DOCKETED

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Project Title:	Appliance Efficiency Pre-Rulemaking for Commercial Tumble Dryers and Air Filter Labeling
TN #:	222329
Document Title:	Presentation - CASE TEAM Response to Docketed Commercial Tumble Dryer Comments - 1-24-2018
Description:	This presentation contains the CASE teams responses to technical comments regarding the test procedure provided to the docket following the August 2017 workshop.
Filer:	Ryan Nelson
Organization:	PG&E, Southern California Edison, SDGE and SoCalGas (CASE Team)
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CASE Team Response to Docketed Commercial Tumble Dryer Comments

Suzanne Foster Porter, Kannah Consulting

on behalf of the California Investor-owned Utilities

January 24, 2018

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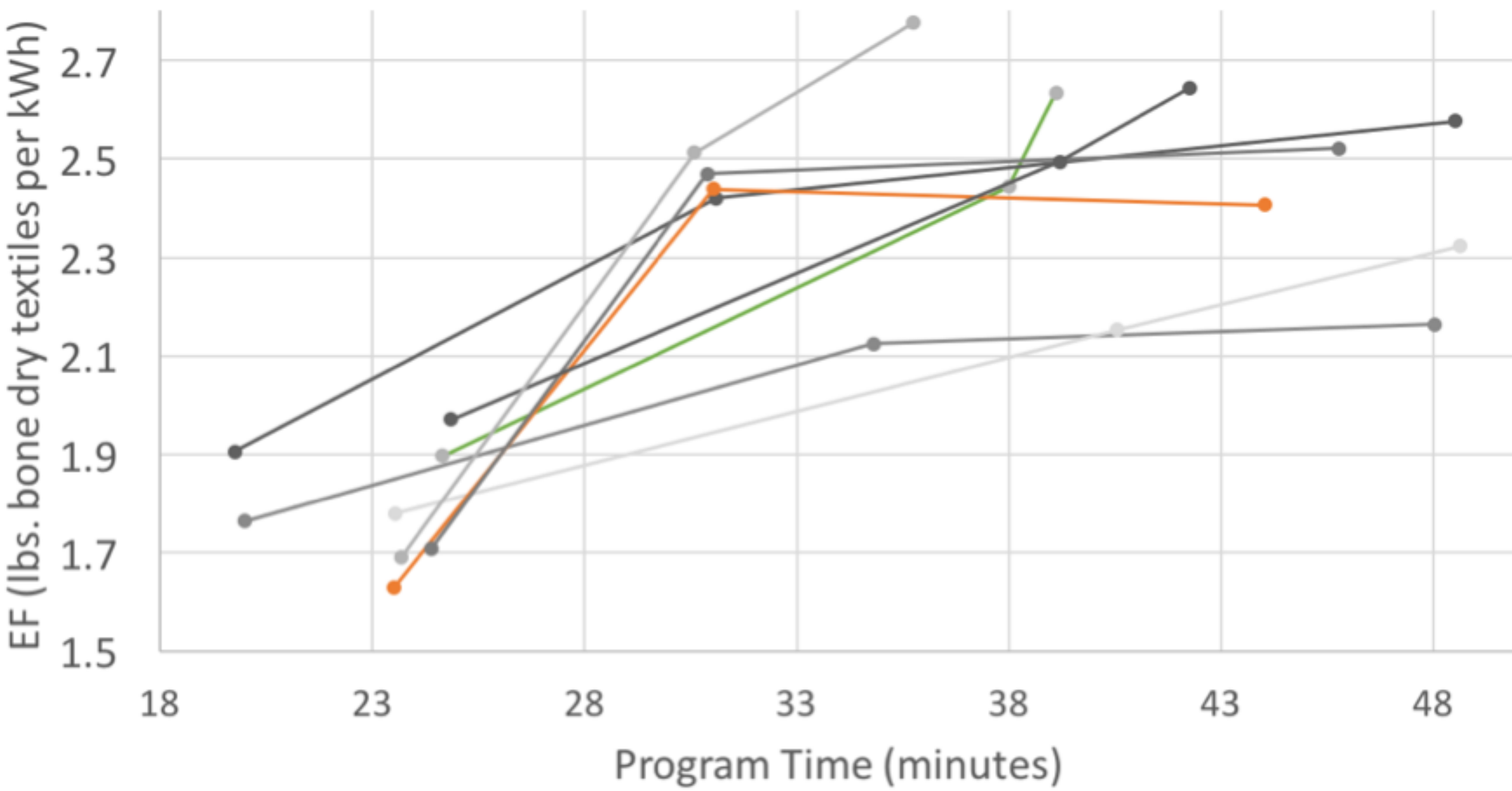
Outline

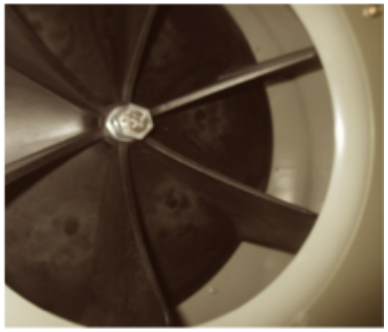
- Justification for a test and list recommendation
  - Program time and efficiency
  - Energy use of commercial tumble dryers in California
- Response to technical comments on the docket
  - Test procedure burden
  - Test procedure details
    - Scope of test protocol
    - RMC values
    - Weighting of runs
    - Timeframe of ambient temperature in environmental chamber
    - Water conductivity
    - Reproducibility

Efficiency generally improves with longer program time



A number of energy-saving technologies can maintain program time

Airflow



- Air sealing
- Axial (semi-axial) airflow
- Right-sizing fan
- Fan modulation

Heating system

- Right-sizing burner
- Heat reclamation
- Heat exchanger
- Burner modulation
- Insulation
- Heat pump (electric only)

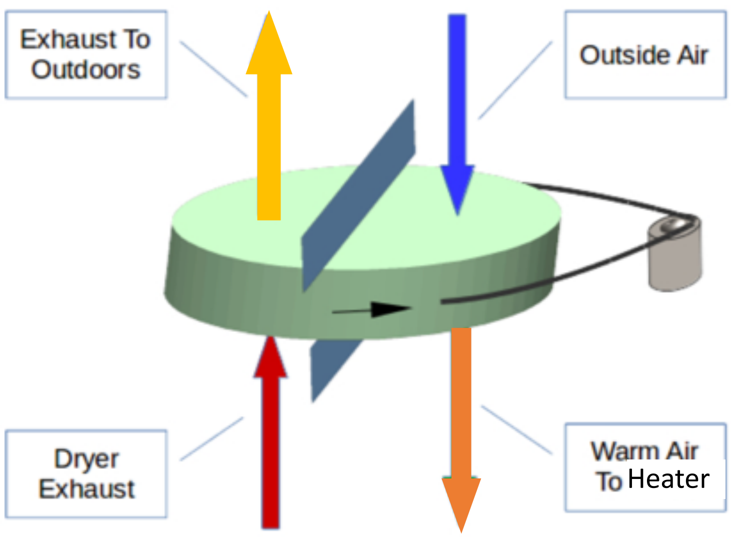
Sensing and controls

- Automatic termination
- Controls for burner and fan in timed dry

Dryers in market today can have different efficiencies with similar program time

	Baseline 23-cubic-foot (80-pound)	Improved 23-cubic-foot (80-pound)
Program time & EF	19 to 48 minutes, average 36 min. Average EF = 1.98 lbs. per kWh	25 to 46 minutes, average 36 min. Average EF = 2.29 lbs. per kWh
Airflow	• Radial airflow through drum • High rate of airflow • Little to no air sealing along air pathway	• Semi-axial airflow through drum • Rate of airflow 60 to 70% of baseline unit airflow • Air sealing of air pathway and damper on exhaust • Drum reversal enables greater air exposure to textiles
Heating system	• Airflow through vents in housing directly to burner box • Burner box has vents in side panels • High BTU output	• Air travels over motors and back of drum, reclaiming waste heat before it enters the burner box • Burner box has few vented openings • BTU output of heater 80 to 90% of baseline

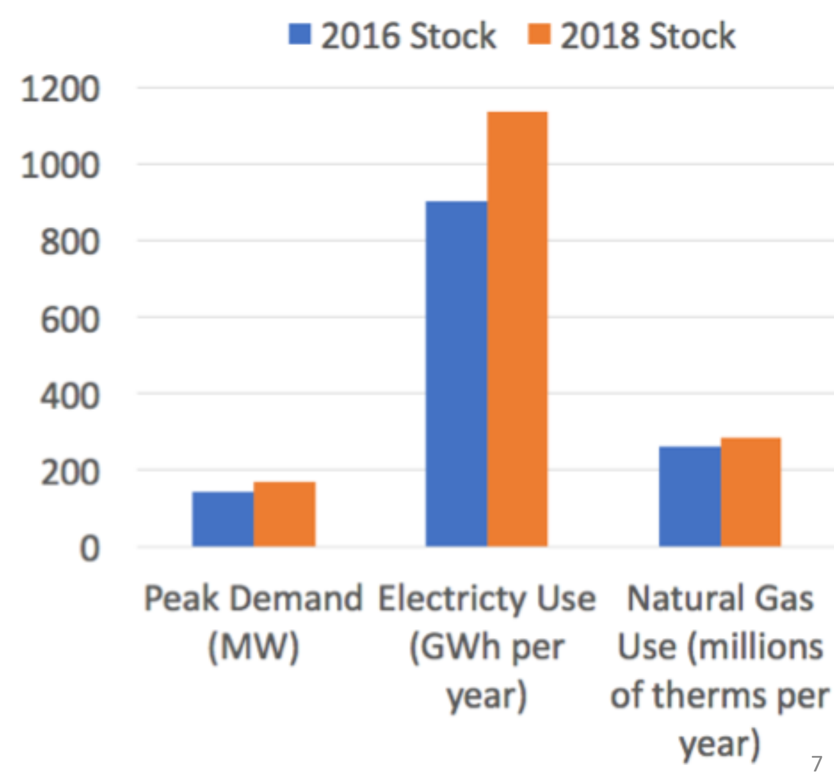
Transferable technologies available to further reduce energy use while maintaining program time



- In 2017, the CASE Team installed a rotary heat exchanger on 23-cubic-foot (80 lb.) improved dryer
- Improved efficiency by 20% (EF of 2.29 lbs./ kWh improved to 2.74 lbs./ kWh) under the test protocol
- Average program of 37 minutes was only one minute longer than original product
- Details of installation and results in forthcoming engineering analysis report

Revised energy model continues to confirm commercial tumble dryers important in California

- 2016 estimate of stock and sales relied on TRC market study focused on units already installed
- Using sales data purchased from a third-party research firm (QY Research), the CASE Team created an alternate energy model
- New energy model confirms 2016 results of commercial tumble dryers
- Details of revised energy model forthcoming in CASE Team engineering report



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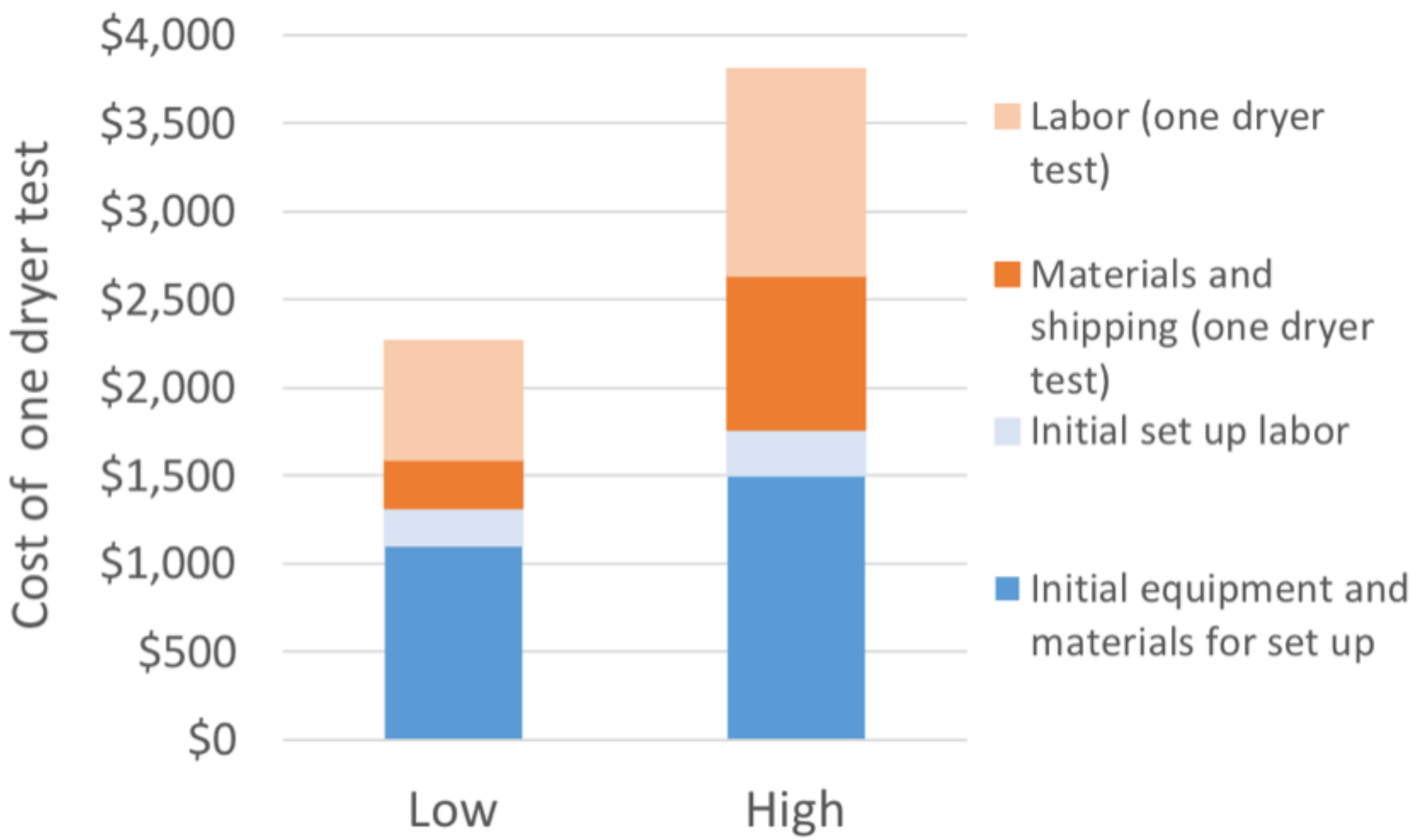
CASE Team estimated cost of applying current test procedure to a single dryer

Initial facility set up cost

- Built from existing environmental chamber that controls for a wider thermal range only
- Estimate assumes all other equipment (gas meters, washer, etc.) needs to be procured
- Assumes 140 dryers tested over lifetime of the facility (approximately 1 in 6 consolidated test facilities for the market)
- Based on PG&E ATS experience setting up lab

Per dryer cost

- Assumed a market-weighted average load size to calculate cost of test cloth
- Builds on CASE Team memo submitted to the docket in June 2017 with per dryer testing labor estimates
- Includes additional cost of maintaining test cloth bank and regularly calibrating equipment
- Shipment cost



Test cost of an estimated 350 current market models ($790 k to $1.3 M) is less than 0.5 % of California's annual energy bill for commercial dryers ($ 450 M)

Test procedure less burdensome than other similar test protocols

Test protocol	No. of runs per appliance	Other factors	Total No. of runs
DOE washer (residential)	9	2 to 3 appliances must be tested, depending on results	18 to 27
IEC 61121:2012 dryer (residential)	5	2 load types (cotton and synthetic)	10 (if testing with both loads)
Comm. tumble dryer	5 to 6	Only 5 runs for dryers without automatic termination	5 to 6
CSA 7.2-2016	1 to 2	Lower expected level of repeatability and reproducibility	1 to 2

Scope chosen to cover all commercial dryers

- CASE Team product survey led to current definition of all tumble dryers with less than 65 ft^3 (210 lb.) also not covered by DOE standard
- Gas and electric models only (no steam) given steam dryers are likely part of industrial/campus system addressed by utility program efforts
- Intent is to cover commercial but <u>not</u> industrial dryers, including residential-platform and large-chassis tumblers
- Covers ~90% energy use of commercial dryers in California

Washer + dryer

Dual-pocket

RMC values chosen to represent possible range of values in real-world use

Run	Run sequence	Load size	IMC	RMC	Settings
A	Shortest timed	Full-sized	60%	1.5% - 4%	Timed, high heat
B				4% - 8%	
C	Over dry timed	Full-sized	60%	≤ 4%	
D	Challenging timed	Partial	75%	2% - 7%	
E	Favorable timed	Full-sized	60%	4% - 7%	Timed, low heat w/ cool down
F	Automatic termination	Partial	60%	≤ 4%	Automatic termination, medium heat

Equal weighting of test runs recommended

$$Avg\ T_{cycle} = \frac{1}{5}\left[T_{cycle(AB)} + T_{cycle(C)} + T_{cycle(D)} + T_{cycle(E)} + T_{cycle(F)}\right]$$

$$Avg\ EF = \frac{1}{5}\left[EF_{AB} + EF_{C} + EF_{D} + EF_{E} + EF_{F}\right]$$

- CASE Team agrees with stakeholder comment that test runs are ideally weighted based on real-world use
- Field data on frequency of different types of loads is not available
- Simple average for determining an average energy factor (EF) and program time is recommended in absence of field data
- CEC requesting data on individual runs <u>and</u> the average to enable consideration of future data on frequency of loads in real-world use

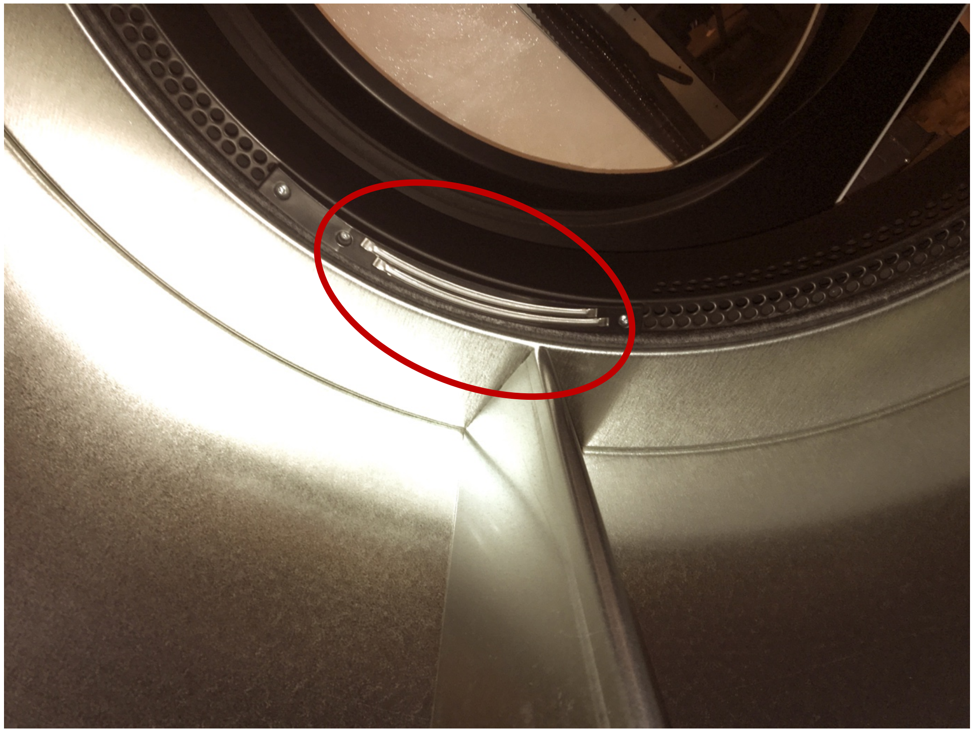
Responsiveness of environmental chamber

PG&E ATS humidity-controlled and temperature-controlled chamber

- Chamber is able to adjust from other test temperatures (DOE's 75°F, CSA 77 °F, etc.) to 65°F specified in this test procedure in a matter of minutes
- Can be accomplished simultaneously with other test tasks (test textile load development, textile wetting and extraction, etc.)

Water conductivity controlled to ensure repeatability of dryers with textile moisture-sensing

- Moisture conductivity sensing is used in some dryers for automatic termination and other controls
- IEC 61121-2012 (Res. Dryers) includes the same control for water conductivity
- To reduce test burden, <u>the CASE Team plans protocol revisions to limit this control to dryers with in-drum conductivity moisture sensing capability</u>



Reproducibility study

- CASE Team tested 7.4 cubic-foot residential-platform commercial dryer in Q4 2017
- Commissioned UL to independently test the exact same dryer to determine repeatability of the test protocol
- UL tests completed in January, and test report from UL forthcoming
- CASE Team plans to share results of this study with stakeholders once data is analyzed

Suzanne Foster Porter

Principal, Kannah Consulting
sfosterporter@kannahconsulting.com

970.312.7179