Workshop on Case Studies of Refrigerators/Freezers Design and Implementation under Energy Efficiency Regulation (EWG 07 2017A)

Introduction to the EWG 07 2017A and Its Implementation Status

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Washington DC
April 9, 2018

Outline

- Project information
- Objectives of the project
- Work plan and timeline
- The energy saving technology seminar and the 1st technical expert group meeting
- Analysis of questionnaire results
- Summary and future work

Project Information

- Proposing economy: Chinese Taipei
- Co-sponsors: China, Korea
- Project overseer: Mr. Shiaw-Jiun Bor, senior specialist at BOE
- Project time period: July 1st, 2017 to Dec. 31st, 2018
- Budget: APEC funding $80,000 + Self-funding $40,000

- This project aims to widespread high efficient refrigerator technologies and energy efficiency (EE) management experience.
- This project works on experience review and information exchange for EE management to accelerate the development, promotion, and application of energy saving technologies for refrigerators.

Objectives of the project

1. Evaluate energy efficiency management system and policies for refrigerators, provide policy suggestions for the APEC economies
2. Evaluate and identify feasible refrigerator energy saving technologies under EE regulation
3. Study practical method of the selected case to improve market share of high efficient refrigerators
4. Establish a refrigerator energy-saving knowledge-sharing platform and integrate EGEE&C network to share knowledge of refrigerator energy saving design
5. Spread project experience, share the best practice and collect comments from the APEC economies

Preparation work

Time	Work plan	Outputs
July-Oct. 2017	• Set up a work plan • Design questionnaire and distribute the questionnaire to the APEC economies in mid-October • Survey for publications about energy saving technologies in refrigerator EE improvement • On behalf of the BOE, prepare to hold an energy saving technology seminar in Chinese Taipei	Work plan and questionnaire design
Nov. 2017	**An Energy Saving Technology Seminar for Refrigerator/Freezer Energy Efficiency Improvements in the APEC Region** • Establish a technical background for international experts of seminar and summarize the presentations to conduct research of the latest refrigerator energy saving technologies. • Establish a technical background for representatives from developing economies in the seminar and summarize the experience sharing on refrigerator EE improvement for each economy • The 1st technical expert group meeting will be held the second day of seminar. • Summarize the outcomes and suggestions of the seminar and the 1st technical expert group meeting	Self-funds an Energy Saving Technology Seminar for Refrigerator/Freezer Energy Efficiency Improvements in the APEC Region

Work plan and timeline (1/2)

Time	Work plan	Outputs
Jan. - Feb. 2018	**Technical Review and survey regarding energy efficiency improvements of refrigerators/freezers** ☐ Review the results of previous relevant APEC projects, including 'Harmonization of Energy Efficiency Test Methods of Refrigerators' (EWG 04 2014A). ☐ Analysis of questionnaire responds from APEC economies about refrigerator/freezer EE management	Two written reports ① research of EWG 04 2014A project, initial findings of questionnaire survey ② Minutes of the technology seminar and the 1st technical expert group meeting in Nov 2017
Feb. - April 2018	**Case Studies of Refrigerators/Freezers Design and Implementation under Energy Efficiency Regulation** ☐ Workshop I will be held during the 51st APEC EGEE&C meeting and experts from different economies can share experiences at the workshop. ☐ The contractor should present the research results at the workshop. ☐ After workshop I, gather representatives from each economy to the 2nd technical expert group meeting to discuss the resolution on the case studies. ☐ Start writing the investigation report: the result of case studies of refrigerators/freezers design and implementation under energy efficiency regulation	A one-day workshop and the 2nd technical expert group meeting Investigation report

Work plan and timeline (2/2)

Time	Content	Outputs
May - Oct. 2018	**Refrigerator/Freezer Energy Efficiency Improvement in APEC Region: Review of Experience and Best Practices** ☐ Conduct a study of successful EE management programs and identify the best practice. ☐ Draft a report of successful methodologies and outcomes for developing economies. ☐ Hold workshop II during the 52nd APEC EGEE&C meeting. ☐ The contractor should present the research results in the workshop. ☐ After workshop II, gather representatives from each economy to the 3rd technical expert group meeting to discuss the resolution on the case studies.	A one-day workshop The 3rd technical expert group meeting
Nov. - Dec. 2018	**Integrating workshop result into final report** ☐ Submit draft report ☐ Revise the draft report based on comments from the PO, EWG members and the APEC Secretariat. ☐ All reports will be published on the APEC websites for public access. *Completion of the project*	Final report

Energy Saving Technology Seminar for Refrigerator/Freezer Energy Efficiency Improvement in APEC Region (Self-funding)

DATE: November 16, 2017

VENUE: Howard Plaza Hotel Taipei, Taipei City, Chinese Taipei

PURPOSE: Gather international experts to discuss the latest energy-saving technology development of refrigerators/freezers

No.	Topic	Presenter	Organization
1	Integration of Appliance for Smart Home	Dr. Morris Pei-Fang Liang	Industrial Technology Research Institute(ITRI)
2	Technical Reference on Harmonization of Energy Efficiency Test Methods of Refrigerators towards the NEW IEC 62552 among APEC Region	Mr. Andy Li Tie	Vkan Certification & Testing Co., Ltd (CVC), China
3	Next Possible Refrigerant for Environmental Consideration	Dr. Yongming Niu	Honeywell International (China) Co. Ltd
4	State-of-the-art Refrigerator Compressor Design	Mr. Alejandro Vázquez Escámez	Cubigel Compressors, Huayi Bacelona, Electrolux Group
5	System Design for Energy Efficiency Improvement of Household Refrigerators/Freezers	Mr. Tony Wen-Ruey Chang	Industrial Technology Research Institute(ITRI)

Energy Saving Technology Seminar on Nov 16, 2017

- ✓ Six APEC economies participated this seminar, namely China, Indonesia, Malaysia, Chinese Taipei, Thailand, and Viet Nam.
- ✓ 40 attendants from domestic manufacturers and lab representatives participated in the seminar.

Technical Expert Group Meeting

Refrigerator/Freezer Energy Efficiency Improvement in APEC Region: Review of Experience and Best Practices

DATE: November 17, 2017

VENUE: Howard Plaza Hotel Taipei, Taipei City, Chinese Taipei

- ✓ 4 economies share experience on refrigerator energy efficiency management
- ✓ Six APEC economies including China, Indonesia, Malaysia, Chinese Taipei, Thailand, and Vietnam participated in the technical expert group meeting.
- ✓ Total 20 participants from different organizations joined the meeting.

No.	Presenter	Organization	Representing Economy	Topic
1	Mr. Hermanu	PT TUV Nord Indonesia	Indonesia	Review of Experience and Best Practices
2	Mr. Chok Ser Gan	Malaysian Air-Conditioning & Refrigeration Association (MACRA)	Malaysia	Minimum Energy Performance Standards (MEPS) for Refrigerator in Malaysia
3	Mr. Pawatt Suwannakut	Electrical and Electronics Institute (EEI)	Thailand	Experience sharing on refrigerator energy efficiency promotion
4	Ms Doan Thi Thanh Van	Vietnam Standards and Quality Institute (VSQI)	Vietnam	Energy efficiency program for refrigerator/freezer in Viet Nam

Technical expert group meeting on Nov 17, 2017

Site visit to Taipei Public Library Bei-tou Branch (Bei-tou Library)

- ✓ Taiwan's first green library opened in November 2006
- ✓ A wooden building with large windows which allows natural light for internal lighting, and provides better ventilation that reduces the use of fans and AC.
- ✓ Partially PV-covered roof to convert sunlight to electricity
- ✓ Collect rainfall for toilet use

Ref: https://www.travelking.com.tw/eng/tourguide/taipei/taipei-public-library-beitou-branch.html

Initial findings of questionnaire results

Refrigerator/Freezer Energy Efficiency Improvement in APEC Region: Review of Experience and Best Practices

DATE: November 17, 2017
VENUE: Howard Plaza Hotel Taipei, Taipei City, Chinese Taipei

- ✓ On behalf of BOE Chinese Taipei, the questionnaire was distributed to all the APEC economies in mid-October, 2017.
- ✓ Present the initial findings of questionnaire results of refrigerator EE management in the APEC region on Nov 17, 2017

Design of the questionnaire

- ➢ Part 1- Refrigeration Market (Q1-5)
  e.g. Annual sales, adjusted volume, annual energy consumption
- ➢ Part 2- EE management policies (Q6-11)
  e.g. Voluntary and mandatory EE policies
- ➢ Part 3- Test methods (Q12-13)
  e.g. Current refrigerator EE test standard, plan for IEC 62552:2015 adoption?
- ➢ Part 4- Technology needed for refrigerator/freezer EE (Q14-19)
  e.g. DC compressor, refrigerants, VIP for thermal insulation, system design

Questionnaire results
Part 1: refrigeration market

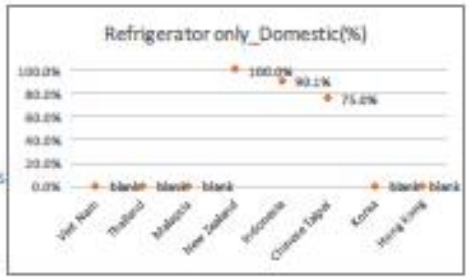
3 types: Refrigerator only, refrigerator & freezer* (compact refrigerator), freezer only

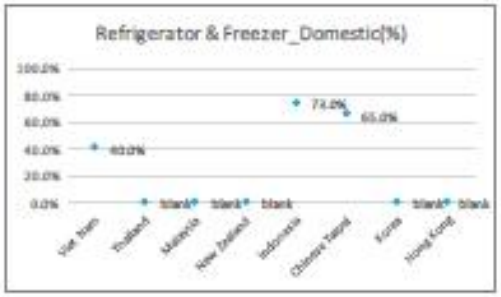
Q1:Annual sales of refrigerators/freezers

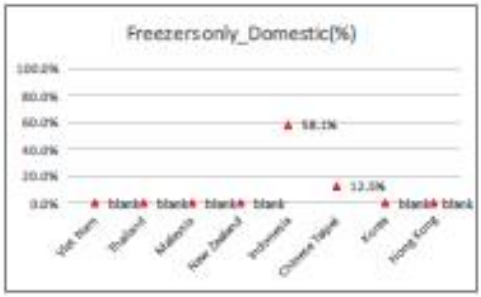
Q2:Annual sales of domestic refrigerators/freezers

Q1-Q2 represents annual sales of imported refrigerators/freezers

*Refrigerator & Freezer refers to one appliance containing both refrigerator and freezer compartments.



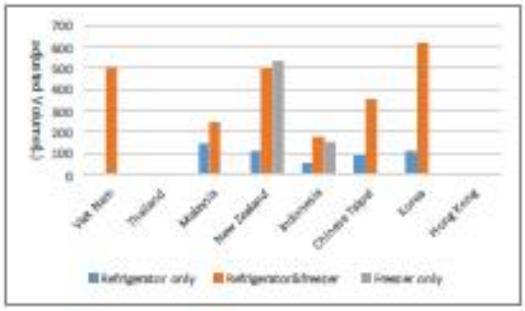


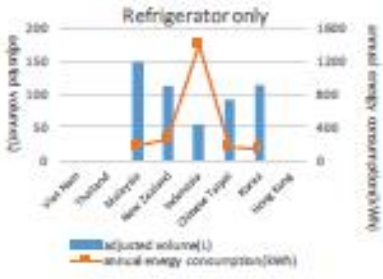


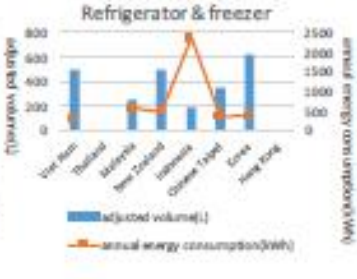
Questionnaire results
Part 1: refrigeration market

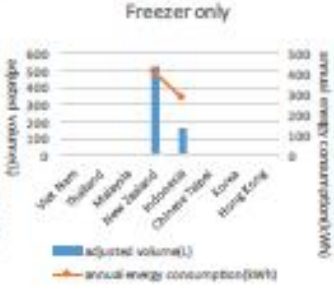
Q3: Adjusted volume which represents the most commonly-used refrigerator/freezer

Q3-1: Annual energy consumption of the most commonly-used refrigerator/freezer.









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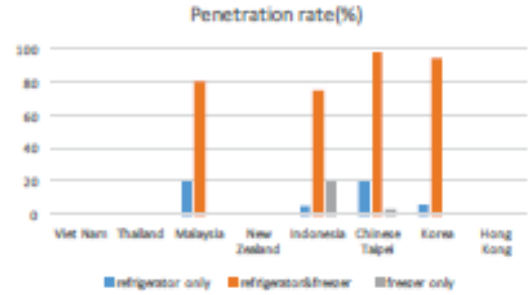
Questionnaire results
Part 1: refrigeration market

Q4:Penetration rate* of refrigerator/freezer

*A penetration rate of 80% means that 80% of households have at least 1 refrigerator/freezer and 20% of households do not have any refrigerator/freezer.

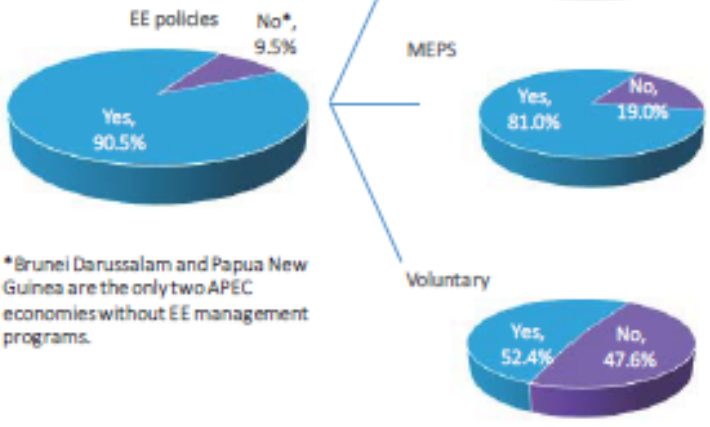


Refrigerator & freezer has the highest penetration rate in most economies.

Q5. How many refrigerators/freezers are there in an average family home?

Economy	Refrigerator only	Refrigerator& freezer	Freezer only
Viet Nam	-	1-2	-
Thailand	-	-	-
Malaysia	1-2	1-2	NA
New Zealand	1-2	1-2	1-2
Indonesia	1-2	1-2	1-2
Chinese Taipei	<1	1-2	<1
Korea	1-2	1-2	NA
Hong Kong	-	-	-

Questionnaire results
Part 2:EE policies



*Brunei Darussalam and Papua New Guinea are the only two APEC economies without EE management programs.

Questionnaire responds:
1. Viet Nam (2011)
2. Malaysia (2014)
3. Indonesia (2017)
4. Thailand (2004)
5. New Zealand (2002)
6. Chinese Taipei (2010)
7. Korea (1992)
8. Hong Kong(2009)**

**Hong Kong, no indication of MEPS

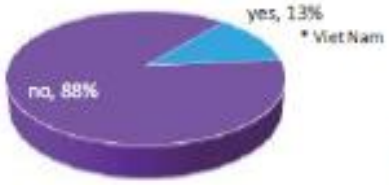
Questionnaire responds:
1. Indonesia (2003)
2. Thailand (1993)
3. Chinese Taipei (2001)
4. Viet Nam (No)
5. Malaysia (No)
6. New Zealand (No)
7. Korea(leaveblank)
8. Hong Kong(1995)

Questionnaire results
Part 2:EE policies

Economy	Q10.Does your economy maintain a registry of approved refrigerators/freezers?	Q11-1.Does your economy have a market surveillance program of efficient refrigerators/freezers?	Q11-2.If yes, how many refrigerators/freezers are tested annually in the market surveillance program?
Viet Nam	Yes	Yes	5
Malaysia	Yes	Yes	when it is necessary
Indonesia	Yes	Yes	depend government buget
Thailand	Yes	Yes	30
New Zealand	Yes	Yes	tested through joint programe with Austhilia
Chinese Taipei	Yes	Yes	40~60
Korea	Yes	Yes	10~20
Hong Kong	Yes	Yes	5% of models approved annually

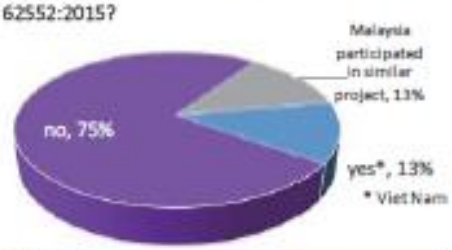
Questionnaire results
Part 3:test method

Q12. Using IEC 62552:2015 for refrigerators/freezers EE testing?



Economy	Current test method	Plan to adopt IEC 62552:2015
Thailand	TIS 2188-2547(2004)	Yes
Malaysia	IEC62552:2011	Yes
New Zealand	AS/NZS 4474.1:2007	Yes
Indonesia	ISO 15502:2008	Yes
Chinese Taipei	CNS2062	Yes
Korea	KS C IEC 62552:2014	Yes
Hong Kong	IEC 62552:2007	-

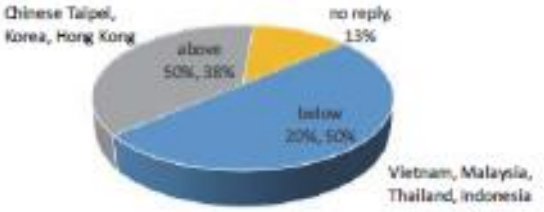
Q13. Did your economy participate in harmonization of EE test methods of refrigerators/freezers toward IEC 62552:2015?



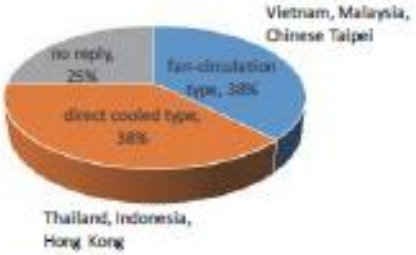
Economy	Q13-2.Does your economy need assistance in standard harmonization in the future?	Q13-3.Please name any assistance needed
Viet Nam	Yes	Update new standards Competence test Round robin test Market surveillance if possible
Thailand	No	-
Malaysia	Yes	Facilities and training
New Zealand	No	-
Indonesia	Yes	-
Chinese Taipei	Yes	Testing procedure & calculation method
Korea	No	-
Hong Kong	No	-

Questionnaire results
Part 4:Technology needed for refrigerator/freezer EE

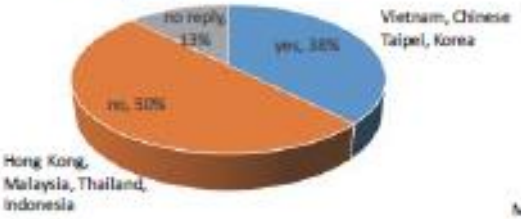
Q14. the percentage of domestic refrigerators/freezers using DC compressors?



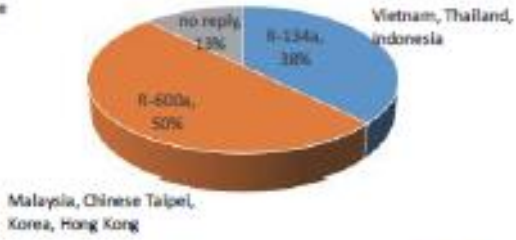
Q15. the most commonly-used refrigerator/freezer type?



Q16. use Vacuum Insulation Panels(VIP) for thermal insulation?



Q17. the most commonly-used refrigerants?



Questionnaire results
Part 4:Technology needed for refrigerator/freezer EE

Economy	Q18.the refrigerator/freezer EE technologies used by domestic manufacturers:	Q19.the technologies your domestic manufacturers need to implement or improve to achieve high refrigerator/freezer EE?
Viet Nam	–	–
Thailand	–	–
Malaysia	• PU foaming insulation • system design	• Compressor technology • system design
New Zealand	–	–
Indonesia	• PU foaming insulation	• Standard harmonization for performance tests • compressor technology
Chinese Taipei	• DC compressor • PU foaming insulation • Vacuum Insulation Panels (VIP) • Heat exchange design • System design	• Smart appliance design • PU foaming insulation & VIP • Standard harmonization for performance tests
Korea	• DC compressor • Vacuum Insulation Panels (VIP) • System design	• Compressor technology
Hong Kong	• DC Compressor	• Compressor technology • Smart appliance design

Technical Review

- Energy saving technology review - international research and development trend survey from open literature and technical reports by many international institutions

- ✓ Over 40 technical publications in open literature were surveyed.
- ✓ Main topics for refrigerator EE improvement:
  - cabinets improvement
  - refrigeration system improvement
  - inverter control
  - system design.

Main trend in domestic refrigeration

Technical Review

- Review of relevant APEC project, i.e. 'Harmonization of Energy Efficiency Test Methods of Refrigerators' (EWG 04 2014A)

➢ Overall objective: to "facilitate energy saving technology innovation for refrigerators and free trade in the APEC region by helping harmonizing current national standards related to energy efficiency testing methods for refrigerators with the IEC 62552 standard".(EWG 04 2014A)

- Desktop Research Report

  Analysis of commonalities and differences between IEC 62552:2015 and refrigerators EE testing standards in the APEC economies

- Laboratory Test Report

  Identify key impacting factors in the commonly used energy efficiency test methods standards with the new IEC62552

- Project Final Report

  Potential pathways/recommendations toward the harmonization for IEC 62552:2015 adoption in the APEC region

Workshop I

DATE: April 9, 2018

VENUE: Embassy suites by Hilton Washington DC conventional center, USA

✓ Representatives from US, New Zealand, Japan, and Chinese Taipei share experience of refrigerator EE management

09:30 - 10:00	Introduction to the EWG 07 2017A Project and its Implementation Status -By Nicole Yun-Tzu Guo, Industrial Technology and Research Institute[ITRI], Chinese Taipei
10:00 - 10:30	Experience sharing of USA on EE promotion of refrigerator/freezer under energy efficiency regulation (Pt.1) -Ms. Stephanie Johnson, Department of Energy, USA
10:30 - 11:00	Group photo and Coffee Break
11:00 - 11:30	Experience sharing of USA on EE promotion of refrigerator/freezer under energy efficiency regulation (Pt.2) -Ms. Rosemarie Stephens-Booker, ENERGY STAR Appliances, Environmental Protection Agency, USA
11:30 - 12:00	Experience sharing of Chinese Taipei on EE promotion of refrigerator/freezer under energy efficiency regulation -Mr. Tony Wen-Ruey Chang, Industrial Technology and Research Institute [ITRI], Chinese Taipei
12:00 – 14:00	Lunch
14:00 - 14:30	Experience sharing of Japan on EE promotion of refrigerator/freezer under energy efficiency regulation -Mr. Hiroki Yoshida, Ministry of Economy, Trade and Industry, Japan
14:30 - 15:00	Experience sharing of New Zealand on EE promotion of refrigerator/freezer under energy efficiency regulation -Mr. Eddie Thompson, Energy Efficiency & Conservation Authority, New Zealand
15:00 – 15:30	Coffee Break
15:30 - 16:00	Conclusion for Case Studies of Refrigerators/Freezers Design and Implementation under Energy Efficiency Regulation -By Project Manager and Technical Woking Group Member Closing of the Workshop
16:00 – 17:00	Technical Expert Group Meeting

Summary and future work

Summary

- ☐ Completed technical review and survey by questionnaire
- ☐ Completed holding an energy saving technology seminar and the 1st technical expert group meeting
- ☐ Hold a one-day workshop and the 2nd technical expert group meeting
- ☐ complete the investigation report

Future work

- ☐ Hold workshop II during the 52nd APEC EGEE&C meeting
- ☐ Invite international refrigerator manufacturers to share practical implementation experience of EE improvement
  - ➢ Expecting manufacturers:
    Hitachi & Panasonic (Japan), LG (Korea), Whirpool (USA), Haier (China), Sampo (Chinese Taipei)
- ☐ Complete final report in Dec.

附件七、中華台北電冰箱能源效率管制經驗分享報告資料

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Workshop on Case Studies of Refrigerators/Freezers Design and Implementation under Energy Efficiency Regulation (EWG 07 2017A)

Experience sharing of Chinese Taipei on EE promotion of refrigerator /freezer under energy efficiency regulation

Tony Wen-Ruey Chang
Green Energy Laboratories,
Industrial Technology and Research Institute (ITRI),
Chinese Taipei
Apr 09, 2018

ITRI

Outline

- Appliance Efficiency Standards
- History for EE promotion of refrigerators
- MEPS & EE Label Standards for refrigerators
- Evaluation for Energy Saving Potential
- EE Technologies and Design Concept to Fit the new Standards
- Future Work--Harmonization towards IEC 62552
- Conclusion

Appliance Efficiency Standards in Chinese Taipei

- Mandatory Energy Efficiency Management Programs
  - MEPS since 1981
    22 product categories
  - Energy Efficiency Grade Labeling
    14 product categories

- Voluntary Energy Efficiency Management Program
  - Energy Conservation Label
    51 product categories

Mandatory Energy Efficiency Management Programs

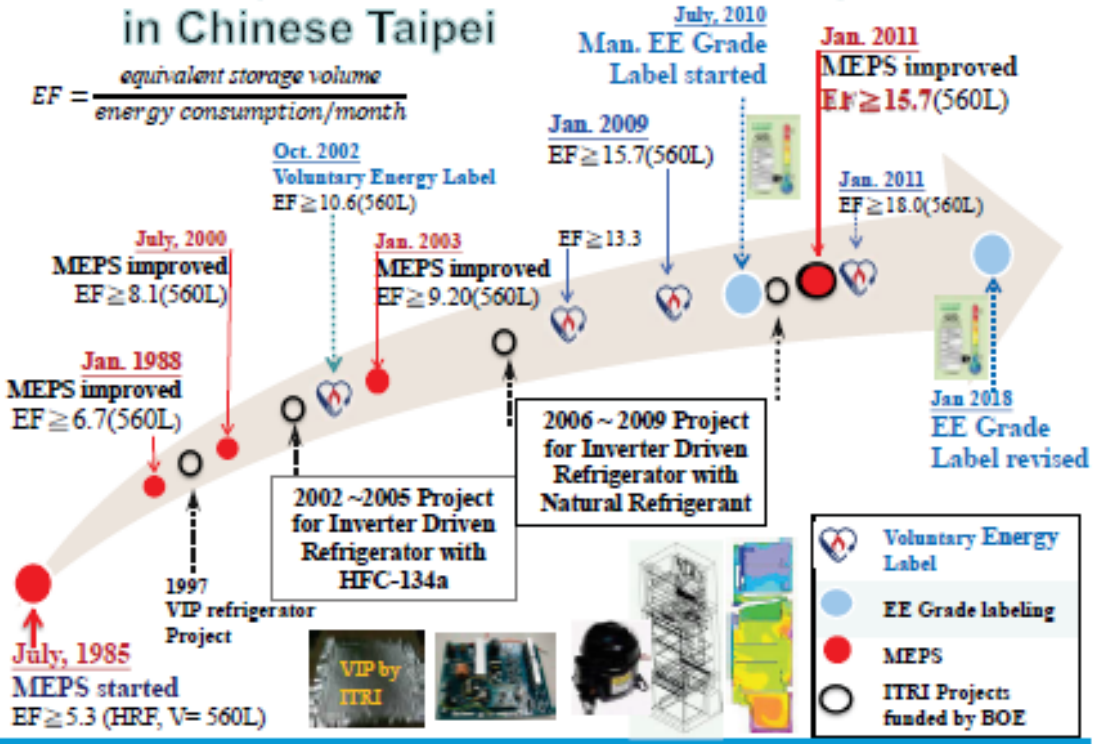
Policy	MEPS	Energy Efficiency Grade Labeling
Promoting Date	December, 1981	July, 2010
Purpose	Manufacturers and importers are obliged to apply in advance for compliance certification	Provide consumers with useful information when they choose among various models
Item	22 product categories	14 product categories
Product Category	1. Air Conditioners (change EER to CSPF) 2. Refrigerators 3. Dehumidifiers 4. Fluorescence Lamps 5. Ballast for Fluorescent Lamps 6. Compact florescent lamps 7. Fluorescent Lamps with embedded ballasts 8. Incandescent bulbs 9. Electric Hot Water Pots 10.Electric Storage Tank Water Heaters 11.Warm-Hot Water Dispensers 12.Chilled-Warm-Hot Water Dispensers **13.Warm-Hot Drinking Water Dispensers** **14.Chilled-Warm-Hot Drinking Water Dispensers** 15.Vehicles 16.Motorcycles 17.Fishing vessel engines 18.Low-voltage single-phase induction motors 19.Low-voltage three-phase squirrel-cage induction motors 20.LED Lamps 21.Air-condition system chiller 22.Boilers	1. Air Conditioners (2010.7.1) 2. Refrigerator/Freezer (2010.7.1) 3. Automobiles (2010.7.1) 4. Motorcycles (2010.7.1) 5. Dehumidifiers (2011.3.1) 6. Self-ballasted fluorescent lamps (2011.7.1) 7. Instantaneous Gas Water Heaters (2012.12.6) 8. Gas Stoves(2012.12.06) 9. Electric hot water pots (2015.01.01) 10.Electric Storage Tank Water Heaters (2015.10.01) 11.Warm-Hot Water Dispensers (2016.12.01) 12.Chilled-Warm-Hot Water Dispensers (2016.12.01) **13.Warm-Hot Drinking Water Dispensers (2018.01.01)** **14.Chilled-Warm-Hot Drinking Water Dispensers (2018.01.01)**

Voluntary Energy Efficiency Management Program

Policy	Energy Conservation Label
Promoting Date	December, 2001
Purpose	Encourage consumers to buy high-efficiency products and to enhance market penetration of high-efficiency products
Item	51 product categories
Product Category	1. Air Conditioners 2. Refrigerators 3. Dehumidifiers 4. Circulation Fans 5. Washing Machines 6. Clothes Dryers 7. Fluorescence Lamps 8. Hand Dryers 9. Hair Dryers 10.Warm-Hot Water Dispensers 11.Chilled-Warm-Hot Water Dispensers 12.Chilled-Warm-Hot Drinking Water Dispensers 13.Warm-Hot Drinking Water Dispensers 14.Vehicles 15.Motorcycles 16.Fluorescent Lamps with embedded ballasts 17.Gas burning cooking appliances 18. Instantaneous Gas Burning Water Heaters 19. Electric Cookers 20. Electric Storage Tank Water Heaters 21. Electric Hot Water Pots 22. Exit Lights and Emergency Direction Lights 23. Televisions 24. Displays 25. DVD Recorder and Player 26. Indoor Light Fixtures 27. Integrated Stereos 28. Compact Fluorescent Lamps 29. Copy machines 30. Printers 31. Air Cleaners 32. Luminaires for road and street lighting 33. Ventilating Fans for Bath Room Use 34. Ventilating Fans for Window Type 35.Notebook Computers 36.Desktop Computers 37.Air Source Heat Pump Water Heater 38.Range Hoods 39.Microwave Ovens 40.Axial flow Fans 41.Centrifugal fan 42.Ballast for Fluorescent Lamps 43.Electric Ovens 44.Electric Storage Tank Boiling Water Heaters 45.LED planar lamp 46.LED Lamps 47.VFI UPS 48.High bay Luminaire 49.Downlights and Recessed luminaires 50.Office and Business Area Luminaire 51.Indoor parking lot smart lighting fixtures

History for EE promotion of refrigerators in Chinese Taipei

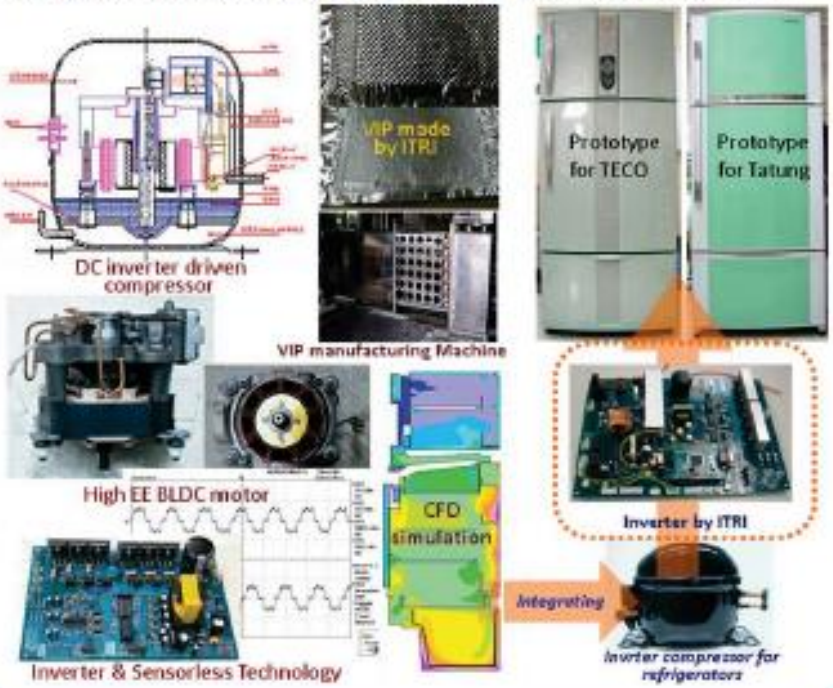
$$EF = \frac{equivalent\ storage\ volume}{energy\ consumption/month}$$



ITRI

History for EE promotion of refrigerators in Chinese Taipei

- Upgrading the Efficiency of Refrigerators/Freezers (2002-2009)



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MEPS & EE Label Standards for Refrigerators in Chinese Taipei

■ Overview

Subject：Revised Refrigerator power consumption standard and power efficiency grade labeling, method, and inspection method regulation (announced on May. 10, 2017)

- The refrigerators of this regulation are those compliant with CNS 2062 and contained in list of products requiring inspection by the Bureau of Standards, Metrology & Inspection (BSMI), M.O.E.A.
- Test and calculate actual energy factor (E.F.) values of refrigerator according to CNS 2062 and round energy factor value to the nearest tenth.
  The actual energy factor ratings shall be greater than standard value (MEPS) and 95% of product rated value.
  Ref. ttps://ranking.energylabel.org.tw

MEPS & EE Label Standards for refrigerators

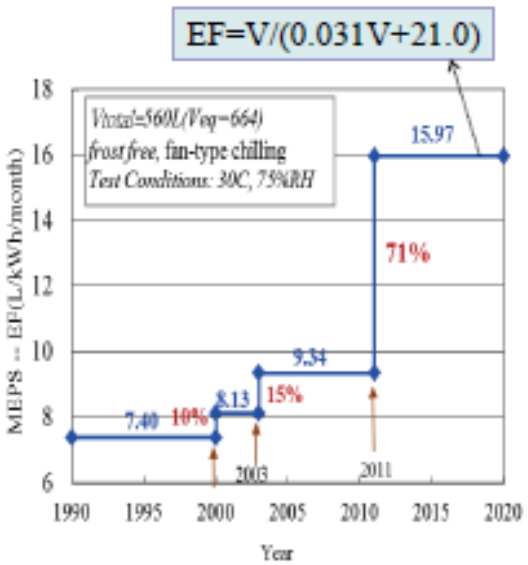
Refrigerator power consumption standard (2011~now)
(Minimum energy performance standard requirements for electric refrigerators and freezers)

Product class	Energy factor value standard (liter/kWh/month)
Smaller than 400 liter fan-type chilling refrigerator-freezer	EF=V/(0.037V+24.3)
Bigger than 400 liter fan-type chilling refrigerator-freezer	EF=V/(0.031V+21.0)
Smaller than 400 liter direct chilling refrigerator-freezer	EF=V/(0.033V+19.7)
Bigger than 400 liter direct chilling refrigerator-freezer	EF=V/(0.029V+17.0)
Refrigerator	EF=V/(0.033V+15.8)

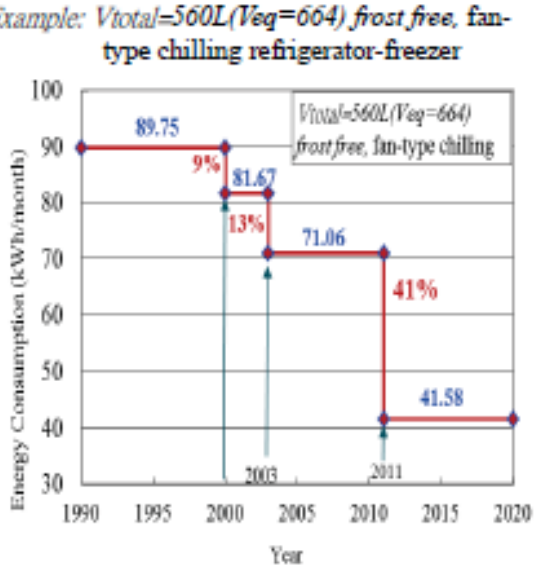
V=equivalent storage volume

MEPS & EE Label Standards for refrigerators

History for MEPS in Chines Taipei



Energy factor value standard
(liter/kWh/month)



Energy consumption per month
(kWh/month)

MEPS & EE Label Standards for refrigerators

◆ Labelling Scheme for Energy Efficiency Rating

(1) Displayed label minimum size：180mm (long)×120mm(width)

(2) Content of energy efficiency rating label

Product model	
Effective internal volume (liter)	
Energy factor value (liter/kWh/month)	
Energy efficiency grade	
Annual power consumption (kWh) Formula for annual power consumption (kWh): rated power consumption (kWh/month) x 12 months, round annual power consumption to the ones	
Publication year and document code of subject refrigerator energy efficiency standard	

MEPS & EE Label Standards for refrigerators

◆ Refrigerator energy efficiency grade standard (2018~)

Product class	MEPS for EF(L/kWh/month)	Grade 5	Grade 4	Grade 3	Grade 2	Grade 1
Smaller than 400 liter fan-type chilling refrigerator-freezer	EF=V/(0.037V+24.3)	MEPS ≤ EF< MEPS×115%	MEPS×115% ≤ EF< MEPS×130%	MEPS×130% ≤ EF< MEPS×145%	MEPS×145% ≤ EF< MEPS×160%	EF ≥ MEPS×160%
Bigger than 400 liter fan-type chilling refrigerator-freezer	EF=V/(0.031V+21.0)					
Smaller than 400 liter direct chilling refrigerator-freezer	EF=V/(0.033V+19.7)					
Bigger than 400 liter direct chilling refrigerator-freezer	EF=V/(0.029V+17.0)					
Refrigerator	EF=V/(0.033V+15.8)	MEPS ≤ EF< MEPS×118%	MEPS×118% ≤ EF< MEPS×136%	MEPS×136% ≤ EF< MEPS×154%	MEPS×154% ≤ EF< MEPS×172%	EF ≥ MEPS×172%

V=equivalent storage volume

MEPS & EE Label Standards for refrigerators

Energy Factor, EF

$$EF = \frac{equivalent\ storage\ volume}{energy\ consumption/month} = \frac{V_R + K \cdot V_F}{W_M}$$

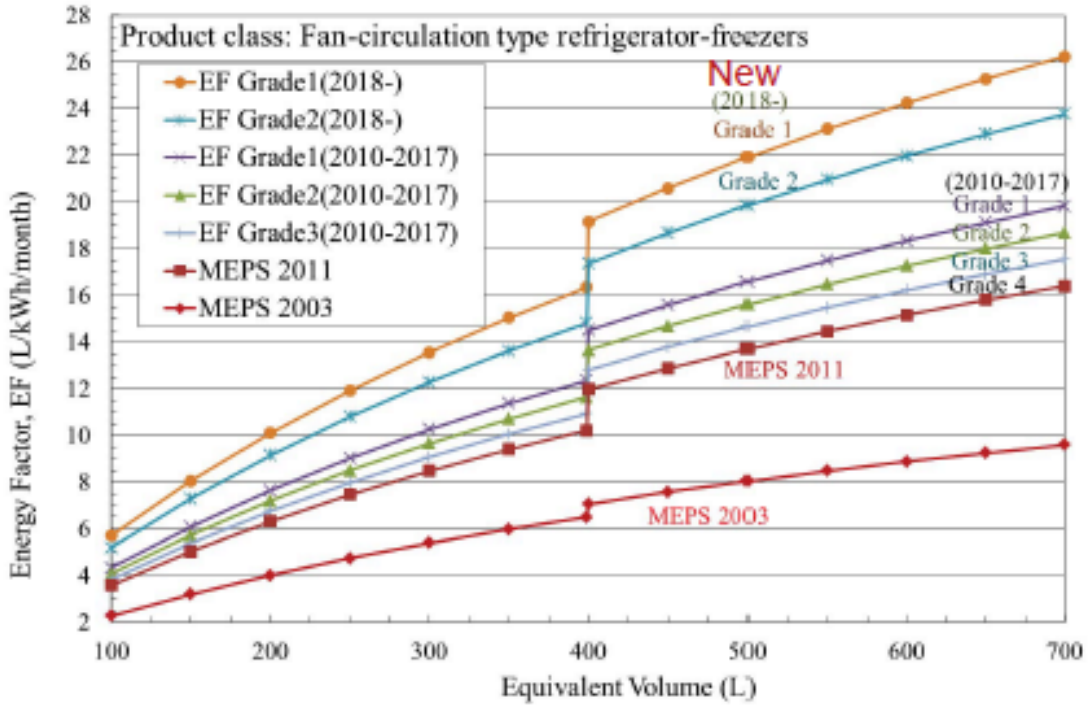
$$K \equiv \frac{T_{amb} - T_F}{T_{amb} - T_R}$$

$V_{eq} = V_R + K \cdot VF$ (*the equivalent storage volume of the refrigerator*)

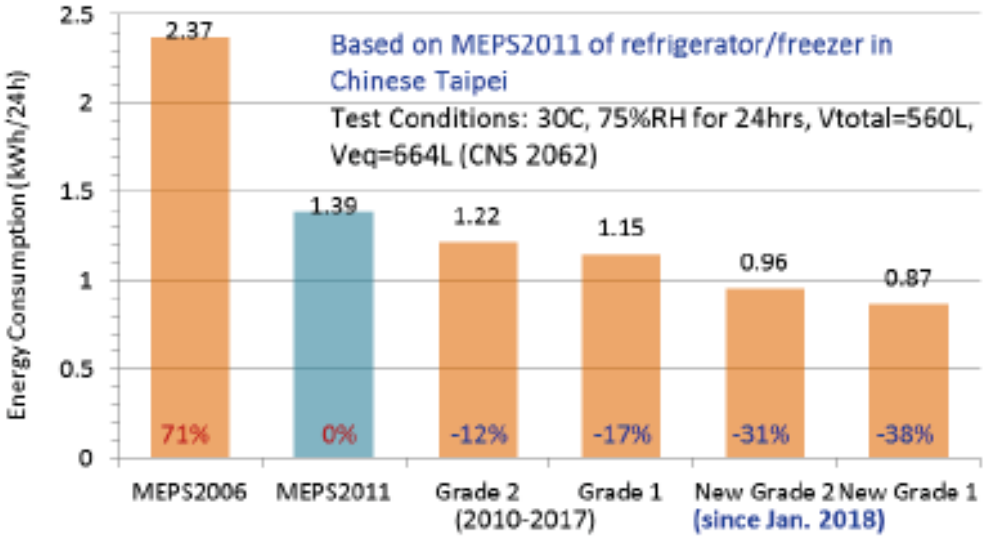
T_F= -18°C , T_R= 3°C , T_{amb}= 30°C, 75%RH (CNS 2062)

K : Adjustment factor for frozen-food storage compartment, two-star =1.56 ; super two-star =1.67 ; three-star and four-star =1.78

ITRI MEPS & EE Label Standards for refrigerators



MEPS & EE Labeling Standards for refrigerators



MEPS & EE Labeling Standards for refrigerators

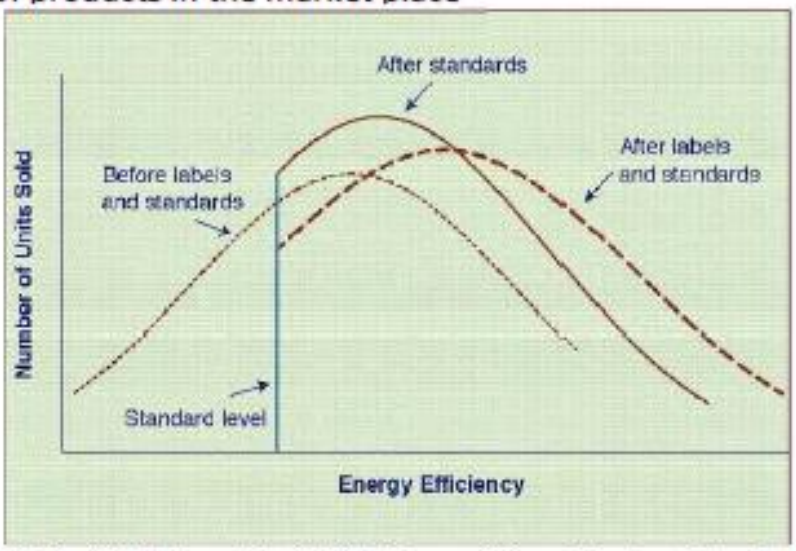
Testing & Compliance for Market Surveillance

- Actual energy factor values of products under test shall be equal to or greater than 95% of their rated value and compliant with refrigerator power consumption and energy efficiency grade standard.
- The 1st one failed the test. → Have twice as many products of the same model.
- The sampling quantity: every 4000 units made or imported last year shall sample one unit for spot check

Year	Total model number for spot test	failed for the 1st test	failed for the 2nd test	noncompliance(%) for EE Grade Labeling
2013	52	5	2	3.8%
2014	34	3	2	5.9%
2015	41	0	0	0.0%
2016	46	6	1	2.2%
2017	46	1	1	2.2%

ITRI Evaluation for Energy Saving Potential

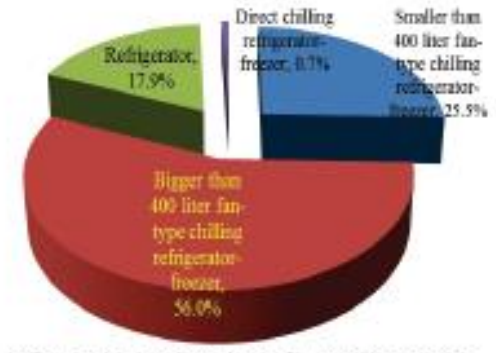
- The impact of EE labels and standards on the distribution of products in the market place



Ref. Wiel, S., & McMahon, J. E., (2005). *Energy-efficiency labels and standards: a guidebook for appliances, equipment, and lighting* (2nd ed.). Washington, DC: Collaborative Labeling and Appliance Standards Program (CLASP).

ITRI Evaluation for Energy Saving Potential

- Regulation Drives the Market
  - Efficiency standard is raised up after the products generally improved

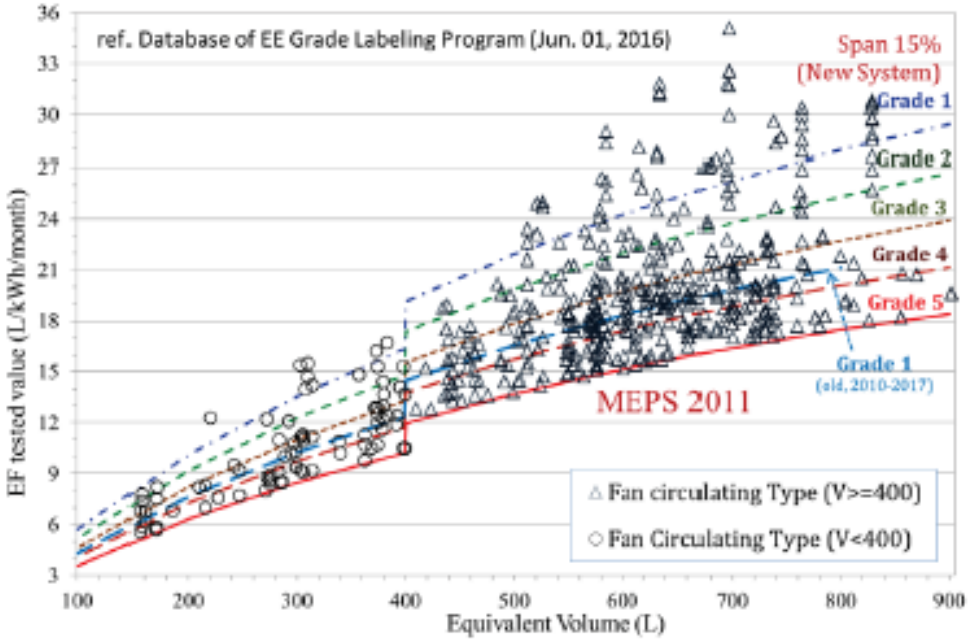


Refrigerator Market Share for Product Types

EE Grade Labeling Program (2010~2017)

ITRI

Evaluation for Energy Saving Potential



EF data distribution with equivalent volume before 2018

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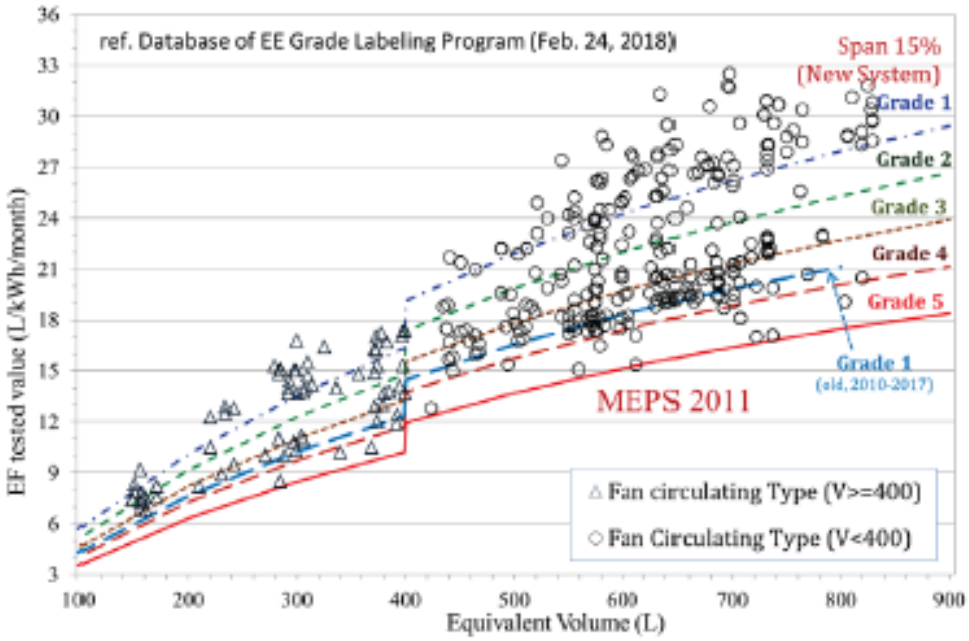
Evaluation for Energy Saving Potential



EF data distribution with equivalent volume in Feb. 24, 2018

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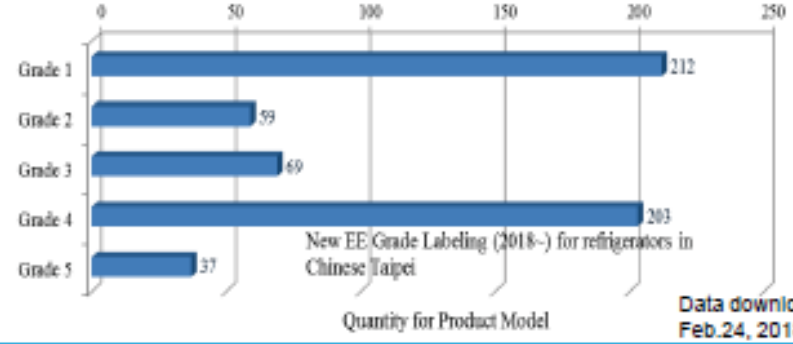
Evaluation for Energy Saving Potential

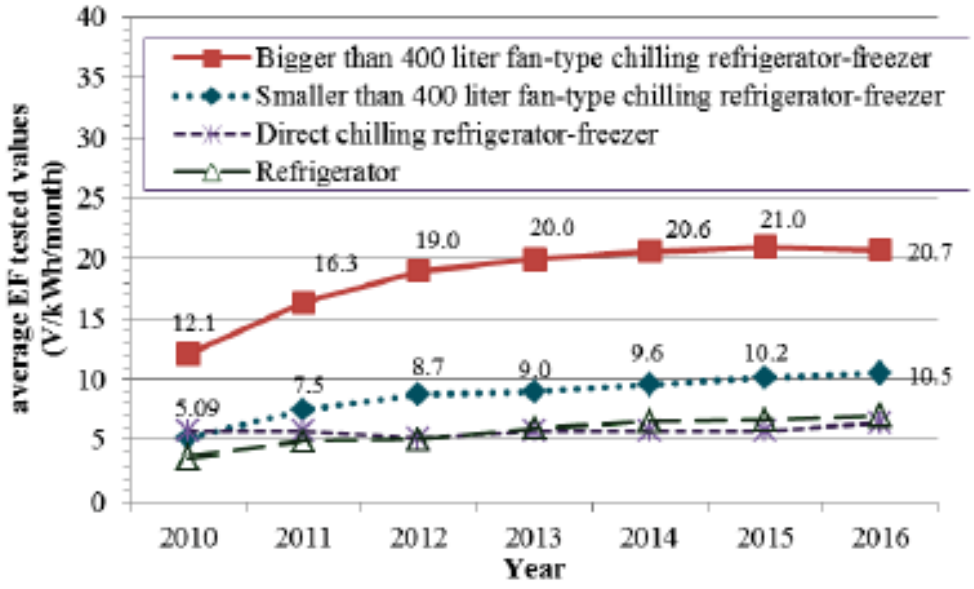
New EE Grade Labeling (2018~) for refrigerators in Chinese Taipei

Product Type	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Model No.
Smaller than 400 liter fan-type chilling refrigerator-freezer	65	13	16	33	5	132
Bigger than 400 liter fan-type chilling refrigerator-freezer	138	27	46	115	29	355
Refrigerator	7	12	5	37	3	64
Direct chilling refrigerator-freezer	2	7	2	18	0	29
Total Model No.	212	59	69	203	37	580
percentage	*36.6%*	*10.2%*	*11.9%*	*35.0%*	*6.4%*	*100%*



ITRI

Evaluation for Energy Saving Potential



Average EF values for refrigerator products sold each year (2010-2016)

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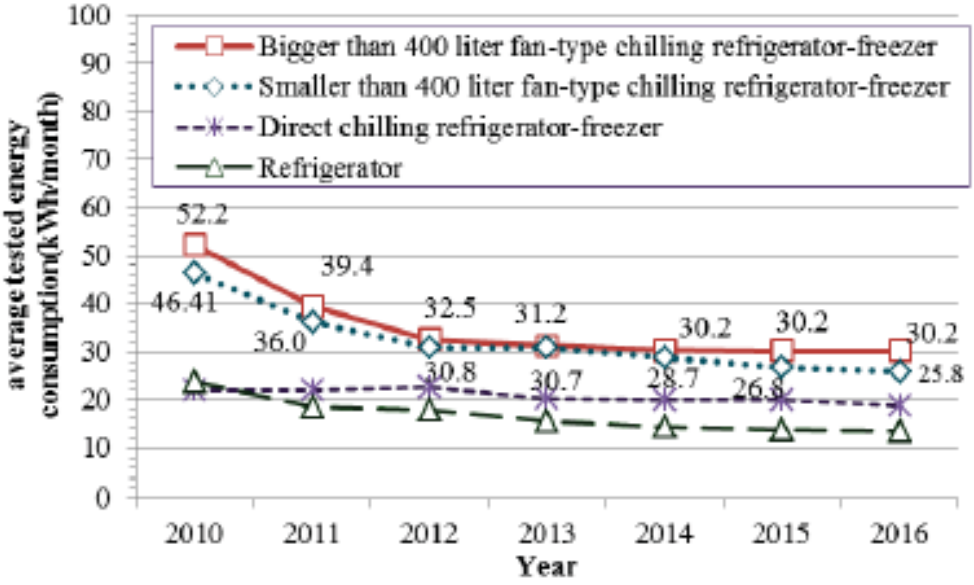
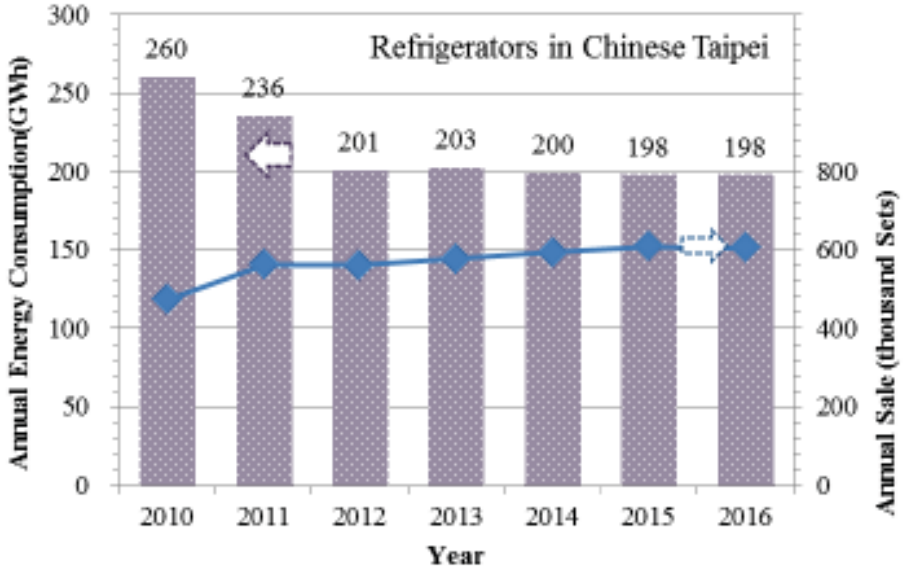
Evaluation for Energy Saving Potential



Average energy consumption for refrigerator products sold each year (2010-2016)

ITRI

Evaluation for Energy Saving Potential



Total energy consumption for refrigerator products sold each year (2010-2016)

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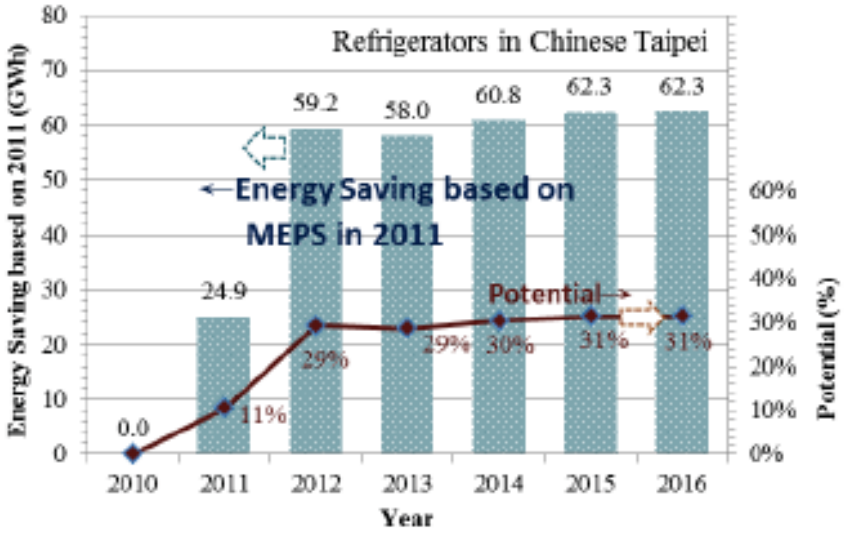
Evaluation for Energy Saving Potential



Energy Saving Potential based on MEPS 2011 for refrigerator products sold each year (2010-2016)

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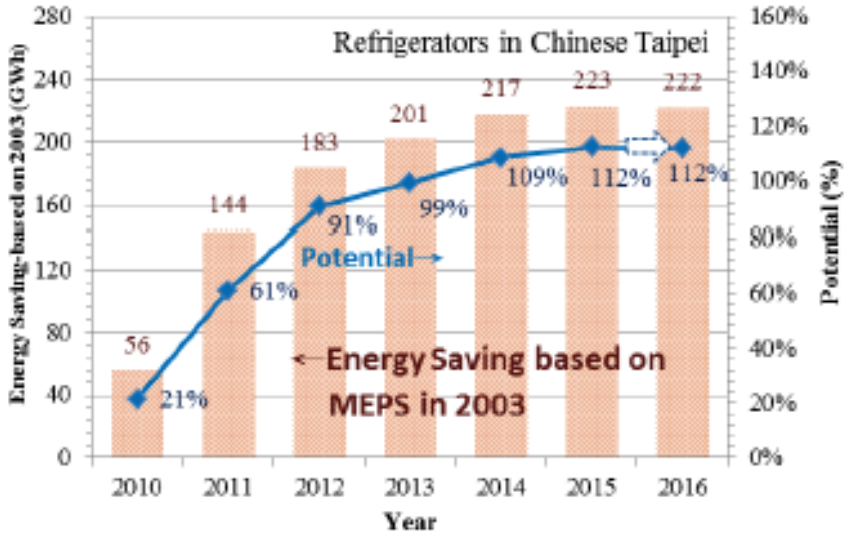
Evaluation for Energy Saving Potential



Energy Saving Potential based on MEPS 2003 for refrigerator products sold each year (2010-2016)

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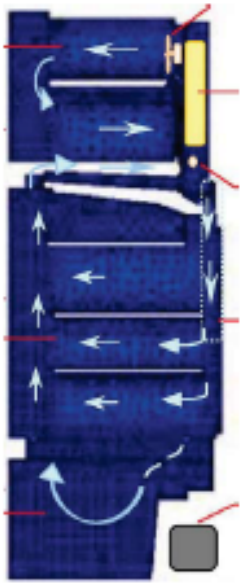
EE Technologies and Design Concept to Fit the New Standards since 2018 in Chinese Taipei

Through a review of research on refrigerator, here show a variety of options that may increase EE of a refrigerator :

- Cabinet improvement: thermal insulation, magnetic seals
- Improvement to the refrigeration system
- Mechanism improvement: defrosting, temperature control
- Minimal thermal stratification in compartments
- Harmonization of Energy Efficiency Test Methods of Refrigerators



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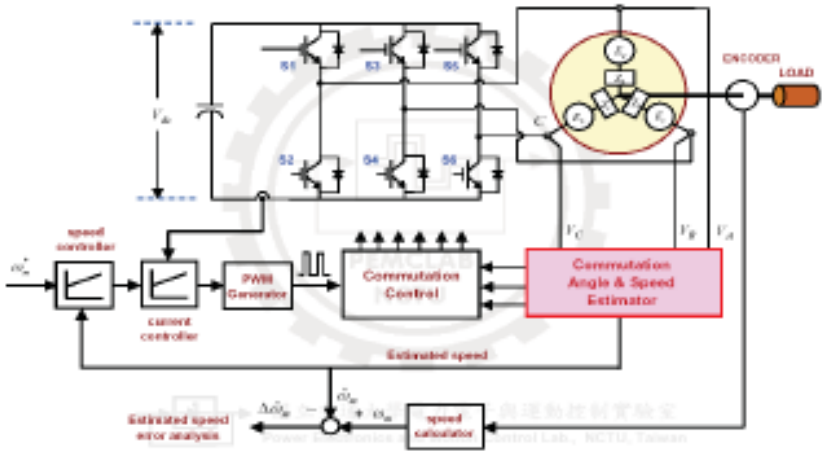
EE Technologies and Design Concept to Fit the New Standards since 2018 in Chinese Taipei

✓ Inverter Driven & System Control



variable-speed compressor

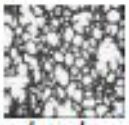
BLDC motor

Control diagram for BLDC motor with PWM regulation

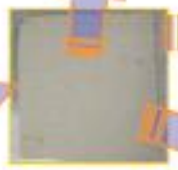
ITRI Technologies and Design Concept to Fit the New Standards since 2018 in Chinese Taipei

✓ Thermal Insulation & VIP

PU sampling for thermal conductivity measurement



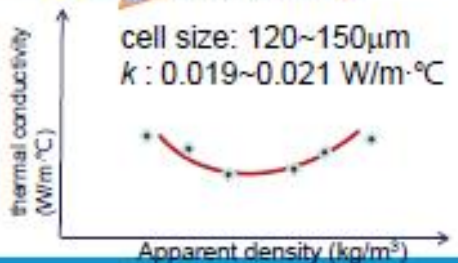
Micro-structure for PU foaming



Apparent density

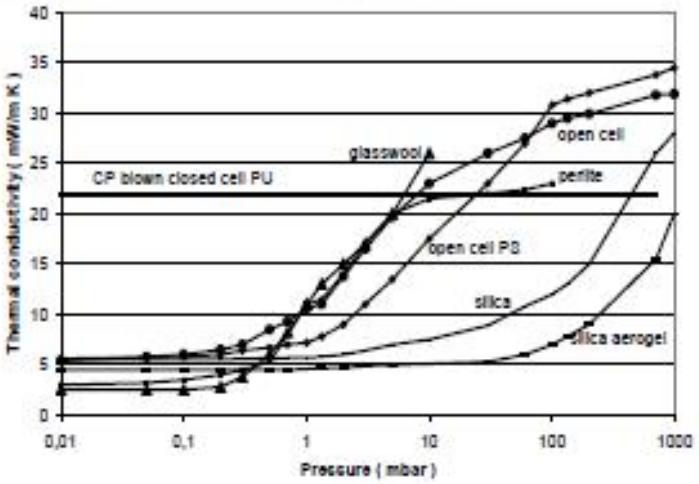
cell size: 120~150μm

k : 0.019~0.021 W/m·℃



ITRI Technologies and Design Concept to Fit the New Standards since 2018 in Chinese Taipei

✓ Thermal Insulation & VIP



Effect of core material and absolute pressure on the thermal conductivity of VIP

VIP made by ITRI

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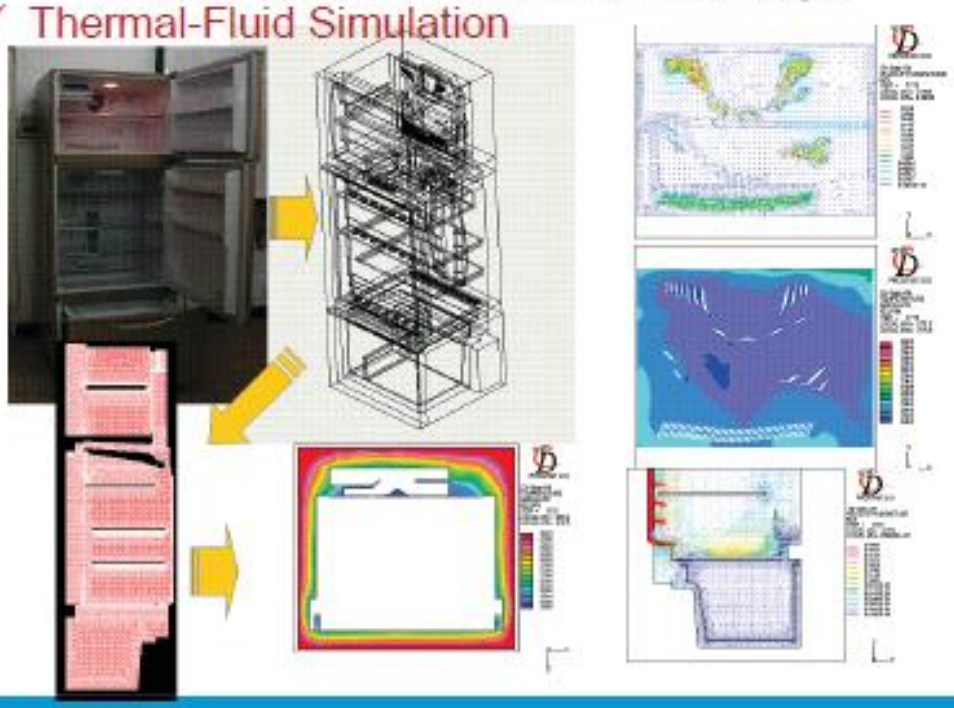
EE Technologies and Design Concept to Fit the New Standards since 2018 in Chinese Taipei

✓ Thermal-Fluid Simulation



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➢Future Work-- Harmonization of Energy Efficiency Test Methods of Refrigerators towards the NEW IEC 62552

- 2017
- 2018
- 2019
- 2020

2017	2018	2019	2020
Comparative study on test methods of refrigerators between CNS 2062 & IEC 62552	• Experimental study and harmonization of the CNS (Chinese Taipei) standard with IEC 62552 • Proficiency testing among laboratories for CNS 2062	•Proficiency testing among laboratories in Chinese Taipei (including domestic makers) •Study on EE benchmarking following IEC 6255 with present EE data (CNS 2062)	• Proposal for MEPS & EE Label Standards based on IEC 62552 • Training course & stakeholder meeting for new standards

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Conclusion

- High efficiency technology has been developed in ITRI for more than two decades. Concerning refrigerator/freezer technology, ITRI carried out and completed high efficiency technology development for industrial, commercial, and domestic refrigeration funded by BOE of Chinese Taipei from 2002 to 2009.
- The 2011 MEPS benchmark value was promoted to 70% of energy factor, as well as 41.5% of energy consumption compared to the baseline in 2003, based on the research efforts by ITRI.
- High EE marking share has been increasing rapidly due to EE grade labeling program as well as the encourage of subsidy programs by BOE.

ITRI

Thanks for your attention

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Email: wrchang@itri.org.tw

附件八、我國 Economy Update -Chinese Taipei 簡報資料

經濟部能源局
Bureau of Energy

Energy Efficiency Management

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Bureau of Energy

Efficiency Standards and Benchmarks

◆At present, Chinese Taipei has announced **MEPS** requirements for **22** product categories; and 51 product categories are authorized for participation in the voluntary energy efficiency labeling program; 14 categories of products are included in the mandatory Energy Efficiency Rating Labeling system in order to provide guidance to consumers for the purchase of products with high energy efficiency.

Mandatory Energy Efficiency Management Programs

Policy	MEPS	Energy Efficiency Grade Labeling
Promoting Date	December, 1999	July, 2010
Purpose	Manufacturers and importers are obliged to apply in advance for compliance certification	Provide consumers with useful information when they choose among various models
Item	22 product categories	14 product categories
Product Category	1. Air Conditioners (change EER to CSPF) 2. Refrigerators 3. Dehumidifiers 4. Fluorescence Lamps 5. Ballast for Fluorescent Lamps 6. Compact florescent lamps 7. Fluorescent Lamps with embedded ballasts 8. Incandescent bulbs 9. Electric Hot Water Pots 10.Electric Storage Tank Water Heaters 11.Warm-Hot Water Dispensers 12.Chilled-Warm-Hot Water Dispensers **13.Warm-Hot Drinking Water Dispensers** **14.Chilled-Warm-Hot Drinking Water Dispensers** 15.Vehicles 16.Motorcycles 17.Fishing vessel engines 18.Low-voltage single-phase induction motors 19.Low-voltage three-phase squirrel-cage induction motors 20.LED Lamps 21.Air-condition systems 22.Boilers	1. Air Conditioners (2010.7.1) 2. Refrigerator/Freezer (2010.7.1) 3. Automobiles (2010.7.1) 4. Motorcycles (2010.7.1) 5. Dehumidifiers (2011.3.1) 6. Self-ballasted fluorescent lamps (2011.7.1) 7. Instantaneous Gas Water Heaters (2012.12.6) 8. Gas Stoves(2012.12.06) 9. Electric hot water pots (2015.01.01) 10.Electric Storage Tank Water Heaters (2015.10.01) 11.Warm-Hot Water Dispensers (2016.12.01) 12.Chilled-Warm-Hot Water Dispensers (2016.12.01) **13.Warm-Hot Drinking Water Dispensers (2018.01.01)** **14.Chilled-Warm-Hot Drinking Water Dispensers (2018.01.01)**

Voluntary Energy Efficiency Management Program

Policy	Energy Conservation Label		
Promoting Date	December, 2001		
Purpose	Encourage consumers to buy high-efficiency products and to enhance market penetration of high-efficiency products		
Item	51 product categories		
Product Category	1. Air Conditioners 2. Refrigerators 3. Dehumidifiers 4. Circulation Fans 5. Washing Machines 6. Clothes Dryers 7. Fluorescence Lamps 8. Hand Dryers 9. Hair Dryers 10.Warm-Hot Water Dispensers 11.Chilled-Warm-Hot Water Dispensers 12.Chilled-Warm-Hot Drinking Water Dispensers 13.Warm-Hot Drinking Water Dispensers 14.Vehicles 15.Motorcycles 16.Fluorescent Lamps with embedded ballasts 17.Gas burning cooking appliances	18. Instantaneous Gas Burning Water Heaters 19. Electric Cookers 20. Electric Storage Tank Water Heaters 21. Electric Hot Water Pots 22. Exit Lights and Emergency Direction Lights 23. Televisions 24. Displays 25. DVD Recorder and Player 26. Indoor Light Fixtures 27. Integrated Stereos 28. Compact Fluorescent Lamps 29. Copy machines 30. Printers 31. Air Cleaners 32. Luminaires for road and street lighting 33. Ventilating Fans for Bath Room Use 34. Ventilating Fans for Window Type	35.Notebook Computers 36.Desktop Computers 37.Air Source Heat Pump Water Heater 38.Range Hoods 39.Microwave Ovens 40.Axial flow Fans 41.Centrifugal fan 42.Ballast for Fluorescent Lamps 43.Electric Ovens 44.Electric Storage Tank Boiling Water Heaters 45.LED planar lamp 46.LED Lamps 47.VFI UPS 48.High bay Luminaire 49.Downlights and Recessed luminaires **50.Office and Business Area Luminaire** **51.Indoor parking lot smart lighting fixtures**

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Mandatory Energy Efficiency Management Programs

MEPS & Energy Efficiency Grade Labeling System

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MEPS for Drinking Water Machine

- **History:**

  Warm-Hot & Chilled-Warm-Hot Drinking Water Dispenser standard has taken effect in **Jan. 01 2018**.

- **Test method:**

  CNS 3910 Drinking Water Dispenser for piping water supply under 60L/h with electric heater for hot water and refrigeration/TE system for chilled water

- **Energy Efficiency Standard:** (MEPS)

	Warm-Hot Type Normalized Standing Loss per 24h $E_{st,24}$ (kWh)	Chilled-Warm-Hot Type Standing Loss per 24h E_{24} (kWh)
MEPS	$0.053 \times V_1 + 0.750$	$0.09 \times V_{eq} + 0.45$

Notes:

$V_{eq} = V_1 \times K_1 + (V_2 \times K_2)/3$

V_1 is the nameplate values of hot-water tank(unit：liter); $K_1 = (Th - Tamb) / (100 - Tamb)$

V_2 is the nameplate values of iced-water tank(unit：liter); $K_2 = (Tamb - Tc) / (Tamb)$

Testing and calculation of normalized standing loss per 24h ($E_{st,24}$) & standing loss (E_{24}) shall comply with CNS 3910 in Chinese Taipei.

經濟部能源局 Bureau of Energy

Drinking Water Dispensers

(has taken effect in **Jan. 01 2018**)

◆ Energy efficiency grade labeling requirements for Warm-Hot Type

Energy Efficiency Rating	Normalized Standing Loss per 24h, Est,24 (kWh)
Class 1	$E_{st,24} \leqq 0.032V+0.450$
Class 2	$0.032V+0.450 < E_{st,24} \leqq 0.037V+0.525$
Class 3	$0.037V+0.525 < E_{st,24} \leqq 0.042V+0.600$
Class 4	$0.042V+0.600 < E_{st,24} \leqq 0.048V+0.675$
Class 5	$0.048V+0.675 < E_{st,24} \leqq 0.053xV+0.750$

◆ Energy efficiency grade labeling requirements for Chilled-Warm-Hot Type

Energy Efficiency Rating	24-hr Energy Consumption E_{24} (kWh)
Class 1	$E_{24} \leqq 0.054\times V_{ol} +0.270$
Class 2	$0.054\times V_{ol} +0.270 < E_{24} \leqq 0.063\times V_{ol} +0.315$
Class 3	$0.063\times V_{ol} +0.315 < E_{24} \leqq 0.072\times V_{ol} +0.360$
Class 4	$0.072\times V_{ol} +0.360 < E_{24} \leqq 0.081\times V_{ol} +0.405$
Class 5	$0.081\times V_{ol} +0.405 < E_{24} \leqq 0.09xV_{ol}+0.45$

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Electric Refrigerators and Freezers

- Revised energy efficiency grade labeling regulation has taken effect in **Jan. 01 2018,** but MEPS keeps as the same as carried out in 2011.
- Test and calculate actual energy factor (E.F.) values of refrigerator according to CNS 2062. ($EF=V_{eq}$ / *energy consumption for 30 days*)
- MEPS

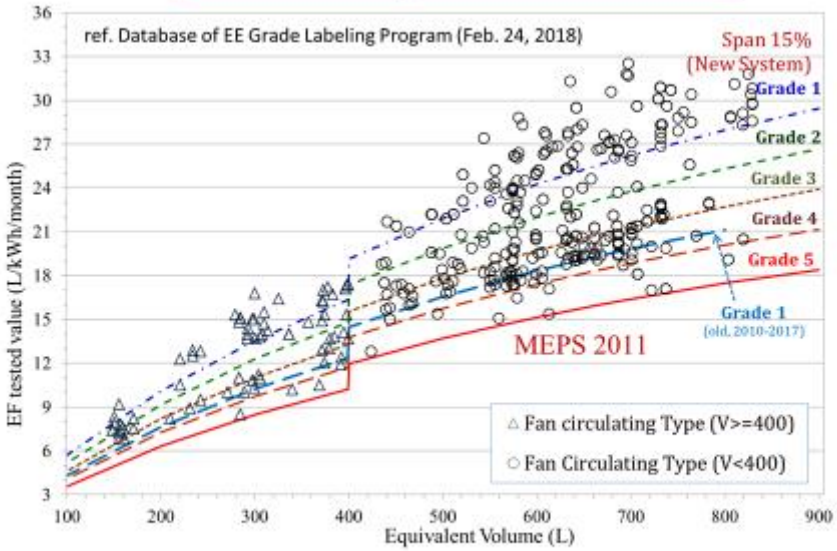
Product class	MEPS for EF(L/kWh/month)
Fan-circulation type refrigerator-freezers for V<400L (automatic defrost)	EF=V/(0.037V+24.3)
Fan-circulation type refrigerator-freezers for V≥400L (automatic defrost)	EF=V/(0.031V+21.0)
Direct cooled refrigerator-freezers for V<400L (manual defrost)	EF=V/(0.033V+19.7)
Direct cooled refrigerator-freezers for V≥400L (manual defrost)	EF=V/(0.029V+17.0)
Refrigerators	EF=V/(0.033V+15.8)

- Energy efficiency grade labeling regulation

Product class	Grade 5	Grade 4	Grade 3	Grade 2	Grade 1
Fan-Type & Direct - Cooled Type	MEPS ≤ EF< MEPS×115%	MEPS×115% ≤ EF< MEPS×130%	MEPS×130% ≤ EF< MEPS×145%	MEPS×145% ≤ EF< MEPS×160%	EF ≥ MEPS×160%
Refrigerator only	MEPS ≤ EF< MEPS×118%	MEPS×118% ≤ EF< MEPS×136%	MEPS×136% ≤ EF< MEPS×154%	MEPS×154% ≤ EF< MEPS×172%	EF ≥ MEPS×172%

經濟部能源局 Bureau of Energy

Electric Refrigerators and Freezers



EF data distribution with equivalent volume in Feb. 24, 2018

10

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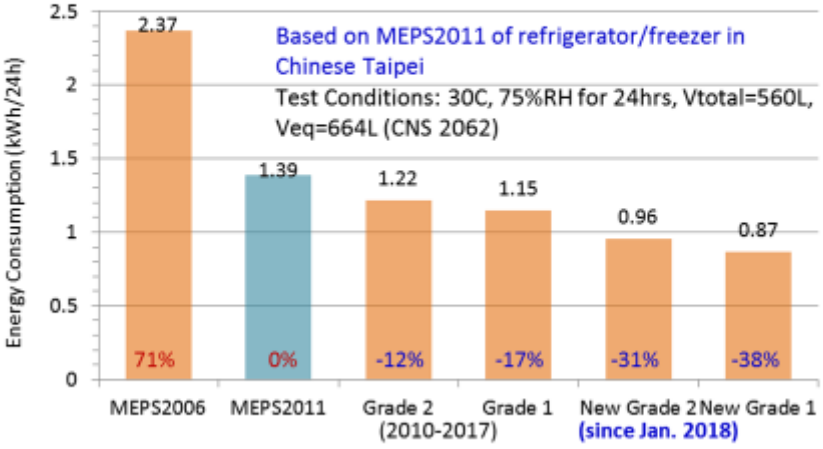
Electric Refrigerators and Freezers

➢ Energy Consumption Comparison for MEPS & the energy efficiency grade labeling standard



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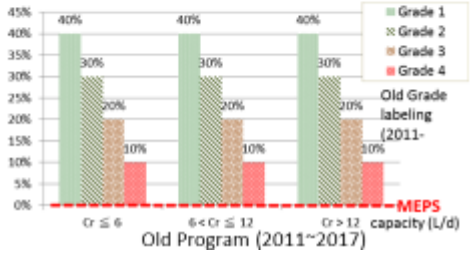
Bureau of Energy

Dehumidifier

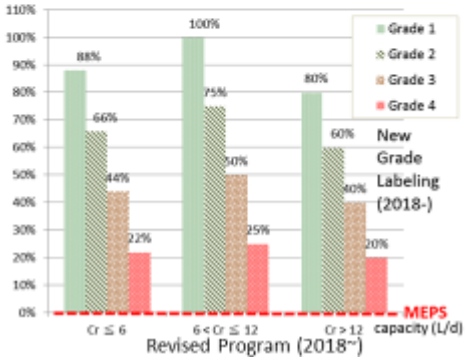
- Revised energy efficiency grade labeling regulation has taken effect in **Jan. 01 2018,** but MEPS keeps as the same as carried out in 2011.
- Test and calculate actual energy factor (E.F.) values of dehumidifier according to CNS 12492 (*EF= Capacity / energy consumption*)
- MEPS

Rated Capacity Cr (L/day)	MEPS for EF (L/kWh)
Cr ≤ 6	1.10
6 < Cr ≤ 12	1.20
Cr > 12	1.40

- Energy efficiency grade labeling regulation



Old Program (2011~2017)



Revised Program (2018~)

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Voluntary Energy Labeling Program

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High bay Luminaire

➢ Scope of Application:

1) Ordinary downward-projecting type of suspended or ceiling-mounted lamps that have been verified by this Office, and the rated total light flux should be over 4,000 lumen (lm).
2) Comply with CNS 14335 and CNS 14115

➢ History:

Announced on Sep. 10,2016. Valid until Feb. 01, 2017

➢ Requirement:

- The tested energy efficiency value shall be over 95% of the indicated value and shall meet the following requirements:

  Tested Energy Efficiency Value (lm/W) = Tested Total Light Flux (lm) / Total Input Power (W)

  (1) Where the total light flux of the lamp is below 20,000lm, then it shall be over 110.0 (lm/W)

  (2) Where the total light flux of the lamp is more than 20,000lm, then it shall be over 80.0 (lm/W)

- Other generality requirements

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Downlights and Recessed luminaires

➢ Scope of Application:

1) Conform to CNS 14335, 14115 and 15592 or other standards approved
2) Downlights: ceiling mounted or downward hanging light with barrel or column looks

➢ History:

Announced on Mar. 23, 2017. Valid until May 01, 2018

➢ Requirement:

- The tested energy efficiency value shall be over 95% of the indicated value and shall meet the following requirements:

  Tested Energy Efficiency Value (lm/W) = Tested Total Light Flux (lm) / Total Input Power (W)

  (1) Actual luminaire efficiency value: 95% or more than the rating and greater than 110.0 (lm/w).

  (2) Other generality requirements

◆Product categories for Energy Efficiency Promoting in 2017

Year	Product categories	Energy Efficiency Promotion (%)
2016	Non-Ducted Air Conditioners	14%~47%
	Motorcycles	9.3%
2017	Electric Storage Tank Water Heaters	13%
	Dehumidifiers	33-46%
	Refrigerators	27-35%
	Warm-Hot Water Dispensers	15.3%
	Luminaires for road and street lighting	LED 78.8%; gas-discharge type 11.7%
	Fluorescence Lamps	5%

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OUTCOMES OF THE ENERGY LABELING PROGRAM

As of January 31, 2018, there were 287 manufacturers with 6,114 products effectively certified with the Energy Label. The number of labels employed has broken the 235 million mark. The results of the Energy Labeling program over the past few years are shown below.