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Off-grid and weak-grid cooling appliances
A TECHNOLOGY ROADMAP

Jeremy Tait, for CLASP and the Efficiency for Access coalition
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Agenda

- Cooling appliance scope
- How stakeholders shaped the Roadmap (over 60 of them)
- About the off-grid cooling appliance market now
- Priorities to develop a sustainable future market
- Next steps - including R&D grants

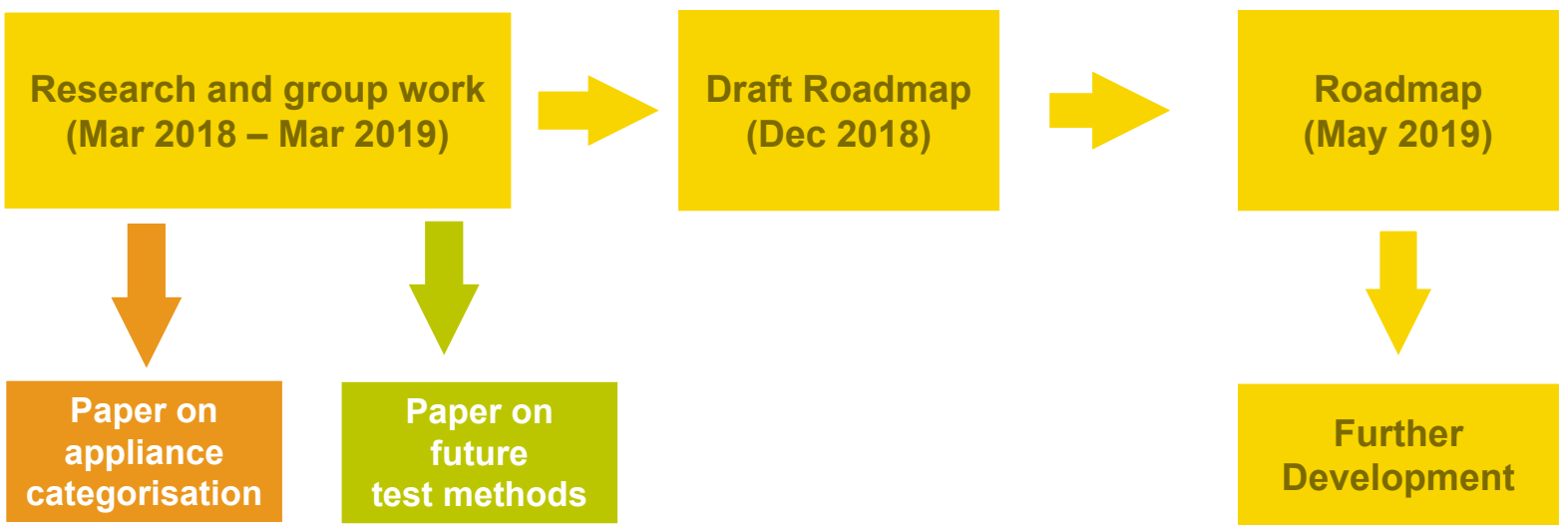
Scope of appliances under the roadmap

*"An insulated cabinet with one or more compartments that are controlled within specific temperature range(s) and suitable for **household** or **small commercial** use for the **storage of foodstuff** and/or **generation of ice** in off-grid and weak-grid communities, prioritising rural and peri-urban low resource environments"*

How stakeholders shaped the Roadmap

- Amsterdam workshop, May 2018 (>45 stakeholders)
- 3 TWG conference calls (>20 each)
- 4 Breakout focus groups
- Bilateral stakeholder calls
- Desk research

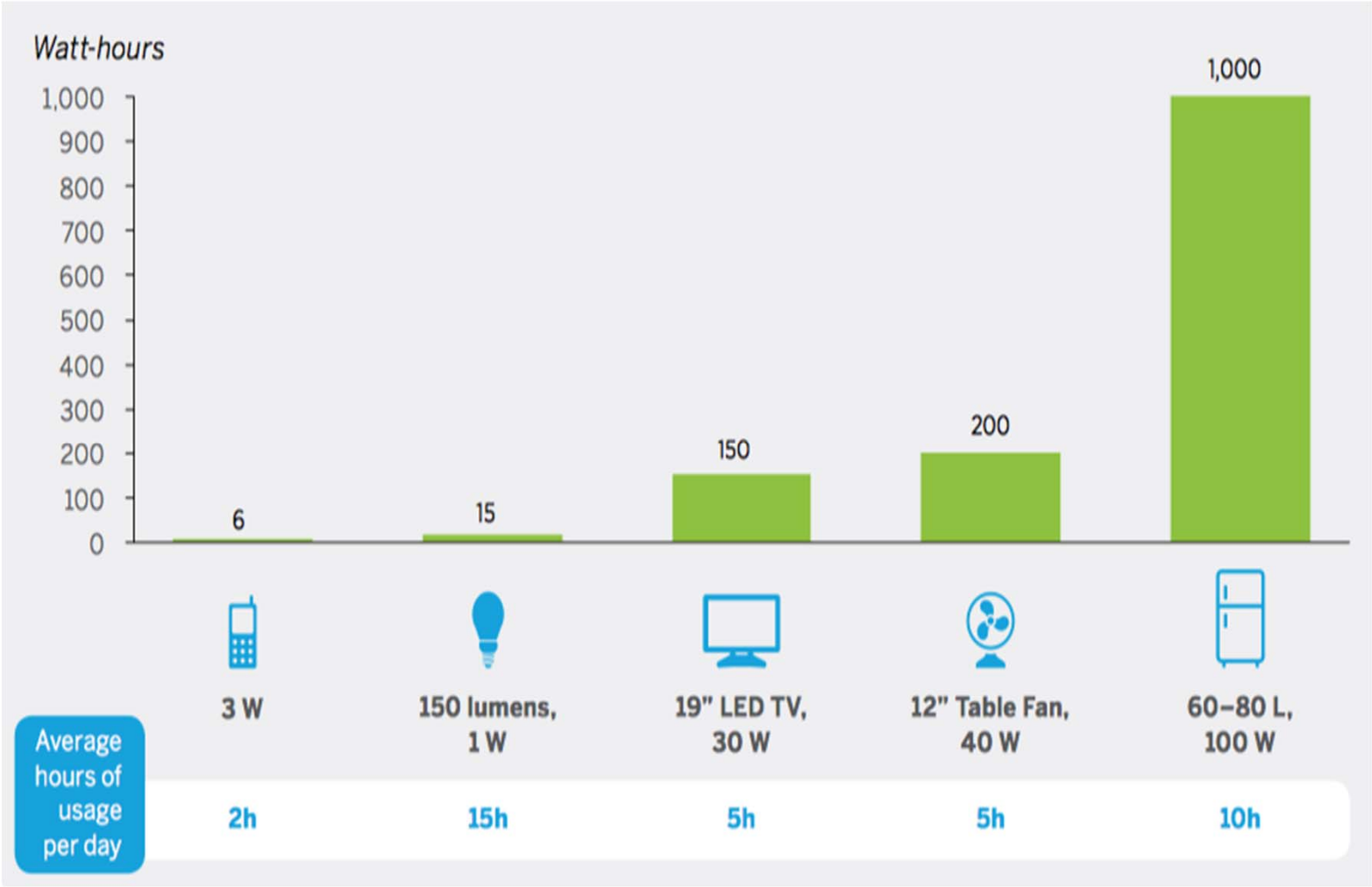
- Comments on draft from 14 external organisations
- Over 300 suggested improvements & clarifications
- Bilateral stakeholder discussions on key sections
- Review by LEIA Team



The off-grid cooling appliance market now *(simplified table)*

Type of usage	For off-grid	For weak / mini grid	Verdict:
Household refrigerator	A few SDD options in place but very limited PAYG	Mostly small conventional grid appliances used; very limited PAYG	Poor economics; low penetration
Small commercial cooling	Limited but growing usage	Conventional grid household appliances mostly used	High demand; ok economics; slow uptake
Small ice maker	A few small R&D pilot machines, or repurposed household freezers	Some repurposed household freezers, plus a few great demo plants	High latent demand; almost no supply; ok economics

A disruptive addition to a Solar Home System (SHS): *Power demand can be x3; total appliances cost x5*



Average energy consumption of mainstream household appliances, adjusted for average hours of use (estimate extrapolated globally from economic analysis of ten developing economies).
(source: The State of the Global off-Grid Appliance Market, Dalberg for Global LEAP, 2016)

Challenges

- High power demand, especially for ice making
  SHS not designed for refrigerators yet; mini-grid ok
- Challenging economics in off-grid situations
  Very challenging for homes; better for productive use
- Poor appliance availability
  Few purpose-made; majority are ex-household grid appliances
- Poor transparency on performance & compatibility
  No international test methods or data formats
- Harsh conditions mean often poor reliability
  Failure rate high; appliances not reparable

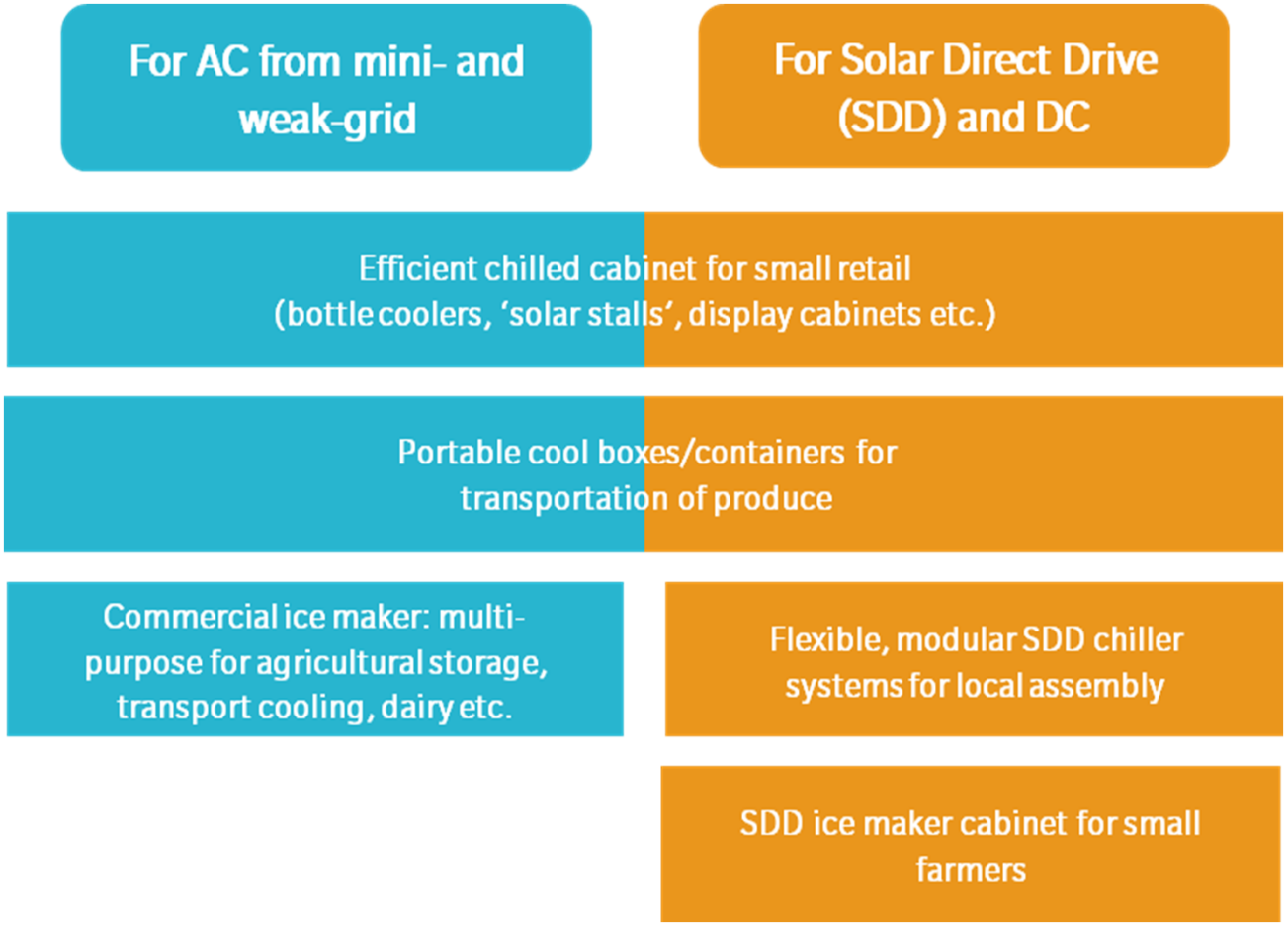
Refrigerating appliance needs

Refrigerated storage

Ice making

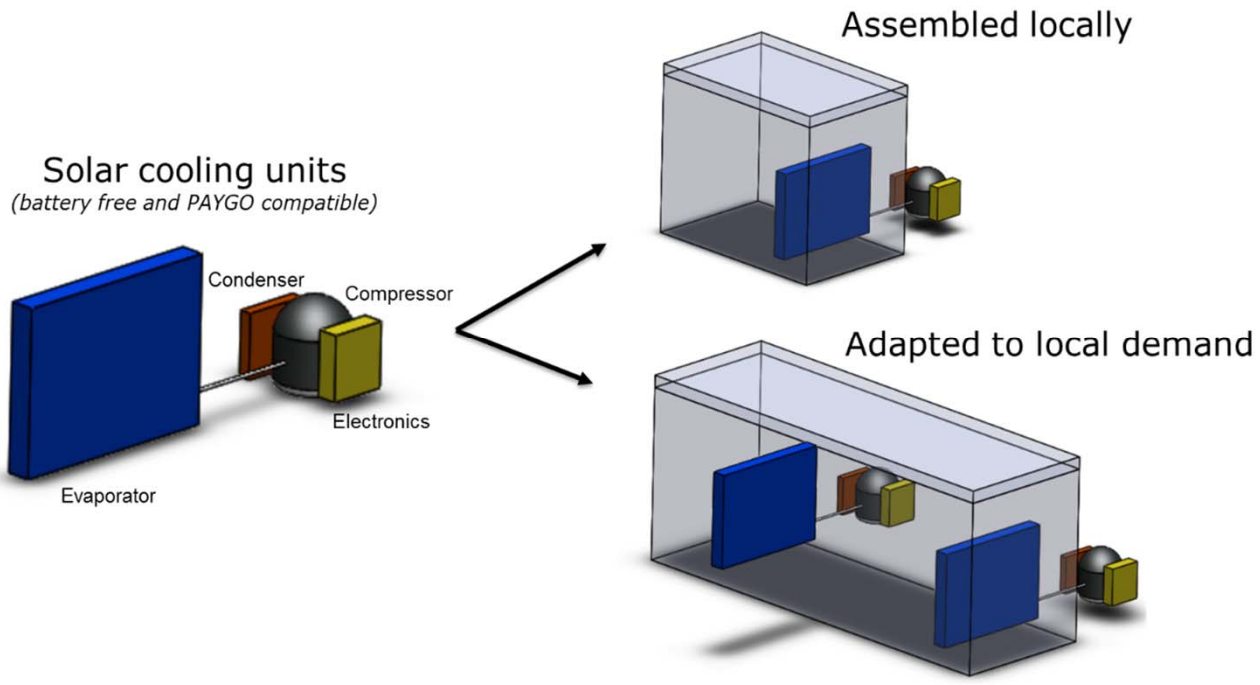
Chilled transportation

Refrigerating appliance needs



Refrigerating appliance needs

Flexible, modular chiller systems for local assembly, an example:

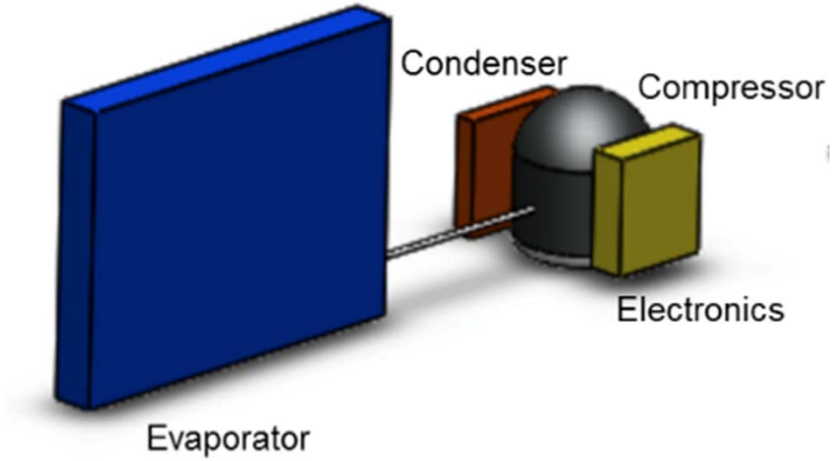


Source of images: 'Do It Yourself solar cooling units', project by University of Hohenheim,
GIZ - Powering Agriculture on behalf of BMZ (German Federal Ministry for Economic Cooperation and Development)

Priority Technologies for a sustainable market

Quick primer:

Appliance main components in a typical electrically powered vapour compression system:



Source of image: University of Hohenheim

Priority Technologies for a sustainable market

- Compressors and controllers
  Wider choice; fully exploit variable speed & efficiency advantages
- Cooling system modular designs
  For ease of transport to place of use, local assembly to suit need
- Control systems
  To manage energy across system with storage and interoperability
- Selection and specification software
  For technical sales, compatibility of appliance and system
- Technologies to increase cooling capacity
  At high ambient temperatures, high humidity

Priority Technologies for a sustainable market

Appliances must also:

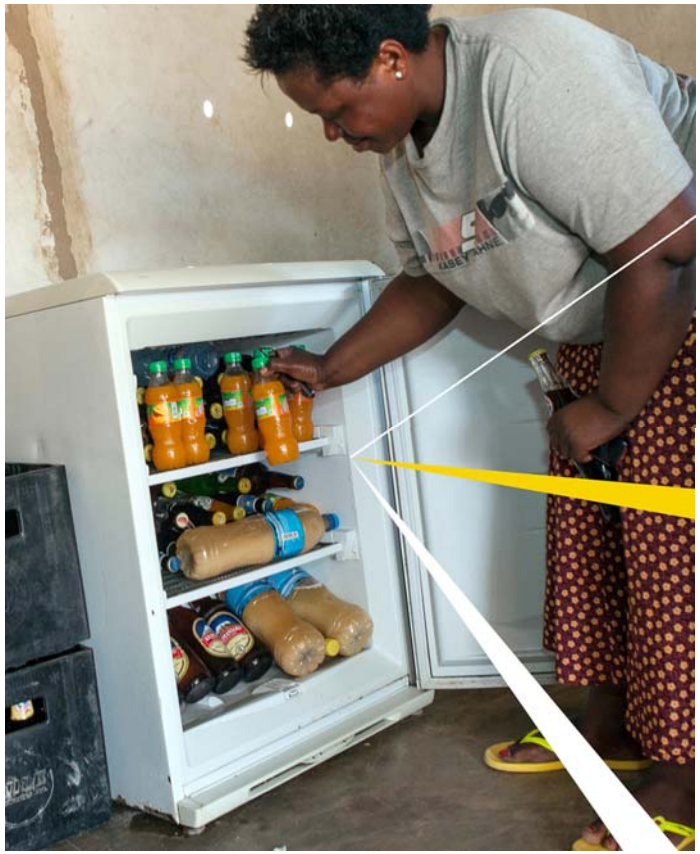
- Achieve PAYG compatibility
- Improve reliability and reparability
- Embrace the circular economy

Market support initiatives, to ensure deployment

- Develop international test standards; facilitate testing; publish performance benchmarks
- Expand financing options
- Develop local technicians to install, maintain and repair
- Market research on affordability, especially with mini-grids
- Raise awareness, encourage supply chains
- Address appliance waste stream, towards a circular economy
- Monitor social & other impacts; address risks

Next steps for the Refrigeration Technology Roadmap

- R&D grants for technologies: www.efficiencyforaccess.org/grants
- Partnerships with mini-grid developers?
- Long term plan for QA framework
- More focus on:
  - User relevant test methods
  - Ice making



For a copy of the roadmap soon,
sign up for the newsletter:
www.efficiencyforaccess.org/newsletter

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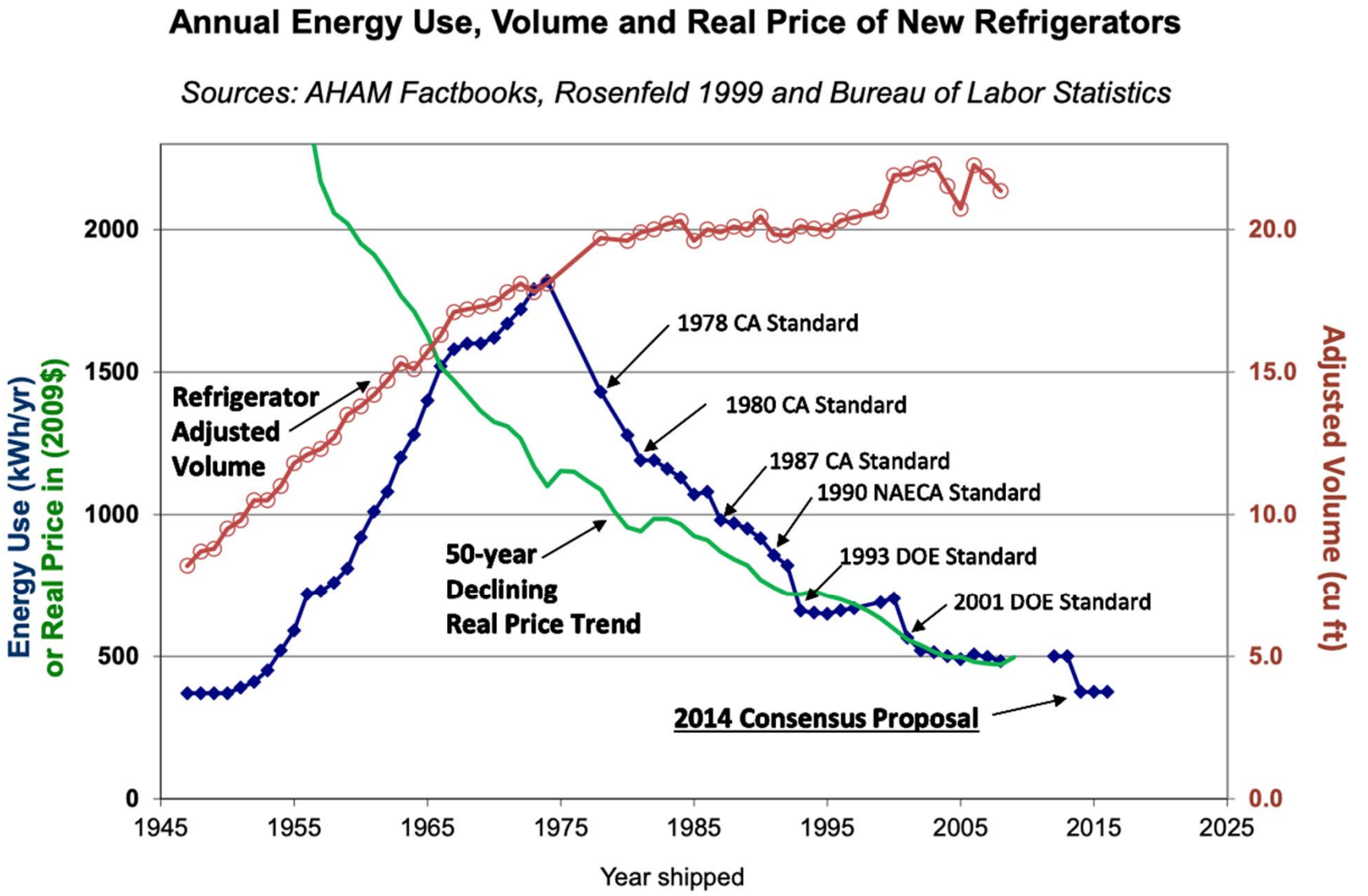
Refrigerator efficiency improvement 1950-2015



CRITICAL requirements *(common to all appliance types)*

1. Effective cooling at high ambient temperatures
2. Affordability (considering the full value proposition)
3. Good ‘holdover time’ (without relying on stored energy)
4. Good electrical resilience / survivability
5. Long service life (good durability)
6. Ease of maintenance and reparability
7. Ease of transportation (to place of use)
8. Meet environmental impact expectations
9. Accessible design appliances (gender, disability)