WATTS HOT Newsletter™

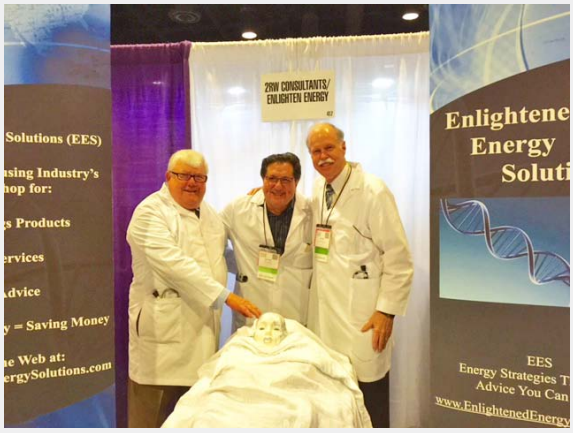
YOUR SOURCE FOR ENERGY, TECHNOLOGY, SUSTAINABILITY & RESILIENCY

APOLLO Engineering Solutions

Winter 2017 | Volume 1, Issue 2

Doctors of Energy Return From the Big Easy

Thank you to all the NAHRO Conference attendees who stopped by the "Doctors of Energy" booth to get a checkup and say hello.



The "Doctors of Energy" (Ken Loar, Dick Santangelo, Mike Nail, and Jack Morrone) at the NAHRO Conference in New Orleans.

We are happy to report that our patient, "Apollonia" returned to good health when given the news that we reduced her portfolio's utility expenses by over 35 percent. Her residents sent get well cards, thanking her for improving their indoor air quality and replacing their obsolete appliances. All in a day's house call for our "Doctors of Energy."

Whether you have questions about energy performance contracting, RAD, utility allowances, finding and procuring the lowest rates for natural gas and electricity, staying compliant with HUD energy regulations or if you just want to learn about some of the newest, exciting, energy saving breakthroughs and incentives, the Doctors can help you.

The "Doctors of Energy" look forward to seeing you in 2017 and sharing their solutions-oriented energy expertise and wit at various industry events. If there is an energy topic you would like discussed at your next meeting, facility seminar, or regional conference, contact Mike Nail at 301-639-3767 for details. We welcome the opportunity to facilitate a discussion on a topic of interest to your group.

Got a question or energy issue that can't wait?

Email your energy question or issue now to connect with one of the on-call Doctors at wattshotnewsletter@gmail.com.

UPCOMING EVENTS

- **NH&RA Annual Meeting**
  February 22-25, 2017
  Bonita Springs, FL

- **ACEEE Hot Water Forum**
  February 26-27, 2017
  Portland, OR

- **NESEA BuildingEnergy Boston Conference**
  March 7-9, 2017
  Boston, MA

- **NAHRO 2017 Washington Conference**
  March 26-28, 2017
  Arlington, VA

- **2017 PHADA Annual Convention & Exhibition**
  April 30 – May 3, 2017
  Chicago, IL

- **Better Buildings Summit**
  May 15-17, 2017
  Washington, DC

- **Novogradac Financing Renewable Energy Tax Credit Conference**
  May 4-5, 2017
  San Francisco, CA

RAD Practice Day – Fall 2016 – Interaction of RAD With Energy Performance Contracts (EPC)

On November 16, 2016, over 130 housing authorities, lenders, investors, developers, advisors, consultants, counsel, and others joined together in a day-long session with numerous HUD staff and former officials focused on continuing RAD's successful implementation and advancing RAD in the next Administration and Congress.

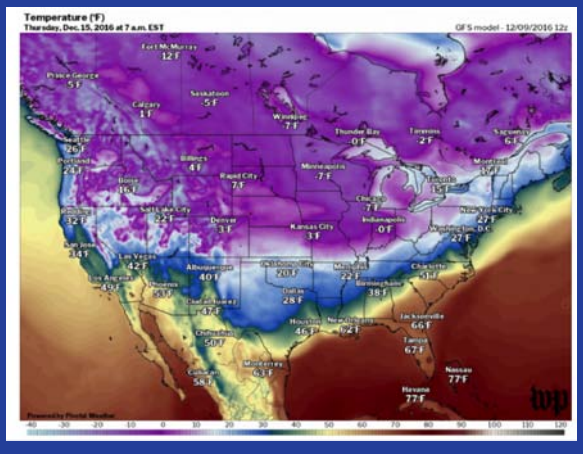
The Council of Large Public Housing Authorities (CLPHA)—with the support of the National Equity Fund (NEF), HAI Group, Reno & Cavanaugh, and CF Housing Group—organized the ***RAD Collaborative*** for interested Public Housing Authorities and their partners using the RAD to preserve and revitalize their public housing properties. PHAs, their many partners, residents and HUD staff should be proud of RAD's implementation success to date.

- Over 480 RAD transactions involving 52,089 units have been closed.
  - Generating over $3.4 billion in new capital improvements, or ~ $65k/unit in PHA properties across the country.
- An estimated 88,400 jobs have been created with this level of construction investment, employing local workers in rebuilding critical community infrastructure.
  - Every additional $1 million in construction activity generates 26 local jobs.
- RAD is responsible for an impressive $9 of private funds leveraged by every $1 of public funds in RAD conversions. Here's what one resident in Austin has to say about RAD—and there are likely thousands more: HACA Property Walk Through.

Spotlight on San Francisco, Austin, and Greensboro

The panel discussion involving *San Francisco (Lydia Ely), Austin (Sylvia Blanco), and Greensboro (James Cox)* exemplifies the successful interaction of Energy Performance Contracting and RAD. San Francisco, Austin, and Greensboro demonstrated how EPC and RAD can work together, complementing the RAD transition. In NAHRO's 2016 Journal of Housing and Community Development article on RAD and EPC the benefits of an existing EPC for a PHA transitioning to RAD are described. Agencies contemplating a multi-phase RAD conversion over several years can bake-in the EPC benefits into their Housing Assistance Payment (HAP) contract by undertaking EPCs before the conversion takes place for those properties not immediately converting, provided the PHA can complete the transition within the permitted conversion timeframe. In addition, implementing an EPC prior to conversion can improve the HUD subsidy (i.e., if an add-on subsidy incentive is part of an EPC) over non-EPC RAD converted properties. The property taking advantage of EPC can see lower operating costs, a fully-integrated energy solution, superior resident comfort, improved asset sustainability, a hedge against future utility rate increases, and better financial leverage. The NAHRO Journal article in its entirety can be found at https://goo.gl/svMIm2.

Utility Forecast Winter 2017



The Polar Vortex is here! "South Prepares for Snow as 73 Million Nationwide Face Brutal Weather" NBCNews 1/6/17. Some of you may huddle together to stay warm as you read this newsletter. Want to know more, *check out **this great overview** of the phenomenon from the Washington Post*.

Cold temperatures are here for a while and the broader projections for a colder than average winter continue to look like they will be accurate. Henry Hub spot prices for natural gas are poised to hit their highest point since December of 2014. We have seen a 14% surge in the demand for natural gas and a 2.8% year-over-year downtick in production due to cold weather

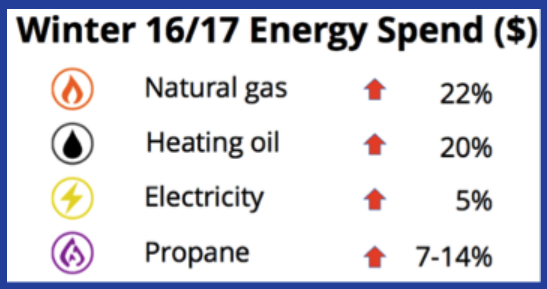
causing wellhead freeze-offs in the Rockies. Looking ahead, the EIA released its Short-Term Energy Outlook last week, providing our first glimpse into 2017.

The highlights:

(1) Henry Hub Spot prices are expected to rise by almost 31 percent in 2017 due to increased heating demand and growth in natural gas exports.

(2) Total consumption is expected to rise 1% because of the colder projections for the coming winter.

(3) Production is also expected to increase 3.2%, spurred by increased prices. 2016 was the first year in over a decade where we saw production decline, and that trend was always likely to reverse course in 2017. The bulk of the production increase, though, will go to the booming Natural Gas export industry, providing little relief for domestic prices. The chart on the right will show what we are looking at in terms of utility costs.



What does this mean for you as a housing provider? There are a number high-confidence indicators that natural gas prices aren't getting any lower soon. If you are hoping that they will dip to the all-time low numbers than have been seen over the past couple of years, we recommend discussing the current state of the market consider locking in rates while they can before any further major spikes occur. Call Dick Santangelo (703-627-7161) or Mike Nail (301-639-3767) to discuss your options.

Resiliency Planning in Assisted and Affordable Housing

This quarter's *Watts Hot Newsletter*™ focuses on resiliency. Never in our history has resiliency been more important. Resilience emerged from the field of ecology in the 1970s, to describe the capacity of a system to maintain or recover functionality in the event of disruption or disturbance. The very number of resiliency definitions in the literature today implies its significance in ordinary life and the many challenges to address it.

> *"The ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events."*[1]
> *"The capacity to absorb or mitigate the impacts of hazard events while maintaining and restoring critical services."*[2]

For cities, the resiliency definition describes the capacity of cities to function, so the people living and working in cities – particularly the poor and vulnerable – survive and thrive no matter what stresses or shocks they encounter. Cities are centers of innovation, investments, opportunities, and diversity that address challenges daily. Cities are crucial to the arguments that define social conscientiousness, economic opportunity, climate change and geographic borders. Cities mirror how well we have progressed as a humans.

If history demonstrates anything, it exhibits the resiliency of human spirit through war, natural disaster, and disease; however, the number of potentially tragic fronts that face us as a Nation, community and individuals are greater than ever before. Climate change, cyber security threats, aging infrastructure, lack of affordable housing, aging populations, disease outbreaks (e.g., sika) makes resiliency and resource planning more important than ever. A quote by William H. Bennett, a noted clergyman stated, "It has been said that when the time to perform arrives, the time to prepare has passed."

Preparing for and adapting to manage a crisis or disruption as it unfolds, makes us better prepared to meet the next occurrence. Mohammed Ettouney, P.E., a resilience expert, who has assisted the Department of Homeland Security and the State of New York, offers the 4 Rs of resiliency planning: robustness, resourcefulness, recovery (or rapid recovery), and redundancy (of systems). Engineers, architects, and developers have an essential role in each of the 4 Rs, Ettouney says. But a common mistake is just focusing on one. "You will have to be well balanced," he continues, "otherwise you will have a problem."

1 Eva Kaplan-Leiserson, Designing Resilience, *The Magazine for Professional Engineers*, June 2014
2 Rockefeller Foundation, ARUP – City Resilience Framework, April 2014

Unfortunately, the most effective lessons have been learned through tragedy.

- **Robustness** - Our ability to bounce back, is based upon history, a collection of knowledge in sustainable design, better understanding of critical operations and functions;
- **Resourcefulness** - Anticipating impacts of multi-hazard events; creating the capacity to rapidly return to and/or reconstitute a more resilient, normal operation;
- **Recovery** - Tolerating loss of some capacity for the duration of the response effort; and,
- **Redundancy** - Partnering through communications, coordination, and collaboration.

Risk today, more than ever, is a part of human conditions. Crossing the street in Manhattan during rush hour, one encounters risk. The key challenge going forward will be to develop strategies that can a provide robustness, resourcefulness that allows us to bounce back from disastrous events. The pace of that bounce back is predicated on planning. Worst of all in looking back after a disaster, at the very least, let us not regret our preparedness, inaction.

There are many fronts to resiliency preparedness. We reference a resiliency planning checklist that can get the discussion going within your organization. While there are many specific aspects to resiliency planning, this quarter's discussion is dedicated to keeping the lights on.

Ever since Hurricane Sandy wrought havoc on the East Coast, resiliency has been a hot topic of conversation among engineers, architects, designers, politicians, and city developers.[3] In November 2012, 'Resilient Design' was a trending search term in Google, moving from near obscurity in the months before the devastating super storm to a popular catchphrase post-Sandy. Natural disasters remind all of us in green design that while sustainable buildings are the prime motivation, it matters little when a building goes dark due to flooding, earthquake, power outages or some other natural or manmade disaster.

U.S. disasters like hurricanes Katrina, Sandy, and Matthew are a siren to call attention, reminding us we need to be vigilant, keeping the long term picture in view when we design, prepare buildings to withstand possible disasters. While the term "sustainability" in today's vocabulary often conjures up an image of LEDs, battery operated cars and low flow toilets, "sustainability" literally means "to endure." Any so-called "green" products and buildings that don't stand the test of time are not sustainable. As climate change turns our attention to the possibility of increasingly likely disaster scenarios, resilient design reminds us to design for durability.

How Can We Keep the Lights On?

Building owners in Newark and New York City learned some resilient design lessons the hard way during Hurricane Sandy; city-wide infrastructure can and will fail. Power outages and blackouts are common occurrence during disasters, requiring backup systems to maintain safety and comfort. This is true for resident building that house the disabled and elderly. Building owners that endured Hurricane Sandy learned the importance of a back-up power supply, higher floor locations (above basement levels), maintaining off-grid heating and cooling capabilities, making sure that building insulation is tight, making sure that natural ventilation is possible when air conditioning fails (operable windows), and maximizing daylight so people can continue to see, work and move around without artificial light. It was little surprise when the *Wall Street Journal* documented in an article that the U.S. government had identified nine key substations (out of 55,000), whose coordinated destruction could knock out power coast-to-coast. This was not a flickering lights situation, but an area-wide outage that could last weeks or even months.

3 Resilient Design: Is Resilience the New Sustainability? Jill Fehrenbacher, founder of Inhabitat, and a LEED-AP green designer and green design consultant, 2013

As far back as 1982, Amory and Hunter Lovins raised the issue in *"Brittle Power: Energy Strategy for National Security."* Talk of the grid's susceptibility heightened following 9/11, and after the Northeast Blackout of 2003, and again recently when gunmen destroyed 17 transformers in an attack on Pacific Gas & Electric equipment. These latest threats are not being ignored. Federal action is underway to better guard the grid. But with so much awareness of the problem, why are we focusing mostly security and surveillance, instead of fixing the grid?

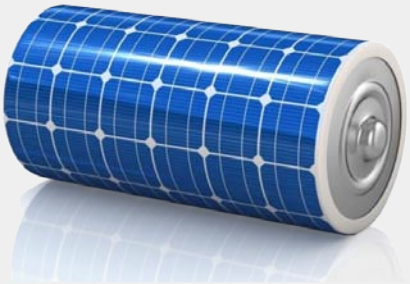
The grid's weakness lies in its interconnectedness, which can lead to domino-like failures experienced in the past.[4] We can reduce our vulnerability by adding decentralized energy – dispersed generation, energy storage, and microgrids – that supply power even when the grid is down. This leads us to the discussion on individual options for addressing resiliency power issues. The two papers in our winter edition of *Watt's Hot Newsletter™ Changing Energy Economics: A Look at the Role of Energy Storage in Affordable Housing Markets* by Wayne Waite and an *Overview of Combined Heat and Power (CHP), or Cogeneration, for Multifamily Buildings* by Bob Groberg are viable options that should be considered in a resiliency preparedness strategy. A third option, solid-state fuel cell technology is discussed in a previous NAHRO Journal of Housing and Community Development, May/June 2014, *Fuel Cell Technology Applications in Public Housing*. https://goo.gl/P8egAu

If you are interested in understanding more about resiliency, the notes after this article are just some references used in this paper. I encourage our readers to sign up with the Rockefeller Foundation's 100 Resilient Cities, which features the full range of resiliency measures in case studies by cities from around the world.

Changing Energy Economics: A Look at the Role of Energy Storage in Affordable Housing Markets

By: Wayne Waite

For over two decades affordable housing property owners have made significant commitments and investments in renewable energy. These investments, while viewed as responsible environmental choices, are largely driven by economic considerations. Such investments make economic sense where reductions to operating costs are predictable and where the savings will cover residual financing costs and provide property owners with the desired rate of return on their investments.



Looking ahead, several factors make the quest for predictable energy savings more challenging. Aside from uncertainties associated with the presidential election, which may affect policies or limit the level of federal support encouraging these investments, a far more significant factor affecting energy economics will be the changing utility landscape and the transition to a smarter, more reliable grid. Within this context, energy storage can play a pivotal role both in the delivery of energy services and in preserving and enhancing the value of energy investments. This paper looks at the emerging financial case for energy storage in affordable housing markets.

Shifting Grid Economics

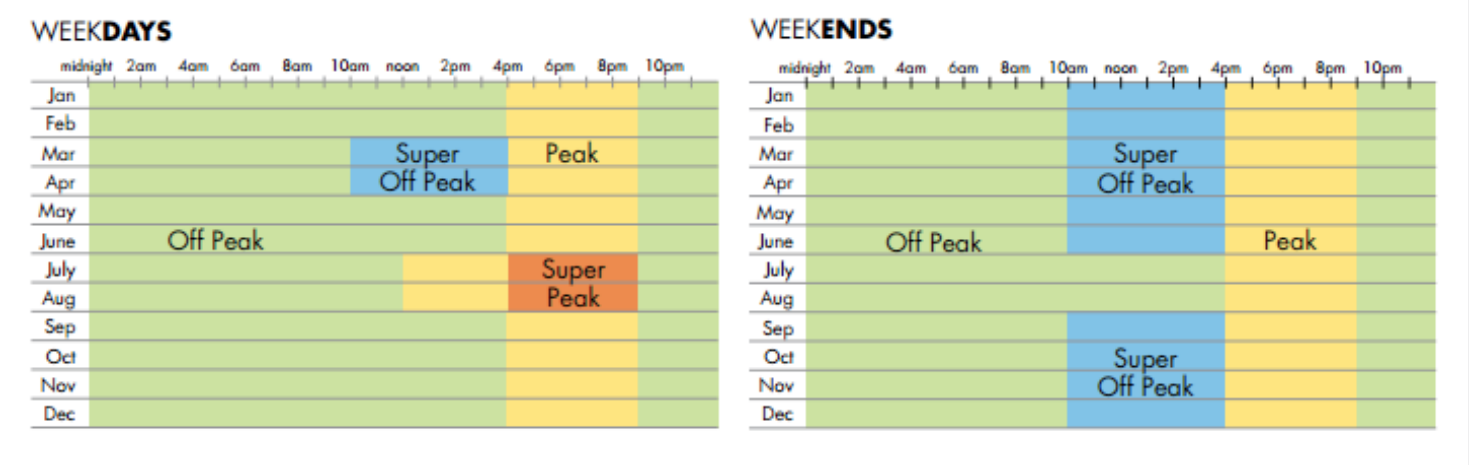
As renewable energy incentives continue to decline in states and at the federal level, the expansion of solar PV in affordable housing markets will largely depend on two factors: declining solar installation costs, which has been the focus of the Department of Energy's Sun Shot initiative; and Net Energy Metering (NEM) policies that credit property owners for the excess solar generation provided to the grid. NEM policies have been a key force in shaping solar markets and economics. While these policies differ in each state, the financial feasibility of solar investments for property owners regardless of the location of the property is largely based on whether the value of solar generation set by NEM policies will be sufficient now and to recover the residual financing or rent payments and earn a reasonable return.

4 Elisa Wood, How Do We Really Protect the Grid from the Bad Guys? March 24, 2014

Because of grid economic and service quality issues[5] the state of NEM policies is uncertain. As solar capacity has increased in response to Renewable Portfolio Standards and market forces, a growing number of public utility commissions have set caps limiting solar capacity that can be developed. These capacity limits have become a focal point of political pressure on utility commissions from the solar industry and utilities. As capacity nears or exceeds net metering caps, utilities companies have sought to revise or eliminate NEM rules, mandate *time of use* (TOU) rates, impose added fees and charges, and otherwise modify how solar is valued. According to the North Carolina Clean Energy Technology Center, in the first quarter of 2016, 35 states were considering policy changes to net metering rules, 18 states considered or enacted fixed-rate increases for solar systems, and 11 states commissioned studies on solar valuation.[6]

To compound the NEM policy problem, as solar generation capacity increases on the grid, basic market forces of supply and demand will also affect the value of solar generation exported to the grid. Electricity pricing will be reset to reflect not only to times when supply is constrained, but also when there is a surplus of electricity generation from solar PV. This means utilities may shift peak pricing periods so electricity would cost the most during weekday evenings when solar systems are producing little to no energy, and cost the least on weekends during the midday period when solar generates most of its electricity. An example of this proposed shift in utility peak pricing is illustrated in Figure 1. This peak shifting proposal is discussed in a 2015 joint staff paper prepared by the California Energy Commission and California Public Utilities Commission,[7] and was also proposed by the California Independent System Operators in a recent rate-making proceeding.[8]

Figure 1 - Matching Time-of-Use Rate Periods with Grid Conditions



Prepared by California Independent System Operators (CAISO)

See: http://www.caiso.com/Documents/MatchingTimeOfUsePeriodsWithGridConditions-FastFacts.pdf

The irony is that when the declining costs of solar PV make clean energy technologies accessible to low-income households, regulators are acting to reduce the value of solar generation. Utility policies that once propelled the growth of stand-alone solar PV investments may not provide reliable or predictable cash flow streams to affordable housing property owners to finance the expansion of clean energy technologies in underserved markets. In this uncertain landscape, affordable housing organizations are well advised to re-focus their investment strategies on integrated energy solutions that also mitigate risks to the future value of renewable energy investments.[9]

5 While the level overall level of PV production is generally predictable, the output from PV systems is variable, and is not "dispatchable" the way conventional generation is. Where the distribution system has high levels of solar PV – 30 percent of peak demand or higher – voltage variability can occur affecting electric service quality. http://energystorage.org/energy-storage/energy-storage-benefits/benefit-categories/renewable-integration-benefits.

6 50 States of Solar, NC Clean Energy Technology Center, April 2016. See: https://nccleantech.ncsu.edu/resource-center-2/fact-sheets-publications/.

7 Joint Agency Staff Paper on Time-of-Use Load Impacts, California Energy Commission, December 2015, CEC CEC-200-2015-009-SP.

8 CPUC Decision 15-11-013 (November 13, 2015).

9 In the near term, property owners undertaking PV solar investments through third party mechanisms such as power purchase agreements should consider putting limits on the use of cost escalators relative to the value of solar received by the property.

Energy Storage – Potential Revenue Streams

Solar PV, as a stand-alone system, provides a single revenue stream to property owners. It can produce energy and deliver solar credits from the generated electricity valued at a per-kWh rate that is higher than the costs of the generation. As already noted, this revenue stream is vulnerable to net metering policy changes and shifts to peak period pricing.

To mitigate these risks, property owners must manage how their on-site solar generation is used to meet the electricity demands at the property. This is possible with renewable energy systems that integrate solar PV installations with energy storage. These combined renewable energy systems provide additional flexibility to both reduce site consumption and electricity demands at times of high utility costs, and export production to the grid at times when solar exports to the grid have the highest value; maximizing the value received from the renewable energy system.

The central value proposition for pairing energy storage with solar PV is that combined renewable energy systems can open multiple new revenue streams to property owners that will improve overall project economics. Combined energy storage and PV systems can smooth the energy used on-site, reduce demand charges, and provide more reliable reduction of energy use costs and demand charges. Combined systems also enhance the resilience of a building's power supply, which can be an important benefit for the residents. The property owner may also benefit by providing auxiliary services to utility companies needed to address intermittency issues and provide greater grid stability. Table 1 summarizes the added revenue opportunities available to property owners from combined energy storage and solar PV systems.

Table 1 – Additional Benefit Available to Property Owners from Combined Energy Storage Plus Solar PV Systems

Revenue Stream	Description	Benefit	Beneficiaries	Status
Demand Charge Reduction	Storage discharges are phased to reduce building peak load spikes.	Reduced demand charges; Reductions to site peak demand may allow property to opt into tariff schedules with no demand charges.	Property owner	Available now
Time-of-Use Bill Management	Storage charging from solar PV and discharging to grid are synced with TOU rates to maximize value.	Increased energy benefits from higher valuation of solar generation and lower consumption costs.	Property owner; Tenants	Available now
Increased PV Self-Consumption	Stores excess on-site PV generation to maximize on-site use of solar generation.	Reduced on-site energy use consumption and costs.	Property owner; Tenants	Available now
Site Resiliency *(Backup Power)*	Temporary on-site back up power to response to outages and power fluctuations.	Protects on-site equipment from power fluctuations/outages; Emergency auxiliary services; Regulatory barriers may exist.	Property owner; Tenants	Limited
Auxiliary services to Utility Company	Contract services to utility company for frequency regulation, voltage support, electricity supply reserve capacity, etc.	Revenue from service agreement with utility for service; Regulatory barriers may exist.	Property owner	Dependent on resolving regulatory issues

Closer Look at Economics of Demand Charge Reductions and TOU Energy Bill Management

Two promising revenue strategies being adopted today by commercial property owners are Demand Charge Reductions and TOU Bill Management. These strategies can provide cost-effective opportunities to improve project economics for multifamily affordable housing, particularly in regions experiencing rapid growth of solar PV and change to NEM policies affecting the value of stand-alone solar.

Demand Charge Reductions (Peak Shaving)

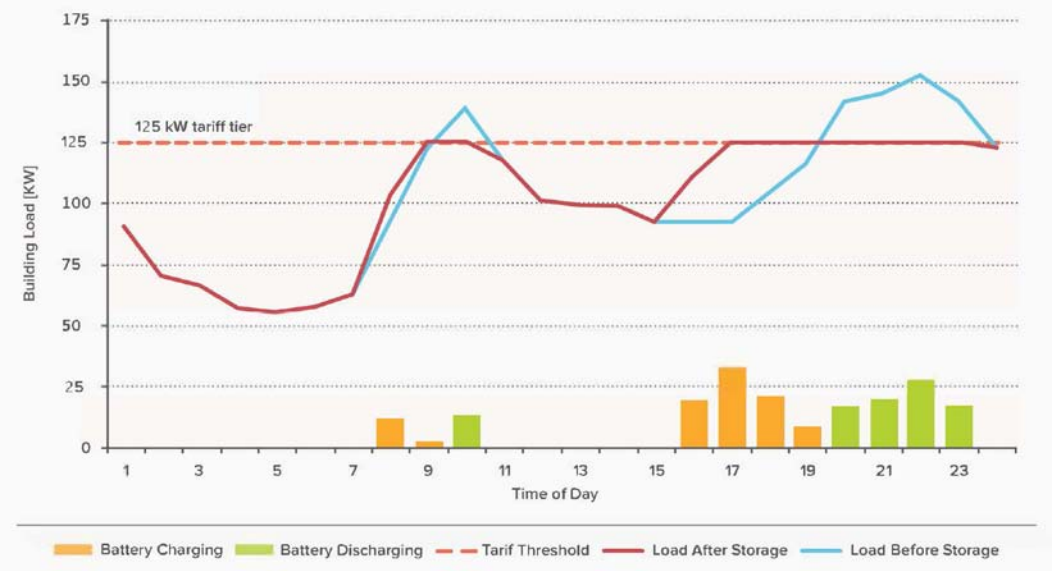
Description: Demand charges can make up a significant portion of total electricity costs (30 to 80 percent). Demand charges have been common for commercial customers, which can include large multifamily properties providing electricity services to common areas and/or tenant units. Demand charges are based on the maximum amount of energy a customer uses during a prescribed time interval (15 minutes, an hour, a day, etc.) over a billing period. In the last ten years demand charges have increased at a rate significantly faster than electric consumption charges in many U.S. electricity markets to support investments in grid modernization needed to integrate renewable energy resources into the grid.

Rational for Energy Storage: Stand-alone solar PV may have only a limited effect on reducing demand charges because of solar intermittency, which can occur due to changing weather conditions or cloud cover, and solar variability between periods of peak solar energy production in the middle of the day and peak electricity consumption in early evening hours. These factors limit solar PV's ability to reduce high peak load consistently and significantly demands during a billing cycle. Combining energy storage with solar PV enables property owners to reduce utility costs that cannot be reached with stand-alone solar PV and mitigates financial risks associated with changing utility rate structures.

Application: Peak shaving is the most ubiquitous and cost-effective application of energy storage systems. If part of a property's utility bill includes demand charges, energy storage can shave the peak loads that affect the demand charge utility rates and costs.

The demand management capabilities provided by combining energy storage with solar PV enable property owners to collect excess, "behind the meter" PV generation and deploy the stored power during brief periods with high-energy demand. Figure 2 illustrates how energy storage can be used to "shave" peak demands and reduce or eliminate demand charges. In the chart, the blue line shows the energy demands throughout the day at a property. The orange and green bars at the bottom of the chart show periods when energy storage systems are charging (orange) and discharging (green). By syncing discharges with periods of high peak demands, the demand charges at a property are reduced. Since spikes in peak loads trigger higher demand charges, energy storage provides property owners with the tools to maintain electricity loads below utility peak demand thresholds. This flatter electricity load profile shown by the red line may also allow the property to opt into more favorable utility rate structures.

Figure 2 – Use of Energy Storage to Reduce Peak Demands



TOU Bill Management (Cost Shifting/Rate Arbitrage)

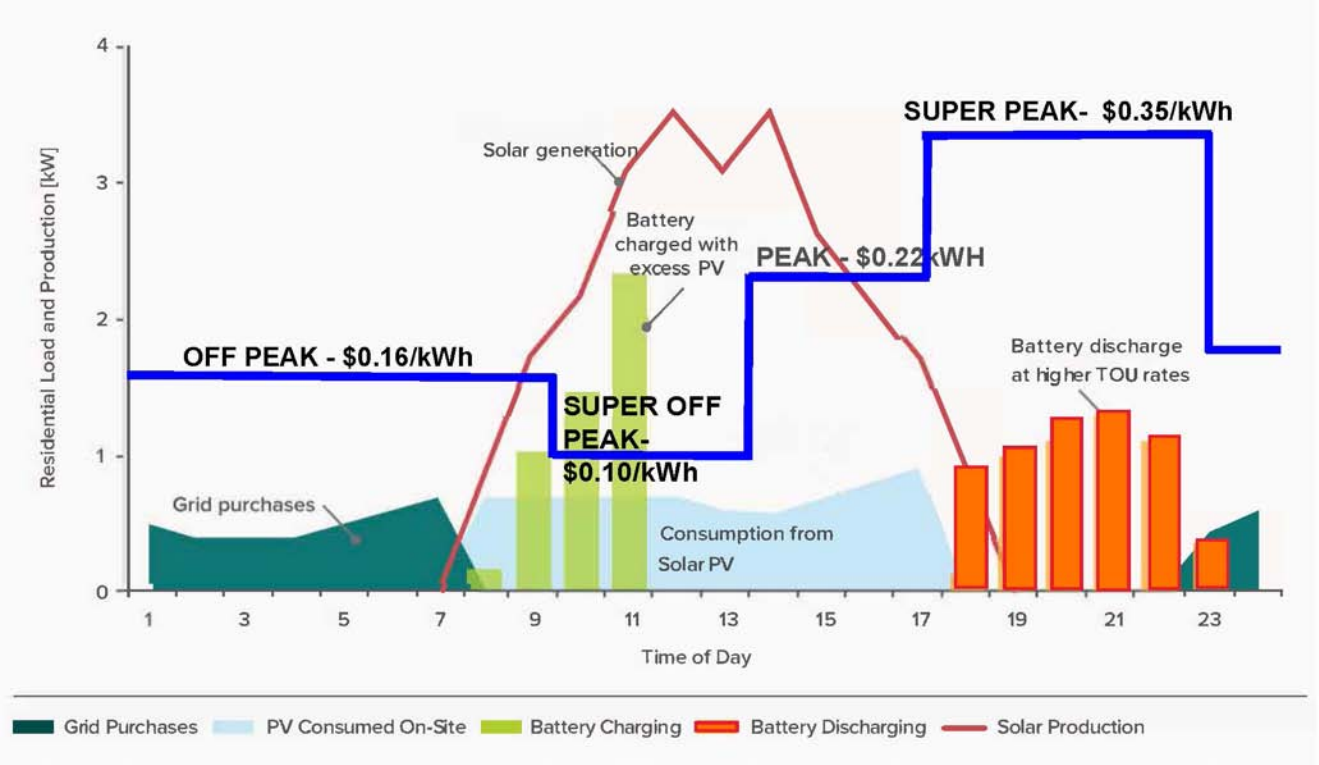
Description: The use of TOU rate structures is a commonplace practice to align electricity costs with consumption. TOU utility rates vary by time of day and season typically in response to changes in electricity supply and customer electricity demands. Consumption not provided by an on-site renewable energy system is billed based on the time of use. Similarly, the solar generation from on-site renewable energy systems exported to the grid solar is credited back to the customer at a value that typically corresponds to the rate in effect when the electricity is exported. With the growth of PV capacity there are growing concerns that customers with behind the meter solar energy systems are passing on grid modernizarion costs to non-solar customers because their on-site consumption is lower. As a result, TOU rate structures are changing with wider fluctuations in electricity use charges throughout the day.

Rationale for Energy Storage: The wide fluctuations to both the costs of electricity and the value of solar during a day or over a season create risks that the customers' energy consumption costs will increase at the same time the value of on-site solar generation is declining. This worst case scenario materially affects the economics of renewable energy investments. Lower energy saving cash flows affect the property owners' rate of return and their ability to cover financing or lease payment costs associated with the renewable energy investment. This financial risk is mitigated with combined energy storage and solar systems that enable property owners to arbitrage utility consumption and PV generation.

Application: If a property and/or tenants are subject to a TOU rate structure, energy storage can lower consumption costs and increase the value of the solar generation exported to the grid.

Figure 3 illustrates how energy storage can manage utility consumption and solar PV generation to maximize cash flows. In the chart, the blue line reflects the TOU rate structure during a day. The red line shows a typical solar generation profile. The green and orange bars at the bottom of the chart show periods when energy storage systems are charging (green) and discharging (orange). By syncing energy storage charge and discharge cycles with the time sensitive electricity pricing, the property owner can align grid purchases with period of low energy costs and schedule discharges from energy storage systems to coincide with periods of high-energy costs/solar value; maximizing the benefits received from the solar energy investment.

Figure 3 – Use of Energy Storage to Arbitrage TOU Rate Structures



Next Steps: Establishing the Financial Case for Energy Storage

Advanced energy storage solutions with real-time predictive analytics and battery packs are being successfully deployed in commercial and industrial markets to intelligently store and discharge energy to shave peak-power demand, optimize solar PV utilization, manage TOU rates, and provide auxiliary services to utility companies.

In the next decade, these same strategies will gain broader acceptance and use in affordable housing markets as property owners seek smarter tools and technologies to manage energy costs and leverage new energy saving revenue streams to improve property energy economics. While these economics look very favorable what a particular affordable housing property might gain from energy storage is a complicated question.

Before investing in an energy storage system, a detailed site-specific analysis is necessary to determine the optimal size and operational requirements of the energy storage system. Numerous variables must be considered including end-user load profiles, utility rate structures, power-energy ratio, and capacity of the battery-based energy storage solutions, and whether on-site solar power generation is included at the property.

The analysis will evaluate the rate at which energy is used at the property and the energy consumed, as well as model utility costs and the applicable time-variant rate structures. The shape of a property's load profile, rate structure, and the amount of installed solar power capacity will determine the optimal peak demand reductions that can be achieved from the energy storage system. Modeling time variant rate structures under various charging and discharging scenarios is also important in determining payback periods and financial returns for the renewable energy system.

A renewable energy storage system will also have several other important performance characteristics that determines how well the energy storage system will operate that must be factored into the analysis. These include:

- ***Energy Capacity:*** Maximum electric usable energy (kWh) stored in a battery.
- ***Maximum Discharge and Charge Rates:*** The peak power (usually given as maximum current) the battery can either provide or accept without damage.
- ***Depth of Discharge:*** What percent of the battery's capacity may be used before it needs to be recharged.
- ***Cycle Life:*** Number of recharge cycles a battery can undergo before it reaches end of life.
- ***Temperature Limitations:*** Acceptable operating temperature for battery. (Note: Some battery chemistries may not operate below freezing temperatures, or at very high temperatures.)
- ***Self-Discharge Rates:*** The rate at which a battery loses charge while not producing energy.

Determining the financial case for energy storage, for both the property and/or tenants, requires complex analysis and modeling. Affordable housing owners should have access to impartial technical support – free of any potential conflicts of interest – to ensure that a project's financial modeling considers recent rate changes and anticipates the risks to project returns from movements in tariff rate components.

The Clean Energy Group, a national non-profit organization with expertise in this technical area, can help properties connect with analytical resources. The Clean Energy Group has also published several reports on energy storage that may be useful to understanding the application of this technology in affordable housing. These reports include Closing the California Clean Energy Divide: Reducing Electric Bills in Affordable Multifamily Rental Housing with Solar+Storage and Resilience for Free: How Solar+Storage Could Protect Multifamily Affordable Housing from Power Outages at Little or No Net Cost.

Wayne Waite is the principal of Waite & Associates and currently provides public policy and technical support services under a grant from the Energy Foundation to a coalition of environmental justice and affordable housing advocacy organizations working to increase access to clean energy technologies in low-income and disadvantaged communities.

He has previously worked as a Regional Energy and Climate Manager for the U.S. Department of Housing and Urban Development, Vice President for Public Policy for Everyday Energy, and as Director for Public Policy for the California Housing Partnership Corporation.

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Overview of Combined Heat and Power (CHP), or Cogeneration, for Multifamily Buildings

What is Combined Heat and Power (CHP)?

Combined heat and power systems generate on-site electric power from a single fuel source—mostly gas-fired—and recover the heat to use it for domestic hot water, space heating and cooling. It achieves over 75 percent efficiency versus 50 percent for conventional power. Central power stations also lose over six percent from transmission lines. CHP decreases environmental pollutants such as CO_2, SO_x, and NO_x. Advanced CHP can be "islanded," that is, with steady gas fuel, designed to stand-alone and continue generating if the grid goes down, providing resiliency.

This overview occurs during a period when the utility industry is exploring creation of microgrids, the growth of distributed generation and the potential for combining solar and CHP generation with on-site storage. It identifies key national and state initiatives to promote its use. As solutions emerge, CHP with standalone capability will play a larger role in resiliency planning.

Why Does CHP Make Sense for Smaller Buildings?

The best explanation will be found in these three profiles:

- ***Boa Vista Apartments*** is a 99-unit public housing elderly high rise owned and operated by the New Bedford Housing Authority in New Bedford, MA. The building has an Aegen, ThermoPower 75 kW CHP system installed in 2009. The annual savings of $58,000 and average annual energy costs from 2010 through 2014 were 43 percent less than 2008 goo.gl/oxaON2.
- ***Seaside Apartments*** is a 275-unit affordable housing complex on Staten Island, NY with CHP installed in 2012. It reduces the carbon footprint significantly; uses over 50 percent less energy. The InVerde 100 kW system is fully self-sufficient, if power grid failure occurs goo.gl/HOfysj.
- ***University Square, in Philadelphia, PA*** is a HUD subsidized community of adults 62+, comprised of 442 apartments goo.gl/eBAHxk.

How Will CHP Enhance My Building's Resiliency?

The resiliency planning for such buildings during emergencies raises questions beyond merely providing "safe-at-home" for residents and their families and friends. It should also consider how such buildings may serve neighborhoods and public functions, and how state support can assist. CHP systems operate every day to save energy and money. Because energy costs are much of its operating budget, building management continually seeks ways to reduce energy expenses for its tenants and reduce the property's impact on the environment. With standalone capacity, they are proven to be more reliable than traditional emergency back-up generators during grid outages. This resiliency makes them popular with multifamily buildings.

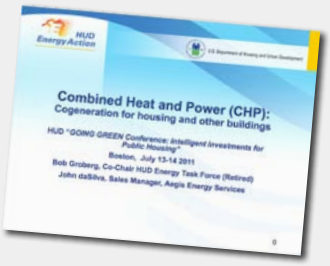
CHP systems will take some of their power from the grid. See "Guide to Using CHP for Enhancing Reliability and Resiliency in Buildings," System Requirements for Reliability, goo.gl/8XAkY6, (see page 9) for a description of the features needed to continue running after the grid goes down, such as black start capability. The Guide describes the Brevoort Coop on lower Fifth Avenue with cogenerated power after Hurricane Sandy took down the NYC grid below 30th Street. Brevoort's Board and residents confirm the importance of resiliency in this video link: www.youtube.com/embed/-SIbcNG_cQY

How Reliable is CHP Design and Installation?

In the early years, systems were fabricated on site. The industry has since developed packaged CHP systems, e.g., 60kW that can be installed more quickly and can run when the grid goes down. Smaller systems have been demonstrated, e.g., 5 and a 10kW system in Chicago. The number of experienced companies has increased to conduct feasibility studies, install systems, maintain equipment with remote monitoring, and even finance or own the installations, saving building owners up-front costs, and reducing payback times.

The 2016 CHP Technical Potential in the United States market analysis report provides data on the technical potential for CHP 19,000 multifamily sites in the US, capable of producing 4,265 MW, goo.gl/UGWSqW. CHP system size range, facility type, and state nationally provide data. Each state's technical potential is shown on state profile pages that include break-downs by size range and facility type.

It's All in the Economics



The total generation of CHP has grown to about 10 percent of electricity generated in the US. The economics of CHP often turn on the difference between the price of electricity and of natural gas, known as *spark spread*. State subsidies, policies and tech assistance have accelerated CHP development. A PowerPoint on CHP used at the 2011 HUD Green Conference: *Intelligent Investments for Public Housing* is available at Combined Heat and Power (CHP): Cogeneration for housing and other buildings.

Resources to Learn More About CHP

DOE has provided technical support to about 1,300 CHP projects in FY 2009-2015, assisting 280 under development or on line with an estimated 2.3 gigawatts. For an overview of DOE's CHP PROGRAM, see goo.gl/Au3nPx. This link will take you to the Installation Database, Profiles, Technical Assistance Partnerships (TAPs), Publications and more. The DOE CHP Deployment Program provides stakeholders with the resources to identify CHP market opportunities. It supports implementation of the seven TAPS, regional centers available to provide technical assistance and answer CHP questions.

(CHP) Project Installation Database goo.gl/uve13Z established in 2002, now maintained by ICF International, updated each June, provides information about CHP systems operating in 28 industries going back to 1962. There were 296 multifamily installations in the 2015 report in ten states - CA, CT, MA, NJ, NY, PA, RI, IL (4 of 5kW and 1 10kW), NH, and TX have one each. Eleven Public Housing Authorities are listed as having CHP: Meriden, Seymour, Winsted CT; Boston, Cambridge, Gardner, New Bedford, Watertown, Worcester MA; Reading PA; Newark NJ. If you have questions about the database or would like to report a new installation, please contact Trent.Blomberg@ifci.com.

(CHP) Project Profile Database: Over 120 CHP project profiles compiled and posted by the CHP TAPs can be searched by state, CHP TAP, market sector, North American Industry Classification System (NAICS code - 53111- Rental Housing for multifamily), system size, technology, fuel, thermal energy use, and year installed, goo.gl/ULHeA0.

DOE's Better Buildings Initiative is a national leadership initiative for commitments "to improve energy efficiency, save money and increase competitiveness." It has created several "Accelerator" initiatives. In May of 2016 the Better Buildings Summit conference brought to fruition many DOE efforts to advance the role of CHP, announcing the new goal of adding 40 gigawatts of CHP by 2020. Two workshops announced the creation of the CHP Resiliency Accelerator, Combined Heat and Power (CHP) for Resiliency Accelerator, and presented NYSERDA's market approach. Key CHP companies involved with multifamily housing described their roles.

We saw the importance of resiliency in the Brevoort video. The Resiliency Accelerator supports consideration of CHP and other distributed generation solutions for critical infrastructure resiliency planning at the state, local, and utility levels. The Accelerator describes its mission as: "a collaborative effort with states, communities, utilities, and other stakeholders to examine the perceptions of CHP among resiliency planners, identify gaps in current technologies or information relative

to resilience needs, and develop plans for communities to capitalize on CHP's strengths as a reliable high efficiency, lower emissions electricity and heating source for critical infrastructure. The Accelerator is developing tools, templates, and other resources to promote deployment of CHP as critical to resiliency planning." Follow its progress on line https://goo.gl/1V8SUo.

New York State Energy Research and Development Authority (NYSERDA)
There are over 40 multifamily buildings with CHP on the NYSERDA DG Integrated Data System web site, goo.gl/UtrOoe. They provide detailed information about each one, including street addresses and numbers of dwelling units. Since around 2010 "standalone" capacity has been required for all new systems, and eight such installations are listed. Extensive technical information is on the NYSERDA link for profiles on: Cabrini Terrace, Concord Court Apartments, Octagon, Trump Tower, Toren Condominiums, Seaside Apartments, Silver Towers, Schwab House.

NYSERDA's approach includes recognition of equipment, "vendors," companies with experience, goo.gl/6cYnuP initiatives. The comprehensive approach of NYSERDA to creating a market has been a model for the DOE 2016 CHP Accelerator Initiative.

Department of Housing and Urban Development (HUD) CHP Efforts
HUD's efforts to assist its programs increase energy efficiency are described in goo.gl/4T3Abz. The document describes work between 1980-1985 in which HUD and DOE promoted District Heating and Cooling (DHC), a joint initiative that funded grants to cities for feasibility and design studies. They often included the potential for cogeneration. HUD-DOE also collaborated to promote energy efficiency in housing 1990-1995. Co-chairing the 2003 HUD Energy Task Force, the HUD Energy Division created three HUD CHP Guides. The first guide, *CHP Guide #1 Q&A for Building Owners* (2009) was based on NYSERDA's 1987 Cogeneration Manual" for NYC, covering considerations for the building, residents, installation, utility, service, economics and more goo.gl/F33hWS.

The second guide, *CHP Guide #2 Feasibility Level 1 Screening for CHP* (2009) goo.gl/HHKBmk included Oak Ridge National Laboratory software for building managers requiring only monthly utility bills and a little information about the building and its occupants. It was based on the Economic Analysis Worksheet in the" Cogeneration Manual." The worksheet has not been updated to reflect current equipment costs.

HUD/ORNL presented a paper at the ACEEE 2008 Summer Study: Promoting Combined Heat and Power (CHP) for Multifamily Properties *Introduction to Level 2 Tool for Multifamily Building Analysis* (2010). The paper led to the development of CHP Guide #3, adapted by Oak Ridge National Laboratories (ORNL), with HUD funds, from a tool used by the Federal Energy Management Program (FEMP) for office buildings, laboratories, and other Federal installations, goo.gl/O8q619.

Other Sources of Relevant Information on These Aspects of CHP are EPA, ACEEE and DSIRE

Environmental Protection Agency's (EPA) CHP Initiatives
EPA's website is http://www.epa.gov/chp providing an online database that allows users to search for CHP policies and incentives by state or at the federal level. The EPA CHP Partnership is a national program mainly focused on education/ outreach about the opportunities and benefits of CHP. Partners include facility owners and managers in industrial, commercial, district energy and multifamily residential sectors. EPA provides information, tools, and resources. It also works to ensure that CHP is properly accounted for in national environmental regulations that EPA develops. Over 30 webinars have been held since 2012; they are available on line from the website. EPA gives ENERGY STAR® awards for advanced systems; Clinton Hills Apartments in Brooklyn received the award in 2008.

ACEEE Policy Database
This State and Local policy database, http://database.aceee.org/ includes comprehensive information on energy efficiency policies implemented at the state and local level. Click a state or city on the map to learn more about the policies that encourage energy efficiency in each area. It notes that MA, MD, NY, and ME are the only states with approved production goals for CHP generation, a policy driver that encourages utilities and program administrators to acquire CHP. CT and RI have defined CHP as an eligible resource standard and offer deployment incentives that improve the economics of CHP investment. ACEEE's 2016 Report ranks states for compatibility with CHP, *"States can encourage or discourage CHP in many ways. Financial, technical, policy, and regulatory factors affect the extent to which CHP systems are deployed. Our scoring*

methodology emphasizes CHP as an energy resource, which we believe is the most important policy driver for increasing the use of highly efficient CHP in the United States."

DSIRE, the Database of State Incentives for Renewables & Efficiency
The most comprehensive source of information on incentives and policies that support renewable and energy efficiency in the U.S. Established in 1995, it is operated by the North Carolina Clean Energy Technology Center (now Technical Assistance Partnership) at N.C. State University and DOE funded. http://www.dsireusa.org/

Our guest author, Mr. Robert Groberg was recognized as a Distinguished Key Contributor to HUD's Energy Efforts during its 50th Anniversary. For many years, Mr. Groberg was the Energy Division Director, Office of Community Planning and Development, Office of Environment and Energy. He also Co-Chaired, HUD Energy Task Force. He was nominated for the 1996 Public Service Award of the U.S. Energy Association. Mr. Groberg was Acting Director, HUD Office of Environment and Energy when he retired in 2010 and has provided pro-bono support for CHP since then. Questions for Bob Groberg can be sent to wattshotnewsletter@gmail.com.

Energy Champions Podium

In keeping with this quarter's theme of Resiliency, the *Watts Hot Newsletter*™ (Winter), *Energy Champion* is the National Housing Trust, for its work on renewable energy.

High energy costs in multifamily housing make it difficult to sustain affordable rental housing for low-income families. Utility costs are the largest variable operating expense for affordable multifamily buildings. Reducing operating expenses in multifamily buildings helps maintain affordability, frees up capital that can address maintenance repair needs and/or make other necessary improvements. Reducing energy costs is a win-win-win: installing solar energy enables affordable housing owners to reduce operating expenses, reduces greenhouse gas emissions, and allows owners to maintain affordable rents and provide resident services for low-income families and seniors.

NHT Renewable, a green affiliate of the National Housing Trust, represents a new model for financing solar energy in affordable multifamily housing. In September 2014, community developers joined to celebrate the grand opening of NHT Renewable at the St. Dennis Apartments in Washington, D.C.'s Mt. Pleasant neighborhood. Since 2014, NHT Renewable has developed three solar projects, totaling 1.5 Megawatts of solar power on affordable housing properties. Because of its success, other housing owners have reached out to the National Housing Trust to partner on building their own solar projects.

Solar power helps harness more environmentally-friendly energy sources, lowering operating costs, and maintaining affordable rents for low-income residents. Starting with 10 of its buildings in Washington, D.C., NHT created a model for installing solar systems across property portfolios. NHT plans to install solar panels on over 20 buildings over the next two years.

The initial NHT Renewable project was financed with a diverse set of sources. Enterprise Community Loan Fund, Inc. provided a $900,000 loan, alongside funds from a MacArthur Award for Creative and Effective Institutions (MACEI) and the District of Columbia Sustainable Energy Utilities (DCSEU). As a separate business entity, NHT Renewable owns, operates, and manages solar installations. Solar panels have now been installed on 20 multifamily properties; home to 800 low-income families. Solar energy enables affordable housing owners to better save money on operating expenses and maintain rents for low-income families. See more at: https://goo.gl/ZkvctF.

National Housing Trust-Enterprise Preservation Corporation, an affiliate of the National Housing Trust, purchases and renovates affordable rental properties at risk of losing their subsidy and keeping them affordable for the long term. The Organization maintains a portfolio of almost 3,000 units of affordable housing, most which are the most marginalized residents in our communities. The properties are located primarily along the East Coast and Chicago. Jared Lang heads up their renewable work under the leadership of Trust President Michael Bodaken.

Congratulations to the National Housing Trust for being the Winter *Watts Hot Newsletter*™, *Energy Champions!*

Watts Hot at HUD

President Donald Trump's transition team has tapped Sarasota Housing Authority Director William Russell to help lead the U.S. Department of Housing and Urban Development on a temporary basis until a permanent team is in place. William Russell will spend the next few months as a special adviser helping the new HUD secretary get established. William Russell has experience working for HUD in Washington D.C. He served as Deputy Assistant Secretary for Public Housing at the agency before moving to Sarasota in 2005 to take over the city's trouble housing authority.

Be it Resolved…

As we move forward into the New Year with our resolutions firmly established and with great intention, let us add one more important one – ***"I Resolve to make my Agency more Energy Resilient and Sustainable, keep my residents secure and work to make my properties energy efficient and continuously operational."*** So how do we start in implementing this important resolution?

Here are general tips on how to proceed:

1. **Educate yourself on resiliency issues** by reading this newsletter and other materials and by talking with HUD and other communities that have developed an effective resiliency plan;

2. **Convene the stakeholders in your agency** (you may also want to include your residents, and representatives from your city/county and community early on because energy resiliency to be the most effective should be community-based) to secure agreement on the importance of the effort and discuss how best to integrate resiliency into the operations of the agency and move forward;

3. **Identify the areas that your agency is most vulnerable** (i.e., grid outages, flooding, etc.). Bring in an expert to help you develop a comprehensive report on where the agency is vulnerable and some recommended solutions;

4. **Identify sources of money that might support the resiliency effort**, including energy performance contracting (EPC), RAD, Capital Funds, state grants and private foundation funding; and,

5. **Develop an agency-wide approach and a plan of action**, and implement!

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Watts Hot Newsletter™ is a reference guide, published quarterly by Dick Santangelo and Mike Nail ("Doctors of Energy") focusing on the newest energy and water technology for the residential multifamily housing marketplace.

The Doctors of Energy will share with readers their combined experience (over 80 years in the energy business) with products, services, and vendors with a proven record of accomplishment for success. We invite guest authors to share experiences in a communal environment of housing professionals to reduce operational costs and maintenance, while improving portfolio's resiliency. *Watts Hot Newsletter*™ recognizes Energy Champions in our industry that have made significant contributions to conservation, sustainability, and resiliency in our Energy Champion's Podium.

Technology is technology. Whether you are private, non-profit, HUD-subsidized, state-financed, controlling operational costs are the key to quality housing. Energy and water costs represent a bigger share of your investment dollar every year, especially if your portfolio is aging. Finding the most effective technical solution to reduce energy and water costs is the common denominator.

Watts Hot Newsletter™ current circulation of approximately 5,000, comprises MF property owners, non-profits, public housing authorities, housing industry organizations, HUD/DOE staff, energy services companies, energy consultants, RAD developers, financing institutions. As a leading housing energy technology resource, *Watts Hot Newsletter*™ is a fantastic, cost-effective method to advertise to the affordable housing community. Advertising space is limited and is available on a first-come, first-served basis.

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