Towards a global framework for energy efficiency metrics

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Energy Efficient Strategies

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Overview

- The concept of energy efficiency
- How could we define common efficiency metrics?
- How efficiency metrics underpin energy labelling and MEPS programs
- The importance of test procedures
- Prospects for a global system
- Complimentary measures

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What is energy efficiency?

- Energy efficiency is defined as the energy service per unit of energy consumption
- To assess energy efficiency we need to quantify both the total energy consumption (input) and the energy service that is delivered (output)
- Ignoring the energy service can lead to many substantial problems

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What is an efficiency metric?

- Determination of energy input is usually quite straight forward (electricity or fuels)
- Measuring the energy service can be tricky
- Some metrics are well known (eg EER for air conditioners) but some are hidden/complex
- For many products, quantifying efficiency metrics is obvious - especially where the energy service delivered can be determined in terms of an energy equivalent - examples are EPS, motors, air conditioners, hot water

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What is an efficiency metric?

- For more complex products, measuring the energy service (output) is complex, either because the outputs themselves are subjective in nature or there are two or more outputs which are not directly correlated, or there are other inputs that are important (eg water)
- Less complex examples where there is some prospect of agreement on the energy service:
  - Dry clothes from clothes dryers
  - Acceptable storage temperatures for refrigerators

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What is an efficiency metric?

- More complicated metrics are:
  - Dishwashers - washing and drying performance, detergent and water consumption (inputs)
  - Clothes washers - washing, spinning, gentleness, rinsing, detergent and water consumption (inputs)
  - Evaporative air conditioners (water, sensible/latent)
  - Televisions - picture quality and brightness, sound, digital tuning and related services
  - Computers and IT equipment, network related issues
  - Lighting - lumen output can be quantified but lighting quality, CRI and user comfort is complex

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Applying efficiency metrics

- Once we know how to determine the energy efficiency of a product using a metric, we can develop a series of equations (or algorithms) which can be used to compare the efficiency of different products
- These algorithms are used as the basis for energy labelling schemes (grading) or for defining minimum efficiency standards (or MEPS)

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Global efficiency metrics?

- If we could agree on test procedures and ways to evaluate or quantify energy service outputs, there is a good prospect for the development of global efficiency metrics
- This has already been achieved for external power supplies (grading system I to V) and development of such a scheme for electric motors is in progress

Pros and Cons of global efficiency metrics?

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- Allows new countries and regions to set efficiency requirements without having to "reinvent the wheel" - draw on global experience and expertise
- Manufacturers will know how their products rate and the region in which they comply or the relevant efficiency grade or rating
- One stop shop for testing for export markets
- Allows international benchmarking

Pros and Cons of global efficiency metrics?

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- Allows countries to adopt levels with timing that is locally relevant and cost effective within a consistent framework
- Gives a menu of efficiency metrics that can be used for labelling or MEPS programs
- However, bad regulations or lots of different existing regulations will stifle the ability to replicate or move to a global approach
- Very large blocks like US and EU will be difficult to move from historical practice

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What are the prospects?

- For products which are not regulated, there is a real prospect for a global approach for test methods and efficiency metrics
- Some products already regulated may have reasonable prospects for harmonisation
- However, many products have been regulated for many years and there are sometimes very different approaches which are already deeply embedded in regulations - there will be substantial inertia to change

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What are the prerequisites?

- Harmonised test procedures - this is the fundamental building block for any global approach to efficiency metrics, energy labelling and MEPS
- If prospects for alignment of test procedures are poor, then there is no chance of developing a global approach to energy efficiency
- Alignment of test procedures will only occur if we can make them globally applicable

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What is a test procedure?

"Test procedures are the method of test used to determine appliance performance, energy consumption and hence energy efficiency. They are critical in that they allow the comparison of products on a fair basis."

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Why align test procedures?

- facilitates international trade
- decrease testing and approval costs
- allow the free movement of the most efficient products (products with a low energy efficiency may be barred if they do not meet local MEPS)
- facilitate international comparisons (based on a uniform metric)
- assist in the diffusion of advanced energy saving technologies.

What makes a good global test procedure?

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- Making good global test procedures can be a real challenge for some products
- For a test procedure to be global it needs:
  - Set a realistic task for energy determination
  - Be relevant to normal consumer use
  - Reflect different usage patterns generically
  - Be able to reflect differences in climate and weather in different countries (for products that perform heating and cooling, including water heaters and refrigeration)
  - Deal with new technologies, anti-circumvention

What are some bad approaches in test procedures?

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- Some of the current IEC and ISO test procedures are poor because:
  - They have no way to deal with climate impacts - this encourages many local deviations
  - They have built in particular user related profiles (eg cooling or heat load pattern, hot water drawoff profiles) - these also encourage local deviations to make them locally relevant
  - Contain test conditions that are not relevant
  - Do not provide a realistic task to perform (allows circumvention, compliance issues)
  - They do not give energy regulators what they need

How can we plan for better test procedures?

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- Ensure there is a capability of dealing with weather or temperature related impacts
- Determination of energy over the whole output range (curve or series of curves)
- Combination of physical measurements and simulation to cover a wide range of possible usage and operating conditions (climate)
- Quantifying the impact of user interaction and/or temperature/climate in a generic way so that any desired user profile or condition can be calculated without further testing (for discrete modes)

How can we plan for better test procedures?

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- Governments and regulators should clearly define the types of efficiency metrics they want for each product type (coordinate?)
- Large corporations should clarify their policies on global approaches to testing
- We need to get the right people onto standards committees that understand the basis for a global approach - a balance of technical expertise together with a political vision

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Dealing with complex outputs

- Within the framework of energy efficiency, consumers will be potentially confused when they have to assess multiple criteria (eg is washing level A and energy D better than washing level D and energy A?)
- In these cases, efficiency comparisons can be simplified if minimum requirements are set for secondary parameters - this provides a level playing field for efficiency comparisons
- However, subjective evaluations (what are clean clothes?) will be always problematic globally: cultural, habits and usage issues to consider

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Preliminary product assessment

- Provides an initial impression of major energy using products
- Major questions that have to be asked for each product are:
  - Is the test method global?
  - Is an efficiency metric likely to be possible
  - What is the level of existing regulation - how much baggage or inertia would we have to overcome to achieve a global metric?
  - What are the prospects

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Electric motors

- Test method: IEC and NEMA now aligned (direct measurement stray losses), but old IEC still widely used
- Efficiency metric: Efficiency vs shaft power over a wide output range widely agreed (curve)
- Regulatory regimes: Wide range of different mandatory and voluntary programs in place, range of test methods (old IEC, JIS, new IEC with various options)
- Reasonable prospects, work under way

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External power supplies

- Test method: Agreed international method, but not yet published by IEC
- Efficiency metric: Efficiency no load plus 25%, 50%, 75% and 100% rated output widely agreed (curve is ideal), range of efficiency levels now defined (I to V, VI in development)
- Regulatory regimes: Mandatory and voluntary programs in place China, USA, Australia and soon EU Korea Japan, all using same metrics
- Already achieved if others copy the approach

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Lighting

- Test method: Wide use of IEC, mostly fine, but complex side issues, CFLs not covered yet
- Efficiency metric: Lumens output widely accepted. Issues regarding secondary requirements such as colour rendering and lighting quality (glare)
- Regulatory regimes: Mandatory and voluntary programs in place around the world mostly using similar metrics but with variations
- Work on standardised metrics required
- Need to control other elements like quality and performance to complement, global initiatives

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Household refrigeration

- Test method: All existing methods have major drawbacks, these do not reflect use or climate effects (JIS very complex)
- Efficiency metric: Typically adjusted volume per kWh, but meaningless as test method does not give a sensible measure of energy related to use
- Regulatory regimes: Most regulated product type in the world for labelling and MEPS, many approaches deeply entrenched in regulations
- Fairly much a disaster without a global test method that can reflect use and climate

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Dishwashers

- Test method: IEC used widely around the world, except in North America - arguments about type and amount of soil vs adhered soil, soil drying
- Efficiency metric: Clean and dry dishes. Little agreement of minimum levels that may be acceptable for “clean”, water and detergent inputs
- Regulatory regimes: Only regulated in a limited number of developed countries, but approaches entrenched in regulations (DOE vs EU vs AU)
- Some prospects for global metrics if test method and acceptable performance requirements agreed

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Air conditioners

- Test method: ISO used widely around the world, except for central and mini-splits in USA. However, concern about variable output systems could create many approaches in the near future
- Efficiency metric: Cooling or heating power output. How this varies by climate and output (inverters) not yet quantified (issue)
- Regulatory regimes: Widely regulated mostly using EER at T1, US different (SEER), Japan looking for seasonal efficiency, inverters now common
- Good prospects if key test points plus simulation can cover all climates and usage patterns

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Hot water

- Test method: No international test methods of note, ISO looking at solar systems, but bogged down. Need to deal with climate, many fuel types (including solar), storage complex, diverse user profiles
- Efficiency metric: Hot water output plus user interaction + climate impacts (solar is big)
- Regulatory regimes: Widely regulated in many countries, usually a specific set of conditions and specific usage patterns which are not at all global
- Poor prospects unless ISO can get physical testing plus a modelling approach to simulate climate and user impacts for all fuel types

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Clothes Dryers

- Test method: IEC used in Europe and some other countries, some local procedures (US, AU)
- Efficiency metric: kg of dry clothes, some debate about “dry”, initial moisture content (washer spin performance) is biggest global variable
- Regulatory regimes: Regulated in some countries, usually at a specific initial moisture content that is locally relevant
- Good prospects - draft IEC method to test at 2 initial moisture contents which will allow interpolation to any desired initial moisture - no need to retest ever, some issues with washer-dryers, condensers

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Televisions

- Test method: Old IEC method not applicable to flat screens, but strong global effort to develop new procedure within IEC nearing completion
- Efficiency metric: screen size, but picture can affect energy - standardised clips, some debate about features and screen settings/brightness
- Regulatory regimes: Not regulated in many places at this stage - Top Runner in Japan and China has MEPS. Energy Star level. About to be regulated by AU, maybe EU and US soon
- Good prospects as not much existing regulation and good participation in new IEC method, perhaps not enough cooperation on metrics at this stage

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Washing machines

- Test method: Existing IEC very Euro-centric, barely applicable to top loading or impeller or cool washing
- Efficiency metric: kg clean clothes, but also spin, gentleness and rinsing are important, water and detergent inputs complicate the equation
- Regulatory regimes: Regulated in many countries. Massive differences in regulatory approaches
- IEC Edition 5 is a big step forward (2009), but there are still issues, consumer habits and practices and variations in detergents and water hardness make defining a metric hard, big differences in regulation would suggest poor prospects

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Home entertainment (not TV)

- Test method: Existing IEC probably OK, set top boxes are more complex - separate
- Efficiency metric: energy service is sometime a bit unclear, much energy used in non active modes, most power in active mode probably not essential
- Regulatory regimes: Regulated in a few countries, mostly non active mode limits as covered by standby and Energy Star
- Reasonable prospects on non-active mode requirements through standby regs, set top boxes should be OK, active mode for other HE unclear

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Information Technology

- Test method: Existing IEC measures energy consumption by mode (many modes)
- Efficiency metric: energy service is very unclear, large fixed energy requirement, incremental task energy small, most normal usage is very small
- Regulatory regimes: Mostly Energy Star, some country requirements, being considered in some countries
- Reasonable prospects for mode harmonisation, but energy management, especially in networks, is the missing link

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Space heating

- Test method: Some IEC and ISO methods but not used much, mostly local or home grown
- Efficiency metric: Heating output. Energy in vs energy out, plus user+climate impact
- Regulatory regimes: Regulated in many countries, usually a specific set of conditions and specific usage patterns which are not at all global (local climate)
- Poor prospects, multiple fuels creates many issues for a comparative system of metrics, many different regulatory approaches

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Standby

- Standby defies the logic of the efficiency paradigm
- In simple terms, standby provides “functions” but the power levels necessary are typically very low
- Standby is more usefully characterised as “waste” and most standby functions are secondary
- Energy savings can be achieved through low technical power levels - technically close to zero can be achieved for many functions
- Power management is the biggest energy saving potential (auto step to lower modes)
- Network issues present large issues to be solved

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What makes a good label

- Clear attractive design, recognised
- Categories work best - but not too fine
- Needs to give consumers guidance on “good” and “bad”,efficiency (what is best)
- Has to communicate to consumers
- Design issues:
  - avoid small print, make understandable
  - Grade steps are meaningful >15% per grade
  - Address language /literacy, cultural issues

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Making labels work

- A label is one part of the efficiency jigsaw
- Complementary measures will improve their effectiveness
- Websites can provide more detailed information, listings of all products, listings of the best products
- Verification and compliance is critical for program integrity and effectiveness, including registration and surveillance (consumers are getting the efficiency that they choose)
- Evaluation to track effectiveness

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Summary

- Harmonised test procedures are the key to developing global efficiency metrics
- IEC and ISO are the bodies to develop global test procedures, but key stakeholders need to have a vision of a global test procedure and actively work towards this goal
- Global efficiency metrics are feasible for many products, but certainly not all
- Efficiency metrics do not belong in IEC/ISO - too slow to develop and maintain, too many diverse interests to reach consensus

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Quote from Despair.com

Tradition:

Just because you've always done it that way doesn't mean it's not incredibly stupid…….

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The End

More information see:

www.energyrating.gov.au

- thank you