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COMMERCE DEPARTMENT

Minnesota TRM 3.2 Proposed Measure Update Discussion

September 28, 2020

Agenda

- Welcome
- Schedule
- Measures
  - Variable speed pool pumps
  - Strip curtains
  - Water heater jacket insulation
  - Lighting controls
  - Line voltage smart thermostats
  - ECM fan motors
  - Evap fan speed controls and motors
- Additional items

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Roll Call

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Schedule

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Schedule

Item	Appx. Dates
Measure updates	9/4 - 9/30
Update discussion meeting	9/28
Discussion via e-mail / Huddle	9/28 - 10/16
Draft TRM submitted in eDockets	10/23
eDockets comments due	11/11
eDockets replies due	11/25
Final TRM submitted in eDockets	12/16

- Use time between now and ~10/16 to dial in updates via e-mail + Huddle
- Goal is a draft TRM ~10/23 that requires little modification
- After draft TRM, comments via eDockets only


Measures

Strip curtains

- Update to submitted version: Modify only; required by code
- ΔkWh savings = ΔkWh/SqFt × A
- A = input or default from table

Facility Type	Pre Existing Curtain Condition	Energy Savings (kWh/SqFt)	Demand Reduction (kW/SqFt)	Default Doorway Area (square feet)
Supermarket - Cooler	Existing curtain	37	0.0042	35
	No curtain	108	0.0123	
	Unknown	108	0.0123	
Supermarket - Freezer	Existing curtain	119	0.0136	35
	No curtain	349	0.0398	
	Unknown	349	0.0398	
Convenience Store - Cooler	Existing curtain	5	0.0006	21
	No curtain	20	0.0023	
	Unknown	11	0.0013	
Convenience Store - Freezer	Existing curtain	8	0.0009	21
	No curtain	27	0.0031	

- Originates from 2016 Pennsylvania TRM
  - "All the assumptions in this protocol are based on values that were determined by direct measurement and monitoring of over 100 walk-in units in the 2006-2008 evaluation for the CA Public Utility Commission."
- Used in WI, AR, and IL as well

Variable speed pool pumps

- Original note was that variable-speed is code, but not quite true.
- ΔkWh savings = $V_{POOL} \times N_{TURNOVERS} \times Days \times (1/WEF_{BASE} - 1/WEF_{EFF})$
- V, N, and Days from 2013 paper by (other) CEE
- Previous: EF_{BASE} = 2 gal/Wh, EF_{EFF} = 8.37 (avg in CA database)
- New:

Equipment Class			Baseline WEF		Mean WEF from ES		
Pool Pump Type	hhp range	Motor phase	Standard	Value Range	Base	Eff	Count
Self-priming, w/ filter	hhp < 0.13	single	5.55	5.55	3.7	10.4	41
	0.13 ≤ hhp < 0.771		-1.3 × ln(hhp) + 2.9	5.55 at 0.13 hhp 3.24 at 0.77 hhp			
	0.771 ≤ hhp < 2.5		-2.3 × ln(hhp) + 6.59	7.16 at 0.771 hhp 4.49 at 2.49 hhp	6.1	7.7	152
Non self-priming, w/ filter	hhp < 0.13	any	4.60	4.60	4.6	8.2	8
	0.13 ≤ hhp < 2.5		-0.85 × ln(hhp) + 2.87	4.6 at 0.13 hhp 2.09 at 2.49 hhp			
Pressure cleaner booster	any	any	0.42	0.42	0.4	0.6	5

- Prefer to list defaults for WEF_{BASE} and WEF_{EFF}? Table on right.

DHW jacket insulation

- Added electric DHW, changed formula format, checked defaults
- Formula previously read U × A, now reads A / R

Unit kWh Savings per Year = (A_base / R_base - A_insul / R_insul) x (T_hot - T_ambient) x Hours / (ElecEff * 3,412)
Electric-fueled storage water heater only

Unit Peak kW Savings = Unit kWh Savings per Year / Hours
Electric-fueled storage water heater only

Unit Dth Savings per Year = (A_base / R_base - A_insul / R_insul) x (T_hot - T_ambient) x Hours / (GasEff * 1,000,000)
Gas-fueled storage water heater only

TRM	R_{BASE}	R_{INSUL}	% of MN Savings	Source
MN	12	18	100%	PA TRM for R_{BASE}, 2020 online research shows R6 added is typical
Mid-Atl	8	18	250%	VEIC review for R_{BASE}, assume R8 added
PA	12	20	120%	Conservative est. of R-12 for R_{BASE}, assume R8 added.
IA	14	24	107%	None
VT	12	22	136%	None
Others	Actual			

Lighting controls

- Previous: occupancy and daylighting only, from older IL TRM

- New: Updated SF for those, plus:
  - Personal tuning
  - Task tuning
  - Multiple
  - Networked lighting controls (NLC)
- Also note and subtract baseline control savings

- SFs from:
  - 2011 LBNL meta analysis (88 studies)
  - 2017 DLC study on NLC (114 buildings)
  - Seventhwave / Slipstream work on task tuning
- Building-level available for many, but average presented too

Line voltage smart thermostats

Algorithm + baseline

- ΔkWh = [Heating kWh of home] × HSF / [Deemed # of t-stats per home]

- Get [Heating kWh of home] from RECS
  - Census Division 4 (IA, KS, MN, MO, NE, ND, SD)
  - SF detached and attached for SF, MF 2-4 and MF 5+ for MF
  - Built-in electric units installed in walls, ceilings, basements, or floors
  - Normalized Division 4 kWh by HDD to produce MN zones estimate

Zone	Baseline Baseboard Heater Household kWh	
	Single family	Multifamily
Zone 1 (Northern MN)	14,184	3,357
Zone 2 (Central MN)	12,824	2,906
Zone 3 (Southern MN/Twin Cities)	11,527	2,612

  - Compare to 17,974 kWh for 2.3 tons heating (mean MN Power HP size, TRM EFLH, HSPF = 3.412)

- [Deemed # of t-stats per home] = 6 for SF, 4 for MF from 2017 WA State paper, root source RTF

Line voltage smart thermostats

Heating savings fraction

- Deeming HSF is difficult
- Possible savings from bimetallic → electronic sensor upgrade
  - Electronic / thermistor sensor may produce savings over bimetallic even if manual control before and after (reduced deadband and droop)
  - Possibly more true for line voltage than low voltage
  - Evidence for this is mixed, 0% - 7% from 2 studies
- Certainly savings from manual → smart control upgrade
  - But no studies of this upgrade for line voltage thermostats
- Other studies of low-voltage thermostats:
  - Mixed to smart, electric, coastal: 10% to 12% savings
  - Mixed to smart, gas, upper Midwest: 5% to 7% savings
  - Manual to smart, gas, upper Midwest: 9% to 13% savings
  - Programmable to smart, gas, upper Midwest: 3% savings (1 study)
- RTF uses 5% (elec sensing) + 1% (smart) = 6%
- Current recommendation: HSF = 10%

ECM fan motors

Current measure

- NOT furnace fan motors; those follow separate rule and must be ECM
- NOT 1 - 200 hp motors; those are the C/I Motors measure and follow NEMA / EPACT standards (Appendix C)

- This is an "…electronically commutated motor (ECM) being applied within fan-powered terminal boxes, fan coils, and HVAC supply fans on small unitary equipment."

- Current MN form: ΔkWh = CFM × [Box Size Factor] * HOU
  - HOU = standard commercial EFLH
  - BSF = 0.32 W/CFM if < 1,000 CFM
    = 0.21 W/CFM if ≥ 1,000 CFM
  - Algorithm and factors from MA TRM, which cites "engineering analysis developed at National Grid" (no link or title, cannot find)

ECM fan motors

Possible updates

- 2018 MN Energy code, following 2018 IECC, requires motors equal to or larger than 1/12 hp (82 W) and less than 1 hp (746 W) must be ECMs or have an efficiency of 70%.
  - If 2018 MN Energy code should be followed, this measure is Replace Working only; no New Construction or Replace on Fail
  - Note 2015 MN Energy code follows 2012 IECC and does not require this
- Add exhaust
  - Only other TRM with this application is WI, which uses lighting HOU for "occupied ventilation" – will research more but this may be best option
  - Plus 8,760 for 24/7 ventilation
- Other algorithms
  - If Replace Working only, less need to make algorithm more robust, but…
  - PA: W_{BASE} and W_{EFF} are user inputs, or hp + assumed efficiency, EFLH
  - WI: hp is user input + assumed efficiency, EFLH or lighting HOU
  - NY: W_{BASE} is user input, assumed efficiency upgrade, EFLH or lighting HOU

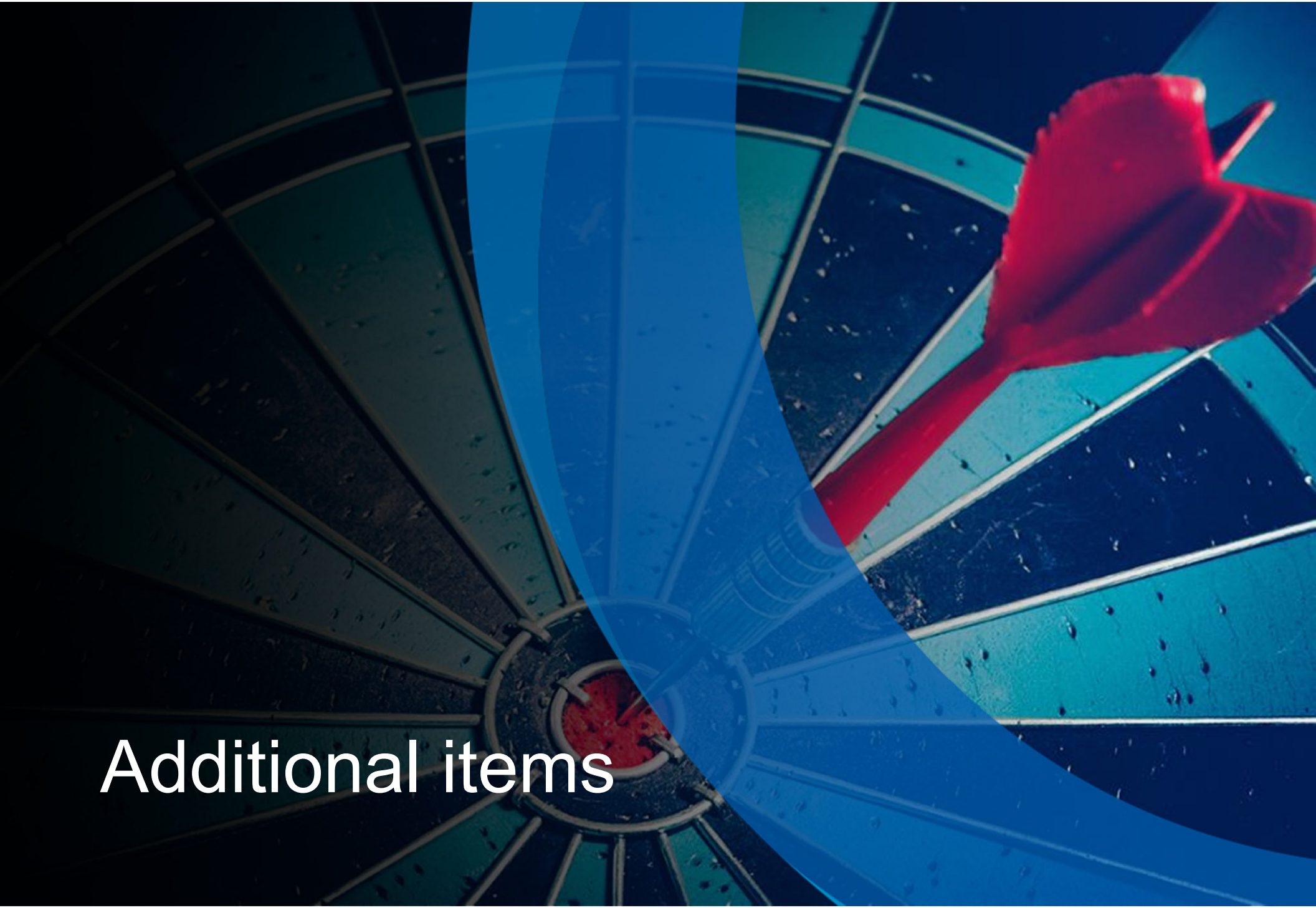
Evap fan ECMs, speed controls

Algorithm forms

- $\Delta kW_{ECM} = (W_{BASE} - W_{EE}) \times [\text{Load Factor}] \times [\text{Duty Cycle}] \times (1 + 1/COP) \times CF$
- $\Delta kW_{CTRLS} = (W_{FULL} \times \%_{FULL} - W_{LOW} \times \%_{LOW}) \times [LF] \times [DC] \times (1 + 1/COP) \times CF$
- Shaded pole, PSC, ECM, full speed, low speed wattages, other inputs from papers, data, RTF assumptions, 8,760 HOU
- Other TRMs take similar approach, using various sources

Possible update

- §431.306 requires ECM or 3-phase for evap fan motors < 1 hp & < 460 V
  - ➢ Will parse against algorithms and update shortly
- Btu/Wh requirements (via Annual Walk-In Energy Factor or AWEF) were updated 7/10/2020
  - Seven walk-in cooler types + sizes, AWEF scales with capacity
  - ➢ Believe still room for motor upgrades



Additional items

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Boiler baselines

- Residential and res-sized commercial boilers, < 300 kBtu/h
- Federal code, 10 CFR Part 430:
  - Made before 9/1/2012: 80% AFUE
  - Made 9/1/2012 - 1/14/2021: 82% AFUE (MN TRM 3.0, 3.1 value)
  - Made on or after 1/15/2021: 84% AFUE - noted in C+S workbook in 2018
- MN TRM 3.2 applies 1/1/2022
  - This is one year of sell-through
  - ➢ Apply 84% AFUE for 3.2 (?)
- Future note, 10 CFR Part 431:

Boiler type, size (kBtu/h)	Current Code / TRM	Code on 1/10/2023
Hot water ≥ 300, ≤ 2,500	80% TE	84% TE
Hot water > 2,500	82% CE	85% CE
Steam natural draft, ≥ 300, ≤ 2,500	77% TE	81% TE
Steam natural draft, > 2,500		82% TE
Steam except nat draft, ≥ 300, ≤ 2,500	79% TE	81% TE
Steam except nat draft, > 2,500		82% TE

Apply for 2024 - 2026 Triennial? One year of sell-through.

Other items

- Res ASHP: $SEER_{BASE}$ 13, $HSPF_{BASE}$ 7.7 → 14 and 8.2

- Commercial lighting: Hope to add new lighting types

- Correct a few references
- Correct / clarify some equation parentheses and examples
  - Steam traps
  - Insulation
  - Air purifiers
- Add clarification to terms in the energy recovery ventilator paper, small tweak to values

- Will be noted in TRM front table, also posted to Huddle with tracked changes for easy comparison

Water kWh factor

- Perhaps around 0.005 kWh / gal for MN
- Likely ~5 - 20% adder for aerator measures
- Likely < 1% adder for CIP
- Unclear path to determining factor for MN
- No issues raised regarding single factor applied, even if water source in one territory and water use in another?

- Continue to keep in mind

Thank You!