Davis-BesseNPEm Resource

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The following eight pages reproduce the slides that were used in the presentation by A. Compaan on 12/18/2010. Minor formatting changes were made and references moved beneath the related slides.

The case for replacing Davis Besse with efficiency improvements and renewable energy sources

Davis Besse re-licensing community hearing
St. Mark's Episcopal Church, Toledo, OH
December 18, 2010

Alvin D. Compaan
Distinguished University Professor of Physics, Emeritus
The University of Toledo

Overview of presentation

1. History of Davis Besse indicates that 20 more years of operation will seriously endanger the surrounding communities.
2. Davis Besse provides only 8.3% of First Energy's base-load generation and can readily be replaced.
3. Ohio Senate Bill 221 and the Advanced Energy Standard ***requires*** FE to:
   - achieve higher efficiency by reducing demand 22% by 2025,
   - achieve 12.5% generation from renewables by 2025,
   - achieve 12.5% generation from "advanced energy" by 2025, which may include ***new advanced nuclear,*** but a continuation of D-B will not qualify.
4. Distributed Generation will qualify for SB 221 credit.
5. Alternative sources are very attractive in Ohio:
   - Wind near or in Lake Erie (class 3 to class 6 -- better than Texas!)
   - Solar PV (costs are decreasing rapidly; FE used data 14 years old!)

What happens to the highly radioactive spent fuel rods?

- Expectation when Davis Besse was built—a federal repository would be constructed for storing the high level radioactive components as needed for thousands of years.
- Yucca Mountain—still does not have an operating license and no funding was proposed in the federal 2011 budget.
- For 33 years, all high-level radioactive components including fuel assemblies have been stored on site at Davis Besse. Initially in a cooling pond and then in above-ground containers.

➢ ***No nuclear plant license extensions should be granted until a long-term storage facility is operating.***

A troubling indicator: *Where does the tritium in the Davis Besse ground water come from?*

From Appendix E: Davis Besse Environmental Report p. 2.3-2:

"Another well, MW-105A, which has been on a slow increasing trend since the spring of 2009, had a tritium level of 4,158 pCi/l. As a result, FENOC is pursuing a root cause approach to identify the source of the tritium in the wells. No tritium concentrations have been detected at or above the USEPA drinking water limit of 20,000 pCi/l (40 CFR 141.66)."

About tritium and its radioactivity:

- Tritium or hydrogen-3 (1 proton and 2 neutrons) is not naturally occurring. It has a half-life of 12.3 years.
- Tritium is produced in nuclear reactors by neutron bombardment of Lithium-6 and Boron-10. [A small amount is produced in the upper atmosphere by cosmic rays.]
- Tritium is radioactive and decays by emitting a high energy electron (beta particle) plus an anti-neutrino.
- The beta particle has an average energy of 5.7 kilo-electron volts. It will not penetrate the outermost skin layers but is very dangerous if inhaled as hydrogen (H_2 or HT) or water vapor or swallowed as water—not H_2O but as HTO.

Excellent alternatives exist to extending the license 20 years and their costs are declining

- The incident and accident record of Davis Besse and the uncharted territory of extending the life of any nuclear plant 20 years beyond the 40-year design life of the original should stimulate FE to get serious about alternatives.
- The best alternatives for Ohio are (IMHO):
  1. Energy conservation
  2. Wind
  3. Solar
- *These are already mandated by the State of Ohio. FE is required to develop these alternatives anyway AND is allowed by Ohio law to pass the costs through to the ratepayers.*

Essential features of SB221

(passed in the spring of 2008)

1. **Alternative Energy Portfolio Standard (O.R.C. 4928.64-.65)**
   - 25% electricity generation by advanced energy by 2025
   - 12.5% by renewables with solar set-aside of 0.5%
   - Remaining 12.5% may include "advanced energy" such as:
     - Clean coal (w/o CO_2 emissions)
     - Advanced nuclear (NRC Generation III technology) [Gen III incorporates ***passive safety systems*** and is ***designed*** for 60 years of operation]

2. **Net metering (O.R.C. 4928.67, 4905.31, 4928.01)**

3. **Energy Efficiency Standard (O.R.C. 4928.66)**
   - 22% reduction by 2025 through energy efficiency
   - 7% peak demand reduction by 2018

➢ ***Costs may be passed through to customers!***

Bricker & Eckler
ATTORNEYS AT LAW

Ohio Senate Bill 221
Alternative Energy Portfolio Standard

Alternative Energy Technologies	2025 R.P.S. Benchmarks	In-State Requirements	Renewable Energy Credits	Enforcement/ Compliance Payments
Renewable ORC 4928.01(A)(35) • Solar – Photovoltaic • Solar – Thermal • Wind • Hydropower • Certain Solid Waste • Biomass • Bio-Methane Gas • Fuel Cells • Wind Turbines – Lake Erie • Off Peak Storage Facilities Utilizing Renewables • Distributed Generation Facilities Utilizing Renewables	Renewable and Solar Benchmarks: 12.5% + ORC 4928.64(B)(2) Y R S 2009: .25% .004% 2010: .50% .010% 2011: 1.0% .030% 2012: 1.5% .060% 2013: 2.0% .090% 2014: 2.5% .120% 2015: 3.5% .150% 2016: 4.5% .180% 2017: 5.5% .220% 2018: 6.5% .260% 2019: 7.5% .300% 2020: 8.5% .340% 2021: 9.5% .380% 2022: 10.5% .420% 2023: 11.5% .460% 2024: 12.5% .500%	At least ½ of renewable energy resources to be implemented by the utilities shall be met through facilities located in Ohio. The remainder shall be met with resources that can be shown to have been delivered into this state. ORC 4928.64(B)(3)	Utilities may use R.E.C.s in any of the 5 calendar years following acquisition to comply with both the renewable and solar energy resource requirements. 1 R.E.C. shall equal 1 Mw Hour of electricity from renewable resources. ORC 4928.65	1) **Annual PUCO Review** ORC 4928.64(C)(1) 2) **If Not in Compliance:** ORC 4928.64(C)(2) A) Solar Benchmark $ per Mw hour : 2009: $450 2010: $400 2012: $350 2014: $300 2016: $250 2018: $200 2020: $150 2022: $100 2024: $50 B) Renewable Benchmark 2009: $45 Adjusted annually per CPI
Advanced ORC 4928.01(A)(34) • Clean Coal • Advanced Nuclear • Energy Efficiency • Fuel Cells • Co-gen • Certain Solid Waste Mercantile Sited ORC 4928.01 (A)(1) • Real/Reactive Power • Waste Heat Efficiency • Demand/Load storage • Advanced/Renewable	Advanced Energy Requirement: 12.5% ORC 4928.64(B)(1)			

Key A.E.P.S. Cost Containment Mechanisms

3% Cost Cap	Force Majeure Provision
Utilities not required to comply with benchmark to the extent compliance will result in 3+% increase in electricity production or acquisition costs. ORC 4928.64(C)(3)	Utility may request PUCO to determine whether renewable resources are sufficiently available to enforce R.P.S. benchmark requirement. If utility shows good faith effort to comply with renewable benchmarks but cannot, PUCO may reduce obligation. Modification does not automatically reduce future benchmarks. ORC 4928.64(C)(4)

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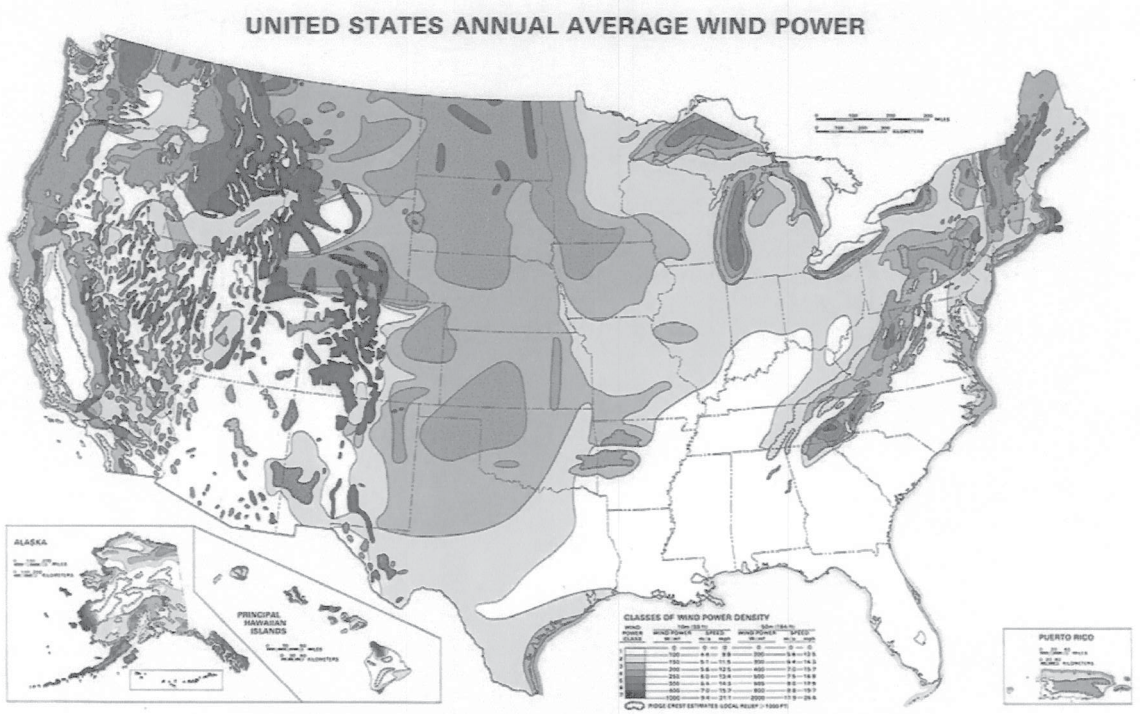
http://www.bricker.com/documents/publications/1533.pdf

Lake Erie and the Lake Erie shore is a great resource for wind energy

Map showing average wind power in Lake Erie better than Texas and the plain states



http://rredc.nrel.gov/wind/pubs/atlas/maps.html

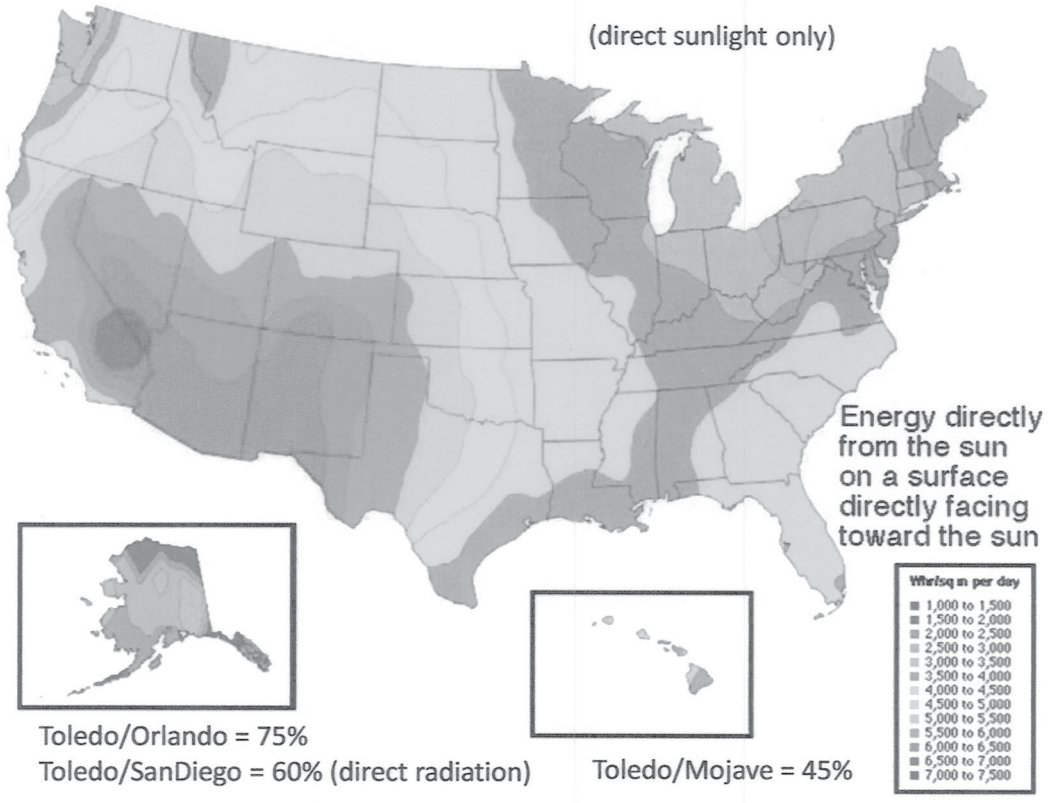
Ohio, and particularly NW Ohio, has excellent solar insolation well-suited for photovoltaics (PV)

Errors in the First Energy Environmental Report (Appendix E):

- must consider full-sky insolation, not just direct solar
- must use current costs and cost projections for PV, not data from 1998!

Average Daily Solar Radiation 1961-1990

(direct sunlight only)



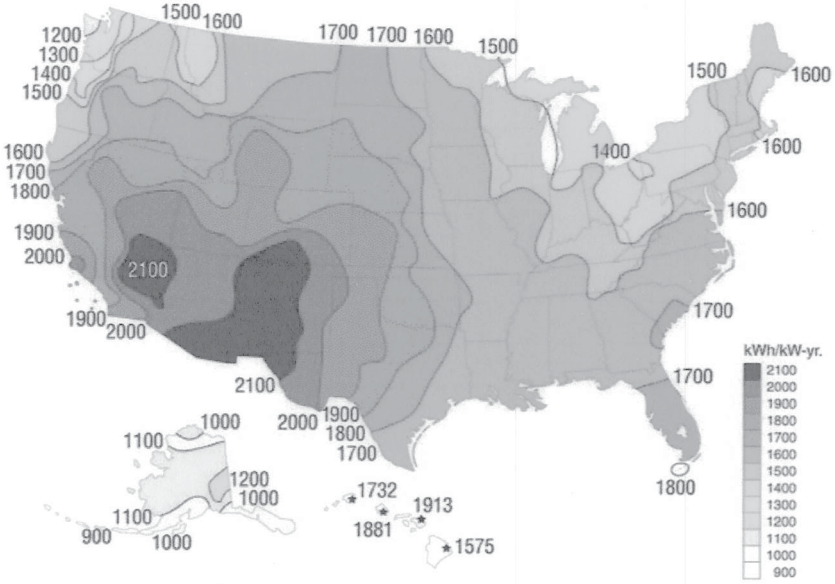
Toledo/Orlando = 75%

Toledo/SanDiego = 60% (direct radiation)

Toledo/Mojave = 45%

http://www.nrel.gov/gis/solar.html

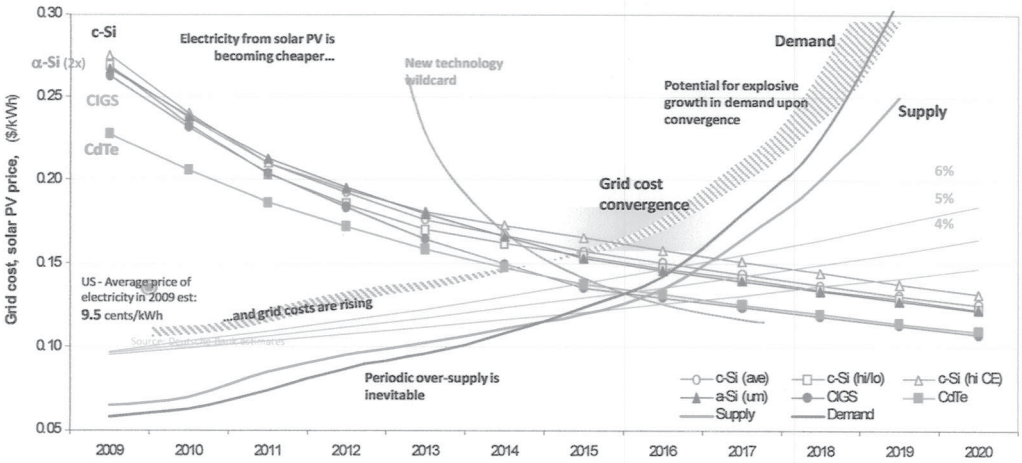
PV Energy kWh/kW-yr



Toledo/Orlando = 86%	Toledo/San Diego = 79% (full sky radiation)

Electricity Price Convergence – 5 to 6 Years

Solar PV industry – long-term outlook



Definitions:

First Generation PV: bulk crystalline silicon (monocrystalline, multicrystalline)
Second Generation PV: Inorganic thin films (CdTe, a-Si:H, a-SiGe, nc-Si:H, CIGS)
Third Generation PV: nanostructures, organic/hybrid, advanced concepts

Source: Deutsche Bank 2009

http://www.slideshare.net/gwsolar/pv-status-and-pathways-stephen-orourke

Stimulating alternatives creates Ohio jobs

- **Energy conservation / efficiency** is a big job creator and saves the consumer money.
- Ohio has a large number of manufacturers that are suppliers for **wind turbines.**
- **Maintenance** of wind turbines creates many jobs.
- In 2009 the largest PV manufacturer in the world was First Solar with all of its U.S. **manufacturing** in Perrysburg.
- Several other PV manufacturers are starting up in Ohio.
- **PV design and installation** creates many jobs.

References

http://www.bricker.com/documents/publications/1533.pdf
http://rredc.nrel.gov/wind/pubs/atlas/maps.html
http://www.nrel.gov/gis/solar.html
http://www.slideshare.net/gwsolar/pv-status-and-pathways-stephen-orourke

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Notes from Davis Besse re-licensing community hearing

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December 2010

Figure Overview of Presentation on 12/18/2010

In section 7.2.2.2 of the Davis Besse Nuclear Power Station License Renewal Application, Environmental Report, First Energy dismisses all forms of renewable energy as a replacement for the 910MW from Davis Besse. Two types that are largely researched and widely used today are solar and wind power, both of which First Energy does not feel are satisfactory forms of energy production to be applied to the grid. The reasons they state are intermittency of power production, large land requirements for installation of either type, the low wind and sunlight irradiance in Ohio compared to other states, associated aesthetic impacts and the high costs per kilowatt-hour of capacity. Low wind speeds and irradiance in the area and costs are discussed in the notes by Dr. Alvin Compaan.

It is true that solar panels will only produce power during the day when the sun is shining, and that both wind speeds and solar irradiance change throughout the day and year; however, by looking at systems that are already in place in the area and around the world, we will be able to gain a better understanding of how to use these different types of renewable energy. This study specifically shows the case for Northwest Ohio and how it can in fact, be applied to the grid.

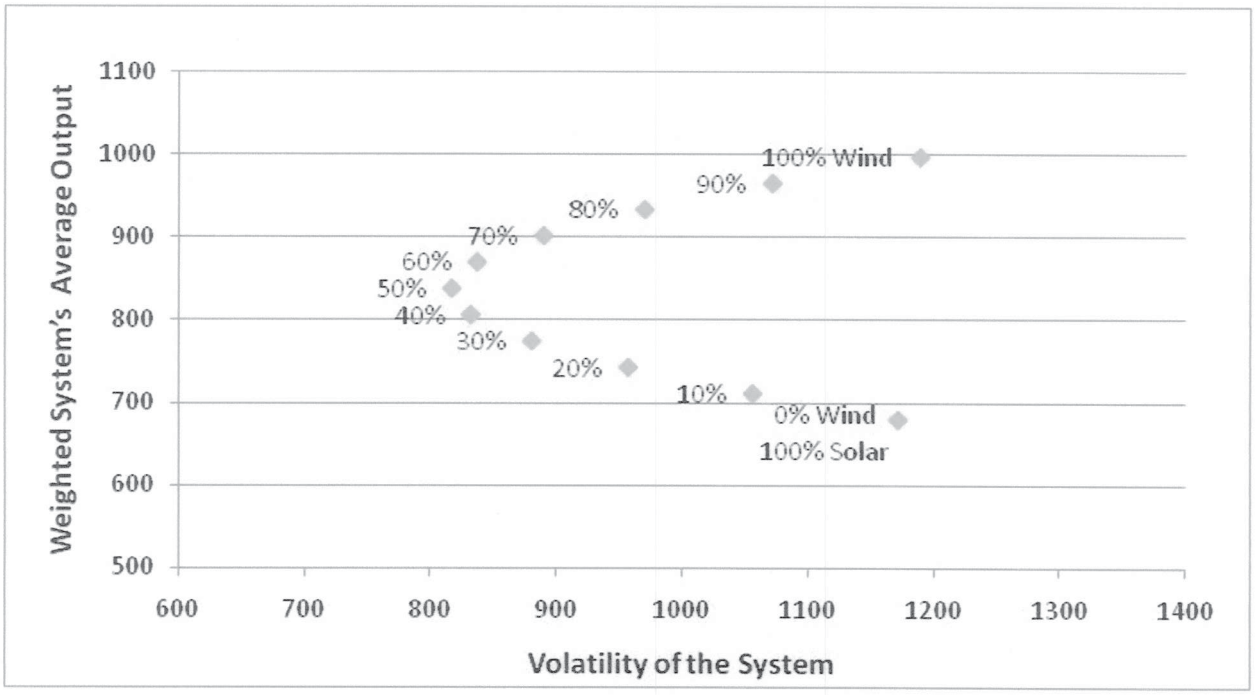

Figure Volatility vs Maximum Output of several hypothetical combination systems of solar and wind

I have used two functioning systems in the area, one wind turbine owned by Bowling Green Municipalities and one solar array on a home located about 20 miles north of the turbine in Toledo. With detailed statistical modeling, the above graph shows the volatility or intermittency of 10 hypothetical systems versus their output. Each hypothetical system is a different weighted combination of solar and wind, from 0 - 100% wind. As you can see, the system with the least volatility (most stable) is an even combination of 50% solar and 50% wind.

A single solar array follows patterns in its power production: only produces in the day, not at night and also the production is higher in the summer on average than in the winter. A single wind turbine also follows patterns: not as much predictability from day to day, however they produce more on average in the winter than they do in the summer months. By combining these two sources at the optimal ratio for the area, a much more stable and predictable output can be obtained. The slide below shows the hypothetical combination system against a large city demand curve like Toledo. We can also look at the system over an entire year and see that the standard deviation (measure of volatility) is consistently lower than either by itself.

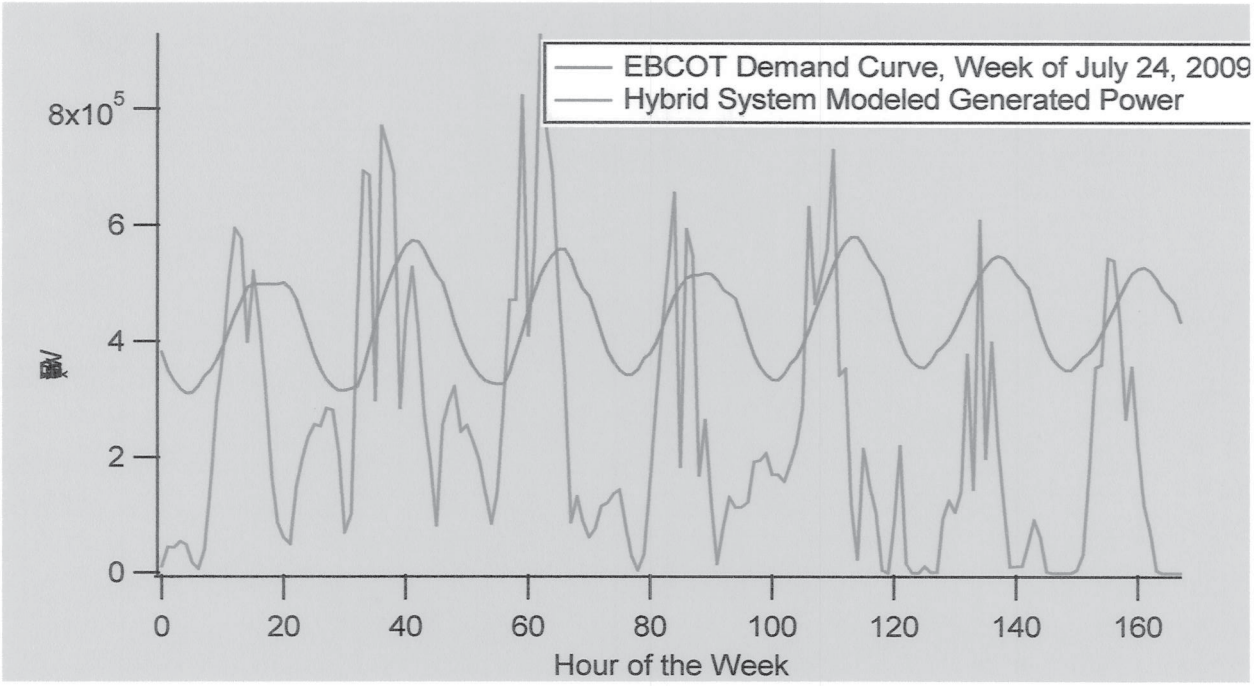

Figure Output of hypothetical system vs demand curve from central Texas, similar to that of Toledo.

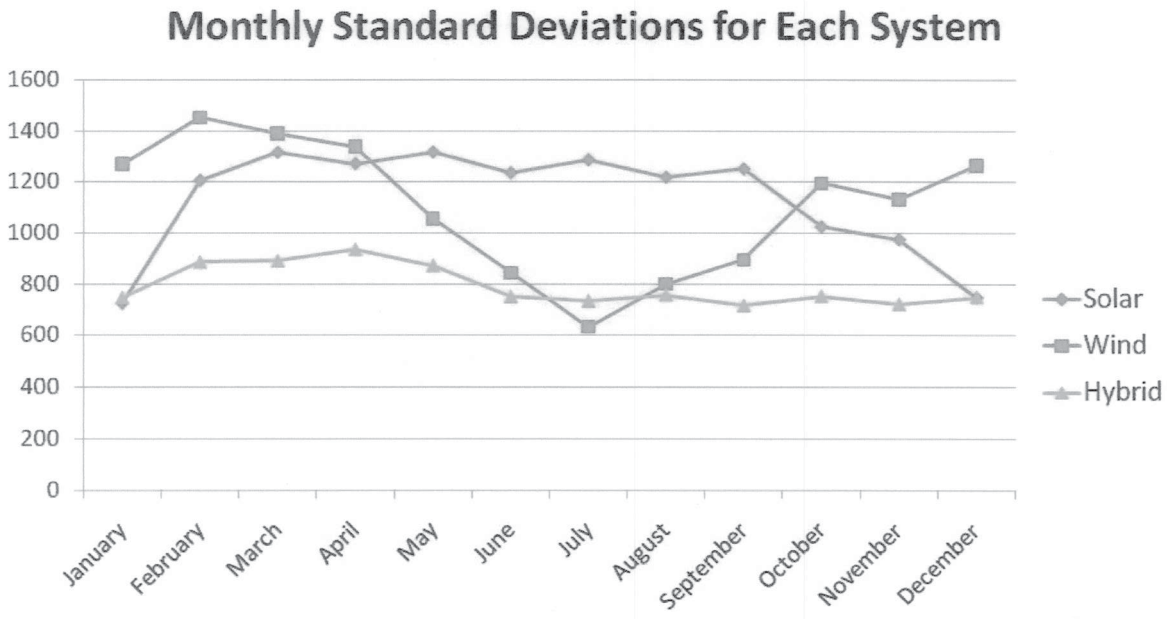

Figure Standard deviation of power production of a solar, wind and hybrid systems.

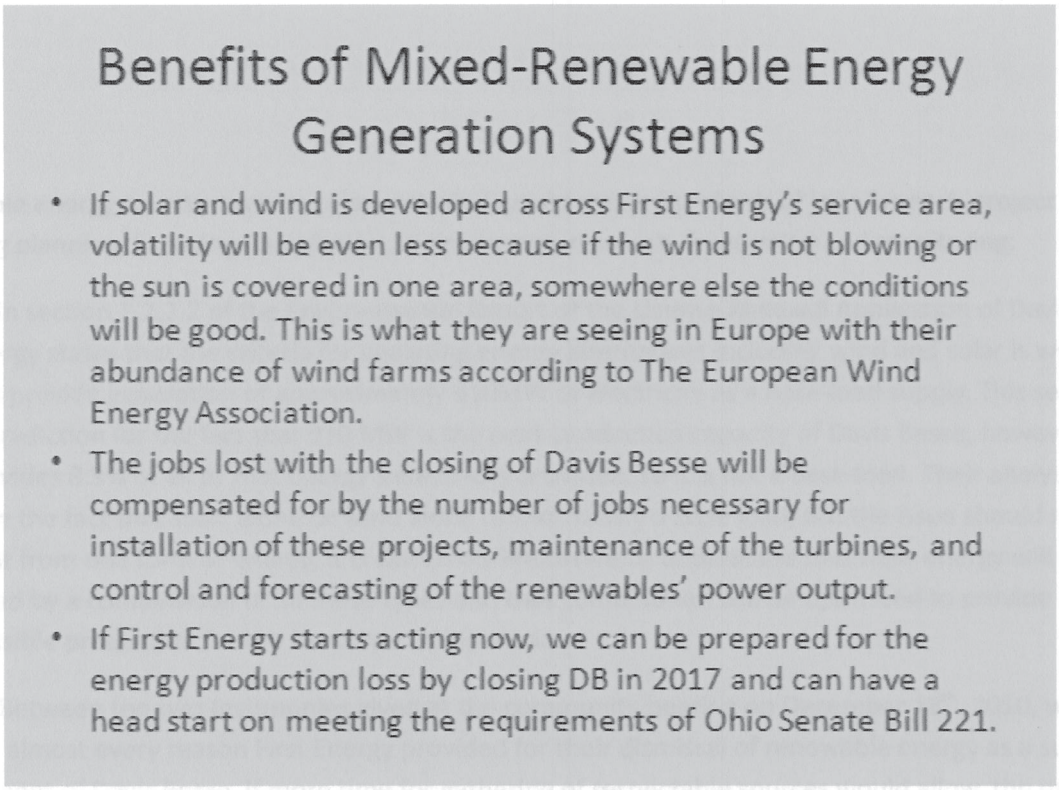

Figure Closing points

It is important to remind here that the work presented here is only based on two specific systems and not a complete representation of a solar or wind farm. If First Energy were to use its resources to install these renewable forms of energy throughout the region that they service, the volatility would be even less. The European Wind Energy Association's annual report put out in November 2010 reported that the intermittency of wind speeds in one location negligibly affects the overall base load that their wind farms produce. When wind is stale in one location, it is blowing in another so the drop in overall production is not seen as great as it is with the one single turbine I studied. The same concept can be applied to solar: when it is a severely overcast day in Toledo, it may be only partly cloudy in Cleveland (Compaan discusses how diffuse light from a cloudy day also produces power, not just direct sunlight). By expanding the area over which the power is produced, the effects of weather changes will not alter the base load as would be expected.

The EWEA report also provided a description of the forecasting which takes place to know what kind of wind speeds to expect. They are able to predict wind speeds 4 hours and up to a whole day even, in advance so they know how to plan for a sharp change. Extensive research and development would be needed in this area, however a mastering could really revolutionize the industry.

In many news articles that are being published about the re-licensing of Davis Besse, they refer back to how many jobs DB provides to the Sandusky area and the economic impact it has. Implementing