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ACHIEVING 25×25 GOALS FOR ENERGY INDEPENDENT COMMUNITIES

RESULTS FROM THE 2010 PILOT PROGRAM

February 2011

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Achieving 25×25 Goals for Energy Independent Communities

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REPORT SUMMARY

The Energy Center of Wisconsin provided analytical support for the Wisconsin Office of Energy Independence's Energy Independent (EI) Communities 2010 program. The 11 entities in the pilot, representing 23 local units of government, were asked to assess their baseline energy usage, set a goal to have renewable energy account for 25 percent of their projected 2025 energy consumption, and develop a plan to execute energy efficiency and renewable energy measures to accomplish that goal. The Energy Center provided baseline assessment and measure analysis tools so that the communities could better understand their energy usage and analyze their plans to determine how close they came to meeting their goals. This is the project's second year; results from the 2009 pilot, which served 10 entities representing 21 local units of government, can be found at www.ecw.org/ecwresults/252-1.pdf.

Taken together, the energy plans of the 11 communities accomplish 125 percent of their collective 25×25 goal and they reduce their 2025 carbon dioxide emissions by 18 percent. (See Table 4 and Table 6.)

ENERGY INDEPENDENT COMMUNITIES

The Energy Center of Wisconsin worked with the Wisconsin Office of Energy Independence (OEI) on OEI's initiative to develop plans for communities to decrease the consumption of fossil fuels and increase the consumption of renewable energy in municipal facilities. Of the many communities that competed for the 2010 funds, 11 were awarded:

- Chippewa Valley Partners (including the cities of Altoona and Eau Claire, and the county of Eau Claire)
- E3 Coalition (including the cities of Fennimore, Gays Mills, Prairie du Chien and Viroqua, the villages of Ferryville, La Farge, Soldiers Grove and Viola, and the counties of Crawford and Vernon)
- Green Lake County and Green Lake School District
- Jefferson
- Kaukauna
- Lac Du Flambeau tribe
- Monona
- Polk County
- Shawano County
- Waukesha County
- Whitewater

Table 1. Population and climate characteristics of the 11 pilot EI Communities

EI Community	Population[1]	County	Minimum Temp.(°F)[2]	Maximum Temp.(°F)[2]
Chippewa Valley Partners	97,474	Eau Claire	12.7	70.8
E3 Coalition	46,200	Crawford, Vernon	15.7	71.4
Green Lake County & School District	19,105	Green Lake	14.5	70.2
Jefferson	7,338	Jefferson	16.8	71.3
Kaukauna	12,983	Outagamie	17.0	69.5
Lac du Flambeau Tribe	1,646	Vilas	10.3	66.4
Monona	8,018	Dane	16.8	71.3
Polk County	44,232	Polk	9.5	68.1
Shawano County	40,957	Shawano	12.5	67.0
Waukesha County	378,372	Waukesha	18.9	71.2
Whitewater	13,437	Walworth	18.9	71.2

25 BY 25

Each community was asked to develop a plan to have 25 percent of their municipal energy usage come from renewable sources by 2025—also known as the 25 × 25 model, a goal each municipality had to agree to pursue as part of the proposal process. Municipal energy usage is concentrated in four segments:

- Building energy use (electricity and thermal energy)
- Outdoor lighting (electricity)
- Municipal water and wastewater (electricity and thermal energy)

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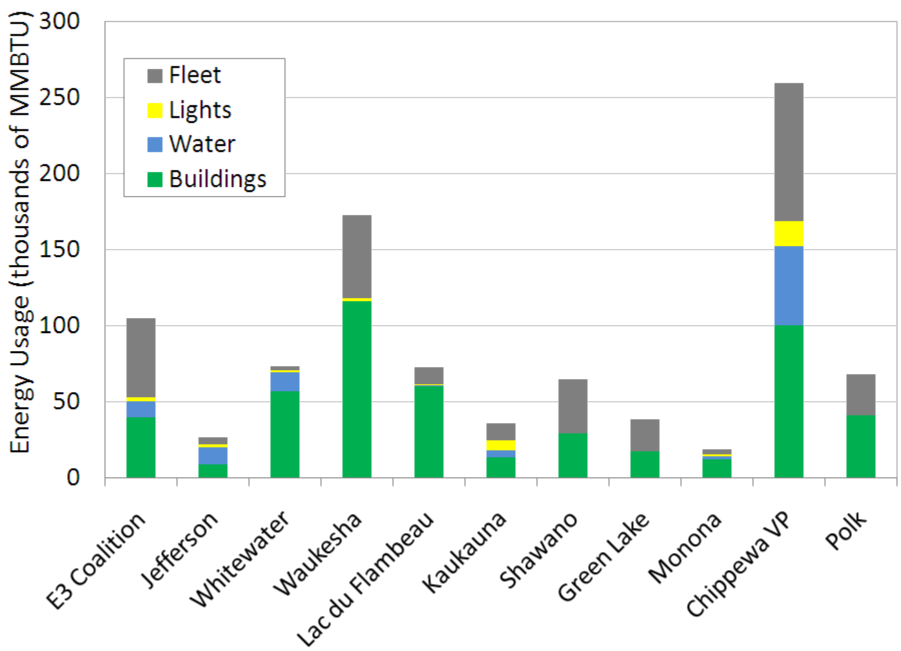
[1] Estimated 2008 population from U.S. Census Bureau (http://factfinder.census.gov). Lac du Flambeau tribe represented by Lac du Flambeau CDP (Census-Designated Place). 2008 estimate not available for Crawford County, Green Lake County, Jefferson, Kaukauna, Lac du Flambeau tribe, Monona, and Whitewater; for these entities, 2000 census data was used.

[2] County-level normal minimum and maximum temperature, monthly. (Wisconsin Blue Book 2009 – 2010, Pg. 698).

- Fleet liquid fuel consumption (unleaded and diesel)

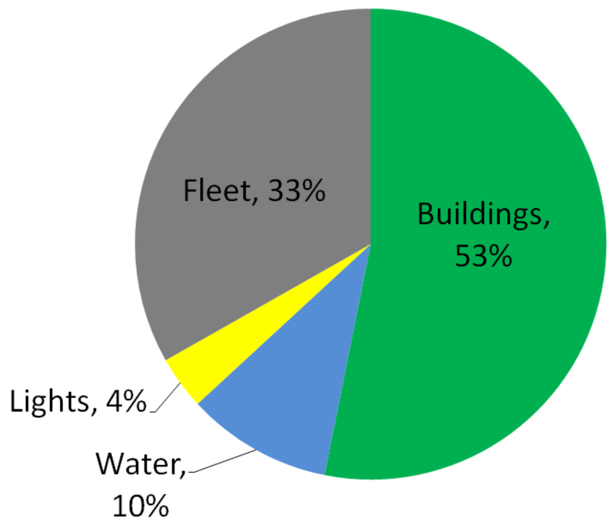
The communities' collective energy usage by segment, as well as by energy type, is shown in Figures 1 and 2. The communities have substantially different compositions—six are (or include) cities, towns or villages, five are (or include) counties, one includes a school district (whose energy consumption can equal or exceed that of municipal government), one is a tribe, and many do not have outdoor lighting or wastewater uses. Figure 1 illustrates the energy consumption of this diverse mix of 23 local units of government.

Figure 1. Total baseline energy consumption for each EI Community



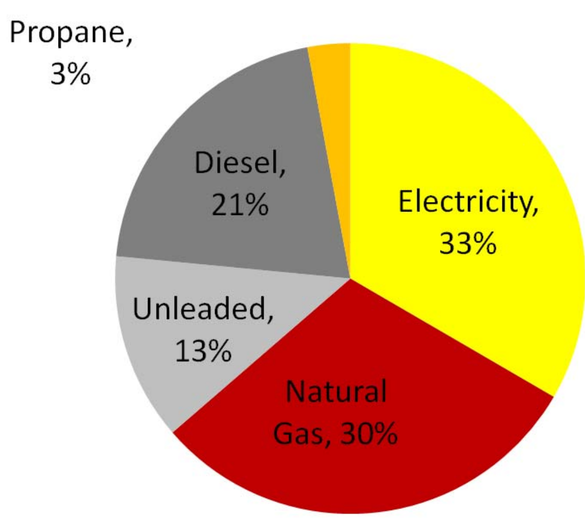
Note that the communities differ in usage considerably, with the Chippewa Valley Partners having the most baseline energy use at 259,000 MMBTUs and the City of Monona having the least at 18,000 MMBTUs. In aggregate, the communities had total baseline energy consumption of 934,000 MMBTUs. According to the Department of Energy's Buildings Energy Data Book and the U.S. Census, this is equivalent to approximately 4800 U.S. homes' annual energy usage.

Figure 2. Total baseline energy consumption in EI Communities by segment



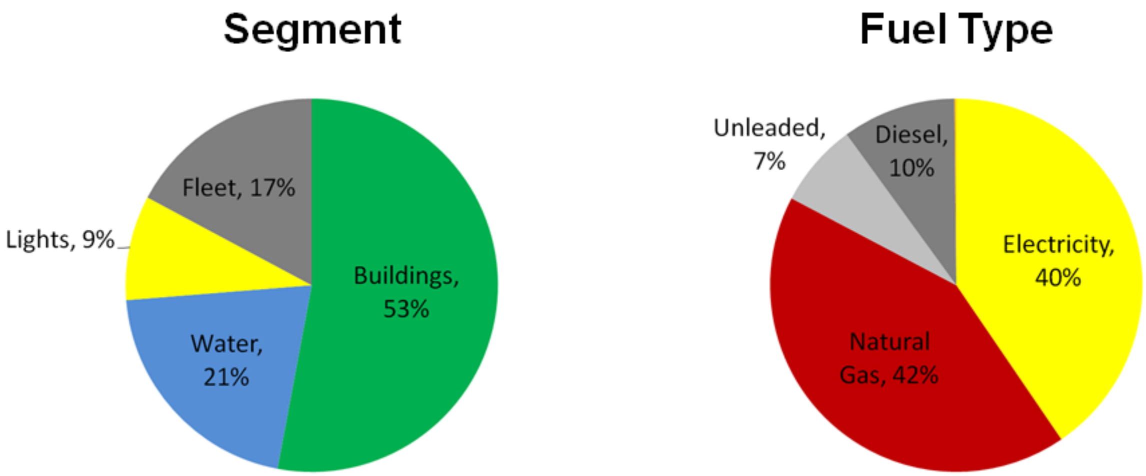
Buildings comprise the majority of the communities' energy usage with fleet comprising about a third. Each individual community's segment usage is different from the aggregate and is illustrated in Figure 1. Figure 3 illustrates the percentage of energy that went to each fuel type for all of the EI Communities.

Figure 3. Total baseline energy consumption in EI communities by fuel type



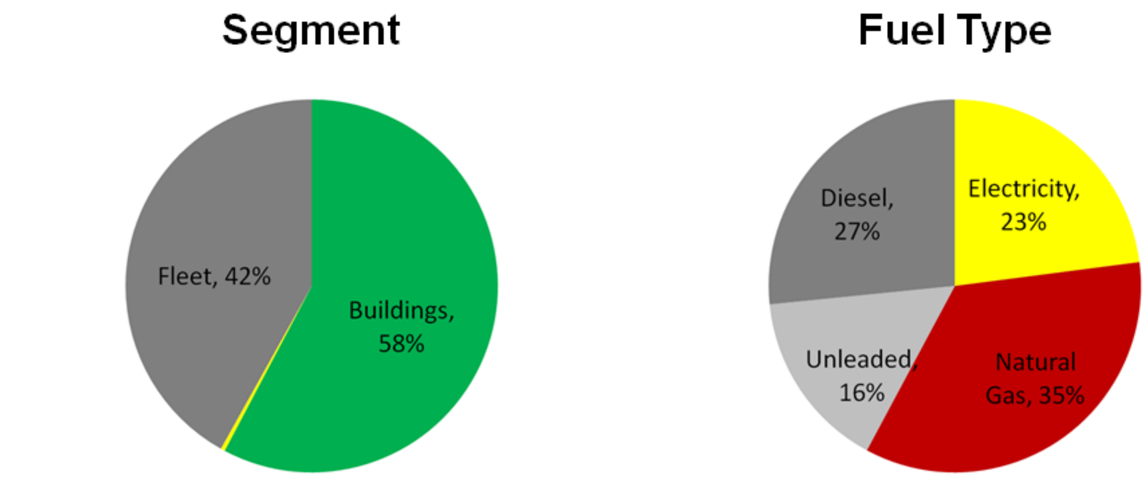
Electricity, natural gas, and transportation fuels all comprise approximately one-third of the communities' energy consumption. Propane makes up the remaining 3%.

Figure 4. Total baseline energy consumption in the four EI cities by segment and fuel type



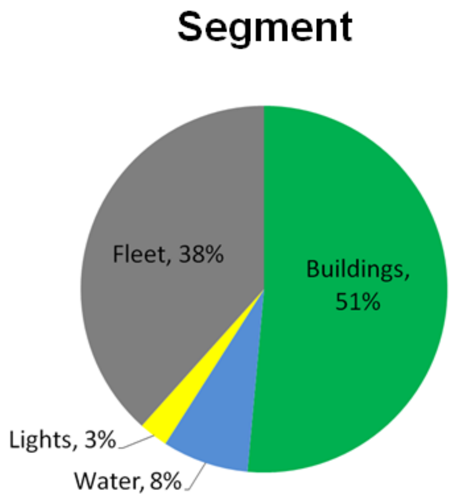
When compared to the overall usage shown in Figure 3, the cities use comparatively more energy for their exterior lighting and water processing/pumping.

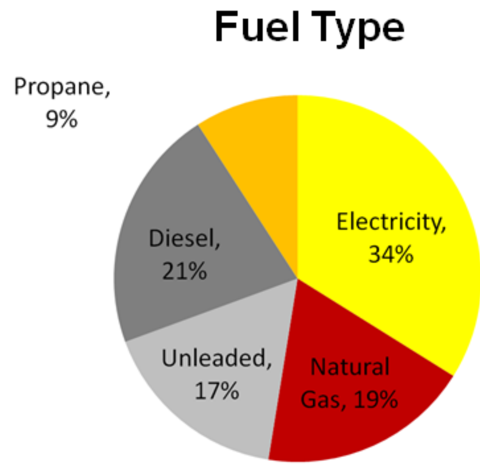
Figure 5. Total baseline energy consumption in the three EI counties by segment and fuel type



The counties have little to no exterior lighting or water usage. A large portion of their usage is attributable to their fleet. This results in a large portion of their fuel type usage going to transportation fuels.

Figure 6. Total baseline energy consumption in the four EI partners and tribes by segment and fuel type





The partners and tribes are a mix of the counties and cities with the exception of the Lac du Flambeau Band of Chippewas Tribe that uses propane for a large portion of their heating needs.

PLAN DEVELOPMENT AND EVALUATION

When evaluating buildings, communities or other systems, the Energy Center pursues a three-step approach:

1. Determine an energy consumption baseline
2. Set goals
3. Develop measures to meet those goals

The 2010 communities were instructed to record their energy use data for buildings and water treatment facilities into the US EPA's online tool, Energy Star Portfolio Manager (ESPM). ESPM collects and analyzes billing data, and it is an excellent tool for benchmarking building performance against other similar buildings. It is our hope that the communities continue to use ESPM, if only to encourage the practice of paying attention to energy bills.

To assist the communities in this effort, the Energy Center created a spreadsheet tool. The inputs to this spreadsheet tool are exported from ESPM's report generator, as well as a separate spreadsheet provided by the Energy Center to communities for recording lighting and fleet billing data. With these inputs, we created energy use baselines for each community. Each community then received a set of tables and charts that showed how each segment and each fuel type contributed to their energy use baseline. The measure analysis component of the tool allowed communities to enter information about energy efficiency and renewable measures. As measures were entered, they populated an interactive spreadsheet that showed the results of a life-cycle cost analysis of each measure and the impact that implementation would have on their projected baseline.

DETERMINING THE BASELINE AND 2025 ENERGY USAGE PROJECTION

We asked the communities to provide energy consumption data for as many years as possible. The period of submitted data ranged from 18 months to nine years, with most communities submitting between three and five years worth of data. Where sufficient data was provided, the Energy Center created a baseline for the communities that averaged their energy use over the most recent three years. If sufficient data was not provided, we treated 2009 as the baseline year.

In order to estimate 2025 energy usage, it was necessary to determine the rate at which energy consumption would change from the baseline. While we left the final decision of determining the annual rate at which their energy consumption would increase to the municipalities, we gave them three values to contemplate:

- The population growth rate projected for their municipality or county by the Wisconsin Department of Administration.[3]
- A discounted revision of that population growth rate which reduces the rate by the proportion of total municipal energy usage attributable to buildings.[4]

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[3] 2008. "Wisconsin Population 2035." Wisconsin DOA Division of Intergovernmental Relations. Oct. 2008. Retrieved in 2010 from http://www.doa.state.wi.us/docview.asp?locid=9&docid=2108.

- The annual growth rate representing the observed increase in energy consumption for as many years of data as were provided.

Table 2. EI Communities' selected annual municipal energy usage growth rates and energy use projections

EI community	Annual *municipal energy* growth rate	2009 baseline (MMBtu)	2025 projection (MMBtu)
Chippewa Valley Partners	0.80%	259,223	294,471
E3 Coalition	2.00%	104,402	143,321
Green Lake County & School District	0.15%	38,213	39,141
Jefferson	0.20%	26,729	27,597
Kaukauna	0.39%	35,875	38,174
Lac du Flambeau Tribe	0.00%	72,394	72,394
Monona	-2.00%	18,727	13,554
Polk County	-1.00%	67,697	57,641
Shawano County	0.04%	64,697	65,206
Waukesha County	4.00%	172,320	322,753
Whitewater	1.50%	72,957	92,581
Average (weighted by 2009 baseline)	1.40%		
Estimated annual Wisconsin *population* growth rate, 2010-2025[3]	0.68%		

[4] This approach was developed in consultation with other experts in municipal energy usage, on the premise that some energy uses such as wastewater and fleet grow in direct relationship to population, while municipal building energy usage will tend to grow at a less direct rate.

SETTING THE GOALS

The stated goal of the 25×25 program is that 25 percent of all municipal energy in 2025 should come from renewable sources. Applying a uniform growth rate to all energy uses allows us to determine the amount by which each energy source is projected to increase, but for the purposes of 25×25 goal-setting, we converted all energy into Btu equivalents, using the factors in Table 3. The 25×25 goal applies to this aggregate energy usage, as opposed to having to separately achieve 25 percent renewable energy in each of the segments.

Table 3. Btu conversion factors (MMBtu = 1,000,000 Btu)

To convert from …	*Multiply by …*
Kilowatt-hours (kWh) [5]	3,413
Therms natural gas[5]	100,000
Gallon propane[6]	91,600
Gallon unleaded fuel[7]	124,000
Gallon diesel fuel[7]	139,000

[5] Value retrieved from http://bioenergy.ornl.gov/papers/misc/energy_conv.html
[6] Value retrieved from http://www.human.cornell.edu/che/DEA/outreach/upload/CompareHeatFuels.pdf.
[7] Value retrieved from http://tonto.eia.doe.gov/energyexplained/index.cfm?page=about_energy_units

Looking only at the communities' accomplishments by the 25×25 metric will understate their accomplishments in terms of reduced reliance on fossil fuels, or reduced carbon emissions. To explain why, consider the following example:

> A community with projected 2025 energy usage of 10,000 MMBtu plans to institute an energy efficiency measure that saves 500 MMBtu and a renewable measure that generates 500 MMBtu.
>
> To accomplish their 25×25 goal, this community first discounts their 2025 energy use projection with the energy efficiency measure:
>
> (10,000 – 500) = 9,500 MMBtu
>
> and so their goal, which is 25 percent of this revised projection, is
>
> 9,500 × 25% = 2,375 MMBtu.
>
> The 500 MMBtu renewable measure therefore accounts for
>
> 500 ÷ 2,375 = 21% of a 25×25 goal

Let us now consider the same example, and suppose a different goal of 25 percent fossil fuel reduction.

> To accomplish their goal of 25 percent fossil fuel reduction, the community has their goal set at
>
> 10,000 × 25% = 2,500 MMBtu
>
> The 500 MMBtu energy efficiency measure and the 500 MMBtu renewables measure contribute equally to the reduction of fossil fuel consumption—the former through avoided consumption, and latter through renewable generation. These two measures therefore account for
>
> (500 + 500) ÷ 2,500 = 40% of a 25% fossil fuel reduction goal

Energy efficiency savings tend to be more cost effective than renewable measures and/or require significantly less up-front cost, while delivering valuable and immediate benefits in terms of reduced fossil fuel consumption and carbon dioxide emissions, as well as reduced costs to municipal government. **While energy efficiency reduces the overall goal, only renewable energy can meet the goal that remains.** This constraint is important if Wisconsin wants to encourage renewable generation.

EVALUATING MEASURES

The Energy Center performed a life-cycle cost analysis on each community's measures, using the savings-to-investment ratio (SIR) of the measure as a more discriminating indicator than simple payback. Where simple payback simply relates the installed cost of the measure to the annual cost of energy saved, the SIR uses present-value dollars and can account for periodic non-energy expenses such as maintenance.

The general formula for the SIR is:

$$SIR_{A:BC} = \frac{\sum_{t=0}^{N} S_t \big/ (1+d)^t}{\sum_{t=0}^{N} \Delta I_t \big/ (1+d)^t}$$

$SIR_{A:BC}$	=	ratio of present-value savings to additional present-value investment costs of the mutually exclusive alternative (A) relative to the base case (BC)
S_t	=	savings in year t in operational costs attributable to the alternative
ΔI_t	=	additional investment-related costs in year t attributable to the alternative
t	=	year of occurrence
d	=	discount rate
N	=	length of study period in years[8]

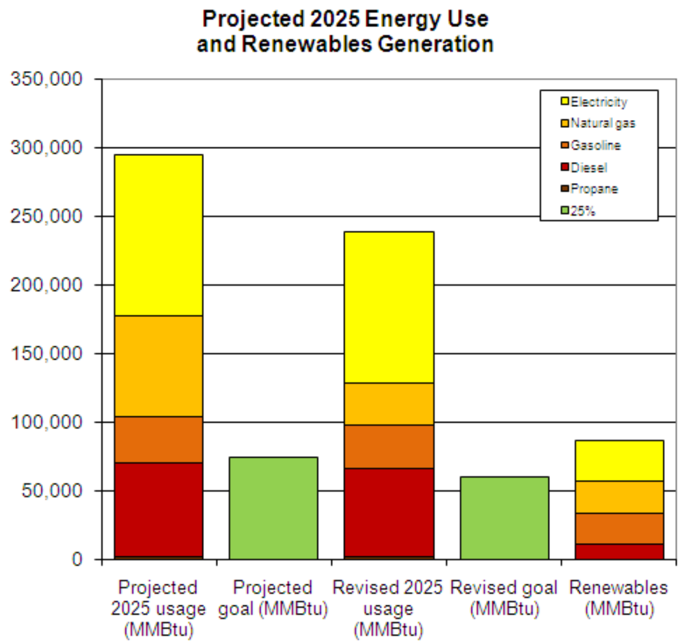
The measure analysis tool uses US Department of Commerce energy price indices and discount factors to separately account for inflation and fuel price escalation.[9]

[8] Fuller, Sieglinde K. and Stephen R. Petersen. 1996. "Life-Cycle Costing Manual for the Federal Energy Management Program." US Department of Commerce Technology Administration, National Institute of Standards and Technology. Office of Applied Economics, Gaithersburg, MD. February 1996. Retrieved online at http://www.bfrl.nist.gov/oae/publications/handbooks/135.pdf

[9] NISTIR 85-3273-24 (Rev. 5/10) "Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis – 2010," USDOC. Retrieved online at http://www1.eere.energy.gov/femp/pdfs/ashb10.pdf

An example of part of the measure analysis tool’s output is given in Figure 7. The first column shows the 2025 projection absent any changes; the second column (green) shows the commensurate 25 percent goal; the third column shows the impacts of energy efficiency to reduce the projected baseline; the fourth column (green) shows the corresponding new 25 percent goal; and the fifth column shows how different kinds of renewable measures have been built up to meet and exceed that goal.

Figure 7. Chippewa Valley Partners measure portfolio (146 percent of 25×25 goal reached)[10]



The measure analysis tool allows communities to enter any number of projects and individually “activate” or “deactivate” them in order to see how different portfolios might achieve their goals, and what impact these choices have on total installed cost, total present value dollars and other metrics. This permits them to evaluate multiple paths to 25×25. The tool is designed for iterative use, allowing communities to select a portfolio of measures that achieves their goal.

[10] The final plan represents many efficiency and renewable measures that will be refined as the project moves into the implementation phase.

As mentioned previously, efficiency measures played an important role in reducing the communities' overall renewable goals. Figure 8 illustrates the percentage by which each community's 2025 baseline was reduced by efficiency measures.

Figure 8. 2025 baseline reduction by efficiency measures.

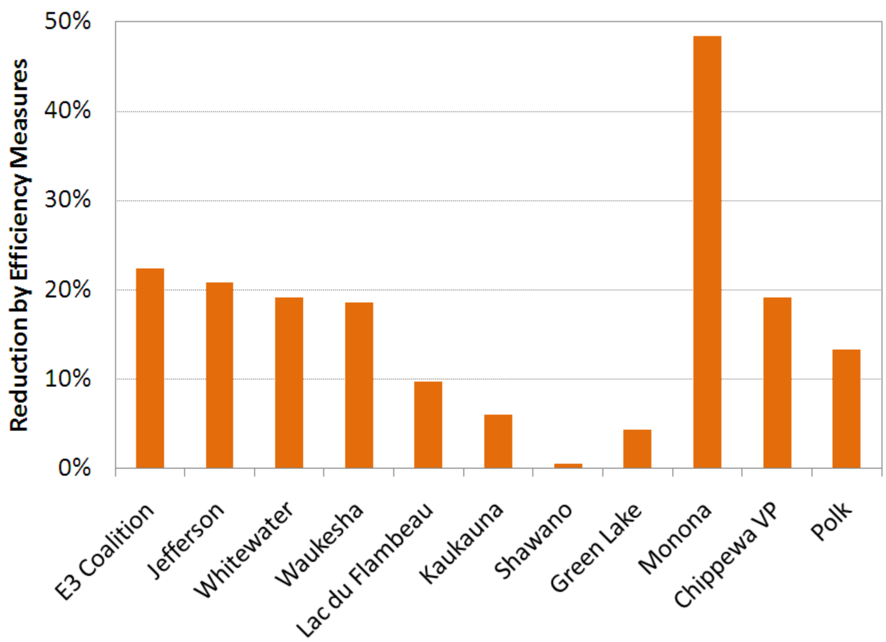
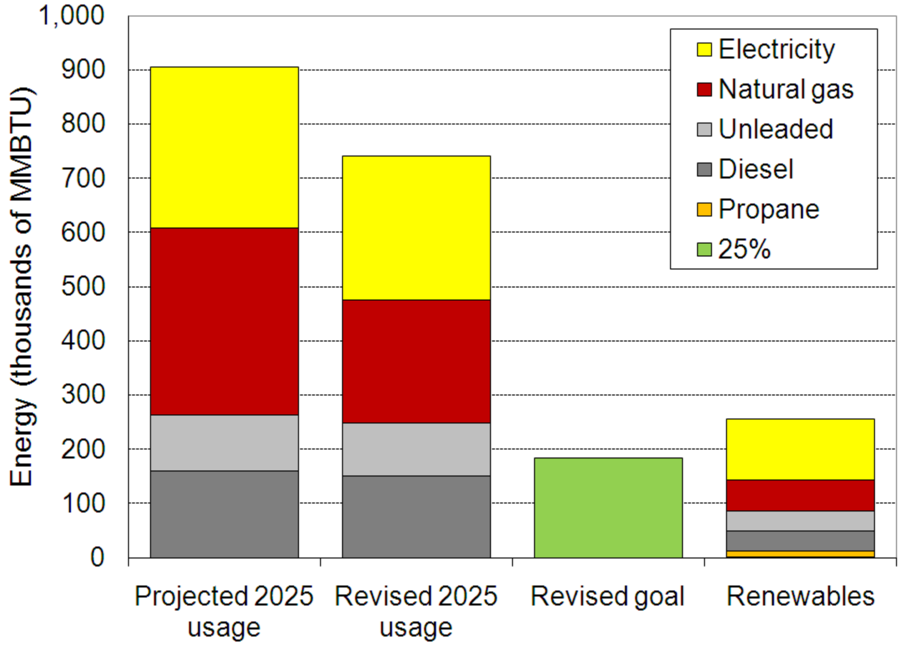


Table 4. 25×25 results for each community

EI community	Projected 2025 energy usage [MMBtu]	Projected 2025 energy usage after efficiency [MMBtu]	Total renewables [MMBtu]	Percent of 25×25 goal achieved
Chippewa Valley Partners	294,471	238,142	86,625	**146%**
E3 Coalition	143,321	111,325	38,856	**140%**
Green Lake County & School District	39,141	37,442	9,438	100%
Jefferson	27,597	21,862	5,463	100%
Kaukauna	38,174	35,877	12,261	**137%**
Lac du Flambeau Tribe	72,394	65,374	16,299	100%
Monona	13,554	6,986	1,747	100%
Polk County	57,161	49,550	13,615	**110%**
Shawano County	65,206	64,862	16,207	100%
Waukesha County	172,320	140,362	34,968	100%
Whitewater	92,581	74,846	28,231	**151%**
Total	1,015,921	846,538	263,709	**125%**

Figure 9. Combined baseline, goal and renewable measures.



Taken as a whole, the 2010 class of communities exceeded their goal by 25%.

Renewable projects included solar photovoltaic, solar hot water, geothermal systems, biomass combustion, wind turbines, and anaerobic digesters. However many of these systems only make sense when paired with compatible existing energy end-uses—for instance, solar hot water requires an existing hot water demand. Economies of scale very quickly begin to matter, and smaller communities may not be able to justify the same projects as larger communities (e.g., anaerobic digesters need a certain flow rate of effluent to become cost-effective).

For these communities, purchased renewable electricity becomes an important way to reach their 25×25 goals. Out of the 11 communities, five elected to utilize purchased renewable electricity. On average, this resource comprised 56% of their renewable portfolio. For a community committed to 25×25 or similar goals, the ability to purchase renewable energy allows them to participate in more favorable economies of scale.

Carbon dioxide reduction

Carbon dioxide emission reduction is another way to frame fossil fuel reduction. For our purposes, carbon dioxide reduction is a matter of avoided fossil fuel consumption, and so energy efficiency measures are again on par with renewable measures.

Table 5. Carbon dioxide (lb CO_2) conversion factors

To convert from …	*Multiply by …*
Kilowatt-hours (kWh) [11]	1.692
Therms natural gas[11]	11.708
Gallon propane[12]	12.67
Gallon unleaded fuel[12]	19.54
Gallon diesel fuel[12]	22.37

Table 6 shows the aggregate EI Communities' CO_2 reduction from their combined plans.

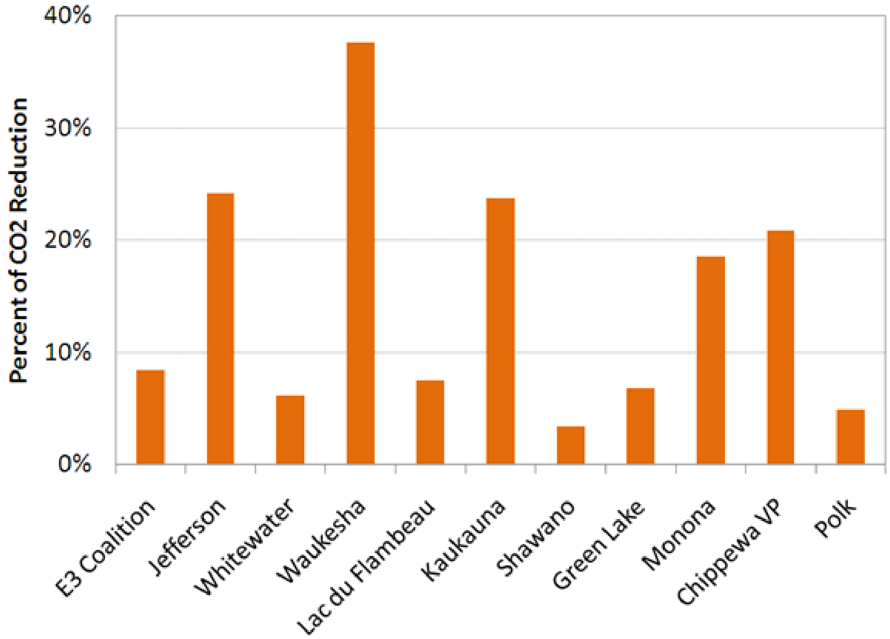
Table 6. Carbon dioxide reduction

	lbs CO_2
Projected 2025 CO_2 emissions	241,111,859
CO_2 reduction from measures	43,537,369
Percent reduction	18%

The 43.5 million lbs (21,769 metric tons) of CO_2 avoided by this portfolio is equivalent to the annual emissions from 3,776 passenger vehicles, the energy use of 1,681 homes, or 2.2 million gallons of gasoline.[13]

[11] PA Consulting. 2008. Focus on Energy Evaluation Semiannual Report (Second Half of 2007) Final: March 17, 2008
[12] Energy Information Administration. "Fuel Emission Factors." Retrieved online in 2009 at www.eia.doe.gov/oiaf/1605/excel/Fuel%20Emission%20Factors.xls

Figure 10. Percent reduction of CO_2 by community.



[13] US EPA Greenhouse Gas Equivalencies Calculator. Retrieved online at http://www.epa.gov/RDEE/energy-resources/calculator.html

CONCLUSIONS

There were several lessons learned from the 2010 EI Communities project. **We recommend that communities continue to use tools such as US EPA's ESPM, a freely available, nationally used tool for recording monthly building energy data.** One caveat is that ESPM has some limitations, and does not capture categories such as outdoor lighting or fleet vehicles. For the major energy end use of buildings, it provides a place for perpetual data tracking, and comparative results about each building so that building operators can understand its relative performance. Additional technical problems with ESPM hampered its usefulness and, in some cases, community satisfaction. These issues mostly centered around additional or new meters on different buildings. These meters disrupted the summary reports used to export information from ESPM. Close communication with EPA is helpful in streamlining the process for a community, and anyone nationwide who looks to ESPM as part of their energy management framework.

The Energy Independent Communities program succeeded in getting its participant communities to take a new approach to managing their energy consumption. **Almost every community expressed that closely tracking their energy consumption was a novel idea, and Energy Independent Community team members seemed unanimous in their appreciation of a baseline analysis that showed just how their community used energy.** Furthermore, the process engaged them in developing thoughtful approaches to achieving their 25×25 goal, and it does not appear that any community was able to proceed in a strictly "business as usual" fashion, instead developing original, out-of-the-box solutions as to how they could more fully participate in an energy-independent future.

The 25×25 model demands renewable energy generation at a scale that can pose a challenge to smaller communities, illustrated by those that participated in the pilot program. Having communities pay utilities for renewable electricity should prove to be an effective market driver for encouraging increased renewable development in Wisconsin and in the region, but at the cost of disassociating the communities' payments with ownership of the related assets. A third path might be for neighboring communities to work together to see if they can jointly achieve favorable economies of scale. **This is an opportunity for local governments to increase collaboration, ensure that these investments are made locally, and maximize generation while minimizing up-front costs.**

The Office of Energy Independence, the Energy Center of Wisconsin, and the Local Government Institute enjoyed working with each community on developing their 25×25 plan. It is our hope that this report will prove useful to other governments pursuing similar goals.

Appendix: Energy Independence Tool Updates from 2009 to 2010

To assist the communities in this effort, the Energy Center created a spreadsheet tool. The tool was developed for the 2009 pilot program and improved for the 2010 program in the following ways:

- Data structure of building, water and lighting tabs designed to receive a modified version of Portfolio Manager exports.
- Update of baseline analysis upon billing data input has been expanded and streamlined.
- Update of result analysis upon measure input is automatic.
- Measure input has been significantly simplified without sacrificing analytical completeness.
- Internal standardization allows for easier updating to different project parameters (for instance, instead of a plan beginning in 2011 to achieve 25 percent renewable generation by 2025 for the City of Jefferson, a plan beginning in 2015 to achieve 30 percent renewable generation by 2035 in the City of Whitewater).
- Individuated growth rates by fuel and segment for easier comprehension and quality control.
- Development of an alternate fuels module to allow communities to determine vehicle fuel replacement in a consistent fashion.
- Aesthetic improvement of "presentation" slides to enhance community presentation of plan results.
- Condensed from two spreadsheets into one.
- Updated to reflect 2010 energy prices and discount rates.
- Updated to Microsoft Excel 2007.
- Documented the equations and analysis used in the spreadsheet.