Appendix A

Tompkins County Energy Roadmap
Summer/Fall 2015 Public Outreach and Comments

June 5	Energy Roadmap Steering Committee
June 17	Planning, Energy and Environmental Quality Committee of the Legislature
June 26	Tompkins County Climate Protection Initiative
July 7	Energy Roadmap Steering Committee
July 15	Planning, Energy and Environmental Quality Committee of the Legislature
July 20	Energy Roadmap Steering Committee
July 22	Tompkins County Planning Advisory Board
July 24	Tompkins County Climate Protection Initiative
Sept 15	Ithaca Tompkins County Transportation Council Planning Committee
Sept 16	Planning, Energy and Environmental Quality Committee of the Legislature
Sept 23	Tompkins County Planning Advisory Board
Sept 24	Tompkins County Planning Department Staff Meeting
Sept 24	Tompkins County Council of Governments
Sept 25	Local Town and City Planners
Sept 30	Energy and Economic Development Task Force
Oct 1	Chamber of Commerce Board and Committees and CEO Roundtable
Oct 5	Economic Development Committee of the Legislature
Oct 8	Environmental Management Council
Oct 15	Press release issued for Open House
Oct 16	NYS Association of Environmental Management Councils' Annual Conference
Oct 20	Ithaca Journal article published
Oct 21	Public Open House
Oct 27	Cornell Chronicle article published
Oct 30	Tompkins County Climate Protection Initiative
Nov 3	Environmental Program Committee of Cornell Cooperative Extension of TC
Nov 15	Last day for public comment
Nov 16	Energy Roadmap Steering Committee
Dec 14	Energy Roadmap Steering Committee
Dec 16	Planning, Energy and Environmental Quality Committee of the Legislature

Public Input and Comments (beyond ideas for messaging)

Planning Advisory Board 9/23/15

Who bears the cost of these investments, homeowners or community? Specify what can be done locally – who needs to do something to get to the goal.

Energy and Economic Development Task Force 9/30/15

REV will play a key role in our energy future and creating new business models for revenue. A lot of work needs to be done around utility rate structures. Carbon payments for RGGI are going up and will impact business decisions.

The Roadmap provides a guide as to what is possible. The next step is to provide a guide on what it costs.

It would be good to translate the results into sq. ft. of solar panels, number of windmills, etc. It would be good to understand how many there are now and how many will be required under different scenarios in the future.

Chamber of Commerce 10/1/15

Need to worry about burdening our developers and businesses to the point that they look outside of the County to locate

Is it really less energy intensive to reduce the number of incommuters if they will be living in housing that use energy here?

NYSAEMCS Conference 10/16/15

Need to better explain how equity lens will be applied to the roadmap – equity thinking should be done in the very early stages of planning for our new energy future

NYS GHG reduction goals are tied to reductions from 1990 levels, ours should be, too, or at least compensate for the difference.

Can't assume that you will use less energy if living in a more dense area, especially if we turn over to 100% electric vehicles. Will need more air conditioning if living in the city, for instance.

Need to emphasize that Tyler's family in the BAU scenario will be suffering the impacts of a greatly disrupted world due to climate change.

Open House 10/21/15

Were the existing efficiency standards for lighting and appliances reflected in the Business as Usual scenario? Seems that they should be.

Questioned using the term "Low hanging fruit" to describe what needs to happen, including efficiency. Achieving efficiency improvements in buildings is extremely difficult.

Was the impact of using CHP for electrical generation factored into the calculations?

Slide on generational change since 1980 should include a greater variety of examples – not just technological change but also other examples such as how we handle waste (recycling vs. landfilling).

Should emphasize decentralization of access to goods and services such as in the 1950s and 60s when people did much of their shopping very close to home.

Should include potential for energy production from anaerobic digestion of agricultural waste.

Question about how feasible the transition to electric cars would be.

Question about how reduction in VMT is calculated. Request that it be clarified. Perhaps discuss as VMT per capita.

Need to consider impact on stream hydrology from micro-hydro particular if diversion of water from the stream is contemplated.

Question about heat pumps. Feasibility? Acceptability? Electrical energy demand.

Could the model be used to identify actions needed for interim goals such as 20% reduction by 2020?

Comment Card: Great presentation, Thanks!! Demographic/population re-densification (i.e., moving population toward center "de-sprawl"): "Densification: has become a buzz word. It is actually very complex and not necessarily good. In many parts of the world what seemed to make sense carried unfortunate consequences. Professors at Cornell are looking at this concept of densification. Seek expert testimony from social scientists and philosophers. Densification is a social and ethical issue – not simply to be studied and discussed by demographers and transportation miles traveled perspective. Thus, for example, it shouldn't be used for tax abatement criteria and development planning. Thanks!

Comment Card: What factors contribute to urban solar potential to being the minority percentage? Is it mostly based on land area? Tree coverage? Etc.

Comment Card: To get more people informed by this and participating with ideas and comments, make a YouTube video of Katie's presentation – the combination of PowerPoint and verbal narrative is very clear and engaging. Create an event with an audience and plant FAQs that people ask and Ed and Katie answer. Excellent event!

Comment Card: I agree with Ian Shapiro: strike the term "Low-hanging fruit". Maybe language like "Obvious/clear positive directions" or "big impact opportunities". Get a marketing person to help wordsmith it and please retire "low hanging" cuz it's more like juicy berries, hard to reach but worth it.

Comment Card: Good turnout of energy enthusiasts, but fewer of those on the fringes or not already engaged with energy issues. How about a video (like Solar Tompkins did) so people can watch from their homes?

Comment Card: Great work! I think it's important to spell out the importance of cultural and structural desegregation of our communities, so we can develop some shared purpose about the big goal. I know that's super difficult, but it's necessary. It's important to highlight the challenge of landlord/renter energy issues and ways to address them and the benefits of generating more local, entry level jobs from renewable and efficiency systems, etc. We need to speak directly to the human/cultural/community level of these issues, not just the technical level, in order to create an engaged community effort. And it can't be colorblind, it must address equity issue.

Comment Card: Add to the "challenges" slide (near the end of the ppt): the challenge of communicating with and including people who culturally or geographically are not part of the conversation right now and don't see why they should be.

Email from Henry Kramer - Received 10/20/15

I am a resident of the Town of Dryden, Counsel and Vice-Chairman of the Tompkins County Republican Party for Communications & Media. I am also a co-founder of the Dryden Safe Energy Coalition. The following is my comment on the Energy Road Map and the County's carbon reduction plan.

I am opposed to both the energy road map and the carbon reduction plan, for the following reasons:

1) Years of business experience showed that planning more than about three years out was rarely effective and almost always inaccurate. The plan goes 35 years out. By then, a breakthrough could see limitless virtually free fusion energy. We just don't know. Also, today's legislature can't bind its future successors. Political and energy winds may change. Fifty years ago, Tompkins County was solidly Republican. In 35 years, it may be again and have no use for your plan.

2) The plan does not take into account that fixing a global man made problem, if indeed there is one, requires global action. If Tompkins County follows its plan and China and India do not, it is useless. So, this issue must be dealt with by national and international authority. The Tompkins plan will be entirely ineffective if most of the world doesn't adhere to it and that is unlikely.

3) Although the plan doesn't say so, achieving a goal such as an 80% reduction without using coercion is also a mythical goal. Is the County going to punish people who don't upgrade the energy efficiency of their homes? Is it going to zone so that everyone has to live in a dense urban environment? Force us to buy electric cars that can't go far enough to take us to Washington or Chicago? What will power the plants that produce the electricity to run the cars? Who will bring jobs to a Tompkins County with unreliable energy and higher costs than elsewhere? I've seen the Cleaner Greener Plan and Agenda 21. The road map conforms to these plans. They envision an America in which the rural areas are depopulated. Coercion and "energy police", no thanks.

4) Relying on renewables just doesn't make sense. There are times when the sun does not shine and the wind does not blow. Today's world is run on computers. Computers need reliable sources of energy, all the time, shut them down and businesses won't be able to operate, students will have trouble doing their homework, doctors won't be able to get to medical records. There will be blackouts and brownouts. Solar and wind are uneconomic without extensive government subsidies and distort the playing field of energy costs. Government subsidies aren't free, we the taxpayers pay for them.

5) Finally, both the energy road map and the carbon reduction plan, with all the modifications of life style they require, are in pursuit of a larger political agenda premised on the concept that man is causing global warming. But, many of the models used to predict the future in use for some time now have shown they are grossly inaccurate. Data has been distorted to try to prove a conclusion instead of being used to neutrally assess one. Of course climate changes over decades, centuries, and eons. But until you have centuries of data, you are measuring weather, not climate.

Please *do not assume a consensus on your plan.* While I am not speaking here for the Republican Party, I know I speak for many of the thousands of less vocal registered Republicans (conservative and libertarian) who support a generally clean environment but take a more balanced approach to weighing economic

factors with environmental ones, want economic development and jobs, want to keep government out of our lives, support reducing our crushing total tax burden, and want local governments to stop meddling in problems that are outside their jurisdiction. Tompkins County cannot solve the world's energy issues and our legislature and their employees should not be telling us all how we are to live. We are used to seeing the City of Ithaca and the Town of Ithaca do these things. But please leave the surrounding towns out of this, thank you, and that means keeping the county level from imposing these plans on the rest of us who don't live in the square miles of insanity.

TCCPI Meeting, 10/30/15 (notes from Peter Bardaglio)

Katie explained overall goal of Energy Roadmap: to assess the potential of renewable energy and energy efficiency in the County and present alternative scenarios that would meet the County, City of Ithaca, and Town of Ithaca goal of an 80% reduction in community-wide greenhouse gas emissions by 2050

Has now given presentation 17 times – lots of feedback from community, mostly around messaging and making presentation clearer

Will be compiling all comments and bringing them to the steering committee

Of the scenarios present, the middle one seemed to gain the most support – offered a mix of different approaches.

Business as usual would result in only a 33% reduction in greenhouse gas emissions by 2050

About 50 people attended TCAD Energy and Economic Development Task Force presentation previous evening at Sciencenter

Katie has presented energy roadmap to the TCAD Energy and Economic Development Task Force – received very positive response but concerns expressed about cost of implementing changes needed to meet the 80% goal

TCAD task force is focusing on first five years – what do we need to accomplish in the short term to ensure we achieve our GHG emissions reduction goal?

Not a static roadmap – will be updated on a regular basis

Clear opportunities:

- Retrofit existing buildings and build new, more efficient ones
- Install lots of solar PV for electricity
- Transition away from natural gas to heat pumps and biomass for heating
- Reduce vehicle miles traveled by building housing in population centers, encouraging car pooling, etc.
- Transition away from gasoline to electric vehicles

Generally positive response to plan from meeting attendees – everyone agreed on importance of educating community but some disagreement over the best approach to messaging

One approach emphasized the need to focus on resiliency, making sure homeowners can be “king of your own castle” – making changes necessary to prepare for more volatile climate

Other approach stressed the need for a more collective approach – focus on building a stronger, more resilient community and making sure everyone is included

Despite their differences, both approaches shared an understanding that climate change is already underway and we need to prepare for it

Email from Dave Bradley - Received 11/11/15 via Brian Eden

Date: November 7, 2015
To: Brian Eden
From: Dave Bradley
Subject: Wind Portion of 2015 Tompkins County Energy Plan

Summary
In the summary of the tentative energy plan for Tompkins County for 2015 (http://tompkinscountyny.gov/files/planning/energyclimate/documents/ERM%20Fall%20Outreach%2010-21-15%20Open%20House.pdf), a scenario for a more sane (than is presently the case) energy supply mix for Tompkins County has been prepared. There are actually a few "sub-plans" within this document, but most of those pertain to the USE of energy and not the GENERATION of it, and in particular, electricity, which is the form of energy most easily accomplished renewably at prices similar to those that now prevail for this form of energy now provided to Tompkins County. Of these, the part discussing wind sourced electricity seems to be particularly obsolete, "sandbagged", "low balled", and out-dated, drastically understating the potential for the lowest cost renewable energy (on an unsubsidized basis) which can be made en mass within Tompkins County. If wind energy portion of this "report" cannot be corrected, it (the wind energy portion) should be just deleted. Perhaps an up to date assessment can be made at some later date for this document. But it would be nice if this plan reflected both actual unsubsidized costs of commercial scale wind sourced electricity as well as present day technology, especially with regards to the alternatives.

Discussion
The wind resources for most of Tompkins County are best described as "moderate", though there are certain spots (hill/mountain ridge-tops with prime access to the prevailing winds from the west-southwest) which can be considered "average" or "decent" by US standards. The unofficial estimate of both solar PV and wind sourced electricity are provided on pages 18 and 19 of the planning summary/presentation, respectively, at 2452 and 992 GW-hr/yr or 280 and 113 MW on an average delivered basis (or megawatt delivered = MWd = (GW-hr/yr)/(8766 hrs/yr)). That is an equivalent to an estimate of a "hydrocarbon reserve" (the amount that can be extracted at a given hydrocarbon price).

Of course, the actual amount of electricity that can be produced is a function of what can get paid for by some combination of sales of electricity, deferred purchases of grid sourced electricity and/or subsidies. Presumably if the net cost to make some form of renewable energy is too high (i.e. greater than the price that is received or deferred), the owner will lose money and eventually have to shut down that generation of that electricity. And while there may be long periods of time when a loss is incurred (as is generally the present case with fracking sourced methane), eventually some reckoning needs to occur – either a higher price for the electricity is paid to at least cover costs or else that source of generation is stopped and the owner/entity of that generation goes bankrupt/sells the generation to someone else or scraps the bankrupt generation system.

Both solar PV and wind based generation have no fuel cost, virtually no direct labor cost. While they do contain "embedded energy - some or most of which is "embedded pollution" (especially for Made in China

PVs) – during their 25 + year electricity production, very little air and water pollution will be made. In effect, they are basically "non-polluting" electricity sources , unlike nuclear, coal and methane -especially "natural gas/associated gas" sourced methane. Most of the cost of generation is entailed in the cost of the money used to buy/install this system as well as the actual cost to buy that system that does get installed (i.e. the purchase price of the components/parts). These tend to be capital-intensive ways to make electricity and price insecurity (the unknowability of what future electricity prices and thus what the revenues from a known renewable energy resource will amount to) can be VERY detrimental to the economics of these electricity production methods. Without a long term knowable (= perfectly predictable) price, both wind and PV can become much more expensive due to the rise in the price of the money/equity used to buy and install these generation projects. This is the "greater risk of non-repayment = higher cost money" arrangement. Thus, one of THE dominant costs factors for wind and PV generation systems is the cost of money, which can be expressed as the as the "Fixed Charge Factor".

With respect to this report, of the 992 GW-hr/yr of probable wind sourced electricity, here is the estimated breakdown of how that could be made based on the size of the wind turbine:

Small scale	40 GW-hr/yr	4.56 MWd	4.0 %
Medium scale	650 GW-hr/yr	74.15 MWd	65.5%
Large scale	302 GW-hr/yr	34.45 MWd	30.4%
	992 GW-hr/yr	113.16 MWd	

"Small scale" is defined as less than 25 kw of capacity, but most likely near 10 kw (the most popular, common size in the USA for such turbines), "Medium scale" is in the 25 kw to 500 kw of capacity while "large scale" is defined as > 500 kw of generation capacity. One of the smallest large scale units still commercially available is a GE 1.65 MW turbine with a 80 to 1000 meter rotor diameters and an 80 meter tall (or taller per customer wishes) tower. In general, "large scale" now translates into wind turbines in the 1.8 to 3 MW range.

This can be translated into an estimate of the number of turbines using the following net efficiency estimates needed to satisfy the above estimates:

Small	10%	10 kw capacity	4560 turbines (e.g. Bergey 10 kw)
Medium	15%	100 kw capacity	4943 turbines (e.g. NPS 100 kw)
Large	40%	2 MW capacity	43 turbines (e.g. Gamesa G114)

At present, there is about 13 GW of wind turbine capacity that is "under construction" in the US, representing an outlay of about $23 billion at the average installation cost of $1.75 million per MW of capacity (LBNL-2014 estimate). Essentially ALL of that money will be used on commercial scale units. This is because commercial scale units can produce electricity at the lowest cost (before or after subsidies are included) of any new renewable electricity generation these days, including from small and medium sized turbines. Most of these commercial scale turbines will be of the "Low Wind Speed Turbine" (LWST) design, where the ratio of swept rotor diameter to kw of generator capacity is greater that 4 m^2/kwc (square meters per kw of (generator) capacity) and in the case of the 2 MW Gamesa G-114, it is 5.1 m^2/kwc. Such turbines can produce net outputs of 35% at average hub heights of 6 m/s. And when these are combined with towers taller than 80 meters, they can tap faster winds at most given sites (especially in the northeastern USA), which pushes the net output even higher. LWST are not just for "low wind regions"; when installed in "medium wind" regimes, net outputs in the 40% to 50% have been commonly documented. The use of LWST in medium (hub height average wind speeds in the 6.5 to 7 m/s range) to

even “decent” (in the 7 m/s to 8 m/s range) wind regions are the major reason why the production cost of wind based electricity has dropped so dramatically in the last few years.

While turbines such as the Northern Power Systems 100 kw are highly regarded for units their size, such tiny units face a math problem, ESPECIALLY in NY State and even more especially in a heavily forested county such as Tompkins. Due to the presence of trees and hills, the average wind shear (expressed as the roughness length (RL), z0, with units of meters) is quite high compared to flat, non-foreseted areas like Texas and Kansas. The high RL values in Tompkins County means that the wind speed slows down considerably from a height such as 100 meters above the ground down to ~ 40 meters (or less) to a much greater extent than a “smooth” area (in NY, an example of a low RL location is the slag bluffs in Lackawanna on the Lake Erie coastline, where z0 is 0.115 meters, or in Lake Erie, where it averages less than 0.001 meter). A 6 m/s average wind at 100 meters would be 4.4 m/s at 30 meters of height (98.4 feet) and 4.7 m/s at 37 meter heights (121 feet). And since the power output is more or less proportional to the cube of the wind speed, a given swept area is likely to only produce 39% of the power at ~ 100 feet as one at 328 feet (100 meters). In addition, there is much more turbulence near the ground (where the wind direction tends to vary a lot even when it is flowing in a general trend), so the wind velocity may be less than the wind speed closer to the ground than at higher heights.

In addition to being on the wrong side of the wind shear equation, smaller turbines are also on the wrong side of the various economic equations. In general, the ratio of swept rotor area to generator capacity is much smaller for smaller turbines than it is for commercial scale units. Furthermore, getting to heights where decent, lower turbulence speeds exist is more costly per kw-hr of electricity delivered, even though the absolute costs for smaller turbines are much lower than for commercial units. In countries where Feed-In Tariffs prevail and small companies/cooperatives/individuals can own commercial scale turbines (Germany, Denmark), very few small units are installed – instead, resources are pooled and commercial units are purchased and installed. In Germany, over half of the 30,000 commercial scale installed wind turbines are owned by individuals/small partnerships/cooperatives and sometimes small towns/municipal electric cooperatives. Of course, that option is highly improbable in the USA, though perhaps the Black Oak windfarm will be the exception to that sad trend (and we hope that happens).

In summary, “small” and “medium” scale turbines produce electricity in a much more costly manner than commercial ones on an unsubsidized basis. As a result, they require greater subsidies to become justifiable. For the very small ones (such as a 10 kw capacity one), on average, these will displace some of the electricity consumed on farms and in rural houses, so in this case instead of trying to compete with the 3 c/kw-hr grid price that now prevails in NY State, they are displacing electricity that is delivered at 15 to 20 c/kw-hr. However, to become net producers at 3 c/kw-hr electricity prices, a 10 kw capacity unit operating at a 10% net output will only make $263 worth of electricity in a year. And since such a unit can cost $50,000 to $75,000, a lot of subsidies need to be obtained. So these units will not be doing anything but producing negligible amounts of grid electricity. However, these do tend to compete with PV units (unsubsidized basis), but due to the significantly greater PV subsidies (for now), the small turbines are hard to justify, especially in the numbers contemplated in this report.

The same thing applies for medium scale units. For example, the installed cost on a NPS 100C-21 unit with a 37 meter tower (http://www.northernpower.com/wp-content/uploads/2015/02/20150212-brochure-NPS-100C-21-US.pdf) is around $500,000. At a 15% net output, this could be expected to yield 132 MW-hr/yr, or about $4,000 of grid priced electricity. They even have an extended blade unit, (http://www.northernpower.com/wp-content/uploads/2015/02/20150212-US-NPS100C-24-brochure.pdf) but it only puts out ~ 170 MW-hr/yr at 4.7 m/s average wind speeds. Without huge subsidies similar to those PV systems presently obtain (averaging near 18 c/kw-hr for a 20 year term), such turbines are very

difficult to justify unless they are solely viewed as Keynesian stimuli (in this tentative plan, that could be $2.47 billion worth of NPS-100's, or less as volume discounts might kick in). Even with a 4.52 m^2/kwc rating, the NPS 100C-24 still suffers from low wind speeds at 37 meter heights above the ground due to high RL values.

On the plus side, both small and medium turbines ARE made in USA, so money spent on them stays in this country. However, there is the matter of ratepayers eventually having to pay the tab, or else poor and middle class taxpayers suffer from a lack of governmental services when government revenues drop due to tax avoidance. The tax avoidance subsidies in the USA are most beneficial to those with the highest active and passive marginal tax rates, which means really, really rich individuals or else corporations with a large passive tax which they want to avoid paying. The ideal use for "medium turbines" is for small companies and farmers who can avoid paying the electricity connection fees if they make their own. Individuals and companies who wish to keep their electricity consumption a secret would also benefit from these turbines.

Finally, this leaves commercial scale LWST. In Figure 1 is an Annual Energy Output Curve for a Vestas V110-2 MW (110 meter rotor), which is one of their more popular models and which exemplifies current trends in the US wind biz:

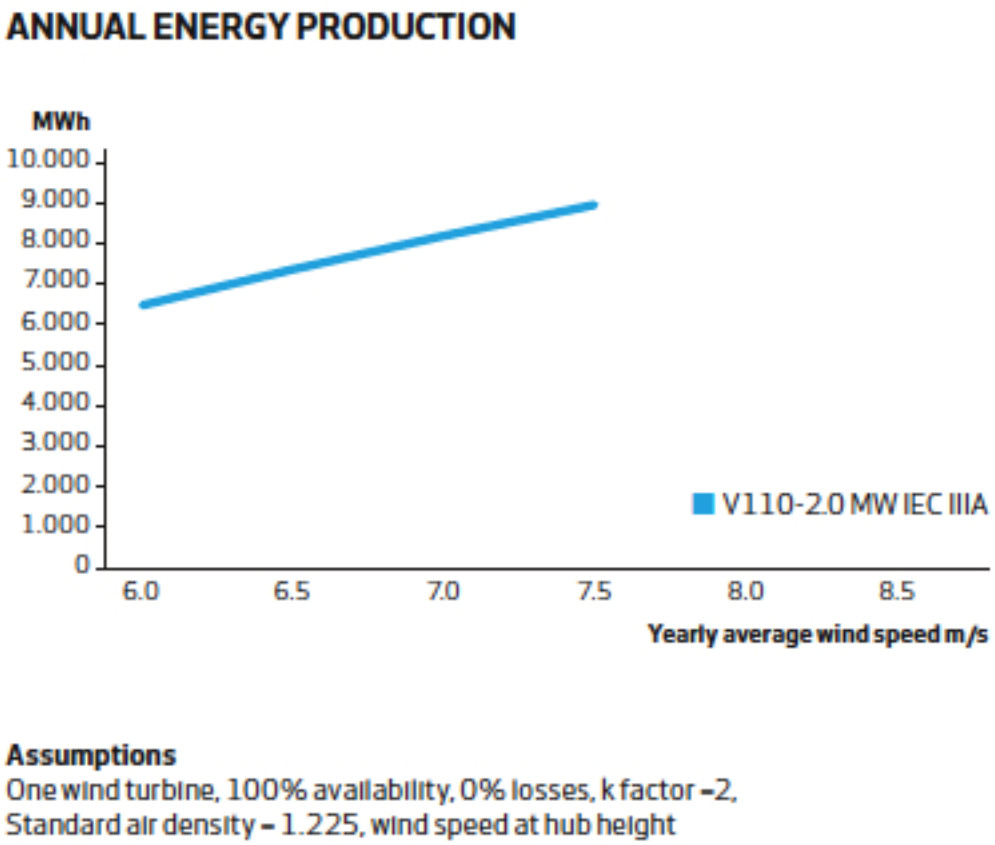

Figure 1

From page 12 in
http://nozebra.ipapercms.dk/Vestas/Communication/Productbrochure/2MWbrochure/2MWProductBrochure/#V110_PowerCurve

At a 6 m/s average wind speed, about 6600 MW-hr/yr can be expected (37.6% net output) before minor losses (uptime of only 98.5%, grid disturbances, possible avian flyway shutdowns in migration times of bade weather, etc). Since these will cost about $5 million with a 95 meter tower, installed, it too would be a tough sell with grid prices at $30/MW-hr (23 c/kw-hr) – around $198,000/yr would be its expected revenue. Either electricity prices have to rise or else subsidies are needed to square this deal, as it has a "simple payback" of around 25 years ($0.198 million/$5 million). However, this is vastly superior to the economics of the medium and smaller turbine. Going to a 120 meter height, wind s at 6 m/s at 80 meters translate to 6.55 m/s at the greater height, which increases the expected output to around 7500 MW-hr/yr. Society would benefit from the greater electricity output (~ 14% more electricity per turbine), but at present pricing, economically this is a wash due to the greater installation cost of the additional 40 meter height extension.

As was stated earlier, PV and wind turbines of any size are capital intensive operations. As such, the "cost of money" (as in interest rate charged on loans or apportioned to investments) is a major determinant of the "cost of production". For "0%" money, the FCF is simply the inverse of the term of the loan/bond/investment. For example, 0% for 25 years is a 4%/yr FCF. For non-zero interest rates, the following formula needs to be used:

FCF = (i * (1+ i)^n)/((1+i)^n -1)

Where i is the interest rate (for example, per year) and n is the time period for this money loan (for example, years). Both i and n have to have similar units (for example, 1/yr and yrs). Some common values for FCF are:

5% for 20 years	FCF = 8.024%/yr
4% for 25 years	FCF = 6.401%/yr
7.76% for 20 years	FCF = 10.00%/yr
10% for 10 years	FCF = 16.27%/yr

Bond yields and loan rate calculations are similar using this formula.

The cost to produce energy for commercial scale wind turbines is approximately:

Electricity Cost = FCF * Installed Capital Cost/Annual Energy Output + $10/MW-hr
= FCF*ICC/AEO + $10/MW-hr

where the $10/MW-hr correspond to the "Operations and Maintenance" (O & M) expenses. For a turbine that costs $5.5 million that has access to 4% money for 25 years and which produces 7500 MW-hr/yr, the production cost would become:

Cost = (0.064/yr) * $5,500,000/(7500 MW-hr/yr) + $10/MW-hr
= $56.93/MW-hr ~ 5.7 c/kw-hr

Using 7.76%/yr for 20 year money, this cost rises to $83.33/MW-hr, or 46.4% more, just for the exact same turbine installed for the exact same price and yielding the exact same energy output. What is more exasperating is that the "cost of money" can be both quite subjective (depends on who is loaning the money out and to whom it is loaned) and can vary with the time that it is loaned (money in 2006 has a different "cost" than in 2015). And yet this can be the single largest determinant of the cost to make that electricity.

Of course, the price charged for the electricity is a completely different thing. In theory, the price charged is supposed to be the same as the cost for a non-profit, and greater than the cost for a for-profit entity or individual owner. By definition, a for profit provider has to be more costly than a non-profit, all other things being equal. However, some non-profits can actually tap lower cost money than any for profit entity. Governments can go into debt by simply creating the money to do such investments, and the Federal Government can "print money" since the US has its own national "fiat" currency. Banks also create money when they create debt.

Within NY State, on a short term basis the price charged for most electricity made does not have to be related in any way whatsoever to the cost to make that electricity. In addition, almost ALL electricity made in NY is subsidized – nukes being the most subsidized via the Price Anderson Act way to avoid paying for catastrophic insurance, the lack of any need for proper waste fuel rod disposal and the huge amount of government R&D that went into our country's nuke efforts. Coal and gas subsidies are primarily based on the ability to dump the CO2 pollution resulting from combustion of these fuels into our atmosphere, regardless of the short term and long term costs (such as rising ocean levels and "Climate Weirding".

But the thing is about subsidies, somebody eventually pays for them, whether this is present day or future society at large, or, as is usually the case, some segment, usually not the high income/wealth ones, either, of our society. For example, the tax avoidance subsidies for wind (MACRS, PTC, NYS RPS) and PV (MACRS, ITC, NYS RPS) are primarily or exclusively for wealthy people. The lower price resulting from wind and PV based electricity gets paid for via reduced government tax revenues, which translates into reduced government expenditures (such as schools, police, fire, pollution monitoring, financial regulation, etc). And since poor and middle class people use these services the most, tax avoidance via the rich also gets paid for by the poor and middle class.

The unsubsidized installed cost of Solar PV in NY State over the period of 11-1- 2010 to 11-1-2015 is estimated by the National Renewable Energy Laboratory as $5110/kw of capacity (http://openpv.nrel.gov). The average PV net output in NY State can be estimated via this internet tool from NYSERDA: http://ny-sun.ny.gov/Get-Solar/Clean-Power-Estimator, though it uses "DC output" for its rating; most people use "AC" electricity, and inverters to convert DC to AC are approximately 90% efficient (http://solardat.uoregon.edu/download/Papers/PerformanceofPVInverters.pdf). A PV system in the 13053 zip code (Dryden) would, according to this estimator, deliver 12.3% of its rated output to the inverter, for a total delivered quantity of 11% of its rating. This means that the unit would be expected to deliver $29 worth of electricity (grid rate of 3 c/kw-hr) at a cost of $5110, for a "simple" payback of ~ 177 years. This is very similar to that of the small wind turbine. The horrid economics are highly subsidized so that this no longer appears to be as bad as it looks from that perspective. For example, when viewed as replacing 15 c/kw-hr, this would replace $144 worth of delivered electricity, which drops the simple payback to a merely pathetic 35 years. To drop this further, additional taxpayer subsidies as tax avoidance possibilities are used.

Anyway, a way of comparing systems designed to feed electricity into the grid can be done by using a constant FCF and payback term for the three systems (PV, medium wind, commercial scale wind). If a 4%/yr for 25 year money cost is assumed as well as a 25 year life for the renewable electricity project, here are the results:

PV	$5110/kwc	11% net output	33.9 c/kw-hr
Medium wind turbine	$5000/kwc	15% net output	24.3 c/kw-hr
Commercial wind turbine	$2500/kwc	40% net output	5.6 c/kw-hr

While the commercial scale wind turbine is still not delivering at 3 c/kw-hr. it is 18.7 c/kw-hr closer to that value than a medium speed wind turbine and 28.3 c/kw-hr closer than is a PV system. In theory, if any of these systems were privately owned (and thus for profit), subsidies greater than 30.9 c/kw-hr, 21.3 c/kw-hr and 2.6 c/kw-hr would be required for PV, small wind and commercial scale wind units.

What would be the approximate required capital investment to deliver an average of 100 MW in Tompkins County?

PV	$5110/kwc	11% net output $4.64 billion
Medium wind turbine	$5000/kwc	15% net output $3.33 billion
Commercial wind turbine	$2500/kwc	40% net output $0.63 billion

Of course, some kind of electrical energy storage/buffering would be required, especially for PV. On a 100 MW scale, the only thing remotely cost effective would be a pumped hydroelectric system, possibly coupled to a "deferred hydro" unit, where possible (Lake Ontario?). This would both add to the needed capacity requirement, especially for PV, since the average generation is ~ 3 hours/day at decent rates, while LWST can generate some electricity about 80% of the hours in a year.

Conclusion
Of course, there are many social benefits to residential based PV that are not reflected in a simple cost analysis. And if the PVs were made in the US/NY State (presently the exception and not the rule) and installed by NY residents, there is also the "Keynesian stimulus" effect in action. But somebody has to pay for those subsidies and at $4 billion to $2.7 billion worth above those needed for commercial scale wind, that adds up fast. So far, few seem to be willing to "take one for the team". The systems proposed to produce the most electricity in our green energy future will require significantly larger subsidies that the lowest cost system (LWST), and a lot more of them, too. After all, in a county with 475 square miles of land, only 125 LWST would be enough to provide most of our electricity. That's about one per 3.8 square miles, assuming there are no objections to looking at them. Unfortunately, that would be the real cause of not choosing the low cost route…

Email from Joseph Wilson - Received 11/15/15

Joseph M. Wilson
75 Hunt Hill Road
Ithaca (Town of Dryden), New York 19850
November 15, 2015

Mr. Ed Marx, Planning Commissioner
Ms. Katie Borgella, Planning Staff
via Email
RE Comments Regarding the Energy Road Map

Dear Mr. Marx and Ms. Borgella,

I have reviewed the County's Energy Road Map and attended several of the County Planning Staff's presentations regarding its preparation and content. I also attended the only public meeting of TCAD's ad hoc Energy and Economic Development Committee where community leaders and members of the Committee discussed the content of the report the Committee is to write about energy and the economy in

our County. The Road Map and the work of this Committee are pertinent to the obligations to protect the health and safety of Town residents and to the Board's desire to foster economic development in Dryden.

Given my review and involvement in the County's process and my knowledge of the thinking of the Town Board over the years regarding these matters, I urge you to consider the following:

- The Energy Road Map is intended by the County Legislature to guide energy-related decisions made within the County through 2050.
- The County Legislature has set a goal of reducing greenhouse gas emissions (including CO2 and methane emissions) by 80% from its 2008 greenhouse gas (GHG) emission inventory by 2050.
- The reasons for doing so include:
    - Meeting this goal will keep money spent on energy in the local economy instead of putting it in the coffers of multi-national corporations.
    - Meeting the goal creates local jobs.
    - Meeting the goal will reduce pollution and improve public health'
    - Meeting the goal will increase our communities' resilience in response to climate change.
- Each of these reasons pertains directly to obligations which this Board must or desires to fulfill:
    - To protect the health and safety of Town residents and
    - To promote local economic development.
- In the County's 2015 Comprehensive Plan, one pertinent Principle and one pertinent Policy are stated:
    - Principle: "...the energy system [will meet] community needs without contributing additional greenhouse gases..."
    - Policy: "Reduce greenhouse gas emissions to reach a minimum 80% reduction ... and reduce reliance on fossil fuels across all sectors."
- Part of the "Bottom Line" in the Road Map is that County residents and businesses must "Transition away from natural gas ... [because we] can't achieve goals and still use the same amount of gas."
- The Physicians, Scientists, and Engineers for Healthy Energy (PSE) has studied the Iberdrola/NYSEG West Dryden Gas Pipeline proposal to estimate the effect on the County's CO2 emissions. Their conclusion is that burning the gas which the Pipeline will provide to users within the County will create "... **a 15.4% to 30.8% increase in the County's CO2 2008 emissions.**" [Boldface is that of the PSE.]
- No competing estimates have been shared with the public.
- Cornell Professor Bob Howarth has also studied the Iberdrola/NYSEG proposal and concluded that within a 20-year time frame (i.e. between now and 2035 depending on when the Pipe became operational), when upstream methane emissions created by the use of the proposed Pipeline are added to the County's 2008 CO2 inventory and to the PSE's estimates for CO2 emissions, the County's Green House Gas emissions could increase by a total as high as 52%.
- This data substantiates the earlier observation by County Planning Commssioner Ed Marx in his October 2014 memo to the County Legislature's Planning, Energy and Environmental Quality Committee where he wrote,

    > "...the proposed [Iberdrola/NYSEG West Dryden] pipeline would provide capacity to allow expansion of natural gas use throughout the urbanized area of the County and beyond well into the future. As we work to achieve the County's stated goal of an 80% reduction in greenhouse gas (GHG) emissions by 2050 and a 20% reduction from 2008 levels by 2020 it is becoming increasingly clear that we cannot achieve that goal if we continue to increase fossil fuel use in the County, including use of natural gas."

This information leads me to the following comments and recommendations:

1. The Road Map should include the estimates of the PSE and Dr. Howarth, and the estimates should be prominently mentioned. (Should competent competing estimates materialize, they should be noted as well.)
2. The Road Map should explicitly and prominently state that an expansion of natural gas infrastructure in the County including but not limited to Iberdrola/NYSEG's proposed West Dryden Road Gas Pipeline and any other increase in the supply or consumption of natural gas within the County will prevent the County from reaching its 2020 and 2050 GHG emission reduction goals.
3. The Road Map should explicitly state that the proposed Gas Pipeline and any other efforts to increase the supply or consumption of natural gas in the County will prevent or seriouisly impede acheiving the objectives for which the Road Map has been created—i.e. money spent on energy in the County staying in the County, creating local jobs, reducing pollution, improving public health, and increasing community resilience in response to climate change.
4. The Road Map should explicitly indicate that all efforts to increase the supply or consumption of natural gas will violate the Principle in the Comprehensive Plan calling for an *energy system which meets community needs* *without contributing additional greenhouse gases.*
5. The Road Map should explicitly indicate efforts to increase the supply or consumption of natural gas will violate the Policies in the 2015 Comprehensive Plan to "reduce greenhouse gas emissions to reach a minimum 80% reduction ... and reduce reliance on fossil fuels across all sectors."
6. We cannot possibly reach the Road Map's "Bottom Line" to transition away from natural gas if we acquiesce or otherwise allow an increase in supply or consumption of natural gas within the County.

Sincerely,

/s/Joseph M. Wilson

Letter Received on Nov 19, 2015

To: Mr. Ed Marx, Planning Commissioner, and Ms. Katie Borgella, Tompkins County Planning Dept.
Subject: Tompkins County Energy Road Map – Comments on the Draft
Date: November 15, 2015
Submitted: Marie McRae, Madison Lavine, Judith Pierpont, Nancy Miller, Sue Stein, Linda Parks, Elmer Ellis Ewing, John Clair Miller, Eliza Evett, Deborah Cipolla-Dennis, Genevieve DeClerck, Particia Dubin, Joanne Cipoalla-Dennis, Mary Lee, Lily Chan, Faye Lee, Hugh Edwards, Linda Clougherty, Mark Witmer, Martha N. Wilson

By a review of the draft Energy Road Map and participation by some of the undersigned at the only public meeting of Tompkins County Area Development's ad hoc Energy and Economic Development Committee, where matters related the Road Map were discussed, we have learned the following:

- The Energy Road Map is intended by the County Legislature to guide energy-related decisions made within the County through 2050.
- The County Legislature has set a goal of reducing greenhouse gas emissions (including CO2 and methane emissions) by 80% from its 2008 greenhouse gas (GHG) emission inventory by 2050.
- The reasons for doing so include:[1]

[1] See Energy Road Map Open House Powerpoint page 5 (10/15/2015), retrieved 11/15/2015 from http://tompkinscountyny.gov/files/planning/energyclimate/doscuments/ERM%20Fall%20Outreach%2010-21-15%20Open%20House.pdf

- Meeting this goal will keep money spent on energy in the local economy instead of putting it in the coffers of multi-national corporations.
- Meeting the goal creates local jobs.
- Meeting the goal will reduce pollution and improve public health'
- Meeting the goal will increase our communities' resilience in response to climate change.

- The County Legislature's 2015 Comprehensive Plan includes a Principle and Policy which apply directly to the Road Map:[2]
  - *Principle: "...the energy system [will meet] community needs <u>without contributing additional greenhouse gases</u>..."*
  - *Policy: "Reduce greenhouse gas emissions to reach a minimum 80% reduction ... and <u>reduce reliance on fossil fuels across all sectors</u>."* [Italics and emphasis added.]
- The "Bottom Line" includes to "*<u>Transition away from natural gas ... [we] can't achieve goals and still use the same amount of gas."</u>* [3] [Italics and emphasis added.]
- The Physicians, Scientists, and Engineers for Healthy Energy (PSE) has studied the Iberdrola/NYSEG West Dryden Gas Pipeline proposal to estimate the effect on the County's CO2 emissions. Their conclusion is that burning the gas which the Pipeline will provide to users within the County will create "... **a 15.4% to 30.8% increase in the County's CO2 2008 emissions.**" [Boldface is that of the PSE.] [4]
- Cornell Professor Bob Howarth has also studied the Iberdrola/NYSEG proposal and concluded that within a 20-year time frame (i.e. between now and 2035 depending on when the Pipe became operational), when upstream methane emissions created by the use of the proposed Pipeline are added to the County's 2008 CO2 inventory and to the PSE's estimates for CO2 emissions, the County's Green House Gas emissions could increase by a total as high as 52%. [5]
- No competing estimates have been shared with the public.
- This data substantiates the earlier observation by County Planning Commssioner Ed Marx in his October 2014 memo to the County Legislature's Planning, Energy and Environmental Quality Committee where he wrote,

  > "...the proposed [Iberdrola/NYSEG West Dryden] pipeline would provide capacity to allow expansion of natural gas use throughout the urbanized area of the County and beyond well into the future. As we work to achieve the County's stated goal of an 80% reduction in greenhouse gas (GHG) emissions by 2050 and a 20% reduction from 2008 levels by 2020 it is becoming increasingly clear that we cannot achieve that goal if we continue to increase fossil fuel use in the County, including use of natural gas."

This information leads to the following comments and recommendations:

1. The Road Map should include the estimates of the PSE and Dr. Howarth, and the estimates should be prominently mentioned. (Should competent competing estimates materialize, they should be noted as well.)
2. The Road Map should explicitly and prominently state that an expansion of natural gas infrastructure in the County including but not limited to Iberdrola/NYSEG's proposed West Dryden

[2] See Energy Road Map Open House Powerpoint page 6 (10/15/2015)
[3] See Energy Road Map Open House Powerpoint page 12 (10/15/2015)
[4] "Impact of CO2 Emissions from Proposed Pipeline along West Dryden Road," PSE Memo dated November 15, 2015 signed by Renee Santoro, Program Director, Environment and Anthony R. Ingraffea, Founding and Past President. A copy can be supplied on request to Joseph M. Wilson, Wilson.joe79@gmail.com.
[5] See TCCPI Meeting Highlights April 2015" on page 2 at htty://tccpi.org/meeting-hihglights-2015.html#April 2015. [Note a typographical error causes Dr. Howarth's estimate of the total increase of the County's "carbon footprint" from the PSE high bound estimate plus natural gas/methane emissions to read "5.2%" when Dr. Howarth stated "52%" at the TCCPI meeting for which the "Highlights" were prepared.]

Road Gas Pipeline and any other increase in the supply or consumption of natural gas within the County will prevent the County from reaching its 2020 and 2050 GHG emission reduction goals.

3. The Road Map should explicitly state that the proposed Gas Pipeline and any other efforts to increase the supply or consumption of natural gas in the County will prevent or seriouisly impede acheiving the objectives for which the Road Map has been created—i.e. money spent on energy in the County staying in the County, creating local jobs, reducing pollution, improving public health, and increasing community resilience in response to climate change.
4. The Road Map should explicitly indicate that all efforts to increase the supply or consumption of natural gas will violate the Principle in the Comprehensive Plan calling for an *energy system which meets community needs <u>without contributing additional greenhouse gases.</u>*
5. The Road Map should explicitly indicate efforts to increase the supply or consumption of natural gas will violate the Policies in the 2015 Comprehensive Plan to "reduce greenhouse gas emissions to reach a minimum 80% reduction ... and reduce reliance on fossil fuels across all sectors."
6. We cannot possibly reach the Road Map's "Bottom Line" to transition away from natural gas if we acquiesce or otherwise allow an increase in supply or consumption of natural gas within the County.