

Creating regional Detroit's first "net zero energy" community

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ABSTRACT:

A multi-disciplinary faculty/student research team (the Team) at an accredited Architectural School, is partnering with the Southwest Detroit Development Collaborative (SDDC) to create a plan for our region's first "net zero energy" community by defining and modeling key elements of a sustainable community to inform the future urban form of Southwest Detroit.

Guided by our investigations, we will make recommendations on how existing community initiatives and the SDDC can use energy solutions, density, and community empowerment to create a sustainable community. The team is focusing on three areas: ecological footprint, LEED ND, and hybrid alternative energy.

Utilizing our unique digital mapping interface, we will add relevant data, model "analysis layerings", and make specific design proposals for these key elements: energy hubs, green economy, targeted, mixed-use density, and green infrastructure to support enhanced pedestrian mobility, mass transit, and electrical vehicle fleets. This project is consistent with the U.S. Green Building Council's Leadership for Energy and Environmental Design [LEED and LEED ND] and will integrate LEED criteria into our digital mapping interface to recommend where points can be gained for sustainable design.

The team will incorporate alternative energy sources such as solar and wind power systems which are the foundation of powering residential, commercial and industrial needs, recharge stations for electric vehicles, sub-grade battery banks, and a system for compressing air in unused salt mines underneath Southwest Detroit. We will establish an ecological footprint for the community, identifying opportunities for repurposing of vacant land and development of alternative energy to drive and support sustainable community and economic growth. It is hoped that the outcome of this research would make Southwest Detroit our region's first net zero energy community, serving as a prototype for the rest of the city and state, as well as cities worldwide.

CONFERENCE THEME: Sustainable Paradigm: Creating Detroit's first net zero energy community

KEYWORDS: sustainable urbanism, urban mobility, alternative energy, densification, digital mapping interface

INTRODUCTION

INTRODUCTION AND PROJECT SUMMARY

A multi-disciplinary faculty/student team (The Team) is building on an existing collaboration with the Southwest Detroit community through the Southwest Detroit Development Collaborative (SDDC) and with the generous support of the Ford Motor Company's College Community Challenge (Ford C3)¹. The Team is partnering with four established SDDC committees: Transportation, Housing, Green Infrastructure and Economic Development and WARM Training to create a plan for Regional Detroit's first net zero energy community. The Team is investigating the roles that an innovative hybrid alternative energy solution, density, and community empowerment play in creating a sustainable community. Further enhancing our unique GeoDesign digital mapping interface on a Google Earth Platform and incorporating geographic information systems (GIS), the Team will add relevant data for vacant parcels and infrastructure, model "analysis" layerings and make specific urban design proposals for the key elements of a sustainable community: alternative energy, mixed use density, urban mobility, public realm and green economy to support enhanced urban mobility, including improved pedestrian environments, mass transit and electrical vehicle fleets (EVs).

CONTEXT

SITE CONTEXT

Detroit, MI, USA, currently the 11th largest city in the US, is located at the center of the Great Lakes Basin bioregion. Detroit's challenges have been well documented in the national and international media.² To address vacancy disinvestment and other structural issues, the current Mayor has recently initiated a "right-sizing" plan for the city, entitled the Detroit Works Project³. Despite the prevailing perception, Detroit still has viable, even thriving, neighborhoods. The project context, Southwest Detroit is a diverse and vibrant community, and serves as an ideal prototype for building a sustainable community. The 12,450 acre (19.45 square mile) neighborhood is bordered by the CBD to the east, the Detroit River to the south and the Rouge River to the west. See *Figure 1*.



Figure 1: Diagram Detroit Municipal boundary and Southwest Detroit [Inset] (Studio [Ci], 2010)

The neighborhood contains the junction of major highway and rail infrastructure, and serves as a critical regional transportation hub which can be leveraged for the creation of the Team's recommended alternative hybrid energy solution. The neighborhood has a base of high wage jobs and established employers within and adjacent to its boundaries (Ford Rouge Plant, Severstal Steel, National Steel, The Port of Detroit, etc.). This history of stable economic activity can be leveraged to establish and grow a future green economy. This industrial legacy has also supplied brownfields and vacant buildings and parcels that become adaptive reuse opportunities for establishing sustainable targeted mixed use density. Southwest Detroit is socially sustainable due to its diverse demographic profile, and is one of the only neighborhoods in Detroit that is adding population.

The authors considered other neighborhoods and organizations to partner with for the Ford grant; however, Southwest Detroit proved the ideal choice. It allowed the Team to build on past collaboration with a community partner and to expand the scope of work to meet the primary author's pedagogic and design research objectives of focusing on the role of density in sustainable urbanism. It also allowed the Team to meet funder goals in several ways. The project gives Ford the opportunity to produce a prototype sustainable community in the shadow of the historic Rouge Plant, which William McDonough+Partners, Dirt Studio, et al created a sustainability Master Plan which includes the construction of new plants, alternative energy, and landscape interventions.⁴ Further, it allows Ford a chance to leverage other investments in Southwest and Detroit proper.

2.0 APPROACH AND RESEARCH METHODOLOGIES

The Team believes that as designers, we must look *beyond the building* employing a holistic approach to the city and its urbanized region. The Team's research subscribes to current theoretical and design approaches to systemic design⁵ and sustainable urbanism⁶. We believe there are valuable lessons to be

learned by focusing on post industrial cities, rather than cities in BRIC nations that are experiencing explosive growth. No matter its growth profile, the city is a consumptive entity, challenging its ecological context. As Mostafavi observes:

How can the city, with all its mechanisms of consumption – its devouring of energy, its insatiable demand for food – ever be ecological? In one sense the “project of urbanism”...runs counter to that of ecology, with its emphasis on the interrelationship of organisms and the environment – an emphasis that invariable excludes human intervention.⁷

The Team is expanding upon the established methodologies for *carrying capacity*⁸ to define a *tipping point* of human habitation in the urban context; defined as: a level at which the new eco-system created through built and population densities begins to negatively impact the natural environment and ecology of an urbanized region. For civilization to endure, cities must begin incorporate into the natural systems that support their existence⁹. In support of this systemic approach we define urban infrastructure broadly as blue, green, gray and white, and view it as the eco-system of the sustainable city, both reinforcing and defying social, political, and cultural boundaries in the same manner as natural systems. We believe that any design and/or policy recommendations that inform the city must simultaneously seek to understand, document and artfully integrate social, economic and environmental parameters. We utilize our research methodology to support the creation of both formal and policy recommendations to encourage informed decision making around balancing the long term benefits and impacts of urban density.

For the Ford C3 project, we have defined the elements of a sustainable community, including social, environmental, and economic aspects, see *Figure 2*.

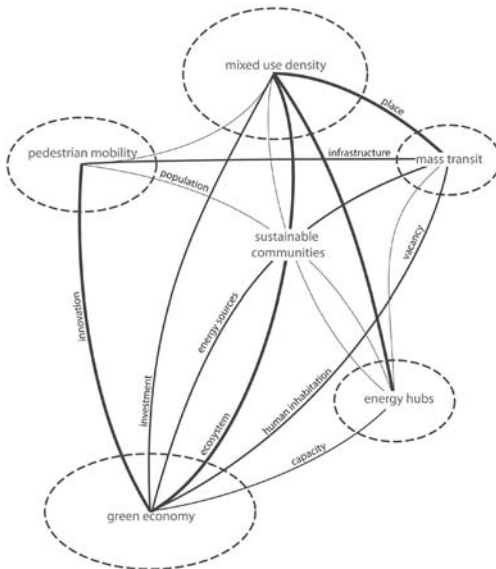


Figure 2: Strategy for a net zero energy community (Studio [Ci], 2010)

The Team is employing a collaborative and inter-disciplinary approach to the project. The Team works with the community through visioning, goals establishment, and the generation of deliverables to create a plan for a *net zero energy community*. This methodology borrows from established participatory planning processes in support of sustainability¹⁰. We are cooperating with our community partner on three tasks: community process+technical assistance, data input+analysis, and design+policy recommendations. Each task features community engagement, training, and specific deliverables to ensure that the project can endure after the Ford C3 grant is complete. *Figure 3*

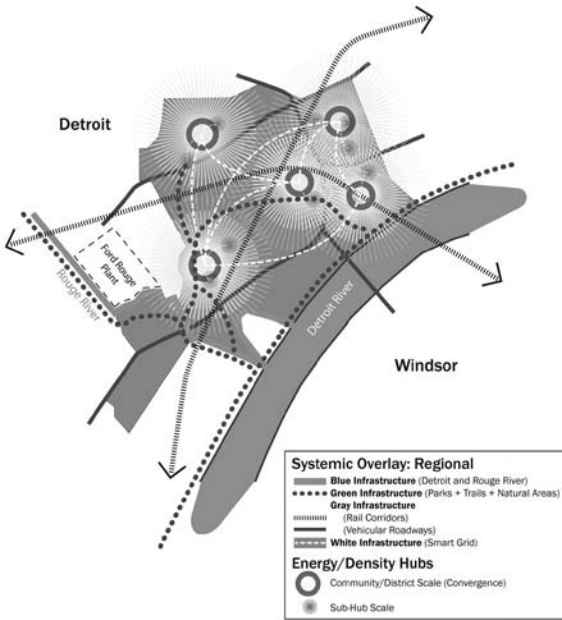


Figure 3: Holistic and Systemic Approach to Creating a Net Zero Energy Community. (Studio[Ci], 2011)

2.1 THE CONVERGENCE OF INTENSITY [CI] METHODOLOGY

The fundamental question in building a sustainable community is: where and how will we sustainably redevelop and support resident populations with energy, infrastructure, services and investment? Since answers to this essential question in Detroit have been dominated by capricious political, market, and social forces, the authors believe that application of metrics and a “criteria driven” approach are essential. Further, that a new urban geography and eco-system are required which leverage the assets and complex combinations of forces of the city-scape. Through the Ford C3 project, we hope to continue to empower the community and prompt a civic dialogue around building a sustainable community. The SDDC and member Community Development Organizations (CDOs) are already creating a culture of sustainability in Southwest Detroit, and this project is assisting in engendering this culture throughout the entire community. Our ongoing efforts in Southwest Detroit have focused on the role of density in sustainable communities.

The authors believe that sustainable community begins with *Value Densification*: an urban design theory, a community process, and a digital mapping interface to empower the community and prompt a civic dialogue toward:

“...a focus on investment and development in neighborhoods and districts where inhabitation, infrastructure, cultural and employment assets [and value] are in evidence.”¹¹

The authors are interested in relevance and the applicability of the digital interface. The response is: Convergence of Intensity [Ci]:

“a value based approach which builds on Value Densification and recommends the new geography of the city. Ci proposes specific criteria for building sustainable communities, arguing that balanced, sustainable, dense and urban development is still possible in a post-industrial city like Detroit. The methodology empowers communities to proactively identify and design for the coming together of a broad host of metrics into a spatial convergence. The primary author defines this purposeful phenomenon of re-sizing the city based upon these metrics as a convergence of densities [intensity] intensive convergence or a convergence of intensity [Ci]”¹².

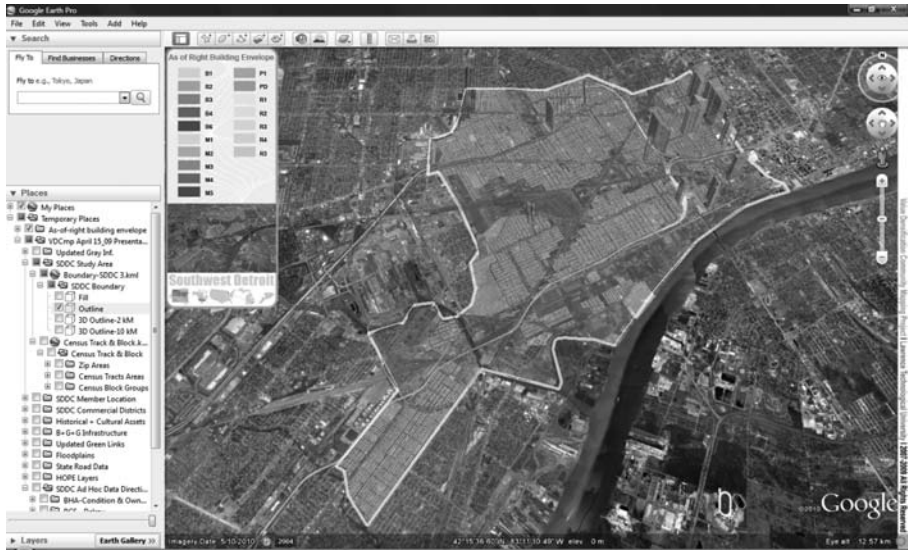


Figure 4: Screenshot of Data Layers in our digital mapping interface using Google Earth. (Studio[Ci], 2009)

Our methodology empowers cities to proactively identify and design for the “coming together” of population, energy, capacity, investment, blue, green, gray + white infrastructure and existing built form into a spatial convergence. We define this purposeful phenomenon of re-vitalizing the city based upon broadly defined density metrics as a convergence of intensity [Ci]. Our Ci methodology consists of three steps:

2.1 IDENTIFY AND MAP BROADLY DEFINED DENSITY METRICS/ASSETS

First, we identify and map density metrics/assets. As urbanists, we believe that density/intensity is sustainable and should be broadly defined and visualized in three primary categories:

1. *Human [inhabitation]* – Focusing on stable, even growing populations. Concentrations of inhabitation serve as the primary criteria. For the Ford project, we are mapping data sets on immigration, age and ethnicity.
2. *Cultural [place]* – Focusing on layers of built and narrative heritage. Concentrations of such resources and embedded meaning become the second criteria. For the Ford project, we are mapping data sets on vacant land and housing¹³, among others.
3. *Infrastructure [ecosystem]* – Focusing on the rich investment in physical and technological infrastructure that supports manufacturing and movement of goods and services and the human settlement associated with these activities. For the Ford project, we are mapping blue, gray, green, and white infrastructure.

We obtain primarily publicly available data from a variety of sources (US Census, etc.) to create “data layers” in our interface. We then create three-dimensional extrusions of the data, so the community can easily see and interpret concentrations of intensity. To date, we have mapped over 115 layers for Southwest Detroit. (See Figure 4)

2.2 CREATE ANALYSIS LAYERINGS UTILIZING DATA LAYERS TO INFORM FUTURE POLICY, PLANNING AND DESIGN:

Second, we create “Analysis Layerings” [or mash-ups] utilizing data layers to inform future policy, planning and design. The Team’s methodology and digital interface allow for multiple data layers to

be overlaid simultaneously so one can see the “convergence of intensity” of community resources/assets. This can construct infinite combinations for collective dialogue, decision making, design recommendations and implementation. The SDDC’s Transportation Committee is focused on several large scale infrastructure projects: the Detroit River International Crossing, and Detroit Intermodal Freight Terminal, among others. An example of how the digital interface supports advocacy efforts is illustrated in the Transit Analysis Layering in Figure 5, which is comprised of three data layers. Armed with the information, the community is utilizing this layering to advocate with their elected officials for a much needed transit stop in their neighborhood.

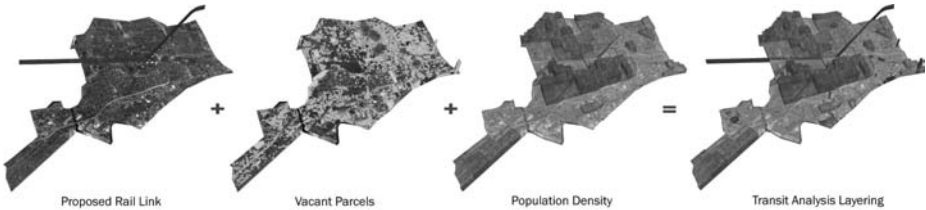


Figure 5: Screenshot of “Transit Analysis Layerings” (Studio[Ci], 2009)

2.3 DETERMINE THE “GEOGRAPHY OF CONVERGENCE” TO DEVELOP FORMAL DESIGN RECOMMENDATIONS

Our third step is Design. In the first application of our methodology, we began by determining the “Geography of Convergence” -- mapping concentrations of assets based on five [5] metrics [criteria]: energy (organizations and informal cultural assets), capacity (as of right zoning), population (density by block group), investment (business and employment density by block group), and infrastructure (neighborhood parks, greenways, proposed rail link) to develop formal design recommendations. Figure 6.

The resultant analysis layering shows the new “geography of convergence” within a ¼ mile walking radius of social, economic and environmental asset density in the Southwest Detroit neighborhood.

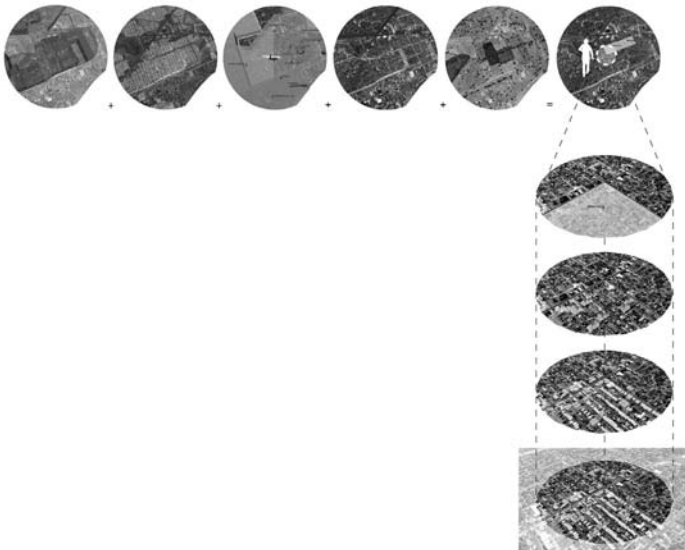


Figure 6: “Geography of Convergence” (Studio[Ci], 2009)

2.4 DESIGN APPLICATION

In this district-scale design application, we partnered with the Southwest Detroit community in 2009. The community client selected Scotten Park a 53 acre area of Southwest Detroit, as a “beta test”. Michigan State Housing Development Authority [or MSHDA] subsidies had been granted to build housing in the district. First, we conducted site visits and existing conditions documentation. Next, we generated a digital model of existing built and proposed development for the study area. Figure 7 (top left) illustrates the community client’s, MSHDA application illustrating low density (8-3BR) townhouses on the identified development parcels. We then we identified all vacant parcels in the study area that were “buildable” and realistic for future development. Our proposal yielded an additional 30 development parcels.

We developed an urban design rationale, utilizing GeoDesign tools and principles to guide our density recommendations, including:

1. *As of Right Zoning* – the study area contains two zoning districts: R2 + B4. Each allows a maximum height of 35’, with front and side setbacks from parcel lines based on existing built context.
2. *Street Grid* – the perimeter streets are four travel lanes each with widths that allow for more height and density, and also present the opportunity to continue the existing pattern of ground floor commercial.
3. *Solar Orientation* – the study area is ideally oriented with southern exposure. The proposed building massing reflects opportunities to maximize sunlight future green infrastructure.
4. *Circulation + Public Realm* –proposed buildings are massed and sited to concentrate pedestrian traffic and entry along perimeter and residential street frontage and contain residential vehicular traffic and parking access via existing alleys. Initial opportunities for green courtyards between and alongside residential buildings were identified.
5. *Building Typology and Program* – two new typologies were recommended: Mixed Use [with Ground Floor, Commercial] and Apartment Residential. We modeled the maximum density allowed under the current City Zoning ordinance. Our “MAX Zoning proposal” is 55 units/acre and 6.5 times more dense “as of right” than the client’s MSHDA application! We designed and modeled 30 new mixed use residential buildings with 482,458 sf. of proposed residential density distributed among 488 total units [111 one bedroom units; 236 two bedroom units; and 141 three bedroom units] and 62,108 sf. of new commercial density in the study area. This proposed density, if built, would essentially double the real estate portfolio within walking distance of the convergence of densities found in the “Analysis Layering”. *Figure 7.*



Figure 7: Design Application: “MAX Zoning proposal” utilizing our digital mapping interface (Studio[Ci], 2009)

We have been encouraged by the results of our initial design process and the resultant formal recommendations and are motivated to continue to enhance the Ci design methodology and interface. We are in the process of implementing a Sketch-Up plug-in software called *Modelur*¹⁴ that creates parametrically controlled building forms for urban scale study.

2.5 APPLICATION OF THE CI METHODOLOGY FOR FORD C3

The project involves employing our digital interface and applying the Ci methodology to meet the goals of the project. This includes mapping context layers of regional energy and new layers, such as Detroit's underground Salt Mines, and updating existing layers, such as vacant parcel layers, and blue, green, gray, and white infrastructure layers, etc. In the initial phase, the Team mapped the proposed major green community projects of interest to the SDDC committees along with the potential impact areas within the community.

The Team then created analysis layerings to determine the new geography of a sustainable Southwest Detroit. This allows us to define the location of concentrations of where to densify, where to site energy hubs, etc. Based on this new geography, we are locating, designing and modeling urban design recommendations for the five key elements: energy hubs, green economy zones, concentrations of targeted, new mixed use density and green infrastructure to support enhanced pedestrian mobility, mass transit and EVs. These urban design recommendations will serve as the core of the Plan. Eventually we will evaluate impacts and benefits of the plan by remodeling the Eco-Footprint for the neighborhood.

3.0 REPRESENTING AN INNOVATIVE APPROACH TO "BUILDING SUSTAINABLE COMMUNITIES"

The Team established a team research methodology, documentation standard and RefWorks account for seven categories to support our process: Eco-Footprint, Alternative Energy, Software, Urban Mobility, Implementation, Regulations+Incentives and Local+Regional+Global Precedents.

In researching precedents for the design of 'net zero energy' communities, we looked both globally and within the Great Lakes Basin in order to learn from and model relevant climatic, cultural and economic conditions. We have researched Masdar City¹⁵ outside of Abu Dhabi designed by Foster Partners, and find that there is relevance to our work in Southwest Detroit, particularly in regard to the goals and principles established for the project, including: Synergy, mobility, energy, and quality of life. Further, the design of Masdar City was guided by 10 principles of *One Planet Living*¹⁶.

However, we find the relevance of Masdar City, and similar precedents, limited, because the project is new construction located in the middle of a desert with significantly different climatic and capacity conditions to Detroit. More relevant precedents relate to extant urban areas with similar climatic and capacity conditions, such as the town of Vauban outside of Freiburg, Germany, the recent work of NYIT Professor Tobias Holler for Long Island, New York, and MIT Professors Andrew Scott and Eran Ben-Joseph for the Tama New Town, close to Tokyo¹⁷.

We have defined and modeled key elements of a sustainable community to inform the future urban form of Southwest Detroit. The Team employs a value/asset-based, community-driven approach for the identification of resources. The Team's unique GeoDesign digital mapping interface on a Google Earth Platform and incorporating geographic information systems (GIS), allows for diverse data and software inputs.

3.1 ECOLOGICAL FOOTPRINT

The Team began the project with the objective of establishing an ecological footprint for Southwest Detroit. This Eco-Footprint is intended to provide a baseline for evaluation of existing capacities, demands and impacts for attainment of a 'net zero' energy profile through specific outcomes (e.g., the urban design and policy recommendations). There exist two generally accepted methodologies to create an ecological footprint: the Compound Method¹⁸ developed to measure the ecological

footprint of nations; and the Component Method to measure the ecological footprint of cities¹⁹.

We conducted a literature search of current methodological approaches, with particular emphasis on the work of William Rees and Mathis Wackernagel, the Global Footprint Network, et al²⁰. An ecological footprint is defined as,

“A measure of how much biologically productive land and water an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates using prevailing technology and resource management practices. The Ecological Footprint is usually measured in global hectares. Because trade is global, an individual or country’s Footprint includes land or sea from all over the world.”²¹

However, these methods, while applicable to an individual, a city or a nation, proved limited for our purposes to establish a baseline Eco-Footprint for the mid-scale: an urban neighborhood. We devised an alternate methodology based on these proven methodologies, to support the sustainable design goals of the project.

We first structured our Eco-Footprint with three main categories: capacities, consumption and impacts. We defined six subcategories of consumption: 1_land+built form, 2_water, 3_food, 4_energy, 5_mobility, and 6_materials+goods+services. Our defined capacities include: land capacities, build out envelope, aquifer/watersheds, microclimate+renewable energy sources, infrastructure, housing, retail and living wage jobs. Figure 3 is a detailed graphic depiction of the complex interrelationships of our mid-scale eco-footprint.

Our second step was to establish two consistent metrics which will generate all other supporting statistics. First, is the population of Southwest Detroit at 106,749 (2010 Census) and second, the area of Southwest at 12,450 acres. We decided not to convert to a standard unit of measure, (e.g., adapt all metrics to standardized global hectares), but allow metrics to vary within the six categories. However, we will maintain these metrics consistently across from capacity to impact. All metrics are based on current and/or actual data; extrapolated or interpolated²².

Our third step was to research publicly accessible databases²³ establishing metrics for each subcategory of consumption, (e.g. for 4_Energy, BTUs by sector and energy sources. Impacts were defined by the six demand subcategories, and include primarily waste flows, but also percentage of land required to absorb or sequester waste, and other impacts. Impacts are primarily a result of consumption and will be further quantified and qualified in the design phase of the work. *Figure 8.*

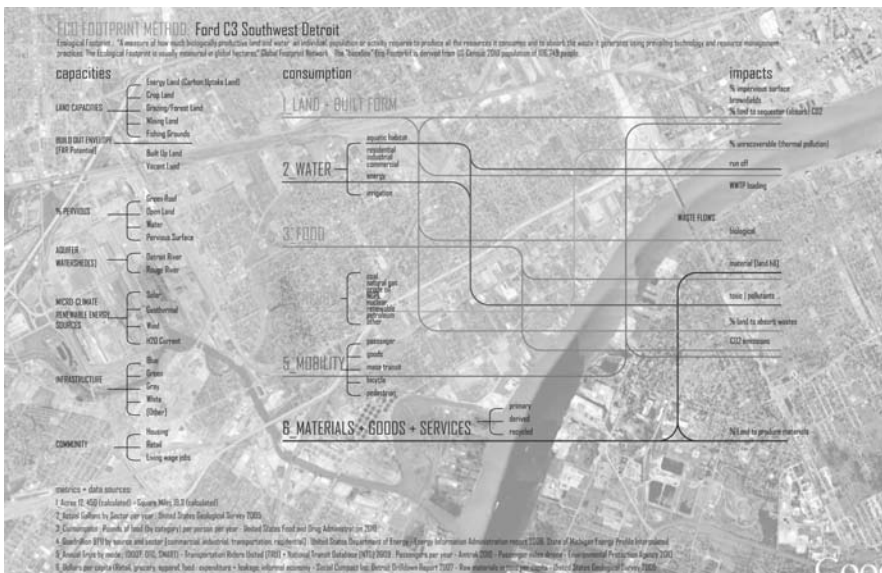


Figure 8: Diagram for Eco-Footprint Method: Southwest Detroit (Studio[C], 2010)

The fourth step was to create an accompanying Excel spreadsheet to document and calculate supporting data sets for each Eco-Footprint category. For example, in the 4_Energy subcategory, we hoped to find local usage data from Detroit's local energy provider, Detroit Thermal Energy [DTE], but instead used the Department of Energy's [DOE] Energy Information Administration [EIA] Annual Energy Review²⁴ representing long-term historical statistics for all source categories. EIA data includes State level data by energy source and sector, which we interpolated using 2010 Census population figures for the neighborhood. Ultimately, we plan to utilize our digital interface to map aspects of the neighborhood's Eco-Footprint, and then evaluate with real time dynamic assessment the positive and negative impacts generated by our urban design proposals.

3.2 APPLICATION OF US GREEN BUILDING COUNCIL LEED NEIGHBORHOOD DEVELOPMENT RATING SYSTEM

The community partner is enthusiastic about exploring how our unique digital mapping interface can be utilized in order to plan for a changed environment. This work is consistent with the focus the USGBC has on *regionalization*, as we will identify bonus point opportunities for sustainable design through LEED-ND (Neighborhood Development). Our approach includes an integration of LEED criteria into the digital mapping interface and recommends that points can be gained based on strategic location, energy, mixed density, and green infrastructure to enhance pedestrian mobility and mass transit. This will align with the SDDC's current model of community investment strategy, which not only focuses on criteria, but also on methods to affect a positive impact within the community.

This approach consists of developing sustainability metrics, both in terms of identifying sustainable development opportunities, as well as subsequently prioritizing areas not suitable for neighborhood development, but alternatively prioritized for open space/recreation, energy hubs, or other non-residential purposes. The LEED-ND²⁵ rating system was selected due to its quantitative rating system that we will use in the prioritization of sustainable neighborhood developments. LEED-ND is a rating system developed jointly by the US Green Building Council (USGBC), Congress for New Urbanism, and the National Resource Defense Council, and it focuses on:

...the design and construction elements that bring buildings together into a neighborhood, and relate the neighborhood to its larger region and landscape (USGBC, 2007).

The metrics that define sustainability in this system include transit-oriented development (TOD), sense of place, mixed-use density, infill development, conservation of wetlands & agriculture, reduction on the dependency on individual automobile transportation, energy efficiency, and walkability, among others. The rating system has three categories of credits (requiring prerequisites in each category), and two categories for bonus credits. The three core categories are: *Smart Location and Linkage (SLL)* – neighborhoods that minimize adverse environmental impacts and avoid urban sprawl, *Neighborhood Pattern and Design (NPD)* – compact, mixed-use neighborhoods with connections to surrounding communities, *Green Infrastructure and Buildings (GIB)* – reducing the environmental impacts of buildings and infrastructure. The two bonus categories are: *Innovation and Design Process (IDP)* – exceptional performance above the requirements or innovative performance not addressed by the rating system. *Regional Priority Credits (RP)* – projects located within areas identified by USGBC as being “regionally important.”

A GIS model will be developed identifying spatially based prerequisites within each of the above categories to ensure the neighborhoods are eligible to pursue LEED-ND certification. GIS will be used for its potential to quantify spatial relationships, which are often used in the LEED-ND system to identify credits and prerequisites. For example, the second prerequisite in the NPD category requires the proposed development must have 140 street intersections per square mile, or an average of 90 intersections per square mile in the adjacent land around the development within ½ mile. (Figure 9) This calculation will be done across the entire Southwest Detroit boundary to determine intersection density, thus identifying where the LEED-ND system is eligible. Similar calculations will be conducted on all prerequisites and thus, prioritizing the sustainable communities within Southwest Detroit.



Figure 9: Neighborhood Intersections (Studio[Ci], 2011)

Many of the parameters in LEED-ND require comparative analysis of the broader region to meet certain prerequisite criteria, and sustainable development credits. Using Southwest Detroit as our project boundary, we will compare the neighborhood to the average values of Wayne County, Michigan as the broader region for the comparative analysis. Data sources include US Census, Social Compact, American Community Survey, Southeast Michigan Council of Governments (SEMCOG), and other publically available data.

The areas that have been identified to meet all prerequisites in the LEED-ND system will be compared with locations identified by our community partners where sustainable developments are currently being pursued, and other “Analysis Layerings” generated through the Ci methodology. This will focus the dialog between community members to ensure that the specific resources of each community are used to the fullest potential. Figure 10.



Figure 10: Neighborhood Pattern and Design (NPD) - An intersection count was conducted within a 1/2 mile radius of Michigan Central Station in Southwest Detroit. The results revealed a total of 165 intersections, surpassing the minimum requirement of 140. (Studio[Ci], 2011)

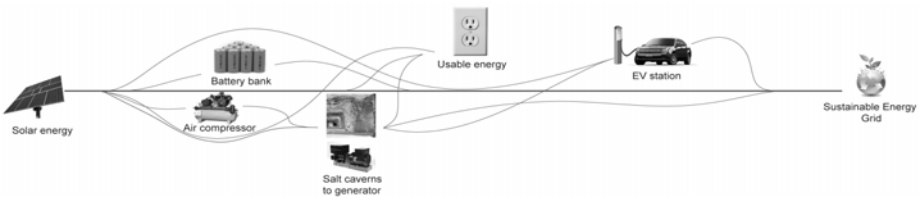


Figure 11: Proposed Hybrid Alternative Energy Approach. (Studio[Ci], 2011)

3.3 THE HYBRID ALTERNATIVE ENERGY APPROACH

The Team and the Southwest Detroit Development Collaborative (SDDC) are interested in implementing alternative energy through several different approaches, including solar, geothermal, and hydro current, to generate energy during different seasons throughout the year. The Team features designers as well as engineers, and believes that a hybrid approach is far more effective than a singular alternative source. As the SDDC works with the city of Detroit on the demolition of 10,000 vacant homes in their targeted service area, the Team has identified the opportunities for the repurposing of vacant land to locate alternative energy collection hubs.

Another approach that will be investigated to supplement the energy system is the storage in the form of sub-grade battery banks. All of these approaches to hybrid alternative energy can and should be integrated into the neighborhood not only for residential, commercial and industrial needs but for sources for EV charging stations and mass transit furthering the goal of carbon neutrality. *Figure 11.*

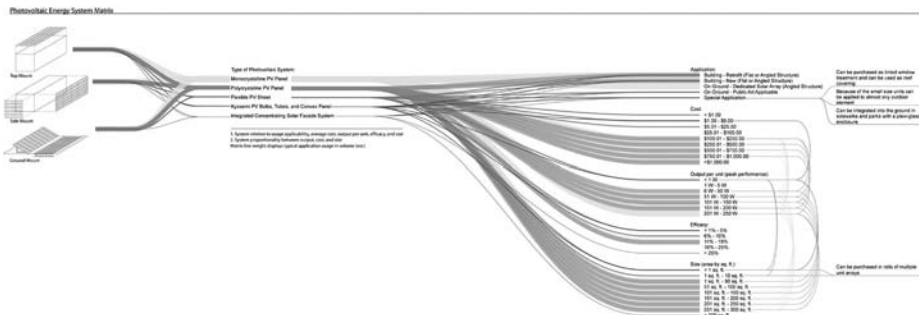


Figure 12: Diagram describing the costs, application and efficiency of solar panels by type. (Studio[Ci], 2011)

An important portion of energy usage for any community is in building heating and cooling, which impacts residential, commercial, municipal, and to a lesser extent industrial energy consumption. To help understand these energy demands for Southwest Detroit one can use the quantitative measure of heating degree days²⁶ and cooling degree days. Data are compiled for a three year period from 2008 to 2010 in *Figure 13* below, and shows high heating demand in the late fall through spring months and high cooling demand in the summer months.²⁷ In the Detroit area fossil fuels provide heating, and electricity provides cooling for air conditioners. Alternative energy systems need to address heating and electrical needs.

Alternative energy resources most suited to this area are solar, geothermal heat pumps, submerged river turbines, and subterranean compressed air. Wind energy is not applicable here due to poor wind availability throughout the year. The annual wind classifications of class 1 (poor) or class 2 (marginal) ratings show that wind is not a viable option, unless turbines are elevated at least 100' above grade.²⁶

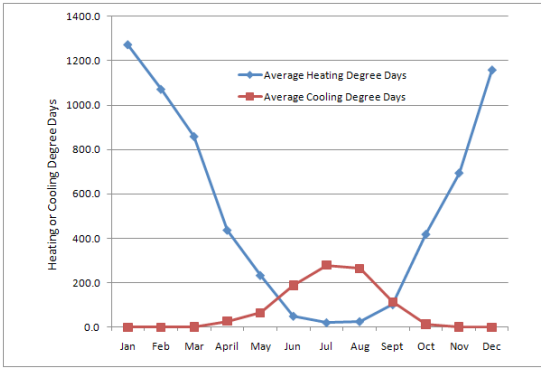


Figure 13: Average heating degree days and cooling degree days for Detroit from the years 2008 to 2010. (Studio[Ci], 2011)

Figure 14 below illustrates the available solar energy for a flat panel at a 27° angle (latitude minus 15 degrees, or 42° – 15° = 27°) in kWh per m² for the Detroit area for each month.²⁸ Correcting for the optimal panel angle of approximately 30° at this latitude on annualized basis yields 1912.9 kWh/m²/yr. Southwest Detroit comprises 12,450 acres (5.038 x 10⁷ m²) and yields 7.837 x 10¹⁰ kWh of solar energy. If 30% of this land could be utilized for solar photovoltaic systems, accounting for the tilt angle and shading from the tilted panel’s footprint, and also accounting for 15% and 95% efficiencies of the photovoltaic panels and inverters respectively, then approximately 2.300 x 10⁹ kWh of solar energy is available annually.

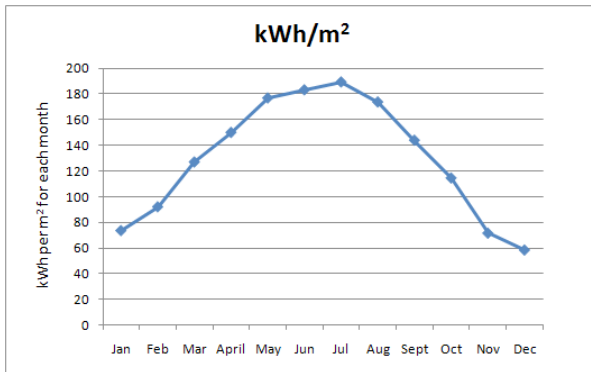


Figure 14: Monthly solar energy available to Southwest Detroit in kWh per m². (Studio[Ci], 2011)

Geothermal heat pump energy availability data for Southwest Detroit is based on known systems in the region and their operation²⁹. Using these data, approximately 267.2 kW/acre can be transferred. If the system is used for 75% of the year, and 30% of the land surface area is used in geothermal heat pump systems (heating or cooling mode) then as much as 6.557 x 10⁹ kWh are available.

The close proximity of the Detroit River and its width, depth and flow rates suggest that it could be an energy source using submerged river turbines.³⁰ If a 10 megawatt system were installed in the Detroit River, comparable to the system put in the East River in New York City, and then it is possible to harvest 6.745 x 10⁷ kWh.^{31 32}

Southwest Detroit has over 100 miles of salt mine tunnels, approximately 1000 feet below the surface of the city. These mines are cavernous with tunnel roads 60 feet wide and 22 feet tall^{33 34}. Several of these passageways are currently unused. If only 40 miles of these chambers were sealed and filled with compressed air and then vented at peak demand periods through a turbine generator, as much as 1.229 x 10⁴ kWh could be available.

If each of these alternative energy systems were implemented as proposed then a total of 8.924×10^9 kWh, or a total of 3.213×10^{13} kJ would be available. A typical medium-sized coal-fired power plant of 800 MW produces approximately 2.426×10^{13} kJ annually (assuming a two week maintenance shut down each year). These data suggest that alternative energy systems can provide a significant, if not *all* of Southwest Detroit's energy needs.

CONCLUSION

The Ford grant has allowed the Team to advance its pedagogic and design research objectives. The project is still in process, and results are expected in 2011. However, the project has already raised awareness in the community and city around issues of sustainable urbanism. While the Team is currently focused on the post-industrial city and Detroit serves as the context for the first application of Ci, but we believe that the design methodology is scalable and replicable to empower the sustainable design of other urbanized regions across the globe. The Ci methodology begins with mapping data sets associated with each urban setting, so we believe our methodology takes into consideration the unique geographic, climatic, and cultural differences of cities and their associated urbanized regions, creating a strong foundation for analysis, design and policy recommendations. Our digital interface and methodology could become an important decision making tool for the creation and perpetuation of sustainable neighborhoods, communities and cities worldwide.

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ENDNOTES

1. Excerpted from the REQUEST FOR PROPOSALS (RFP) FORD COLLEGE COMMUNITY CHALLENGE, Ford Motor Company Fund, Dearborn, Michigan, March 19, 2010: "The Ford Motor Company Fund is reaching out to colleges and universities to request proposals for a third round of an innovative grant-making initiative: The Ford College Community Challenge (Ford C3). This one-time special program seeks to work with partner higher education organizations to catalyze community-building projects that address pressing local needs
As in previous years, the overarching theme of the Ford College Community Challenge is "Building Sustainable Communities." At Ford, we understand that to be a truly sustainable organization, we must play an active role in the larger community, helping to address a wide range of vital issues from education to safety to mobility. Ford Fund hopes to support our partner colleges and universities as they design and develop programs and initiatives that address critical community needs in new ways, with a focus on helping the community become a more sustainable place to work and live. While we realize incorporating this new feature will be challenging, it is our hope that participating schools will find their creativity and resourcefulness engaged in meaningful and unexpected ways."
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6. Joachim, Mitchell, "Envisioning Ecological Cities", Ecological Urbanism, Harvard University Graduate School of Design, Lars Müller Publishers: 2010; pages 224-229
7. Mostafavi, Mohsen with Gareth Doherty, Editors: Introduction, Ecological Urbanism, Harvard University Graduate School of Design, Lars Müller Publishers: 2010; page 17
8. McHarg I L 1969 Design with nature. Garden City, NY Natural History Press; and Meadows D H, D L Meadows J. Randers, and W Behrens 1972 Limits to growth. New York: Universe Books

9. Specifically, the Cities as Sustainable Ecosystems [CASE] method, based on the Melbourne principles, described in Newman, Peter and Jennings, Isabella: *Cities as Sustainable Ecosystems: Principles and Practices*, Island Press: 2008
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11. Bodurov C. C. Creech C, Hoback A, and Martin, J: 2009 *Multivariable Value Densification Modeling Using GIS*. *Transactions in GIS*, 2009, 13(s1) Blackwell Publishing Ltd.
12. Bodurov, Constance C. and Martin, Jordan R.M.: "Convergence of Intensity [Ci] or how to purposely shrink a City" in *The Proceedings of the 99th ACSA Annual Meeting*: New Orleans, LA. 2010. p xxx-xxx.
13. The Vacant Property Campaign and Data Driven Detroit have recently mapped more updated data of Detroit's approximately 40,000 vacant parcels and have made the data publicly available.
14. www.modelur.com
15. <http://www.masdarcity.ae/en/index.aspx>, <http://www.oneplanetliving.org/index.html>; Masdar City will be 6 sq km zero-carbon and zero-waste sustainable development, located within a short distance from downtown Abu Dhabi. Masdar City will be an emerging global clean-technology cluster located in what aims to be one of the world's most sustainable urban development's powered by renewable energies. Masdar City will be designed for a wide spectrum of uses including: residential, light industrial, business centers, researchers and development, academia, creating an international hub for companies and organizations focused on renewable energy and clean technologies. The first phase of construction began in 2008 and is nearing completion.
16. Developed by Bioregional and WWF. These are: zero carbon, zero waste, sustainable transport, local and sustainable materials, local and sustainable food, sustainable water, natural habitats and wildlife, culture and heritage, equity and fair trade, and health and happiness.
17. See Tobias Holler, NYIT, et al: *Long Island Radically Rezoned ACSA NER Proceedings 2010*; and Eran-Ben Joseph and Andrew Scott, MIT: *Sustainable Community Design: a Systems Approach*, expected in 2011.
18. Wackernagel, M., and W. Rees, *Our Ecological Footprint: Reducing Human Impact on the Earth*, 1996, New Society Publishers
19. *Best Foot Forward: the City of London* has recently utilized this method.
20. http://www.footprintnetwork.org/en/index.php/GFN/page/footprint_science_introduction
21. Global Footprint Network. One U.S. acre is equal to 0.405 hectares. In the US, Footprint results are often presented in global acres (ga), rather than global hectares.
22. According to the Global Footprint Network, "Bio" or Carrying Capacity data considers only present and past years.
23. United States Census Bureau, etc.
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27. Web site: <http://www.landpolicy.msu.edu/WPT/> (last accessed 1/3/2011)
28. *Solar Radiation Data Manual for Flat-Plate and Concentrating Collectors*, National Renewable Energy Laboratory, Golden, Colorado
29. Data were collected in July 2010 from the geothermal heat pump system at Lawrence Technological A. Alfred Taubman Student Services Center, Southfield, Michigan, USA. This system has 120 wells with 87 at approximately 100 meters deep and 33 at approximately 50 meters deep distributed over a land surface area of approximately 1.553 acres. The heat transfer fluid is 40% propylene glycol and 60% water.
30. Web site: http://www.lre.usace.army.mil/greatlakes/hh/outflows/discharge_measurements/detroit_river/ (last accessed 1/4/2011)
31. Web site: http://www.msnbc.msn.com/id/18096246/ns/us_news-environment/ (last accessed 1/4/2011)
32. Web site: <http://verdantpower.com/what-initiative/> (last accessed 1/3/2011)
33. Web site: <http://www.detroit salt.com/home.htm> (last accessed 1/3/2011)
34. Web site: <http://www.geo.msu.edu/geogmich/saltminingM.html> (last accessed 1/4/2011)