Emerald City 100% Renewable Energy Plan

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Abstract

This paper presents the practical policy and project implementation steps of a 10-year conceptual plan to transition the heat and electric power systems of Traverse City, Michigan to 100% renewable energy. Pitched as "Emerald City", it proposes the deployment of a mix of solar, wind and bioenergy systems—coupled with energy storage, energy efficiency, demand management, mini-district heat, and optimal control strategies. Potential city specific renewable energy, efficiency and storage projects are outlined, representing an abundance of choices for citizens and stakeholders working together, or as autonomous actors. The author, the developer of the first green pricing program in the United States (US), argues that green pricing programs are no longer appropriate, and should be replaced. The Traverse City renewable energy plan can be accomplished with minimal electrical distribution infrastructure changes through the following strategies: targeting a 300% increase in electric energy distribution, displacing natural gas in a 7,800 heating degree day (HDD) climate, and applying the concepts of the "Harmonious Grid" (NW Energy Coalition), "Link and Sync" (C. Gruenwald – Blattner Energy), and Green RE-Heat (Smiley)—with focus on thermal energy storage. Unique policy applications such as unlimited solar net metering, flexible and targeted climate/carbon fees, maximizing on-bill financing for efficiency, solar, energy storage, and fuel switching, can also help achieve 100% renewable energy while lowering and fixing energy costs indefinitely.
Keywords: 100% Renewable Energy, carbon fees, on-bill financing, harmonious grid

1. Introduction

This "Emerald City" 100% renewable energy plan for Traverse City, Michigan is a 10-year "concept plan" of how to make a small city of 15,000 100% renewable energy heated and powered. The focus is on very practical steps, describing the community energy profile, promulgating policy, identifying projects, financing, and then implementing these policies, systems, and projects. This is a conceptual plan because, since extensive detailed research and project development work will be required by utility staff, analysts, engineers, and financiers.

Economists, when writing policy should state their foundational political economic principles relevant to their study. Here are four which provide a framework for my plan:

- "All energy choices and prices are based on politics and policy". John Pestle (ret. energy attorney).
- "Make the market your slave, not your master." Frede Hvelplund, Aalborg University, DK
- 21^{st} Century economics must be, "distributive and regenerative". Kate Raworth; *Doughnut Economics* (2017)
- "Wealth is regenerated solar radiation." R. Buckminster Fuller; *Operating Manual for Spaceship Earth* (1969)

Backed by green bonds, green banks, climate fees, and on-bill utility financing, the capital bottleneck can be removed releasing the tremendous latent demand for clean energy by local citizens of all income levels—investing in conjunction with the municipal electric utility. Unlimited and unrestricted solar net metering can help rapidly expand

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solar energy within the city limits, with full net metering for residential customers and adjusted net metering for large commercial installations. I project that the impact on utility revenues will be less than one percent with an unrestricted solar net metering program. Planned community solar, as well as utility scale wind and solar installations can generate roughly three times the present electric energy consumption in Traverse City. Flexible and targeted “climate crisis cost recovery” fees will be uniquely applied, positive on-peak, and negative off-peak so that off-peak period electricity will out-compete natural gas for space and water heating. Quick response combined heat and power (CHP) biogas engines, with thermal storage, enough to run the city on average (35 MWe), with load control and as emergency back-up will be installed throughout the city. This can displace the emergency back-up generators that represent roughly 50% of the city electric load, sitting idle over 99% of the time—representing a tremendous economic waste. Thermal and electric battery storage will be distributed throughout the city with thousands of controlled hot water tanks (both large and small), and electric battery systems. Electric vehicles will be phase in with incentives and low-cost time of use (TOU) charging rates. Distribution grid modernization will be conducted, including retrofitting distribution substations for bi-directional control and at least one large utility-scale wind and utility-scale solar collection substation. A broadband monitored “grid harmonization” control plan will be implemented as outlined by methodologies such as Charley Gruenwald’s “Link and Sync” and the Brattle Group. Any excess renewable energy can be sold into the regional grid to help avoid curtailment. With climate fees phased out over 10 years energy costs will lower than present and fixed indefinitely.

2. Geography, Resources, Economic and Energy Profile

“Emerald City” is based on the geographic, economic and energy characteristics of Traverse City, Michigan. Traverse City currently has a population of 15,000, covering 8.7 square miles, in a humid continental climate with 7,794 (F) HDD and 458 (F) cooling degree days, situated at 44 degrees north latitude. The solar resource is 1,350 kW-hrs/m^2/year and the wind resource category is IEC Class IIIA on surrounding higher ground. It is not the sunniest or windiest place, but there is a good seasonal balance with twice as much wind in the winter and twice as much sun in the summer (see Figure 1). The windiest hour on average is 3 PM, aligning with peak period electric use. Adequate feedstock for biofuels is available.

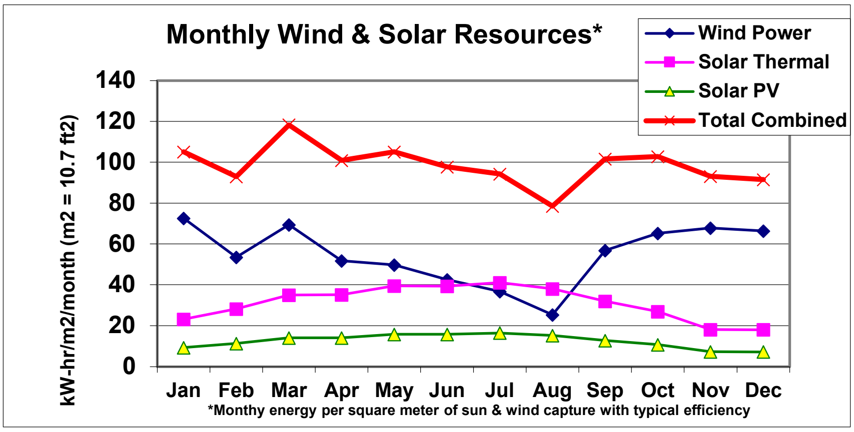

Figure 1

2.1. Energy and Economic Profile

Currently, in Emerald City, 93% of the non-transportation-related energy is natural gas (64%) and coal (29%) respectively (see Figure 2). Wind and solar account for roughly 5% with land-fill gas and natural gas combustion turbines (CT) filling in the balance of the generation mix.

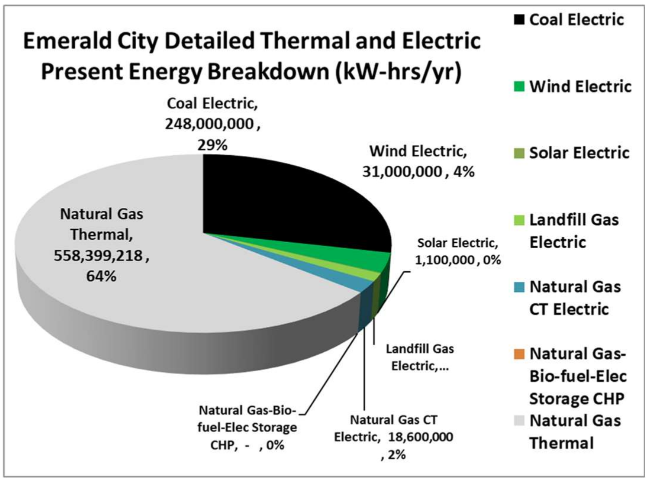

Figure 2

The summer peak is roughly 70 MW's, the average load is 40 MW and the base load (night-time) is roughly 25 MW (see Figure 3). Annual electric consumption is roughly 310 million kilowatt-hours (kW-h) and annual natural gas use is roughly 560 million kW-h.

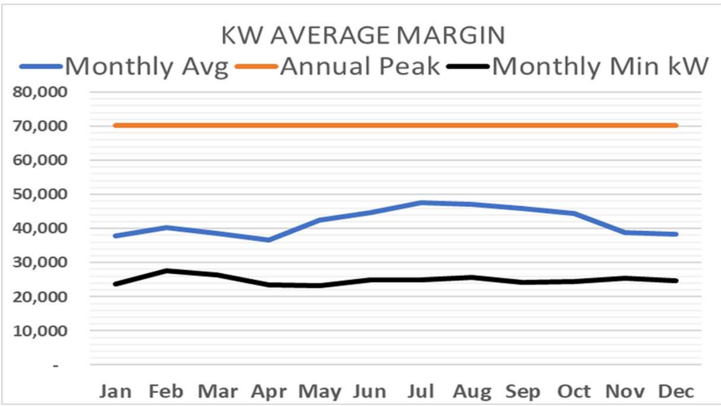

Figure 3

The customer economic electric profile shows important distinctions with 87% of the metered customers residential and the balance of 13% commercial, institutional, and industrial (see Figure 4). In contrast to this, 87% of the electric revenues (see Figure 5) are commercial, institutional, and industrial. Put another way, with residential consumers representing only 20% of revenues, if they cut their electric use 50%, it would only impact utility revenues by 10%.

The annual electric expense is roughly $35 million, and the natural gas expense is roughly $20 million--with a total annual community expense of $55 million. Transport fuels have not been estimated.

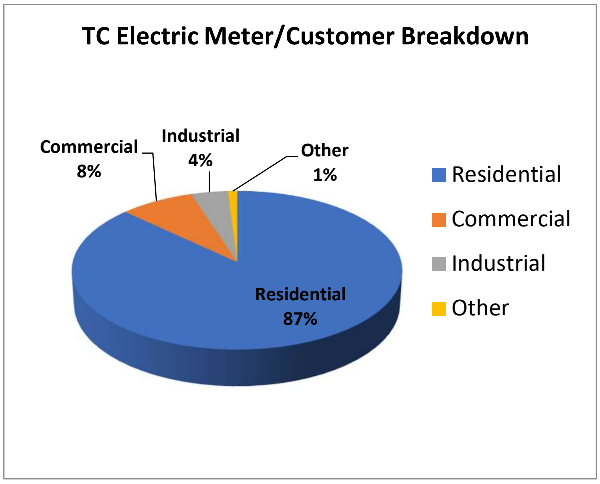

Figure 4

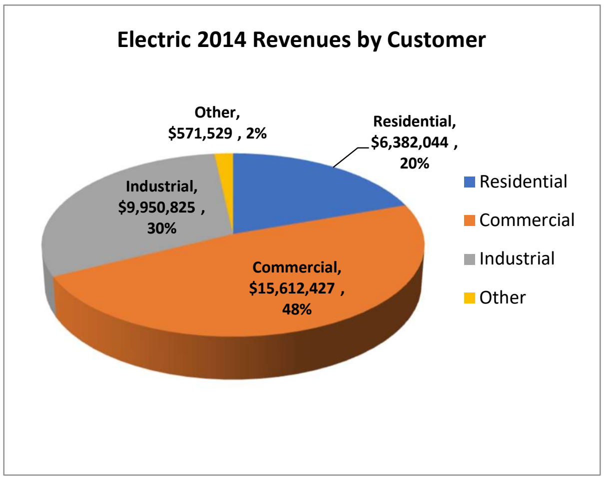

Figure 5

Next, Figure 6 illustrates a typical winter daily electric demand profile with peak rated capacity, hourly demand, and a net capacity. The peak capacity available is higher in the winter due to colder temperatures. The net capacity availability which reaches 55 MW during the night-time raises the question, "is this enough electric capacity to heat the city--eliminating natural gas use?" One might conclude that it is, especially with the leverage provided by heat pumps. But even without heat pumps, low cost electric resistant heat systems can meet the need most of the time. Therefore, with the existing electric distribution capacity, we can heat the city, including both space and water heating. With this, we can use thermal energy storage for space and water heating, one of the least cost energy storage systems. Thousands of controlled domestic hot water heaters and a few large commercial hot water storage systems (i.e. 3 MW hot water boilers with variable load controls can meet the demand.

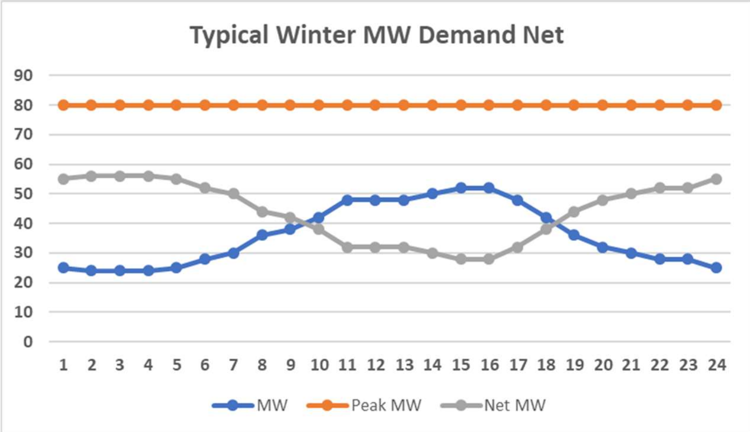

Figure 6

3. Policy

3.1. *Unlimited Solar Net Metering*

All limits should be removed on solar net metering. Presently there is a 20-kW size limit, with annual metered kW-hours as the basis for maximum system sizing. For residences, even if 20% of the city's homes, churches, businesses, and multifamily units had 100% net zero solar the impacts, on the community owned municipal utility would be less than 1% of revenues. The reason the impacts on utility revenues are insignificant are fourfold. First, residential customers make up only 20% of the total utility revenues so with tree lined shaded streets, roof space and orientation limitations, it is estimated that only 20% of properties have reasonable solar access resulting in 4% solar potential. Second, most properties will not have adequate roof or yard space to offset annual kW-h, further limiting the residential solar output. Third, excess solar generation is automatically consumed by the nearest non-solar neighbor with near zero distribution expenses, a neighbor who pays the full retail price plus a proposed climate fee for that solar energy. And fourth, since solar is typically generated during peak periods, peak period distribution capacity is increased while power quality is improved.

More importantly, commercial, and industrial consumers should be allowed to maximize solar opportunities on their properties. For larger solar installations, with economies of scale, a lower solar value can be implemented (basically a fair feed-in-tariff), but it must be enough to "make a market", at minimum the 10% return on investment we guarantee our monopoly investor owned utilities (IOU's). With this, the net revenue effects on the community can be near zero.

3.2. *Community Solar*

In this tree lined city solar opportunities in residential neighborhoods are limited by shading, with the trees providing beauty, oxygen, and free air conditioning (passive solar cooling!) for the community. Therefore, community solar, whether cooperatively owned or utility customer owned, provides an important element of a 100% renewable energy plan. Importantly, since larger community solar projects are lower cost, there should never be a solar premium on a utility bill, but at minimum, an equal offset on the electric bill. If a utility consumer buys into a community solar project, dedicating a portion of their electric bill to the investment in the solar project, they should have a net lower electric bill. This provides opportunities for lower-income citizens. For citizens that are not metered consumers independent cooperatively owned larger solar systems provide an investment opportunity. Citizens have tremendous latent demand to invest in solar locally if the program is fair and promoted aggressively by the utility.

3.3. Climate Crisis Recovery Fee

A "climate crisis recovery fee" (CCRF) is proposed as an alternative to a carbon fee. Most electric utilities have guaranteed rate adjustment fees generally called "power service cost recovery" (PSCR). When fossil fuel supply costs go up or down, adjustments are automatically made to rates. A variable and flexible CCRF is proposed as part of investment fund raising for the municipal utility, to offset external environmental and social costs associated with pollution, to account for distribution system retrofits, and as a mechanism for fuel switching from natural gas to electricity. This CCRF is much more than a carbon fee and it is not calculated based on avoided tons of carbon. The CCRF benefits accrue much beyond carbon avoidance. The CCRF is a flexible and variable fee that varies with time of use electric rates, with the fee high during on-peak periods, moderate during intermediate periods and negative during off peak periods. The CCRF should be phased in over roughly three years, reaching, for example 3 cents per kWh on-peak and negative 1 cent per kWh off peak. The goal is to raise revenues on balance but to push off peak electric rates low, below the cost of natural gas with simple electric resistance heat values, roughly 4 cents per kWh. This provides the basis for clean nighttime and weekend electricity to out-compete natural gas for space and water heating, provide an incentive for thermal energy storage, and low-cost off-peak storage for electric vehicle charging, electric busses, and other electric battery applications, such as landscape equipment, tools, forklifts, phone and computer chargers.

With heat pumps, whether ground source, water source, or air source for heating and cooling, the electric energy value is at least doubled, cutting the thermal value of the 4 cents per kWh off-peak electricity to 2 cents per kWh. Electric vehicle fuel at 4 cents per kW-hour is half of the cost of gasoline at the pump, and during the weekends there are 65 hours of off-peak low-cost electricity to fuel EV's.

3.4. On-Bill Financing

On-bill financing for efficiency and solar PV is another critical component for distributing equitable investment resources towards the 100% renewable energy goal. On-bill utility financing, with the assistance of green banks, can capture the benefits and financial markets that traditional banks have ignored. Emerald City experimented with on-bill financing and many cities are conducting pilot projects, yet none have added solar PV to their programs. With no credit checks, just an electric bill, all income levels can participate. One's ability to pay for efficiency and solar is demonstrated by one's ability to pay their electric bill. This provides access to solar energy for all income levels. The program must be set up, so the net electric bill stays the same or is lower. If fuel switching retrofits are included, as it should be, the net gain from the elimination of natural gas systems can reduce the total energy costs. The goal is to eliminate natural gas and replace it with renewable energy. Overall, total energy costs will be lower.

On-bill financing (that can provide added revenues to the utility) must have a long enough term to ensure the total cost (electric and gas) to the consumer is lower than before the financing. "On mortgage" financing is an excellent comparison example with the potential demonstrated by the Grand Traverse Habitat for Humanity Depot project where the lower-income homeowners have their grid tied solar systems powering all of their electricity and HVAC on a net annual basis, with the cost of solar in the 30 year mortgage—adding only $35 per month, fixed for 30 years. This is clean energy security and financial security for these lower-income residences. Since we finance natural gas equipment in the mortgage, why not solar equipment?

3.5. Rebates

Rebate programs are a critical incentive for implementing energy efficiency, solar systems, thermal and electric storage. Rebates are cheap way for a utility to buy "nega-watts" and to incentivize solar deployment and energy storage. Emerald City, like most electric utilities, has a good rebate program in place that simply requires expansion to include fuel switching from natural gas to electric HVAC systems, thermal and electric storage systems, demand management systems, electric vehicles, and their charging systems.

3.6. Time of Use Rate Reform

Emerald City has time of use (TOU) rates for some customer classes. TOU meters must be provided to all customer classes with new TOU rate structures. If necessary, an intermediate period can be added to the off-peak and on-peak periods. The on-peak period is from 10 am to 5 pm, weekdays. All other times, including weekends and holidays are considered off-peak. Off-peak primary service high load factor commercial kWh energy rates average 5 cents per kWh. With grid harmonization, high off-peak energy use, and fuel switching and storage, most rate payers will become "high load factor" consumers, justifying the low off-peak rates for all customer classes.

3.7. Develop Grid Harmonization Inside the Distribution System

Grid harmonization is a generic phrase for various control methodologies to optimize the utilization of renewable energy, energy storage systems and to balance loads. One example is monitoring wind energy to switch on thermal storage systems during a cold windy night when marginal cost wind power nears 2 cents per kWh. Grid harmonization starts from the inside out, peak shaving, and managing demand, while monitoring renewable generation and prices. A graphical example of such a grid harmonization system is shown below in Figure 7, referencing Charlie Gruenwald's "Link and Sync" plan. However, the Emerald City plan would exclude the MISO transmission portion and be focused on the distribution side of the utility.

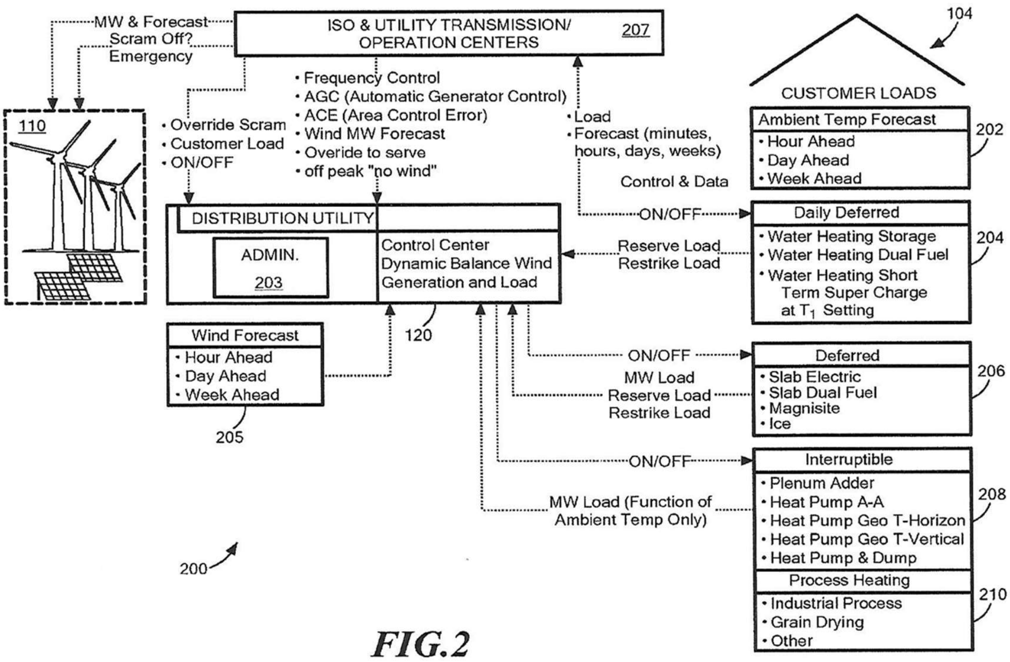

FIG.2

Figure 7

Electrical building codes need to be modernized in conjunction with solar and demand management systems. Solar electric interconnection guidelines and electric service sizing requirements are irrational, especially with new demand management systems. The electrical load on the average Emerald City residence is 7 amperes. A standard 100-amp electric service should not need expansion in the typical residence.

Electric utilities, for the most part, can control their own electric generation and distribution inside the distribution substations. The large multi-state Mid-Continent Independent System Operator, (MISO) has costs and control of transmission level electric system activities. New generation outside the utility distribution system must meet MISO planning, interconnection and operating requirements, and project owners must pay fees to participate the system. The MISO queue for generation is long, due in part for the high demand for cost-effective new renewable energy. By focusing on renewable energy projects inside the distribution system MISO complications and costs can be avoided.

3.8. Ban on New Natural Gas Lines

With electricity out competing natural gas for existing HVAC systems it makes both economic and environmental sense to phase out natural gas and place a ban new natural gas connections, while developing biogas systems (i.e. green gas) for special cases. Bans on new natural gas pipeline connections are being implemented in many cities for environmental, cost and safety reasons. Replacing old leaking natural gas lines is waste of money and they should be shut off for financial and safety reasons while the consumers convert to all electric systems.

3.9. Green Bonds, Banks, and Other Financing

Green Bonds, Green Banks, and other financing sources such as PACE (property assessed clean energy financing) should be implemented. Munis can raise capital with green bonds, usually as much as needed, within the fiduciary regulatory limits on municipal bonds. The green bonds can be promoted and sold locally to maximize the local economic benefits. A local green bank, whether independent of banks or a special division of local banks should be established, with special expertise and focus on green energy systems from generation sources, energy storage, fuel switching, efficiency applications, mechanical and electrical retrofits.

4. Projects

Projects consist of three primary generation sources, solar energy, wind energy and combined heat and power (CHP) biogas engines. Projects will also include grid harmonization infrastructure with thermal and electric energy storage plants and systems. The 100% percent net annual energy target is roughly 870 million kWh. The proposed target generation mix is 300 million kWh of solar energy, 400 million kWh of wind energy, and roughly 170 million kWh of CHP generation. The tables below (see Tables 1-3) breakdown potential installations and capacity. It should be noted that even during a low wind, low sun day the energy available from the three primary generation sources can meet the city average energy needs.

Energy efficiency measures and practices are an important component of projects, but they should not take precedence over renewable energy generation. While the potential for energy efficiency is significant, actual results do not match the potential. Commercial and industrial consumers who make up over 70% of the city energy consumption typically do not place energy efficiency as a high priority in their capital and operating expense decision making. First, there are many competing financial needs in a business, so when there are excess revenues a business manager may decide to hire another worker or buy a new production machine rather than invest in energy efficiency measures. Second, energy costs for many businesses are a small part of the operating budget, often small in comparison to labor, insurance, and taxes. Businesses will take the easy low hanging fruit, such as LED lamps, but more aggressive actions, such as window replacement, is complicated and expensive. Energy efficiency measures and practices will reduce the eventual total amount of renewable generation and energy storage projects, and this is important, but they do not change the fundamental fossil fuel, carbon intensive energy delivery system.

Incumbent electric utilities will argue that 100% renewable energy is not possible in the near term because of long-term contracts and debt obligations for fossil fuel and atomic generation. These contracts and debt must be renegotiated, bought-out or cancelled as soon as possible. During the 2008-2009 financial crisis millions of citizens lost their homes and property due to no fault of their own - they simply had to default and walk away. With the climate crisis we must be prepared to do the same with our underwater coal and atomic power plants that are costing citizens hundreds of millions of dollars every year, just in the upper Midwest. The state legislatures of Illinois, Indiana and Ohio have forced their citizens to unfairly subsidize these emitting power generation sources. In the largest power plant bond default in the 1980's, the Washington Public Power System defaulted on $2.5 billion in bonds and yet survived and prospered. The contracts and debt on dirty, underwater power plants need to be cancelled as soon as possible to make room for lower cost renewable energy.

Local ownership and control are paramount to maximize community economic benefits and to dispatch the renewable energy resources to optimize grid harmonization. Utility-scale solar arrays and wind turbines must be merchant power plants wholly owned and controlled by the city utility. The traditional power purchase agreement (PPA) used by electric utilities is an economically dysfunctional, tax avoidance based, financial approach that discourages local ownership, drains money out of the community, increases economic inequality, and makes permitting projects more difficult. Community ownership brings community acceptance. While tax credits do help account for the environmental benefits and non-market external costs and, as such, are justified, these financial benefits must be made available to all non-profit organizations, municipalities, and other public entities. Recently proposed 2020 federal legislation (House Bill 2) attempts to correct this flaw in our clean energy incentive programs—and would be a boost to non-profit public renewable energy projects. Nevertheless, a municipal utility can compete with tax advantaged PPA's by utilizing long-term, lower interest financing and utilizing their own or hired project development expertise. The Emerald City utility and public works department must staff up with policy and project development expertise, basically energy "concierges" to guide the advancement of the 100% renewable energy plan.

4.1. Solar Energy

Solar energy systems inside the city need to be quickly advanced to push the energy inside out to reduce loads on distribution substations and increase distribution capacity.

There are four project types for solar electric implementation. First, there are individual property owners investing on their own (with or without utility on-bill financing), including residential, multifamily, condominiums, and businesses. Second, non-profit public and government consumers, including schools, governmental buildings, churches, and public facilities represent a project type. A third type are community and cooperative solar projects. And fourth, utility-scale installations. The following list includes examples of solar site opportunities in Emerald City. 80% of the solar energy generation is projected to come from utility scale, large commercial and community solar projects. With economies of scale these projects provide the most cost-effective, dispatchable and controllable solar systems—with costs comparable to the utility's present "avoided cost."

Table 1

SOLAR ELECTRIC	Acres	Installed KW	Capacity Factor	Energy (kWh/yr)	kW on Cloudy day	Est. Capital Cost ($million)
Airport / Aero Park Drive Area	125	25,000	0.18	39,420,000	2,500	31.3
Solar PV - NMC/CHS/Civic Center	10	2,000	0.18	3,153,600	200	2.5
GT Commons Solar PV	10	2,000	0.18	3,153,600	200	2.5
South Hwy 31 Solar PV - West JR High/Meijer/...	250	50,000	0.18	78,840,000	5,000	62.5
Sub-station Solar PV w/ 22 MW PPA +TWP FARMS)	400	70,000	0.18	110,376,000	7,000	87.5
M72 V44 Wind Site Solar PV - 3 MW +	15	3,000	0.18	4,730,400	300	3.8
Distributed "Community Solar PV" (with established policy)	50	10,000	0.18	15,768,000	1,000	12.5
Distributed net metering residential/commercial/institutional	100	20,000	0.15	26,280,000	2,000	35.0
Schools: T Heights, G Loomis, CGS, EE, etc	6	1,200	0.18	1,892,160	120	1.5
West Bay Abandoned Coal Yard--Solar	0.25	140	0.18	220,752	14	0.2
Industrial Sites; trackers and single axis large net metering	15	3,000	0.18	4,730,400	300	3.8
SOLAR TOTAL	807	161,340		288,564,912	16,134	$ 243

Since many utility customers (~80%) do not have optimal solar access on their property, community or cooperatively owned solar projects are essential to provide opportunities and distributed benefits for all citizens. As demonstrated by many of the good community solar project models, the investment can be handled on one's electric bill with on-bill financing. Shares purchased for the lower cost solar energy should reduce one's electric bill, so the total electric bill is the same or lower than before, without the solar investment. For those without electric bills, shares can be provided for cooperatively owned projects. There are dozens of good community solar project models and the State of Minnesota has some of the best examples. Community or cooperatively owned solar allow the electric utility to optimize the location and size of the systems to aid in grid harmonization. For instance, a 10 MW community solar array can be placed on a 10 MW distribution circuit that can essentially zero out a distribution substation—leveraging more capacity on the distribution circuit.

4.2. Wind Energy

With the recent rapid development of tall tower, large rotor, high capacity factor wind turbines that operate at around 50% capacity factors, generating electricity roughly 90% of the time, the cost of wind energy out-competes all energy sources, averaging 4-5 cents per kWh in moderate winds, with a marginal cost on a windy day approaching 2 cents per kWh—without tax incentives (see Figure 8).

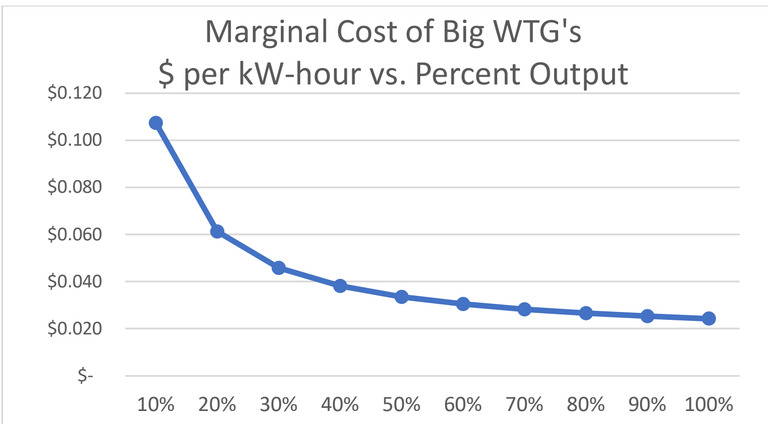

Figure 8

The moderate winds on the city's surrounding hills specify IEC Class IIIA wind turbines that will generate at a high capacity factor with rotor diameters of roughly 150 meters, nominally rated at 4 MW's peak capacity. The windiest hour is 3 pm and the windiest months are in the fall and winter, from October to April.

Here, 21 wind turbines are proposed in addition to the existing five, 2 MW wind turbines (10 MW total) that were contracted under a PPA several years ago. The proposed wind projects are classified as distributed wind, where one to four turbines are grouped together, typical for this terrain and landscape with small farm parcels. Distributed wind projects in multiple townships are not attractive for international wind developers who develop based on large wind farms in vast agricultural areas owned by outside investors, selling the energy under power purchase agreements. Such large wind farm projects reduce community economic benefits that come with locally owned distributed wind energy. The local utility has, or can hire, the expertise needed to develop and install distributed wind projects.

Table 2

COMMERCIAL WIND	Number	Installed KW	Capacity Factor	Energy (kWhr/yr)	kW on Low Wind Day	Est. Capital Cost ($million)
Existing Heritage 10 MW	5	10,000	0.3	26,280,000	500	$ -
City Distributed Wind Projects	1	4,200	0.48	17,660,160	210	$ 7
Garfield Twp Wind	2	8,400	0.48	35,320,320	420	$ 14
Elmwood Township	4	16,800	0.48	70,640,640	840	$ 29
Long Lake Township	4	16,800	0.48	70,640,640	840	$ 29
East Bay Township	2	8,400	0.48	35,320,320	420	$ 14
Acme Township	4	16,800	0.48	70,640,640	840	$ 29
Peninsula Township	1	4,200	0.48	17,660,160	210	$ 7
Blair Township	3	12,600	0.48	52,980,480	630	$ 21
WIND TOTAL	**26**	**98,200**		**397,143,360**	**4,910**	$ 150

4.3. Combined Heat and Power

Combined Heat and Power (CHP), gas engines are low cost and relatively easy to install providing a dispatchable generation source. While the goal is to run the engines on biogas, initial planning and installations can begin on natural gas if necessary. Intelligently designed and operated CHP systems will run between 80-90% efficient, displacing other natural gas systems of lower efficiency, and providing a net gain in efficiency and reduced emissions. It is proposed the CHP plants be dispersed throughout Emerald City, roughly 5 MW each units, totaling 35 MW's, installed near large thermal loads and distribution substations. This includes schools, the college, public works, hospitals, and industrial consumers of hot water for process, domestic water, and space heating. Large hot water storage tanks, combined with the gas engines, can also be heated with excess wind and solar energy. The primary role of the CHP system is as a load balancing source, sized approximately to the average city electric load which can also run in the event of grid outages. The engines will be dispatched to run when there is inadequate wind, solar and battery storage. The long-term goal is to build one or more biogas production plants (as part of the city waste handling system), generating green gas from the local organic waste stream including such sources as food waste, process waste, agricultural waste, and septic system waste. Examples of such biogas plants are found at Lemvig, Denmark and Trollhatten, Sweden.

Table 3

COMBINED HEAT AND POWER (CHP) NG-Biogas-Thermal Storage		Installed KW	Capacity Factor	Energy (kWh/Yr)	Est. Capital Cost ($million)
College/Schools/CHS/EE/CC/MC Hospital/District heat	1	5,000	0.5	21,900,000	$ 5
Aero Park /Coast Guard/ District heat	2	10,000	0.5	43,800,000	$ 10
Hillshire Foods/BATA/District Heat	1	5,000	0.5	21,900,000	$ 5
GT Commons/Munson Hosp/W Jr High/Meijer/ District Heat	1	5,000	0.5	21,900,000	$ 5
Public Works/Library/Waste Water Plant/District heat	1	5,000	0.5	21,900,000	$ 5
Cone Drive/Oryana/Govt Center/Downtown/District Heat	1	5,000	0.5	21,900,000	$ 5
TOTAL	7	**35,000**		**153,300,000**	**$ 35**

4.4. Investment Criteria

The total capital expenditure for full implementation, with grid infrastructure retrofits and grid harmonization systems, can approach $450 million. With annual community energy expenses of approximately $55 million (without transport), investing $450 million from public and private sources makes economic sense. One can ask the simple question; "how much would one invest to earn $55 million a year?" The logical answer will far exceed $450 million.

The appropriate investment criteria vary with the project type and investor. These include non-profit public works, including schools, churches, hospitals, municipal services (including the utility); individual net metered properties including residences, multifamily apartments, condominium associations, and renters; commercial for-profit business; and cooperative or community solar projects.

For public works, such as utility-scale solar systems or large public systems, benefit/cost analysis should be conducted. Selecting a project is a simple matter of conducting benefit/cost analysis on proposed system alternatives to find the best value for the community.

For net metered solar consumers, especially with long-term, on-bill or other financing, no investment analysis is required as the solar system cost is already budgeted. The budget is one's utility bill, which is paid either way, a lifetime energy mortgage or debt that can be off-set and eliminated once the solar system is paid for. The Grand Traverse Habitat for Humanity Depot project is a good example, where the cost of the solar systems, providing 100% net-metered energy for all electric and HVAC systems, is included in the 30-year mortgage adding only $35 per month, fixed. This is affordable energy security that distributes solar to lower-income citizens.

Commercial for-profit solar installations, where the solar system generation is beyond offsetting one's own electric consumption, become an earning investment. The municipal utility must provide a fair price for the solar to "make a market". Since all IOU's are guaranteed roughly a 10% return on investment, all businesses investing in solar should be treated the same, or better. Solar energy prices should be scaled to make a market accounting for economies of scale. The German feed-in-tariff program provides a good model, with long-term guaranteed prices, and priority to the grid. With tax advantages accounted for, private or public organizations, can simply conduct a standardized analysis to insure the minimum 10% return on investment.

5. Conclusions

The following graph (Figure 9) illustrates the ten-year planned changes.

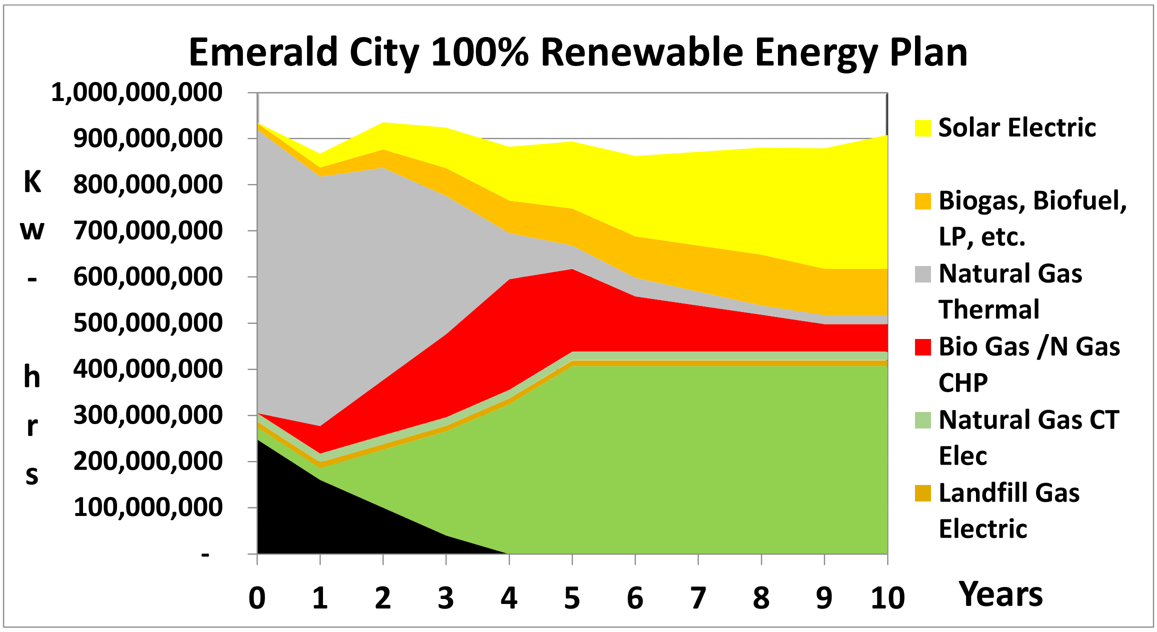

Figure 9

With green financing mechanisms, green bonds, green banks and utility on-bill financing, Emerald City can achieve a distributive and regenerative energy economy with energy security, economic and environmental justice. The public utility will as much as triple its electric distribution to displace natural gas and gasoline, increasing quantity and quality at a lower unit cost. With unlimited solar net metering, community solar and wind projects, waste to biogas CHP, harmonized with distributed energy storage, all citizens, rich and poor, will have the opportunity to benefit, bathed under the abundance of solar energy.

Utilizing a climate crisis fee, positive and negative, with the marginal cost of wind energy near 2 cents per kWh, natural gas will eliminated for the most part, keeping $20 million a year in citizens pockets to pay for more efficiency measures and green electricity to heat, cool and power the community.

It is irrefutable, that at some point our communities will be 100% renewable energy heated and powered. It may be 10-20 years before polluting fossil fuels are physically, economically, or politically gone. Yet we are in a race against time. Now that wind and solar and other distributed renewable energy sources are the least cost option, every delay is costly to society and the environment. Community power is the fastest path for a sustainable future, where metered results can be achieved quickly. Communities do not need permission or legislation from the state or national government. With results demonstrating meaningful solutions we address the climate crisis and provide hope, abating the anxiety and depression inflicting our communities, in turn reenergizing the community.