Walter Reed AMC Redevelopment – Executive Summary

DOE Better Buildings Case Competition: Team Endotherm

The Perkins + Will redevelopment plan for Walter Reed frequently conjures images where a vibrant multi-use district harkens to the hospital site's history of healing—this time ecological healing. Despite these cohesive goals, Walter Reed presents a tangled front for implementation and funding, with many concerned parties having varying degrees of scope or authority. Further, the development timeline is very long, requiring creative capital expenditure strategies.

We believe partnering with the private sector and bidding to market, combined with the right access to the municipal markets, will channel the widest range of expertise to this issue, provided the right incentives and policies are in place to shape the project. Much like the leading edge building technologies outlined, this innovative funding strategy will provide a more scalable and sustainable alternative to simple reliance on tax increment financing or federal grants. Our conveyance plan for the site rests on three broad phases of development related to horizontal, vertical, and operating timelines. In each, the LRA will outline performance benchmarks, select partners capable of meeting them, and oversee implementation, while ensuring transparency and extensive community engagement.

1. HORIZONTAL DEVELOPMENT: This phase entails creation of a district energy infrastructure to finance, build, and administer a trigeneration system to replace the existing, outdated central heating unit. We propose a bidding process for the "build-own-operate" service, either funded by the contractor or by industrial revenue bonds issued through the LRA. District energy will eventually be responsible for aggregating demand and managing billing, so it will need to plan for sub-metering and smart grid strategies.

2. VERTICAL DEVELOPMENT: This phase involves the selection of a master developer through a rigorous process of bidding and verification. Design guidelines central to the project's zero carbon goals will be provided to prospective developers to initiate screening. To ensure baseline energy and water performance, the LRA will hold funds from the purchase of the propertyin escrow pending a post-occupancy performance analysis. The LRA will further incentivize sustainability by offering certain opportunities for building occupants and residents to fund project innovations via on-bill financing.

3. OPERATING PHASE: This phase ensures that end users coordinate energy conservation to the fullest capabilities of the development. Groundwork comes from intensive sub-metering strategies that will include dynamic pricing options, direct load control, and aggregated demand capacity bidding services. A neighborhood energy engagement program with usage statistics and conservation games will add a legible surface to the back end complexity of this phase.

Though the end horizon of this project is frankly distant, we believe the right starting infrastructure will provide the best and most adaptable performance solution—both within each phase and throughout the timeline. Given this site's proximity to embassy buildings in the Department of State-owned parcel, Walter Reed must act as a statement of domestic values. The result will ideally be a keystone national achievement.

1. HORIZONTAL PHASE

District Energy System

We propose a "build-own-operate" service model for the district energy system to provide energy, manage the distribution system, and interface with customers. The chosen company, which we will refer to as the Neighborhood Energy Utility (NEU), will provide steam heat, chilled water, and electrical power (a trigeneration system) to all of the facilities in Walter Reed and manage the development of on-site renewable energy sources to meet the 100% renewable energy target by 2030. The NEU will also: own and maintain the associated infrastructure, such as steam pipes and substations; manage interconnection to the grid and the relationship with PEPCO; and manage all associated user-facing services related to the smart grid and billing (smart grid-related services are described in further detail in section 3).

This build-own-operate contract, designed to achieve the greatest possible benefits in line with the District's goals for the site, includes the retrofit of the existing plant and refurbishing and expansion of the heat, chilling, and electricity distribution systems. The District would require that all buildings at WRAMC connect to district energy, and it would allow the NEU to collect revenues. The LRA should coordinate with the NEU as to the phasing in of development at WRAMC, allowing for an appropriate scale-up in central trigeneration capacity.

A build-own-operate model has the following advantages: first, it allows for the costs of these services to be borne by an outside provider. Second, it allows for economies of scale by having a large private sector player involved. Third, a qualified private operator brings expertise and experience, which the LRA or other public entity would otherwise have to find on its own. A private operator can also bring new ideas to the table, for cost-minimization or other process improvements, during construction and operation of the system. Lastly, the LRA can work with the NEU to implement energy efficiency services for WRAMC's ratepayers.

For financing, we would evaluate the overall life time cost of the NEU funding the project from their own balance sheet or borrowing directly from the markets versus the cost of the LRA issuing industrial revenue bonds on behalf of the NEU. In either case, this avoids the need to push for public grant or tax increment finance money. Notably, the city is considering light rail service for the area, so resting Walter Reed's energy infrastructure on public financing would create a precarious situation in which our proposals would have to compete with various other interests. In this setting, private financing is actually liberating.

Bidding Process

In order to minimize costs and carbon footprint, the NEU shall retrofit the existing heating and chilling plant into a trigeneration system to provide energy efficient, cost-effective electrical and thermal needs to the site. Furthermore, we recommend that the LRA conduct a bidding process requiring a carbon intensity standard that interested bidders must meet in their trigeneration plans. We propose that the LRA further require that interested bidders develop a plan to move trigeneration to zero carbon by 2030.

An excellent example of such a process and district energy system is the HafenCity development in Hamburg. This redevelopment of Hamburg's outmoded port facilities encompasses new and retrofitted buildings on 157 acres, with nearly all buildings connected to district heating. The

energy supply was procured by inviting bidders to meet a carbon intensity of 125 gCO_2 per kWh or less. The winning bidder is now planning to provide firing using a combination of woody biomass, a biomethane fuel cell, and heat pump, which will achieve 89 gCO_2/kWh. In contrast, conventional gas heating has a carbon intensity of 240 gCO_2/kWh. Notably, the system is being constructed with several firing plants that can be launched as the site builds out over time.

The LRA should partner with a third-party expert to identify a forward-looking yet practical carbon standard for the site. This approach avoids the LRA having to prescribe specific generation technologies and instead focus on the end result. Specifically, the LRA should retain this expert to assess and validate the submitted bids, to ensure that the proposed technologies are, in fact, under the intensity threshold, and that the proposed plan for 2030 is a feasible approach. For example, the expert, such as those third-party validation and verification companies that evaluate carbon credit projects, could determine if a woody waste fuel source is in fact low-carbon.

We believe such a carbon standard approach will provide multiple benefits over a technology-prescriptive approach. First, it is a results-oriented approach, focusing on the actual outcomes of site build-out. It is also more aligned with the overall approach of the LRA, which is seeking to provide policies and incentives to shape development, not specific designs. Third, the carbon performance standard inspires creativity and innovation in supply: cutting-edge technologies or combinations of technologies, such as fuel cell, wind, solar, or even less conventional sources such as those used in HafenCity, may be proposed to reach the target. Indeed, the resulting supply technology could provide a model for other district energy systems.

Design Concept - Trigeneration

Trigeneration is an attractive system for Walter Reed because it can serve the year-round heating needs of the hospital, while also meeting cooling demand. Based on some simple calculations, it appears that trigeneration may be cost-effective compared to individual building energy systems and since we already have a central plant system in place, our recommendations are to modernize it while keeping the same overall structure. It remains unclear the extent to which 2,500,000 lbs/day on “average” are seasonally dependent versus steady high pressure steam demand. We know that one boiler supplies the heating needs for the hospital, even in the cooling months. With a large, old and unmetered network of steam piping on the site, a large fraction could be from leaks. Further investigation will be necessary for the third party to successfully size and design the trigeneration system, but we have provided a starting point for the analysis to provide context.

We have been conservative in sizing the system for a continuous year-round heating need of approximately 1,000,000lbs/day. This assumes that the boiler providing heat to the hospital during cooling months is one of the smaller, 60,000lbs/hr units while still falling well below that output. A 7,500kW turbine, with initial capital cost of approximately $15M will provide such steam output and has a simple payback of between three to five years, assuming a gas-fired system. The ultimate decision of what fuel to use, however, will be up to the bidder. Given the quick payback of the system described above, additional cash can be used to fund renewable energy fuel-based systems, such as those run off biomass.

Our recommendation is for a turbine sized to just a portion of the total heating plant capacity in order to serve the steady heating load on site. Additional waste heat during the cooling season can be diverted to an absorption chiller. The trigeneration system is also an appropriate way to respond to climate adaptation needs. In the coming decades, average temperatures in the District are expected to rise, creating growing demand for summer daytime cooling and reducing the typical demand for winter heating. Accordingly, the cooling capacity provided by absorption chillers will be especially prudent in the medium-to-long term. The infrastructure of chilled water distribution is already in place, and should be brought to modern standards of excellence during initial site development, in order to save on construction costs. The operational status, expected lifetime and efficiency of the existing chillers should be considered closely while determining when to phase in more modern substitutes, including absorption chillers.

District Energy System

Micro-grid – Electrical Services and Governance

The NEU should administer an electrical "micro-grid". The micro-grid can realize reliable and high-quality power supply, important for sensitive loads onsite such as the hospital and diplomatic offices. An electric micro-grid consists of local electrical distribution infrastructure and distributed energy resources, which can operate independent of the broader macro-electrical grid and can also connect to it.[1] The NEU will:

- Meet WRAMC site occupants' energy service needs, and administer energy and thermal energy billing.
- Develop and market renewable generation and electrical energy storage. Power development will include trigeneration, rooftop solar, and other mechanisms. Buildings developers will be required to accommodate solar via "solar readiness" or components in design guidelines for developments (see Vertical Development below). The micro-grid will allow the NEU to develop generation and storage infrastructure incrementally, as they become cost-effective.
- Administer demand response programs at WRAMC (see Operations Phase below).
- Sell and purchase power, capacity and ancillary services to PEPCO and/or the wholesale market. Exchanges with PEPCO will likely be required to balance loads at the WRAMC site. As the micro-grid adds generation, demand response, storage, and power quality infrastructure, it will be able to provide increasing services off-site, providing revenue streams for the local utility that can be passed onto customers.

Establishing the micro-grid will require the LRA to coordinate with PEPCO and the DC Public Service Commission (DCPSC) before contracting the NEU. The LRA should arrange for the District of Columbia to sell the transmission system on the WRAMC site as part of the financing for the NEU; owning the lines outright will ease the billing of occupants for energy services. Additionally, the LRA must negotiate with the DCPSC to ensure that occupants of the WRAMC are not subject to retail choice of electricity providers. It is possible that the cost per unit of power from outside retailers could be cheaper than the NEU can provide. However, sourcing power from other retail providers would jeopardize the net-zero energy goals for WRAMC. A

[1] NYSERDA. September 2010. Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State.

condition of living on the site will be forgoing retail choice. Furthermore, the overall energy costs could be about the same before and after the redevelopment.

Comparison of Costs
After preliminary calculations, we believe that ultimately the cost of energy as prescribed above could be on par or lower for residents after this system. Despite the fact that a kWh provide through the gas or biomass-fired trigeneration plant could cost twice as much as the coal-fired equivalent bought from PEPCO, we expect reduced energy costs from two sources. First, our plan stipulates the developer construct buildings that consume approximately 1/3 less energy. Furthermore, trigeneration units have shown to reduce overall energy costs, at a rate of about $1 per 2 square feet. These two savings could reduce the overall cost of energy, and results in a similar overall cost for occupants as prior to the master development.

2. VERTICAL DEVELOPMENT

Energy and Water Efficiency
Minimizing energy and water use is the most important means of achieving environmental sustainability at WRAMC. The LRA can minimize energy use in new buildings by providing appropriate targets, incentives, and capacity building for developers, designers, and builders.

Targets – Specify Energy and Water Use Intensity Targets
The LRA should specify both building energy intensity targets (kWh/sf/yr) and water use targets (gallons/occupant/year). These targets should be specified in the real estate contract with the master developer, to ensure accountability.

It is especially important that the LRA reference an absolute energy intensity target, as opposed to the performance goal relative to ASHRAE 90.1 Energy Standard for Buildings, which is currently referenced.[2] Referencing only ASHRAE 90.1, it does not optimize "passive design" strategies that profoundly influence how much energy buildings use, including: Building form and orientation; interior layout; window size, orientation, and shading feature; and storage of thermal energy using building mass. Indeed, specifying that buildings must achieve a certain degree of performance beyond ASHRAE 90.1 can create perverse incentives to design buildings that do not optimize passive design strategies - a building with poor passive features can sometimes achieve greater energy savings through improved equipment and envelope than one that already maximizes energy savings through its form and orientation. Instead, the LRA should specify energy use intensity targets for the development. These targets could be disaggregated into different loads (cooling, heating, lighting, etc.), to facilitate incentives for good energy performance by the design team (see below).
Likewise, the LRA should specify water use targets. Using super-low-flow and no-flow fixtures and water efficient appliances could save 20-40 percent beyond the District of Columbia Plumbing Code.

Incentives – Reward Developers, Designers and Builders for Performance Relative to Energy Intensity Targets

[2] ASHRAE 90.1 also underpins the LEED green building rating system.

Agency is a major problem in energy and water efficient building – developers typically want to complete projects as quickly as possible at low cost. Likewise, designers, including architects and engineers, and contractors are often paid a flat fee, and thus have little incentive to maximize building performance, especially where pushing into superior performance is seen as increasing risk without any additional financial compensation. To encourage attention to energy use after conveyance of the properties, the LRA could include three types of incentives in its conveyance plans:

- The real estate contract should require that developers place a certain amount of money in escrow, perhaps amounting to $1/sf. Should weather-adjusted energy intensity exceed the target during the first few years of operation, the LRA would keep the fund. The City of Hannover included such a stipulation in its land sale contract in its Kronsberg sustainable neighborhood development. Conversely, exceptional performance could be rewarded with a density bonus (from the escrow) for subsequent developments, recognition from the District, or other incentives.
- The architects, engineers and builders should be subject to an incentive contract, specifying a target price, target fee, and an equation for how much designers will be compensated, based on energy savings and water systems performance.
- On-bill financing can serve as a tool for additional capital investments related to future innovations within the development time frame, given LRA approval. This mechanism can also be provided to building occupants as a way to purchase energy efficient appliances by accessing 0% or low interest loans, provided by the NEU. On-bill financing has been shown to be an effective mechanism by a range of utilities across the country.

The contracts with the master developer should only apply to thermal (heating and cooling) energy use, which can be measured from the District Energy System's meters. Incenting thermal performance would better isolate the energy loads that designers and builders have the most influence over, preventing them from being overly liable to pay for occupant behavior. Occupants would still be obliged to pay for all their consumed thermal energy.

Capacity Building

The LRA, in partnership with government, foundations and/or non-profits, should commission a leading design firm to develop a Design Toolkit, outlining low energy design strategies and a model Integrated Design Process (IDP). Passive design strategies and IDP have proven essential to realizing deep green buildings at a reasonable cost.[3] The Toolkit should provide design guidance for multifamily and mixed-use buildings – the new development on the site. It can serve as resource for WRAMC developers, and for other similar building developments in Washington's climate zone. The City of Vancouver's Passive Design Toolkit and the New York Battery Park City are good examples of such guidelines.

Design guidelines for the site should include "solar ready" guidelines, including a solar access on the rooftops and a conduit through the building to facilitate connection to neighborhood

[3] L.D, Danny Harvey. A Handbook on Low-Energy Buildings and District-Energy Systems: Fundamentals, Techniques and Examples. London: Earthscan; 2006.

electricity and thermal infrastructure. Solar readiness will facilitate subsequent power development by the NEU.

The LRA should also include conditions for community labor participation, as was done in the recent Kroc Center project. Working with the City of Boston and community organizations, Suffolk Construction ensured with over 50 percent of the workforce was comprised of minority group residents living within a one-mile radius of the city. This combined with a 15% female workforce made it one of the diverse work sites in Boston's history.

Water recycling and use reduction

The reuse plan for WRAMC dictates that wastewater treatment and storm water management will be installed on site. We propose that the LRA pursue a comprehensive strategy including greywater reuse, stormwater use, and eventual blackwater utilization.

In pursuing water reuse, it is important to consider public pushback for wastewater systems. However, clear explanations of how the treated water is used, and the system's benefits, can make the difference between enthusiastic adoption and pushback. Singapore has demonstrated a number of great strategies for public engagement around water infrastructure, including establishing the Marina Barrage, a large water catchment area that also serves as a forum for recreation and education around the innovations there. Through increased public awareness, Singapore was also able to reduce the average water usage. Low flow fixtures and feedback (see smart metering section) provide support for water efficient behavior as well.

Grey / Stormwater Management

Greywater and captured stormwater should be filtered, treated by anti-microbial systems, and reused for end-uses such as irrigation, flushing toilets, and facility maintenance. Recycled water outlets could be installed in nonresidential buildings and marked clearly as non-potable water. This solution is especially applicable for uses in institutional and education buildings, such as in machine shops or studios where there is significant water usage and less stringent water quality concerns. Furthermore, at the central district energy plant, treated waste water can also supplement the needs of the open-loop cooling system. Since that open-loop system will have filtration and anti-microbial systems in place, the risk of using treated water is mitigated.

The ownership and maintenance of the gray/stormwater management system should be the responsibility of the master developer. The developer can introduce a service fee for gray/stormwater management to individual buildings. This ownership arrangement is appropriate since gray/stormwater management will need to be integrated into initial site development, and, for the site's users, contributes significantly to water cost reduction. Vertical development and infrastructure should be conducted with "purple pipe" systems such that grey and black water can be handled separately.

The master developer will finance the majority of the costs to build, install, and upgrade the storm water and grey water reuse system. This requirement is comparable to the Naval Air Station South Weymouth redevelopment arrangement, in which the master developer paid $150 million for site improvements and infrastructure. In addition, since the District of Columbia

Water and Sewer Authority benefits from water reuse at WRAMC (i.e., a lowered demand for water provision and treatment), the LRA should also pursue municipal finance in collaboration with the Water and Sewer Authority to cover part of the cost of the storm- and grey-water reuse.

Black Water Management

To achieve the goal of full water reuse by 2030, a black water system will have to be installed. We propose that an onsite black water treatment facility be built during the second phase of the project. Pursuing implementation of a solution once the WRAMC project is well underway will mean that users of the site will be supportive of more innovative sustainability approaches and there will be greater clarity on the suitability of technological approaches in black water treatment.

Black water treatment has significant potential to be used for heat or electricity generation. Microwave treatment of black water is one possible technology that would go into this direction.

We propose that the LRA pursue a mix of three primary financing options for the onsite black water treatment facility. First, the LRA in collaboration with the District of Columbia Water and Sewer Authority would issue municipal bonds to finance the cost of the system. This will, however, lead to an overall water price increase in the DC area. Second, the master developer will provide financing for a portion of the costs to build, install, and upgrade the system. Finally, the technology provider can also be invited to provide the technology at a discount. Technology provider would likely want to do this as WRAMC would provide a stage for showcasing technology and competitive advantage.

The blackwater treatment system should be owned by the local water and sewer authority with prospective of privatization and operated by an independent company. Blackwater reuse should be free for building occupants, to provide an incentive for the inhabitants to switch from gray water reuse to black water reuse, especially as there are significant concerns about quality and safety. The design goal for the treatment system should be self-sustainability though waste recycling, energy generation, and monetization of the waste process byproducts. This pilot project could serve as an implementation and financing model for private on-site blackwater treatment systems.

3. OPERATING PHASE

Behavior and Operations Savings – Enabled via Information

Typical building occupants are largely blind to the breakdown of their energy use, and that has been the case historically at Walter Reed, where there are no meters outside of the central plant. Our operations guidelines begin with sub-metering and move toward increasingly ambitious strategies. All of them focus on leveraging the benefits of the district energy infrastructure to enable extensive demand response and behavioral savings. Further, the data-intensive system will substantiate the site's energy goals and foment continued innovation by highlighting progress still to be made.

This technology's potential is immense. The Federal Energy Regulatory Commission (FERC) has estimated that for the Mid-Atlantic region, a 12% increase in peak load reduction[4] can be captured from demand response activities that go beyond current offerings, relying specifically on a combination of advanced metering, dynamic pricing, enabling technologies and services such as direct load control. Ft Collins, CO has recently contracted a smart grid system containing the array of technologies we outline here. Siemens and eMeter partnered to install the system at a price of roughly $430 per unit.[5]

Below we identify a number of strategies to be used at the Walter Reed site.

Initiate individual metering at all facilities

The LBNL report *Driving Demand* underscores that "designing for data collection and evaluation at the start allows for mid-stream adjustments, better selection among strategies, and knowing success when it arrives."[6] This depends on performance and demand response data, which must be obtained at the building and unit level. Thus, we propose meter installation in all residential and commercial units, with sub-metering in any industrial facilities. This also becomes the backbone of the demand response and dynamic pricing proposals below.

Install advanced metering infrastructure (AMI) and home area networks (HAN)

Individual metering should deploy advanced metering infrastructure (AMI), including "smart meters," enabling the utility to measure usage at short intervals. Additionally, each unit will ideally be equipped with home area networks, where the meter is connected to smart appliances and programmable thermostats for direct and automated control of devices by both customers and utilities. Currently, the ZigBee/HomePlug Smart Energy profile is the most promising communications protocol. In-home interactive displays, such as those made by Lucid Design Group, would improve customer education and interaction with their energy systems. However, a web-based portal (such as that currently under development by PEPCO[7]) may suffice given costs. In either case, bundling all usage metrics into a single interface makes our complex infrastructure clear and legible to end users. These interfaces

Issue default dynamic pricing schedule in opt-out framework

Smart meters and home area networks reach their maximum potential under dynamic, or time-of-use, electricity pricing. As such, we propose that the district energy establish a dynamic pricing protocol. Specifically, we propose that real-time pricing be established as the default rate structure for both residential and commercial facilities, with the option for customers to opt-out into less aggressive pricing structures, such as a critical peak pricing or a traditional flat rate with peak time rebates. This builds on PEPCO's Smart Grid project, which also has a goal of deploying time-based rates.

Facilitate the deployment of direct load control (DLC), interruptible load (IL), and aggregated demand response capacity bidding services

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[4] FERC, *A National Assessment of Demand Response, 2009; p. 30.*

[5] http://www.smartgrid.gov/sites/default/files/09-0007-fort-collins-project-description-08-12-11.pdf

[6] Lawrence Berkeley National Laboratory, *Driving Demand,* 2010; p. 3.

[7] See http://www.smartgrid.gov/project/pepco_holdings_inc_dc_smart_grid_project

To further support customers in dynamic pricing context and to bolster demand response in general, we propose direct load control (DLC) (for residential and small commercial) and interruptible load (IL) (for large commercial and industrial) programs. These should be offered as a default utility agreement at the point of purchase or signing of lease for properties.
In addition to facilitating the advancement of DLC and IL services, we propose that the Walter Reed project take an innovative step in demand-side management by offering an aggregated demand response capacity bidding program for all customers on the Walter Reed site, taking advantage of the PJM Demand Response Capacity Market.[8] In the US, this has been deployed successfully for large commercial and industrial facilities,[9] but is nascent for residential properties. Walter Reed's mixed-use context is ideal to prove that residential customers can be included in such a program—a natural step from existing residential DLC programs. Under this program, the LRA would likely work with PEPCO to provide the aggregation service and to bid into the capacity market, however PJM allows a large number of curtailment service providers (CSPs) that could also be contracted to provide this service.

Partnerships
Given the innovative nature of this project, we envision the LRA partnering with a range of private companies to provide the technology. For smart meters, potential partners include Siemens and Cisco. For demand response, we envision partnering with companies like EnerNOC for the commercial and industrial, and EcoFactor or Comverge for the residential component.

Public Education
The back end complexity of these systems doesn't make public education impossible—indeed, education will be crucial for their success. However, innovations in user feedback make the face of this education genuinely exciting. Companies such as OPower have created an entirely new format for personalized, intuitive metrics. These strategies have gone so far as making competitions or games around energy conservation. The appeal of such games may be surprising, but OPower draws on experimental social psychology to suggest that socialization and peer comparison form a much stronger incentive for behavioral change and skills acquisition than standard approaches touting the technology's beneficial qualities.[10]

4. CONCLUSION

The dominant theme of our recommendations is that careful infrastructure choices will allow the site to achieve the highest performance feasible today, while remaining open for future innovations, which we foresee being numerous even during the site's development. All of our proposals are substantiated by successful deployments, though we believe the scale of this plan is still special. Finally, we believe the private sector's handling of these technologies has matured such that Walter Reed can be a scalable model for industry development. We don't believe standard methods of "free" civic support are possible, either financially or politically. These limits have spurned us to seek innovative public-private partnership frameworks that future developments are likely to replicate and broaden.

[8] See http://pjm.com/markets-and-operations/demand-response/dr-capacity-market.aspx
[9] See EnerNOC, http://www.enernoc.com/
[10] http://www.marcgunther.com/2010/01/19/opower-peer-pressure-and-climate-change/