Unveiling the mysteries of refrigerator energy consumption and how to reduce it

(everything you wanted to know about refrigerator energy but were afraid to ask)

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A2SE Summer Study, Sydney, February 2013

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Overview

- How many refrigerators are there?
- Historical trends in energy
- Factors that affect energy during use
- Field measurements of refrigerators
- Test methods for refrigerators
- Regulatory proposals for Australia in 2015
- Conclusions

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Just how many refrigerators are there?

- 1.4 refrigerators per house in Australia (steady)
- 0.4 freezers per house (declining)
- 1.2 million new units per year sold in Australia
- Australian stock (including offices) – 17 million
- World production – 100 million per year (more than cars)
- World stock – 1.5 billion
- World energy – estimated at 1000 TWh/year – 5% of global electricity

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Trends in refrigerator energy

- Labelling was introduced in 1986 (Victoria and NSW)
- MEPS was introduced in 1999, updated in 2005
- Since energy labelling started, the energy of refrigerators has DECREASED by 65%
- The real price has DECREASED by 50%
- The size has INCREASED by 20%
- Trends confirmed through field measurements
- There is no doubt that energy policies have had a large impact on energy consumption
- But there have been natural technology improvements as well

Long terms trends in energy, price and size

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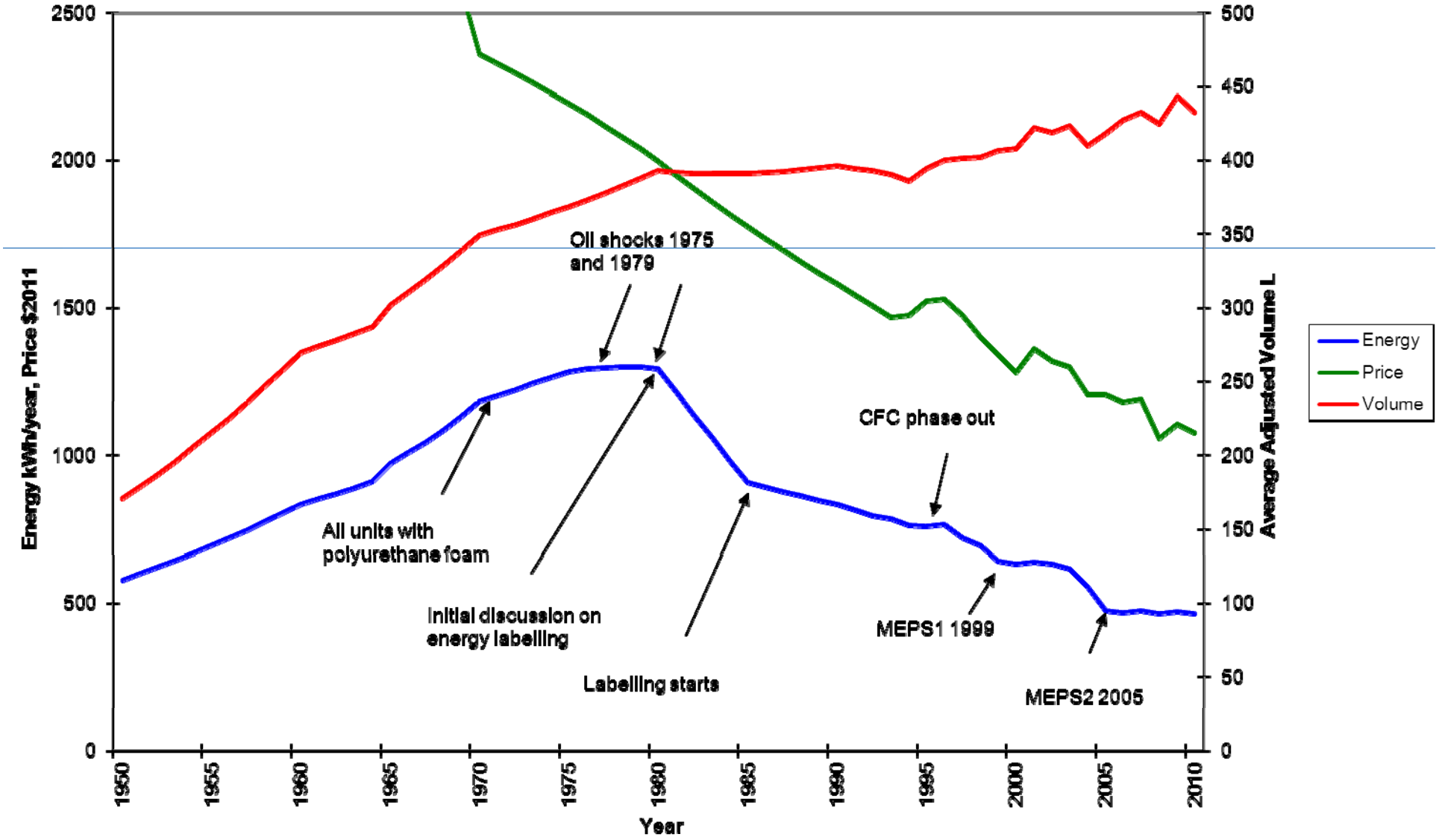

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What about energy during use?

- The main factors that impact on energy during use are:
  - ambient temperature in the room
  - user interactions (door openings, food loads)
  - incremental defrost energy and frequency
  - compartment temperature set points
  - auxiliaries

Impact of ambient temperature on energy

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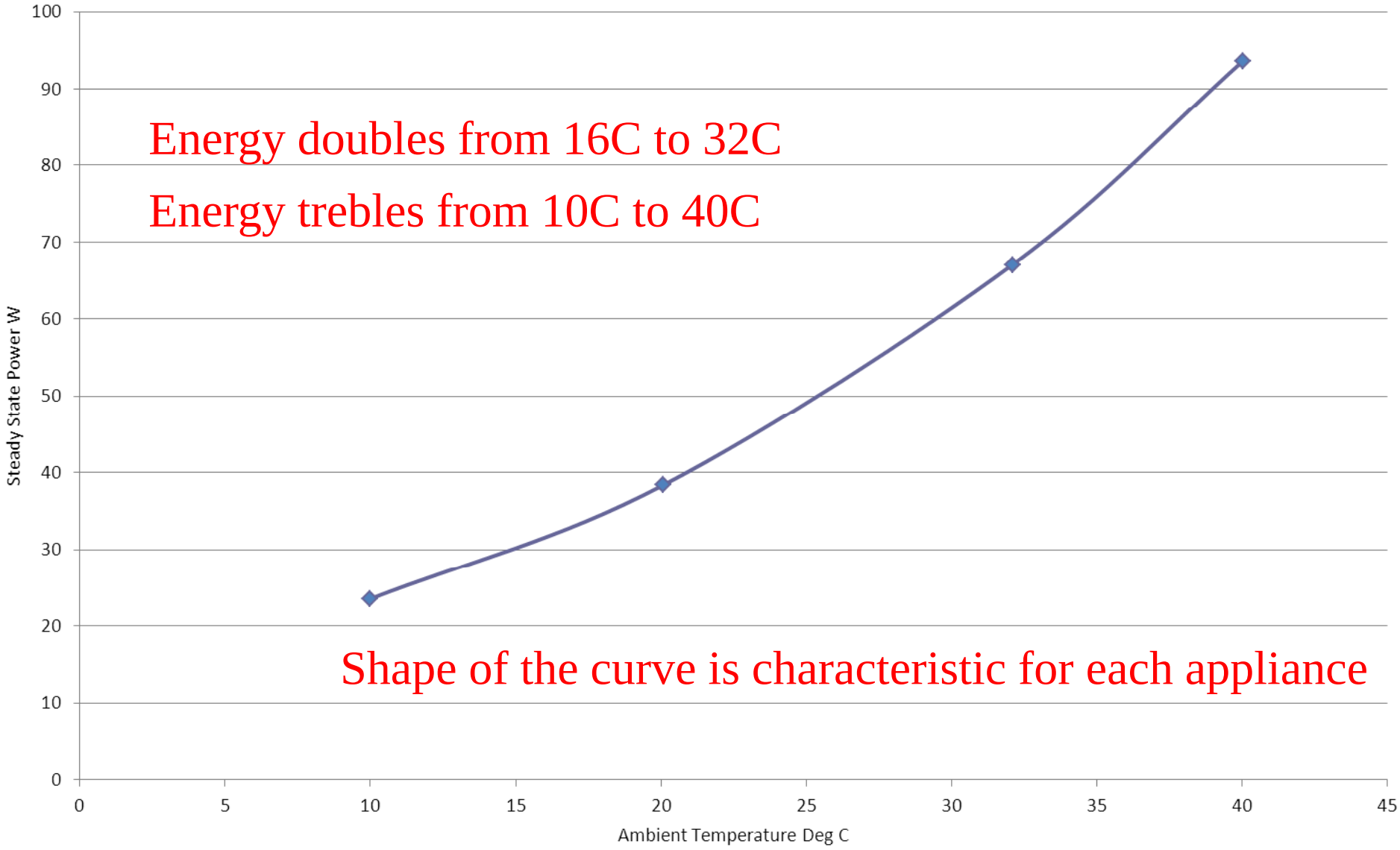

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Field measurements on refrigerators

- Undertaken as part of a PhD investigating refrigerator energy during normal use
- Will cover some 300 refrigerators in the field
  - about 150 in Victoria, 75 in Sydney
  - 40 in Brisbane and 25 in Cairns
  - some regional towns
- Detailed installation survey – age, clearances, household demographics
- Energy and room temperature data usually for >6 months (seasonal effects)

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Key data from field measurements

- Room temperatures show a strong seasonal effect (unconditioned + outdoor = stronger)
- Indoor temperatures vary significantly through the day (5K is common) (U+O more variable)
- Clearances around refrigerators vary a lot, but about 20% have poor ventilation
- About 10% are exposed to a heat source (ovens = low use, less common is direct sun = daily impact)
- For the main refrigerator, door openings for fresh food are roughly 12 per person per day (more with teenage children, it seems)

Seasonal variation of temperatures - Victoria

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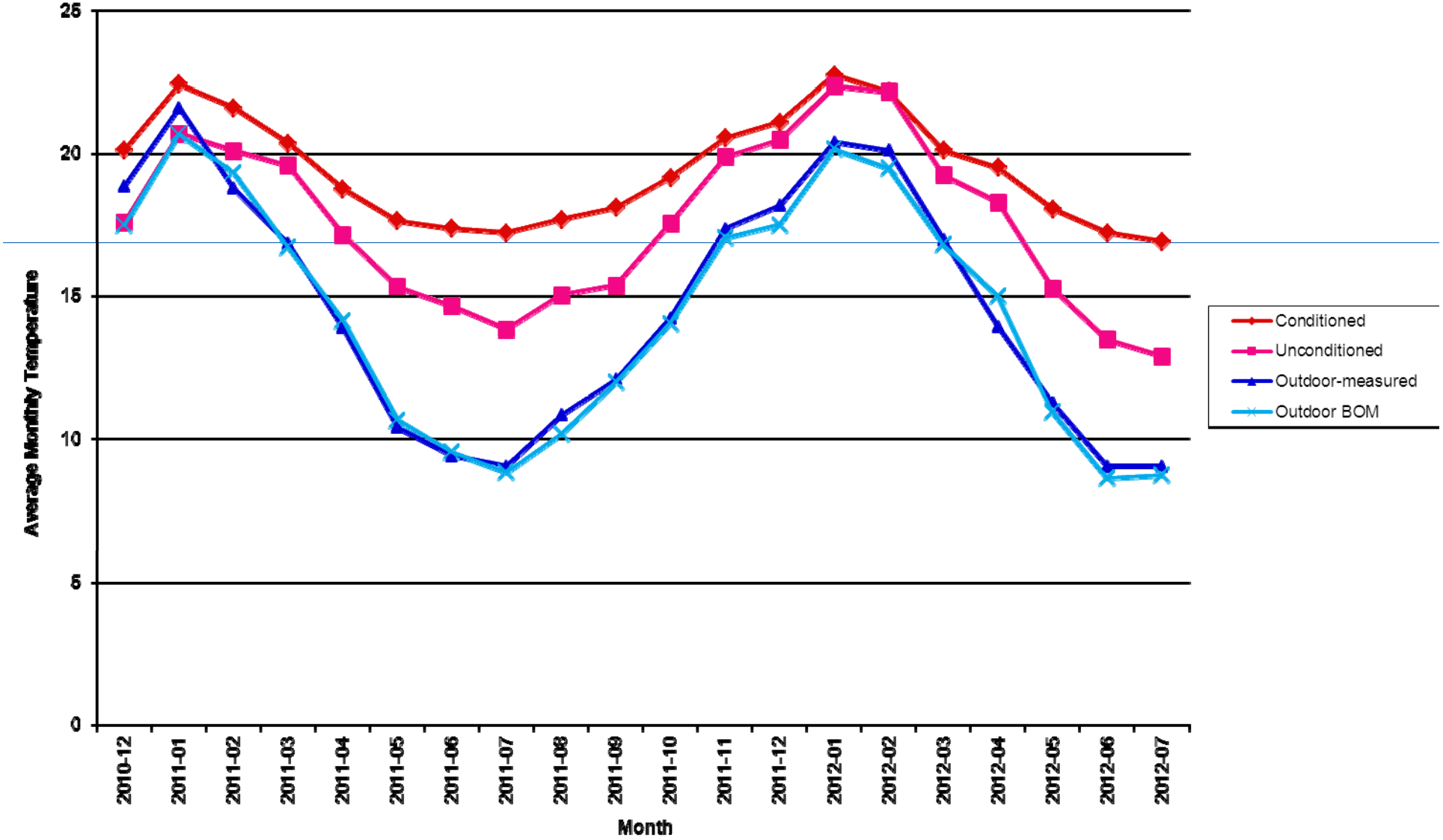

Seasonal variation of indoor temperatures by climate

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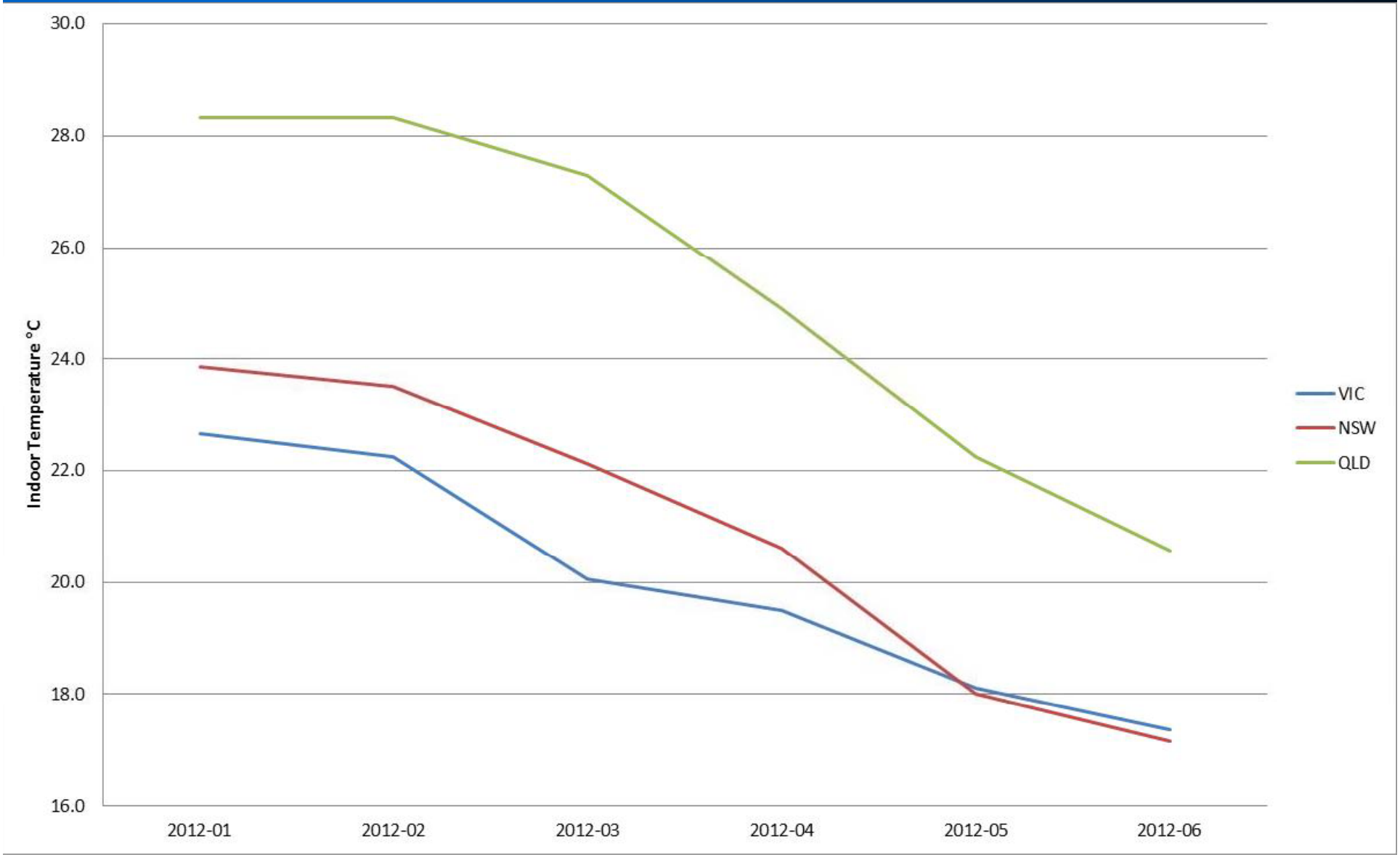

Impact of ambient temperature on energy (VIC)

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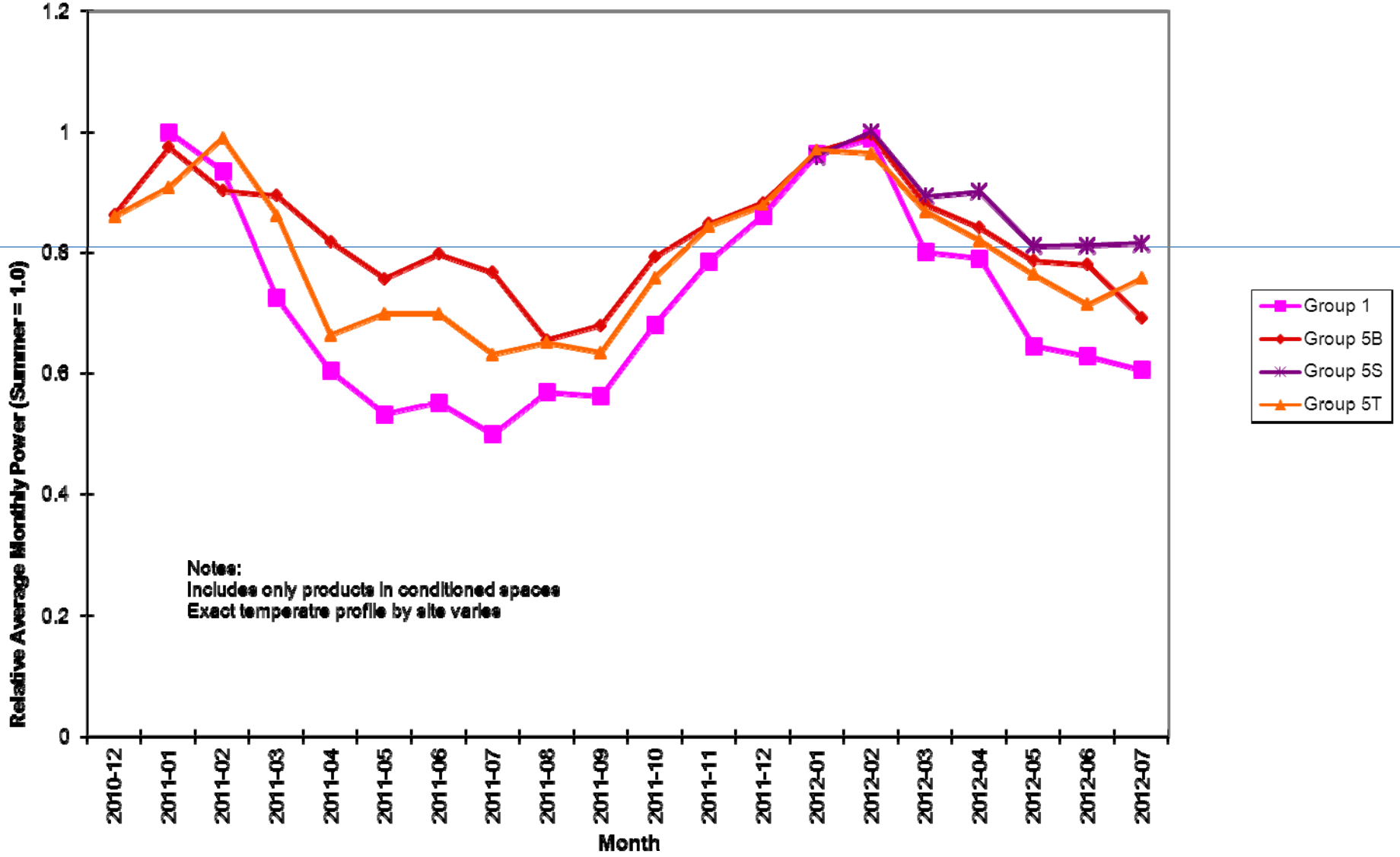

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Test procedure issues

- Energy under the current test procedure is measured in a hot room (32°C), no use – this is far away from normal usage in the home
- Extra energy to deal with user interactions (heat loads) not currently measured
- Focus on defrost and internal temperatures
- Historically, we have ignored important factors (ambient and user loads) with all emphasis on less important ones (defrost, internal temperatures)
- Disconnect between lab measurement and energy during normal use – wrong design paradigm

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New IEC Global Test Method

- energy at two ambient temperatures
- explicit measurement of load processing efficiency
- same approach to compartment temperatures
- better disaggregation and characterisation of defrost and recovery energy
- explicit inclusion of specified auxiliaries
- Allows regions to put the LEGO blocks together in a way that can estimate energy during use

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IEC global test method status

- Currently released as Committee Draft for Voting
- Publication in late 2013 or early 2014
- Japan likely to adopt quickly after publication
- AU proposing adoption by 2015
- USA has aligned with most elements of new IEC
- Also under consideration in a number of Asian countries
- Alignment in major trading partners offers many benefits (reduced testing, cooperation on compliance, international benchmarking)

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Regulatory changes in 2015/2016

- Australia is proposing alignment with new US 2014 MEPS levels, commencing in 2015/2016
- Papers included on www.energyrating.gov.au
- New MEPS levels will result in 30% reduction in average energy across most groups
- Moving to new IEC test method
- Rebasing energy labelling to be closer to normal use using IEC test elements
  - Weighted average of 2 ambient temperatures
  - Inclusion of processing load

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Conclusions

- Refrigerators and freezers are a major consumer of electrical energy in Australia and around the world
- Energy policies in the past have delivered large energy savings
- Next round of MEPS levels for 2015/2016 will deliver further substantial energy savings
- Despite the continued strong downward trend in energy over nearly 3 decades, real prices have also been falling in parallel

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Conclusions

- Despite widespread global regulation of refrigerators and freezers for energy, there has been poor alignment of test procedures
- Existing test procedures are generally inadequate as they cannot reflect typical use
- While our AS/NZS test procedure for refrigerators and freezers is “State of the Art” in terms of methodology, it is far from normal use and is not aligned with other regions (they are all bad)

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Conclusions

- The new global IEC test method for refrigerators and freezers provides a rare opportunity to rebase our energy labelling scheme to be closer to normal use
- This will reward manufacturers who can design low energy products in the field
- It will also allow international cooperation on energy policy issues such as compliance, benchmarking and fast-tracking of globally acceptable efficiency requirements

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The End

- thank you