Emerald City 100% Renewable Energy Plan

Steven B. Smiley

Email: smiley27@earthlink.net

SOLAR 2020
"VIRTUAL"
CONFERENCE

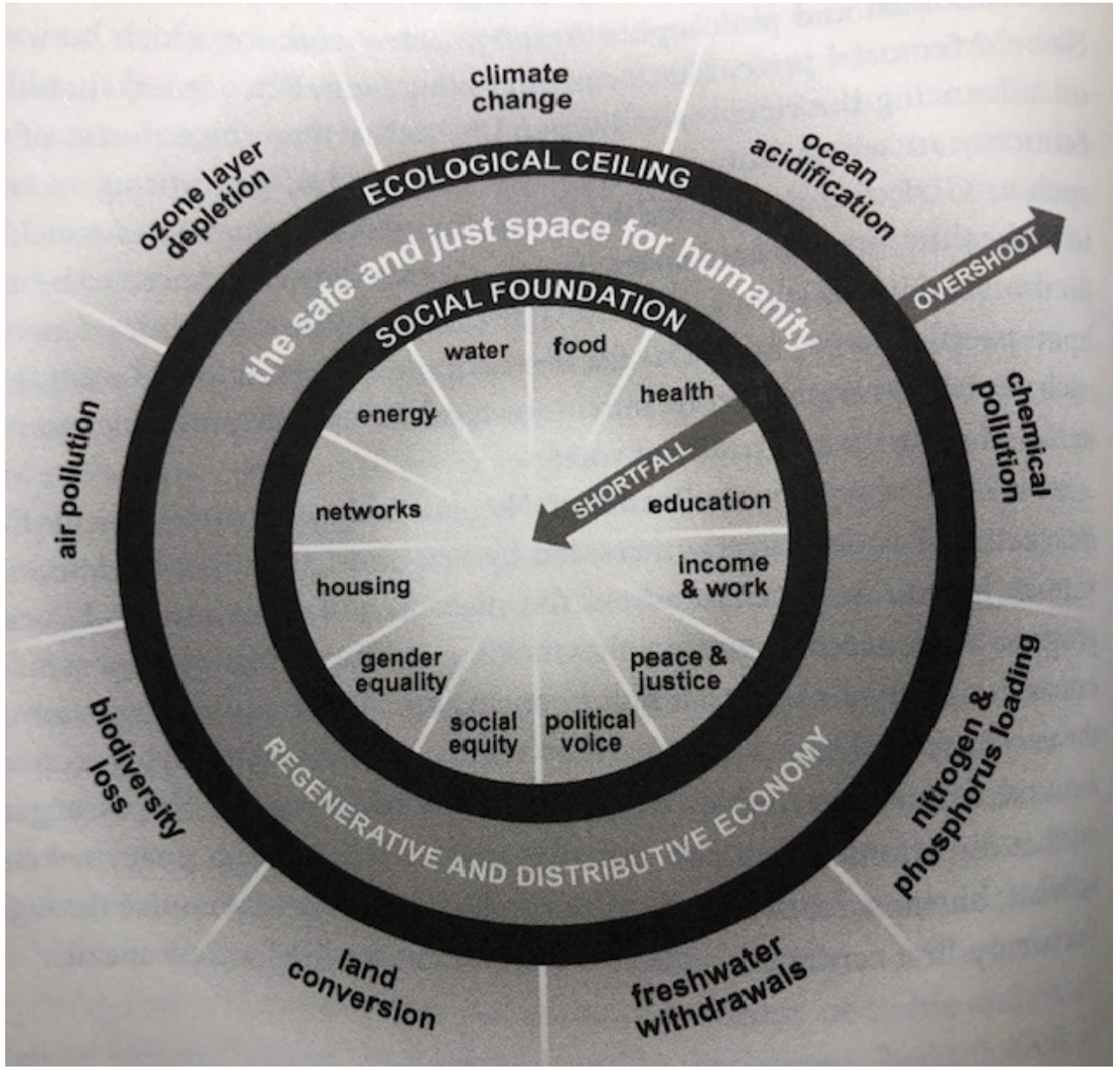
June 24 – 25, 2020

American Solar Energy Society

Washington, DC

Energy and Economic Philosophy

- **"All energy choices and prices are based on politics and policy"- John Pestle (MI energy attorney (ret.)**
- **"Make the market your slave, not your master" Frede Hvelplund; Aalborg University, Denmark**
- **21st Century economy: Must be "Regenerative and distributive" - Kate Raworth; "Doughnut Economics" 2017 >>**
- **"Wealth is regenerated solar radiation" - R. Buckminster Fuller – "Operating Manual for Spaceship Earth"**



Summary Conclusions

- **Back by green bonds, green banks and on-bill utility financing, the capital bottleneck will be removed releasing the tremendous “latent” demand by local citizens of all income levels and the muni for clean energy.**
- **New wind and solar generation will be roughly 3 times the present electric consumption, and 3 times the peak.**
- **Unlimited solar net metering with < 1% impact on utility**
- **Flexible and targeted carbon fees, negative at off-peak, will drive out natural gas.**
- **CHP quick response biogas engines (enough to run the city on average) and as back-up in the event of grid failures.**
- **Electric battery storage and EV’s will be phased in with incentives and low-cost TOU charging.**

Conclusions (cont.)

- **Distribution grid modernization will be conducted. This includes retrofitting distribution substations for bi-directional control and + 100 MVA of renewable energy sub-station(s).**
- **1,000's of electric hot water and other thermal storage units will be integrated into the system and managed with "grid harmonization". Large thermal storage associated with some CHP/district heat**
- **Excess energy can be sold into the regional grid, avoiding curtailment.**
- **Energy costs will be lower than present and fixed indefinitely.**

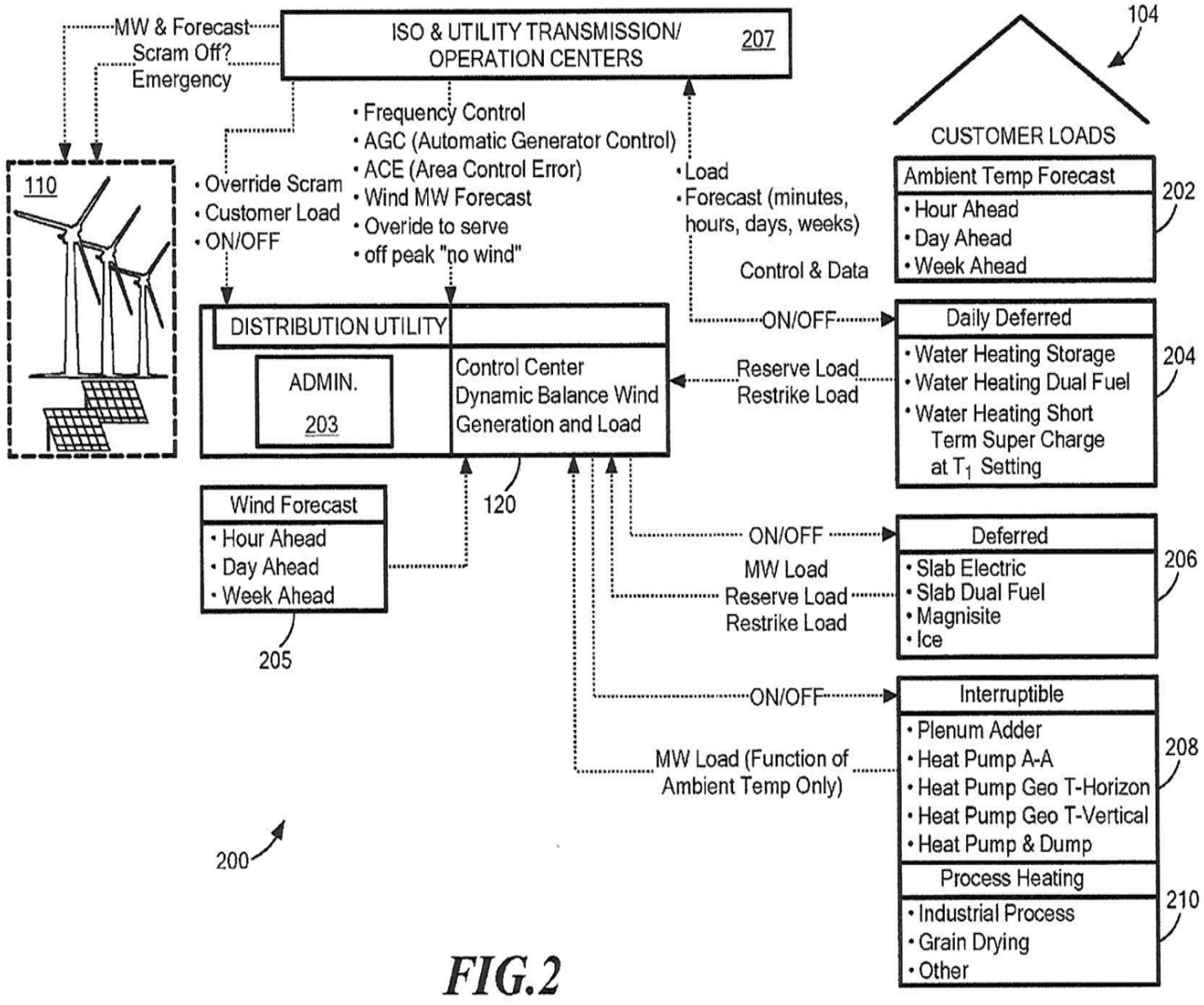
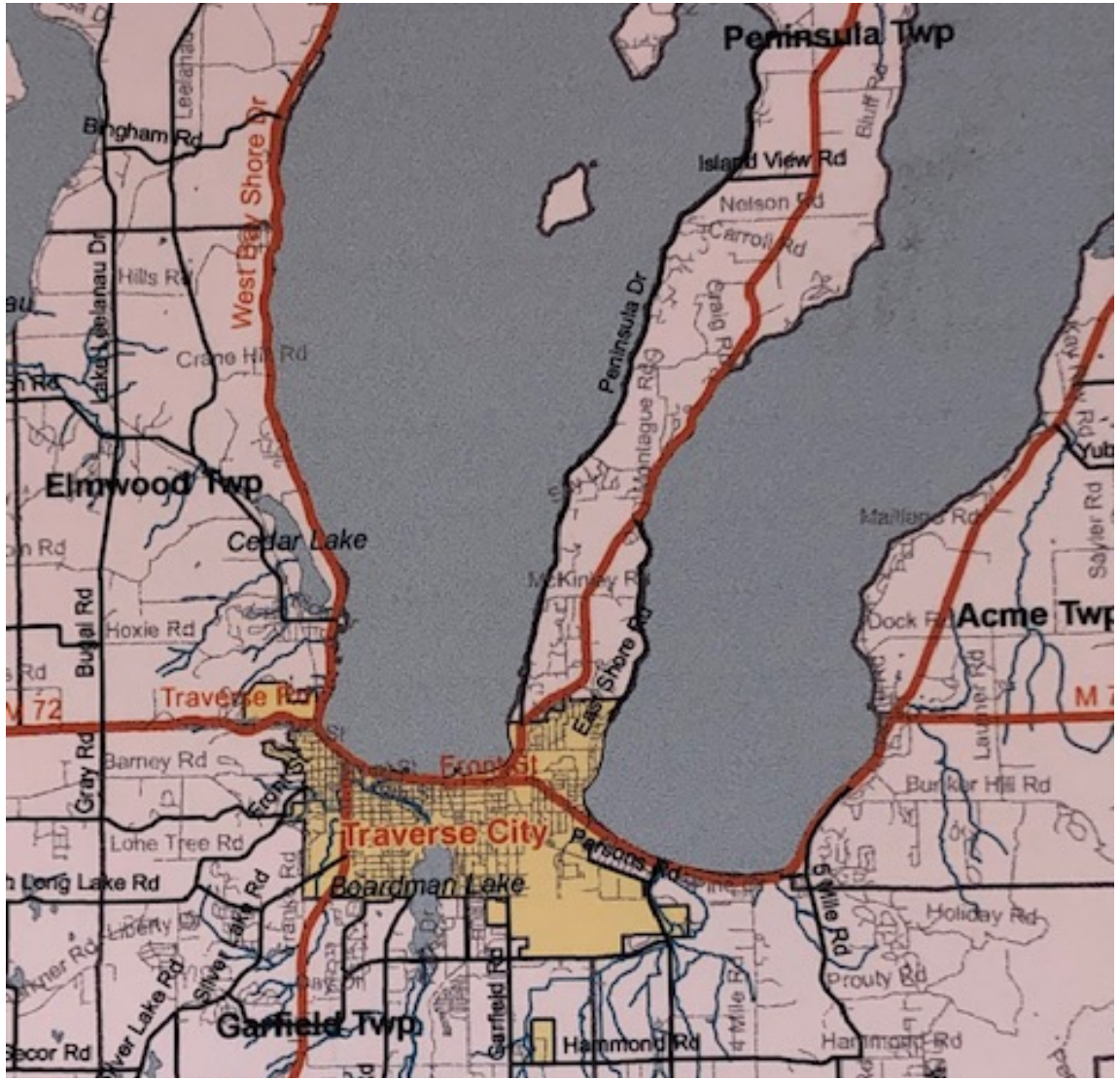


FIG.2

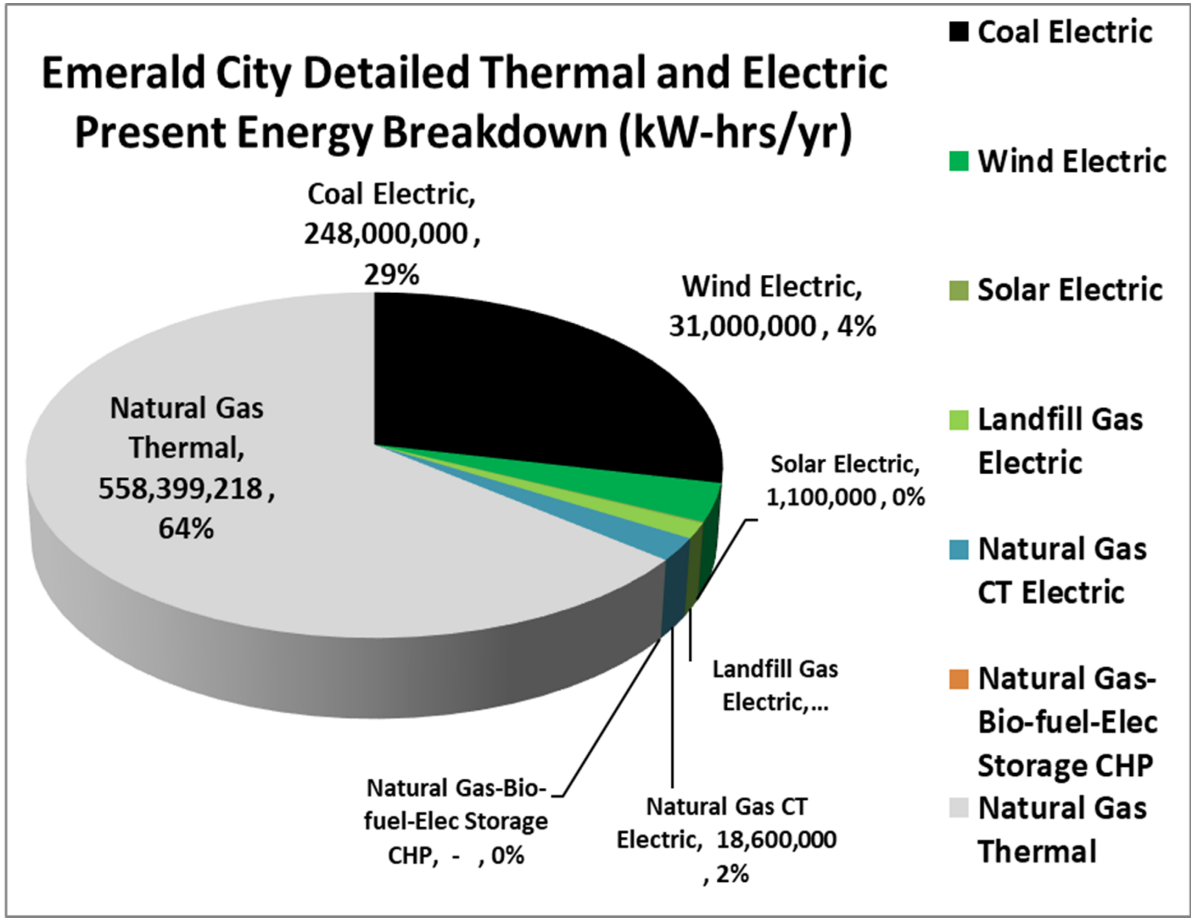
Emerald City – Geography and Resources

- **Humid continental climate: 7,794 HDD and 458 CDD (deg F)**
- **44 degrees N latitude**
- **Population: 15,000**
- **Area: 8.7 sq. miles (22.5 sq. km)**
- **640 feet mean sea level – 1,000 feet (300 m) elevation max.**
- **Solar resource: 1,350 kW-hours per sq. meter/yr.**
- **Wind resource: IEC Class III on surrounding hills**
- **Biomass and biofuels feedstock available**



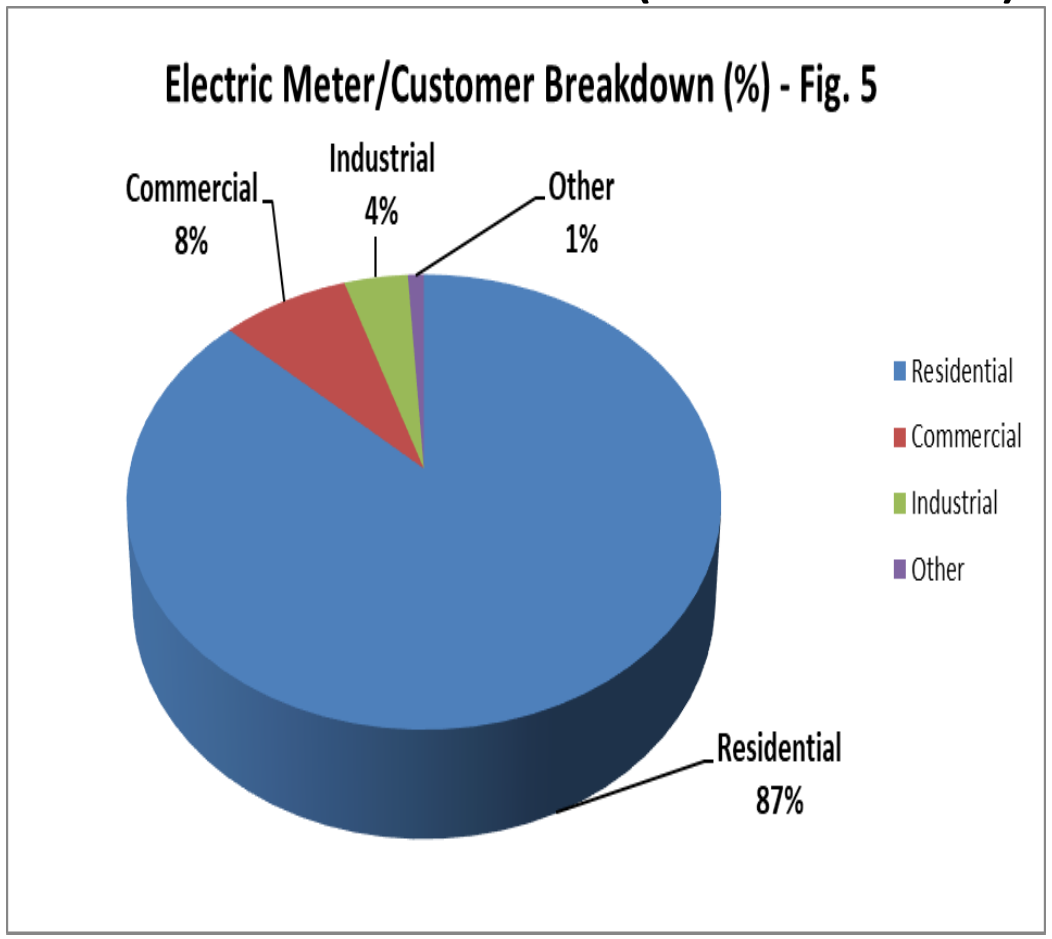
Energy - Economic Profile (w/o transport)

- Annual electric and gas expense: $55 million
- Annual electric expense: $35 million
- Annual Natural gas: $20 million
- 93% of energy supply (non-transport) is coal and natural gas
- Annual electric consumption: 310 million kW-hours
- Summer electric peak: 70 MW
- Base load electric demand: 25 MW
- Average electric demand: 40 MW
- Annual Natural gas consumption: 560 million kW-hours
- Average customer electric cost $0.11/kW-hour

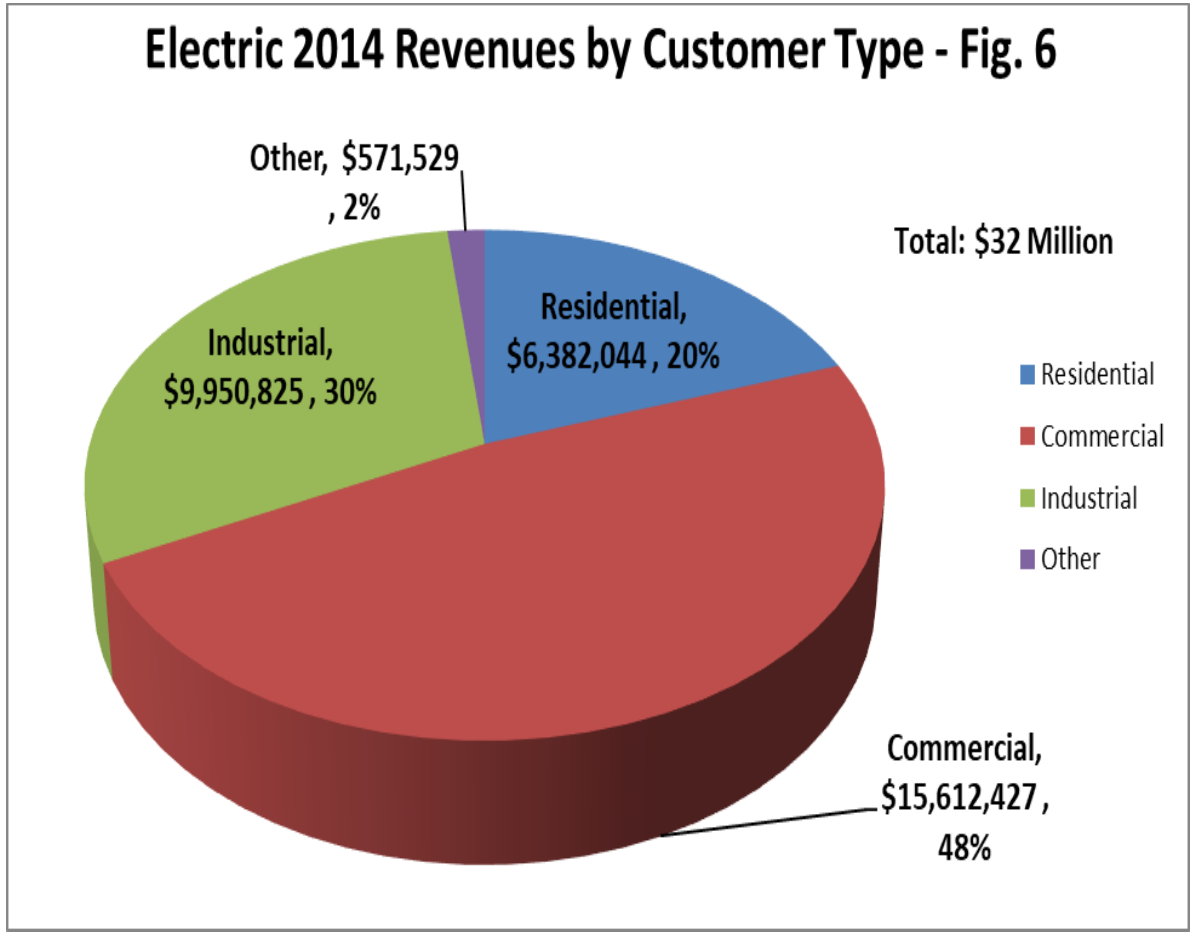


Customer Economic/Electric Profile – Important Distinctions: 87% of customers – residential - 80% of electric revenues non-residential

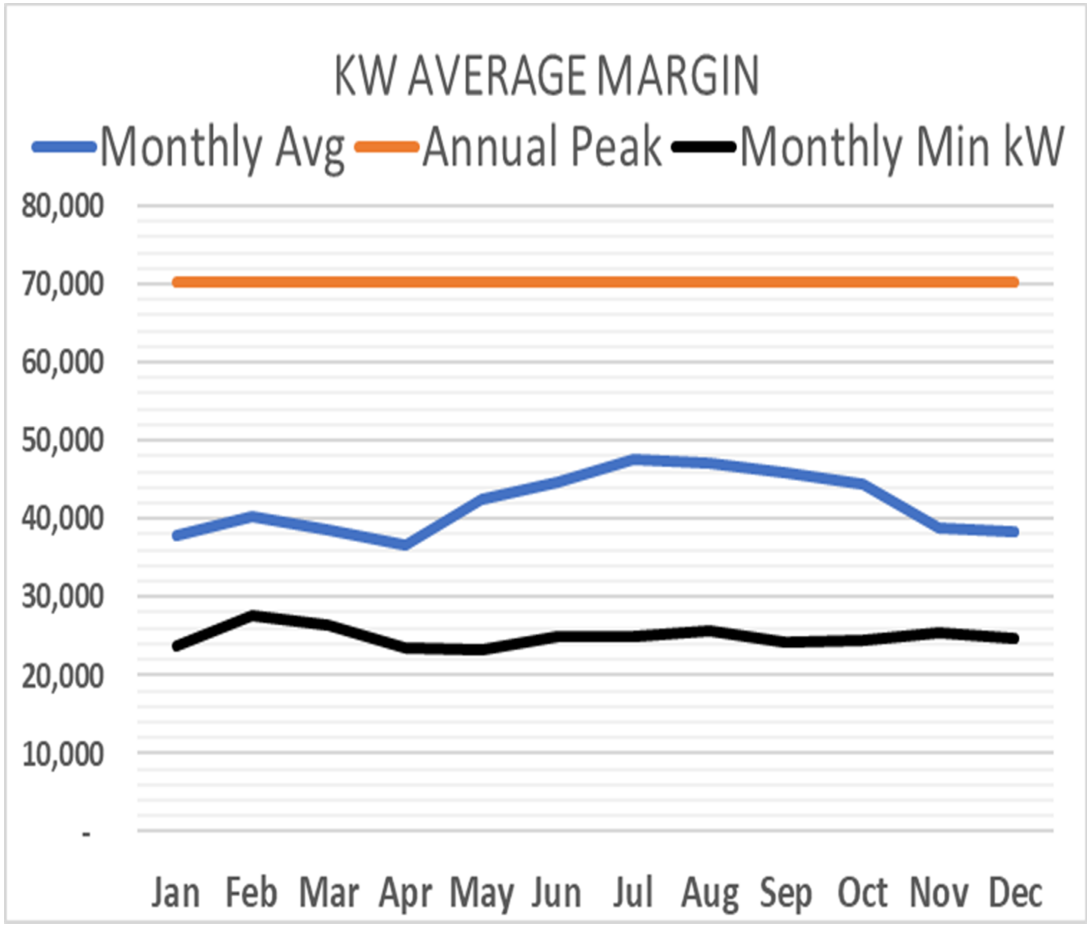
Customer Class Breakdown (87% Residential)

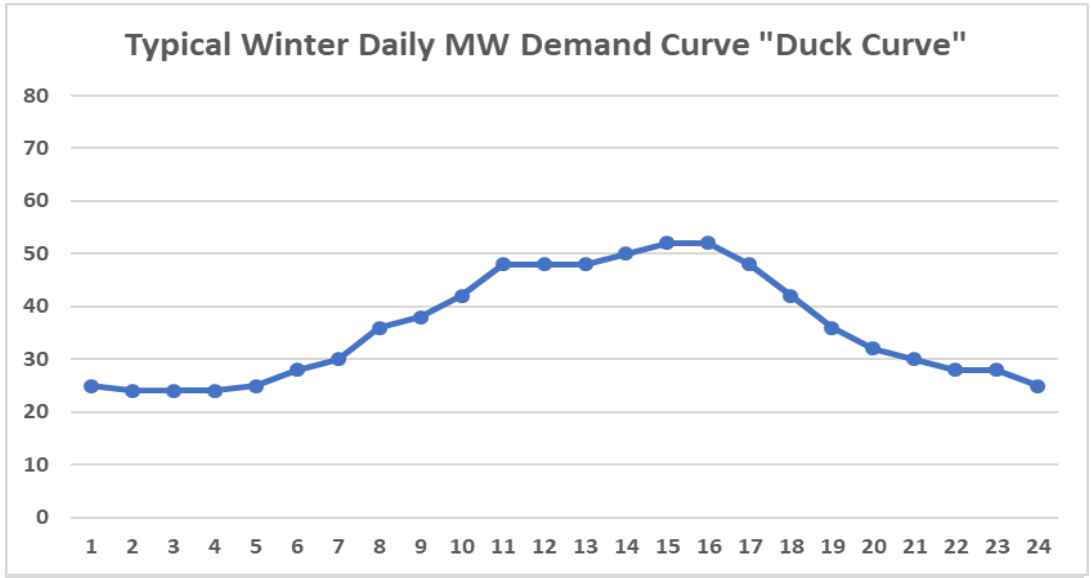


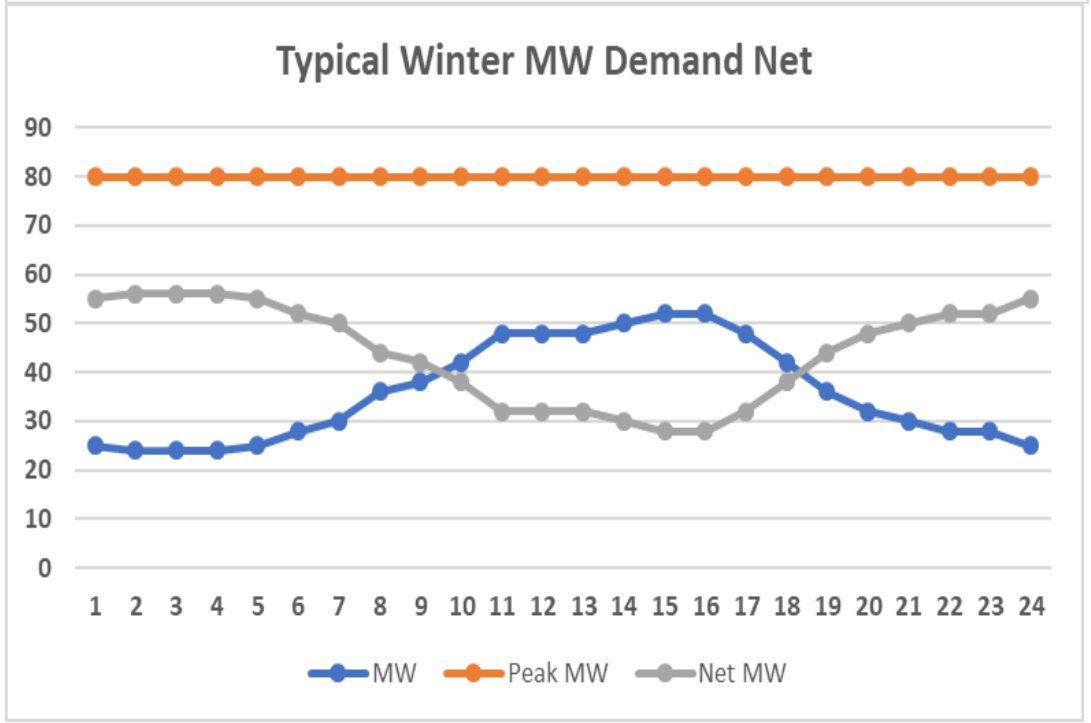
Customer Revenue Breakdown (80% Non-residential)



Electric Load Profile







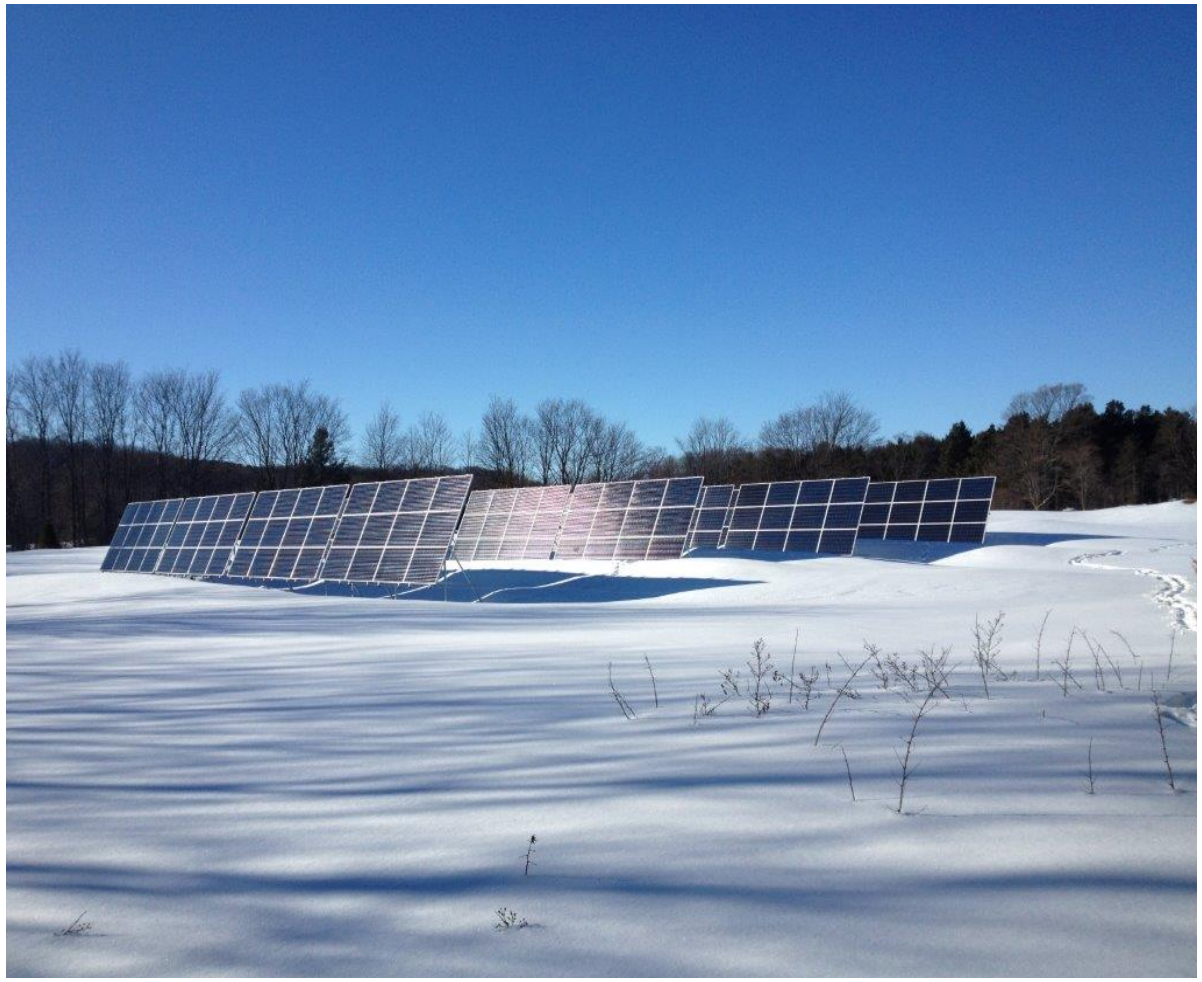
Solar Net Metering Expansion

- **<u>Critical to start ASAP to push solar energy from inside out</u>**
- **Net impact on utility revenues < 1%**
- **Remove 20 kW limit on individual solar net metering installation so larger commercial customers can be net zero**
- **Remove net metering total system kW-hour caps (MI has 1% cap)**
- **Conduct localized "value of solar" study with all direct and indirect benefits accounted for and adjust net meter price by economies of scale (i.e. larger systems paid less than small residential systems)**
- **Provide long term on-bill financing for solar electric systems**
- **Provide rebates for solar installations**
- **No added fixed monthly fee for solar net metering!**
- **Provide long-term (20 years) contract guarantee**

Net metered 9kW with EV

Community and Cooperative Solar

- **Solar for citizens that want to “own” a share of solar with on-bill financing and credits**
- **Builds on existing models that are in place**
- **Taps into local citizen financial resources**
- **Provides for targeted system locations to balance city wide solar loads – i.e. near distribution substations**
- **Provides for utility engineered and managed storage systems to optimize and dispatch distribution**



Targeted Variable Carbon Fees and Distribution

- **Variable carbon fee: (With senior and low-income citizens protected)**
- **Target carbon fees with time-of-use electric rates**
  - **High fee during peak periods (i.e. + 2 cents/kW-hour**
  - **Negative fee (i.e. – 1 cent/kW-hour) on off-peak rates to out-compete natural gas (i.e. <4 cents per kW-hour), and to encourage fuel switching, storage, EV charging, etc.**
- **Phase down fee as carbon emissions are reduced**
- **Where possible, put carbon fee on natural gas use in city**
  - **Some Muni's that distribute gas can do this**
  - **Those cities that don't distribute gas (Emerald City) can provide the competitive basis for eliminating natural gas with low off-peak rates, fuel switching, heat pumps, and thermal storage that out-competes natural gas**

On-bill financing for efficiency, solar, storage, fuel switching, EV charging, controls…

- **Variable finance term lengths appropriate to balance against savings, solar system costs, storage, fuel switching costs– with terms based on customer preference**
- **Include benefit of natural gas savings (avoidance), in loan calculation and ability to pay**
- **Low interest, backed by a utility loan guarantee.**
- **No qualifications other than electric bill – no credit check, beneficial for low income**
- **A Source of utility revenues for service**

Rebates for Efficiency, Solar, Storage (thermal and electric), Fuel Switching, Demand Controls, EV

- **Good Rebate Program In Place**
  - **LED, refrigeration, HVAC, ECM efficient motors, solar ($90/kW – could be higher)**

- **Need to add energy storage and electric vehicle rebate incentives**
- **Need to add fuel switching rebates**

Ban/Eliminate New Natural Gas Connections

Natural Gas Phase Out Process

- **<u>Step One: make electricity competitive with natural gas for thermal energy--</u> space and water heating—so economic incentive to change**
- **Only allow special exemptions for new natural gas hook ups**
- **Do not repair or replace old gas lines as it's lower cost to retrofit to green electricity than to repair and/or replace aging gas lines**
- **In any event, aging (60 years +) gas lines are leaking and dangerous and must be abandoned for safety reasons**

Transition

- **Step Two: Transition natural gas CHP systems to bio-gas and electric storage systems (especially large thermal storage) during ten-year plan**
- **Note: Local economic benefits of keeping natural gas money at home exceed $20 million per year, plus multiplier effects, air quality benefits, etc.**

Project Summary: Wind/Solar/Storage/CHP

- **Wind**
- **Est. 28 wind turbines 1 – 4 per surrounding townships**
- **Approx. 400 million kW-hr/year**
- **100 +/- MW Peak Capacity**
- **Solar**
- **800 acres – 1.25 sq. miles – in city and surrounding open land**
- **Approx. 300 million kW-hrs/year**
- **160 +/- MW Peak Capacity**
- **CHP – Biogas**
- **150 million kW-hrs/year**
- **35 MW Peak Capacity**
- **Battery / Thermal Storage – (With market-based incentives – customer choice)**
- **EV Implementation – (With market-based incentives – customer choice)**

Wind: Utility Scale

- **Large rotor – 4 MW +**
- **Class III – low-wind resource turbines**
- **High capacity factor: 40% – 50%**
- **Generating 90% + of time**
- **<u>Two to four turbines per surrounding townships</u> – sharing energy benefits (i.e. Leelanau and Grand Traverse Counties, for ex)**
- **Least-cost energy**
- **Locally owned – public/private**

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	$ 18
City Distributed Wind Projects	1	4,200	0.45	16,556,400	210	$ 8
Garfield Twp Wind	2	8,400	0.45	33,112,800	420	$ 15
Elmwood Township	4	16,800	0.45	66,225,600	840	$ 30
Long Lake Township	4	16,800	0.45	66,225,600	840	$ 30
East Bay Township	2	8,400	0.45	33,112,800	420	$ 15
Acme Township	4	16,800	0.45	66,225,600	840	$ 30
Peninsula Township	1	4,200	0.45	16,556,400	210	$ 8
Blair Township	5	21,000	0.45	82,782,000	1,050	$ 38
WIND TOTAL	**28**	**106,600**		**407,077,200**	**5,330**	**$ 192**

Projects: Solar Technology

- **Phase I: Inside the distribution system**
  - **Distributed, net and virtual metering**
  - **Community / Cooperative Solar**
  - **Schools, hospital, public facilities**
  - **Utility “distribution” sub-station based, projects**
  - **Industrial sites**

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
Solar PV - NMC/CHS/Civic Center	10	2,000	0.18	3,153,600	200	$ 3
GT Commons Solar PV	10	2,000	0.18	3,153,600	200	$ 3
South Hwy 31 Solar PV - West JR High/Meijer/...	250	50,000	0.18	78,840,000	5,000	$ 63
Sub-station Solar PV w/ 22 MW PPA +TWP FARMS)	400	70,000	0.18	110,376,000	7,000	$ 88
M72 V44 Wind Site Solar PV - 3 MW +	15	3,000	0.18	4,730,400	300	$ 4
Distributed "Community Solar PV" (with established policy)	50	10,000	0.18	15,768,000	1,000	$ 13
Distributed net metering residential/commercial/institutional	100	20,000	0.15	26,280,000	2,000	$ 25
Schools: T Heights, G Loomis, CGS, EE, etc	6	1,200	0.18	1,892,160	120	$ 2
West Bay Coal Yard Solar	0.25	140	0.18	220,752	14	$ 0
Industrial Sites; trackers and single axis large net metering	15	3,000	0.18	4,730,400	300	$ 4
SOLAR TOTAL	**807**	**161,340**		**288,564,912**	**16,134**	**$ 242**

Projects: Combined Heat and Power

- **Inside the distribution system—”merchant power plants”**
- **Load balancing and emergency back-up features—rated at average city electric load (35 – 40 MW)**
- **Large thermal storage (r. in photo) both with CHP and with wind/solar electric**
- **Combined in conjunction with critical facilities, hospital, schools, public works (water/sewer/critical facilities)**
- **Begin with natural gas engines if necessary, then phase in bio-gas over ten-year period**
- **Note: CHP gas should be 80% - 90% efficient, no less that other displaced natural gas systems**
- **A few chimneys versus 1,000’s of chimneys**

Lemvig Denmark Biogas CHP – Good Example

Lemvig Biogas – Renewable Energy and a Sound Economy

Since 1992 Lemvig Biogas has been the largest biogas plant in Denmark. Slurry from approx. 75 farms and waste and residual products from industrial production are used to generate heat and power. This results in a good economy both for the plant and for the households consuming the heat. In addition there are associated fringe benefits such as the degradation of pollutants and a reduction in the emission of greenhouse gases.

More than 33 million kWh electricity is generated per year from the biogas produced. This electricity is sold into the local grid.The surplus heat from the gas engine cooling system exceeds 55 million kWh per year. This heat is distributed to the users of the Lemvig central heating plant. The users number more than 3000 households. The biogas plant has been supplied by the company BWSC on a turn-key basis.

Sources of waste typically received are

- Fish waste
- Source-separated organic household waste
- Slaughterhouse waste
- Feed waste/residues
- Soft drinks, beer, alcohol
- Pharmaceutical waste products
- Bacteriologically or chemically contaminated foods
- All organic matter with a high content of fat, protein or sugar

Financing and Economics

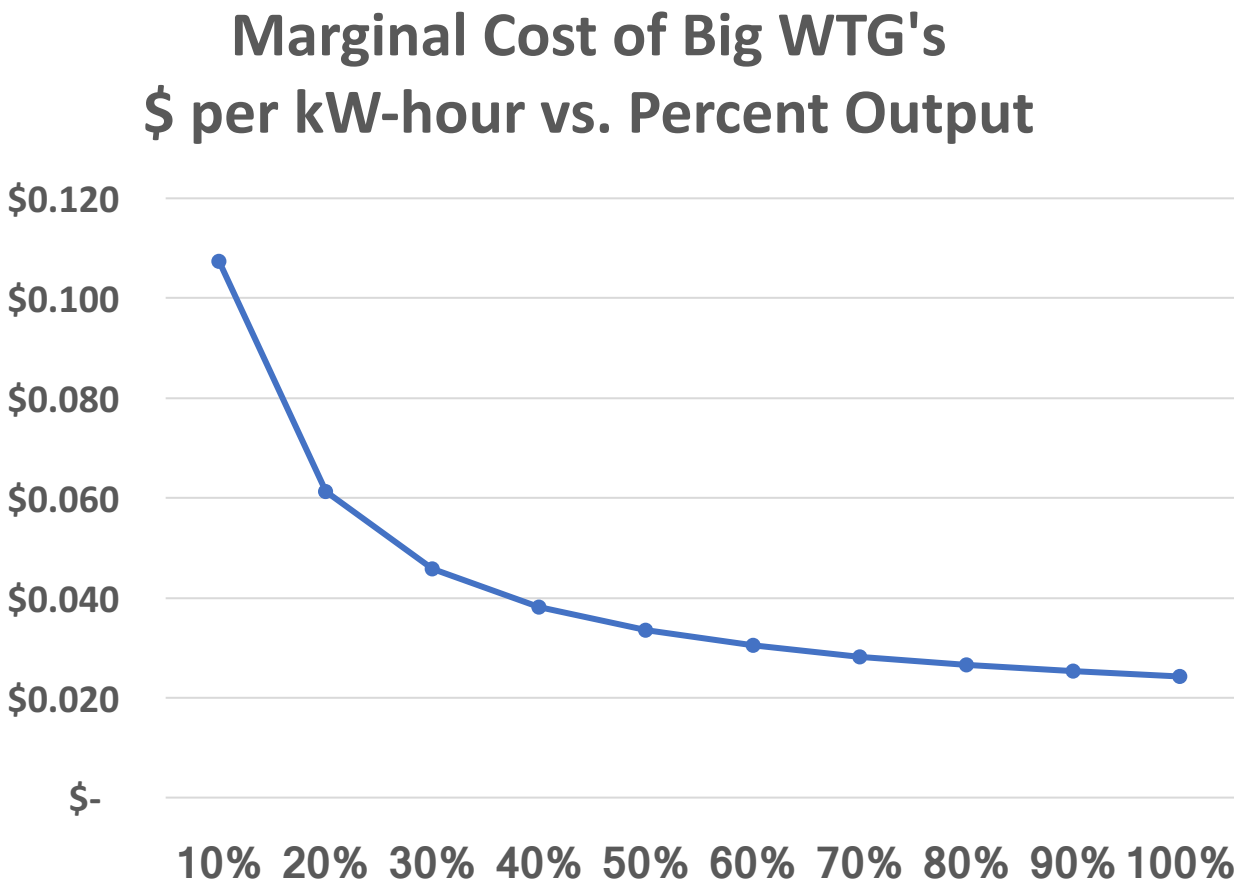
Financing (multiple sources)

- Green Bonds (Emphasis on local bond buyers)
- On-bill utility financing
- Carbon fees
- Community / Cooperative Project Finance
- Habitat for Humanity – Solar “Depot” Financing
- Consumer self-financing (cash & credit)
- PACE financing (property assessed clean energy), Michigan Saves..
- Contractor/project developer financing (solar, wind, mechanical, electrical, etc.)
- Energy Service Companies (shared savings)
- Bank financing, construction loans, mortgage, etc.

Revenues

- 100% distribution and sale of green electricity – what the customers want and willing to pay for
- Utility kW-hour “sales” tripled –earn money on QUANITY!
- Carbon fee revenues
- On-bill utility financing (fees and interest) revenues
- Community / Cooperative project revenues
- Sales of excess wind and solar to grid and neighboring utilities
- Technical services
- Local multiplier effects – keeping $$ at home - 2 X multiplier

Marginal Cost of Wind Beats Natural Gas



- **At average capacity factor of 40% - 50% MC = <4 cents/kW-hour**
- **On a windy night MC approaches 2 cents/kW-hour**
- **If installed in the “distribution system” grid, there os no or low transmission expense**
- **If locally owned “merchant plant” MC valuation applies**
- **The low-cost wind electricity value for heating can be leveraged by a factor of 2 + with heat pumps; out-competing natural gas at < 2 cents/kW-hour**

Distribution Grid Harmonization

- **C. Gruenwald: "Link and Sync" – "Virtual Battery"**
- **Smiley: Green RE-Heat**
- **Brattle Group – Grid Harmonization**

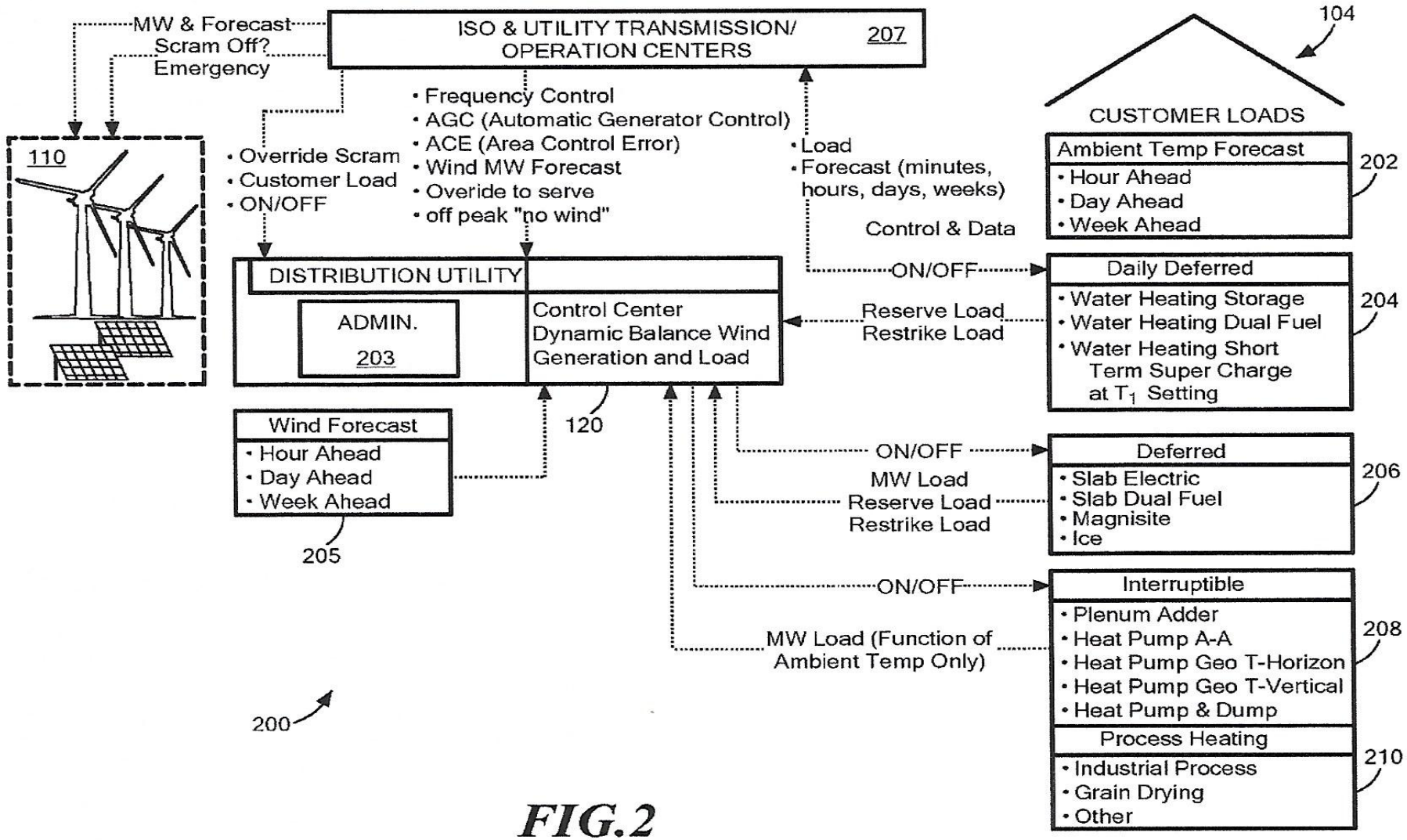


FIG.2

Summary Take-away Thoughts

- **Unlimited solar net metering, affecting utility revenues < 1%**
- **Carbon fee positive on peak, negative off peak, out competing natural gas, knocking natural gas out of the market**
- **Utility "merchant" wind power at 2 cents/kW-hour marginal cost energy beating natural gas**
- **On-bill financing and incentives for solar, storage and EV's, letting the market pick the winners**
- **Triple electric sales, cutting prices with quantity**
- **Lower energy costs, fixed indefinitely**
- **Local Green New Deal: Muni's (small or large) can lead and show how it can be done**
- **It can be done because it has been done; at least in part!**
- **Take best parts from many – put them together in one good program**
- **Study Experience of Leading Muni's**
  - **Austin Energy, Texas**
  - **Green Mountain Power**
  - **Burlington (VT) Electric Department**
  - **Sacramento Municipal Utility District**

Thank you for listening!

- Steven B. Smiley
- Email: smiley27@earthlink.net
- Ph: (231) 883-4850