demonstration in NY (Interoperability Project) was awarded to Con Edison in 2009. The objective of the project was to develop and demonstrate methodologies to enhance the ability of customer sited Demand Response resources, both conventional and renewable, to integrate more effectively with electric delivery companies. In order to achieve the project objective, interoperability between the delivery company and the demand response resources had to be achieved. The electric delivery company does not actively control these demand response resources, thus through this project the interoperability was demonstrated, by integrating the operations of a demand response service provider (DRSP), a large multi-facility retail customer (RC), and a delivery company (DC).

The electric delivery company in this project, Con Edison, is dedicated to lowering costs, improving reliability and customer service, and reducing its impact on the environment for its customers. These objectives also align with the policy objectives of New York State as a whole. To help meet these objectives, Con Edison's long-term vision for the distribution grid relies on the successful integration and control of a growing penetration of distributed resources, including demand response (DR) resources, and distributed generation (DG). The Interoperability Project provides an example of how these demand response resources can be integrated into the operations of the utility and the value of these resources and their integration to customers.

The project focused on four main components; the Demand Response Command Center (DRCC), the incremental Building Control Unit (IBCU), the Thermal Storage Plant (TSP) and the Virtual Generator (VirG). An analysis of the customer benefits of the VirG and the TSP are displayed later in the report along with the architecture and a set of protocols had to be developed associated with the DRCC and the IBCU to enable secure integration with the customer sited resources. All of these components were designed and configured to provide value to both the electric delivery company and the customer. The project ultimately showed that customer sited demand response resources can successfully be integrated into electric delivery company operation.

2. Project Overview

The Interoperability Project demonstrated a number of innovative methods of integrating Demand Response resources to help make the grid more efficient, improve grid reliability and create economic value for facility owners. The project participants successfully demonstrated a number of concepts identified in table 1 below.

Table 1 - Interoperability Project Research Areas

Research Topic	Contribution of Interoperability Project
Ability of DR to Improve Reliability in the Distribution System	Demand Response Resources with rapid response and ability to maintain load reductions for multiple hours when needed can help maintain reliability during times of grid contingencies
Ability of Demand Response Resources to Provide Ancillary Services to the Electric Grid	This was the first application in the NYISO control area where an area where DR resources are dispatched in the same way as a conventional generator
Requirements for cybersecure interoperability between DR resources and an Electric Distribution Utility	Demonstration of remote activation of DR resources by the utility using a secure link compliant with NIST 7268
How precise controls of facility loads can be harnessed for application beyond simple peak shaving or energy efficiency	Through precise control of building loads, demonstrated ability to control resources to set points established by the Regional Transmission Operator (RTO)
The potential for an aggregation of multiple DR resources to alleviate a forecasted capacity shortage in a Control Area	Via the Virtual Generator (VirG) concept, (see description on following page in Technical Approach section), the project was able to show how a large aggregation of resources can be an economical solution to a forecasted shortage of regional capacity

In most cases the technical effectiveness was extensively exercised and successfully tested. Economic feasibility was tested whenever possible and when actual test data was not available, results were obtained by system modelling. These concepts above closely align with the original statement of project objectives especially in the areas of operational profiles of participant facilities and protocols set up to operate DR resources in a cybersecure fashion. A list of these participating facilities can be found in appendix 7.3. The command center that was created out of this project, called the Demand Response Command Center (DRCC), served as the central platform that enabled the interoperability between the participating facilities and the delivery company (electric distribution utility).

Many of the project goals were met but there were differences between the project accomplishments and the original goals and objectives of the project. From a broad perspective, the project spent less money than originally budgeted. The primary driver behind this was that the original budget included a combined heat and power (CHP) installation using a fuel cell which was replaced by a less costly Thermal Storage Plant following a review of the cost benefit analysis of a fuel cell installation versus a Thermal Storage Plant. Not only did the TSP cost less, but its use in the project led to the development of the Incremental

Building Control Unit, which added value to the installation and was not envisioned when the project was originally proposed to the Department of Energy. Other factors that led to the selection of the TSP were the fact that its proposed location would be in New York City as opposed to Westchester for the fuel cell. New York City has higher electricity prices and higher demand response payments available. Also it wasn't clear if the fuel cell would be able to be used to provide ancillary services to the NYISO, while the TSP was definitely an acceptable technology for ancillary services.

Other items that were originally proposed as project objectives, such as a wind plant and a facility with plug in electric vehicles (EVs) were not undertaken because the wind plant was deemed not economically feasible and there were no EV fleet sites were found available to include in the project. The original objectives also included a project to retrofit Nitrogen Oxide (NOx) control installations. Although a study was conducted as part of this sub project, the environmental regulations requiring these retrofits did not materialize so the project wasn't continued at the time. Another objective was to develop an interconnection plan that would allow parallel operation of a customer facility and the distribution grid and injection of power into distribution grid. At the time the complexity and possible distribution grid problems associated with enabling this type of operation caused the project to focus strictly on load reduction and not parallel operation for participating facilities.

In addition, subsequent to the award of the Interoperability Project, Con Edison was awarded the Secure Interoperable Open Smart Grid Demonstration Project [DE-OE0000197]1 and Con Edison invited Innoventive Power to participate in several milestone demonstrations. Participation in these demonstrations required the build out of the web services portion of the DRCC for integration with Con Edison's Visualization Platform. Coordination with the SGDP afforded us further opportunities for testing the remote dispatch system of the DRCC, culminating in the Capstone Demonstration in July 2013.

Another accomplishment that was not anticipated in the original goals of the program was the design and implementation of a central load curtailment controller with cybersecurity provisions enabling it to be used within the framework of a major national telecom network. One of the Phase I goals of the project was to develop protocols between the end use resources and the DRSP or Utility. Verizon was very concerned about outside demands to affect changes in its operation. To alleviate these concerns a secure interface was developed that bridged the gap between the broader internet and Verizon's internal control system in such a way that Verizon's staff is comfortable with its operation and security. This design will likely be replicated with other customers who desire such a level of security. The system also allows Verizon to leverage its manpower as efficiently as possible by providing sophisticated alarming and control capability via a secure remote link with every facility in its footprint.

Technical readiness of participation in spinning reserves ancillary service markets in the NYISO control area was demonstrated. Appendix 7.3 shows the project schedule and lists the buildings that have been and will be retrofitted to supply these services as part of an aggregation of over 20 MW of curtailable load. Participation in the ancillary services reserves market basically requires a reduction of one MW or more and the ability to respond within 10 minutes. The ancillary services regulation market is more stringent in its requirements as participants are required to raise or lower load by 1 MW or more. Participants must control their load in response to signals from the NYISO with a +/- 1% tolerance.

Additionally, the value of a large aggregation of demand response resources was shown to be a possible solution to a forecasted potential shortage of capacity in the NYISO control area. The VirG concept is

[1] Secure Interoperable Open Smart Grid Demonstration Project, December 28, 2014

capable of being tested and implemented in less time and for less cost than conventional new generation or transmission capacity. This prompted the NYISO to classify the VirG as a possible solution to its forecasted capacity shortages. The potential closing of the Indian Point Nuclear Generating Station in 2016 would make the development of the VirG even more valuable. Although the VirG would not be the entire solution to the capacity shortage caused by the possible Indian Point closure it is definitely a viable demand management tool that can be a part of the solution.

The following two issues impacted the project and affected the ability to complete demonstrations of economic feasibility in the most favorable conditions.

a. Super Storm Sandy – this storm flooded the facility hosting the Thermal Storage Plant and resulted in a one year delay in the installation and commissioning of the plant. The project construction delays reduced the time to test the plant under high cooling loads. The research to complete the economic feasibility studies utilized a mix of models and actual test results. Testing is thus ongoing at this point.
b. Demand Response resources were approved for participation in NYISO Ancillary Service markets in 2008. At that time, the NYISO rules required all required telemetry to be passed through the Transmission Operator in whose control area the resource is located. The technical barriers to connecting demand response resources to the NYISO through the Transmission Operator were significant. These barriers were relieved in early 2012 when the NYISO revised its rules to allow for direct communications between demand response resources and the NYISO's dispatch system. This direct communications capability was added to the Innoventive DRCC as quickly as possible, however, the delay precluded market sales of the spinning reserves product before the end date of the project.

3. Technical Approach

This project consisted of four major technical components:

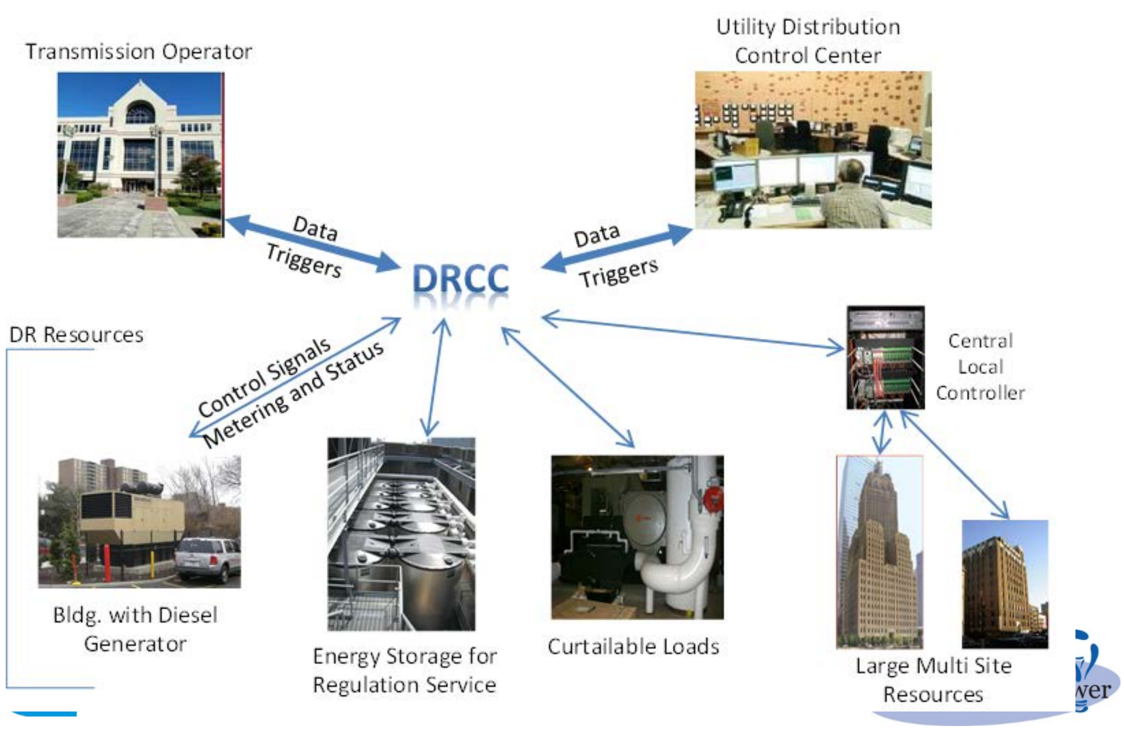
- **Demand Response Command Center (DRCC)**
  The DRCC represents a secure software system designed to aggregate demand response resources for activation in response to various conditions of the electric grid. The DRCC was tested may times throughout the project demonstrating technical effectiveness. In fact, the DRCC developed during this project is being utilized in a production environment to enable automatic demand response for project resources. A total of 23 facilities and 20 MW of generation has been integrated into the DRCC.
- **Incremental Building Control Unit (IBCU)**
  The IBCU is a set of hardware and programmed strategies that can control facility loads in response to market signals or as a tool to optimize energy efficiency. The IBCU was installed and demonstrated as part of an installation of a Thermal Storage Systems. Technical effectiveness of the IBCU system was tested and demonstrated. While sufficient operating experience was not acquired during the test period to enable economic feasibility to be demonstrated, results are modelled and reported later in the report.
- **Thermal Storage Plant**
  A 10,000 ton-hour Thermal Storage Plant (TSP) was installed at a Verizon facility which houses office space and a telecom central office. The plant was installed to demonstrate how this technology could be used to supply valuable services to the electric grid while

also optimizing energy efficiency at the facility. Testing to date has demonstrated the ability of the Thermal Storage Plant to supply spinning reserves ancillary services as well as its ability to reduce air conditioning demand during peak electric demand periods. Changes to local incentives for participation in demand response programs led the team to re-evaluate technical feasibility late in the project resulting in greater economic benefits than originally envisioned.

- **Virtual Generator (VirG)**
  A concept which was a result of our research was the characterization of a Virtual Generator or VirG. A VirG is created by the activation of an aggregation of DR resources by the DRCC. This aggregated set of resources is able to supply virtual generation (VirG). A VirG is able to solve a capacity shortage on the transmission system, as well as address system contingencies in electric distribution networks. Figure 1 illustrates the type of DR resources which may be dispatched by the DRCC and the architecture used to tie in all the resources. Backup power provided by standby generators is an excellent candidate to provide targeted, persistent load reduction to address network events by responding to dispatch signals from a grid operator within five minutes. Economic feasibility was examined in detail and is presented in Appendix 7.6. The benefits provided to the grid by the VirG are shown to be greater than the costs to supply this service In fact, after meeting with Innoventive Power the NYISO has included the concept of the VirG in its "Reliability Needs Assessment" as part of a potential solution to forecasted regional shortages of capacity.

The project benefited electric customers as it demonstrated new ways to integrate DR resources into the NY electric distribution grid. Integration of existing DG resources into the VirG can be established and commissioned in a short time and can be utilized to respond to forecasted capacity shortages. Figure 1 below shows the architecture that was put in place to enable the interoperability between the different components.

Figure 1: DRCC Architecture



Once the DRCC is in place, the VirG can be established in a relatively short time because it requires neither siting approvals nor large capital expenditures as is the case with conventional generation or transmission lines. The ability of a variety of resources to address growing electrical demand benefits both customers and electric utilities. In the long term, the variety of resources allows electric utilities to choose the best solutions to address the time and financial constraints around managing electrical demand. In the short term, the utility can provide more reliable service by initiating these resources when there is a system need. Customers benefit financially by participating in managing demand and receiving payment and also because the utility has a lower overall cost to maintain the electrical system, which can translate to lower bills.

4. Methodology

This section summarizes the methods to achieve the goals of the overall project. Detailed schedules, lists of participating facilities and benefit analysis individual components of the project can be found in the Appendix at the end of the report.

4.1. Scope of Work

The Scope of Work included the following elements:

- Design and implement a Demand Response Command Center (DRCC) capable of monitoring and dispatching aggregations of demand response resources
- Demonstrate interoperability of demand response resources with Con Edison Distributed Energy Resource Management System
- Demonstrate remote activation of demand response using an aggregation of telecom facilities while maintaining a high level of cybersecurity for these resources
- Design and install a 10,000 Ton-hr Thermal Storage System capable of supplying ancillary services such as Regulation and Reserves to the electric grid
- Design and implement an Incremental Building Control Unit (IBCU) capable of directing an existing Building Management Systems (BMS) to optimize efficiency and enable operating the facility to provide ancillary services such as Regulation and Reserves to the electric grid
- Develop and implement a plan to provide ancillary services such as regulation and reserves to the electric grid
- Design and implement a unique closed transition switching technique that could enable more end user facilities to participate in Demand Response Programs

Each of these elements represented a subproject that was addressed by Innoventive Power, Verizon and Con Edison. Many of these elements were worked in parallel based on the workloads of the participating companies.

4.2. Key Development Factors in Project

The objective of the project was to develop and demonstrate methodologies to enhance the ability of customer sited Demand Response resources to integrate more effectively with electric delivery companies and regional transmission organizations. The objective was translated into a system architecture, shown previously in Figure 1, with the central element being the DRCC. Since the development of the project, two changes in costs and value of demand response occurred and these favorably affected the value of the investment, namely:

a. The original estimated cost to construct Demand Response Command Center was dramatically reduced by hosting the DRCC at a data center in a cloud computing environment rather than hosting or constructing a physical computing center.
b. The value of demand response resources in the Con Edison service territory has increased substantially in the face of forecasted potential shortages of capacity in the area. In fact, the value of demand response participation in NYISO and Con Edison sponsored Demand Response programs has almost tripled since the project was first proposed in 2009.

Table 2 below shows how an investment of $1.28 million for the DRCC and retrofit costs associated with preparing the 23 sites for participation in demand response programs makes possible almost $5 million in annual income to a market participant. This translates to a payback of less than one year.

Table 2: Economic Analysis of Aggregation with DRCC

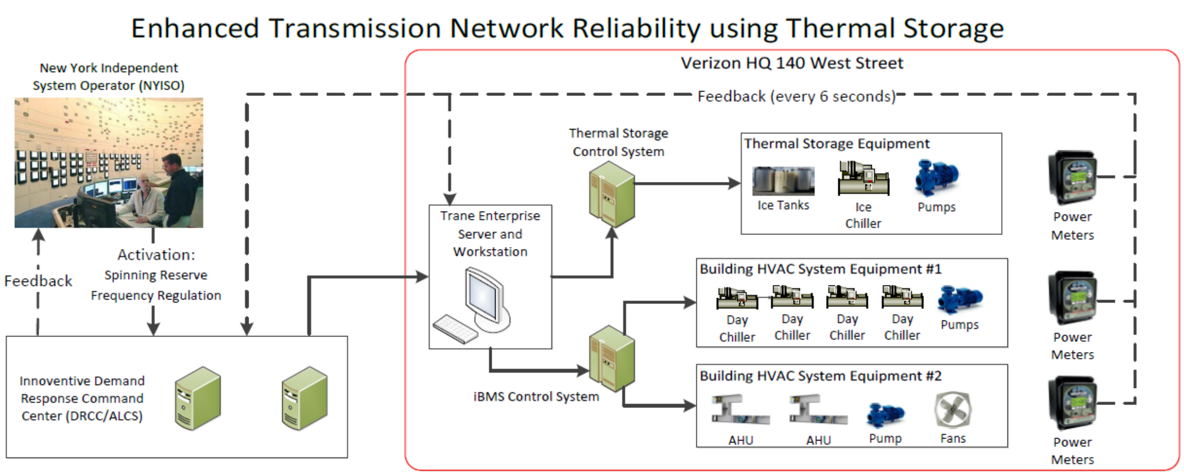
Retrofit Costs	$1,278,000
Annual Operating and Maintenance costs	$1,169,000
Revenue Sources	
Installed Capacity (ICAP) – Special Case Resources (SCR)	$3,193,020
Spinning Reserves	$675,000
Distribution Load Relief Program (DLRP)	$394,200
Commercial System Relief Program(CSRP)	$657,000
Total	**$4,919,220**
Net Annual Value	**$3,750,220**
Payback (Years)	**0.34**

Another significant outcome of the research is the finding that deployment of 20 Megawatts of a VirG product could yield an annual benefit of $6.4 million to the retail electric customers in NYISO's Zone J. The ratepayer benefit is derived from supplying DR capacity and reducing the congestion component of the marginal cost of electricity in the NYISO Zone J.

Finally, it is noted that the Thermal Storage Plant can provide more economic benefit when operated as a DR resource than as a peak shaving tool as originally intended. The analysis is shown in detail in the Appendix. This is a surprising conclusion and raises questions on how to best utilize energy storage resources. This conclusion is specific to regions where the value of DR participation is especially high, such as in the Con Edison service territory. Had recent tariff changes not taken place in response to forecasted shortages of capacity in the region, then use of the Thermal Storage Plant as a peak shaving and energy efficiency resource capable of supplying spinning reserve ancillary services would be the best economical use of the plant.

Another activity which should be highlighted was the creation of the Incremental Building Control Unit (IBCU). This consisted of a control system layered over the facility's original Building Management System (BMS) that was programmed to operate the facility in strategies that optimized energy efficiency. This system is capable of responding to a spinning reserve or frequency regulation request from the NYISO as required by operating conditions. The system, designed and implemented by Trane U.S., Inc. operates continuously and is easily modified as conditions in the facility change. The ICBU has enabled the project to get more value from the Thermal Storage Plant than would be expected from using the plant solely for peak shaving. Appendix 7.1 analyzes the flexibility of operation and associated value gained by using the ICBU to control the Thermal Storage Plant.

Figure 2: Incremental Building Control Unit (IBCU) Architecture



4.3. Web Interfaces and Technology

4.3.1. Web interfaces

The web sites or user interfaces developed for this project are integral to the DRCC. The interfaces are only accessible to the groups for which they are created and they provide the specific user with information that allows for monitoring and control of customer sited resources. For both the customer and the utility these interfaces are integral to providing comfort in the use of customer sited resources being integrated into the utility operations.

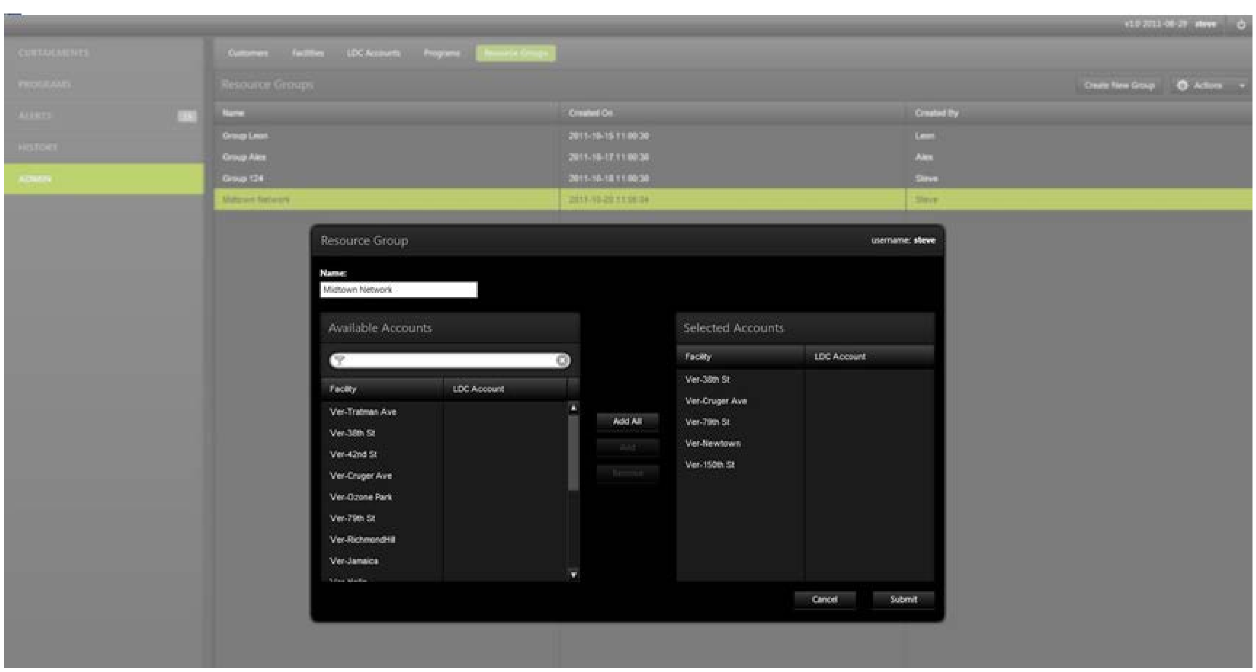
The DRCC Utility Operator Interface is designed to give the utility operator visibility into present loads and amount of curtailable loads to address system contingencies. It also allows the utility operator to request demand response activations. This interface was a precursor to the

Distributed Energy Resource Management System (DERMS) designed by Con Edison and implemented by Siemens as part of the Smart Grid Demonstration Project [DE-OE0000197]. In the SGDP demonstrations, this interface was bypassed and a secure web service was used to transmit telemetry and curtailment requests to the DRCC from Con Edison. As shown in figure 3, the interface allows the operator to select a resource and see its current load, its load over 24 hours and its baseline (load that it will reach during a DR initiation).

Figure 3: DRCC Utility Operator Interface

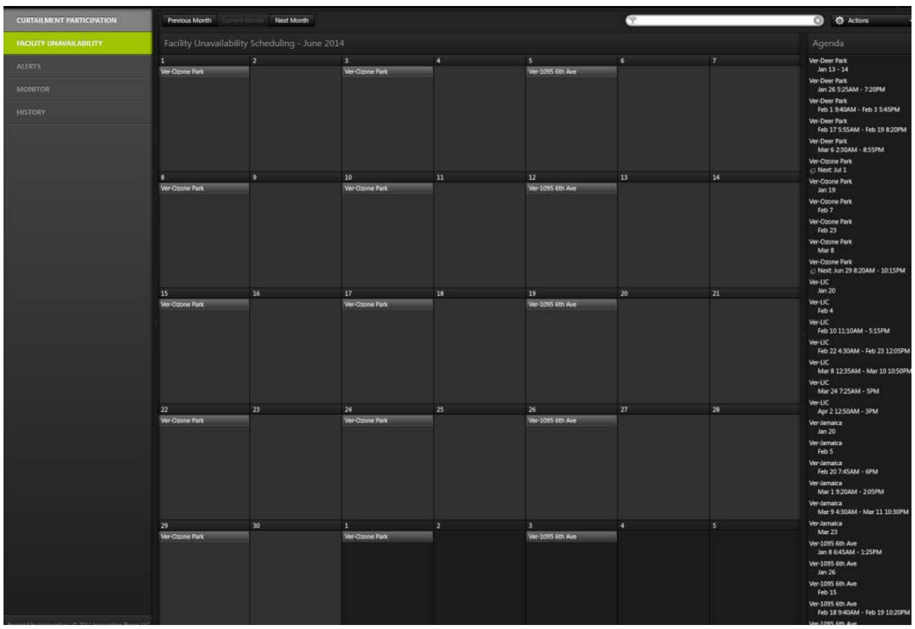
The DRCC Curtailment Service Provider Interface shown in figure 4 below allows the DRSP to request curtailments based upon grid conditions and requests from the utility. It is designed to give the DRSP the flexibility to group facilities as needed and dispatch as required in response to changing system conditions.

Figure 4: DRCC Curtailment Service Provider Interface



The Facility Manager Interface allows the facility manager at participating buildings to review operations and inform the DRSP of upcoming maintenance outages. It was designed to allow the end use customer to opt in and opt out of certain demand response programs as program availability allows. For spinning reserves ancillary services, offers to sell capacity are made day ahead, which allows flexibility to accommodate maintenance and other facility unavailability. Figure 5 shows the Facility Manager Interface calendar view where the facility manager would view and select or deselect the resources that can participate in a demand response program on different days.

Figure 5: DRCC Facility Manager Interface



4.3.2. Technology

The project developed and demonstrated the technical readiness of the DRCC and IBCU.
The DRCC, IBCU and Thermal Storage Plant are significant developments which enable the VirG to become a major system asset capable of supporting the reliability of the transmission system in New York State as well as the distribution system in New York City. There were no inventions/patents or licensing agreements developed as part of this project.

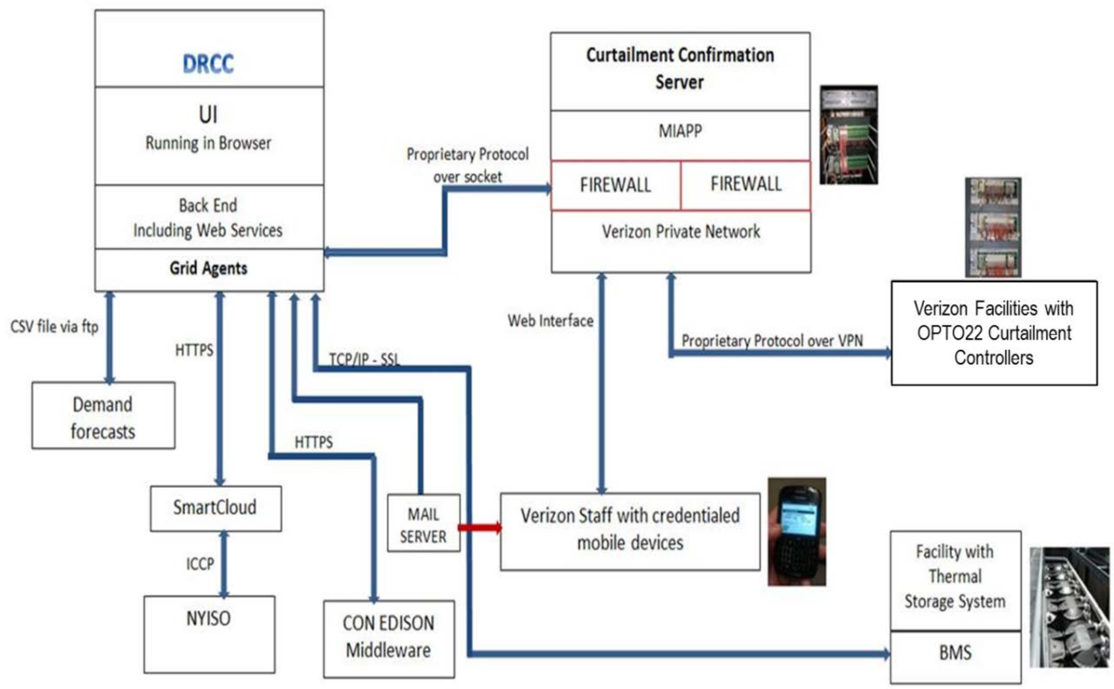
A large amount of software development was conducted to achieve the project goals. The main software systems are categorized into the following functional areas:

a. Demand Response Control Center (DRCC) – Including user interface, secure communications capability, data manipulation and archiving
b. Central Load Curtailment Controller at Verizon facility – incorporate ultra secure firewalls as well as secure communications from central controller to individual facilities

c. Facility curtailment controls – Program curtailment strategies at individual facilities
d. Energy Efficiency and load controls associated with Thermal Storage Plant – Programming of IBCU.

The software system architecture of the project is illustrated in Figure 6, below and its development is described in Appendix 7.4.

Figure 6: Architecture of System Software



4.3.3. Hardware Requirements

The hardware requirements for the thermal storage plant, the DRCC and each retrofit installation were specified by Verizon and Innoventive and Trane, approved before installation and commissioned upon completion.

4.4. Modelling

The project required the development of a number of models to make estimate building loads and energy usage. These estimates were then used in financial models to assess cost/benefit potential. These financial models were also used to compare costs before and after the installation of energy efficiency and cost saving measures at the facilities. The models conformed to all requirements imposed by ASHRAE for building load models.[1],[2],[3]

[1]ASHRAE Standard 90.1 "Energy Standard for Buildings Except Low-rise Residential Buildings", ANSI, 2004 or later Edition

The following two categories of building models were used for this project:

a. A forecasting tool was needed to determine the amount of curtailable load for a facility in any given hour. An hourly forecast for the total building load and loads for major components for 48 hour was created to formulate offers for participation in the DSASP. A base for this system is a single building load forecast program - a statistical model consisting of a set of regression equations that calculates the building hourly electric load as a function of the weather conditions (OAT -outside air temperature), time-of-day (0:00 to 23:00) and day-of-week (week day, weekend, holiday).

$$\boldsymbol{EL = f(OAT, hr, day)}$$

The model contains a set of 48 third-power equations (24 equations for each hour of the day, separately for weekdays and weekends/holidays):

$$EL_i = A_i * OAT^3_i + B_i * OAT^2_i + C_i * OAT_i + D$$

Where:

EL_i – electric load at hour (i);
OAT_i – outside air temperature at hour (i);
A_i, B_i, C_i and D_i – coefficients for hour (i).

For generation of coefficients A, B, C and D, a regression analysis program was developed that uses a one year (8760 hours) batch of the building electric load historic data and historic weather information. The same program is used for a periodic upgrade of the coefficients that is necessary because building physical conditions, occupation and equipment characteristics are changing and the forecast should reflect its actual conditions. The model consists of a set of regression equations that calculates the building hourly electric load as a function of the weather conditions (OAT -outside air temperature), time-of-day (0:00 to 23:00) and day-of-week (week day, weekend, holiday).

b. A Trace program model from the Trane Corporation was used to create a base case model of building performance for comparison of pre and post project conditions. This analytical model included the following data in its analysis:

- Equipment Schedules (HP, efficiencies, tonnage, # of units, design static pressures, etc.)
- Architectural Drawings information (wall construction, floor footprints, glass Ufactors, shading coefficients, square footages, etc.)
- Original Design and/or actual parameters (people per square foot, lighting and equipment watts per square foot, etc.)

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[2] ASHRAE Handbook 2005 ISBN 1-931862-73-7

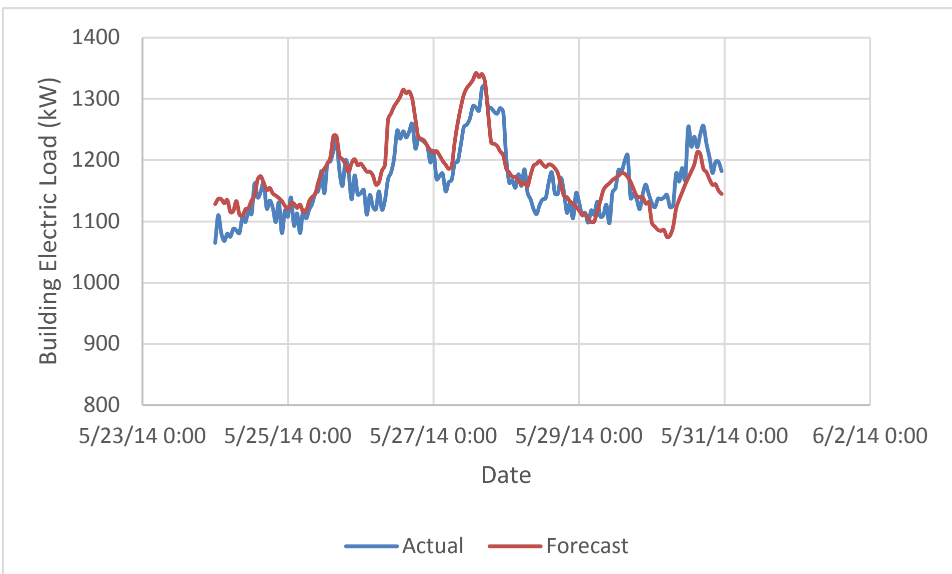
[3] Fed Register 10 SFR 434 PART 434—ENERGY CODE FOR NEW FEDERAL COMMERCIAL AND MULTI-FAMILY HIGH RISE RESIDENTIAL BUILDINGS

- Building Use Details (office space, kitchen, data center, square footages)
- Building and Equipment Operating Schedules
- Equipment Set-points (CHWS temps, VAV box minimums, space thermostat settings, etc.)
- Existing controls schemes and general sequence of operations
- Utility Billing and interval data

4.4.1. Performance criteria for the model

In the case of the statistical models, accuracy in the range of 4– 6 % was common. Figure 7 below is an example of the output of on statistical model showing its performance against actual loads is well within this range.

Figure 7: Load Forecasting Model Performance



For the Trace model used in the analysis of the Thermal Storage Plant, variation from actual conditions of less than 5% was considered acceptable.

4.4.2. Test Results

The project was intended to demonstrate the interoperability of DR resources as well as the economic viability of aggregation. Tests were conducted to confirm the technical readiness of the technologies developed. An important concept to verify was the successful operation of multiple DR resources, aggregated and operating together, in response to signals from the transmission and distribution system operators.

The ability to test was limited for the following reasons:

- The Thermal Storage Plant has the most economic value during the summer peak period. The Thermal Storage Plant was successfully tested during October 2013, and the data were extrapolated to peak conditions. With the data collected, the project was able to update the economic feasibility analyses, the results of which are included in Appendices 7.1 and 7.5. Verification of this analysis will be performed using actual data outside the scope of this project.
- Testing of the 23 aggregated buildings participating in the ancillary services market was not completed as planned. The timing of the NYISO's development of Direct Communications procedure for DSASP and the subsequent registration, application and modelling of the resource by the NYISO lead to a timeline that limited the project to testing only the technical readiness. The NYISO worked closely with Innoventive Power, even providing sample data for testing.

The facility models used either a statistical analysis of past loads or in the case of the TRACE model, a mathematical model of the components in the facility. The project needed to demonstrate that the use of DR resources to supply reserves and frequency regulation could be done economically. The phase one analysis confirmed the validity of the assumptions, the second phase demonstrated the ability to construct the necessary installation and the third phase demonstrated the technical viability.

4.5. Technology Transfer and Collaboration Activities

During the project, Innoventive Power created several significant networks/collaborations.

- Con Edison served as a provider of project management, metering services, and collaborator on web services and related requirements for the SGDP demonstrations
- Verizon worked with Innoventive diligently to conceptualize how its resources could best participate in the project while maintaining the highest level of network security. Verizon provided project facilities and made personnel available to address all concerns throughout the project
- Trane U.S., Inc., designed of the thermal storage plant, and worked closely with Innoventive to design the Incremental Building Control Unit (ICBU). Trane's engineers were pivotal in programming the control systems at the facility to enable the facility to respond to demand response activations as well as to optimize operations for energy efficiency and cost savings. Trane and Innoventive are currently pursuing multiple projects in which IBCU controls will be installed.
- Energy & Environmental Modeling and Solutions, LLC (EEMS) was responsible for creating facility load models for the participating buildings for use in load forecasting. EEMS will continue to work with Innoventive through the commercialization of the systems developed.
- ECM performed base case and post installation modeling of the facility hosting the Thermal Storage Plant. ECM will continue to work with Innoventive to develop future performance measurements of the Thermal Storage Plant.

- GBS was the Software vendor responsible for programming the curtailment controllers in use at the Verizon facilities as well as the central curtailment controller used as an interface between the DRCC and the end use facilities. GBS will continue to work with Innoventive through the commercialization of the systems developed.

Innoventive developed a proposal to the NYISO in response to its 2012 Reliability Needs Assessment. Proposals were requested for this assessment by the NYISO for resources to be installed to enable the reliability of the NY State electric power transmission system to maintain the level of reliability at which the system is required to operate. Innoventive Power proposed a 500 MW VirG, consisting of demand response resources. The resources are comprised of an aggregation of resources capable of curtailing loads in response to remote signals within 5 minutes. In addition the resources must and maintain the curtailment for up to eight hours. The VirG is attractive in that it is less costly than a conventional generator or transmission line and does not have the major siting/construction impediments of conventional generators. The NYISO accepted the VirG proposal and included it in the Comprehensive Reliability Plan (CRP), which was published in January 2013. Since that time, Innoventive continues to have discussions with the NYISO about the details of a DR product which has the characteristics of the VirG.

Innoventive and Con Edison in conjunction with the Electric Power Research Institute (EPRI) created a case study2 that explored the TSP that was created as part of this project. Innoventive and Con Edison also participated in a Deep Dive Webcast presentation which explored the case study and allowed viewers to ask questions of both Innoventive and Con Edison. These can be viewed by accessing the EPRI website and associated Product ID.

5. Conclusions

The Interoperability Project focused developing methodologies to enhance the ability of customer sited DR resources, both conventional and renewable, to integrate more effectively with electric delivery companies. When these integrated resources are enrolled in an established demand response resource the resources can provide a monetary benefit to the customer operating the resource in addition to allowing the electric delivery company to manage the electrical system more efficiently.

As stated earlier, Con Edison is dedicated to lowering costs, improving reliability and customer service, and reducing its impact on the environment for its customers. As part of this strategy, Con Edison's long-term vision for the distribution grid relies on the successful integration and control of a growing penetration of distributed resources, including DR resources.

In December of 2013, the NYPSC announced that it would comprehensively consider how the regulatory paradigm and retail and wholesale market designs effectuate or impede progress toward achieving the policy objectives underlying system benefits programs and regulation of electric distribution utilities. As of April 24, 2014, the NYPSC outlined these objectives in its strategic report, "REV"[3].

Today these policy objectives are stated as follows:

[2] EPRI Product ID: 3002003870

[3] Reforming the Energy Vision, NYS Department of Public Service Staff Report and Proposal, April 24, 2014.

- Enhanced customer knowledge and tools to manage the energy bill
- Market animation and leveraging customer contributions
- System–wide efficiency
- Fuel and resource diversity
- System reliability and resiliency
- Reduction of carbon emissions

These objectives also align with Con Edison's policy objectives. The Interoperability Project addressed a portion of these objectives by setting an example of how customer contributions can be integrated into utility operations and contributing to system wide efficiency. This was verified through a series of live demonstrations conducted by Con Edison and its partners[4] (including Innoventive Power) using a platform called the Distributed Energy Resource Management System (DERMS). The DRCC was integrated through the DERMS platform and operators were able to visualize near real-time customer load information associated and curtailment capacity available from the DR resources participating in the project. The operator was then able to initiate targeted DR. The targeted DR request was received by Innoventive Power which then initiated a VirG to reduce load. When integrated in utility operations targeted DR can alleviate a particular distribution feeder overload condition by calling upon only the distributed resources that can effectively reduce the overload, thus improving overall grid reliability.

From the customer and DRSP perspective the project set the protocols for integration. The protocols provide comfort to the end use customer by defining how the customer's resources will be used to participate in demand response. Although there is a technical component to enabling customer resources, customer knowledge and comfort are also paramount in growing the amount of customers choosing to participate in demand response. As the energy landscape shifts customers may have more incentive to enroll their resources into demand response programs. This was shown in the installation of the TSP which was meant to be a peak shaving resource but was determined to have a more advantageous use as a demand response resource. Regardless of its use, either peak shaving or demand response, it still serves as a resource to the utility in terms of reducing load.

Overall, the results of the Interoperability Project are consistent with the NYPSC's and Con Edison's shared objectives for of leveraging demand response resources and increasing system efficiency. The customer sited resources that were configured in the project are set to be enrolled in both Con Edison and NYISO demand response programs and the knowledge gained in the project will be applied to future demand response projects and thus should help grow the demand response portfolio of the Con Edison service territory.

[4] Secure Interoperable Open Smart Grid Demonstration Project, December 28, 2014

6. Glossary of Acronyms

ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers

BMS – Building Management System

CHP – Combined Heat and Power

DC – Delivery Company

DG – Distributed Generation

DERMS – Distributed Energy Resource Management System

DR - Demand Response

DRCC - Demand Response Command Center

DRSP – Demand Response Service Provider

IBCU - Incremental Building Control Unit

NYCA - New York Control Area

NYISO - New York Independent System Operator

RC – Retail Customer

RTO - Regional Transmission Operator

TSP - Thermal Storage Plant

VirG - Virtual Generator

7. Appendices

7.1. Analysis of Economic Performance of Thermal Storage Plant

A 10,000 Ton-Hr Thermal Storage Plant (TSP) was installed as part of this project and modeled using a Trace system. A base case model of the host facility was created to represent the building before the project was initiated and the model was updated to the improved performance of the facility once the installation was complete. Changes in the incentives for participation in certain demand response programs led to a comparison of the economic benefit of using the Thermal Storage Plant as originally intended to using the Thermal Storage Plant primarily as a Demand Response (DR) resource. The analysis below compares the two operating modes and defines the way in which the plant is used in each scenario.

Table 3: Analysis of TSP Operating Modes

Source of Value	**Scenario 1 – Use TSP as originally intended to supply Peak Shaving and Ancillary Services plus use IBCU for Energy Efficiency Measures**	**Scenario 2 – Use TSP primarily as a Demand Response Resource to supply ICAP, support to distribution system DR programs and Ancillary Services, and use IBCU for Energy Efficiency Measures**
Peak Shaving	$56,089	$0
ICAP Tag Reduction	$114,196	$114,196
ICAP Sales	$142,440	$239,115
DLRP	$0	$29,838
CSRP	$0	$49,730
Savings from Energy Efficiency Measures	$265,154	$265,154
Supply Ancillary Services	$12,313	$12,313
Total Value	**$590,192**	**$710,346**

Program definitions:

- Peak Shaving – Operate the Thermal Storage Plant to reduce demand during the summer peak demand periods which are 8:00 AM until 6:00 PM and 8:00 AM until 10:00 PM to minimize the monthly utility demand charge. The demand reduction during these peak hours is created by using the stored thermal energy to cool the chilled water loop rather than using and electric chiller.
- ICAP Tag Reduction – Minimize demand during the system wide summer peak hour to reduce the amount of ICAP that must be procured for the site by its electric commodity supplier and paid for by the end use customer.
- ICAP Sales – Sales of installed capacity by participation in a wholesale demand response program (Special Case Resource Program).

- DLRP – Con Edison Distribution Load Relief Program – This program is activated with two hours' notice in specific networks in response to contingencies on the distribution network.
- CSRP – Con Edison Commercial System Relief Program – This program is activated with a Day ahead notice when the Con Edison system daily peak is expected to be at least 96% of the forecasted annual peak load.
- Energy Efficiency Measures – strategies that include the optimization of fan speeds and pump speeds to match the facility cooling loads
- Supply Ancillary Services – Supply spinning reserves by responding to reserve requests from the NYISO. These requests have a typical duration of 10 – 30 minutes.

Discussion:

Scenario 1 represents the originally intended use of the Thermal Storage Plant. The benefits are derived from peak shaving to reduce demand charges and to reduce the amount of ICAP required to supply electricity to the facility, reduced energy usage from implementing the energy efficiency measures with the IBCU and payments from the sale of Spinning reserve service. The total benefits come to $590,192 per year.

Scenario 2 represents using the Thermal Storage Plant to supply Demand Response services to Con Edison and the NYISO rather than continuously using the plant to perform peak shaving. Scenario 2 still captures the benefits of reduced energy usage from implementing energy efficiency measures with the IBCU as well as recued ICAP costs. The additional value from selling ICAP in the NYISO Special Case Resource Program and selling Demand Response Services in the Con Edison DLRP and CSRP programs pushes the total benefit to $710,346, which is a 20% improvement over the originally intended use of the plant. The higher benefits because the plant is providing greater support to both the transmission and distribution systems than originally planned.

Conclusion

The conclusion that using the Thermal Storage Plant as a Demand Response Resource had more economic value that using it as a peak shaving device was surprising result. The recent increases in payments for supplying DR services to Con Edison played a major role in driving this situation.

Another outcome from this analysis is that less energy storage capacity is required for a given facility in order to supply only DR services (Scenario 2) rather than peak shaving (Scenario 1) in the Con Edison territory. For peak shaving, a Thermal Storage Plant must be capable of reducing load, by melting ice, during the entire fourteen hour peak demand period whereas for supplying DR services the plant needs to melt ice for only six hours. The installed cost of the plant can be reduced because less ice storage capacity is required and a chiller with less cooling capacity is required to make half the amount of ice in the same number for off peak hours as with peak shaving. By cutting the storage capacity and the capacity of the chiller to make ice by approximately 50%, the installed cost of the Thermal Storage Plant would be reduced by 40% and economic benefits to the end user as well as benefits to the transmission and distribution systems would be increased. A 40% reduction in installed cost plus the added benefits would result in a 48% improvement of simple payback.

7.2. Interoperability Project Schedule

The table below shows the project schedule. Phase 1 of the project reflects mainly the development of the protocols that would govern customer sited demand response participating in this project. It also reflects the assessment phase of the project where different sites were and technologies were analyzed and selected for the project based on their feasibility and fit for Innoventive and Verizon. Phase 2 represents the physical work of installing resources and demand response equipment and building and configuring the DRCC.

Table 1: Schedule for Interoperability Project

Interoperability Schedule - Phase 1	**587 days**	**100%**	**10/1/2008**	**12/30/2010**
Interoperability Schedule - Phase 2	**1017 days**	**86%**	**5/7/2010**	**3/31/2014**
Project Management Plan	**40 days**	**100%**	**5/7/2010**	**7/1/2010**
Interconnection Equipment	**393 days**	**100%**	**6/1/2010**	**12/1/2011**
Ice Storage Plant	**825 days**	**95%**	**2/1/2011**	**3/31/2014**
Design/Install Ice Storage Plant	**825 days**	**95%**	**2/1/2011**	**3/31/2014**
Site Selection: Review Task 10a analysis and select a site to install a	**228 days**	**100%**	**2/1/2011**	**12/16/2011**
Ice Storage Design: Develop detailed installation plan, proposed te	**177 days**	**100%**	**10/4/2011**	**6/6/2012**
Regulation Services	**766 days**	**35%**	**4/25/2011**	**3/31/2014**
Submit application to be a supplier	10 days	100%	4/25/2011	5/6/2011
Register to supply spinning reserve capacity	44 days	20%	11/18/2013	3/31/2014
Purchase / Installation of Chiller Plant	**377 days**	**100%**	**6/7/2012**	**11/15/2013**
Issue installation order	5 days	100%	6/7/2012	6/13/2012
Begin installation	5 days	100%	6/14/2012	6/20/2012
Demolition	20 days	100%	9/3/2012	9/28/2012
Deliver/install Ice tanks	22 days	100%	9/14/2012	10/15/2012
Hurricane Sandy	1 day	100%	10/29/2012	10/29/2012
Damage Assessment	20 days	100%	10/30/2012	11/26/2012
Chiller re-design	21 days	100%	11/27/2012	12/26/2012
Issue new schedule	1 day	100%	4/17/2013	4/17/2013
Review schedule w/Con Edison	1 day	100%	4/18/2013	4/18/2013
Chiller construction and installation	**186 days**	**100%**	**1/14/2013**	**9/30/2013**
MER Chiller Room, to start-up	85 days	100%	1/14/2013	5/10/2013
BMS Controls / Programming	186 days	100%	1/14/2013	9/30/2013
D Level Tank Farm / Riser	75 days	100%	2/4/2013	5/17/2013
Complete testing and commissioning of Ice Storage Plant	67 days	100%	8/15/2013	11/15/2013
Load Reduction Systems (VZ locations)	**841 days**	**83%**	**1/10/2011**	**3/31/2014**
Design / Install Load Reduction Systems	**841 days**	**99%**	**1/10/2011**	**3/31/2014**
Technical Plan	**841 days**	**93%**	**1/10/2011**	**3/31/2014**
Review all bldgs Phase 1 feasibility results w/Verizon	20 days	100%	1/10/2011	2/4/2011
Prepare plan to modify bldgs, and business case	45 days	100%	2/7/2011	4/8/2011
Test facility to confirm expected responses	61 days	100%	1/3/2012	3/27/2012
Develop day-ahead load forecasting tool as each building is ad	25 days	60%	4/23/2012	3/31/2014
Simulate Ancillary Services (AS) activation calls from NYISO, activa	**406 days**	**100%**	**5/4/2012**	**11/22/2013**
Establish communications between each DR resource and DRC	337.5 days	100%	5/4/2012	8/23/2013
Ancillary Services simulation prep	65 days	100%	8/26/2013	11/22/2013
Remote Activation	**642 days**	**100%**	**7/18/2011**	**12/31/2013**
Prepare bldgs. to respond to ICAP / SCR, AS and DLRP via remo	334 days	100%	7/18/2011	12/31/2013
Install real time meters for participating facilities	393 days	100%	3/1/2012	12/31/2013
Connect real time meters to Opto-22 gateways for telemetry	371 days	100%	4/2/2012	12/31/2013
Design / Install Load Reduction Systems (LIC Pilot)	**841 days**	**66%**	**1/10/2011**	**3/31/2014**
Review ADLRP plan created during Phase 1, then:	**755 days**	**100%**	**1/10/2011**	**11/29/2013**
Conduct marketing campaign for VG components	666 days	100%	1/10/2011	3/31/2014
Aggregate 2 buildings and demonstrate staged curtailment	209 days	100%	8/1/2011	11/29/2013
Based on the output from 2.14.b.1.3, prepare plan to modify speci	**506 days**	**28%**	**4/23/2012**	**3/31/2014**
Develop day-ahead hourly load forecasting tool	366 days	15%	4/23/2012	3/31/2014
Implement w / task orders for specific buildings	304 days	50%	7/16/2012	3/31/2014
Test bldg modifications to confirm expected responses	123 days	15%	8/13/2012	3/31/2014
Make DRCC Modifications	**841 days**	**86%**	**1/10/2011**	**3/31/2014**
Determine Requirements	**841 days**	**70%**	**1/10/2011**	**3/31/2014**
Review equip. requirements from Phase 1	5 days	100%	1/10/2011	1/14/2011
Implement direct comm'ns w/NYISO for DSASP	**490 days**	**70%**	**5/15/2012**	**3/31/2014**
Contract w/direct communications vendor	57 days	100%	5/15/2012	8/1/2012
Determine and implement data interface between vendor and	88 days	100%	8/1/2012	11/30/2012
Test interface w/NYISO	223 days	50%	12/10/2012	3/31/2014
Locate property, identify modifications	**560 days**	**100%**	**1/10/2011**	**3/1/2013**
Engineering review for construction requirements	5 days	100%	1/10/2011	1/14/2011
Architectural design of property requirements	10 days	100%	1/24/2012	2/6/2012
Issue RFQ's for Cloud-Based Siting	225 days	100%	4/23/2012	3/1/2013
Procurement / Integration / Commissioning	**136 days**	**100%**	**6/1/2012**	3/1/2013
Develop specs for hosting site	21 days	100%	6/1/2012	6/29/2012
Collect quotes from hosting sites	22 days	100%	7/2/2012	7/31/2012
Evaluate Quoations and select vendor	11 days	100%	8/1/2012	8/15/2012
Build and test hosting system with DRCC software - Dev and producti	22 days	100%	8/16/2012	9/14/2012
Facilities commissioning and test project schedule	20 days	100%	9/17/2012	10/12/2012
IT pre-commissioning and testing schedule	20 days	100%	9/17/2012	10/12/2012
IT installation and test project schedule	20 days	100%	10/15/2012	11/9/2012
Communications commissioning and test project schedule	10 days	100%	11/12/2012	11/23/2012
IP security installation and commissioning schedule	10 days	100%	11/26/2012	12/7/2012
Full facility and system acceptance testing	10 days	100%	11/26/2012	3/1/2013
Interoperability Schedule - Phase 3	**96 days**	**20%**	**11/18/2013**	**3/31/2014**
Operation and Data Gathering	96 days	20%	11/18/2013	3/31/2014
Evaluate Technical and Economic Performance	43 days	20%	1/30/2014	3/31/2014

7.3. Buildings Participating in Interoperability Project

The table below shows the location of the Verizon buildings that participated in the Interoperability project schedule. The building locations were dispersed throughout the Con Edison service territory. The table also shows the curtailable load available from each facility and whether the building was able to supply synchronous spinning reserves (SR) or non-synchronous spinning reserves (NSR). Synchronous spinning reserves refer to ancillary reserves that can be supplied at the same frequency as the electric system. Non-synchronous spinning reserves do not supply ancillary reserves at the same frequency as the electric system and thus are not as valuable as synchronous spinning reserves (SR).

Buildings Participating in Interoperability Project

Service Address	Borough	Building Name	Real-time Meter Installed (y/n, #)	Capable of Remote Auto Response	Curtailable Load (kW)	RT meter	auto start (SR)	auto start (NSR)	Total Bldgs
1095 Avenue of The Americas	Manhattan	42nd St	yes, 2	yes	1,400	1	1		1
140 West St	Manhattan	West St	yes, 6	yes	2,800	1	1		1
East 56th St	Manhattan	56th St	yes, 1	no	2,480	1		1	1
435 W 50th St	Manhattan	50th St	no	no	2,120				1
210 W 18th St	Manhattan	18th St	yes, 1	no	1,920	1		1	1
208 East 79th St.	Manhattan	79th St	yes, 2	no	1,040	1		1	1
380 Convent Av	Manhattan	Convent Av	yes	no	460	1		1	1
1 Forest Hills Av	Queens	Forest Hills	yes, 1	yes	1,020	1	1		1
118-15 115th Ave	Queens	Ozone Park	yes, 1	yes	560	1	1		1
28-27 30th St	Queens	Astoria	yes, 1	yes	580	1	1		1
11-31 46th Rd	Queens	Long Island City	yes, 1	yes	750	1	1		1
71-40 164th Street	Queens	Fresh Meadows	yes, 1	yes	380	1	1		1
140-06 183 ST *	Queens	Laurelton	yes, 1	yes	620	1	1		1
71-40 164TH ST	Queens	North Jamaica	yes, 1	yes	490	1	1		1
89-63 163rd St.	Queens	Jamaica	yes, 2	yes	960	1	1		1
9715 Christie Ave *	Queens	Corona	yes, 1	yes	230	1	1		1
87-28 109th Street *	Queens	Richmond Hill	yes, 1	yes	500	1	1		1
82-11 Broadway ENT	Queens	Newtown	yes, 2	yes	1,400	1	1		1
1775 Grand Concourse *	Bronx	Grand Concourse	yes, 1	yes	500	1	1		1
38 Avenue U	Brooklyn	Avenue U	yes, 1	yes	500	1	1		1
360 Bridge ST ENT *	Brooklyn	Bridge St	yes, 1	no	1,410	1		1	1
2111 Coney Is Ave	Brooklyn	Avenue R	yes, 1	no	450	1		1	1
43 New Dorp Lane	Staten Island	New Dorp	yes, 1	yes	450	1	1		1
					23,020	22	16	6	23

7.4. Software Requirements Development Process

Software developments were required for each element of the project and included the following requirements:

- Secure interface to Con Edison Middleware
- Secure interface to Curtailment Controller at customer location
- Secure interface to NYISO ICCP portal
- Real time telemetry of load data facility status
- Design of load curtailment algorithms and controls to modulate system loads in response to regulation set points, build TRACE model of target facility
- System must be equipment agnostic (i.e., be able to interoperate with equipment from different vendors)
- Capability of working with different types of controls at customer sites

For each subproject a set of functional requirements were developed for the software vendor. Many of these requirements were based upon business rules for demand response programs that were already in existence. Some requirements were based upon rules for programs that were either conceptualized as part of this project (such as the Automated Distributed Load relief Program) or were under development by the NYISO (Demand Side Ancillary Services Program). In some cases the rules for such programs changed, which led to an update of the functional requirements for the software.

Functional requirements were the governing documentation for how the software is to operate. In the case of the DRCC there was a benefit from building the software on top of a technology called Grid Agents which had previously been developed by Infotility as part of other projects. This was customized and built upon by Innoventive Power to create the building blocks for the DRCC software. For each subproject the software Development can be characterized as follows:

DRCC backend – Build upon Grid Agents
DRCC User Interface (UI) – Build UI based upon agreed functional specifications
ICCP Interface to NYISO – Contract with supplier of ICCP interface (SmartCloud, Inc.) including data center. Customize Interface to work with DRCC
Curtailment Confirmation Controller – Contract with controls vendor based upon functional specifications
Demand Reduction Systems – Verizon contracts with Controls vendor
Controls for Thermal Storage System – designs based upon business rules for supplying Ancillary Services and Energy Efficiency

7.5. Case Study: Supply Ancillary Services Using NY Verizon Facility

A Verizon facility located in Manhattan, NY has been registered to supply spinning reserve service in the NYISO Demand Side Ancillary Services Program (DSASP). The facility, which is a telecom switching center, occupies 4 floors of a highrise building located in Manhattan. The facility will respond to NYISO activation calls for DSASP services (initially, the facility will supply spinning reserve capacity) by switching its electric equipment to battery stations that can provide about 800 kW of load reduction and by shutting down air handler units, which increases the curtailment capability to about 1,100 kW. To prepare the facility for DSASP program participation, several changes were made in the current equipment control system including installation of several controllers and associated electronics.

FACILITY DESCRIPTION

The facility occupies 4 floors in a high rise building in Manhattan. The entire space on four floors (# 6, 7, 10, and 11) is occupied by IT equipment, and two floors are partially occupied by one power room (floor #12), and a control room and 2 emergency generators.

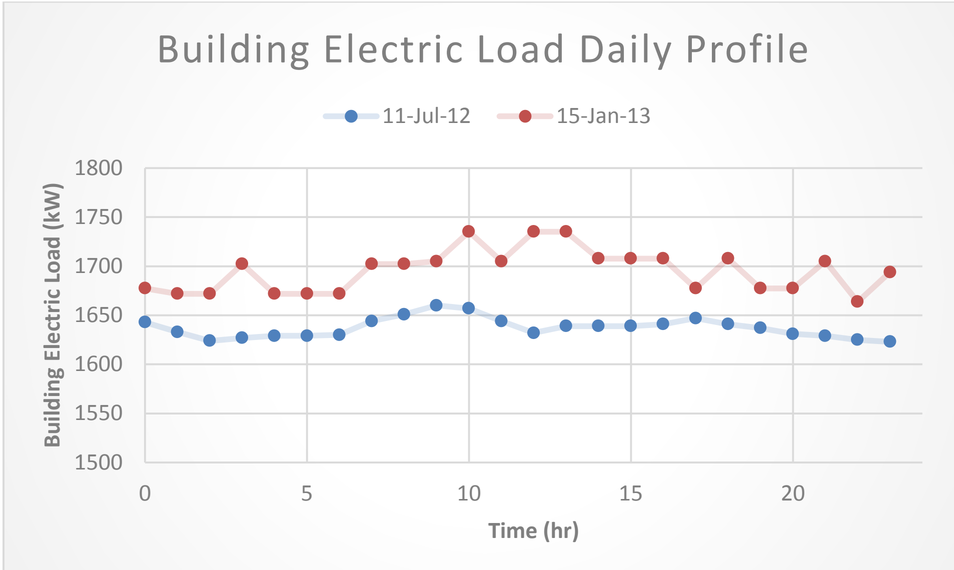
Total battery capacity (when fully loaded) can supply the entire IT equipment for 3 hours. Assuming that on average a spinning reserve curtailment event might continue from 10 to 30 min, the storage capacity of the facility battery plants is sufficient for providing reliable service for the DSASP program, as well as for the DC equipment load.

Other components of the facility electric load consist of HVAC and lighting equipment.

The building electric load is supplied by 2 commercial feeders. When the facility is switched to batteries, about 400 kW of load remains on utility power.

There are a limited number of operators at the facility with almost no office space. Therefore, the building cooling load is mostly a result of heat dissipated by the IT equipment, HVAC and lighting, with a smaller component coming from the building heat exchange with the atmosphere. As a result, the facility daily electric load profile is pretty flat. Figure 8 shows daily profiles for a typical summer and winter days.

Figure 8. Building Electric Load Daily profile

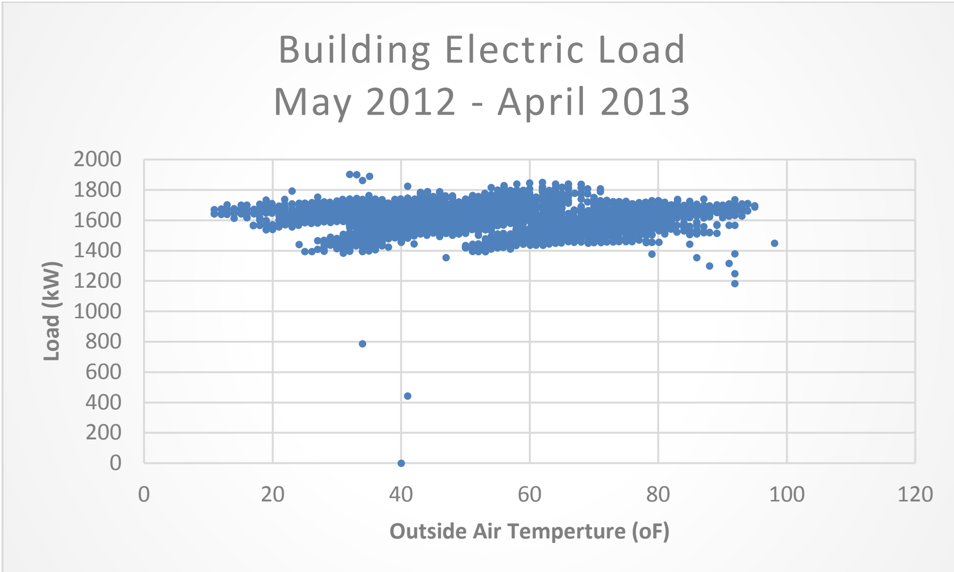


ENGINEERING ANALYSES

A detailed engineering analysis of the facility electric load available for curtailment in response to a DSASP call was conducted using facility hourly electric load records collected by interval meters during 2012 and 1013. The building electric load correlation with the outside weather conditions is presented on Figure 9. It shows that at any weather condition building electric load will not drop below 1400 kW.

Assuming that about 400 kW always stays on commercial power, it can be expected that 1100 kW can conservatively be sold for the DSASP program at any time.

Figure 9: Building Electric Load versus Outside Air temperature



MEASUREMENT AND VERIFICATION

Measurements of the total building electric load taken at a frequency of 6 seconds will be performed by real time interval meters approved by the New York Public Service Commission, meeting NYISO and Con Edison specifications. These data averaged on the hourly basis are constantly collected by the Curtailment Service Provider, Innoventive Power LLC, and are available through the Innoventive website.

The website also contains information on every curtailment event, including electric load curtailed and load remaining in utility power.

ECONOMIC EVALUATION

The following is analysis of the value of supplying Spinning Reserves in this sample facility:
The project cost calculations are presented in Table 2.

Table 4: Project Cost Calculations

Cost Component	Cost ($)
Hardware	4,411
Software	6,000
Installation	46,446
Engineering & Project Management	11,372.
Total Project Cost	**68,229**

To calculate potential project revenue, 10-minute spinning reserve prices for NY City as of 2012 were used along with the assumption that the facility can sell 1100 kW of curtailment at any time. Results for two options of celling curtailment capacity - 24 x 7 all year long or only for weekdays from 8:00 to 17:00 – are presented in Table 3.

Table 5: Potential DSASP Revenues and Project Payback Period

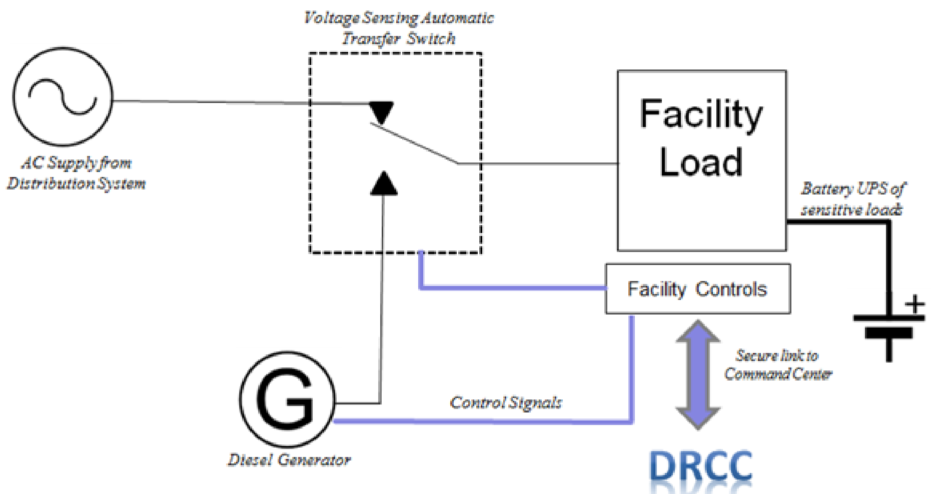
Curtailment Period	Capacity sold (kW)	Total Annual Revenue ($)	Simple Payback Period (Year)
24 x 7 all year	1000	52,249	1.31
8:00 to 17:00 all year	1000	19,616	3.47

7.6. Analysis of the Economic Performance of the Virtual Generator (VirG)

The economic value of the VirG to the grid is shown below to be greater than the cost to supply the service it provides.

A VirG is an aggregation of DR resources that are configured as shown in the figure below. Each resource in a VirG aggregation includes a real time meter, a distributed generator, and a set of remotely activated transfer switches.

Figure 10: VirG Configuration



To qualify to be part of a VirG aggregation, the facility must be able to respond to remote activation signals within 5 minutes and maintain its load reduction for up to eight hours. Such performance qualifies the VirG to supply ancillary services such as 10 minute non-synchronous reserves and Installed Capacity (ICAP) in markets administered by the NYISO. The VirG may also participate in two Con Edison DR programs, the DLRP and CSRP. Providing these services generates value for the resources while contributing to reliability of the New York electric transmission system as well as the Con Edison distribution system.

Table 4-1, shows the result of the analysis of the costs vs benefits of retrofitting a building to enable it to become an element of a VirG. The results are presented for a 1 MW element of a VirG. There is a significant average retrofit cost to a facility with existing backup generation of approximately $80,000. The $80,000 covers the cost of real time metering, associated telemetry and remote activation equipment. This retrofit cost is off-set by an income of almost $260,000/MW-year from participating in DR programs.

Table 6: Cost Benefit for 1 MW VirG Resource

	Average Retrofit costs		$80,000
Sources of Income			
	ICAP Sales	$133,392	
	DLRP	$33,950	
	CSRP	$60,000	
	Non-Synch Reserves	$32,445	
Total		**$259,787**	**$80,000**
Payback (Years)		0.27	

By supplying these services to the grid with VirG, the cost of electricity in New York City is reduced. There are two markets affected by the addition of the VirG capacity. The combined reduction in costs in the Capacity and Energy markets is actually greater than the payments to the VirG participant. The reductions in cost in the two markets are derived from:

a. Reduced Capacity costs – as each megawatt of Installed Capacity (ICAP) is added to the available capacity in the NYISO Zone J, the clearing price of capacity in NYISO administered auctions is reduced. Table 7 shows how the addition of one megawatt of capacity in New York City (NYISO Zone J) reduces the cost of capacity in the zone by about $170,000.
b. Reduced Energy Prices – Energy prices in New York are a combination of the underlying cost of energy plus the congestion cost, which is the component of the hourly price of electricity representing the marginal cost to provide the next increment of load within a transmission zone. The fixed amount of transmission capacity leads to higher congestion prices when loads increase. Table 8 shows how the addition of one megawatt of VirG capacity reduces the cost of the congestion component of energy prices by approximately $138,000.

The combined benefit of the reduction in ICAP costs and the reduction in energy prices comes to over $308,000, per year. This benefit to electricity buyer in NYISO's zone J is greater than the payments made to the supplier of the VirG capacity.

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Table 7: Impact of Excess ICAP on Capacity Prices

NYISO DATA SHOWING IMPACT of EXCESS CAPACITY on CAPACITY PRICE			
Year	**Average ICAP Price ($/kW-Month)**	**Average Excess Capacity (MW)**	**Impact ($/MW-Month)**
2012	$11.7	688	
2011	$13.5	810	
Impact of reduced Excess Capacity per MW- Month			$14.79
Zone K Peak Demand (MW)		11,500	

Annual Benefit of Adding one MW of VirG Capacity in Zone J During a summer capability period	**$170,137**

Table 8: Impact of Increased Energy Supply on Congestion pricing in Zone J

NYISO DATA SHOWING IMPACT of INCREASED ENERGY SUPPLY & LOWER CONGESTION in ZONE J				
Date	**Peak Demand (MW)**	**Daily Energy Cost per MW ($/ MWH)**	**Daily Congestion cost per MW ($/MWH)**	**Impact ($/MW-Month)**
8/1/2012	10,150	806	293	
8/3/2012	8,990	747	102	

Annual Reduced Energy/Congestion Benefit during summer capability period	**$138,149**