Michigan Wind Energy Consumption: Electric Vehicles and Recycled Battery Storage for Grid Peaking

Working Assumptions for Charging Recycled EV Battery Banks

- 100% Capacity: 15 kWh
- Reject Capacity (75%): 11.25 kWh
- PC* Capacity (50%): 7.5 kWh
- 2011 Production**: Based upon Mfr Projections
- Production Increase: 10%
- Usable Life, Reject***: 10 yrs
- Usable Life, PC: 5 yrs
- Capacity Loss: 10% annually

Assumption Notes:
* PC= Post-consumer
** National Production
*** Rejects available immediately

Figures 1 & 2 below depict the amount of wind capacity, and total annual wind energy, required to meet the demand of charging Michigan’s EVs and recycled EV batteries based upon the assumptions stated above.

Working Assumptions for Charging Michigan’s EVs

- Michigan EV’s on Road: ~3% of National EV’s
- Wind Capacity Req’d per Ave. 1,000 EV’s*: ~1 MW

Wind Capacity to Offset EV Energy Consumption:

5 kWh battery:
5,500(miles/yr) / 4(mi/kWh) / (8670hr/yr*25%CF)= 628 kW/EV or 1.6 EV/kW= 1600 EV/MW

15 kWh battery:
16,500(miles/yr) / 4(mi/kWh) / (8670hr/yr*25%CF)= 1.88 kW/EV or .53 EV/kW= 530 EV/MW

MI RPS: 10% by 2015
1. Minimum 1,100 MW Wind Capacity Installed per RPS.
This is ~5x the capacity req’d to charge the battery bank and Mi EV’s.

2. Estimated up to 2,800 MW Wind Capacity Installed (See Table 1)
20% by 2030

3. >10,000 MW (Not shown on linear graph)
In order to understand the capacity of wind turbines needed to charge Michigan’s electric vehicles (EV’s), and recycled EV batteries for energy storage, a few assumptions must be made.

- 35,000 EV’s are assumed to be produced nationally in 2011, and according to a recent DOE report on manufacturer projections, will increase as shown in Figure 3.
- These EV’s batteries are to be accumulated in a battery bank as they become insufficient for consumer use, after about 5 years of being used. They have an estimated remaining useful life of 5 years.

Figure 5, above, shows the potential number of batteries accumulated from the assumed production rates. At a 10% manufacturer reject rate for EV batteries, the first 35,000 produced should yield 3,500 reject batteries. These batteries have 10 years of usable life (See Figure 5, Note 1). After 5 years (2016), the 35,000 EV’s produced in 2011 will submit 35,000 batteries into the battery bank and remain in use for 5 years (See Figure 5, Note 2). This pattern continues as EV production rate increases, providing more reject and post-consumer batteries. After 15 years (2025), given production rates and battery useful life, a potential of 2,800,000 batteries could be obtained (See Figure 5, Notes 3a and 3b).

At a capacity of 7.5 kWh, 2,800,000 batteries could supply 21GWh, ~21 GW of power if discharged in 1 hour. The Ludington Pumped Storage facility produces ~2 GW of power. For both Toyota Prius and Chevy Volt batteries, the energy density is approximately 1.7 kWh/ft³. With 20 ft ceilings, a facility would need to have a 618,000 ft² footprint for batteries alone.
Wind energy captured will be directed into the facility and stored until needed or otherwise disbursed. The Department of Energy (DOE) estimates that approximately 16 GW of wind power could be captured on land in Michigan.\(^4\) By 2015, the Renewable Portfolio Standard (RPS) aims to have 10% of Michigan's energy supplied through renewable resources; estimated at approximately ~9,600 GWh.

### Table 1. Estimated Additional Wind Capacity Installed\(^5\)

<table>
<thead>
<tr>
<th>Renewable Portfolio Standard (RPS) - Michigan</th>
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<tbody>
<tr>
<td>(Current Data From MPSC DeLEG Report, Feb. 2011)</td>
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<tr>
<td><strong>Current Production:</strong></td>
<td></td>
</tr>
<tr>
<td>96,611 GWh</td>
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<tr>
<td><strong>RPS 2011:</strong></td>
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<tr>
<td>3.63%</td>
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<tr>
<td><strong>Current Renewables</strong></td>
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<td>3,507 GWh</td>
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<td><strong>RPS 2015:</strong></td>
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<td>10%</td>
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<tr>
<td><strong>Required Renewable Production:</strong></td>
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<tr>
<td>9,661 GWh</td>
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<tr>
<td><strong>Additional Production Required</strong></td>
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<tr>
<td>6,154 GWh</td>
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<tr>
<td><strong>Installed Wind Capacity</strong></td>
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<td>2.81 GW</td>
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</tbody>
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### Figures 6 & 7: Comparison of Alternative Models\(^6\)

Sources:

1. 2011 Public Service Commission of DeLEG, Julie Baldwin
2. 20% Wind Energy by 2030, DOE
3. One Million EV’s by 2015 February Status Report, DOE
4. Wind Powering America FY08 Activities Summary, DOE
6. Deployment Rollout Estimate of Electric Vehicles, Center of Automotive Research