PARADOX TO PARADIGM
Sustainability & Performance of Heritage Buildings

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ABSTRACT

A veritable sea change in attitude about the performance of heritage buildings and systems has placed them prominently into the sustainability equation. Far from their maligned reputation as "energy hogs," our historic buildings are increasingly recognized for their inherent energy efficiency—thermal mass, durability, indigenous materials, passive systems, integrated landscapes, embodied energy and regional design distinctions. The key lies in holistically identifying, then fine-tuning, existing elements within systems, buildings and communities that affect energy consumption, coupled with data collection of actual performance to prove out results. The authors will demonstrate through case studies a significant reduction in the cost and scope of interventions, along with greatly enhanced appreciation and operation of historic buildings, ultimately benefiting economy, environment and community.

KEY WORDS

Sustainable Preservation, Energy Conservation, Energy Performance, Energy Audit, Clean Energy, Passive Systems, Mechanical Systems, Radiant Heating, Lighting, Window Restoration, Convective Cooling, Thermal Lag, Embodied Energy

PROLOGUE: A PHILOSOPHY OF AUTHENTICITY & REDISCOVERY

In the arena of energy conservation and efficiency, our heritage buildings offer something of great value that new buildings simply cannot claim: the ability for us to measure *actual* performance on-site, in real time and under true life conditions. This is no small matter, given the shortcomings shown by predictive modeling of energy-related performance that is often presumed—and widely marketed—for new buildings. The key to a proper examination and analysis of the performance of heritage buildings is ensuring that the site being measured is operating at optimum levels and as the original architect or master builder intended. Once this crucial analysis is complete and the building has been "re-tuned," any further interventions desired in the name of increased energy efficiency will have a far better chance of being selected for appropriate reasons, right-sized, durable and representing greater value in both initial installation and long-term operation.

INITIAL APPROACH: INSIGHTS ON INHERENT ENERGY PERFORMANCE

Sustainability is not a new concept. It is useful to keep this in mind when considering how the progenitors of our heritage buildings responded to nature in context. Early buildings tend to be sensitively sited to landform and designed with deliberation in their orientation and exposure to fundamental elements of their specific environment: sunlight, radiant heat, breezes, convective cooling, rainfall and water collection. Historic buildings had to rely on natural and efficient forms of heating and cooling, which is often directly reflected in building form and material selection. Local or indigenous materials were used because they were better performers, already adapted to the climatic and seasonal conditions into which they would be exposed. Design elements such as high ceilings, operable windows, varying roof pitches, solid masonry walls, deep overhangs and porches each contribute in their way to create a setting that is naturally energy efficient. Coupled with building form and material selection were systems of heating, cooling and lighting that often were quite simple yet enormously effective, including radiant heat, evaporative cooling, convection, wind catchers and shading devices. Over the past few decades we have become perhaps overly reliant on complex technological and mechanical systems for heating, cooling and ventilating our modern buildings, which has led to—even encouraged—our ability to design nature right out of our buildings. We now tend to forget, or forego, the benefits of our original systems; their rediscovery is the first step in putting back into service what has always, demonstrably, served us well.

***Fig 1.** The four fundamental elements of design contain seeds of energy efficiency.*†

BENEFIT OF EXISTING BUILDINGS: MEASURING *ACTUAL* PERFORMANCE

We now recognize that many claims of extraordinary levels of energy efficiency in new buildings—predictions born of computer modeling and simulation—have proved less than accurate once the building is constructed and subjected to the vicissitudes of human occupancy, actual weather conditions and real-life performance of installed systems and materials. Heritage buildings, on the other hand, offer a valuable and uniquely advantageous gift: the ability to measure *actual* performance…and under a virtually infinite range of conditions.

This clearly has the benefit of tempering overzealous attempts to upgrade or replace heritage building systems or components when that is neither required nor advised. Accurately measuring existing performance, however, requires a keen understanding of the original energy-saving measures represented throughout the building and its site, cataloguing them and ferreting out how well they have been maintained or preserved over the years. Following this, modifications to the building and site must be evaluated for their potential to diminish or otherwise corrupt the originally intended level of function represented by each system, both passive and active. Actual performance will be accurate only when the original systems and architectonic features are functioning optimally, and as designed.

The advent of international codes—covering construction, green building and energy while encompassing vast arenas of efficacy and performance of building assemblies and systems within diverse regional environments—promote a important new tool: the energy audit. These audits are becoming increasingly mandated, regulated and sophisticated. This is welcome news; however, for heritage sites each audit is only as accurate as the auditor's ability and intention to measure a site from the studied

† Credit: The Particle Adventure

vantage of understanding early energy systems, both passive and active, and how they were intended to operate. Not surprisingly, direct and measurable increases in energy efficiency are being achieved not through new interventions but, to the contrary, through the removal of inappropriate earlier alterations, along with the restoration and maintenance of the original building systems, optimizing their performance.

Embodied Energy

It has long been recognized that conservation is the most cost-effective form of energy independence and efficiency; that is, using less and appreciating the value of what we already have in hand. Every intervention toward the goal of energy savings has an associated energy cost with getting it into place: the extraction of raw materials, transport to a manufacturing facility, manufacturing & packaging, transportation to a job site and installation. The sum of this embedded (and very real) cost is globally referred to as "embodied energy," and heritage buildings possess it in abundance. As a representation of costs already incurred, there is great economic—and energy—savings by maintaining and preserving the service life of embodied energy, embracing it as an essential part of the holistic evaluation of lifetime energy costs of a given building. Strictly speaking, embodied energy is defined as the accumulated emissions of CO_2 during construction, maintenance and building/system upgrades, and is differentiated from the emissions emanating from the ongoing operation of a building. Thereby, the global energy costs are a composite of two central elements, as follows:

$$\textit{Lifetime Energy } (\Sigma_E) = \textit{Embodied Energy } (E_C) + \textit{Operational Energy } (E_O)$$

Embodied energy can easily surpass years of operational energy, so care in its application and retainage (preservation) is essential to an energy-saving objective. Further, because the environmental toll relating to the production of historic materials (e.g., glass, cast metals, steel, Portland cement) likely had higher levels per capita of associated CO_2 during their production process than they would today (largely because of salvage and recycling) and since so many historic materials simply are no longer available, the embodied energy of heritage buildings represents an increasingly precious commodity that appreciates—or should—over time.

Thermal Lag & Thermal Mass

Another among the most overlooked energy-related attributes of heritage buildings is thermal lag. Traditional walls, particularly those constructed of solid masonry or cast-in-place concrete, contribute to energy efficiency via thermal mass, a passive system that buffers exterior and interior environments in a highly beneficial way. This occurs principally through the absorption of radiant energy from the sun, which is stored in the walls and transferred slowly to the interior, where it is released diurnally during cooler periods when the heat energy is more easily assimilated or modulated. Often this system becomes corrupted

Fig 2. *Restoring thermal capacity of masonry walls via injection grouting, Christ Church Bronxville, New York.*†

† Credit: Walter Sedovic Architects

by the leaching of mortars or binders within the walls (rendering them too porous) or when walls become saturated with rainwater (affecting thermal conductivity). Deterioration of exterior masonry walls quickly renders this feature ineffective. Typically in modeling calculations of building envelope systems we rely on “R” values (resistance to heat flow; usually applied to specific materials) or “U” values (thermal transmittance through materials and assemblies). Less-frequently discussed but equally essential for energy performance is the role of heat capacity, the measure of how much heat a material can hold. This is generally defined by the equation:

$$\text{Heat Capacity } (C) = \text{Density } (\rho) \times \text{Thickness } (t) \times \text{Specific Heat } (H_c)$$

This demonstrates that higher mass materials exhibit superlative energy performance than that expected by basing evaluations solely on “R” or “U” values. Thermal mass therefore should be considered a more influential determinant of exterior envelope performance than, say, insulation: preservation over intervention.

Breathability (Balancing Air Quality & Humidity)

Transpiration—as differentiated from infiltration—is beneficial for buildings. Historic assemblies are particularly adept at balancing ambient humidity and, in turn, comfort levels. Introduction of modern materials and waterproofing systems in an attempt to impair breathability can trap moisture within walls and cavities, leading to various types of decay as well as the generation and support of mold colonies, resulting in poor air quality. A building that efficiently transpires moisture is inherently more capable of adjusting to weather-related changes throughout the year, relying far less on mechanical systems to balance indoor environmental quality. Porous building materials such as lime and earth-based mortars, renders and plasters absorb and release ambient moisture, buffering the air during alternating periods of excessively high or low humidity. Most modern materials and assemblies do not exhibit this property; their impermeability demands a reliance on mechanical systems to perform this task of adding or removing humidity. Avoiding the use of mechanical systems to temper moisture is inherently both energy- and resource-efficient. As with thermal lag, the importance of properly maintained heritage wall and roof drainage systems is paramount.

Natural Ventilation

The type, location and distribution of fenestration in heritage structures reflect needs dictated by regional and environmental considerations as well as by style. Style aside, the arrangement of windows, transoms, skylights and other means of effecting natural ventilation often represents a considered relationship between prevailing winds and the desired induction of convective currents, which in turn provide for evaporative cooling. Venting units are highly effective passive systems for expelling unwanted heat, and are found in virtually all building types historically: homes, hotels, schools, public buildings…even early skyscrapers. Simply, when hot air rises, cool air takes its place. This natural effect of warm air rising results in the stratification, or layering, of the air inside buildings, referred to as the “stack effect.” It is often accommodated via clerestory windows and high vented ceilings. Additionally, many early heating systems rely on ambient levels of fresh air to induce currents that maintain combustion. One ubiquitous intervention that began in the 1970s and continues to the present—adding “protective” glazing over stained glass windows in cultural and sacred sites—has obviated the use of many operable sash, rendering convective cooling a bygone relic, virtually impossible to achieve without mechanical intervention in the form of ventilating fans or forced air systems for cooling. Proven correlations exist between a lack of natural ventilation and increased levels of carbon monoxide (CO), radon and mold. Conditions such as these resulting from a lack of natural, recurring ventilation have in turn set the stage for Legionnaire's Disease, Sick Building Syndrome and, in recent years, alarmingly increased levels of certain types of lung cancer and asthma, especially among populations of the most susceptible: elderly and children.

While natural ventilation is a positive attribute for the health and well-being of building occupants, reintroducing it in heritage buildings is more likely to be offered via a duct than a window. Codes tend to be complicit by not sanctioning the introduction of fresh air through windows. Also, leading standards for engineering mechanical systems virtually preclude the introduction of natural ventilation through windows into calculations for determining equipment size, output and air exchange and filtering.

TUNING FOR OPTIMAL EFFICIENCY

Building on the recognition and inventory of traditional energy-efficient measures—both passive and active—the driving strategy is to intervene only after the inherent systems are verified to be acting in sync with one another, and optimally. This step engages the art of maintenance. Since maintenance can seem contrary to the *status quo* cycle of remove-dispose-replace, and likely will require sensibilities beyond the daily regimen of many practicing contractors or mechanics, expect this phase of increasing energy performance in heritage buildings to be the most onerous—but also the most enlightening.

Repair and maintenance of integral historic elements and systems, incorporating a regime of data collection before and after each treatment described below, allows for irrefutable proof of claims often cited by sustainable preservation practitioners: that substantial benefits—environmental, economic, cultural—derive from restoring historic windows, maintaining thermal lag, incorporating lifecycle cost assessments (LCA) in each component of the work to ensure that decisions are made on the basis of durability and long-term performance, not on initial cost alone. Coupled with effective methods of measuring the performance of our interventions, we are now building a growing portfolio of data-driven results that will in turn become further implemented, collated, refined and distributed. These tools enhance our ability to consistently demonstrate actual performance and the benefit of each step we take, from the beginning of our engagement at every heritage site.

Exterior Envelope

Optimizing a building's capacity to buffer temperatures relies on a combination of attributes provided by materials, building form and condition, including reflectance, thermal mass, heat capacity and site/roof drainage. Safeguarding the performance of these inherent traditional systems is best achieved through a program of regular maintenance and appropriate repairs that maintain thermal mass and opacity while decreasing water absorption: saturated walls will negate the thermal capacity of mass masonry. Maintenance and restoration must incorporate the preservation of original materials and solidity of wall assemblies, especially those with rubble cores that are highly susceptible to loss of critical binders. As the building's first line of defense, durability and performance are crucial, affecting the efficient operation of virtually every other system housed within the envelope.

Recommended Tune-up:

- Maintain and restore roof and drainage systems, including connections to subsurface drains, site drainage systems and municipal storm sewers.
- Restore site drainage systems at and below grade, such as swales and basins; this imperative includes removal of impervious overlay materials such as asphalt and concrete.
- Restore wall integrity, especially of critical mortars, renders, grouts and binders; this includes pointing and injection grouting with materials—such as lime and natural cements—that maintain and enhance the walls' ability to breathe, act as a thermal buffer and shed water.

Window Restoration

Unquestionably, the single most potent, pandemic and contentious issue affecting the performance of heritage structures centers on windows. Mass marketing of replacement windows (or, more likely, replacement window *sash*) provides a steady barrage of often misleading information to the public indicating that replacing heritage windows is necessary in order to render a building energy efficient. This is patently untrue. Yet, the message persists even as preservation proponents seek to distribute to an increasingly large audience facts about actual performance of historic windows, payback periods, artisans who are equipped to restore historic windows and the multitude of options that abound for outfitting early window units with effective thermal upgrade components.

Fig 3. *Hudson Area Association Library, New York, reflects the dawn of a new era of window restoration.*†

U-value, promoted as a key beneficial feature of replacement windows, is not in fact the most critical performance criterion; rather, infiltration—often *not* included on NFRC†† or similar window performance rating labels—is the culprit most directly affecting occupant [dis]comfort. Infiltration originates in multiple locations in and around a window, and is responsible for creating undesirable convective currents, setting the stage for annoying drafts. It is this reputation as "drafty" that has led to the widespread message windows need to be replaced. Far from it; a restored window can readily exceed the performance of new windows, particularly when coupled with integrated weatherstripping and a storm window. An overriding issue is that many replacement windows are in fact just replacement sash, so that the locations of perimeter infiltration between walls and frames, or frames and sash, are no better—and could become worse—through replacement. Also, many new window systems are fabricated using materials (vinyl, fibreglass, aluminium) and techniques (glue, heat weld, staples) that are not readily restored.

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† Credit: Walter Sedovic Architects

†† National Fenestration Rating Council, US

The “U”-value of an historic window in workable condition with a storm exceeds that of new insulated glass window units; in fact, the actual performance of an historic window with just the addition of interior drapes has a remarkably high energy rating…one that compares favorably with new window performance, at a far lower cost of installation, not to mention the loss of valuable historic fabric that cannot be replaced at any cost.

A fallacy exists on the relative value that windows play in the overall equation of energy performance of the exterior envelope. Windows generally account for about 15-20% of surface area of exterior walls. Further, heat tends to move up through roof or out the perimeter of the foundation walls at grade. Most confounding, though, is the recommendation to purchase and install windows that often have a greater U-value than the walls themselves (not, of course, taking into account other ambient features such as thermal mass and heat capacity discussed herein). A window with greater resistance to heat transfer than the wall into which it is installed is a waste of resources, financial and otherwise.

Buildings require maintenance. It has been said that when building products are sold as “maintenance free,” the underlying message is that the product can’t be repaired. Replacement windows generally fall under this category: Unlike their historic counterparts—designed to be restored on a never-ending basis—once the replacement window system fails, owners are left with the decidedly non-energy-efficient predicament of having bought in to a continuing cycle of replacement.

Finally, the cost savings espoused by replacement window manufacturers often translate to payback periods that extend beyond the life of the replacement window units themselves; it is not at all unusual to find actual—not advertised—payback periods extending 100 to 200 years!

Recommended Tune-up*:*

- Eliminate wall-to-frame infiltration using sealants with backer rod.
- Restore complete original window system (all types, including sash & frame).
- Upgrade weatherstripping at frame-to-sash & sash-to-sash connections.
- Install laminated glass with linseed/soy/lime glazing; use low-e glass
- Replace cotton rope with braided metal chain; adjust and balance weights
- Salvage, repair, lubricate and replace original hardware; adjust sash locks
- Consider installing storm windows: interior or exterior, removable or operable

Radiant Heating

Whether hydronic, atmospheric steam or closed vacuum systems, radiant heating is as efficient as it is misunderstood. Inefficiencies and failures result when these systems are not regularly and properly maintained. As less elegant ducted forced air systems become a widespread alternative to radiant heating, innate understanding and experience with radiant systems is rapidly becoming a scarce commodity; even service companies promoting “maintenance” programs focus more on burners and fuel supply lines than on the system and its component parts.

A boiler has no necessary end life, any more than a teakettle. Several specific issues that readily conspire to diminish the effectiveness of radiant systems are easily corrected, with remedies that themselves are long lasting and inexpensive. These include periodic servicing of a few replaceable parts—vents, traps and valves—as well as ensuring that the boiler fluid is non-corrosive and pH balanced.

Piping and distribution components require periodic investigation, which may be performed as a pressure test (generally at twice the system's working pressure), a smoke test (to determine breaches), an ultrasonic test (for pipe wall cohesion, thickness & type) and/or physical extraction (removal of a section of piping in critical locations to visually ascertain condition). Following this, each radiator may be addressed singularly. First, radiators should never be finished with metallic paints (e.g., silver or gold). Covers over radiators greatly limit their ability to *radiate*. Thermostatic control valves may be installed to individualize the specific output of any or all radiators, allowing effective "zoning" at significantly lower cost.

Recommended Tune-up:

- Regularly inspect vents, traps & valves; replace if necessary (every 5-20 years)
- Regularly inspect elbows, bushings & threads; do not use dissimilar metals
- Maintain low internal pressures for steam systems (3-5 psi, typically)
- Install thermostatic valves (e.g., Danfoss®) at selected radiators
- Install programmable thermostat, but avoid fluctuating temperatures of >4°F
- Be mindful of makeup water; clear condensate trap and ensure consistent pitch; install low-water cut off valve to protect boiler and verify water quality[†]

Lighting

All light eventually converts to heat. This is perhaps the single most important consideration of the qualities of light sources and their efficacy. Lighting for buildings takes three principal forms: daylighting, interior and exterior (site, signage, security & building highlighting). Each of these combine to become the second largest consumer of energy; it is therefore, imperative to optimize lighting in terms of addressing needs as well as lowering operational expenses and the exploration of the inverse relationship between levels of natural and artificial lighting. Heritage buildings capitalize on capturing daylight, thus reducing artificial lighting and resulting heat loads. Energy efficiency therefore benefits through the retention and restoration of internal courtyards, large window openings, shading devices (e.g., porches, awnings,

Fig 4. *Eldridge Street Synagogue, New York, heralds a prodigious array of lighting & system refinements for energy efficiency and international code compliance.*[†]

[†] Credit: F Charles Photography

recessed positioning within walls and window hoods), light tubes (an ancient technology recently re-introduced), skylights, oculi and passive directional lens such as Luxfer® prisms that passively refract light and sent it deep into interior spaces. Complementing daylighting, increasing efficiency of existing historic lighting fixtures may be readily achieved through relamping, which may also be modified to address specific task, performance, egress or other desired lighting enhancements.

Recommended Tune-up:

- Restore original levels of natural daylighting existing prior to artificial lighting.
- Restore windows, transoms, light tubes & skylights, including original size and mullion configuration. Note that modern replacement windows, with their bulky mullion profiles, can reduce the amount of allowable visible daylight by 15-20%.
- Remove protective glazing (polycarbonate) and early protective coatings such as Bakelite®, approaches to fire protection and stained glass preservation; these dramatically reduce light transmittance.
- Remove paints & coatings from Luxfer® prisms that were applied as ersatz waterproofing or response to changes in fashion.
- Relamp all existing fixtures with energy efficient bulbs. Virtually all lamp types are readily availabe in a wide variety of shapes, sizes, wattages & color, in order to provide desirable task & ambient lighting levels in heritage applications; we are no longer limited to compact fluorescent lamps.

ESTABLISHING VERIFIABLE BASELINE DATA BEFORE INTERVENTIONS

Like the restoration of building fabric, interventions must be designed around a set of criteria that incorporate levels of durability, performance and aesthetics on a par with those of the historic resource. Sizing must complement real conditions, both physical and operational, not simply those dictated by universal mechanical system guidelines or, worse, the claims of product manufacturers. Selection of adjunct systems must be based on facts gained through real-life analysis.

First Step: Energy Audit

With inherent energy and environmental systems identified, catalogued, restored to proper working order *and* fully integrated into the realm of building components, an energy audit may now be conducted to provide the baseline data to fill in any gaps between actual and desired—or mandated—performance levels. An energy audit performed in a sequence of “understand first, intervene last” will naturally result in solutions better tailored to refined conditions and more clearly defined goals.

Myriad types of tests and equipment/monitoring devices are readily available in a growing market to attain accuracy without great expense. Tools include hand-held models with digital readouts, microprocessors that surreptitiously collect data (that may be periodically downloaded and collated) and elements comprising a larger electronic network of linked data-logging devices accessed globally.

Blower door technology is fast becoming *de rigueur*, providing holistic evaluations of heritage buildings’ energy efficient potential in a highly effective, non-destructive and universally applied format, generally measuring levels of heat loss as a function of loss of applied pressure. Such tests may measure a single space or entire building, with the distinctive benefit of providing generous amounts of data for heretofore challenging spaces (e.g., capacious sanctuaries of sacred sites). Blower doors pinpoint locations of energy-sapping infiltration; other tests include: Hobo® (thermal lag); IR (conductive & convective loss); thermography (variations of heat/cold); smoke trace (drafts/infiltration); moisture meters & palm test (moisture migration); CO monitoring (updraft, ventilation) and radon monitoring (for cellars & crawl spaces).

DETERMINING APPROPRIATE LEVELS OF INTERVENTION

As indicated above, clearly interventions are not appropriate if they begin to interfere with or diminish the effectiveness of the established architectonic elements already providing energy-related benefits. That said, there are many levels of intervention that complement existing passive and active systems, and the key to their success will rely on three principals: Ease of use, maintenance and reparability. We get handed a maintenance manual with the purchase or lease of a car, yet an equivalent "manual" is non-existent when we become the owners or stewards of a building.

Insulation

Insulation is not the panacea that it is often promoted to be; yet it is a vital component of an holistic energy-efficiency program when thoughtfully applied and can be an effective and long-term performer in appropriate applications. Insulation systems are designed principally to inhibit the transfer of heat, and generally do not take into account the movement of moisture (as both vapor & water) and attendant issues of water-borne salts and other pollutants within walls and wall cavities.

Insulation installed in or on historic masonry walls counters their inherent benefits by severely hindering breathability and thermal lag, thus rendering the traditional value of the assembly inert, or worse. When functioning passive systems are interrupted, they must be compensated for with mechanical systems, which in turn have costs associated with energy use and maintenance. Thermal bridging (locations where insulation is not continuous), moving dew point and, ultimately, condensation suggest that improperly insulating can and does lead to unintended consequences. Perhaps the most efficacious location for insulating heritage buildings is above the highest floor ceiling, which may be an attic floor, cockloft or roof deck.

Mechanical, Electrical & Plumbing Systems

<u>Sizing & Code Requirements</u>. Generally, methods of calculating mechanical and plumbing systems to meet codes often leads to sizing for worst-case scenarios: an overly large system optimized for an event that might occur infrequently, if ever. Tempering the demand loads with common sense and anecdotal information—coupling actual performance measurements gained through an energy audit—will more likely lead to appropriately sized equipment. In this vein, it may be more practical and energy efficient to provide temporary systems to supplement those permanently installed for the few occasions where extreme conditions prevail.

<u>System Controls</u>. Too often the issue of incorporating controls ends up as an after-thought. Control systems represent the heart of coordinated operations, requiring care in selection to ensure compatibility with equipment and ease of use. Establishing the need and function of controls to complement—not eliminate—human dimension in ascertaining appropriate levels of regulating and controlling environmental conditions.

Plumbing & Hot Water. One simple measure effecting substantial energy cost savings is isolating the domestic hot water from larger building heating systems. It is not uncommon to find hot water produced as a by-product of steam or hot water heating production, either directly or indirectly through a heat exchanger or condensing unit. The energy costs of running large boilers is extremely inefficient during non-heating seasons, and the decoupling of domestic hot water may be achieved through the use of a small independent hot water heat, an instantaneous heater located at sinks, or a booster heater for dishwashing. In every case, water may also be pre-heated using a solar thermal system.

Another tactic is adjusting hot water temperatures so that they are appropriate to need and do not require mixing with cold water to achieve a working safe temperature prescribed for routine hand washing or similar daily uses. Further water savings may be achieved through the upgrade or replacement of fixtures and fittings that incorporate aerators and similar devices that reduce flow without reducing effectiveness, or toilet fixtures that offer "half-" and "full-flush" options.

***Fig 5.** Wind & solar at off-grid Block Island North Light, Rhode Island, provide 100% of the site's energy.*†

System Commissioning. Systems are only as good as they actually (not theoretically) perform. With so many variables in installation, operation and occupancy, commissioning is vital to obtain optimal efficiency. System commissioning is best provided by a third party, which ensures that the components and equipment in whole or part are installed and functioning as specified, and that the ultimate users of the system are well versed in its proper operation. Beyond initial commissioning, a program of periodic supplemental commissioning will ensure continued efficiency and timely critical adjustments reflecting seasonal/usage variations.

Renewable & Clean Energy Sources

Growing international interest in renewable & clean sources of fuel have spawned programs ranging from garbage incineration, methane recapture and solar, window & ground-source energy production, for applications both on- and off-grid. Preference of one system over another becomes highly dependent on local geographic, environmental, economic and regulatory concerns. The installation and use of these systems within an historic context is generally highly desirable, beneficial and readily coupled with existing distribution systems (electrical, heating, plumbing). A general list of options, each of which are further subdivided, include those provided through public utilities and distributed along existing networks, or independent installations within property boundaries of an historic site or part of a community-based initiative:

- Geothermal, in a wide variety of configurations;
- Solar hot water;

† Credit: Malcolm Greenaway Photography

- Solar electric, as panels or building-integrated photovoltaic (BIPV) components;
- Wind & tidal turbines; and
- Co-generation plants sized for non-industrial applications.

BEYOND BUILDINGS: EMBRACING COMMUNITY-BASED SOLUTIONS

The penultimate note on energy efficiency is that the more we share, the more we benefit. Stewards of heritage buildings naturally concentrate on the site under their care; however, knitting together multiple sites—especially with divergent uses—into one energy-based community allows for operating efficiencies on a much grander scale. For instance, ground-source based systems may be converted to loops that several individual buildings may tap into, thus lowering initial costs. Further, highly efficient co-generation plants, or district heating systems, may be employed that effectively share energy across platforms on demand: excess heat in one building may be siphoned off to directly heat another space in another building; similarly on the cooling cycle. From a practical standpoint, a school kitchen may export its excess heat to warm a classroom, or a cool church sanctuary may temper the heat in an auditorium or classroom. Community-based energy solutions represent a global network of expanding ideas, products and positive results.

CONCLUSION

The rush to intervene—coupled with misguided perceptions that heritage buildings are somehow inherently energy inefficient—often overshadows a more considered view of the inherent capacity of heritage buildings to be stellar energy performers. Furthermore, it needs to be underscored that in terms of meeting the requirements of prevailing codes, including International Building, Green Construction & Energy, historic buildings should never be exempt. Advocating for their exemption serves only to perpetuate the myth that our historic buildings are energy hogs and cannot compete with their more recent counterparts. Rather, we need a larger and increasingly accessible database of actual performance that demonstrate that historic buildings not only meet or exceed applied standards, but set the stage for smart, durable and regionally-adapted methods of both passive and active energy efficiency. The widespread introduction, and resulting reliance, of mechanical systems to provide what nature used to has spurred an unrealistic, unsustainable demand for instantaneous comfort levels coupled with a forgotten tradition of maintenance versus disposal. As a result, we have tricked ourselves into believing that our historic buildings are operating at a deficit, when in fact if we uncover, re-deploy and work with—not against—our heritage of traditional sustainable systems, we might just discover the energy-efficient gems already within our grip.

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