Lessons Learned from New Technologies & Customer Expectations

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CLASSIFICATION LEVEL: PUBLIC

The Alliance

neea

Avista
Bonneville Power Administration
Cascade Natural Gas Corporation
P.U.D. Chelan County
Clark Public Utilities
EnergyTrust of Oregon
Idaho Power An IDACORP Company
NorthWestern Energy
NW Natural
Pacific Power
Portland General Electric
PSE Puget Sound Energy
Seattle City Light
Snohomish County PUD Public Utility District No. 1
Tacoma Power Tacoma Public Utilities

What Does NEEA Do?

EMERGING TECHNOLOGIES

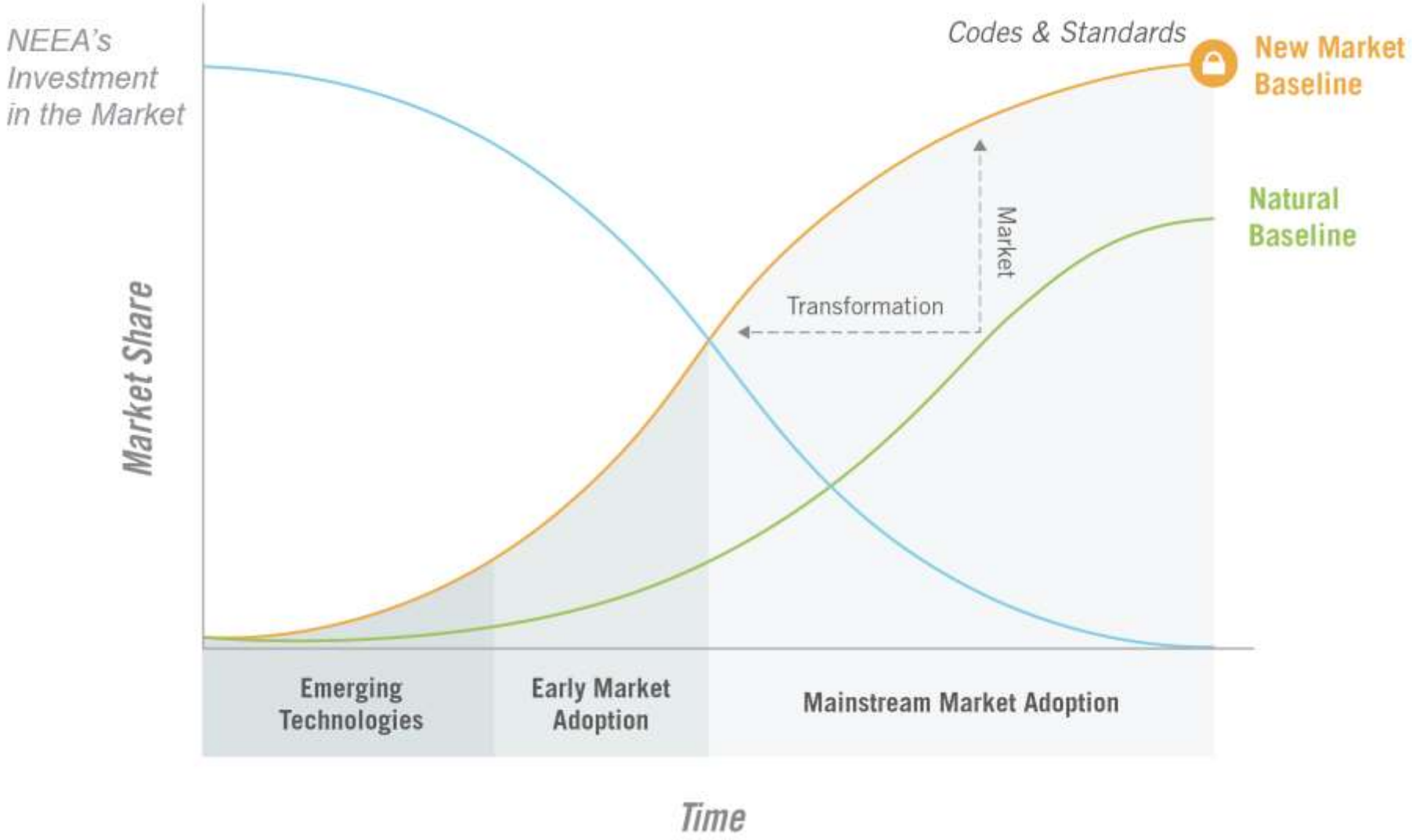
PORTFOLIO EXECUTION

CODES & STANDARDS

CONVENE AND COLLABORATE

MARKET INTELLIGENCE

Market Transformation



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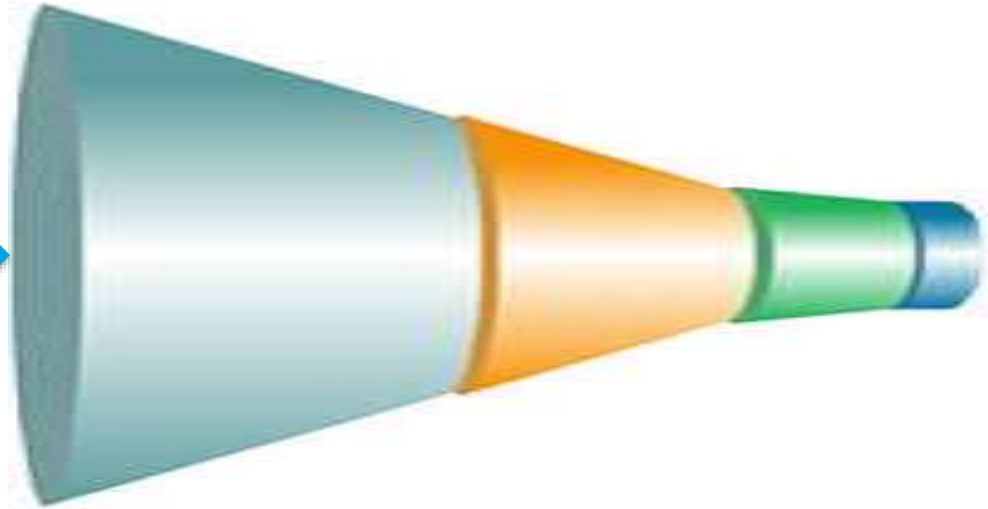
New Technologies and Customer Adoption

- Why do customers select a new product?
  - Addresses a need or a want
  - Customers adopt a technology due to the benefits, not the feature
  - Same or better experience than their current product
    - Noise
    - Reliability/longevity
    - Reduced cost of ownership, etc.
  - More energy efficient

Getting from ET to a Measure

Emerging Technologies



New Measures

Readiness
- Product
- Market
- Program

When Reality Meets Expectations

- There is a long list of products that didn't meet consumer expectations and failed
- The Museum of Failure provides some examples…

Image courtesy Museum of Failure

DeLorean DMC-12

- Missed its target price point
- Marketed as a luxury sports car
  - Severely underpowered engine
  - Slow
  - Stainless steel was difficult to maintain
- On the market for 24 months

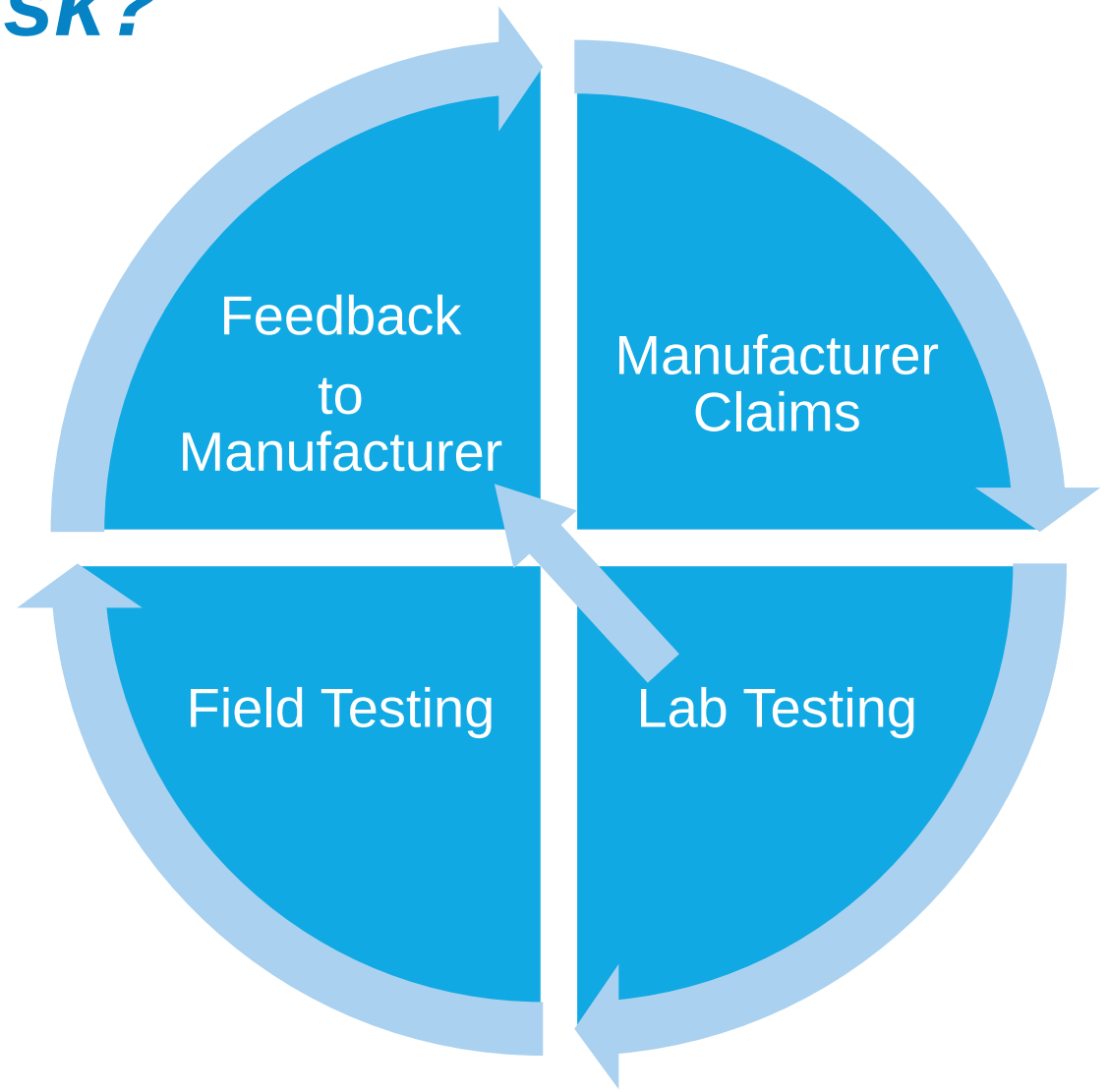
Olestra – Fat Free Foods

- Fat substitute with zero calories
- Promise to eat the foods you love with reduced calories
- The body cannot absorb it resulting in painful gastric side effects
- On the market for 48 months

Image courtesy [Museum of Failure]

How Do We Reduce the Risk?

- Lab Testing
  - Industry standard
  - Customized
- Field studies
- Manufacturer claim validation
- Test procedure validation



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Compact Fluorescent Lights (CFLs)

Image courtesy General Electric

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Image courtesy Sylvania

Compact Fluorescent Lights (CFLs)

Image courtesy General Electric

Image courtesy Sylvania

	Incandescent	CFL
Price	$	$$$
Life (hours)	3,000	10,000
Lifetime Cost	-	↑
Quality of Light	☺	↓
Noise Level	☺	↓
Dimmable	Yes	**No**
Three Way	☺	↓
Disposal	☺	↓

Compact Fluorescent Lights (CFLs)

Image courtesy familyhandyman.com

- How the market responded
  - Development of industry standards (ANSI/Illuminating Engineering Society)
  - ENERGY STAR specification
    - Coloring Rendering Index
  - Bulb recycling programs developed by waste disposal companies
  - Product improvements – color quality, noise, dimmable, 3-way bulbs

Heat Pump Dryers

Image courtesy Samsung

	Conventional	HP Dryer
Price	$-$$	$$-$$$
Energy Efficiency	-	↑
Ventless	- / ↓	↑

HP Dryer Service and Maintenance

Image courtesy Mr. Washy Washy You Tube Channel

Image courtesy N. Lentz

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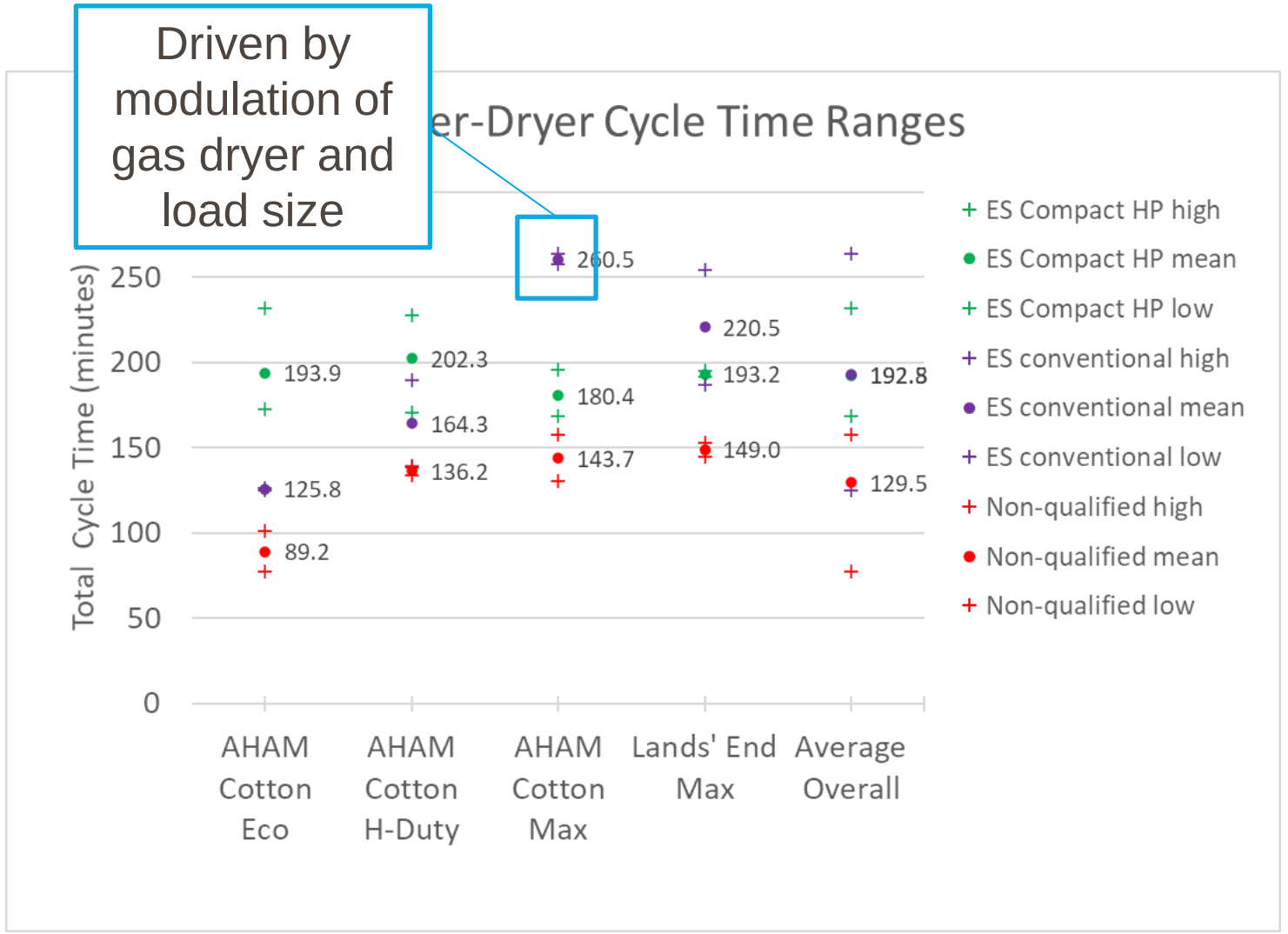
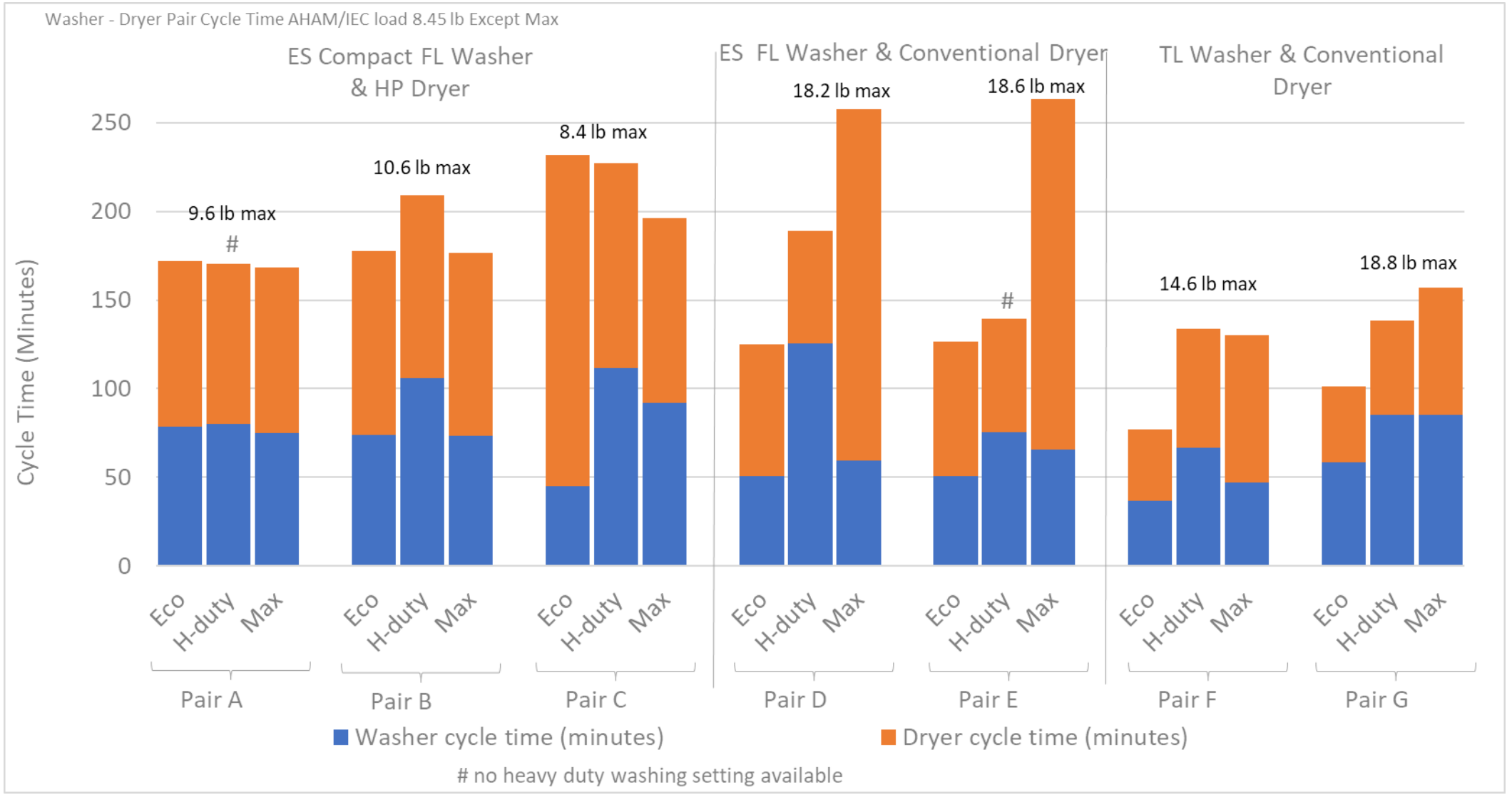
Heat Pump Dryers

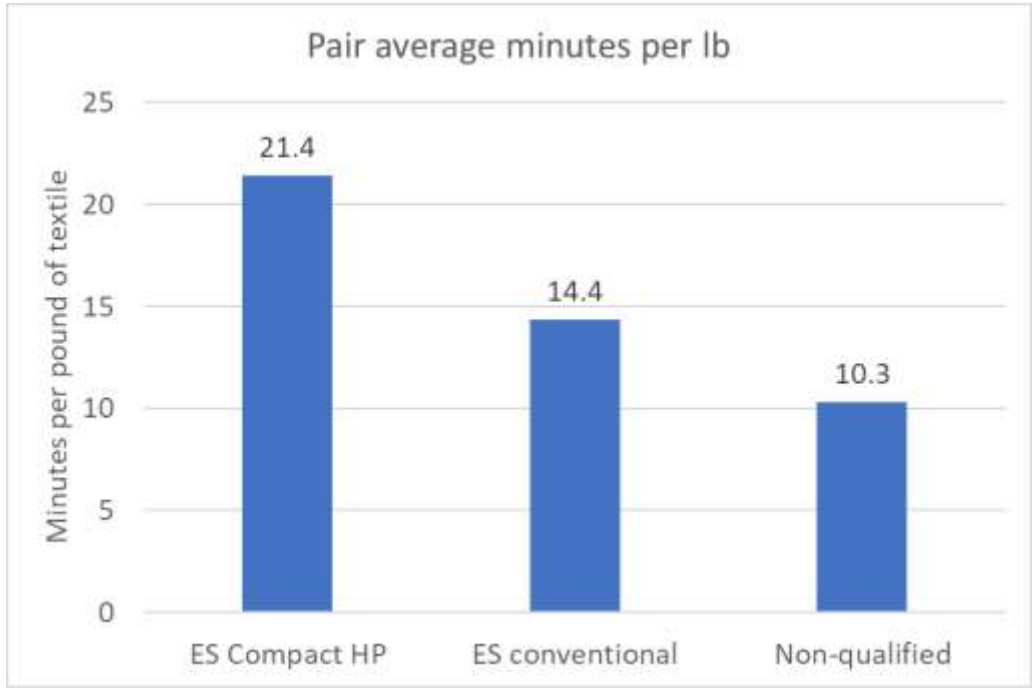
- The compact heat pump pairs take longer to wash and dry the 8.45 lb load (Eco and H-Duty) compared to all the conventional pairs.
- For the loads that are normalized to the washer basket size (Max), the heat pump pairs have a shorter cycle time than the ENERGY STAR qualified conventional pairs
- Note that Max is maximum load size as defined by the washer J2 test procedure along with cold wash and rinse in the washer and DOE D2 settings (Eco) in the dryer

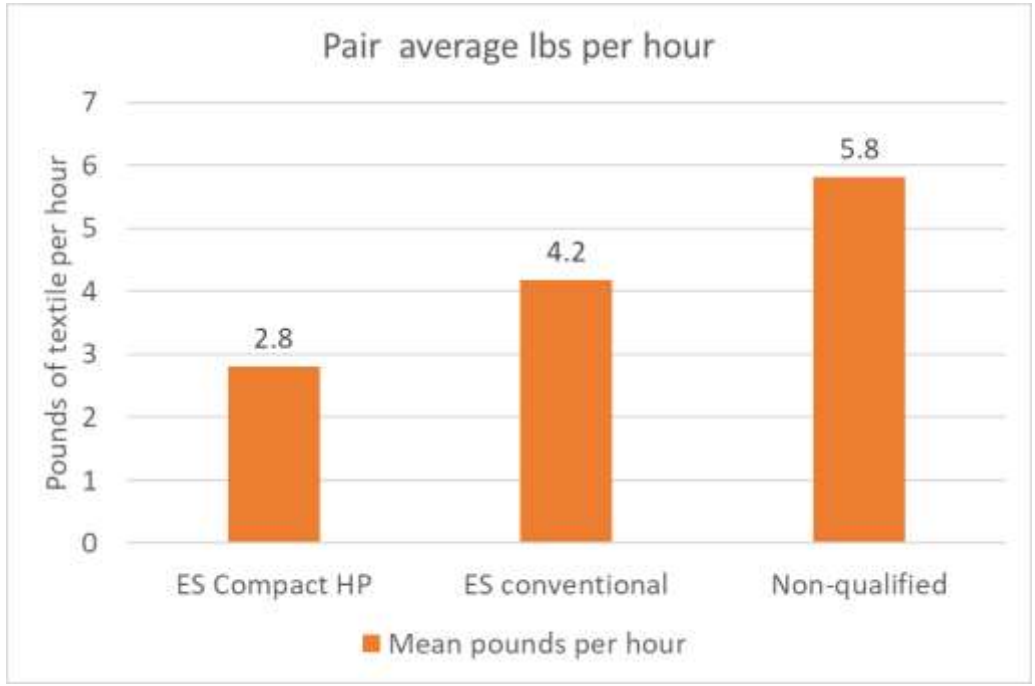


Heat Pump Dryers



Heat Pump Dryers





Heat Pump Dryers Summary

- HP dryers can provide significant energy savings
- Consumers need to be educated about the difference in performance and maintenance
  - Cycle Time
  - Load Sizes
  - Two filters v/one filter
  - Energy use
- Product Support is important for the customer experience

Heat Pump Water Heaters

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Heat Pump Water Heaters

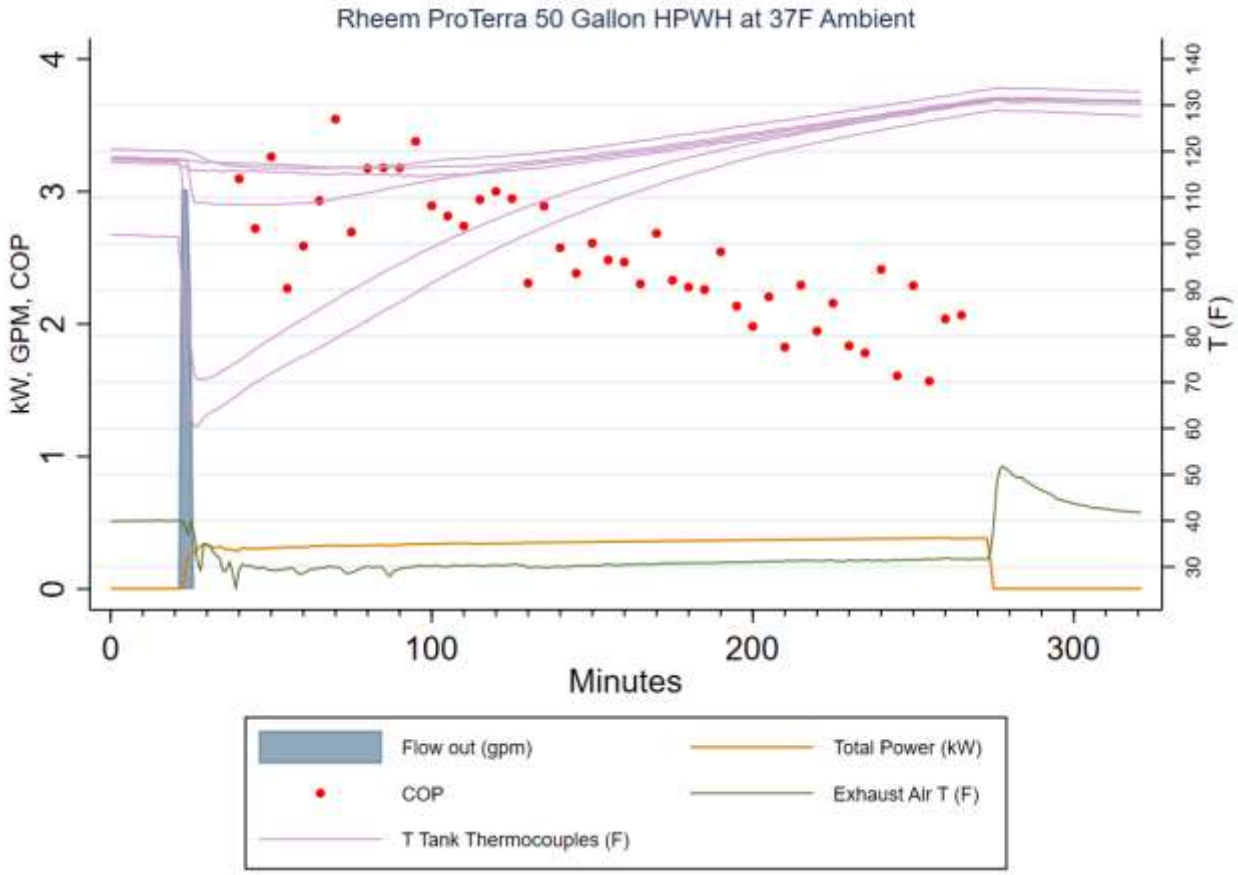
Circa 2010	Resistance	HPWH
Price	$	$$$
Height (50 gal)	48 in-59 in	75.5 in
Noise	Virtually silent	54 db
Min. Ambient Temp.	-	42 °F
Sales & Installer Familiarity	High	**Low**
Replacement Time	~ 2.5 hours	~ 3.5-4.5 hours
“On the truck”	Yes	No
Condensate Line	No	Required
Venting	-	Required

Heat Pump Water Heaters

- Development of Advance Water Heating Specification[5, 6] that specifically calls out performance standards for cooler water and air performance standards
- Worked closely with key market actors to improve performance in cold climates resulting in marked improvements
- Studied the interaction of HPWHs and space conditioning[2, 3]
- Field studies showing performance of HPWHs in colder climates as part of the Regional Study of over 100 HPWHs installed in the four NW states
- Partnered with OEMs on installation recommendations for colder climates and confined space applications[10]
- Built and continually update recommendation materials for market actors (Architects, Designer, Installers, Raters, Code Officials and Owners) of how to install and commission HPWHs in single family and multifamily homes[1]

Cold-Climate Heat Pump Water Heater Performance

- Field tests prove HPWHs operate efficiently at low ambient air temperatures[4]
- Field measurements were performed with products available at the time *(Tier 1 and 2 of AWHS[5,6]).*
- Current HPWHs have even better performance (*AWHS Tier 3 and 4*).
  - Greater heat pump efficiency
  - Reduced sound level
  - Lower minimum ambient temperature operation
  - Less electric resistance operation
- Lab tests confirm findings from field studies showing high COPs even at 37°F[7,8]



*After a 15-gal. draw, this water heater ran a **COP of 2.5** when reheating the tank in 37° ambient air lab testing*

Fleet Efficiency HPWH Then and Now

	2013	2019
NW Regional Sales	~2,500	+15,000
AWHS Tier	Tier 1	Tier 4
Manufacturer Brands	4	14
Demand Response Capable	0%	60%
Noise Level	54 db	48 db
Fleet Efficiency (UEF)	2.7	3.5
Min Operating Temp.	42 °F	35 °F
Override Expiration	No	72 hours
HPWH Wattage	700 watts	350-450 watts
First Hour Rating	64.3 gal	66.3 gal
Product Height	75.5 in	61 in
Air Volume Requirements	Vented	Louvered door
Available Voltage	240	120/240

New generation HPWHs are quieter than your average refrigerator.

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Lessons Learned

- Validate manufacturer claims
- “Off the shelf” doesn’t mean always reliable
- Understand customer expectations, make sure the product meets the application
- Communicate product experience differences
- Ensure that the supply chain is ready from manufacturer to designers to installer to service network

Thank you!

Appendix

HPWH References

HPWH Handbook – Summary paper on all technical research as of 2018

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Interaction factor

2) Widder, S., C. Metzger, J. Petersen, and J. McIntosh. 2017. *Interaction between Heat Pump Water Heaters or Other Internal Point Source Loads and a Central Heating System*. Report #E17-302. Portland, OR. NEEA. http://www.neea.org/docs/default-source/reports/interaction-between-heat-pump-water-heaters-and-heating-system.pdf?sfvrsn=4

3) Larson, B. 2018. *Understanding HPWH Interaction with Space Conditioning Systems in the Field*. Presented at 2018 American Council for an Energy Efficient Economy Hot Water Forum. https://www.aceee.org/sites/default/files/pdf/conferences/hwf/2018/5b-larson.pdf

HPWHs field study

4) Ecotope. 2015. *Heat Pump Water Heater Model Validation Study*. NEEA Report #E15-306, Portland, OR. http://neea.org/docs/default-source/reports/heat-pump-water-heater-saving-validation-study.pdf?sfvrsn=8

Advanced Water Heating Specification

5) Advanced Water Heating Specification (AWHS) https://neea.org/resources/advanced-water-heating-specification

6) AWHS Qualified Products List https://neea.org/img/documents/HPWH-qualified-products-list.pdf

HPWH lab tests

7) Larson B., and Kvaltine, N.. 2015. *Laboratory Assessment of GE GEH50DFEJSRA Heat Pump Water Heater*. NEEA Report # E15-013. Portland, OR. https://neea.org/resources/laboratory-assessment-of-rheem-generation-5-series-heat-pump-water-heaters

8) Kvaltine, N. and Larson, B. 2015a. *Laboratory Assessment of A. O. Smith HPTU Series Heat Pump Water Heaters*. NEEA Report #E15-306. Portland, OR. https://neea.org/resources/hpwh-lab-report-ao-smith-hptu-12-09-2015

Residential Building Stock Assessment (RBSA)

9) https://neea.org/data/residential-building-stock

10) Larson, B. and Larson, S, 2022 *Heat Pump Water Heaters in Small Spaces Lab Testing: "The Amazing Shrinking Room."* Report: #E22-334. Portland, OR. NEEA https://neea.org/resources/heat-pump-water-heaters-in-small-spaces-lab-testing-the-amazing-shrinking-room

HP Dryer References & Resources

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- Hannas, B., Gilman, L., 2014, *Dryer Field Study*, Report #E14-287, Portland, OR. NEEA https://neea.org/resources/rbsa-laundry-study
- Dymond, C., 2018, *Heat Pump Clothes Dryers in the Pacific Northwest – Abridged Field & Lab Study Report.* Report #E18-305, Portland, OR. NEEA https://neea.org/resources/heat-pump-clothes-dryers-in-the-pacific-northwest-abridged-field-lab-study-report

