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Solar Urban Planning: Addressing barriers and conflicts specific to Renewable Energy Policy and the current field and practice of Urban Planning within the context of a changing Climate

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Addressing barriers and conflicts specific to Renewable Energy Policy and the current field and practice of Urban Planning within the context of a changing Climate

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***"When the sun shines in my eyes, I can see tomorrow come"* – Folk Musician**

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Abstract

The world is in a period of rapid urbanization while experiencing unprecedented rise in global temperature as a result of climate change. Questions have been raised as to how strategies for urbanization will be able to address the fetish for energy, while halting carbon emissions produced by traditional energy sources for urban inhabitants around the world. First, this paper seeks to look to cities, at the intersection of solar energy and the field of urban planning, looking into the opportunities and challenges that are currently surfacing. Conflicts and barriers in traditional urban land use patterns emerge as a topic of discussion alongside urban morphologies and constraints posed towards a broad-reaching application of solar energy in dense cities, both domestically in the United States, and by way of international case studies. Conflicts in land use practice along with community level net zero benchmarking are discussed as well to better understand tools for progress in urban planning addressing climate change mitigation. Additionally, local action and the impacts of Green Communities Legislation are investigated alongside the need for Federal action such as bold renewable energy portfolio standards as macro policy solutions. Lastly, the conflict between the traditional role for utilities and the emergence of distributed generation technologies and subsequent policy support including the potential impact of micro grids, are included in an analysis of the energy production and delivery system for the urban environment at present. Within this paper, two in-person qualitative interviews are included to bring perspectives from active professionals and policymakers into the research. New thinking and conclusions illustrate the need for specific policy action across local, state, and federal spheres, and the need for urban planners and urban practitioners to act with intention and rapidity relating to the climate imperative.

Table of Contents

List of Abbreviations

APA – American Planning Association
AICP -American Institute of Certified Planners
BESCOM - Bangalore Electricity Supply Company
DOER – Massachusetts Department of Energy Resources
EEA - Massachusetts Department of Energy and Environmental Affairs
EFL - Electricity Feed Law
EPA – Environmental Protection Agency
GATT - General Agreement on Tariffs and Trade
GCA – Green Communities Act
HABITAT - United Nations Human Settlements Programme
IEA – International Energy Agency
ISCOCARP – International Society of City and Regional Planners
KERC - Karnataka Electricity Regulatory Commission
MIT – Massachusetts Institute of Technology
NIMBY - Not In My Backyard
NYSERDA - New York State Energy Research and Development Authority
PII – Permitting, Inspection, Interconnection
PPA - Power Purchase Agreement
PV - Photovoltaic
RPS - Renewable Energy Portfolio Standard
RMI – Rocky Mountain Institute
SEP - State Energy Plan
SUNY - State University of New York
UCS - Union of Concerned Scientists
UN – United Nations
WTO – World Trade Organization

The world is experienci1ng increasing urban growth while at the same moment beginning to feel the increasing impact of rising temperatures as a result of climate change. One of the largest known contributors to the latter is the ferocious appetite that urban centers possess in both the developed and developing world in terms of energy demand. The impacts of urbanization, with significant influence from western ideology and dogmatic development frameworks of progress, rely largely on the reliability and availability of electricity and energy supply to fuel both industry and technology. Questions have been raised as to how urbanization strategies will be able to boldly address both the desire to produce massive volumes of energy while halting at minimum, if not reducing, carbon emissions produced by current energy production sources. This effort seeks to save our humanity from the likely disastrous impacts of a warming climate.

This body of research seeks to illustrate strategies to put forth an agenda for urbanization that is equitable, reliable, and at its core an exercise in sustainable development, serving both people and the environments in which they live. This project seeks also to lay out a variety of strategies aimed at achieving these goals as well as addressed the role of urban planning both domestically and abroad. First I seek to look at cities and the intersection of solar design and planning, looking at the opportunities and challenges that are common in the fields of urban planning and design. Conflicts and barriers in common urban land use patterns immediately emerge as a topic of interest. Additionally, a trend toward community strategy that takes on carbon net zero patterns also emerges as a means of providing productive tactics to counteract such conflicts and land use trends. The role of urban planners and energy strategy that is currently employed both domestically and abroad will be discussed, relating to emerging technological frameworks such as micro grids and integrated solar building designs, geothermal modeling, as well as utility conflicts with current and emergent distributed generation trends.

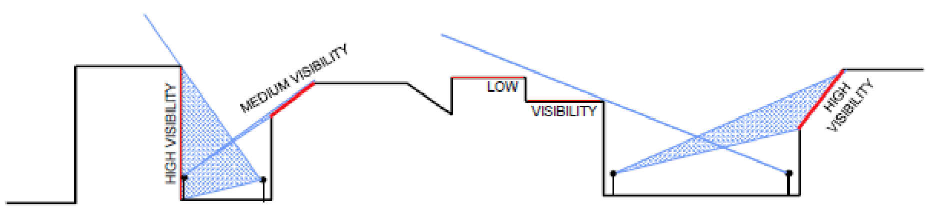
These topics will construct a substantive investigation of policy oriented challenges and opportunities in the macro context. From a qualitative standpoint, one on one interview from both a private sector and public sector expert have been included, bringing about first hand experiences from individuals working in the realm of energy. These individuals discuss their experiences in micro grids and direct government investment programming for sustainable community frameworks in my home state of Massachusetts.

At present there have been a host of local government initiatives, mostly in larger cities, that have begun to strategize and plan for sustainable energy solutions and urban resiliency relating to climate change. As of this year, a host of notable and broad-reaching actions have been taken, including the historic *COP21* climate summit in Paris, the *C40* initiative, *2030 Districts*, and *100 Resilient Cities* spawned by the Rockefeller Foundation. One of the most notable and high profile of these took place this October which marks the United Nations Human Settlements Programme (HABITAT) Conference, and was the third conference on global urban development ever assembled. The last of its kind was hosted in Istanbul, Turkey in 1997. *The New Urban Agenda* refers to the United Nations macro-oriented framework for addressing a number of urban challenges facing our global human society in the near future, energy and energy planning playing a key role. Of course there is value in international frameworks for dealing with challenges of climate change and energy needs for a rapidly urbanizing planet. Climate change is most certainly a macro issue and rightfully should be discussed and addressed at the International level. However, there is much lost by macro institutions like the UN their often grand scheme and ‘best practice’ solutions. Context matters for urban strategy and it matters with relation to energy portfolio planning and urban energy planning. Western approaches to development have been one of the main challenges to the climate paradigm we have created as a people and much of the leadership in the United Nations across numerous sectors are to blame. This paper will seek to dig through much of this strategy and address how identifiable conflicts can emerge which result in counterproductive energy planning and urbanization strategies. But this paper also addresses opportunities and successful strategies that have emerged. I will look at good policy solutions that have shown quantitative and qualitative results by way of incorporating community planning, sustainable principles, and effective stakeholder engagement. I also look at practical and impractical components of incorporating solar as a specific technology into the urban fabric, emergent and current conflicts within urban planning paradigms and the many stakeholders and stakeholder issues affect the incorporation of solar. This paper focusses on the following four subject areas: urban planning, conflicts and policy implementation, planning processes and urban design, and solar energy technology and its current applications, challenges, and successes. This body of work seeks to offer solutions while simultaneously identifying barriers, conflicts, and bottlenecks that must be addressed to realize a wider application of solar technologies into the field of urban planning necessary to in effect cool a warming planet.

Urban Morphology and Solar Energy

When looking at the relationships between urban morphology (urban form and makeup) and environmental sustainability, both consumption and generation must be analyzed as key variables in terms of the potential to generate renewable energy within city boundaries. This research topic is of growing interest due to the fact that solar energy is the most available, abundant, and readily harnessed resource on earth.

Solar urban planning, represents a deeper dive into the notion that urban planning practices can specifically include, advance, and fortify the incorporation of solar and ultimately rely upon it as a substantial tool for addressing global warming. An Italian architect and researcher conveyed the following about how to integrate solar energy into existing building stock: “The question is no longer whether one is in favor or against the use of solar systems in cities...but that we will need to define adapted local minimums of integration quality, and present the factors needed to establish smart solar energy policies in order to preserve the quality of pre-existing urban contexts while promoting solar energy use.” (SHC, 2016). This type of reframing of the critical need for solar energy in urban planning is crucial to begin the conversation as to how solar can be incorporated into existing urban forms in a manner that respects historical tradition, urban culture, neighborhood character, and ultimately solicits community buy in. Cities represent the fabric of our cultural lineage as humans. Energy solutions such as solar cannot simply be slapped onto building and within street corridors wily niley, but rather be brought into the urban context through intelligent design parameters and zoning requirements that incorporate pre-existing urban contexts. From the pedestrian’s vantage point or street level may be the first step for intelligent analysis.



Assessing solar integration by identifying three different levels of visibility: low, medium and high.
Source: Maria Cristina Munari Probst LESO/EPFL

Illustration - Solar Heating and Cooling Programme, International Energy Agency, 2016

With consideration of the numerous socio-political factors that make up positive and constructive urban planning practices, solar can be included into urban processes rather easily, but must be done so intentionally. A 2012 study explains how urban planning process and solar urban design come together as ‘sustainable solar urban planning’ through an iterative process bringing together parametric urban designs, solar simulation, plan implementation proposals and modeled solar energy production (Amado, M., & Poggi, F.).

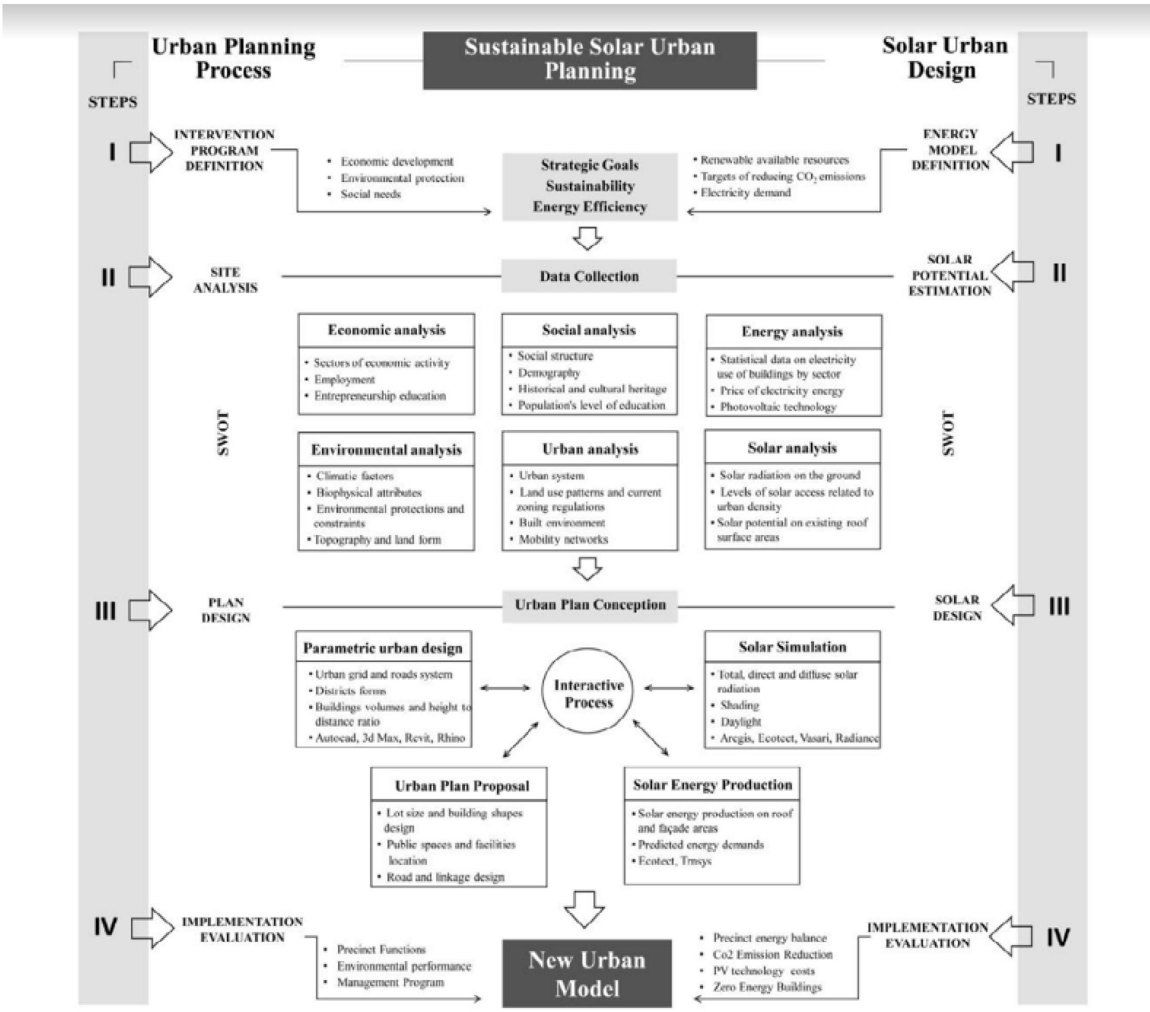


Fig. 1. Sustainable Solar Urban Planning Methodology

Solar Urban Planning Illustration - Amado, M., & Poggi, F. (2012) pg. 1264

There is most certainly a scientific approach to the confluence of urban design and urban planning which also addresses the socio-political context(s) in this field. Two examples of technical research on this matter which quantify the policies discussed above in the Solar Urban Planning Illustration are offered here. First, a recent study of the City of London relied upon neighborhood-scale statistical models to explore the relationships between urban form and the potential to harvest solar energy locally (Sarralde, 2015). In essence the study sought to link common elements of urban form, such as corridors, nodes, blocks, and other geospatial urban design descriptors to how effective they were or not at capturing solar gain. The study focused both on thermal collection as well as photovoltaic collection. The results show that through very minimal urban design parameters, *solar irradiation of roofs* (potential to build rooftop solar collectors) could be increased by 9% while *building façade thermal collection* (ability for buildings to heated passively by the sun) could increase by up to 45% across the entire city (Sarralde, 2015, pg. 10). This type of technical analysis is based on modeling solar potential and the tweaking of inputs such as building perimeters, building heights, and lot coverages for neighborhood blocks to come up with contextual urban design principles that can inform new zoning policy and practice. This analysis alongside others of its kind influence design parameters for urban planners to build in practical and impactful designs which bring solar into traditional development agendas and dialogue in urban settings. The second example focuses on a similar study at Lund University which concluded that certain geometric forms in some of the densest cities in southern Sweden were contributing to a solar energy reduction of anywhere from 10-75% in solar potential (Kanters, J., & Horvat, M., 2012, pg. 1151). The study introduces a new set of conflicts which are inherent to an increasingly popular European building and zoning law. Many municipalities have begun to require that all new construction or major redevelopment work produce the entirety of their energy onsite. While this sounds quite ideal from an energy perspective and potential positive impact on global warming at large, the study notes that this is largely impossible. Especially in dense urban morphologies where development is vertical rather than horizontal, there is simply not enough roof space for photovoltaic (or other) renewable or frankly non- renewable energy to be produced. So where should power come from? The answer is energy efficiency. Good policy which requires, but funds, energy efficiency measures for all new development projects can serve to minimize building loads enough that in fact all power can be produced onsite, resulting in an incredible energy revolution for urban environs across the globe. Simply imagine the energy reductions globally if cities were to become net zero, with energy efficient building stocks taking leading the charge. Conflicts that emerge surely must be addressed by putting real estate developers in discussion with urban planners, designs, policy makers, and master planning groups. This agenda has symbiotic and holistic benefits, from job creation to energy savings, climate mitigation to livable neighborhoods. The potential impacts of building envelope and usage efficiencies are vast.

Urban Design and Policy trends

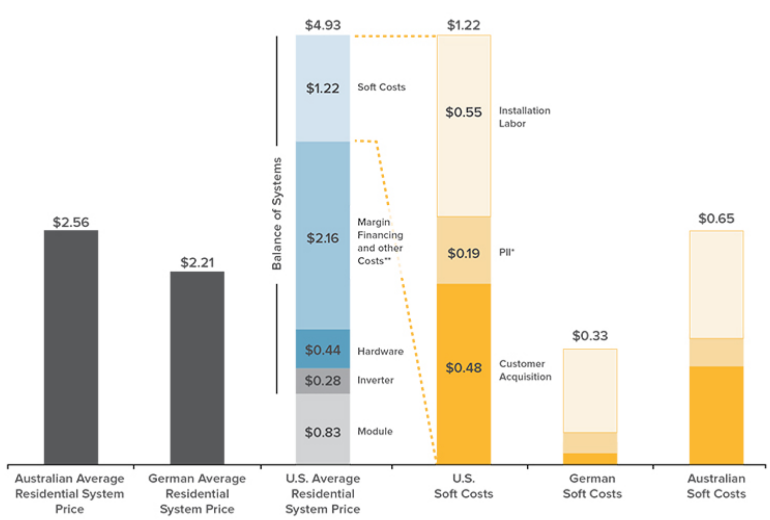
At present the international community has taken a broad step towards engaging with and providing an agenda and set of guiding principles for cities around the world in the face of rapid urbanization, climate change, political and urban conflict, and energy planning. The United Nations (UN) Habitat III Conference, held in Quito Ecuador in October of this year brought together urban planners, governments, climate experts, private sector developers, energy companies, and international organizations to discuss a new urban plan. This new plan ultimately seeks to guide the future of human settlement. The last UN Habitat Conference was held in 1997 in Istanbul, Turkey, and thus a summit of its kind has been long overdue. The hope is that this will frame what the UN calls the *New Urban Agenda* which it seeks to establish out of the Habitat III summit. This agenda loftily seeks to ‘set the path towards a new model of urban development that is able to integrate all facets of sustainable development to promote equity, welfare, and shared prosperity’ (United Nations, 2015). Relating to energy and cities in the context of climate change and conflict, there is much to be discussed during an international meeting of the minds. However, the exact policy outcomes often result in broadly defined best management practices, tool kits, and the like. Very little progress is typically made towards defining policy conflicts and barriers inherent to current urbanization and renewable energy planning. The need, is to create frameworks for building cities that do not suck electricity un-satiated and unchecked, but rather *create* energy, through use of solar technologies, sustainable building practices, and other usable and accessible urban policy proposals. Of course this type of summit does not change the world overnight, but the conference was seen as a large success in that the widest ever stakeholder group (including online submissions from all around the world, largely used by historically underrepresented regions and countries) came together to discuss some of the most important challenges to our civilization. Aim was set at climate change and social inclusion in the context of urban settlement and an ever urbanizing world, and the New Urban Agenda was elevated to one of the UN's top priorities for the foreseeable future.

Elsewhere on the international stage, the historic COP21 conference in Paris, France symbolized a risky global but successful step towards mitigating the seemingly insurmountable challenge of reversing global warming. Of course, any step forward typically is met with two steps backwards, and the recent national elections here at home is sure to halt much of the ambitious agenda set at COP21, led largely by the United States, essentially the world's largest historical polluter. Donald Trump, and vocal climate denier who feels that climate change is largely fictitious, was elected president and leader of the free world in the latter part of this year. One of his first appointments was a new EPA director, who himself is a climate skeptic, and this appointment illustrates just how fragile even bold global alliances can be without bold leadership and buy-in from the world's superpowers. The amount of resources, planning, and careful political maneuvering that took place to bring together world leaders to one summit was herculean, but to in fact get them to agree on a global climate agenda is even more astonishing. The United States selection of Mr. Trump however underscores how volatile such large issues like climate change can be and just how fragile and loaded this conflict point is. Ultimately, there is much to be done not only to ensure that the global citizenry is educated about the climate imperative and its dire consequences if left unresolved, but that it rises to the forefront of the political agenda. Pop culture stars like Leonardo DiCaprio have devoted their careers to this agenda, but nationalist fears and populist voting in this most recent election prove that climate change is still one of the lowest citizen concerns of the day. This is a conflict and this a barrier to enacting radical change to energy policy.

Locally, there has not been nearly enough advances in urban policy shifts to create confidence that municipalities can take on this fight on their own. The barriers likely revolve around funding for climate change initiative that often fall as ‘extra’ spending initiatives external to vote-driving municipal functions such as paved roads and adequate school budgeting. Energy, planning, and climate mitigation typically fall to the state and provincial sphere and of course the federal/national realm. However, initiatives like Cambridge Massachusetts’ Net Zero Framework which will be discussed in greater detail, have been popping up more and more as the climate imperative begins to sink into the consciousness of local officials coupled with an increasingly informed electorate. But is this enough?

It is apparent that specific policy is needed to bolster and stimulate investment in solar, so as to drive the costs of this technology downward. Today, federal, state, and even local incentives largely inflate the sector, and some believe it is falsely propped up. The impetus to lower the costs of solar is so that building owners, residential, commercial, and industrial alike, have an economic incentive to update aging buildings by 2030 and to incorporate onsite solar, that incentive being that it makes good economic sense. This has particular impact on cities and urban design. In the United States and across the globe the cost of solar photovoltaic panels has dropped during the period between 2008-2012, and is recently seeing a continued decline. The price of sub-10-kilowatt rooftop systems in the U.S. (smaller, typically single family applications) has decreased by a staggering 37% in that four-year period. However, 80% of that cost decline was due to decreasing costs of the actual solar PV module. It can be seen that <u>total soft costs</u> —including customer acquisition; installation labor; Permitting (building electrical and zoning), Inspection, and Interconnection (referred to as 'PII'); and other associated costs— now make up approximately 70% of the total installed priced for a U.S. residential PV system. The following illustration puts US costs up against both German and Australian costs to emphasize this variance:

FIGURE 1: RESIDENTIAL PV SOFT COSTS IN THE U.S., GERMANY, AND AUSTRALIA



*Permitting, inspection, and interconnection costs

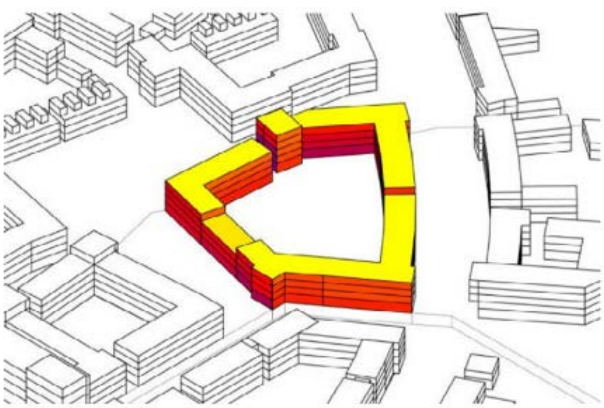
** Includes installer and integrator margin, legal fees, professional fees, financing transactional costs, O+M costs, production guarantees, reserves, and warranty costs.

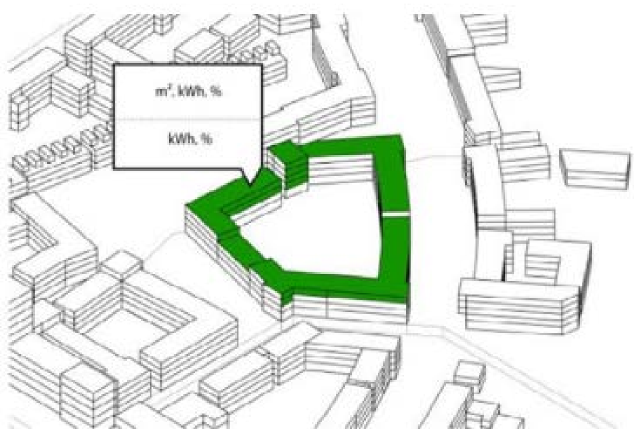
(Fig. 1 SIMPLE Solar Balance of System Rocky Mountain Institute, 2016)

Thus soft costs represent 'a land of opportunity for cost reductions', which can help accelerate customer adoption of residential rooftop solar (Rocky Mountain Institute, 2016). There is an innate conflict present in this area of the sector. That conflict is the need for standardization, which acts as means of reducing labor costs and labor hours, more specifically speaking: jobs. For solar technology to have political appeal, realistically at any level, state, federal, or international spheres, it must go hand and hand with bolstering labor economics and job creation. While standardization will reduce costs of systems and stimulate its proliferation through building modernization initiatives, reduced job creation is not politically appealing. Standardization of solar systems must go hand and hand with expansion and other programming to keep job creation levelized if this is to be politically compromising and realistic in terms of economic growth, largely influenced by employment in any given sector. If not properly managed, this conflict will entrench system costs and disable the ability for solar costs to lower as rapidly as they have over time. Solar systems must be compact, cheap, and easily accessible for building owners and real estate developers to incorporate them in cities and towns. This is essential to the proliferation of solar.

Conflicts in Land Use and Net Zero benchmarking

"The urban scale has often been neglected in the debate of energy consumption and climate change" (Kanters & Horvat, 2012). A Lund University study illustrates that by 2020 all European Union member states will be required to ensure that all newly constructed building consume 'nearly zero' energy and that their energy needs come from sources generated locally to the best of their ability. As urbanization rates globally increase based on a host of macroeconomic trends, urban development will be stimulated, densities will increase, and energy demands will skyrocket. There is no better time than the present to connect urban planning processes and renewable energy planning for growing cities globally. Let us look to Europe where urbanized areas there house approximately 80% of the population which by extension produce approximately 75% of the continents total CO2 emissions (Kanters & Horvat, 2012). The Lund study concludes that even with the most minimal zoning and siting orientation tweaks, enacted for new construction alongside passive solar gain strategies, that energy cost savings of 20-50% can be achieved through integrated planning. This does not suggest tearing up zoning ordinances and starting from scratch, nor rewriting building code whole hog, but rather working within existing urban policy frameworks with minimal adjustment criteria. It further suggests that 'utilization of solar radiation in urban areas appears to be both essential and practical' in addressing huge energy savings in cities therein (pg. 1143). The study models buildings and building clusters for their potential thermal gain, meaning the passive radiant heat that the sun can provide buildings by way of infiltrating window and semi-translucent building envelopes (yellow and orange). The study also models buildings and building clusters for their potential to generate photovoltaic electricity on their rooftops (green).





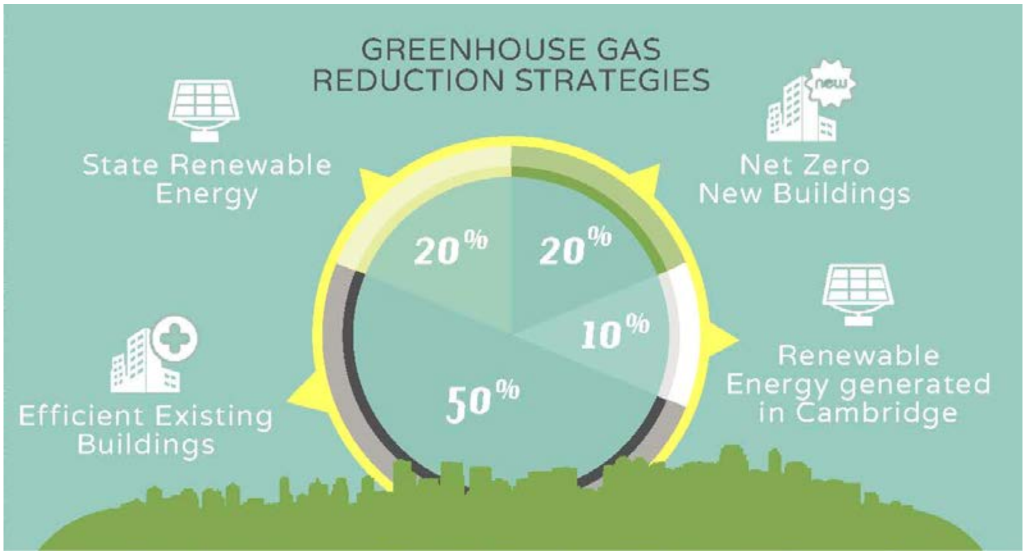
Solar Thermal modeling illustration pg. 1150

Solar PV rooftop modeling pg. 1150

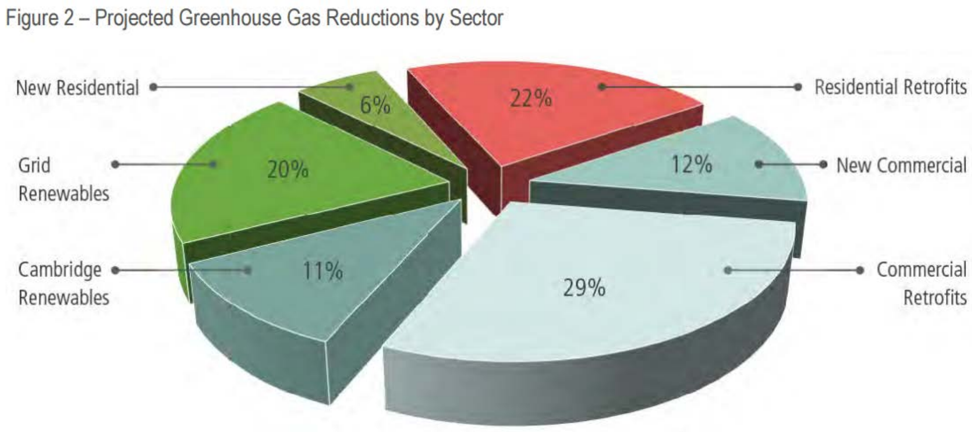
When designing and laying out city blocks, urban planners should bring actors to the table who can simulate, calculate, and model these new layouts with specific emphasis on solar gain potential so as to give all stakeholders this insight during the conceptual stages. The sun is abundant and should be considered a design attribute rather than a design constraint. This goes for upgrades and redevelopment initiatives not simply new construction, which is only a small fraction of the economic potential for urban development. Analyses should include the production of active solar systems (in Kilowatts), the production over the year, the ratio between photovoltaic and solar thermal city block by block and building by building, as well as architectural integration issues (color, texture, dimensions, etc.) (pg. 1151). The study concludes generally and through its parametric modeling that solar energy can provide substantial thermal and electrical benefits to urban environments with proper urban planning applied. In addition, what is termed 'solar zoning' can serve as an adder to the incorporation of solar in urban environs, specifically those that are denser and will require added regulation to move/Shepard new construction and rehabilitation projects towards solar energy solutions. While this is but a single example of the great potential that linking urban planning to solar energy planning can result, the study symbolizes the importance of doing so as one of many potential ways in which urban planning and design may contribute directly to cost savings for building owners and reduced energy demand for rapidly urbanizing cities. The sun is an abundant resource, it is the key to our food system and thus our very survival. It has been an extremely brief moment in our human history in which we have paid such little design and planning mind to this abundant resource. Cities of ancient Samaria, the roman empire, and early European urban patterns have all utilized cardinal alignment much more effectively than modern planners have succeeded in doing. The Lund study exemplifies the type of paradigm shift and technical analysis that planners and urban designer can offer in terms of reducing energy demand while simultaneously increasing solar energy production. Buildings can become their own energy production plants in this way, and entire city blocks by extension may exceed net zero capacities and in fact produce energy in excess of what they require. There will most certainly require collaborations within building clusters, City Wards, and subzones of cities to reap the most aggressive savings possible, but with collaboration and multi stakeholder engagement this *is* possible.

Cambridge, Massachusetts

An example and compelling case study for this can be found in Cambridge, Massachusetts. The City has adopted through its legislative body a ‘Net Zero Framework and Action Plan’ which sets a goal for a carbon neutral city as a whole, inputs, outputs, and throughputs. This type of policy and planning not only serves as a model for other historic and densely urbanized cities to learn from, but the plan itself is very much replicable. The action plan distills neatly into five categories: *energy efficiency in existing building*, *net zero new construction*, *energy supply of low carbon and renewable energy*, *local carbon fund*, and *engagement and capacity building through communication and resources* as the core tools to achieving net zero carbon emissions for the community at large, within a self-imposed 25-year time horizon. With this plan Cambridge will reach a 70% emissions reduction by 2040 (Cambridge Net Zero Action Plan, 2015). The plan opens by framing the United Nations 5th Emissions Gap Report issued in 2014 which articulates the need for a carbon neutral economy by the years 2055 to 2070 in order for the climate to remain static and not reach the two (2) degree Celsius increase that scientists link to the worst and most severe climate crisis (UNEP, 2014). Of course even the most advanced scientific work embeds disclaimers into all analyses that these timeframes, predictions, and ultimate outcomes are merely predictive and not prescriptive, as changes to the earth of such total magnitudes are inherently unpredictable. These predictions do however allow benchmarking, and thus the City of Cambridge relies upon this for its scope towards net zero. The plan sets out robust and holistic strategies for achieving net zero, across a multitude of sectors, while focusing squarely on existing buildings and building efficiencies as the main sector requiring attention, as it is identified as producing 50% of the greenhouse emissions in the city.



Strategy breakdown Illustration (City of Cambridge, 2015)



Further breakdown of sectors Illustration (City of Cambridge, 2015)

The plan also cites the Massachusetts Green Community legislation, within which Cambridge is a member-community, as playing an important role in advancing statewide sustainability measures. At a more fundamental level, the initiative was created by a 500 citizen-signed petition, entitled the Connolly Petition, which called for the Cambridge Zoning Ordinance to be amended to require that all new buildings be required to be constructed with net zero certification (City of Cambridge 2015). This was the accelerant which spawned the movement for net zero benchmarking for the city at large. This petition was met with great support by the City Council at that time, but there were concerns that economic impacts resulting from such a broad mandate would negatively affect the construction economy, driving real estate investment out of town. The city's interest in the petition, coupled with trepidation from the construction and real estate community, resulted in the council's creation of a net zero Task Force and its deployment to look at this potential opportunity through the lens of economic actors and potential conflicts. The task force included MIT and Harvard, obviously incredible resources that most communities do not have the luxury of leaning on. But the inclusion of academia was an important conflict-mitigating strategy later realized by the city and is notable for scaling this model in that it engendered public trust as well as private sector buy-in. The involvement of the University's allowed for a broader discovery process of opportunities and challenges. The task force was also made up of developers, community groups, resident and businesses. The case study provides a real world and current example of a community that can and will achieve net zero in the not so distant future. While Cambridge is a rather wealthy city, it has an extremely old building stock, high densities, and a number of other constraints that challenge the implementation of net zero policies. If Cambridge can set these goals, can other communities? What if the state were to step in with funding and policy directives to enable cities to pull together net zero task forces? By extension, policy which leverages federal funds and disseminates those directly to states, and communities whom thereafter focus squarely on local strategy, would seem to be policy that could enforce building by building strategies resulting in net zero benchmarking at the municipal level. National and state directives may be the only way of putting pressure on everyone, by incentivizing private sector spending and investment, while holding public officials and their constituents accountable, all in an effort to incrementally reshape our communities towards net zero systems.

Local actors

Local government is a crucial starting point for CO2 reduction as city governments can influence energy use both directly through its procurement of services (transportation, sanitation, buildings, water provision, etc.) but also indirectly through policies such as enforcing energy efficiency in buildings through code enforcement. Local government can also lead in the creation of land use codes and planning rules which have profound impact on urban morphologies and layouts. And while little is quantifiable in terms of cities and their indirect influence through policy on energy use, it is estimated that such indirect influence may account for roughly a quarter of the total cities energy use (Jollands, pg. 138). Clearly, issues of land use policy need to be understood to emphasize the role of local government towards creating a carbon neutral world.

One example from the International Energy Agency highlights the potential of indirect influence of code enforcement on energy. An example of some zoning snafu which caused quite an uproar in a number of locations in North America, is the replacement of dryers and drying machines by citizens for traditional cloths lines as a means of saving energy use and ultimately reducing CO2 at the individual level. This ‘old school’ technique of drying cloths actually has been taken up by thousands of individuals whom are working to do what they can in everyday life to reduce their carbon emissions and carbon footprint(s). Unfortunately, local ordinances often view these drying lines as eyesores, or ‘not in my backyard’ (NIMBY) uses, and in a number of instances have actually banned them from use (OECD 2008). This is a striking example of how local land use policy and code enforcement can work counterproductively against a warming climate without particularly knowing that they are doing so.

Local governments are significant energy consumers in their own right, with hospitals, schools, municipal offices and street lighting listed as but a few examples. While conflicts and stakeholder disagreement certainly exist within local frameworks, politically and ideologically, a rallying point for local government is that the economics of energy efficiency and Renewables are *relatively* conflict free and almost unanimously favored. They possess a high market share which means they can ‘coalesce a critical mass in favor of renewable energy’, especially when efforts are coordinated at a regional scale (IRENA, 2016). Much attention has been focused on municipal energy usage, and for good reason. Cities and town control or at least influence the source of energy they consume and because they are large users across a number of sectors, they also possess the ability to drive renewable procurement and purchase options as well as provide case studies for private sector benefits. This is most striking for municipalities that own their own utilities, referred to as ‘coops’ or ‘municipally-owned utilities’. In 2013, over 2,000 US communities, which represents cities for 1 in every 7 Americans, received their electricity from city-owned utilities (ILSR, 2013). The Sacramento Municipal Utility District as of 2012 constructed a 100 Megawatt solar program costing the utility a low (at the time) 12 US cents per kilowatt hour. Just to the south an interesting case study is Austin, Texas made history in 2011 when the city became the largest local government in the United States to procure 100%

renewable energy for all municipal buildings and facilities, through a program called *GreenChoice.* This city-level policy also propelled the state of Texas to become one of the leading regions in wind energy production for the world stage, illustrating how strong local policy possesses the potential to impact state and regional markets. Municipalities can also join with other entities to generate demand for renewables. An international example illustrates several businesses and universities teaming up with municipal authorities for the *Melbourne Renewable Energy Project* in Australia. Developed and managed by the city council, it is seeking to purchase 110 Gigawatt hours of renewable energy per year. Melbourne aims to source 25% of electricity consumption from renewables by 2018 and to have zero net emissions by 2020 (Sparkes, 2016).

As discussed prior, city governments can promote renewable energy in their role as regulators. Mechanisms include land-use planning and zoning, urban building codes, solar ordinances, grid connection regulations, technical standards, and public housing programs. Municipal building codes adjustments set by municipalities can include waving height restrictions for rooftop solar systems, simplifying requirements for building permits for solar infrastructure, or imposing energy efficiency and renewable energy requirements, as in the case of the San Francisco. Making new buildings “solar-ready” adds almost no additional construction costs (City of Minneapolis, 2013) similar to subsections of the Massachusetts Green Communities Act, but can allow for future incorporation of solar as prices shift downward. Cities therefore stand to benefit greatly from making all new buildings ready for the next generation of energy production. Municipalities can distribute information on solar-ready guidelines during the permitting or design review process. Municipal thermal mandates, also known as ‘Solar Ordinances’, are a compelling example of the impact of city regulations. Another international example is found in São Paulo, Brazil which in 2007 adopted a Solar Ordinance to lower electricity demand for water heating. It required all new residential, commercial and industrial buildings to install solar water heating systems to cover at least 40% of the energy used for heating water. The Solar Ordinance is estimated to have avoided expenditures of more than USD 400 million between 2007 and 2015, according to the Brazilian Association of Refrigeration, Air Conditioned, Ventilation and Heating Services (IRENA & ICLEI, 2013). This is good urban policy, and rather than mandating 'all' water heating be produced on site, a percentage approach minimizes conflicts between real estate developers and municipal policy makers and reduces lag-time from sluggish policy conflicts during enactment.

Examples of municipally driven social housing programs which have integrated renewable energies into their planning illustrate savings through renewables as well. Mexico City's Social Housing Program endorses the use of PV panels for all multi-family structures, while the City of Johannesburg, South Africa installed solar energy systems in 2,700 new homes, while simultaneously fortifying city centers housing stock with low income housing options.

Through creative net metering policy, cities and town actually can *find* revenue generating opportunities. Net Metering refers to producing power at one location and essentially selling the value of that power, through credits rather than actual electrons, to offsite consumers located elsewhere but on the same utility service area that the power was produced. An International Energy Agency study (2015) suggests that if municipalities themselves purchase and sell electricity to end-users, they can find opportunities thereby generating on average 30% and in some cases up to 90% of municipal revenues. Cape Town, as other cities in South Africa have done, sells and distributes electricity to final consumers. Cape Town recently introduced a net metering policy which allows excess generation can be used as credit to offset later consumption. So far, the city has succeeded in commissioning more than 4.5 Megawatts of grid connected small-scale solar PV capacity, almost all of which has been in commercial and industrial buildings. The city also developed guidelines to promote the safe and legal installation of rooftop solar PV systems, which harps back to the notion of balance of system cost reductions through standardization, in this instance propelled by the Cape Town city government itself.

For cities which have a limited role in the power sector, they may alternatively play a major role in administering and coordinating national or state level initiatives. An example is Bangalore, one of India's largest cities who is benefiting from a net-metering program to develop rooftop solar capacity. The program involves several local and state-level entities including the Government of Karnataka, the Karnataka Electricity Regulatory Commission (KERC), and the Bangalore Electricity Supply Company (BESCOM). The KERC is responsible for determining the energy pricing (referred to as tariffs) while BESCOM is responsible for the administration of the program. The program has grown steadily, with 14 Megawatts of solar PV installed in the past 3 years. Local government buildings alone offer considerable roof surface and space, which can be used to produce solar electricity, and reduce energy consumption on sight and thus energy bills.

A wonderful example of national-level policy advancing the renewable agenda is Germany's 1991 electricity feed law (EFL) which set the price for wind and solar at 90% (or a 10% discount) of the retail electricity. A more recent law known as the Renewable Energy Sources Act (EEG) was enacted in 2000 to strengthen the EFL. Its goal was to double the amount of renewable power and obtain 20% of electricity from renewables by 2020. German national banks offered loans at 1% to 2% below market for the first 75% of project costs for renewable production initiatives and has become a key infrastructure finance tactic (Kammen, 2006, pg. 85). Key to the success of Germany's feed-in tariff were and continue to be long-term contracts, guaranteeing purchasers and pricing that provide adequate rates of return for renewable suppliers. This simply means stability for all parties and stakeholders. The law promotes a diverse ownership structure for renewable energy that includes power companies, municipalities, agricultural users (particularly focusing on wind technology) and residential solar PV producers (essentially homeowners who put up solar on roofs or in backyards). This feed-in tariff has resulted in the German rise to the world's largest producer of solar and wind energy. Production totals in 2005 were 18,000 Megawatts in Germany, 10,000 in Spain and 9,100 Megawatts in the United States (Kammen, 2006, pg. 86). About 20% of wind and 10% of German solar PV technology is exported resulting in Germany's ranking of second only to Japan in solar PV production. The PV market increased more than ten times from 1999-2003, while the cost dropped 20% and Germany thus accounts for 55% of global solar electricity production, and solar electricity equipment (pg. 90). Of course the employment numbers associated with this sector are impressive in the region and beyond.

Good Policy, But Where?

In terms of unpacking utility regulations to understand the web of actors, policy incentives, and decision that make up the energy sectors around the world. Each region addresses the need for advancing renewables in its own way, countries have varying resource challenges, unique socio-political environments, and contextually run the gamut in terms of how energy is supplied, delivered, procured and regulated. This is one of the most convoluted sectors in the modern economy. The examples offered in the sections above provide simply a snapshot into a few examples cities and national governments who've instituted entrees to reforming energy and creative programs that are utility focused on bringing about renewables. But at the core of the energy questions for urban is environment is the question of land use, where exactly and how exactly to incorporate this into the existing fabric of energy. Land use is a critical component to create a direct conduit for rapid urbanization and net zero (or beyond net zero) to coalesce in the near future. Large scale renewable projects largely have no place in dense urban environments and thus have fallen to the wayside in terms of land use paradigms and renewable energy in cities. We turn to the question of how solar can be incorporated practically into form.

While modeling rooftops for urban environs can be quite helpful, at the ground level there remain numerous challenges to building solar, specifically when dealing with aging building stocks in tightly regulated (and dense) cities like New York. New York lends an excellent case study for some of these particulars. The New York Times (September 2016) recently reported that while building owners in the city are in fact interested in solar assets on rooftops to reduce the rising cost of building upkeep and aging structures, fire code requirements for six (6) foot walkways create a conflict between emergency responder's safety and energy independence (Laterman). The average row house in New York, which is the dominant residential form across the city, can fit a mere 16 traditional full sized solar panels on average on its rooftop. This is due to the required 6-foot buffer from all building edges, doorways, vents, and electrical equipment found on rooftops in the city. Even still, a system incorporating 16 average sized crystalline panels is estimated as resulting in an average savings of $6,000 to $10,000 per year, defraying some if not all of common area costs for building owners and bolstering coffers for larger building upkeep and efficiency projects. Impactful building upkeep such as modern heating and cooling systems which are in New York, incentivized at the local level by building efficiency tax projects and abatements are largely passed over by building owners unwilling to spend money on superfluous items. There lie social implications to solar savings however, and conflicts/barriers emerge with regard to solar costs. In many cities including New York, stakeholders in economically depressed areas for example today in Kings County (Brooklyn NY) there is a 23.7% poverty rate (NYSCAA, 2015); many socially-focused organizations have expressed concerns that they will be left behind during any solar advances that might take place, as solar systems continue to be expensive. Community housing organizations have lobbied for solar in New York as an economic and environmentally smart choice, as did the West Harlem Environmental Action organization, but worry that the systems would be largely loan financed, and thus dipping deep into organization's finance reserves has turned them off of the technology. Even in light of long-term savings from solar, this type of financial decision making is not easy for such organizations (Laterman, 2016).

As far as solar potential in cities and where such technologies can be deployed practically, there appears to be a need for aggressive urban policy that *requires* modeling of rooftop and thermal solar potential. If building owners, corporations and government institutions were required to incorporate both thermal and rooftop into their building designs as building stocks are upgraded, significant attention would be draw to the issue. Without such requirements status quo upgrades and inefficient maintenance will remain the norm simply because this is cheaper. Through a conflict lens a requirement of this type would likely not be all that politically appealing. Thus, dollars for solar modeling must be appropriated at the community level to steer clear of potential conflicts. Technology such as Google's Project Sunroof exemplifies the way in which open sourcing has enabled modeling of residential rooftops, as a free and even democratic means of understanding rooftop potential across the United States. This is an example of mitigating conflicts for mandating solar modeling to building owners and real estate actors, because such technology is free and open to the public. Governments can leverage such open source technology to mitigate inevitable pushback from the private/real estate sector regarding tighter regulations and policy for building efficiency and solar implementation at the urban scale.

Example open source solar gain & energy savings model (Google Project Sunroof, 2016)

But alas, there are inherent conflicts and barriers related to solar access, from both real estate, land use, and environmental justice perspectives. As far back as the late 1970's literature was emerging which sought to construct a legal, real estate, and social welfare framework for solar access, or more simply put, direct sunshine. Professor Stephen Williams (1978) wrote the article *'Solar Access and Property Rights: A Maverick Analysis'* in which he explained that solar power is the only source of energy available that is 'conflict free'. Williams framed the issue by describing the ways in which oil reserves largely come from nations with strenuous relations with the United States, and also amongst one another. Today this is truer than ever. He described coal and its finite supply and the direct correlation between its combustion and severe environmental impacts, most importantly climate change. He lastly described the multitude of issues associated with both nuclear fission and fusion. Solar he argued, was internationally abundant, infinite (substantially) and without interruption, while most of all, a non-polluting energy source (pg. 430). All of Williams' framing was intended to construct a means of pushing political actors to set up solar access as a 'right' for all citizens. As time has passed solar access has been a studied and legally authenticated right, assigned by federal, state and local regimes to property owners from a land use perspective, and within legal frameworks one landowner may not restrict another's right to their access. One can find references to solar access in nearly any local zoning ordinance. Obviously in dense urban environments not everyone has direct solar access, nor do all landowners necessarily want access, but the right is described and has become a part of planning practice. However, there is an environmental justice issue that embodies this conflict in that a single building may have better solar access than others. If governments require, or even incentivize solar usage as either thermal or photovoltaic applications, those who do not have access automatically lose. To minimize this inherent conflict produced by legal frameworks for solar access, community shared solar becomes an important tool for good policy minimizing conflict, potentially. Community solar has become a very recent but largely supported renewable source.

Take for example community solar legislation in the solar-friendly state of Massachusetts. In 2008 Massachusetts adopted the Green Communities Act (S. 2768) which created a multi-pronged approach to enhance energy efficiency, increase investment in clean energy solutions, and create savings for residents in the Commonwealth. The Act has provided significant benefits to the solar sector specifically by increasing the renewable energy portfolio requirements for the state to achieve 15% (renewable) of total energy production by 2020 in addition to allowing for Net Metering, which has allowed for long term contracts with utility companies, and additionally allowing for municipally-owned and utility-owned renewable energy projects, i.e. community solar (Reid, 2008). Net Metering as mentioned refers to the production of power in a single location, and the distribution of that power into the utility grid and subsequent purchase of that power in the form of credits to multiple separate locations, including households and businesses. The meter which tracks power for such projects effectively operates in ‘two directions’, allowing any power produced onsite that is not used to be sold onto the grid at a fair market price (Reid, 2008).

Resulting from this policy adoption and in the case of solar this has spawned a huge increase in the development sector, specific to solar farms ranging from 60 Kilowatts (the amount of panels that would fit onto a large residential rooftop) to 2 Megawatts (approximately 14 acres of ground mounted solar panels). A 2014 Study provided by The Analysis Group found that in Massachusetts during the first six years of the Green Communities Act (GCA) economic impacts resulted in 1.2 billion dollars in net economic benefits in the state, and more than 16,000 jobs (Hibbard, Tierney & Darling, 2014 pg. 3). Of the 1.2 billion, 155 million represented Massachusetts state and local tax revenues and did not take into account spillover benefits to neighboring states. This injection of revenue for the state was significant and the total economic benefits to the state even more so. A major component of this relates to community solar projects which allow for densely populated areas to source renewable energy from elsewhere, and makes a positive case for solar access, solar rights, and a unique way to think about land use and solar access.

Table ES-1
Massachusetts Economic Value Added and Jobs Created as a Result of the GCA
(Reflecting Base Case and Alternative Scenarios
Discounted at Private and Public Discount Rates)

Description	3% Discount Rate		7% Discount Rate	
	Value Added*	Jobs**	Value Added*	Jobs**
Base Scenario	$1.17 billion	16,395	$0.63 billion	16,395
High Gas Price (+30%)	$1.80 billion	21,651	$1.13 billion	21,651
Low Gas Price (-30%)	$0.60 billion	11,781	$0.18 billion	11,781

"Economic Value Added" reflects the total economic value added to the economy, which reflects the gross economic output of the area less the cost of the inputs. The reported numbers reflect net present value of economic value added.
"*Jobs*" reflect the number of full-time job years over time, and are not discounted.

(Hibbard, Tierney & Darling, 2014 pg. 4 - Table ES-1)

Beyond economic benefits, the study further illustrated the effects of the GCA on the state's power production and the addition of 1,300 Megawatts of Massachusetts-based renewable energy facilities and the subsequent reduction in fossil fuel-based and other high carbon emitting production in the near and long terms. During the study period is was observed that there was a 31 million metric ton reduction in C02, and significant reductions in other air borne pollutants such as Mercury, Nitrogen Oxides, and Sulfur Dioxides, all emission controlled in relation to power production in the northeast United States (Hibbard, Tierney & Darling, 2014 pg. 7).

I had the pleasure of speaking in person with a top representative of the Massachusetts Department of Energy and Environmental Affairs (EEA) Green Communities Program, someone who has traveled across the state engaging cities and towns with the benefits of the program since its inception in 2008. I learned that the program is in fact financially incentivized, in that towns who join the program receive anywhere from $125,000 to $1 million in state funding if they sign up and engage a host of projects related to sustainability and energy resilience. I asked whether or not the voluntary participation was proving to be effective or not, with such a time sensitive climate change agenda that we are facing here in Massachusetts and across the world. I inquired to understand whether or not they thought this effort could move fast enough to ensure that towns and cities across the Commonwealth were able make a meaningful impact. The response was largely that from a regulatory perspective, the ‘carrot vs. stick’ approach to sustainability has historically favored the carrot-approach in terms of long lasting, politically enduring successes. My interviewee personally believed that incremental change is ideal, and noted that the State of Massachusetts and EEA specifically seemed to also share this vision for sweeping State energy and planning initiatives. The goals of the GCA in Massachusetts is to marry policy with practice over time, and stretch existing frameworks for community development (that local officials have become comfortable and accustomed to) towards sustainable goals. I gleaned from this research inquiry that while incremental change may be slower than what the climate imperative requires, it may be the only way to create holistic buy-in and wide reaching upgrades. This stylistically syncs with one of the American Planning Association’s most revered urban planning theorists, Charles Lindblom who famously coined the terms ‘incrementalism’ in his 1959 publication *The Science of “Muddling Through”*. Many planners today feel that practically, an incrementalists’ approach works, and perhaps this is the best way forward for solar urban planning. An example that we discussed during the interview was incorporating solar requirements for all new construction, in that all rooftop building operational equipment (HVAC, air venting, fire escapes, etc.) would be required to be located on the *north* facing facade of the building. While this does not increase costs significantly to real estate developers, such policy steps allow buildings to incorporate solar solutions later on down the road on the south, east and west facades much more readily, and in a more passive manner act to incentivize building owners to build solar once the initial costs of building construction have been recovered. This is an interesting way to incrementally move regulatory codes towards more radical solutions, i.e. requiring that all new construction produce 100% of their power needs on site, or operate as net zero, both which can be difficult and create practical and ideological conflicts and barriers between economic development and sustainability. Another code concept being shepherded through the GCA requires that all new construction be equipped with electrical conduits from the roof to central electrical boxes (even if there is no electrical wiring constructed) so as to enable the installation of rooftop solar, battery storage devices, or solar heating devices, in the future in hopes that the building owner may include them as respective costs decrease over time. Overall I learned from this research inquiry that the GCA is not only robust across the state but also evolving to changing realities in light of real estate shirts, the rise of distributed energy projects, and utility policy shifts. I found this interview extremely beneficial to the understanding of practical land use and solar urban planning solutions.

With regard to this specific policy, significant benefits can be seen across a number of states who have initiated Green Communities legislation. Massachusetts is a clear example; however, this has not emerged as a trend or national strategy. John Nolan (2009) of the American Planning Association argues that while local governments do not receive the proper support from state and federal entities to create Green Communities, they ought to (pg. 6). He critiques the importance of energy efficiency mandates and restrictive codes, and argues that laws and protocols are what is needed such as those that create, such as local sustainable development protocols and laws which can in fact stimulate/create renewable technologies such as wind, solar, and micro turbines (pg. 8). Regarding national energy policy and the creation of renewable energy portfolios in the macro context, Nolan views Federal support of Green Communities as a missing ingredient. In looking at some of the internationals models I have introduced, this likely possesses tremendous potential at the federal level and should be addressed by federal energy policy.

Conflicts of Macro-Influence

We turn now to national policy and examples of how they can impact the energy economy and stimulate renewable energy advances in the macro-context. At the core of federal policy is obviously a functioning congressional, executive, and judicial balance of power and common vision for the future. At this level of governance however, no period in modern history has proven less productive than the present, with near gridlock in Washington DC between rivaling Senate and House legislators. To push renewables at scale and thus address the local and global threats posed by climate change, a common vision must be established. At the core of a federal vision is a functioning federal government to set such goals but in terms of anything substantial only the President has so far shown initiative, most notably with his commitments and attendance at COP21 in Paris. There are a few bottlenecks to progressive federal energy policy, and include dirty energy lobby-interests in Washington namely those supporting coal and natural gas two of the largest national power producers. Other bottlenecks relate to domestic and international oil lobbyists as well as large regional utility interests. While the oil lobby is widely focused on the transportation systems, regional utilities are successful in leveraging ratepayers as their bargaining chip to maintain dirty energy supply chains so as to keep energy costs low to that stakeholder group. This is an extremely successful political calling card. The barriers and conflicts present at the national level are vast and extremely interwoven. However, there has been recent and impactful federal-level solar and large scale renewable enabling legislation that has broken through this deadlock.

The Solar Investment Tax Credit represents potentially the single most important Federal program aimed at broadening the influence and renewable energy portfolios for the United States at large. This legislation, which in 2015 was extended through the year 2025, has resulted in the expansion of the commercial solar sector by an order of magnitude that is not yet quantifiable. This is an important step towards national leadership specific to large scale and decentralized solar energy production. Political idealism relating to energy policy and incentives can swiftly change course as fast a congressional leadership shifts. The United States is an example of such policy uncertainty as the Republican Party takes over executive and legislative branches of the federal government in 2017. This is a glaring conflict inherent to energy planning and the success or failure of energy independence and sustainability. Perhaps the former, articulated as energy ‘independence’ is a more accurate and stakeholder-focused means of gaining politically diverse perspectives on energy, rather than a focus on ‘sustainability’ which is a more loaded term and volatile across the aisle.

At the International level it is unclear how the trends in the United States, the world’s largest carbon emissions producer, will affect solar energy production globally. In light of the recent COP21 global climate change summit and agreement in Paris, it was thought that the American-led commitment to a climate mitigation strategy was a turning point to global efforts. The United States is by no means a leader in solar and other renewable energy technologies, with European nations like Germany and The Netherlands advancing the agenda in both solar and wind policy and their implementation through local and national efforts. But nonetheless, the recent signals from the U.S. in Paris seemed to illustrate a shift in Western policy changes. However, it should be emphasized that there is far more at play in terms of political dialogue on the International stage. One example of many notable examples is the recent ruling by the World

Trade Organization (WTO) against India’s proposal to exclusively purchase solar panels and other technology domestically, rather than as regulated by the General Agreement on Tariffs and Trade (GATT) established over three decades ago in 1994. The WTO’s argument for the GATT framework is to enable the cheapest and most efficient goods and services (International Centre for Trade and Sustainable Development, 2016) and thus the Indian government's decision to use domestic solar infrastructure only for future projects was seen as an undermining policy to the WTO’s main objective of price control. This is an example of macro policy conflict, and counterproductive International efforts regarding renewable energy, solar in particular, and climate change mitigation at large. This example highlights the modern economic agenda, rooted in neoclassical theory and dogmatic focus on the concept of efficiency and market obsession. Modern economic thinking does not seem to support but rather undermine domestic energy policy, and is narrowly focused, especially as compared to effective and wide reaching policies such as state Green Community enabling legislation.

There has been an increase in the prevalence of national governments and the provision of guidelines for local climate policy. Germany’s guidebook on local climate protection (Kern, 2005), and Austria’s Klima:aktiv Program to name a few. In the UK, urban planning recommendations have been enacted which require local governments to make provisions in addressing climate change. While data collection and greenhouse gas emission inventories for cities represent excellent progress, there is a need for these efforts to be standardized and complemented by protocols for monitoring emission reductions and advances in energy efficiency. Other approaches like the GCA seek to aim funding directly at climate change mitigation. The most far-reaching funding framework exists in the Netherlands: ‘The KlimaatCovenant’, a tiered arrangement involving local governments, provinces and ministries at the national level and seeks to radically reshape the country's housing stock to net zero within a just a few years (Netherlands Ministry of Housing, 2006). Within the three-year time horizon of 2008-2011 the Ministry of Housing budgeted EUR 37 million in subsidies to local governments, provinces and ministries at the national level for broad retrofitting and energy efficiency upgrades. The plan is a direct subsidy program, aimed at reducing carbon emissions and incentivizing local governments to do even more than they might already be planning, towards net zero frameworks.

Current conflicts - Utilities & Grid Modernization Technology

Here at home, the United States does not have a national renewable energy portfolio standard. A renewable energy portfolio standard (RPS) is just that, a standard by which utilities companies are required by the government to meet. As all utilities are regulated in some way by tariff and law structure, even municipally-owned utilities, they are thus beholden to these government regulators to do what they say. States in the US have portfolio standards, however the national government at large does not, as compared to the European Union, which had a 12% renewable standard for electricity production by 2010 in addition to standards in place in 25 member countries. The American Council on Renewable Energy estimates that a national portfolio standard could create USD 700 billion in economic activity and 5 million jobs by 2025 (American Council on Renewable Energy, 2007). This concept could provide a significant economic throughput, and thus might be serve as both a job creation mechanism and energy independence program that would attract federal consensus across the aisle.

Unfortunately, there are tall mountains to climb, as it is apparent that our energy system is not modernized, nor renewable, nor free of the historical generation patterns that have fueled development activities across the world to date. As far as capacity is concerned in the United

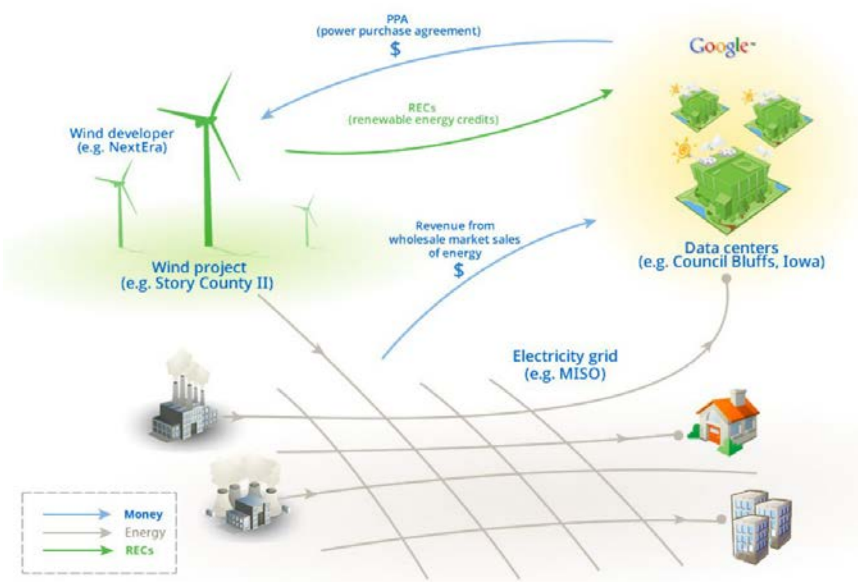
States, The Union of Concerned Scientists (UCS) estimates that roughly 45 gigawatts of new renewable energy capacity will be needed by 2020 to fulfill current state renewable portfolio standard policies alone, while Global Energy Advisors estimate that more than 52 gigawatts would be required, amounting to approximately 3% of United States 2020 electric sales.

In New York State as an example there are signs of progress towards a large scale renewable reality in the energy planning sector. A recent Order was released by the Public Services Commission of New York, adopting a clean energy standard in which a series of 'deliberate and mandatory actions to build upon and enhance opportunities for consumer choice' were deemed necessary to achieve the state's environmental, public health, climate policy and economic goals. The Order seeks to preserve existing zero-emissions nuclear generation resources as a 'bridge to the clean energy future' while engaging in actions consistent with the most recent State Energy Plan (SEP). Such action stipulates that 50% of New York's electricity be generated by renewable sources by 2030 as part of a strategy to reduce statewide greenhouse gas emissions by 40% by 2030 (State of NY PSC, 2016, pg. 1-3). While we cannot overhaul energy systems of this scale and scope overnight, it is clear that energy 'transitions' as the PSC describe them above will take quite a long time, relying heavily upon traditional production technologies due to our culture's massive appetite for energy spanning across huge territory boundaries. While nuclear is carbon free and thus consistent with climate change mitigation, there are certainly other risks associated with its use, and its continued reliance undermines market and government injections aimed at bolstering renewable and particularly solar programs from taking hold. NY State serves as a prime example of path dependence on nuclear energy production, along with slow energy reform, but of indeed some minimal progress on renewables.

Utility vs. Distributed Generation

There is a major conflict unfolding in the United States at present which has been brewing between an emerging and every popularizing movement towards distributed generation, i.e. solar on homes, community solar farms, distributed and cost effective batteries systems; and the traditional and immensely powerful influence of utilities. Further complicating the matter are recent advances in smart grid technology, battery storage technology and lastly micro grids, all of which I will discuss in this section.

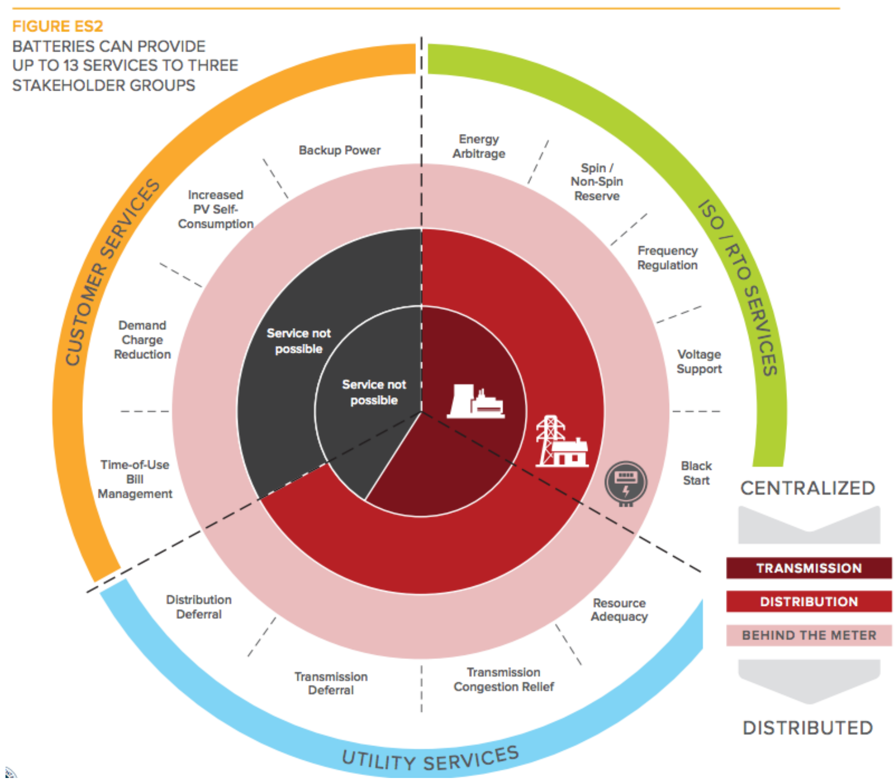
Privately held utility companies, like the UK based company National Grid, have a tremendous economic and political stranglehold on the energy future, and history for that matter, of the United States. National Grid's April 2016 release, 'The Democratization of Energy: Climate Change, Renewables, and the American Dream' offers a somewhat optimistic future however. The publication presents an interesting look at this unfolding conflict and one of the nation's largest Utilities who is attempting to stay afloat in a rapidly changing energy sector. On the opposite side of this debate, advocating for a different view of the future of energy, is California-based battery giant Tesla. In making the case for the acquisition of SolarCity one of the nation's largest solar companies, Tesla confirmed its own long term corporate strategy of 'expediting the move from a mine-and-burn hydrocarbon economy towards a solar electric company' (Fabode, 2016). This short statement underlies the company's transformative goal; to radically transform America's national business model consisting of approximately 3,200 utilities providing electricity to 140M customers across the US. Tesla's CEO and founder Elon Musk described this transition a few months ago in the company's latest technological release. He noted that 'the provision of Model S/X/3 (a combined solar panel system – power wall unit) for consumers to deploy and consume energy in an efficient and sustainable way lowering costs and minimizing dependence on fossil fuels and the utility grid' was the future of electricity as we know it (Fabode, 2016). Companies and private sector actors have shown incredible interest and market potential in this way, and perhaps are making the case for Tesla and distributed generation at scale to emerge, and is cause for concern for the eventual demise of traditional utilities. The argument is essentially that if energy can be generated *on site* for homeowners, businesses and industry, in this distributed fashion, there will be no need for massive utilities to produce huge amounts of power and ship that power across hundreds of miles to end users. An example of this playing out is the rise of corporate power purchase agreements (PPAs) which has led to approximately 3.7 Gigawatts of wind power development in 2015 alone (Maloney, 2016). With solar rooftop incentives popping up in major cities in the US, New York City and Washington DC, to name some of the major players, this private transaction between independent energy producers and corporations looking to procure energy external of traditional utility provision will continue to grow, and could lead to the erosion of utilities relevance as we know it today.



Google's Corporate Power Purchase Agreement (PPA) Illustration (UtilityDive.com, 2016)

To expand upon the emerging conflict between distributed generation and utilities, it is important to understand a few other emerging technologies and trends in the energy sector. One concept that has emerged quite recently is that of smart grids. This is a means of thinking about cities and towns as intelligent in both consumption and production of energy resources. This term refers to locational specific electricity distribution networks that provide power utilizing advanced technology which responds to not only electricity generation but also the demand-side and end user, by way of utilizing energy-response infrastructure to run the entire network in the most efficient, 'smart', manner possible. The Department of Energy (DOE) defines them as unique to traditional utility grids, through their use of computer-based remote control and automation, and made possible through the application of two-way communication technology and computer processing. 'Much in the way that a "smart" phone these days means a phone with a computer in it, smart grid means "computerizing" the electric utility grid (Office of Electricity Delivery and Energy Reliability, 2015). Smart grids have offered a new way of modernizing grids and allowing for power outages and blackouts to be mitigated if not eliminated entirely by way of utilizing renewable energy sources like solar and wind aligned with large scale battery storage. This is another potential source of erosion for the role of traditional utilities, as it lies largely outside of their reach, and we have just begun to see its potential.

Central to the thesis and effectiveness of smart grids is the application of batteries. Battery storage possess a host of customer (energy users), distribution (the network that connects homes and businesses to electricity), and transmission (the network that moves wholesale energy long distances) aligned benefits, the majority of which can be captured by customers. They are critical component to smart grids and the future of distributed energy in cities and elsewhere.



The Economics of Battery Storage (Rocky Mountain Institute, pg. 4)

The above illustration provided by the Rocky Mountain Institute (RMI) provides thirteen tangible services that batteries can provide, through today's understanding and technology solutions, all of which are made possible with behind the meter storage applications (illustrated in pink). Behind the meter refers to just that, battery banks that function behind the utility meter which reads the electricity a given customer purchases from a distribution grid. When a battery is installed behind the meter, it serves as a repository of energy, enabling that energy (with the incorporation of relatively simple computing and monitoring software and technology) to be deployed in the most efficient manner possible. Rather than purchasing power from the grid during the highest cost hours of the day, or highest polluting hours of the day (ex. during the evening when coal plants are running at their maximum potential to satisfy end of day demand) batteries can store energy produced during the day when the sun is shining powered by a solar array either on the customer's home/business or a solar array offsite. That energy may be used during high peak, as it has been stored throughout the day, to offset or substitute any use of peak demand electricity. At the urban scale or any macro-scale for that matter, this lowers peak demand and the production of polluting electricity while simultaneously lowering the cost of electricity for that consumer, and for all consumers.

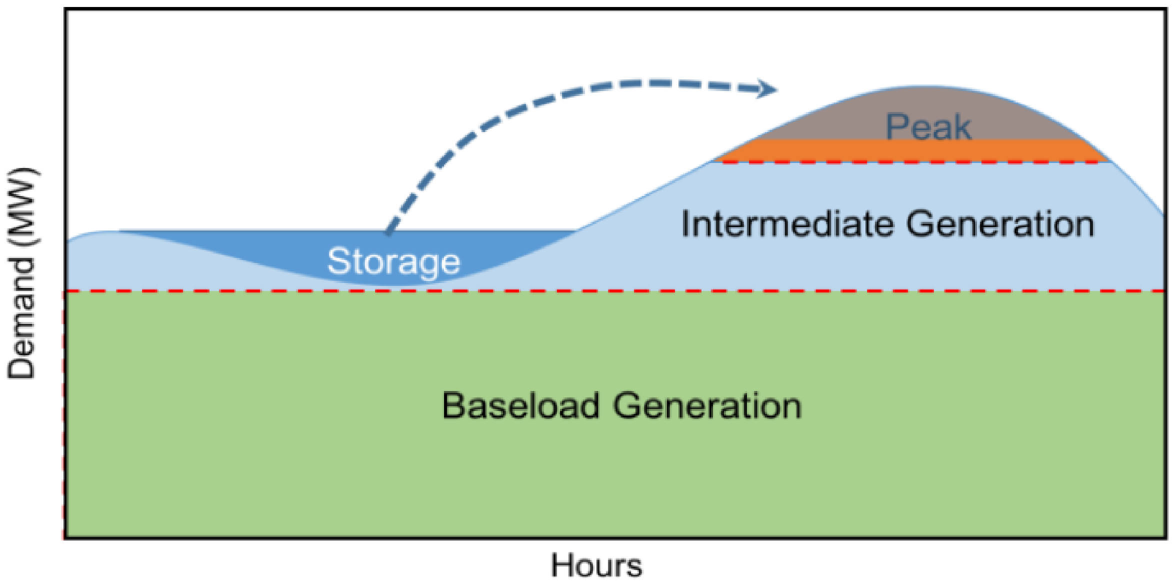


Figure 3: Energy storage can use off peak energy during times of high demand

(State of Charge, pg. 6)

The conflict or barrier to entry here lies in the fact that this ‘distributed storage’ network in theory and practice lowers the production of power for large energy companies, natural gas, coal, and nuclear producers, whom have large operating costs, very profitable market shares, and obvious political lobbying power to the utilities and public-facing officials that engage in setting pricing for consumers. These are referred to as Public Service Commissions, ISO’s, and State and Federal energy offices. Other conflicts relate to sluggish or half-baked policies which bolster, incentivize, and expedite the use of battery storage, which will be necessary and crucial to reduction of wasteful CO_2 producing power production which dominate the current electricity marketplace, contributing to 40% of our carbon production nationally (Rocky Mountain Institute, 2016). The State of Massachusetts released the Massachusetts Energy Storage Initiative Study in 2016 and a subsequent $10-Million-dollar investment in the capability of battery and storage solutions across a host of industries in the state. The ultimate goal of the study was to lay groundwork for the types of policy needed to bolster the technology, and of course to ensure that consensus exists for a technology which can bolster existing renewables, specifically solar.

As discussed earlier in the every growing conflict between utilities and an emergent distributed energy market, battery storage brings about the concept of Micro grids. The Massachusetts Department of Energy Resources (DOER) defines micro grids as a collection of generation assets and other distributed energy resources and loads within a defined boundary that can operate in a grid-connected mode or separate manner, referred to as an "island", from the broader electricity grid (2016, pg. 173).

As part of this body of work I had the pleasure of speaking with a member of a for-profit company known as *The Micro Grid Institute*. This multi stakeholder engagement entity seeks to connect community leaders and renewable energy opportunities together to create resilient energy systems that are not only stand alone, or islanded, but also sustainable. The Institute provides the following visualization in a specific case study that we discussed during the interview:

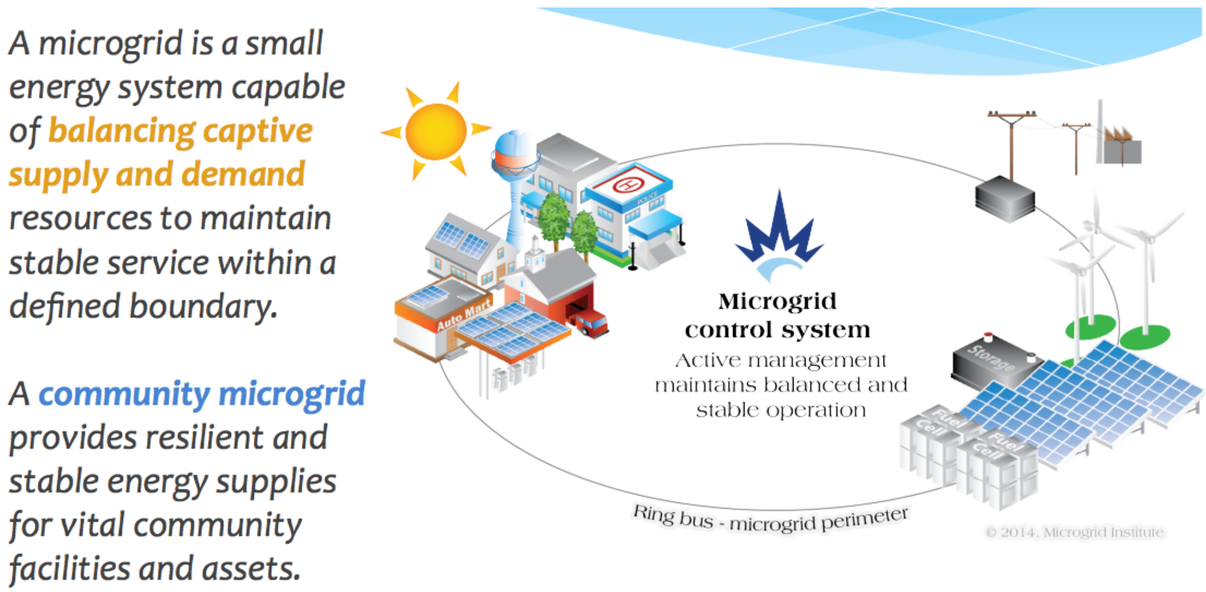


Illustration – Micro Grid Institute (2014, pg. 5)

During a phone interview I was able to interface with a member of the organization and I learned about the ways in which recent events such as superstorm Sandy which ravaged the east coast in 2012, along with hurricane frequency increases, have coalesced to create an awareness and readiness for communities to begin thinking about their core functions alongside energy resiliency in the context of climate change. They described how micro grids are used to stabilize economic forecasts for communities, specifically municipalities, that are experiencing ever increasing costs with ever shrinking revenues. Beyond economic importance I learned that micro grids serve to limit power outages which is the most common main concern for many of the Institute's clients. It was described to me that micro grids include hospitals, colleges and universities, large housing complexes, schools, and other large institutional energy users that suffer from high risk profiles due to their electricity and heating needs for patients, students, and their other users. We discussed the City of New Paltz, NY which was a case study that the Institute received funding from the New York State Energy Research and Development

Authority (NYSERDA). For New Paltz, the Institute designed, managed and brought together a multitude of stakeholders in the creation of a 3-4 year visioning and implementation of a micro grid. The study is currently in Phase II of III which would serve the State University of New York (SUNY) New Paltz, the Town and Village of New Paltz, the State Environmental Department, The New Paltz Central School system, and will interface with the local utility provider, Central Hudson Gas and Electric. I learned that the goals were twofold, one to save money and provide sustainable energy from renewable sources, while secondly to 'keep the lights on' during storm events for critical infrastructure that made up these four (4) stakeholder groups. The interview brought to light how difficult, if not impossible integrated planning can be and it became clear to me that this project may in fact never be fully realized. The project which is still in the midst of its lifecycle while still heavily reliant on state funds from NYSERDA, illustrates how difficult integrated planning approaches are for renewable 'off grid' energy project as articulated during this interview with The Microgrid Institute. Not only was it heavily reliant on State pilot funding to initiate, but private sector actors were central to keeping the project on track and time bound. While the impetus to 'keep the lights on' seems obvious, I asked for the rationale behind initiating a process such as this amongst such a wide set of agencies. The response was essentially this: as communities continue to lose revenues due to macroeconomic forces and changing free market factors, their costs to operate institutions and the municipalities themselves continue to rise. The only way to meet growing energy demand is to bundle services, share costs of energy upgrades and delivery, and ultimately lean on new cheaper technologies to do so. It was described to me that while solar and other battery storage technologies are more expensive up front, the long term payback due to the sun's absolute reliability in the case of solar acts as a means of stabilizing institutional budget imbalance.

Another interesting topic that came out of the interview was the Microgrid Institute's latest initiative that seeks to bundle specific micro grid projects across a number of states, into what was referred to as 'micro grid portfolios', which serve as a more lucrative and stable investment opportunity for large investment entities like banks and large energy focused venture capital funds.

It appears that the main barrier to the scaling of micro grids is that they are both expensive and involve long runway planning efforts. They are both highly cost and complicated to roll out. Beyond this, they carry a risky investment profile and cannot be visible to their central beneficiaries for years. The solution to scaling micro grids perhaps lies in the bundling of their risks across numerous regions and policy environments. Coupled with long-lead renewable energy projects this bundling could potentially invite more investment and thus scale micro grids to achieve more resilient communities nationally or worldwide, as the benefits community by community act as a multiplier and their popularity can thereby expand. Realistically, this is a long way off as far as The Microgrid Institute is concerned. But, micro grids in concept and application are slowly entering the energy planning space as an important byproduct of the emergent conflict between distributed generation and utilities nationally.

Summing it up

So what has worked? Massachusetts has illustrated a state-level policy that seems to be taking hold as Green Communities Legislation and the 2008 Green Communities Act has resulted in jobs, expansion of solar energy, and municipal engagement with issues of climate change, energy independence, and energy efficiency. But has its deployment been rapid enough and broad reaching enough to make significant advances? With COP21 in our recent past, HABITAT III over and the UN's New Urban Agenda in effect, will countries act on their commitments to reduce emissions or develop the necessary tools to implement deep changes to the status quo of development patterns while actually developing towards a carbon free future? I have looked at a number of good policy solutions that have shown both quantitative and qualitative advances in the realm of community planning, sustainable principles, and effective stakeholder engagement. I have investigated the incorporation of solar as a specific energy technology into the urban fabric at home and abroad and the wide set of conflicts and barriers that exist within urban planning practice. And while there are innumerable challenges poised to maintain status quo in terms of traditional urban planning techniques and urban morphologies we see today, there are vast examples of creative urban policy, urban design, and conflict mitigating measures being deployed from Cambridge Massachusetts to Freiberg Germany that lend powerful tools for the incorporation of renewable energy into the urban fabric. While at their core the density we find in cities create a challenge, this is also an opportunity. Thermal mass, intelligent neighborhood block design, community enabled energy procurement, local zoning policies aimed at incorporating photovoltaics on every rooftop; these are but a few of the many possibilities cities inherently possess which can steer urban leaders to net zero communities and solar-centric urban planning practice. These techniques when properly employed have the tremendous potential to reduce local government expenses while stimulating economic growth both in terms of real estate development and job creation within the renewable energy sector, while also scaling effective solutions aimed at mitigating climate change. Within the context of rapid urbanization and the continued migration of rural inhabitants to cities around the world, thoughtful, actionable, and understandable solar urban planning will be a necessary movement both here in the United States and across the world if we are to continue to develop while capping harmful emissions as soon as possible. It is the imperative of our time. We must develop our cities and towns paying direct mind to health, safety, and a literal alignment towards the sun as the most reliable input for energy in terms of both electricity and thermal gain. Policy advances must be strong and broad reaching if cities are to develop quickly enough to impact rising energy demand in a meaningful way. Interestingly enough, recent press from the White House has begun to engage with issues of density here in the United States where President Obama himself has commented on the importance of density, for not only housing price reduction but conflicts inherent to archaic zoning policy here at home (Wollert, 2016). This is something rarely contemplated let alone publicized by executive leaders, and gives some hope towards progress.

We need a national renewable energy portfolio standard to guide energy policy, create jobs in the sector, and aggressively take on carbon mitigation. Another part of the energy revolution for cities will be seriously tackling energy emissions. Net Zero communities will need to be the majority, and case studies such as Cambridge must quickly be deemed scalable and become used by urban legislatures rapidly, and as part of the recipe for success. Building requirements for efficiency must be enacted, and neighborhood organizations and community-led coalitions must engage with urban planners and policy makers to ensure that urban design incorporates the needs of its citizenry. This includes the alignments of buildings to the sun of course, but more importantly the protection of the rights of existing communities and the heritage and cultural values present to those regions. These are what make cities livable in the first place, and wonderful homes for people to live and to create livelihoods.

While I have focused much of this paper on the 20% of the world, or less, living in developed nations with modern grid infrastructure and holistic distribution networks, a startling two and half billion humans rely on simple biomass, wood, to meet their energy needs (Habitat

III, 2015 pg. 3). This results in massive deforestation and environmental degradation, and of course contributes to carbon emissions in this way. While 75 % of total global energy generated is consumed in cities, of this number around one quarter of the world's urban population continue to live in informal settlements, lacking basic services and infrastructure and energy networks. When we talk about grid modernization, solar cities, and smart infrastructure, we are largely skipping over this entire populous of the world, and thus missing a massive opportunity and conversation to engage those most in need of economic development, services, and infrastructure. This includes women and children with an emphasis on the need to gender specific analysis.

With regard to the past election in the United States, the global community is waking up to the fact that Donald Trump's election is a wide reaching reaction to globalization, alongside the ills of the democratic process and US government's inability to address common problems. How this backlash will sync or not sync with the climate imperative is yet to be seen, as climate change is directly linked to the processes of globalization or at minimum *linked* to global transactions and interdependence. The New York Times reported the day after this shocking presidential campaign and Trump victory: 'Pessimists will find abundant support for despair this morning,' John Sterman, a professor of system dynamics at the Massachusetts Institute of Technology, wrote in a Climate Interactive analysis on Wednesday morning:

> *With Mr. Trump in the Oval Office and Republican majorities in both houses,*' Mr. Sterman wrote, '*there is little hope that the Clean Power Plan will survive in the Supreme Court or for federal action to meet the U.S. commitment under the Paris accord. Worse, other key emitter nations — especially India — now have little reason to follow through on their Paris pledges: If the U.S. won't, why should developing nations cut their emissions?*
> (Davenport, C. 2016)

But perhaps the world will shift climate leadership away from the U.S. rather than looking to it for guidance, if in fact the likely scenario results in continued denial of climate change at the highest office. Hopefully countries will not stifle their own efforts in light of conservative energy policies by the world's former leading polluter, the United States of America, but rather take matters into their own hands to affect their own progress and climate destiny. Ideally, this will be our future. But realistically, we must effect change more than ever at the local level to seek the results we have no choice but to ensure for our very survival. Context matters, and therefore we will need to put into context concrete urban strategies that identify conflicts, minimize their impacts, and implement policies sensitive to them.

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