BEFORE THE

COUNCIL OF THE CITY OF NEW ORLEANS

IN RE: RESOLUTION REGARDING PROPOSED RULEMAKING TO ESTABLISH INTEGRATED RESOURCE PLANNING COMPONENTS AND REPORTING REQUIREMENTS FOR ENTERGY NEW ORLEANS, INC.	**DOCKET NO. UD-08-02** **AUGUST 8, 2016**

MOTION BY BUILDING SCIENCE INNOVATORS, LLC FOR ONE BATTERY PILOT PROGRAM FINANCED BY THE CUSTOMER LOWERED ELECTRICITY PRICE (CLEP) TARIFF WITHIN THE 2015 ENTERGY NEW ORLEANS INTEGRATED RESOURCE PLAN

ON MOTION of Building Science Innovators, LLC (BSI), appearing herein through undersigned principal, and upon representing the following:

A. Overview

BSI Proposes that a pilot project be initiated within the 2015 Entergy New Orleans Integrated Resource Plan consisting of 1000+, customer-hosted, CLEP, battery pilot where roughly 40% of these batteries will be owned by ENO.[1]

Battery system specifications include both functionality and prices consistent with what is currently offered by sonnen: with an average cost of roughly $15,000 per home (after the investment tax credit is applied) and a performance of12 kWh and 8 kW. The sonnen system comes with a smart inverter capable of time-shifting both energy and power as well as selling, in an orchestrated fashion, four kinds of ancillary services: Spinning Reserve, Frequency Regulation, Reactive Power and Low-Voltage Pass-through; sonnen's technology can also defer loads to outside of peak demand without even deploying energy from the battery.

This on-site battery pilot design ***anticipates*** expected volunteer participation from experience gained in a regulator-approved, battery-pilot offering in Rutland, Vermont where the roll-out began in early 2016. In that pilot, all 500 participants were residents and all received the same Tesla system (https://www.tesla.com/powerwall) which included a 6.4 kWh battery with a 3 kW relatively "dumb" inverter and at a retail price of around $7000. Both the number of cycles and the functionality of the Tesla system utilized in the Rutland battery-pilot project are inferior to Sonnen equipment. Both systems are warranted for 10 years and thus the pilot program in Vermont and the ENO pilot are for ten years.

[1] For an explanation of CLEP (Customer Lowered Energy Price) and how it is calculated, the reader is referred to the discussion in the Pure CLEP Pilot Project motion submitted by BSI into the same docket on the same day.

The Vermont and proposed ENO pilots have these four features in common:
a) Roughly 10-20% of volunteers (Group 1) purchase the battery system out-right, keep complete control of the system and receive no income from the utility.
b) Roughly 40% of the volunteers (Group 2) purchase the battery system out-right, but agree to give up almost all control of the battery system resource to the utility in return for a major monthly cash flow almost as large as what is effectively used in Group 3.
c) Roughly 40% of the volunteers (Group 3) receive the battery system from the utility at no upfront cost. In that case, each resident pays a small monthly payment as a contribution. The benefit to them is largely restricted to protection from power outages.
d) A spreadsheet for the entire pilot is included in the battery pilot proposal. That spreadsheet contains a line-item of a "negative" cash flow to support a 10% return on investment, and thereby, non-participants will not be asked to subsidize the pilot.

However, the ENO pilot will have better economics than the Vermont pilot because it will allow customers, who agree to accept the CLEP tariff, to enhance the cash flow coming back to them by any combination of
i) adopting a different lifestyle containing a different time-of-use consumption profile,
ii) investing in "traditional" energy-efficiency retrofits,
iii) purchasing PV equipment on-site or remotely connected[2], and/or
iv) investing in "non-traditional" retrofits that facilitate time-shifting of consumption without interfering with "normal-time" energy service "consumption".

This ENO CLEP customer pilot will **also** be open to other customers who want access to the CLEP tariff. These may be residential, commercial or industrial customers. They need not purchase batteries. There will be a limit on the size of this group; perhaps this pool of customers will be limited by a total consumption and demand comparable to no more than 100% of the fully-subsidized, aggregated, residential group (Group 3).[3]

Obviously, the lion-share of the investment by ENO will be to purchase and support the 40% fully-subsidized residential component; currently envisioned to be on the order of $6 million.

"Fading fast is the decades-old dictum that electricity is the one commodity that cannot be stored, thus necessitating the continuous adjustment of supply resources, through the precise operation of multiple generators, to match the sum of all customer demands. A new precept is rapidly replacing that conclusion, holding that substantially increasing energy storage resources either are already, or inevitably soon will be, capable of producing and delivering cost-effective solutions to many electricity infrastructure and operating needs." To see a snapshot of Energy Storage activities in 24 different states at the onset of the 2015 ENO Integrated Resource Planning process, see Appendix B.[4]

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[2] BSI is also simultaneously submitting a CLEP Community Solar Pilot sized at at least 1 MW. Participants in the battery pilot will be urged to also buy or rent 1 kW of that farm. This will have the dual advantages: 1) the net first capital cost to residents from owning the battery and 1 kW will be lower than just owning the battery after the federal Investment Tax Credit is applied and 2) the economics of battery ownership tied to solar enhances the economic performance of both. Since both pilots utilize the CLEP tariff, the customer will benefit from both cash flows in an integrated fashion.
[3] However, as mentioned in the "Pure" CLEP pilot description, non-residential customers will have to established eligibility for the CLEP cash flow by submitting a custom proposal of how CLEPm's avoided demand will be measured and why the appropriate coefficient should be whatever is asserted; once approved for CLEP, such non-residential customers will be accepted.
[4] "Envisioning State Regulatory Roles in the Provision of Energy Storage," Tom Stanton, Principal Researcher, Energy and Environment, National Regulatory Research Institute, Briefing Paper No. 14-08, June, 2014.

B. **<u>Proposed Specifications for the Battery Pilot Program</u>**.

TO MAKE OPTIMAL SENSE IN READING THE FOLLOWING, PRESUME THAT THE FOLLOWING WAS WRITTEN BY ENO AND THEREFORE, THE FOLLOWING IS IN EFFECT A SUBMISSION BY ENO TO THE NEW ORLEANS CITY COUNCIL AS A REQUEST TO RUN A BATTERY PILOT. Because ENO is not originating this pilot request, BSI wrote the description as a motion to request the regulator to require ENO to revise the following and create a pilot program with the following as a starting point.

ENO will begin offering Advanced Battery 12 kWh systems as part of an integrated package of energy storage appliances (IPESA) to its customers on a pilot-basis on or after January 1, 2017.

These exciting innovations in distributed energy storage technology are part of ENO's mission to deliver cost-effective, low-carbon and reliable energy solutions for its customers. Each IPESA installation will be custom-configured to each home.[5] The Advanced Battery 12 kWh system- IPESA will improve customers' reliability and resiliency while at the same time empowering that customer to save money and be part of a radical transformation in how energy is generated and stored. It should be noted that the added resiliency is particularly important for the livability and economy of the City of New Orleans as a whole after inevitable major storm events. The improved resiliency will allow residents to return earlier and resume their lives quicker and accelerate the City's recovery from major storm events. ENO is the first utility to offer such an IPESA with an Advanced 12 kWh battery to its customers and ENO believes this unique offering will advance energy policy and move New Orleans to the cutting edge of innovation.

For most (but not necessarily all) customers in the pilot(s), the IPESA is a necessary but not sufficient ingredient in the pilots. **CLEP** is a requirement of the pilot. This battery pilot has a companion community solar pilot described in an accompanying document; the economics of each are enhanced by the other. **CLEP** is a requirement in the community solar pilot as well.

About the Advanced Battery 12 kWh-Backup System

Advanced Battery's 12 kWh system (may) include a rechargeable lithium-iron-phosphate battery with 8 KW of power (unlike Li-ion, it has no tendency to catch fire) designed to store energy at the residential level with several benefits:

(1a) **<u>Backup Power</u>** — *the batteries can provide back up to critical loads in the event of an outage for as long as a week[6] or up to several weeks when paired with rooftop solar*
(1b) Unlike most alternative back-up systems, Advanced Battery's system can also schedule orderly shutdown of loads during the onset of a power outage in a manner dependent upon both the depth of discharge of the battery bank and the nature of the power outage. Namely, Advanced Battery's equipment is not limited to a binary "all loads" or "critical loads" option; instead, it can progressively change in steps from full reliability to powering only critical loads. Moreover, these steps can be programmed-in according to whether it is an unexpected outage or caused by a predicted, major storm event. In the latter case, the Advanced Battery equipment will immediately shift to "critical loads only" in order to maximize the duration of resiliency.

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[5] ENO will be encouraging customers to also purchase GE's WIFI-Connect™ appliances as well as ice-making HVAC equipment referred to in the Pure CLEP pilot's motion submission. Financing may be provided in a manner similar to what is done in Energy Smart for the GE GEOSpring™ heat pump water heater already in that category.
[6] Resilience duration will vary depending on the size of the critical loads it serves and the size of the battery bank.

The value of electricity reliability to the customer was estimated in a 2011 PEPCO survey to exceed $500/year per residence and more than four times that for the average commercial customer.

BSI notes that on first view of the avoidable costs of the utility, in the case of widely-distributed, consumer-sited backup power systems, it would seem that ENO has no avoidable cost. However, in fact this is far from true. In such a case, there are multiple streams of avoidable costs:

a. Avoiding the NERC, National Electricity Reliability Council, standards is possible assuming that the battery system accommodates what the utility does not provide;
b. Avoiding MISO's reserve capacity requirements; and
c. Avoiding retrofitting and/or "hardening" the grid as consistent with the proposed, January, 2016, $30 million ENO pilot program to replace a few hundred power poles.

It might be, in the future, given well-distributed or even mandated by building codes battery systems in all buildings, that these responsibilities for 99+% reliability will have been completely or largely shifted from the utility to the building.

(2) **Load Shifting** — the batteries can provide financial savings by charging during lower-priced "off-peak" periods and discharging during higher-priced "peak" periods when demand for energy is greater.

Cash flow (2) and cash flow (3) were all that were considered to justify the successful request in 2015 by Green Mountain Power of its regulator for a 500 battery pilot in Rutland Vermont (attached).

Also called Energy Price Arbitrage, load shifting (as just defined) can be projected to generate income, i.e., avoided costs of the utility, at around $50-100/year. Avoidable costs for a utility from well-planned or utility orchestrated drops in demand provided by peak reduction from the battery discharge and/or load deferral (to be defined in 3 and 4 below) can easily be worth ten times as much as energy price arbitrage to the utility. [These are the obvious cash-flows of CLEP5 and CLEPm, respectively.]

(3) **Peak Reduction** — the batteries can be dispatched at specific times to coincide with the monthly ENO and Entergy system peaks as well as the annual MISO peaks. In doing so, ENO will reduce its overall contribution to these peaks thereby reducing capacity and transmission costs for customers.

(4a) **Load deferral** — even when there is no grid power interruption, the battery system can temporarily shut-down non-critical loads, i.e., less time-sensitive loads like clothes dryers, dishwashers, and water heaters, during times of peak demand of the utility. This can provide great economic benefit for the utility at times when the utility is challenged to meet high demand.

(4 b) **Partial load deferral** — this similar to 4a but would allow remote control of special and highly power-intensive energy services: e.g., a refrigerator's defrost cycle can be turned off without turning off the cooling machine. Similarly, AC equipment can be set to only circulate air or only do dehumidification. In these cases, advanced battery's control functions will be utilized to command functions of specially installed energy service equipment provided by other vendors.

5) **Additional Load on demand** — is a kind of "negative" demand response that can help a utility deal with either unexpected or expected periods of over-capacity. For example, the Geospring water heater can be remotely controlled to overheat its water from 120F to as high as 170F. This can allow the utility to avoid running plants at partial power or dumping excess energy produced by base-loaded plants. To perform this function, the control signal can be directly facilitated by the GE equipment's control cloud or indirectly controlled with the advanced battery's cloud. Orchestrated electric vehicle charging can fall into this category. **Additional load on demand** is economically very similar to electric price arbitrage and should generate income at a similar rate.

6) **Selling ancillary services to the utility or the wholesale electricity marketplace**— is done by aggregating stored capacity; utilities can increase voltage and frequency support to minimize power losses for customers during extreme weather or peak demand events. Reactive power can also be an output of the smart inverters that Advanced Battery sells. Purposely injecting negative or positive reactive power can be used to help resolve problems with poor power-quality on individual feeders.

In the recent past, the PJM wholesale electricity marketplace provided a cash flow for purveyors of frequency regulation support, the projected cash-flow provided by a 20 kWh battery system can exceed $1500/year. Preliminary research suggests that this opportunity currently has negligible value in MISO, the wholesale marketplace of ENO; but that could change within the 10-year span of the pilot. Even if MISO is not "ripe" for this transaction, what are the costs of providing clean power or voltage support within ENO? Experts assert that these services can be provided by batteries at costs typically lower than alternative technologies.

7) **Bidding directly into the wholesale marketplace** — is the capability of aggregating 100+ kilowatts of curtailed demand within a single defined region, and earning capacity and wholesale payments through bidding resources directly into day-ahead wholesale markets at a price that can beat the daily wholesale energy prices. This is expected to generate income considerably in excess of over $500/year per system.

(8 a.) **Smoothing of Solar 1** — when aggregated as part of a micro-grid network, the energy storage can be controlled to reduce the grid impact of solar intermittency.
(8 b.) **Smoothing of Solar 2** — when aggregated as part of a micro-grid network, the energy storage can be controlled to reduce the tendency of solar curtailment (expected at 10 AM with 20% PV penetration).
(8 c.) **Smoothing of Solar 3** — when aggregated as part of a micro-grid network, the energy storage can be controlled to reduce the height and slope of residual utility peaks after sunset.

The economic value of smoothing solar is highly dependent upon the percent of PV penetration in a utility market; when the percent of penetration is below 5%, smoothing solar has negligible value to a utility. However, as the percent of PV penetration increases above 5%, a lack of cheap batteries has been shown to allow PV energy value to drop linearly from its initial value to less than half of that when penetration is 20%. This effect impacts all PV installation whether or not they were first or last to be added to the grid. Currently, ENO does not have sufficiently deep PV penetration for this to be an issue at this time. However, this may soon become an issues because ENO has 36 MW of rooftop PV within its system that has a total peak demand of around 1800 MW, i.e., current PV penetration is around 2% of total peak demand.

9. **Solar Conservation (a.k.a. Zero Export Capability)** — when aggregated as part of a network of nano-grids[7], the energy storage can be controlled to reduce the percent each solar system exports to the grid.

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[7] BSI would like to properly choose the name "nano-grid" or "micro-grid", however, the notion that each separately controllable and "islandable" component is the size of a single building or residence does not seem to fit either category. A home is too big to be a nano-grid and too small to be a micro-grid; perhaps residences in this pilot should be called "***Vishu***-grids" because of a story in the Hindu religion that relates Vishu's power within "one ten-millionth" of a material's substance.

In the case of regulations that push back on Net Energy Metering (NEM) rates, solar conservation can be valuable. In such a case, the value of Solar Conservation to the customer increases with the percent of PV energy that that customer had been sending to grid. The current ENO Integrated Resource Planning process is looking closely and reviewing NEM in a manner that may be progressively averse to a retail customer with a higher percent of PV energy exported to the grid. BSI considers that **solar conservation** is probably not the most economical way to use batteries because it unnecessarily stores power that can be immediately utilized by neighbors on the same grid. BSI believes that this problem is best handled with a smart tariff like CLEP rather than with draconian restrictions and extra charges like those imposed in Hawaii, Arizona, Nevada and under consideration in other jurisdictions. It can be argued that ENO has net-metering and therefore sees no concern or costs to be avoided. However, the extensive arguments within the Net Energy Metering Workshops held by ENO during the Spring of 2016, show that "Cost of Service" arguments indicate that customers with large PV systems compared to their demand present economic problems for the utility. If so, what is that cost? Can that cost be avoided with CLEP? If so, then the lost income from such customers can be avoided. This is relevant to CLEPm's valuation.

10. **<u>Buying Zonal Resource Credits ZRC</u>**. A requirement of ENO membership in MISO includes that ENO's projected supply should meet ENO's projected demand. ENO can accommodate this deficiency by any of the following: decreasing demand, increasing supply, or purchasing adequate ZRC which accomplish the same goal. Although ENO has a 100 to 200 MW short-term projected shortfall in supply, MISO's capacity market is currently severely depressed. Therefore, this predicts poor payment to battery owners. However, the capacity market could easily become quite substantial within the 10-year window of the pilot which would make this cash flow significant.

* * *

CLEP will provide the cash flow to support this pilot.

Although specifically requested from ENO in a data request by BSI filed in June, ENO has not provided any estimate of the value of avoided costs associated with the above customer-side energy/demand consumption/production activities. In the absence of that data, BSI asserts that the best surrogate of that information is the CLEP tariff using CLEPm's coefficient set at $57.60.
Payments for CLEP5, i.e., buying energy when it is cheap and/or selling it back to the grid when it is more valuable is important, but is not likely to generate income exceeding 5% of the average customer's annual energy bill and thus around $50/y for the average customer.[8]

The real money needed to support a battery pilot is in the CLEPm payments: Assume that a target home has a reference home with an average 5 kW demand during peak hours during the peak demand months. Increasing CLEP payments depends primarily upon how effectively the target home's averaged demand during peak-hours decreases. CLEPm is the difference between observed reference home demand and target home demand, **d**, multiplied by the factor of $57.6/kW-month during the months of May through September. If in the target home, by use of the battery equipment, other equipment and efforts by the consumer, has an average demand during peak hours during a cooling-season month of 2.5 kW, then **d** = 5 kW – 2.5 kW = 2.5 kW.

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[8] However, CLEP5 may be much more lucrative. BSI learned less than 3 days before submitting this motion that testimony in a regulatory environment for a utility operating in the northern part of MISO's territory asserted that "optimized" price-arbitrage can pay for relatively more expensive and relatively less efficient batteries than those specified in this CLEP battery pilot in four years: i.e., in about 40% of their warranted life.

This pilot program does not guarantee a minimum CLEP payment to any pilot participants but will utilize the battery system to minimize demand during peak hours.

To maximize income for battery owners whether consumer-owned or utility-owned, the battery system should be controlled to minimize demand and/or maximize supply back to the grid during peak hours.

Because the average home in New Orleans uses around 30 kWh a day and has a 5 kW average demand during peak hours and somewhere around 50% of the energy is consumed during utility peak demand times (2 PM to 7 PM), a 12 kWh battery system is probably too big **because** it would easily avoid almost all demand during peak hours. Although such a battery will save 5 kW on average, this savings is done at too high a cost of battery resources and does not provide optimal additional economic opportunity for the customer.

Advanced Battery makes smaller and larger systems starting from 4 kWh and ranging up to 20 kWh.

Although some customers with average demand and consumption will want 12 kWh batteries, this is not the most economical way to deploy batteries and it will probably forestall deepest exploitation of CLEP income against the cash flow needed to pay back the capital cost of the batteries. [9]

In fact, the most economical and best fit to maximize opportunities for customers to both pay for the battery system (and possibly make a small profit) is to choose a battery size that is slightly too small to avoid half of the demand during peak hours. This means that some homes will choose to install systems as small as 4 kWh and other homes will choose systems as large a 20 kWh. BSI thinks that average battery size will be 12 kWh for all homes in the pilot and continues the discussion with that assumption.

In this case, the home's reference home will have a 10 kW average demand during peak hours and the battery system will accomplish **d** = 5kW. That is, with the battery system working hard to minimize demand, the cash flow will be (5kW for each month) * (5 months eligible for CLEPm payments [May through September]) * $57.6 = $1420 /y. Together with the CLEP5 payment, the cash flow is just about $1500 / y which will provide just enough to pay off the cost of a $15,000 Battery System in ten years.

BSI is firm believer that customers should be rewarded or charged for well-timed consumption and negative demand in the same month that it is earned in order to optimally influence customer responsiveness to economic opportunity. Therefore, the CLEPm payments will be paid in the next bill from May until Sept, while the CLEP5 payments will be made every month.

However, for the purposes of generating a spreadsheet and continuing this analysis, the $1500/y will be divided by 12 to make a projected monthly payment of $125.

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Advanced Battery manufactures the 12kWh storage system to be optimized for pairing with solar or standing alone and can be cycled roughly three times a day to provide a number of benefits to the customer and to the grid. ENO will provide the 12kWh system paired with a bi-directional, 8KW inverter, which is optimal for both pairing with solar or standing alone and charging directly from the

[9] This comment is more fully explained at the bottom of this document among the bulleted list that explains the spreadsheet.

grid. The Advanced Battery 12 kWh system comes with a 10-year, 10,000 cycle warranty, and Advanced Battery will take back and recycle the 12 kWh systems at the end of their useful lives. The 12 kWh rating of the battery is rated for 100% discharge and recharge. The cabinet system design has a compact, sleek, and modern appearance which is suitable for the inside of your home.

Advanced Battery Cloud-based Energy Management Software provides a Utility level API which provides visibility into usage and performance data for single and aggregated systems to help utilities achieve their energy management goals.

Key features of the Advanced Battery equipment are its abilities to both dispatch the batteries **and** orchestrate most of the energy demands of the home when either the battery output and/or the avoided energy demands of the home provide the most value to the utility. Control of the IPESA will be done through software and the Advanced Battery cloud that comes standard with the Advanced Battery inverter as part of the 12 kWh package. For most residents, the IPESA is expected to create a stream of utility cost savings sufficiently large to completely finance the IPESA equipment.

The Advanced Battery and Inverter System Will Be Used to Lower ENO's Power Supply Costs
ENO's ability to control the Advanced Battery system provides a unique value stream that will lower power supply costs. During normal (i.e., non-outage) conditions, ENO will have the ability to control the charging and discharging cycles of the batteries as well as load deferral and additional load services (as described above). For customers who agree, this will enable ENO to:

A) Discharge batteries and lower demand of the home’s appliances during (1) times of high market prices to help lower its energy costs, and (2) times of peak load to help reduce significant capacity and transmission expenses.
B) Increase demand to help consume excess utility capacity.
C) The utility can also make use of the ancillary services that the battery and smart inverters can provide. Those savings will directly benefit customers.

As described below, in this Pilot, ENO seeks to return this significant value back to participating customers as a credit on their utility bills which can be used to completely offset the price of the 12 kWh battery system in exchange for allowing ENO to control the system during critical or peak times or any other time that minimally affects customer needs and provides valued avoided costs to the utility.

Pilot Offerings
Advanced Battery announced ENO as its first utility partner and one of its four highlighted 12 kWh distribution partners in September 2016. Since then, we have heard from many of our customers asking to be on the waiting list for our first round of 12 kWh batteries. This has provided the opportunity to ask our customers what they want.

Some customers may want to purchase the Advanced Battery systems outright and maintain sole access to the battery for continuous use. Other customers may wish to include the Advanced Battery systems with new home or retrofit construction and still fully owning the 12 kWh system, although open to giving ENO some level of access to the 12 kWh battery (in other words, they don't need the 12 kWh to be operating continuously). Finally, another category of customers includes those who do not want to incur the upfront cost and for whom extensive sharing access is more acceptable. This was the experience of Green Mountain Power in the end of 2015 in preparation for their 500 home battery pilot currently rolling out in Rutland, Vermont. See footnote.

We have designed three pricing options with these categories of customers in mind:

Pricing and Sharing Options		First Cost to Customer*	Cost / Month	Average Monthly Bill Credit from CLEP
Option 1:	Direct Sale w/ no ENO access	$18,200	$0	Variable and not really relevant.
Option 2:	Direct Sale w/ ENO some shared access	$18,200	$0	$125***
Option 3:	Utility buys w/ ENO primarily controls	$0	$44**	$0

*Price calculation: advanced battery's price (MSRP) for the 12 kWh is $18,750. 25% discount from Advanced Battery for block sales in excess of 200 at a time yields about $14,000. Louisiana and Orleans Parish Sales taxes add up to just under 10% or $1,400. A 20% surcharge to accommodate ENO's cost to run the program is $2,800. Thus the total charged for the Advanced Battery equipment per customer is $14,000 + $1400 + $2800 = $18,200. The federal Investment Tax Credit (ITC) can be applied to all of these costs for a 30% discount. Supposing that eligibility for the ITC requires a minimum size for PV ownership of 1 KW and this can be purchased from a Community Solar enterprise at $3/W, the additional cost of this solar equipment would be $3000 + 300 in sales taxes. Therefore, the total equipment available for the ITC would be 30% of $14,000 (Advanced Battery battery) + $2800 (ENO's 20% add on) + $1700 (sales tax) + $3000 (PV investment) = $21,500, or $6450. Therefore, for homeowners with adequate federal tax obligations, the net cost of the system and minimal solar equipment would be $21,500 - $6450 (ITC) = $15,050.
** This monthly charge is very likely to rapidly decrease to zero in less than ten years as pilot customers more and more fully exploit CLEP.
*** This cash flow is likely to increase substantially above $125 as each customer more and more successfully exploits CLEP.

OPTION 1: Direct Sale of Battery — Customer Maintains Full Access

Under this first option, ENO will sell the 12 kWh battery and bi-directional inverter to the customer outright and the customer will maintain control of the ***Advanced Battery system***. The cost to the customer will be $18,200*, which includes the 12kWh battery, bi-directional inverter, sales tax, and a 20% mark-up covering ENO costs as well as provide a small margin that will flow back to all ENO customers as a discount in rates. Under this option, the customer in the pilot will have the responsibility to cooperate with ***Advanced Battery certified installers*** and ENO personnel to install and maintain the 12 kWh units, subject to Advanced battery's 10-year warranty; the cost of installation, maintenance and customization is included in the price. However, such customers are strongly encouraged to buy into a PV system for at least 1 KW; in that case the total cost minus the Federal Investment Tax credit become $15,050.

This option is designed for customers who want to purchase the 12 kWh battery outright and who wish to maintain access to the battery, for example, pairing the 12 kWh battery with solar without limitation.

ENO's preliminary projection is that of the 1020 homes in the pilot with 12 kWh battery units, approximately 200 units will be sold under Option 1.

OPTION 2: Direct Sale of Battery — Customer Shares Access
Under this second option, ENO will sell the 12 kWh battery system and bi-directional inverter to the customer outright and somewhat share access to the 12 kWh system with the customer (as described above). The cost to the customer will be the same $18,200 (or $15,050 for those who also buy 1 KW of PV), which includes the 12kWh battery, bi-directional inverter, sales tax, and a 20% mark-up covering ENO costs as well as provides a margin that will flow back to ENO customers in rates. Under this option, customers will receive a monthly bill credit of 95% of $125, which represents the value coming from avoided utility costs as described in items 1 through 10 above but spelled out in the CLEP discussion that followed items 1 through 10. As in option 1, the customer in the pilot will have the responsibility to cooperate with ***Advanced Battery certified installers*** and ENO personnel to install and maintain the battery system, subject to Advanced battery's 10-year warranty.

In this scenario, ENO is assuming that the batteries are dispatched to harvest 90% of the opportunities listed in items 1 through 10, above.[10]

This option is designed for customers who prefer to purchase the system outright and who are able to share access to the battery. ENO's preliminary projection is that of the 1020, 12 kWh units, approximately 400 units will be sold under option 2.

OPTION 3: Rate Rider Option — ENO primarily controls batteries
Under this third option, ENO installs, owns, and maintains the 12 kWh units, subject to Advanced battery's 10-year warranty. The pricing structure under this option is similar to how ENO charges for street lights. The customer pays nothing up-front for use of the 12 kWh units in their home and is charged a daily adder to their residential rate, reflecting the depreciated cost of the battery less the power supply savings value of ENO sharing access to the battery and using it to manage loads (i.e., all items listed in 2 through 8 above). The customer will also commit to stay on this rider for 10 years, representing the useful life of the 12 kWh units.

For purposes of the initial pilot, we have estimated the net daily adder as follows: Using a standard cost of service model, we determined the revenue requirement for a fully installed 12 kWh system. This resulted in a daily adder to a residential customer of $44 per month. (This information was indirectly calculated by the accompanying spreadsheet.)

This option is designed for customers who prefer no upfront cost and who are able to extensively share access to the 12kWh system.[11] This "rider" option, including details regarding disconnection and other customer service issues, is set forth in additional detail in the attached spreadsheet.

ENO estimates that of the 1020 pilot 12 kWh units, approximately 400 units will be installed under Option 3.

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[10] These values reflect ENO's preliminary projections regarding our ability to dispatch the batteries in tandem with energy price and demand peaks. The estimates take into consideration some variability in communication systems, battery control systems, and the ability to successfully predict the peaks.

[11] ENO assumes a higher success rate at hitting the energy price and demand peaks for the rate rider as opposed to the direct purchase option. This is caused by the fact that ENO will own the assets under the rate rider option—thereby providing greater certainty of status and condition of the battery system

Timing and Scope

In December 2016, ENO will test the 12 kWh units with approximately four sets of 5 customers each: located among 1) recent Energy Smart customers with deep energy-efficiency retrofits, 2) customers with very nearly exactly 5 KW of rooftop PV, 3) customers within the "Make it Right" neighborhood, 4) as well as approximately 5 customers located in areas that experience a relatively high frequency of outages. This "pre-pilot" activity will be done at no cost to the initial 20 customers.[12]

By January 2017, ENO expects to receive its first shipment of 100, 12 kWh units, with approximately 200 to follow on a monthly basis until ENO takes receipt of approximately 1020 12 kWh units. ENO will make 12 kWh units available on a first-come, first-served basis.

To start, ENO seeks to accomplish the following as part of this Pilot:
1. Sell a portion of initial 12 kWh stock as a simple resale to customers;
2. Enroll customers in the new Residential Rate Rider;
3. Work with homebuilders and solar installers to package the 12 kWh units into a new home build, retrofit or new solar-install;
4. Improve CAIDI & CAIFI[13] (https://en.wikipedia.org/wiki/CAIDI) reliability metrics for customers that install an Advanced Battery 12 kWh units; and
5. Demonstrate ENO can successfully control 12 kWh units and reduce energy, capacity, and transmission costs.

The 12 kWh units Advance New Orleans' Stated Goals

The 12 kWh system offering will help advance stated goals. First, the 12 kWh units provide a clean alternative back-up power solution for customers that would otherwise rely on a fossil-fuel generator. Second, the 12 kWh units represent an innovative, dispatchable resource that can be used during peak periods to help reduce ENO's power supply costs, which lowers costs for all customers. Third, the 12 kWh units can aid in the significant development of distributed energy resources consistent with New Orleans' commitment to the April 22, 2016 Paris accord on Global Climate Change. Specifically, dispatch control of the 12 kWh units can be used to help smooth grid impacts caused by a high penetration of solar energy, potentially avoiding more expensive, traditional grid upgrades. In similar fashion, dispatching the 12 kWh units in the New Orleans area will contribute to improving the reliability of 46kV sub-transmission network during system contingencies. This dovetails neatly with ENO's Energy Smart Plan that was filed with the New Orleans City Council in April 2016 and can be used to forestall the need for distribution system (power pole) upgrades estimated to cost $30 million in a pilot program described by ENO on January 28, 2016.

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[12] 20 initial 12 kWh units are not included in the financial modeling in the Appendix A spreadsheet.

[13] Although the typical reliability index for a utility is the "system wide" reliability metric, 'SAIFI' (https://en.wikipedia.org/wiki/SAIFI), because we are monitoring the impact of the 12 kWh units on the individual customer, we will be tracking the customer-specific metric, 'CAIFI' for both the reduction of the frequency and duration of power outages as perceived by each customer in the pilot(s).

Summary of Projected Costs and Revenues
Direct Sale — The costs and revenues shown in accompanying spreadsheet are for 600, 12 kWh units sold in year one. These figures assume that 400 of the 600 customers will allow ENO extensive control of the 12 kWh units. The monthly bill credit described above is factored into these projections.
Rider — The costs and revenues displayed in Appendix A is a ten-year projection for the 400, 12 kWh units that ENO expects to deliver as part of the rate rider option. It reflects the ten-year useful life of the 12 kWh units. Initially, the expenses exceed the costs due to the fact that capital expenditures impact rate-base more significantly in the first few years; however, starting at year 9, the 12 kWh units have depreciated to the point where the revenues exceed the total expenses. The accompanying spreadsheet assumes all 400, 12 kWh units are installed halfway through the ENO fiscal year.

Energy Smart Non-Conflict Explanation and Collaboration Certification
By this filing, ENO certifies that the Advanced Battery Pilot does not conflict with work being performed by Energy Smart. ENO has discussed the scope and objectives of this pilot with the administrators Energy Smart, (ENO's DSM program) and Energy Smart is supportive of the Pilot.

Status Updates
ENO proposes to provide status updates to the Utility Committee of the New Orleans City Council regarding the Advanced Battery Pilot's progress on a six-month basis until the pilot expires in 120 months. In the event ENO decides to terminate the Pilot prior to the passage of 120 months, it will provide prompt notice to Utility Committee.

WHEREFORE,
BSI moves the City Council approve a battery pilot program financed by the Customer Lowered Electricity Price (CLEP) tariff within the 2015 Entergy New Orleans Integrated Resource Plan.

RESPECTFULLY SUBMITTED,

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Myron Katz
Director of Research
Building Science Innovators

Appendix A.
The following discussion helps to explain the accompanying spreadsheet of battery cash flows, i.e., appended Excel document.

ENO Advanced Battery Pricing captures the following components not shown in the table below:

- 10% Sales Tax
- 2% A&G (Rate Rider Option Only)

  ENO includes the following additional expenses in the program as explained below:
- Other O&M

  Captures an expected cost per unit in year one to roll out the pilot, and an estimated maintenance cost for an expected 5% of units each additional year
- Additional A&G

  Captures a general ENO overhead cost including a 2% escalation for the duration of the pilot.
- The "Return on Rate Base" row is calculated as negative (and thus displayed in red) in Appendix even though this a clearly a positive cash flow to the utility, because one of the purposes of Appendix is to demonstrate to the utility regulator that all costs and cash flows of the pilot are accommodated within Appendix. Therefore, the non-participating utility customers will see no negative impact upon their bills from having to subsidize the battery pilot. This means that the more than $4 M in this row looks like a cost, but is in fact a fully-funded payment to the utility of the same amount.
- Power Supply Benefit of ENO Control is estimated at $1500/year per system on average. This is estimated as $80 from price arbitrage & from accepting load on demand, $1420 from avoiding demand during peak demand hours, and $0 bidding onto the wholesale marketplace and $0 from the avoided costs of providing ancillary service.
- Red numbers in the spreadsheet means negative values, black positive. During the 10-year pilot, ENO will have to invest a total of almost $6 million. During the very first year, ENO makes a $1.3 profit; but the investments must continue. By the end of the 2nd year they are almost $6 million in debt. ENO recovers its investment via cash flows of depreciation and return on investment, as well as, the positive cash flow from CLEP. Because of the need to convince the utility regulator that the pilot's cash flow avoids sending costs to non-participants, the first two of these are depicted as red (and counted as negative) while the third is black. Eventually the positive cash flows from avoided costs from CLEP catches up to bring the whole investment to paid off; this is likely because the first two must decline to almost zero during the 10-year pilot while the CLEP income is presumed to hold steady at $1500/y per participant. In the meanwhile, all consumers get more reliable electricity and the opportunity to deeply benefit from CLEP. If many customers deeply benefit from CLEP, the monthly $44 can be reset to much smaller amounts and may even go to $0. This is a great benefit to low income customers. As the cash flow improves, peak demand rapidly drops.
- In this discussion the phrase "deeply benefit from CLEP" is repeatedly used. To explain this, consider that the model must make conservative assumptions about what will happen when a customer starts to see the new entry on their bills from the CLEP tariff. All customers will see this entry whether they are in the Group 1, Group 2 or Group 3 of battery recipients. In the Group 1 and Group 2, the CLEP income will actually be added to the utility bill as a credit no matter how small or large. In Group 3, the CLEP income will not affect the customer's net energy bill unless the CLEP tariff's effective income exceeds the rate of 1/10 of the battery

investment for that home; in that case, the net effect on the bills of consumers in Group 3 will be the CLEP tariff's annual income minus 1/10 of the battery investment. For example, suppose a low to moderate income resident has a home with annual energy consumption of roughly 8000 kWh and an average demand during peak hours of roughly 4 kW; such a home should probably be fitted with a battery system of 4 kWh hours. By using the pilot's average cost of battery systems of roughly $1500/kWh (even though if that same resident were to go to the marketplace to purchase the system as an individual, the retail price would be over $2000/kWh), that customer's battery system is "deemed to have a retail cost of" $6000; therefore, annual CLEP income exceeding $600/y will create a credit on the bills. If the annual income from CLEP is below $600 a year, the resident will see no effect on his bills; however, if the CLEP income were $700 in one year, the net credit would be $100 for that year. I call "deeply benefit from CLEP" any net income to the customer in the third group or equivalently, any annual CLEP income in the first two groups that exceeds 1/10 of the cost their battery systems. The spreadsheet assumes that each customer on average will merely reach parity and generate a CLEP income sufficient to pay for the battery system in 10 years. If, as BSI suspects, the CLEP tariff is actually transformative by design, many to most customers will see the opportunity and work to deeply exploit this income opportunity. As that happens more and more customers will "deeply benefit from CLEP" and the cash flow to Entergy will more rapidly turn the spreadsheet from red to black. As this happens, Entergy's first job will be to reduce the $44/m charge for the 3rd group until it hits zero. Customers in all groups will start to see higher and higher CLEP income and while they are at it, the pilot will prove that this market-based tariff can quickly reduce peak demand and do this without subsidies.

- On the other hand, it may be the case that a number of customers in Group 3 will be free-riders and ignore the CLEP entry because it is not really affecting their bills; if this is predominant and significant, these customers can cause a significant deficit in the projected cash flow. However, the utility can largely protect itself against this possibility because it has control over the battery systems in those homes.

The spreadsheet is left as a separate file so that the reader can better study its formulas. It is called: PilotCashFlowOver10years-v3.xlsx
If printed, the spreadsheet belongs here as a table.

Appendix B Energy Storage Initiatives Active in 24 different States During June 2014 [14]

State/ Territory	State/Territory Storage Activity Type									
	Active Dockets	**Completed Dockets**	**Demos, Pilots (#)[1]**	**IRP**	**Proposed Legislation**	**Microgrids (M), Plug-In Vehicles (PEV)[2]**	**R&D Centers**	**RPS**	**Storage Mandates**	**Tax Credits, Financial Incentives**	**Working Groups**
Arizona	✓		✓ (7)								✓
California		✓	✓ (125)		✓	M, PEV	✓	✓	✓	✓	
Colorado			✓ (8)	✓			✓				✓
Connecticut			✓ (3)			M, PEV				✓	
Florida		✓	✓ (3)			PEV					
Hawaii	✓		✓ (15)	✓		M, PEV		✓		✓	
Iowa	✓		✓								
Kansas								✓			
Maine			✓(1)			M, PEV				✓	
Maryland			✓(2)			M, PEV				✓	✓
Massachusetts	✓		✓(5)			M, PEV		✓			
Michigan			✓(8)			PEV	✓	✓			
Minnesota			✓(11)	✓		M, PEV				✓	
Montana								✓			
New Jersey		✓	✓(5)			M	✓			✓	✓
New Mexico			✓(5)								✓
New York	✓		✓(25)		✓	M, PEV	✓			✓	
Oregon	✓		✓(2)	✓	✓	PEV					✓
Puerto Rico								✓	✓		
Vermont	✓		✓(2)	✓		PEV	✓			✓	

[1] See Table Notes on next page.

[14] "Envisioning State Regulatory Roles in the Provision of Energy Storage," Tom Stanton, Principal Researcher, Energy and Environment, National Regulatory Research Institute, Briefing Paper No. 14-08, June, 2014.

State/ Territory	State/Territory Storage Activity Type										
	Active Dockets	**Completed Dockets**	**Demos, Pilots (#)**[1]	**IRP**	**Proposed Legislation**	**Microgrids (M), Plug-In Vehicles (PEV)**[2]	**R&D Centers**	**RPS**	**Storage Mandates**	**Tax Credits, Financial Incentives**	**Working Groups**
Washington			✓(7)	✓	✓	PEV		✓		✓	✓
West Virginia		✓	✓(4)					✓			
Wisconsin					✓						✓

[1] Source: U.S. DOE *Global Energy Storage Database*, http://www.energystorageexchange.org/projects. Only states reporting at least one additional activity type are included in this table, and only selected Demo and Pilot projects listed in the *Global Energy Storage Database* are included in the brief descriptions that follow. Numbers in parentheses represent the count of projects in each state that are included in the DOE *Global Energy Storage Database.* States and Territories with demonstrations and pilots that are not listed in this table include: Alabama (1 project), Alaska (5 projects), Arkansas (1), Delaware (1), Georgia (4), Illinois (6), Indiana (2), Kentucky (1), Missouri (6), Nevada (8), New Hampshire (1), North Carolina (8), Ohio (6), Oklahoma (2), Pennsylvania (16), South Carolina (3), Tennessee (6), Texas (19), Utah (3), and Virginia (5). States not listed either in the table or here have no currently-identified demonstrations or pilot projects.

[2] Eight states are participating in a Zero Emissions Vehicles (ZEV) Action Plan: California, Connecticut, Maryland, Massachusetts, New York, Oregon, Rhode Island and Vermont (http://www.nescaum.org/topics/zero-emission-vehicles). Rhode Island is not listed in this Table. Michigan also has some PEV tariffs and Minnesota has directed utilities to offer PEV tariffs, but those states are not participating in the ZEV Action Plan.