SOLAR DECATHLON 2017
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Mission Statement

The University of Maryland 2017 Solar Decathlon Team is dedicated to changing our paradigm for sustainable design, educating and inspiring faculty, students, homeowners, regulators and policy makers. Maryland’s prototype will demonstrate an integrated approach to renewable energy, water conservation and waste recycling which works in partnership with the natural ecosystem. Working with manufacturers and developers, the SD2017 prototype will serve as a blueprint for a new generation of regenerative communities. These innovations will be shared with a diverse group of people at the local level and across the world.

Contest Strategies

Architecture

Maryland has assembled a strong multidisciplinary team of students and faculty to create the Architectural design of the house. These designs are being developed through dedicated graduate-level studio courses, with guidance from faculty and a team of professional design mentors.

Maryland’s SD2017 prototype will advance and demonstrate regenerative design principles, creating a home which functions as an integral part of its environment, harvesting energy and water from the site and from ongoing home use, returning nutrients to the soil, and promoting a healthy modern lifestyle for its occupants and the community.

The architectural design of the house will clearly communicate these regenerative features, educating visitors about various solutions to pressing concerns regarding energy, water and waste, inspiring them to adopt similar features in their own homes.

The design also features a flexible indoor/outdoor living space (a courtyard) that acts as the soul of the house. This space is enclosed by a responsive skin that modulates and controls the flow of energy, water and nutrients within the house.

Through an Integrated Design Process (IDP), the prototype will reflect careful analysis of energy and water efficiency, natural ventilation and daylighting, healthy materials and life cycle ‘costs’. All aspects of the design will be carefully detailed to enhance the beauty and function of the house, and to facilitate its construction and transportation.

Documentation of the design will be performed using 3D Building Information Modeling (BIM) tools to ensure consistency and clarity of the Drawings and Specifications. These digital representations will also facilitate communication within the team and rapid prototyping of components. Computer renderings and virtual tours derived from the BIM models will be featured on Maryland’s SD2017 on-line exhibition.

Starting in the Fall of 2016 and through the Summer of 2017 we will shift our architectural attention to Integrated Project Delivery (IPD) methodologies as we seek to advance our project relationships to manufacturers, suppliers, construction and transportation logistics and efficiencies. Our design vision for a successful SD2017 venture includes designing the entire delivery process suitable for larger scale use and market application.

Market Potential

The Maryland SD2017 home is intended to serve a small family – a couple with up to two young children, for example. The target market is environmentally conscious people that want to explore a modern, healthy lifestyle working in partnership with nature and embracing learning through doing and seeing. The goal is to develop technologies and diverse design prototypes which can empower people to live virtually off-the grid while promoting comfort, awareness and beauty. We are also exploring the design implications of home expandability (family growth) and the aggregation of homes (neighborhood implications) into denser configurations. These
considerations will help position the work of Maryland’s SD2017 project to have more versatile and broader market potential.

The Maryland Team draws on the experience of academic departments throughout the University, including Architecture, Engineering, Real Estate Development and the Business School. The UMD Team will also working with a tribe of indigenous people in Bylas, Arizona who are interested in creating a sustainable community of over two hundred homes based on the principles explored and illustrated in the SD2017 prototype. Maryland’s design team is creating not just one prototype but a family of houses based on regenerative design principles, facilitating variations in size and configuration to meet the diverse needs of a real community. The design will also facilitate modifications for climate variations and availability of sustainable/local building materials.

UMD is aware that many people will find many of the proposed innovations a little unusual and even unsettling. By allowing UMD to demonstrate the efficacy and aesthetic merits of these non-standard features to a wide audience, the Solar Decathlon provides a perfect opportunity to foster change in the residential market. Technologies like the Smart House system will, we believe, address many of the concerns some homeowners feel regarding the technical complexity of sustainable systems.

Working in partnership with manufacturers, Maryland’s Team will explore strategies for developing new commercially available products and supply system innovations which are market ready, environmentally sensitive, and cost effective. Maryland will also demonstrate the affordability of Living Buildings and Communities1 when life cycle costs of utilities like water, power and waste management are included. Consideration of the true and total costs of development must be considered in building an authentic sustainable future.

Students, working in collaboration with professional tradespeople, will focus on quality, efficiency and craft in construction of the Maryland SD2017 prototype. Modularity, standardization, and flexibility of components, along with an intrinsic disentanglement of systems and their interdependence will be among the strategies the UMD Team will employ to increase build-ability, reduce construction and transportation costs, and to facilitate changes and/or upgrades over time.

**Engineering**

Maryland intends to take maximum advantage of new rules encouraging innovation in the Solar Decathlon houses. Maryland has assembled a multidisciplinary team of students and faculty from across the University. The UMD Team is determined to bring cutting edge engineering demonstrations to the Competition in Denver and see these advanced successfully commercialized for use throughout the building industry. Technologies will be selected which truly enhance the performance of residential housing; solutions must ‘buy their way in’.

Maryland’s team is developing solutions to a broad range of issues related to sustainability including energy efficient building construction, lighting and comfort control, renewable energy generation, water purification and nutrient recycling. Alternative technologies will be evaluated, optimized and integrated with the architectural design using simulation tools in an Integrated Design Process.

Physically based computer models will be used for the design and optimization of the energy, water, and other house mechanical systems, and also will form the heart of an advanced adaptive control system that will help Decathletes maintain and optimize the performance of the house during the Competition. This Smart House system will anticipate resident behavior and needs, as well as changes in exterior conditions (weather, solar irradiance). Simulations will be used to select control strategies which simultaneously maximize comfort and efficiency; stochastic optimization strategies will be used to maximize the resilience of our design.

The Systems Engineering Team also will develop innovative structural systems which enhance the building’s strength, resilience, transportability, buildability, and resource efficiency.

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1 Living Building Challenge and Living Community Challenge are trademarks of the International Living Future Institute.
The Engineering systems will be highlighted in the public exhibition and through on-line media; the Model Predictive Control strategy UMD is pursuing lends itself particularly well to public demonstration of how anticipated electric power loads will be met over the control system’s prediction horizon.

Documentation of the design will be performed using 3D Building Information Modeling (BIM) tools to enhance consistency and clarity of the Drawings and Specifications. These digital representations will facilitate technical collaboration and coordination within the team, and will assist in rapid prototyping of components.

**Communications**

Maryland will create a coordinated multimedia approach to communication, education and outreach for their SD2017 entry. This begins by creating a powerful, yet diverse brand identity, using images that visitors will find compelling and memorable. Maryland has demonstrated its skill in this endeavor with past entries like LEAFHouse and WaterShed.

Maryland’s greatest communication tool will be the house itself, along with its diverse capabilities. The public exhibition and tours will focus on creating a positive, educational and engaging experience for visitors. Prior to transporting the prototype to Denver, UMD’s Communications Team will conduct numerous public tours, educational and fundraising events at the University construction/testing site. These events will not only communicate the Team’s message of regenerative living to our local constituents (including the general public), but will also help improve the tour and associated materials, hone the Decathlete’s skills at managing crowds and answering questions.

In addition to using the house itself as an educator, the Maryland will create extensive interpretive displays along the tour route covering a broad range of topics related to the Team, design alternatives, underlying principles and implementation processes, construction methodologies, materials, systems, products, ecology, technology, science, culture and sustainable communities. These displays will include a combination of color signage, models, alternative treatment examples and mock-ups, as well as function demonstrations (‘how does composting work?’ for example). Pre-Competition tours in Maryland will provide opportunities to test and refine these materials and ideas as well.

Maryland will develop an on-line experience which parallels and extends the live tour described above. On-line displays will be completely interactive, allowing visitors to delve deeper into the material, link to photo and video galleries, blog posts, detailed product information and technical references as they desire. A 3D virtual tour (enabled for screen or stereoscopic display) will allow on-line visitors to explore the house, get more information about what they find, view the house under different conditions (day and night, summer and winter, etc.).

During the Competition, subscribers will be kept up to date about Maryland’s progress and what’s happening in Denver via social media: Twitter, Snap-Chat, Facebook and Linked-In to name a few on-line venues.

The Maryland Team will form educational partnerships not only within the University, but also with local public schools (in the DC area, in Bylas, Arizona and in Denver), allowing educators and interested parties access to images, information and interviews with Team Members. Similar forums will be set up with professional organizations like the American Institute of Architects (AIA), the U.S. Green Building Council and Green Building Certification Institute, the International Living Future Institute and others. There will be great opportunities for people of all ages and technical backgrounds to learn from this project.

**Innovation**

The Maryland SD2017 house will expand the horizons of integration in residential building. Following the example set by Nature, each function within the dwelling will be performed by multiple components, and each component will be designed to serve multiple functions. Maryland will use this project to demonstrate new analysis applications in the context of a concurrent multidisciplinary design framework. Regenerative design embodies truly sustainable living systems of energy, water, waste, nutrients and materials. This will require a revolution in multidisciplinary research and design.
This research will lead to specifications for new components and systems for energy generation and storage, water purification, waste recycling and building materials. Maryland will work in partnership with manufacturers to develop products like these for test and demonstration in the SD2017 Competition, and for commercialization beyond the Solar Decathlon.

Innovations will include not only new products as described above, but also new applications for existing technologies. Innovations may be high tech or low tech, passive or active. Wherever possible, Maryland will develop both high and low tech solutions to satisfy different interests and markets. Working with industry partners, Maryland will demonstrate the cost-effectiveness and safety of any technology proposed for the public exhibit, and will share these designs with the Competition Organizers for approval before the final designs are submitted.

Water

Water is an important focus of the Maryland SD2017 prototype. Drought is becoming an increasingly critical issue for communities across the U.S., but especially in the West where both the target site for the house and the Solar Decathlon competition are located. Sustainable design practices generally call for the use of low-flow fixtures to minimize the damage done by the building to the local ecosystem and its balance of water. Maryland has taken the position that simply doing less harm should not be the goal of sustainable design; designers should look for opportunities to do more good (net positive water). The Living Building Challenge addresses this issue by requiring projects to harvest all water from rain that falls on the site, preserving lakes and rivers and underground aquifers.

The UMD house is being designed to harvest rainwater from the roof, then filter and sterilize it for potable uses: drinking, cooking, showering, dish washing and clothes washing. Drinking processed rainwater is still against building codes in many parts of the country, but Maryland’s goal is to demonstrate the viability of this approach to water conservation and exhibit the systems involved. UMD will submit technical specifications and test data to the Competition Organizers as early in the design and development process as possible for approval.

It is likely that during the Competition, the Maryland house will rely on water provided by the Competition Organizers since rainfall will be unpredictable and the house will only be on-site for a limited period (and therefore unable to collect and store rainwater from rain events leading up to the Competition). If approved by the Competition Organizers, however, Maryland will seek to capture, treat and use any rain that does fall during the Competition to both demonstrate and underscore its longer term interest.

It should be noted that the Bylas, Arizona, the target site for the house, receives only about 9 inches of rainfall a year, while Denver itself gets about 18 – 20 inches of precipitation. Initial calculations indicate that this quantity of rain is insufficient to meet the potable water requirements for the target residents (a family of 3 to 4). It would therefore necessary that some amount of wastewater would have to be recycled for potable uses, even with low-flow fixtures and dry composting toilet. Maryland’s house will explore systems to recycle, filter and sterilize greywater for use in clothes-washing and showering. Recycled greywater will not be proposed for drinking, cooking or dishwashing, however. The majority of greywater (still filtered and sterilized) will be used for on-site irrigation, including edible varieties. Fruits and vegetables will be thoroughly washed with potable water before being consumed.

Water will not be used for toilet flushing if composting toilets are approved by the Competition Organizers (toilets are not actually used during the Competition). Maryland will also explore technologies for sterilizing composted human waste for use as fertilizer on food crops (again, no such waste will be available during the Competition). This process can also generate methane, which can be stored and later burned to heat water, cook food, and so on.

Maryland will also explore the development of a solar still or similar technology for extracting useful water from urine.
Maryland will install instrumentation to monitor the use of water in the house, and the Smart House system will use this information to estimate available water resources, including predicted rainfall.

**Health and Comfort**

Energy simulations and Life Cycle Analysis tools will be used to optimize the thermal envelope for performance, cost effectiveness and resource utilization (including embodied energy). Vapor permeable air barriers will be specified to meet the required air infiltration rate of no more than 1 ACH @ 50 Pascals, while also preventing the accumulation of moisture within the house structure. Heating and cooling equipment will be selected and sized to meet the Competition’s comfort specifications (temperature and humidity) year round.

Maryland is proposing the use of a ‘chilled beam’ or radiant based system for heating and cooling of the house. Additional dehumidification and humidification equipment will also be specified, based on whole-house simulations and manufacturer specifications.

For optimum indoor air quality and comfort, the Smart House system will provide suggestions to the residents for opening and closing windows (via audible signals, visual cues and text messaging to their mobile phones). During periods where the exterior conditions do not favor opening windows, the house will be equipped with an Energy Recover Ventilator (ERV). The ERV will draw stale air from either the bathroom or kitchen (depending on current conditions measured by the Smart House system), and will be exhausted high on the exterior wall. Fresh air will be taken from different locations on the house exterior depending on the interior and exterior conditions at any given time and delivered to either the living room or bedroom (or both) depending on which space is currently occupied. The ERV will exchange sensible and latent heat between the exhausted and intake air. ERV activation and fan speed will be controlled by CO2 meters located in commonly occupied spaces.

Maryland will perform a blower door test prior to installation of interior finishes in order to identify air infiltration paths while they can still be easily corrected. Infrared cameras will also be used to identify areas of maximum heat loss.

Maryland’s SD2017 competition design will also abide by the ILFI materials ‘Red List’ to protect the long term health and safety of occupants, workers and communities. The house will employ innovative and uncommon uses of healthy, local building materials wherever possible.

**Appliances**

To the greatest degree possible, and in accordance with the published Rules of the Solar Decathlon, the Maryland Team will attempt to use all appliances in a manner representing normal or average behavior for the target residents. Extraneous or frivolous use of the appliances, such as frequently opening the door to the refrigerator and freezer, will be discouraged, however. This is essential in meeting the scoring criteria of the Competition.

In 2017, Teams will be allowed to choose when to perform certain tasks such as washing and drying clothes. Maryland’s innovative Smart House system will determine the optimum time to perform these tasks based on energy generation and use ‘rates’ specified by the Competition Organizers, and will start the appliance cycles automatically.

The Smart House will also automatically optimize heating of water for the scheduled Hot Water draws in order to save energy and maximize comfort. This simulates the function it would normally perform for its target residents, providing hot water as efficiently as possible based on the residents’ normal behavior (waking time, showering times, cooking times, etc.).

All appliances selected for the Maryland SD2017 prototype will exhibit high performance, but to the greatest degree possible will also reflect commonly available brands and consumer choices.
**Home Life**

Daylighting and artificial light design will be verified using computer simulations under a wide range of conditions. These simulations will also assist the Maryland Team and the Competition Organizers in selecting appropriate locations for the Competition light meters. Based on these simulations and on the Solar Decathlon Competition schedule, the Smart House control system will automatically turn lights on and off as required.

The Smart House control system will also ensure that the home electronics are activated during the times prescribed by the Competition Rules.

The Maryland Team has a proud history of hospitality in Solar Decathlon Dinner Parties, and will work to surpass our past successes. These events will be carefully planned ahead of time to ensure that all requirements specified in the Competition Rules are met. Similar care will be taken with the organization of hosted Game Nights.

The Smart House control system will control the charging of its electric vehicle in order to optimize its availability for use in required Competition tasks, and to maximize efficiency (particularly considering the variable rate structure specified by the Competition Rules). The Smart House controller will ensure that the car is fully charged at the end of the Competition. The electric vehicle will be extensively tested prior to the Competition to ensure that it charging times, operating performance and range are fully understood and programmed into the control system.

**Energy**

Careful analysis of the Maryland SD2017 house performance, year-round isolation values and predicted conditions during the Solar Decathlon Competition will be used to determine the optimum size of the photovoltaic and solar thermal arrays. Physically based model elements corresponding to the PV, battery storage, indoor air quality, and building thermal dynamics are under construction, along with discrete-time stochastic simulators of the Denver solar irradiance and weather conditions corresponding to the anticipated SD2017 competition period and throughout the year. The equipment, including charge controller, inverter will be extensively tested and characterized prior to the Competition in order to help ensure success.

The Smart House controller will assist the Decathletes in predicting the energy balance of the house throughout the competition, including considerations of predicted weather, all scheduled operations and events, contingencies and margins. This will help ensure that the Maryland house ends the Competition with a positive energy balance and that other completion requirements – such as all battery storage systems be fully charged at the completion of the Competition – are met.

Maryland’s SD2017 prototype will be equipped with a commercially available battery storage system to promote resilience and enable load shifting in order to optimize our performance relative to the rate structure specified in the Competition Rules. The sizing of the primary battery system and its integration with the home PV and other electrical system components will be guided by the model-based engineering approaches made possible by our current emphasis on model development.
Innovative Technologies, Components, Materials and Systems

Responsive Skin

In climates with extreme seasonal temperature swings, such as in Denver and the team’s home state of Maryland, adaptive skins that respond to various climate conditions amplify a home’s performance. Maryland’s SD2017 Team is developing a system monitored by Smart Technologies that will adapt to variations in weather by closing or opening the central courtyard space based on comfort conditions and energy harvesting potential. In colder seasons, the courtyard will be enclosed by a transparent, insulated glass roof and walls to capture solar gain and disperse the energy throughout the house. Plants can also be brought into the insulated courtyard to extend their growing season. In warmer months, the glazing will retract, and the courtyard can be sheltered with a shading skin or opened to the sky. The courtyard will not only enhance performance and capitalize on passive energy flows, it will also provide a social core and a place of retreat for occupants.

Rainwater Harvesting and Use

Water is an increasingly critical issue in all parts of the world today. The centralized water and waste infrastructures of the 20th century have created wide-spread damage to the ecosystem, and are themselves beginning to breakdown. The Maryland SD2017 house will demonstrate technologies for conserving water, harvesting rainwater and recycling waste. These technologies will be integrated with the architectural design and lifestyle of the proposed market to stress the feasibility and relevance of these sustainable decentralized solutions in the 21st century.

Schematic diagrams of the proposed water and waste systems are provided below.

Rainwater Harvesting – the house will be designed to harvest rainwater falling on the site, filter and sterilize it to potable standards. These systems will be part of the public tour and UMD’s education and outreach program. During the Competition Period, the house will most likely use rainwater provided by the Competition Organizers due to uncertain rainfall and the limited period that the home will be on-site in Denver. Maryland will submit product and system specifications as well as test data to demonstrate the efficacy of the prototype system by February of 2017.

Greywater Recycling

Recycling Shower – In order to reduce the amount of water needed for showering, we are proposing to use systems that recycle water from the drain to the shower head, filtering the water in-line. Several products, including those from Orbital Systems (orbital-systems.com) and CiNTEP (http://www.recyclingshower.com.au/) are commercially available and we intend to work with companies like these to improve the economics of such systems.

Greywater Capture, Recycling and Storage – Greywater will be conveyed from the shower, lavatory sink and clothes-washer to a storage tank. Drain pipes and storage tank for greywater will be dedicated for that purpose, and will be appropriately marked as required by applicable law and building codes. Greywater will be filtered to remove the minimal amounts of incidental solids anticipated from those fixtures before being stored. Non-toxic disinfectants will be added to the greywater if required to prevent it from becoming septic.

Greywater stored in this tank will be used in different ways depending on water quality required and on available energy for processing. Greywater uses will include:

1. Irrigation, toilet flushing and other ‘non-potable’ uses – Unsterilized greywater will be delivered directly to the root zone of plants (including edible varieties) and will not be sprayed into the open air. Unsterilized greywater will not be applied to the edible portion of any plant. All plants will be thoroughly washed with potable water before being consumed.
2. For use in toilet, shower and clothes-washer – Graywater will be treated and filtered to remove any suspended and dissolved impurities, and will be subsequently sterilized by UV light. Specific filtration systems and technologies have not been identified yet, but full documentation will be submitted to the Competition Organizers no later than February, 2017. Greywater will not be used during the Competition for drinking, cooking or dishwashing.

**Composting**

Organic material which humans commonly perceive as waste can actually be a useful source of nutrients. Maryland’s SD2017 prototype is designed to be an integral part of the natural ecosystem, consuming edible and decorative plants from the landscape and returning nutrients to support the web of living organisms in the soil.

**Composter** – Food waste from the kitchen and yard waste from the site (garden, etc.) will be converted to nutrient-rich compost using an on-site composter. Vermiculture (earthworm and microbial) bins are one option also being considered for the production of compost. Maryland plans to transport a functioning composter (including partially or fully composted organic material and worm colony) to the Competition Site in Denver if possible. Alternatively, the composter may be displayed empty, demonstrating the principle.

**Composting Toilet** – Human bodily waste can also be a source of nutrients when properly treated to kill all pathogens. The Maryland SD2017 home will include a commercially available composting toilet. UMD is also considering demonstration of modified or auxiliary equipment that uses solar energy to accelerate the composting process, kill the pathogens and produce biogas. Since the toilet in the house will not be used during the competition, the operation of this system will not be fully demonstrated at the Competition in Denver, but the public exhibit will include explanations of the system function, health safety and economic considerations. Fully composted materials will be on display in sealed containers.

**Urine Distillation**

Human urine is mostly water, but also contains important nutrients such as Nitrogen. Maryland’s SD2017 prototype will demonstrate solar distillation of urine (separated from solid matter in the composting toilet) for recovery of the water and concentration of the nutrients as a fertilizer. Commercially available systems are being considered, as are experimental prototypes. Maryland will submit full details of the system, including test data, to the Competition Organizers for approval no later than February of 2017.

**Energy Recovery**

The Maryland SD2017 prototype is being designed with a tightly integrated mechanical core, facilitating the recovery and reuse of waste heat from refrigerator, cooktop, oven and other appliances in the house. UMD is exploring innovative systems to transfer, concentrate and store this waste heat for use in domestic hot water heating and desiccant regeneration.

Heat will be recovered from waste water as it is flowing through drains, but no batch heat recovery will be used in the Maryland prototype.

The Maryland house will also be equipped with an Energy Recovery Ventilator (ERV). This system will be designed to be reconfigured by the Smart House system to draw its stale and fresh air from different locations inside and outside the house depending on current conditions, maximizing comfort and efficiency. Similarly, fresh air can be delivered to different interior spaces depending on occupancy and other operational factors for maximum health, comfort and efficiency.

**Air Distribution, Heating and Cooling**

Maryland is exploring alternative air distribution systems, including underfloor plenums, to maximize thermal comfort, control and energy efficiency.
Maryland is also performing analysis of liquid desiccant dehumidification systems similar to those demonstrated by UMD in the 2007 and 2011 Solar Decathlon Competitions. These systems absorb moisture from the air using a brine solution, and regenerates the desiccant using relatively low temperature solar thermal energy.

**Smart House Control System**

A key technical innovation of our design it its reliance on an integrated library of physically based models we are developing to describe the instantaneous state of home power, thermal, and water systems dynamics. Our objective is to create a ‘virtual home’ that can be used to quantitatively compare design choices and to assess house performance over a spectrum of conditions corresponding to the Solar Decathlon contest period.

Our extensive modeling work leads naturally to our planned synthesis of a Model Predictive Control (MPC) system for house-wide management of all electrical and mechanical systems in a coordinated and predictive manner. Of course, the environmental monitoring and control system will be integrated with the house safety monitoring and alarm system.

Dynamic stochastic optimization for the integration of house PV, battery-storage, and power management systems for house use-cases developed from the 2017 SD competition rules and projected weather conditions also builds logically on our modeling work.

We have implemented rigorous Systems Engineering methods for requirements management and to help systematize the engineering concept development process and initial hierarchical decomposition of the major home components.

The development of an indoor comfort level objective function that takes into account indoor temperature, relative humidity, radiant temperature, light level, and indoor air speed and chemical composition (e.g., CO2 level) is planned and will be used in the context of our MPC strategy. Appropriate sensors for these quantities will be assessed and/or developed.

**Gravity Assisted and Human Powered components**

The Maryland Team intends to demonstrate several innovative systems for harnessing gravity and human movement for specific applications. In one example scenario, a Decathlete would lift a weight which, as it descends powers a small work light. These devices will be located and operated so as not to impact the thermal comfort, energy balance or lighting levels measured during the Competition.

Innovative mechanisms will also be used for manually opening and closing windows, skylights, etc. In some cases, these mechanisms will be manually preset to perform these operations when triggered by the house’s Smart Control system.

**Miscellaneous Technical Enhancements for Renewable Energy**

Preliminary engineering design of a single-unit glycol-sorbent based carbon dioxide and water vapor absorber and regeneration system for indoor CO2 and humidity control is underway.

Smart and solar-activated thin films for home thermal management, self-cleaning surfaces, and solar-powered disinfection applications are planned.
**Solar Appliances**

*Solar Oven* – Maryland will integrate a solar oven with the design of its SD2017 prototype house. A solar oven is a highly insulated box, glazed on one side and with reflective surfaces on other sides to focus and trap solar heat for cooking purposes. UMD will create a new spin on this conventional idea by adding automatic controls.

**Public Exhibition, Communication & Outreach Strategy**

*Public Exhibition, Communication & Outreach Strategy*

An important part of Maryland’s mission is public education and outreach on topics of sustainable design and living. UMD is working to create a rich, varied, informative and entertaining storytelling experience for visitors to the Competition in Denver, and to Maryland’s online SD2017 home.

Public Exhibits at the Competition in Denver will include signage along the tour route relating:

- background information about UMD Team Members, their motivation and SD2017 experiences
- the genesis of the home’s design, construction and implementation
- intended resident profiles (market)
- economic benefits of sustainable living
- health benefits of sustainable living
- target climate, adaptation and variations beyond the Decathlon
- technical features of the prototype home’s structure, envelope, materials and systems (at multiple points along the tour route)
- important innovations found throughout the house (at multiple points along the tour route).
- permaculture landscape design
- scientific explanations of the principles behind key house components and systems.
- references for visitors to obtain more information beyond the Decathlon

The home’s computer and control system displays will be used to display additional information available on Maryland’s on-line resources, as well as real-time feedback from the Smart House control system:

- a dynamic view of recent past and predicted future power supply and demand levels
- a description and demonstration of the home’s Model Predictive Control system, illustrating the controlled and manipulated variables.

In addition to the education signage described above, Maryland will exhibit functional demonstrations of scientific principles and technologies in and around the house. Exhibits currently planned include:

- how artificial wetlands work.
- high performance building envelope cross section.
- how passive solar heating works.
- how a solar oven works.
- how dynamic models are used to predict the state of the house over the contest period.
Maryland Team Members will be available at the competition site to conduct guided tours, while trained explainers will be stationed at key locations along the tour route as well. Experts in key systems will also be available for deeper dives into various aesthetic, cultural, scientific and technical topics as needed. Tour guides and explainers will be provided with printed references and electronic tablets (which will be charged daily from the home’s solar array and batteries).

Maryland’s SD2017 is sure to be favorite for visitors, and it will be important to ensure a smooth tour experience, avoiding overcrowding and bottlenecks inside the house, as well as long lines outside. UMD’s team will conduct public tours of the house while it is still at the University. These tours and events will help the Team find solutions to problems before the Competition in Denver.

Printed brochures available to all visitors will facilitate self-guided tours through the home and will serve as a field journal for reference being the Decathlon. These brochures will be printed using ecologically sustainable link and media.

Maryland’s SD2017 prototype will be displayed on the Maryland campus in a publicly visible and celebrated site. UMD will create partnerships with local schools and organizations to take advantage of this outstanding educational opportunity. Similar partnerships will be forged with schools and organizations in Denver and in Byalas, AZ to use Maryland’s Solar Decathlon house as an educational resource during and after the Competition as well.

Of course, not everyone will be able to visit the Maryland SD2017 house in College Park or in Denver, so that a comprehensive, compelling and informative on-line destination will also be essential. All exhibit materials and brochures created for the Public Exhibition will also be available through Maryland’s website dedicated to the Decathlon. Many of these materials will be enhanced with interactive features which allow the on-line visitor to explore these topics in greater depth. An interactive 3D Virtual Tour will also be available through the website. These on-line educational resources will be part of a ‘distance learning’ program Maryland will develop with schools and organizations from across the Country and the planet.

Maryland’s SD2017 website will also host numerous blogs chronicling the research, design, construction, transportation and operational experiences of the Team Members. Blogs on various topics will include images, photos and video accounts as well as the written word. In addition to capturing the perspectives of Team Members from all backgrounds, UMD is recruiting Journalism students to produce special features regarding various topics related to the Decathlon. These feature articles may include video pieces filmed throughout the project, including live webcasts from the Competition in Denver.

**Health and Safety Plan**

**Training**

Responsibility for supervising safety during the construction, assembly and disassembly operations related to Maryland’s SD2017 prototype house will be shared between three Faculty Team Members. These Safety Supervisors will receive the 30 hour OSHA training recommended for construction (https://www.osha.gov/dte/outreach/construction/index.html).

All students, faculty, mentors and volunteers involved in the construction, assembly and disassembly operations will receive (at a minimum) the 10 hour safety training program recommended by OSHA, or similar training as recommended by the University of Maryland according to its own Health and Safety practices.

**Supervision**

At least one Safety Supervisor will be present at the construction and assembly sites whenever work is on progress. These individuals will be identified to all workers as part of their orientation. During operations at the Competition site, Safety Supervisors will be identified by a brightly colored shirt / vest to facilitate identification by others in the case of an emergency or when contact with the Competition Organizers is required.
Safety Supervisors shall be fully aware of all health and safety procedures associated with the Competition, including contact information for Competition Organizers responsible for Health and Safety, contact information for on-site emergency medical services, etc.

Safety Supervisors will have authority to order a stop in operations as needed to ensure worker or visitor safety. Work will remain on hold until the problematic condition is resolved. All workers will be encouraged to be vigilant identifying unsafe or unhealthy conditions and bringing such concerns to the attention of a Safety Supervisor immediately.

All electrical work will be supervised by a licensed electrician.

Fire Safety

The completed and operational house will be equipped with smoke alarms and automatic fire sprinklers per the requirements of the Solar Decathlon Building Code. The kitchen and mechanical spaces will also be equipped with readily accessible fire extinguishers intended for use on all types of fire. These will be kept fully charged, and will be regularly inspected by the Safety Supervisors.

In the event of an emergency related to fire, all visitors and workers will be evacuated and the appropriate Fire Control authorities notified. No workers or visitors will be allowed back into the structure until cleared to do so by the appropriate authority. Tour guides will receive training in proper evacuation procedures to be used during public and Jury tours. These procedures will be clearly documented and tested in fire drills prior to commencement of the Competition.

Medical Emergencies

Safety Supervisors (at a minimum) will be trained in emergency medical procedures such as CPR. In the event of an emergency (during construction, assembly, use, disassembly and operation of the house), the appropriate Emergency Medical Services authority will be contacted immediately. Tour guides will be trained to assess possible medical emergencies and provide crowd control during an actual medical emergency, providing an unobstructed path to the affected area for EMS personnel.

The construction, assembly, and Competition sites will be equipped with a fully stocked First Aid Kit.

Personal Protection Equipment (PPE)

During the construction, assembly and disassembly phases, all workers on site will be required to use PPE including hard hats, protective eyewear with side-protection, work-gloves, hard-soled and toe protected work boots with ankle support, and long pants (no shorts). Any visitor will also be required to wear hard-hats and appropriate footwear during construction.

When working more than 6 feet above the ground, workers (and visitors) will be required to wear appropriate fall protection harnesses.

Heavy Machinery Operation

Heavy machinery such as forklifts and cranes will only be operated by workers certified in their use. Operations involving the manipulation (loading, unloading, placement, etc.) of heavy components (walls, modules, roof panels, etc.) will be performed only by properly certified subcontractors. Students, faculty and other personnel not involved in these operations will be required to maintain a safe distance specified by the subcontractor.
ID for Licensed Professional

Garth Rockcastle, FAIA, is the professional architect who will be overseeing the conformance of the design documents in compliance with all jurisdictional and life safety standards applicable for the Team Maryland. Rockcastle is both the former dean, and currently a tenured faculty member, at the University of Maryland, and the founding principal (1981) of MSR Design (Architecture, Interiors and Urban Design) based both in Maryland and in Minnesota. The firm principals hold registrations and have practiced in most states, including Colorado. Rockcastle has been the principal in charge of over $850 million of construction over the past 35 years, including work in diverse residential, institutional and commercial building types.

Preliminary Design Specifications

Specific materials and products have not been selected for the Maryland SD2017 prototype. The following information is intended as a preliminary performance specification.

General Material Properties:

All materials used throughout the project will be ‘Red-List Free’ or ‘Red-List Compliant’ according to the requirements of the International Living Future Institute’s DECLARE program (though not all materials may be officially certified under that program). Maryland’s 2017 Solar Decathlon project will submit at least one new product for DECLARE certification.

To the greatest degree possible, materials will be 100% recycled and recyclable, including compostable materials that are recycled as ecosystem nutrients. Rapidly renewable materials will also be favored.

Locally harvested, manufactured and distributed materials will be favored where they meet performance specifications.

Interior Finishes:

Wall and ceiling finishes will be low-VOC and have a ½-hour fire rating. Paints and other coatings be loe-VOC as well.

Walls in wet service areas (showers, etc.) will have waterproof finishes (tile or similar) with moisture and mildew resistant backer panels. Ceilings in these areas will be TBD moisture and mildew resistant wallboard with paint or other moisture-resistant coating.

Hard floor surfaces (as opposed to carpeting) will be used throughout the project to maintain superior air quality, eliminating surfaces that can attract dust and pollen. Area rugs will be used as needed and will be considered furnishings. Tile floors will be used in all wet service areas such as bathrooms, laundry and mudrooms.

Wood

All wood used in the project will be FSC Certified, rapidly renewable or reclaimed. Wood composite materials may be used, but shall be urea-formaldehyde-free.
Insulation

Several alternative insulation materials are currently being considered, including cotton batts, cellulose, foam and rock-wool. No decision has been made. Insulation must be low-VOC.

Target R-values are as follows:

- Roof – R-60
- Walls – R-35
- Floors – R-20

Structural Framing

Structural insulated panels, light-gage steel framing and wood framing are all options currently being considered as structural materials. No decision has been made.
Roof Plan

Telescoping Glass Roof

PV Array

64" x 40" Solar Panels

Pergola
1. Courtyard Shaded | Summer
2. Courtyard Open | Temperate Night
3. Courtyard Sealed | Winter
**WellSpring**

At the University of Maryland

**Team Name:**

**Address:**

University of Maryland
School of Architecture, Planning & Preservation
Bldg 145, College Park MD 20742

**Contact:**

**Issue Date:** 29 April 2011

**Drawn By:**

University of Maryland

**Checked By:**

P001

**Schematic Diagram**

- **Blackwater Tank**
- **Greywater Tank**
- **Filter & Sterilize**
- **Pump**
- **Downspout**
- **Prefilter**
- **Rainwater Storage**
- **Pex Manifold**
- **Dishwasher**
- **Cloth washer**
- **Kitchen sink**
- **Shower**
- **Lavatory**
- **Washer**
- **Ice Maker**
- **Whirlpool**
- **Filter & UV Sterilize**
- **Sterilized Greywater**
- **Composting Toilet**
- **Biogas**
- **Biogas Storage**
- **Fire Pit**
- **Transfer Solids**
- **Thermal Hydrolysis Digester**
- **Urea**
- **Solar Still**
- **Class A Biosolid**
- **Garden**
- **Composting System**
- **CW**
- **HW**
- **CW**
- **HW**

**Keynotes:**

- Hot Water
- Cold Water
- Waste Water Drain Line
- Rainwater
Hot Water
Greywater
Cold Water

Notes:
Biosolids & urine distillation systems are not shown.
Filtration & sterilization system is not shown. May be stored under courtyard

Keynotes:
DN
1' - 8"
3' - 3 1/2"
2' - 4"

HWH
Blackwater Storage Tank 5'*8'*2'
Composting Toilet
Portable Water Storage Tank 5'*8'*2'
Rainwater Storage Tank 5'*8'*2'

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School of Architecture
Planning & Preservation
BLDG 145, College Park MD 20742

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University of Maryland

Sheet Title:
P101
Plumbing Plan

1/4" = 1'-0"
Supply Fresh Air
Fresh Air in
Stale air intake (Return)
Control Valves
Exhaust
Liquid supply for chilled beam
Air flow

NOTE:
Chilled beam HVAC system
1. Winter day fresh air in at roof
2. Summer fresh air in (at deck level)
3. Winter night fresh air in near south facing thermal mass
4. ERV unit above heat pump
5. Chilled beams 8"x2"x3' above recessed ceiling panels
6. Condensate sensor
7. Stale air intake
8. Exhaust, 2' above roof
1 flat bed truck carrying mechanical core, furniture, and tools.
3 trucks carrying 3 forty foot containers to and from site.
WellSpring
At the University of Maryland

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Address: University of Maryland
School of Architecture
Planning & Preservation
BLDG 145, College Park MD 20742

Contact:

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Sheet Title: On Site Construction

01

Placement of foundation jacks.

02

Placement of panalized floor modules.

03

Placement of panalized walls.

04

Placement of panalized roof modules.

05

Placement of deck.