

August 29, 2017 -- **DRAFT**

TO: DER and Advisory Committee  
FROM: CEE Project Team  
RE: **Initial Energy Efficiency Measure List for DSM Potential Study**

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## **Overview**

This memo describes the attached list of initial energy efficiency measures developed by the CEE Team for the Minnesota Statewide Energy Efficiency and Carbon Saving Potential Study. As further described in the Methodology Memo,<sup>1</sup> energy efficiency measures provide the basis for the calculation of potential. This initial list of measures is divided into the following categories:

- Conventional measures;
- Emerging technologies;
- Behavioral measures; and
- Load management/demand response measures.

In addition, the potential model will also include custom measures, as further described below. This list is being provided for comment by stakeholders, and will be further refined based on feedback received. Once the list is finalized (expected in September), the measures in the final list will be fully characterized (i.e., define the applicable building segments, savings value, etc.), as described in the Methodology Memo.

## **Conventional Measures**

The list of conventional measures is composed of all the measures in the Minnesota TRM, selected measures from the TRMs of other states that are applicable to Minnesota, and measures applicable to custom CIP projects.

The general approach to characterizing the costs and benefits of conventional efficiency measures for the study is to use the Minnesota TRM V2.1 (“MN TRM”)<sup>2</sup> to the extent possible to develop discrete measure characterizations. However, the MN TRM is not exhaustive, and there are extant, well understood opportunities that are not covered by that resource. To address this, the measure list has been supplemented with key opportunities included in other states’ TRMs.

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<sup>1</sup> See the “Methodology and Model Inputs (DRAFT) memo, 6/5/2017, available at:

<https://www.mncee.org/mndemandstudy/committee-work/>

<sup>2</sup> For the most recent published version of the TRM, see:

<https://mn.gov/commerce/industries/energy/utilities/cip/technical-reference-manual/>

## **Emerging Technology Measures**

This study will estimate energy efficiency potential in Minnesota through the year 2029. To that end, it must consider technologies (potential energy efficiency measures) that either have not been implemented or do not yet exist (i.e., that go beyond conventional measures). Thus the project team identified hundreds of both near-term and mid-term emerging technologies for inclusion in the potential study, from multiple sources, including E Source's database of existing technology, recent cold-weather technology research, recent potential studies, and relevant conference proceedings. The list was narrowed based on relevance to Minnesota, expected cost-effectiveness, savings potential, savings certainty, and the level of expected applicability.

### ***Near-term (3 years - 2017 – 2020)***

This group of emerging technologies are near-term measures that are currently or soon-to-be available, but not yet implemented in Minnesota. It includes measures that are market-ready or expected to be market-ready at the potential study baseline year of 2020 (e.g. aerosol residential envelope sealing). Generally, this includes emerging technologies for which published savings estimates or credible technology demonstrations are available. It includes measures that are similar to existing measures (i.e. a new sector or end use). These are measures for which there is little technological risk, basic R&D is complete, and commercialization is underway. The approach with this group of technologies most closely resembles that taken for existing measures. The only major uncertainty is associated with the rate of adoption of the measures. Most of the energy savings from emerging technologies are expected from this group.

### ***Mid-term (3- 13 years - 2020 – 2029)***

The second group, referred to as mid-term emerging technologies, includes measures for which significant applied R&D and product development are still needed. These technologies have already been associated with specific products, services, and end uses. However, the measures are not expected to be available by the potential study baseline date of 2020 (e.g. natural gas absorption heat pump furnaces), but they are expected to become available over the analysis period (3 – 13 years). These measures may currently exist in the prototype stage: demonstrations of savings potential exist, but robust savings estimates or pilot demonstrations are likely incomplete. There remains significant technological uncertainty as to whether these technologies will develop into energy savings measures. Cost and performance are not yet well established for these measures so cost-effectiveness remains uncertain. There is added uncertainty due to delays in technological development or commercialization, or savings that do not match original claims. Savings from these technologies will be independently characterized, but will require more assumptions than near-term technologies. The savings from these measures is anticipated to be small, but growing each year over the study period.

While we have tried our best to predict the future, we are honest enough to acknowledge that our list, looked on in the year 2029, will be seen as lacking very important technology that is not, in 2017, on our radar. Therefore, we will also accommodate the effect of currently unknown technologies in our treatment of custom measures, as described below.

## **Behavioral Measures**

The behavioral measures were selected from a comprehensive literature review of existing program evaluations, conference proceedings, and recent research such as CARD-supported studies. We defined residential behavioral measures as *any low/no-cost elective action or default that manages the use of equipment or space in a home.*

For commercial measures, we relied primarily on the recently completed CARD-support research conducted by Illume and Seventhwave to elect measures. Commercial measures were defined as *any elective action, policy or default that manages the use of equipment (or space) in a business.* This includes, but is not limited to:

- Employee behaviors;
- Building operator behaviors and maintenance practices; and/or
- Management or control of equipment or space that is facilitated by technology, such as occupancy sensors or Energy Management System / Building Automation System timers (which could also include a measure-based solution to managing equipment).

When the behavioral measures are characterized (see the Methodology Memo for more information), any potential for overlap between behavioral measures and technology-based measures (e.g., Energy Management System measures) will be accounted for.

## **Demand Response Measures**

Demand response measures that result in decreased energy consumption, or at a minimum don't increase energy consumption, are being considered for inclusion in the potential study model. We are focusing on discreet technologies or measures as opposed to pricing mechanisms. These criteria limit the selected demand response measures to those traditionally included within the scope of CIP and help avoid expanding into territory typically covered by a demand response potential study.

## **Custom Measures**

Although not listed specifically in the measure list, another category of measure that will be included in the potential study will be custom measures. Even with a comprehensive measure list, not every discrete efficiency opportunity can be predicted or characterized at such a granular level. Therefore, in addition to TRM-based measures, we plan to use of a set of "custom" measures intended to capture opportunities that exhibit highly site-specific operating parameters or are otherwise not broadly applicable.

Historical efficiency program results for custom measures will be reviewed to inform savings estimates and costs in terms of dollars per unit of energy saved. This review will prioritize results from MN programs, but will also incorporate data from other national energy efficiency leaders. In addition, studies published by efficiency "think tanks" such as the New Buildings Institute, Rocky Mountain Institute, and the national laboratories regarding what is possible for deep energy retrofits will be

reviewed to further refine the savings estimates. To the extent practicable, this review will focus on recent, high quality, and regionally applicable studies.

A critical aspect of this work will be to ensure that there is no “double-counting” of savings between discrete, conventional measures and the broader custom measures. Historical efficiency program results will be leveraged to assess this potential overlap.

We will also develop an “emerging technology” category of custom measures to account for measures that would otherwise be omitted. This category will grow as a new wedge of savings over the study period.

# Energy Efficiency Measures for Minnesota DSM Potential Study

## Draft - August 29th, 2017

Conventional Measures	Sector
1. High Efficiency Fans	Agriculture
2. Dairy Farm Long Daylighting	Agriculture
3. Poultry Farm LED Lighting	Agriculture
4. Engine Block Heater Timer	Agriculture
5. High Efficiency Grain Dryers	Agriculture
6. Livestock Waterer	Agriculture
7. VSD Milk Pump	Agriculture
8. Plate Cooler	Agriculture
9. Compressed Air Leak Detection	Commercial, Industrial
10. Compressed Air Receiver	Commercial, Industrial
11. Cycling Air Dryers	Commercial, Industrial
12. Engineered Nozzles	Commercial, Industrial
13. Ice Machine	Commercial, Industrial
14. Low Pressure Drop Filters	Commercial, Industrial
15. No Loss Drains	Commercial, Industrial
16. Variable Speed Drive Air Compressors < 50hp	Commercial, Industrial
17. Fast Acting Doors	Commercial, Industrial
18. Loading Dock Door and Pit Seals	Commercial, Industrial
19. Electric Oven and Range	Commercial, Industrial
20. ENERGY STAR Dishwasher	Commercial, Industrial
21. ENERGY STAR Electric Combination Oven	Commercial, Industrial
22. ENERGY STAR Electric Convection Oven	Commercial, Industrial
23. ENERGY STAR Electric Fryer	Commercial, Industrial
24. ENERGY STAR Electric Griddle	Commercial, Industrial
25. ENERGY STAR Electric Hot Food Holding Cabinet	Commercial, Industrial
26. ENERGY STAR Electric Steamer	Commercial, Industrial
27. ENERGY STAR Gas Combination Oven	Commercial, Industrial
28. ENERGY STAR Gas Convection Oven	Commercial, Industrial
29. ENERGY STAR Gas Fryer	Commercial, Industrial
30. ENERGY STAR Gas Griddle	Commercial, Industrial
31. ENERGY STAR Gas Steamer	Commercial, Industrial
32. Gas Conveyor Oven	Commercial, Industrial
33. Gas Oven, Broiler, Pasta Cooker	Commercial, Industrial
34. Gas Rack Oven	Commercial, Industrial
35. Kitchen Demand Control Ventilation	Commercial, Industrial
36. Faucet Aerator (1.5 gpm) with Electric Water Heater	Commercial, Industrial
37. Faucet Aerator (1.5 gpm) with Gas Water Heater	Commercial, Industrial
38. Gas Water Heater	Commercial, Industrial
39. Heat Pump Water Heater	Commercial, Industrial
40. Pre-Rinse Sprayers (1.6 gpm) with Electric Water Heater	Commercial, Industrial
41. Pre-Rinse Sprayers (1.6 gpm) with Gas Water Heater	Commercial, Industrial

42. Boiler Modifications, Space Heating Only	Commercial, Industrial
43. Boilers, Space Heating Only	Commercial, Industrial
44. Chiller Systems	Commercial, Industrial
45. Chiller Tune-up	Commercial, Industrial
46. Computer Room Air Conditioner (CRAC)	Commercial, Industrial
47. Condensing Unit Heaters	Commercial, Industrial
48. Demand Control Recirculation Pump	Residential
49. Demand Control Ventilation	Commercial, Industrial
50. Destratification Fan	Commercial, Industrial
51. ECM Blower Motors	Commercial, Industrial
52. ECM Circulators	Commercial, Industrial
53. ECM Fan Motors	Commercial, Industrial
54. Energy Management System (EMS)	Commercial, Industrial
55. Energy Recovery Ventilator	Commercial, Industrial
56. Exhaust Energy Recovery	Commercial, Industrial
57. Forced-Air Heating Maintenance	Commercial, Industrial
58. Guest Room Energy Management Controls	Commercial, Industrial
59. Heat Pump Systems	Commercial, Industrial
60. High Volume Low Speed Fans	Commercial, Industrial
61. Infrared Heater	Commercial, Industrial
62. Mini Split Ductless Systems A/C only and Heat Pump	Commercial, Industrial
63. Parking Garage Exhaust Fan CO Control and Heating	Commercial, Industrial
64. Programmable Thermostats with Electric Heating	Commercial, Industrial
65. Programmable Thermostats with Gas Heating	Commercial, Industrial
66. Smart Thermostat	Commercial, Industrial
67. Steam Trap	Commercial, Industrial
68. Unitary and Split Systems	Commercial, Industrial
69. Unitary Equipment Economizer	Commercial, Industrial
70. Variable Speed Drives	Commercial, Industrial
71. CFL Standard to Low Wattage Retrofit	Commercial, Industrial
72. Controls	Commercial, Industrial
73. Exit Sign Retrofit with LED/LEC	Commercial, Industrial
74. Exterior Canopy/Soffit Retrofit with LEDs	Commercial, Industrial
75. Exterior Wall Pack Retrofit with LEDs	Commercial, Industrial
76. Fluorescent to LED High Bay Systems	Commercial, Industrial
77. High Pressure Sodium Retrofit	Commercial, Industrial
78. Incandescent Over 100W Retrofit	Commercial, Industrial
79. Incandescent Up to 100W Retrofit	Commercial, Industrial
80. LED Screw-In Lamps in Walk-in Coolers and Freezers	Commercial, Industrial
81. LED Troffer Retrofit Kits	Commercial, Industrial
82. LED Troffers	Commercial, Industrial
83. Lighting End Use	Commercial, Industrial
84. Mercury Vapor Retrofit	Commercial, Industrial
85. Metal Halide Retrofit	Commercial, Industrial
86. New Construction	Commercial, Industrial
87. Occupancy Controls for Refrigerated Case Lighting	Commercial, Industrial
88. Pin-Base LED Lamps Replacing CFLs	Commercial, Industrial

89. Pulse Start Metal Halide Retrofit	Commercial, Industrial
90. Refrigerator/Freezer Case LEDs	Commercial, Industrial
91. Stairwell Fixtures with Integral Occupancy Sensors	Commercial, Industrial
92. T12 8-Foot Retrofit	Commercial, Industrial
93. T12 Up to 4-Foot Retrofit	Commercial, Industrial
94. T8 Optimization	Commercial, Industrial
95. T8 Standard to Low Wattage Retrofit	Commercial, Industrial
96. Building Operator Certification	Commercial, Industrial
97. Motors	Commercial, Industrial
98. Advanced Tier 2 Power Strips	Commercial, Industrial
99. Beverage Machine Controls	Commercial, Industrial
100. Non-Refrigerated Vending Machine	Commercial, Industrial
101. Snack Machine Controls	Commercial, Industrial
102. Anti-Sweat Heat Control	Commercial, Industrial
103. Case Night Covers	Commercial, Industrial
104. ECM Compressor/Condenser Fan Motors	Commercial, Industrial
105. ENERGY STAR Refrigerator and Freezer	Commercial, Industrial
106. Evaporator Fan Motor Retrofit	Commercial, Industrial
107. Evaporator Fan Speed Controls	Commercial, Industrial
108. Low-Heat and No-Heat Doors	Commercial, Industrial
109. Refrigerated Vending Machine	Commercial, Industrial
110. Refrigeration - Reach-In Storage	Commercial, Industrial
111. Refrigeration - Tune Up	Commercial, Industrial
112. Refrigeration - Walk-in Cooler	Commercial, Industrial
113. Refrigeration - Walk-in Door	Commercial, Industrial
114. LED Traffic Signal	Public
115. ENERGY STAR Clothes Washers	Residential
116. ENERGY STAR Dishwashers	Residential
117. ENERGY STAR Refrigerators and Freezers	Residential
118. Secondary Refrigerator/Freezer Removal	Residential
119. Drainpipe Heat Exchanger with Electric Water Heater	Residential
120. Drainpipe Heat Exchanger with Gas Water Heater	Residential
121. Electric Water Heater Jacket Insulation	Residential
122. Electric Water Heater Setback	Residential
123. Faucet Aerator (1.5 gpm) with Electric Water Heater	Residential
124. Faucet Aerator (1.5 gpm) with Gas Water Heater	Residential
125. Gas Water Heater	Residential
126. Gas Water Heater Setback	Residential
127. Heat Pump Water Heater	Residential
128. Low Flow Showerheads (1.5 gpm) with Electric Water Heater	Residential
129. Low Flow Showerheads (1.5 gpm) with Gas Water Heater	Residential
130. Pipe Insulation with Electric Water Heater	Residential
131. Pipe Insulation with Gas Water Heater	Residential
132. Thermostatic Restriction Valve with Electric Water Heater	Residential
133. Thermostatic Restriction Valve with Gas Water Heater	Residential
134. Central AC/ASHP	Residential
135. Central AC/ASHP Quality Install Additional Savings	Residential

136. Central AC/ASHP Tune-up	Residential
137. Duct Sealing	Residential
138. ECM Blower Motors	Residential
139. ECM Circulators	Residential
140. Electronic Ignition Hearth	Residential
141. ENERGY STAR Dehumidifiers	Residential
142. ENERGY STAR Room A/C	Residential
143. Furnace Quality Installation/Maintenance	Residential
144. Furnaces & Boiler Tune-Up	Residential
145. Furnaces and Boilers	Residential
146. Ground Source Heat Pump Systems	Residential
147. Insulation and Air Sealing	Residential
148. Mini Split Ductless Systems A/C only and Heat Pump	Residential
149. Thermostats with Electric Heating	Residential
150. Thermostats with Gas Heating	Residential
151. CFLs and ENERGY STAR Torchiere	Residential
152. Controls	Residential
153. ENERGY STAR Ceiling Fan	Residential
154. ENERGY STAR CFL Fixtures	Residential
155. ENERGY STAR LED Lamps and Fixtures	Residential
156. ENERGY STAR Outdoor Fixtures	Residential
157. LED Holiday Lighting	Residential
158. Lighting End Use	Residential
159. Variable Speed Pool Pumps	Residential
160. Advanced Tier 2 Power Strips	Residential
161. Pool Cover	Residential
162. Pool Heater	Residential

#### Emerging Technology Measures

	Sector
163. High-efficiency direct drive/BLDC appliance motors	Residential, Commercial
164. High-efficiency refrigerators	Residential
165. High-efficiency clothes washers	Residential
166. Energy Efficient Clothes Dryers (Residential) - (HP and US)	Residential
167. Energy management systems (e.g., ISO 50001)	Industrial
168. High R-Value Integrated Window System	Residential
169. Integrated heat pump (heat,cool,dhw)	Residential, Commercial
170. Residential economizing	Residential, Commercial
171. Energy recovery - heat pump	Residential, Commercial, Industrial
172. Minisplit air source heat pumps (cold climate)	Residential
173. High efficiency dehumidification	Residential
174. High efficiency inverter AC/HP systems	Residential, Commercial
175. Envelope sealing (areoseal) retrofit	Residential
176. Incremental improvements to conventional vapor compression cooling technologies (“Advanced RTU”); EERs continue to improve, but plateauing; improvements in part load performance	Commercial
177. Through-the-Wall Condensing Furnace/Air Conditioner Packages	Commercial



178. Optimizing energy savings from heat recovery chillers	Commercial, Industrial
179. Split System Economizer	Commercial
180. High-Efficiency Retrofit of Residential HVAC Blower Motors	Residential
181. Low capacity modulating furnace (GTI)	Residential
182. Advanced motor systems (including pump, fan, and air compressor technology and system design)	Industrial
183. OLED Lighting	Residential, Commercial, Industrial
184. Improved GSHP ("ClimateMaster HP is 30% more efficient")	Residential, Commercial
185. Q-Sync synchronously-controlled evaporator fan motors	Commercial
186. Networked lighting and integrated systems	Residential, Commercial
187. Data center cooling - Liquid cooled heat sinks in servers (Chilldyne)	Commercial
188. CO2 heat pumps (NEEA)	Residential, Commercial
189. High efficiency AC/DC converters (small appliance, chargers)	Residential, Commercial
190. Advanced Commercial Clothes Dryer Technologies	Commercial
191. Data Center Waste Heat Recovery	Commercial
192. Gas absorption heat pump technology (DHW)	Residential, Commercial
193. Gas absorption heating systems (NH3)	Residential, Commercial
194. Energy efficiency Grain Drying and Field Irrigation	Commercial
195. Failure of buildings to meet code	Residential, Commercial
196. Smart range hoods	Residential

#### Behavioral Measures

	Sector
197. Cold water washing	Residential
198. Thermostat setbacks	Residential
199. In home display feedback	Residential
200. Turn off lights	Residential
201. Change hot water temp	Residential
202. Computer power management	Residential
203. No heat dry on dishwasher	Residential
204. Smart phone feedback app	Residential
205. Thermostat setbacks	Commercial, Industrial
206. Kitchen exhaust	Commercial, Industrial
207. HVAC maintenance	Commercial, Industrial
208. Lighting optimized to occupancy	Commercial, Industrial
209. Lighting optimized to daylight	Commercial, Industrial
210. Computer power management	Commercial, Industrial
211. Equipment power management	Commercial, Industrial
212. Refrigeration air leakage (night covers )	Commercial, Industrial
213. Refrigeration maintenance	Commercial, Industrial
214. Refrigeration lighting (turn off lights overnight)	Commercial, Industrial
215. Commercial Energy Report	Commercial, Industrial
216. Home Energy Report	Residential
217. Gas Water Heater Setback	Residential
218. Optimized Large Building Operations	Commercial, Industrial

Demand Response Measures	Sector
219. Smart Thermostat	Residential
220. Central A/C (DLC)	Residential
221. Window A/C with Smart Plug	Residential
222. Electric Heat (DLC)	Residential
223. Dehumidifier with Smart Plug	Residential
224. Refrigeration	Commercial
225. RTU	Commercial
226. Smart Thermostat	Commercial
227. Lighting Controls	Commercial
228. Pool Pump	Commercial

Custom Measures	Sector
229. Custom - Motors	Industrial
230. Custom - Compressed Air	Industrial
231. Custom - Electro-Chemical	Industrial
232. Custom - Process Heating	Industrial
233. Custom - Process Cooling	Industrial
234. Custom - HVAC	Industrial
235. Custom - Lighting	Industrial
236. Custom - Process Heating	Industrial
237. Custom - Space Heating	Industrial
238. Custom - Other, Process	Industrial
239. Custom - Other, Non-Process	Industrial
240. Custom - Spacing Heating	Commercial
241. Custom - Cooling	Commercial
242. Custom - Ventilation	Commercial
243. Custom - Water Heating	Commercial
244. Custom - Lighting	Commercial
245. Custom - Cooking	Commercial
246. Custom - Refrigeration	Commercial
247. Custom - Office Equipment	Commercial
248. Custom - Computing	Commercial
249. Custom - Other	Commercial
250. Custom - Space Heating	Commercial
251. Custom - Water Heating	Commercial
252. Custom - Cooking	Commercial
253. Custom - Other	Commercial
254. Custom - Process	Commercial