Asia-Pacific
Economic Cooperation

Reducing Barriers to Trade through Development of a Common Protocol for Measuring the Seasonal Energy Efficiency (SEER) of Air Conditioners

FINAL REPORT

APEC Energy Working Group

January 2010

EWG 01/2009T

Prepared by Chinese Taipei

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APEC#210-RE-01.10

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1. Introduction

1.1 Objective of the project

The performance of an air conditioner is an important indication of the energy consumption. There are various measurements and procedures being used to test the performance of an air conditioner. Energy Efficiency Ratio (EER) is currently the one most commonly adopted. However, it does not always accurately reflect the actual performances of air conditioners. This is because the rating is based only on a particular environmental condition and does not consider the entire annual seasonal cycle of operation. Moreover, the EER testing standards are different from one country to another. This is a major barrier to harmonization. Thus, the purpose of this project is to develop a common protocol of Seasonal Energy Efficiency Ratio (SEER) to reduce such a barrier to the trade of air conditioners. On this simple platform, as the worldwide users enter their respective local environmental parameters, the SEER value can be calculated based upon weather data and the test results of the air conditioners.

This platform is applicable to both constant-speed air conditioners and inverter-type air conditioners, with a capacity under 10 kW. It helps all economies establish and reach their goals of energy savings and related CO_2 reductions, provides social benefits from improved air conditioner performance and increase in economic activity by liberalizing the performance standards for over 50 million APEC manufactured air conditioners.

Air conditioners consume much electrical energy. Via the implementation of Seasonal Energy Efficiency Rating (SEER) program, we not only can understand the actual performance of an air conditioner, but also precisely calculate the cooling loads and the electrical consumption through the cooling seasons. It helps reduce electric demand peaks. There are about 50 million air conditioners sold in the APEC regions. A reduction of 20% of air conditioning electric consumption in APEC regions can be achieved; this is an annual 10,000 GWh of electricity saving. At a CO_2 emission rate of estimated based on 0.54 kg per kWh, the saving will yield a reduction of 5.4 million tons of CO_2 emission. Thus, the implementation of the SEER platform program will bring the positive effects to energy saving and the reduction of CO_2 emission in APEC regions.

1.2 Budget

The total cost of proposal for this study is US$250,000, and the total approved budget is US$60,000 from APEC funding. Self-financing budget is US$190,000.

1.3 Scope of Work

The main output of this project is an analytical platform presented as a software package that evaluates the SEER value for room air conditioners to be tested. The program produces a prompt and accurate estimation of the air conditioners' energy performance. With the aid of such a program, the design of high-efficiency air conditioners becomes possible. Furthermore, the program reduces the market trade barrier and brings the economic prosperity in the APEC communities and provides the benefits of energy saving with high-efficiency air conditioning units and environmental protection with CO_2 emission reduction.

This project produces an objective estimation of SEER for room air conditioners made and traded within the APEC economies. The program can promptly and accurately calculate the SEER value for an air conditioner tested based upon the standards and regulations of its manufacturing countries. As a result, this project provides the air-conditioner industries in the APEC regions, a common platform to assess their energy performances. Consequently, it brings the realistic benefits to the users, as it provides better real use information, manufacturers, and traders of air conditioners, and creates the opportunities for the development of high-efficiency air conditioners, lesser barriers in trades and the economic prosperity in the APEC communities.

Followings are the steps to complete the project:

(1) Collect the weather data and the building load curve of the regions concerned.
(2) Develop a common code for performing Seasonal Energy Efficiency Ratio (SEER) of room air conditioners.
(3) Design and deliver one and a half days open workshop at Chinese Taipei on topic of air conditioning SEER to those experts or representatives mainly from APEC economies.
(4) Publish (consistent with APEC publication policy) and distribute 3 electronic copies of the outcome of workshop to workshop participants and others APEC Economies member.
(5) Provide an electronic copy of the above publications and the outcome of the development of SEER program to the APEC Secretariat for dissemination via the APEC Website.

1.4 Gender Considerations

This SEER project is carried out in an R&D environment where the intellectual ability is demanded more than physical ability. In such an environment, man and women demonstrate their knowledge and skills with the equal opportunities. Furthermore, this project upholds the principle of equal opportunities for men and women throughout the project period, and offers the equal benefits to both genders.

Through the implementation of the SEER program, air conditioners will be designed to run efficiently and consequently reduces CO_2 emission to the environment. The implementation of SEER program can push the manufacturing toward high quality and multi-functioning and create the employment opportunities. Literally, it creates the career opportunities not only for men but also, expectedly, for women in the work of R&D, fabrication, sales, and more. In such an expectation, women’s talents in labor force are notable.

2. Workshop for the Development of SEER

2.1 Agenda

A Workshop was held on Oct. 5-6 in conjunction with 34th EGEE&C in Taipei. The agenda of the workshop was as follows:

First day – Seminar (5th Oct., 2009 / Mon.)	
	Topic / Speaker
Venue	4F/CR-403, The Howard Plaza Hotel Taipei, Taipei
09:00 ~ 09:30	**Registration**
09:30 ~ 10:00	**Opening Remarks** *Chair:* Dr. Robert Yie-Zu Hu, Deputy General Director of Energy and Envirnment Research Laboratories, ITRI *Co-Chair:* Mr. Terry Collins, Chair of EGEE&C, APEC *VIP Speech:* Mr. Huey-Ching Yeh, Director General of the Bureau of Energy, MOEA, Chinese Taipei
10:00 ~ 10:40	**Title: Policy and standards for the rational use of energy in Japan** *Speaker: Dr. Chaobin Dang, Assistant Professor The University of Tokyo, Japan*
10:40 ~ 11:00	Break
11:00 ~ 11:40	**Tilte: CSPF & HSPF for air-conditioner and heat pump in Korea** *Speaker: Dr. Jun-Young Choi, Chief Researcher Korea Testing Laboratory/Energy Technology Center, Republic of Korea*
11:40 ~ 13:10	Lunch Break
13:10 ~ 13:50	**Title: SEER for air conditioners in New Zealand** *Speaker: Mr. Edward Winter MSc., Technical & Standards Advisor (Heating & Refrigeration), Energy Efficiency and Conservation Authority, New Zealand*
13:50 ~ 14:30	**Title: The Seasonal Energy Efficiency (SEER) of air conditioners in China standards** *Speaker: Prof. Cheng Jianhong, Researcher China National Institute of Standardization, China*
14:30 ~ 14:50	Break
14:50 ~ 15:30	**Title: The role of SEER of air conditioner in energy efficiency management in Chinese Taipei** *Speaker: Mr. Shin-Hang Lo, Manager Energy and Environment Research Laboratories, ITRI, Chinese Taipei*
15:30 ~ 16:10	**Title: SEER testing method and standard development in US** *Speaker: Mr. Christopher G. Stone, General Manager Intertek, USA*
16:10 ~ 16:50	**Title: Establishment of the CNS standards and development of SEER measuring method for air conditioners in Chinese Taipei** *Speaker: Mr.Chwan-Shing Huang, Vice General Manager Research & Planning Department, Taiwan Electric Research & Testing Center, Chinese Taipei*

16:50 ~ 17:20	**Panel Discussion**
Second Day – Panel Discussion (6th Oct., 2009 / Tue.)	
09:30 ~ 10:10	**Title: The measures of promoting SEER for air conditioners from manufacturer's point of view** *Speaker: Mr. Yi-Hung Huang* *TRAEA, Chinese Taipei*
10:10 ~ 10:50	**Title: Introduction of the development of an analytical platform for measuring the SEER of air conditioners of APEC member economies** *Speaker: Ms. Hsiao-Chi Hsu, Associate Researcher* *Industrial Technology Research Institute, Chinese Taipei*
10:50 ~ 11:10	Break
11:10 ~ 11:40	**Panel Discussion**
End of Workshop	

9 experts from different economies have given great speech and discussion. All the presentation files are included in Appendix A.

2.2 Speakers and participants

(1) Speakers invited by Chinese Taipei are from 5 different economies, which are China, Japan, Korea, New Zealand, and USA. And 4 speakers were from Chinese Taipei.

NO.	Economy	Name	Topic of presentation
1	New Zealand	Mr. Edward Winter MSc., Technical & Standards Advisor (Heating & Refrigeration), Energy Efficiency and Conservation Authority	SEER for Air Conditioners in New Zealand
2	Japan	Dr. Chaobin Dang Assistant Professor, The University of Tokyo	Policy and standards for the rational use of energy in Japan
3	China	Dr. Jianhong Cheng Researcher, China National Institute of Standardization	CSPF & HSPF for Air conditioner and Heat pump in Korea
4	Korea	Dr. Jun-Young Choi Chief Researcher, Korea Testing Laboratory, Energy Technology Center	The Seasonal Energy Efficiency (SEER) of Air Conditioners in China standards
5	US	Christopher G. Stone General Manager, Intertek	SEER testing method and standard development in US

(2) Active participants invited by Chinese Taipei are from 3 different economies which are Indonesia, Malaysia, and Russia.

Active Participant	1	Russia	Sergey Molodtsov Deputy Director on science, Centry for energy policy, Moscow
	2	Malaysia	Zaini Abdul Wahab Demand Side Management, Energy Commission, Malaysia
	3	Indonesia	Totok Sulistiyanto Vice President, ASHRAE Indonesia Chapter

(3) The total number of participants is 51 which are from 10 economies.

2.3 Discussion in the Workshop

In the panel discussion, the workshop was brought out some very constructive suggestions and actions to follow, such as:

- **Natural refrigerant** application to air conditioners is a beneficial issue not only to energy efficiency lifting, but also to environmental protection issue. That means the green energy is a critical issue for natural refrigerant in air conditioners, instead of HFC and HCFC refrigerants.
- **Connection channel** built to other international organization, such as APP, ISO and others is suggested to seek. Through the channel built, the information and experience can be shared and exchanged, so that it will be conducive to the elimination of trade barriers.
- **Manufacturers** should be invited and actively involved in the SEER developing stage, so that the implementation of any regulation will be easier to promote.
- This meeting mainly focuses on the discussion of the efficiency of air conditioners, but the **renewable energy** is another big issue and has drawn attentions worldwide. Hope that this issue can be discussed in the upcoming APEC relative meetings.
- The **humidity factor** can be considered in the SEER calculation software developed by Chinese Taipei. Hopefully, its application can also include the package units, not just for room air conditioners or window-type units.

Followings are the summary of the discussion in the workshop:

No.	Question	Answer
1	There are many VRV or VRF systems in Japan, what is the current test method or standard for these systems in Japan?	The JIS 8616 also has some comments about VRV systems, but it's not satisfactory. So far in Japan, JIS 8616 is still used as a test method for VRV systems, but some parameters maybe change. From 2007, we started the experiments for the VRV testing, and we are going to revise the test method for the VRV systems. We have a committee from industrial associations, heat pump associations and the government to improve JIS standard, but it's not a constant committee.
2	In JIS C standard, the Cd value for room air conditioners is 0.25. Why the Cd value of package air conditioners is different with room air conditioners?	For variable-speed compressor, Cd can be zero when it operates at low frequency and there is no on-off cycle. If the compressor is constant-speed type, the Cd value is 0.25 even for package air conditioners.
3	The consumers in Japan accept products with high efficiency performance. Do the consumers also accept the high price?	It's a little difficult for consumers in Japan to afford now. The government promotes the sales of high efficient products by giving some subsidies to consumers.
4	The procedure of SEER testing for Korea is complicated shown in the presentation. How does the temperature bin be developed?	It depends on different countries. You can obtain your climate data from your government or organizations, and develop your temperature bin.
5	For the VRV system which has two different compressors, one is fixed-speed compressor and the other one is variable-speed compressor, which category do you put for this testing?	In Korea, manufacturers normally categorize the systems into three types: Fixed-Speed Compressor, Multi-Speed & 2-Compressor and Variable Speed Compressor for SEER testing. The Multi-Speed & 2-Compressor category could be adaptive.

6	Are there any schedules to use SEER to evaluate the inverter-type air conditioners in Korea?	SEER concept has been adopted to evaluate the inverter-type air conditioners in Korea. EER is used only for fixed-speed type.
7	How do you handle the test for partially non-ducted and partially ducted systems?	In Korea, non-ducted means window type. Our energy program is only for window type, not inclusive of ducted systems. It's still unknown to define this system.
8	How does New Zealand implement the star rating?	Importers and manufacturers in New Zealand may not sell air conditioners or heat pumps unless they are tested and registered, and meet or exceed Minimum Energy Performance Standards. Importers, manufacturers, retailers and people selling new appliances have obligations to ensure that energy rating labels are affixed or supplied when appliances are available for sale. You can organize the testing yourself or ask the manufacturer to provide you with a test report that clearly shows that your product meets the required standard. EECA's products' program uses laboratories accredited by IANZ or NATA for its regulatory enforcement activities. This means from time to time we select a sample range of models for a product and test them to make sure that they meet the legal requirements.
9	In Japan, the efficiency of each categorized product is printed, and everybody can access the information for all products on the category. China was trying to promote that kind of system for three selected products, namely refrigerator, air conditioner and	In China, we are working on some programs. One is to improve the MEPS and second one is to have more energy-labeled products. Another is the certification label program. We are trying to give more information to consumers such as room air conditioners. In the future, we hope the publication project can support standard and label programs.

	washing machine, and that would help consumers to know more about the efficient products. Is there any further development about that issue? If you could give us some information on that, that will be very much appreciated.	
10	What is the compliance enforcement program in relation to energy efficiency of appliances in China?	In China, there are some ways to check market products. Agencies involved in implementation and enforcement of appliance standards and labels include: AQSIQ and its provincial branches, CNIS, and CSC. The China Energy Label Center (CELC) was recently established within CNIS to supervise the registration and to monitor the use of energy information labels.
11	Is humidity a considered factor in the SEER calculation program developed by Chinese Taipei?	The humidity factor is not considered in the SEER calculation program right now. Since humidity is a quite complicated parameter, and we may need more researching time to study this issue.
12	How does the SEER of a packaged air conditioner be calculated in the calculation program?	This calculation program is only developed for room air conditioners right now.
13	In China, the survey shows that the actually running hours of AC vary very differently according to people's habit. Hope the SEER calculation program can consider this factor.	There is a user define function in the calculation program. User can input the real running hours to calculate SEER.

2.4 Activity pictures

2.5 Attendance book

Workshop on Reducing Barriers to Trade through Development of a Common Protocol for Measuring The Seasonal Energy Efficiency (SEER) of Air Conditioners

5-6 Oct., 2009

No	Name	Organisation	Economy	Signature	Remark
1	Tim C Farrell	Department of the Environment, Water, Heritage and the Arts (DEWHA)	Australia		
2	CHENG Jianhong	China National Institute of Standardization	China	Cheng Jianhong	speaker
3	Jui Fah Chou	Alpha Engineering Inc.	Chinese Taipei		
4	Feng-Hui Chuang	Bureau of Energy, MOEA	Chinese Taipei		
5	Kung-Yuan Lin	Bureau of Energy, MOEA	Chinese Taipei		
6	Ling-Hui Chen	Bureau of Energy, MOEA	Chinese Taipei		
7	Shu-Fang Kao	Bureau of Energy, MOEA	Chinese Taipei		
8	Wen-Hsin Lin	Bureau of Energy, MOEA	Chinese Taipei		
9	Yunn-Ming Wang	Bureau of Energy, MOEA	Chinese Taipei		
10	Chung-Kuan Kung	Department of Mechanical Engineering, NTU	Chinese Taipei		
11	Hung-Ping Cho	Department of Mechanical Engineering, NTU	Chinese Taipei		
12	Derriek Shih	Electronics Testing Center, Taiwan	Chinese Taipei		
13	Haga Eiji	Hotai Development Co., Ltd	Chinese Taipei		
14	Yang, Hui-Lin	Hotai Development Co., Ltd	Chinese Taipei		
15	Yeh, Chun-Ming	Hotai Development Co., Ltd	Chinese Taipei		
16	Bing-Chwen Yang	Industrial Technology Research Institute	Chinese Taipei	Bing-Chwen Yang	

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17	Chin-Yu Tung	Industrial Technology Research Institute	Chinese Taipei		
18	Chung-Szu Wei	Industrial Technology Research Institute	Chinese Taipei	Chung-szu Wei	
19	Hsiao-Chi Hsu	Industrial Technology Research Institute	Chinese Taipei	Hsiao-Chi Hsu	speaker
20	Hsu-Cheng Chiang	Industrial Technology Research Institute	Chinese Taipei		
21	Jane-Sunn Liaw	Industrial Technology Research Institute	Chinese Taipei	J S Liaw	
22	Jian-Yuan Lin	Industrial Technology Research Institute	Chinese Taipei	[illegible]	
23	Liang-Jyi Fang	Industrial Technology Research Institute	Chinese Taipei		
24	Robert Yie-Zu Hu	Industrial Technology Research Institute	Chinese Taipei	✓	
25	Shin-Hang Lo	Industrial Technology Research Institute	Chinese Taipei	✓	speaker
26	Wayne Cheng	Industrial Technology Research Institute	Chinese Taipei	[illegible]	
27	Yu-Choung Chang	Industrial Technology Research Institute	Chinese Taipei	Yu-chong Chang	
28	Yu-Juei Chang	Industrial Technology Research Institute	Chinese Taipei	Yu-Juei Chang	
29	Yu-Lin Wang	Liung Feng Industrial Co., Ltd	Chinese Taipei		
30	Yi-Min(August) Tseng	Mitsubishi Electric Taiwan	Chinese Taipei	Yi-Min Tseng	
31	Ing Youn Chen	National Yanlin Univ. of Science & Technology	Chinese Taipei	Ing Y. Chen	
32	Chris Huang	Nationl Fedesation of Air-conditioning & Refrigeration Paofeesional Engineer Guilds	Chinese Taipei		
33	chiao Tseng Hong	Soundair Co., Ltd.	Chinese Taipei		

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5-6 Oct., 2009

34	Vince C. Mei	St. John University of Science & Technology	Chinese Taipei		
35	Men-Ioh Yang	TA Tugn	Chinese Taipei		
36	Bill H.J. Chen	Taiwan Association of Energy Service Companies	Chinese Taipei		
37	Lan-Ching Yang	Taiwan Association of HVAC & R Professional Engineers	Chinese Taipei		
38	Chwan-Shing Huang	Taiwan Electric Research & Testing Center	Chinese Taipei		speaker
39	Chung-Hsin Ko	Taiwan Hitachi	Chinese Taipei		
40	Rong-Chuan Chang	Taiwan Hitachi	Chinese Taipei		
41	Yi-Hung Huang	Taiwan Hitachi	Chinese Taipei		
42	Ching-Hai Chuang	Taiwan Refrigeratin and Air-Conditioning Engineering Association of ROC	Chinese Taipei		
43	Ching-Yueh Weng	Taiwan Refrigeration and Air Conditioning Engineering Association of R.O.C	Chinese Taipei		
44	Liu-Ming Kao	Taiwan Refrigeration and Air Conditioning Engineering Association of R.O.C	Chinese Taipei		
45	Steve R.C. Chang	Taiwan Refrigeration and Air Conditioning Engineering Association of R.O.C	Chinese Taipei		speaker
46	Mira Wu	Taiwan Society of Heating, Refrigerating and Air-Conditioning Engineers	Chinese Taipei		
47	Tony Soo	Taiwan Society of Heating, Refrigerating and Air-Conditioning Engineers	Chinese Taipei		
48	Yu-Cheng Chang	Taiwan Society of Heating, Refrigerating and Air-Conditioning Engineers	Chinese Taipei		
49	Totok Sulistiyanto	ASHRAE Indonesia Chapter	Indonesia		

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50	SHOGO TOKURA	HEAT&PUMP THERMAL STORAGE TECHNOLOGY CENTER OF JAPAN	Japan		
51	Yukari Yamashita	The Institute of Energy Economics, Japan	Japan		
52	Chaobin Dang	The University of Tokyo	Japan		speaker
53	ZAINI BIN ABDUL WAHAB	MALAYSIAN ENERGY COMMISSION	MALAYSIA		✓
54	Edward Winter MSc.	Energy Efficiency and Conservation Authority	New Zealand		speaker
55	Laura Kate Christen	Energy Efficiency and Conservation Authority	New Zealand		
56	Terry Collins	Energy Efficiency and Conservation Authority	New Zealand		
57	José Luis Rodríguez Vásquez	Ministry of Energy and Mines / General Directorate Electricity	Perú - South America		✓
58	Jun-Young Choi	Korea Testing Laboratory/Energy Technology Center	Republic of Korea		speaker
59	Sergey Molodtsov	Centre of energy policy	Russian Federation		✓
60	Christopher G. Stone	Intertek	USA		speaker
61	Chiau-Hung, Cheng	Soundair	Chesen Taipei	Chiau-Hung, Cheng	
62	Yang-Men-Iou	TATUNG		楊孟[illegible]	
63	林福[illegible]	Kimetco	Taiwan	Franklin	
64	杜[illegible]煌		Taiwan	杜[illegible]煌	
65	江明松	台灣大電力 Enos	Taiwan	江明松	

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66	東南科大	謝建新 Hsieh, Chieh-hsin		v	
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3. SEER Calculation Program for Room Air Conditioners

3.1 Methodology

The parameters in the SEER calculation program include (1) the weather data of the regions concerned, (2) the curves of cooling capacity and power consumption under the different ambient temperatures. Should it be the case of a Inverter AC unit, the additional curves of medium cooling capacity and power consumption are necessary; (3) the curve of building load; (4) Degradation Coefficient (C_D), namely, a factor efficiency loss due to the cycling of an air conditioner, which is an important parameter for the ON-OFF cycling. The value of C_D is derived from experiments. It is not needed if the system is running without ON-OFF cycling.

The research approaches and the calculation procedure of the SEER platform include:

(a) Establish the calculation method for constant-speed AC units and Inverter (or variable speed) AC units.

(b) Obtain the cooling capacity and power consumption of the system from the standard test condition.

(c) Establish the average bin temperatures for the climatic region concerned.

(d) Estimate the cooling capacity and power consumption of the system in each bin temperature.

(e) Make a summation to generate Cooling Seasonal Total Load (CSTL) and Cooling Seasonal Energy Consumption (CSEC), respectively. Then, divide the former by the latter to obtain SEER, as expressed by the following equation and as shown in Figure 1.

(f) Construct the interface of the SEER evaluation program.

$$SEER = \frac{\sum_{j=1}^{n} \phi(t_j) \cdot n_j}{\sum_{j=1}^{n} \dot{P}(t_j) \cdot n_j}$$

where n = temperature bin

j = the *j*-th bin,

$\phi(t_j)$ = cooling capacity in the *j*-th bin,

$\dot{P}(t_j)$ = electric power consumption in the *j*-th bin,

nj = total time of temperature occurring in the *j*-th bin

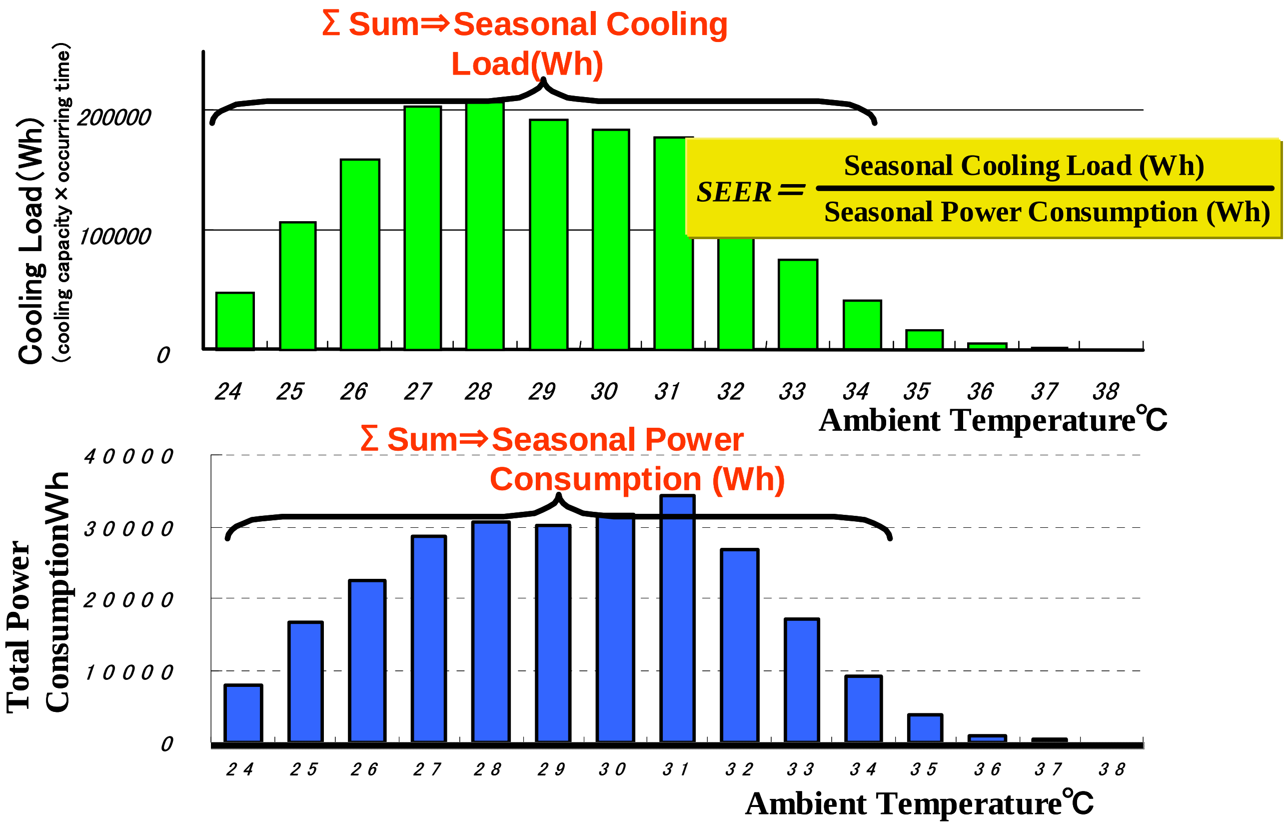


Figure 1. Illustration of parameters in SEER

For practical application, this project was intended to develop a program for the users by entering the information required, such as the weather data and test results, to deliver a performance results. Thus, most of the work in this project focused on program development. To verify the applicability of the program, broad data collection and performance testing were conducted and a seminar was given for open discussion and opinions input.

After the completion of this project, we may consider the possibility of publishing a paper in an international journal or holding a seminar, to introduce the essence of the SEER program and promote the usefulness of it.

3.2 SEER Standards for APEC Economies

First, we collected the testing and performance standards for air conditioners in APEC member economies from the APEC Energy Standards Information System. For some economies, like Australia, Canada and USA, there are several standards used in the same time. And for some economies, like Chile, Malaysia and Peru, the relative standard is currently under consideration.

Table 1 shows the SEER standards adopted in APEC Economies. USA and Canada have used SEER to rate central AC for a long time. Japan is going to use APF to rate all packaged AC in 2010. China and Korea established their SEER standards referred to JIS C 9615. Chinese Taipei drew up a draft in 2008 and plans to make it a domestic standard in few years. New Zealand currently is working on it.

Table 1. SEER Standards for APEC Economies

Economies	USA	Canada	Japan	China	Korea	Australia & New Zealand	Chinese Taipie
Standard	ASHARE 116-1995	CAN/CSA C656-M92	(1)JRA 4046 : 2004 (2)JIS C 9612 : 2005 Appendix 3	GB/T 7725-2004 Appendix E	KS C 9306-2007	AS/NZS 3823 -2001	CNS 14464 & CNS 3615
Reference	ANSI/ASHRAE 116, Methods of testing for seasonal efficiency of unitary air-conditioners and heat pumps	(1) All types of central air conditioners are rated using SEER (2) test procedure for central air conditioners : ARI 210/240-89 & ASHRAE 37	(1) JRA 4046, Room air conditioners, 2004 (2) JIS C 9612, Room air conditioners, 2005	GB/T 7725-2004, Room Air Conditioners	KS C 9306-2007, Room air conditioners	Working on it	Draft

3.3 Key parameters for SEER calculation

For calculating SEER, there are several key parameters affecting the value.

(1) The cooling capacity and power consumption obtained from the standard tests. The curves of cooling capacity and power consumption under different ambient temperature.

(2) Degradation Coefficient (C_D): When the air conditioner is in on-off cycle state, the degradation coefficient is needed to be included in calculating the consuming power.

The United States and Canada proposed to use C_D equal to 0.2. Japan, China, Korea and Chinese Taipei used C_D equal to 0.25.

(3) Building load curve (BL): Usually is a straight line, and the outdoor temperature is as the horizontal axis. The intersection between air conditioner's cooling capacity and building load curve can be used to decide the operation mode of the air conditioner, i.e. on-off cycle state, continuous operation mode or variable speed operation mode.

In Japan, China, Korea and Chinese Taipei, when outdoor temperature is 23^oC, the BL is 0. When outdoor temperature is 33^oC, the BL is equal to rated cooling capacity, except China. The BL is equal to rated cooling capacity when outdoor temperature is 35 ^oC.

In USA and Canada, building load is 0 when outdoor temperature is 65^oF (18.33^oC). And BL is equal to rated capacity divided by 1.1 when outdoor temperature is 95^oF.

For New Zealand, it is assumed that the BL is 0 when outdoor temp. is 20^oC, because when outdoor temperature greater than 20^oC, it is cooling season.

Table 2 shows the comparison with BL and C_D in each economy.

Table 2. The comparison with BL and C_D in each economy

Economy	USA, Canada	Japan	Korea	Chinese Taipei	China	New Zealand
	ASHARE 116-1995 ARI 210/240	JRA 4046：2004 JIS C 9612：2005	KS C 9306-2007	Draft-2008	GB/T 7725-2004	Working on it (assumed)
BL	BL(65°F)=0 BL(95°F)=Cooling capacity／1.1	BL(23℃)=0 BL(33℃)=Cooling Capacity			BL(23℃)=0 BL(35℃)=Cooling capacity	BL(20℃)=0 BL(33℃)=Cooling capacity
CD	0.2	0.25				

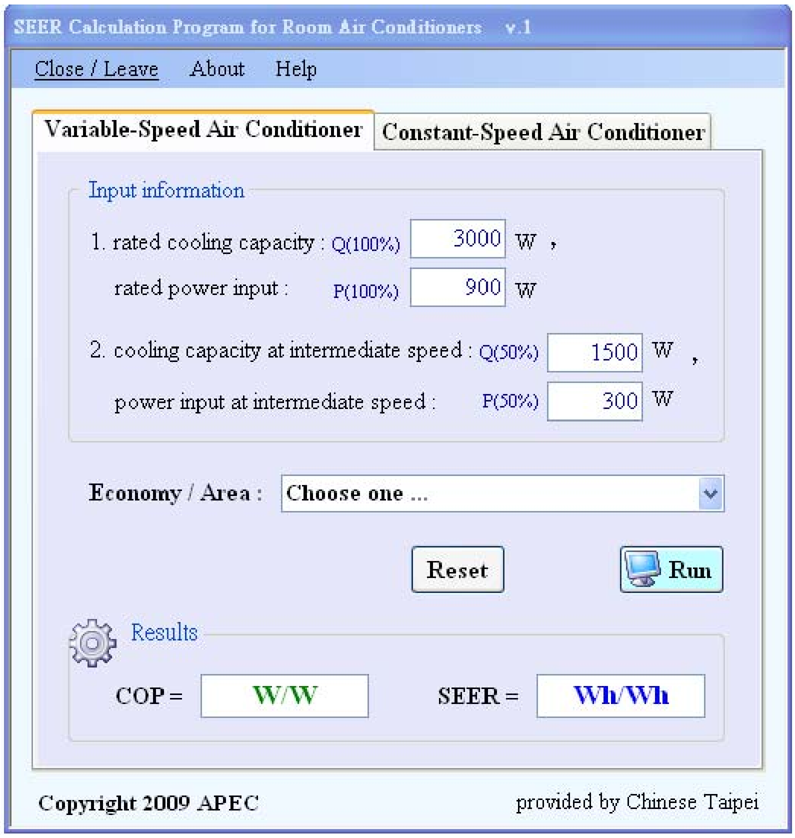
(4) Meteorological statistics: Data of the whole year's average outdoor temperature of the region. Weather condition is an important parameter for calculating SEER. Basically for the same AC, if the weather condition is hotter, the calculating SEER value is lower. Table 3 shows the comparison with bin temp. for SEER standards in the economies. USA use 8 bin temp. which range is from 64°F to 102°F. (17.8°C to 38.9°C) Japan, China and Korea use 15 bin temp. which range is from 24°C to 38°C.

Table 3. Comparison with bin temperature for SEER standards

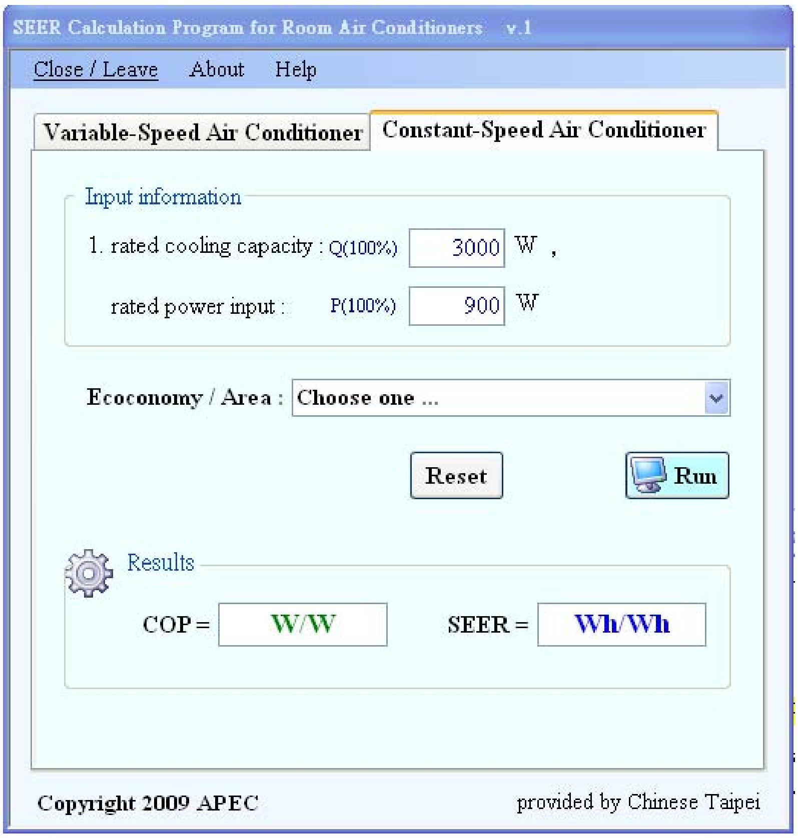
	USA	Japan	China	Korea	Chinese Taipei	New Zealand
Standard	ASHARE 116-1995	JRA 4046：2004 JIS C 9612：2005 Appendix 3	GB/T 7725-2004	KS C 9306-2007	Draft-2008	Working on it (assumed)
Temp. range	64°F～102°F	24℃～38℃	24℃～38℃	24℃～38℃	24℃～37℃	21℃～34℃
Bin temp.	8 bins (5°F/bin)	15 bins (1℃/bin)	15 bins (1℃/bin)	15 bins (1℃/bin)	14 bins (1℃/bin)	14 bins (1℃/bin)
Reference	Weather data in America	1. JRA 4046:2004—weather data in Tokyo 2. JIS C 9612:2005—weather data in Japan	Weather data in China	Weather data in Korea	Weather data in Chinese Taipei (1999~2006)	Weather data in Christchurch
Period	Based on ASHRAE Handbook	Cooling period： 3.6 months (Jane 2 to September 21) Heating period： 5.5 months (October 28 to April 14)	—	—	Cooling period： $T_{out}>24$ ℃	Cooling period： $T_{out}>20$ ℃
Time		Operating time： 18 hours(6:00 to 24:00)			Operation time： 24 hours	

3.4 Introduction of SEER Calculation Program

Integrate above information and data, this project constructed an interface of the SEER evaluation program. Figure 2 shows the main frames of the SEER calculation program. User can select variable speed AC or constant Speed AC to calculate the SEER of his system.



(a) SEER calculation for variable-speed AC



(b) SEER calculation for constant-speed AC

Figure 2. The main frames of the SEER calculation program

The steps to get the calculating value are:

(1) Input the cooling capacity and power consumption first as shown in Figure 3. For variable-speed AC, the intermediate cooling capacity is usually about half value of the rated capacity.

(2) Then, choose the economy or area where the AC operates as shown in Figure 4. This program so far includes 6 economies' standards (or drafts) about SEER.

(3) Finally, click the "Run" button to calculate COP and SEER.

(4) If choose "User Define" function (Figure 5), user can set the bin temp. V.S. bin hours or just load the default data (Figure 6) and modify the relative bin hours. User can also set the value of degradation coefficient (C_D) and the definition of building load (BL) as shown in Figure 7.

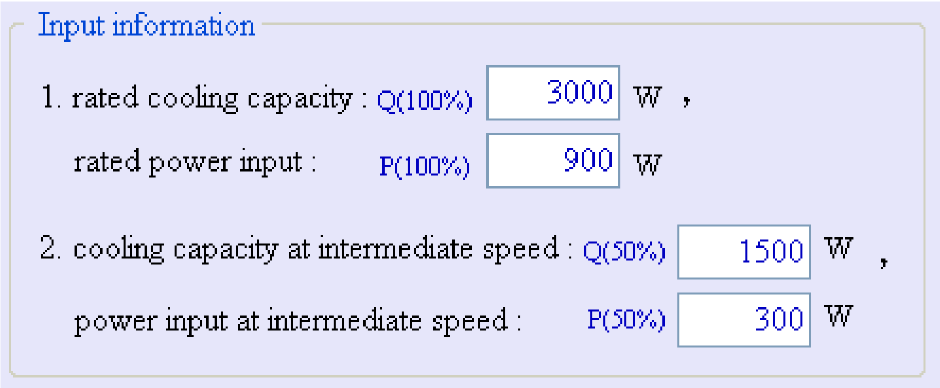


Figure 3. Input information for SEER calculation of a variable-speed AC

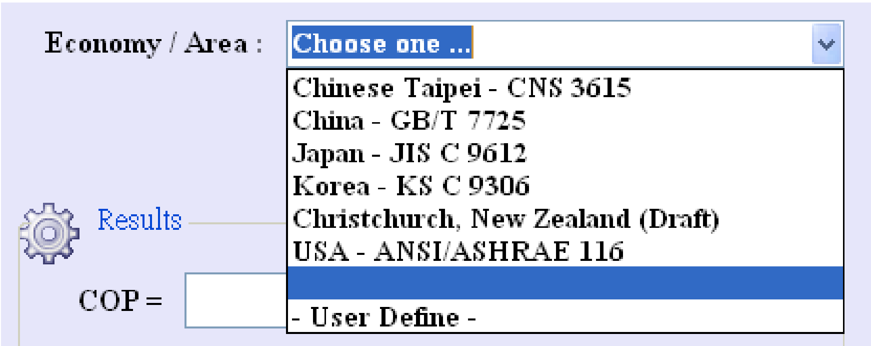


Figure 4. Choose the Economy or Area where the AC operates

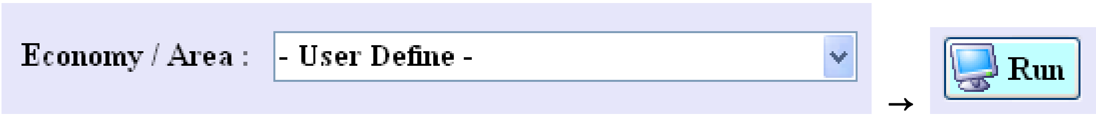


Figure 5. Choose "User Define" and click "Run" to activate the function

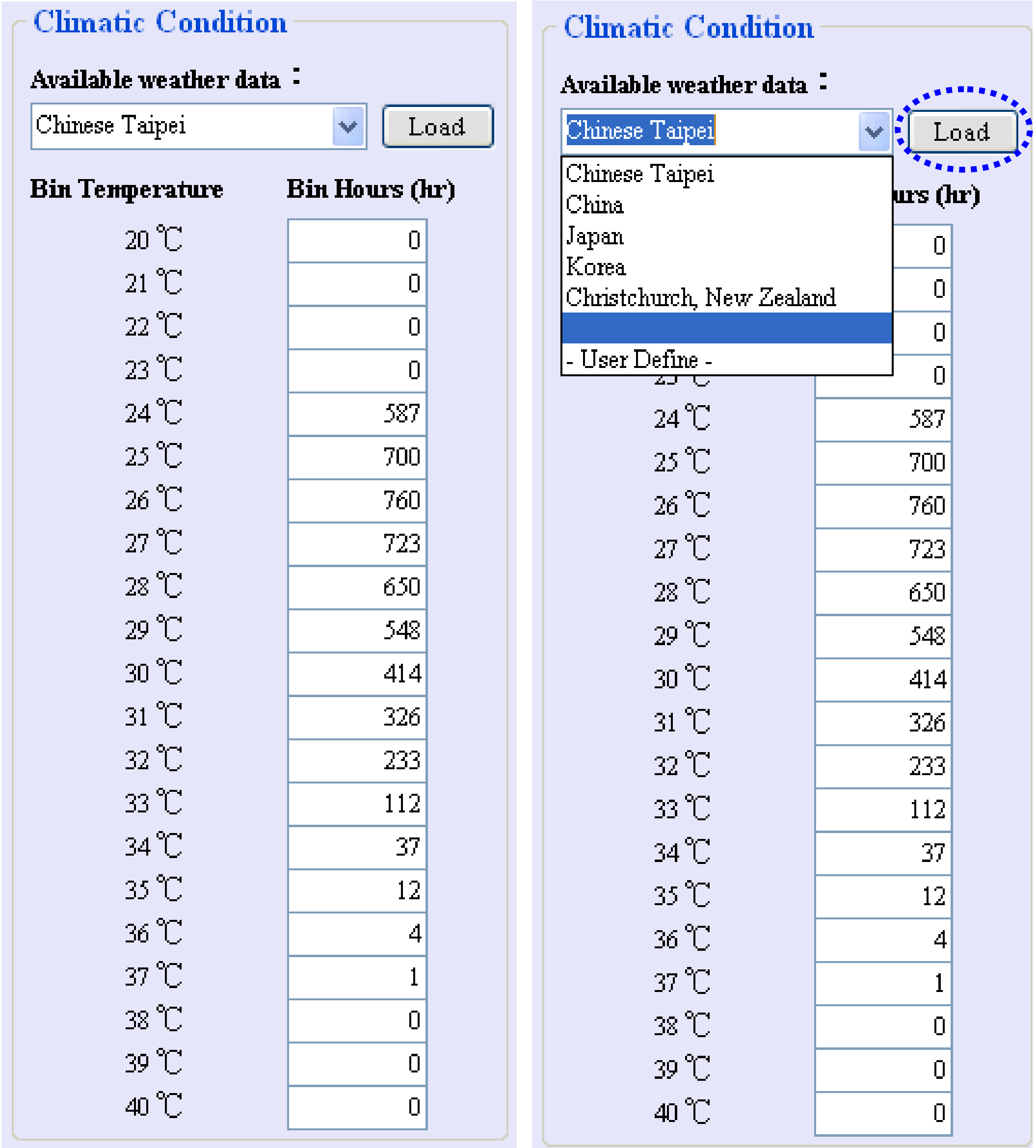


Figure 6. Set the climate condition of User Define function

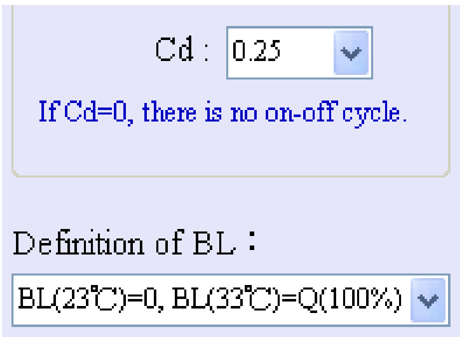


Figure 7. Set the value of degradation coefficient (C_D) and the definition of building load (BL)

3.5 Examples of using SEER calculation program

Following is an example of using SEER calculation program. Assume that there is a variable-speed air conditioner which rated cooling capacity is 3000 W and the rated power input is 950 W. And at intermediate speed, the cooling capacity is 1526 W, and the power input is 320 W. Figure 8 shows the input information.

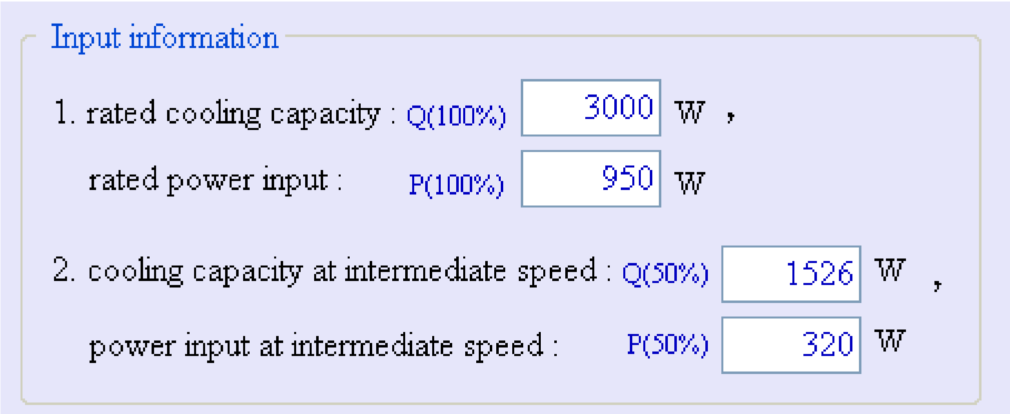


Figure 8. The input information of a sample AC

Then choose the economy or area where the AC operates, and click "Run" to calculate COP and SEER.

If the AC operates in Chinese Taipei, the COP of the AC is 3.16, and the SEER is 4.86 as shown in Figure 9.

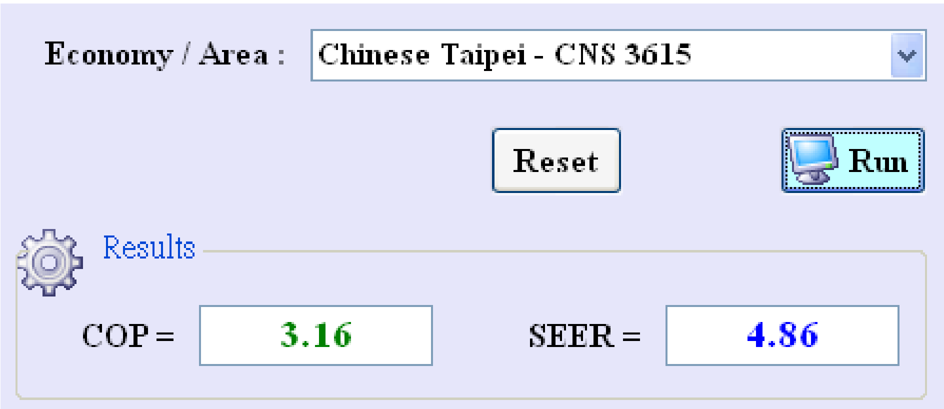


Figure 9. The COP and SEER of a sample AC which operates in Chinese Taipei

If the AC operates in China, the COP of the AC is 3.16, and the SEER is 4.95 as shown in Figure 10.

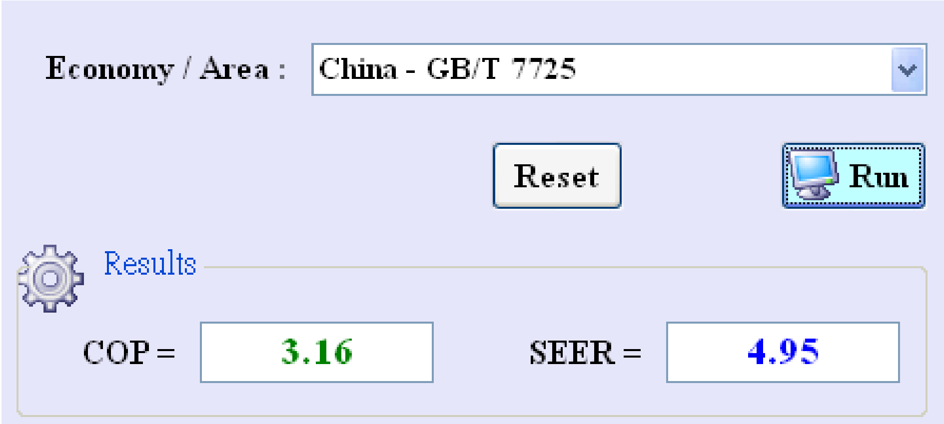


Figure 10. The COP and SEER of a sample AC which operates in China

If the AC operates in Japan, the COP of the AC is 3.16, and the SEER is 5.02 as shown in Figure 11.

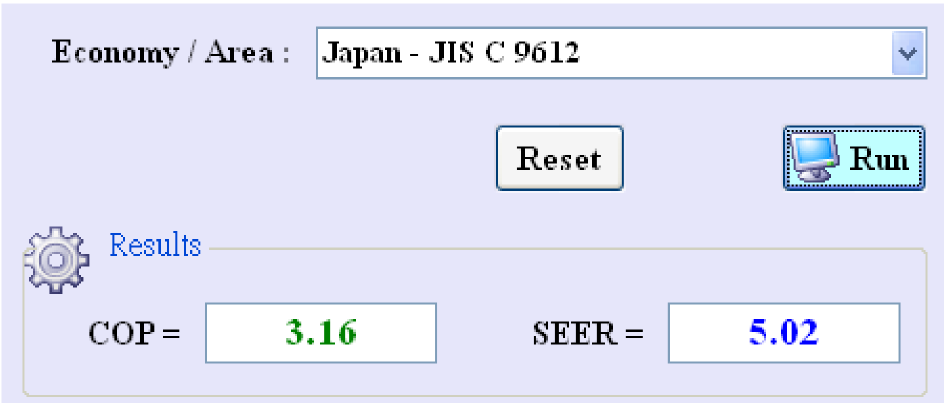


Figure 11. The COP and SEER of a sample AC which operates in Japan

If the AC operates in Korea, the COP of the AC is 3.16, and the SEER is 4.6 as shown in Figure 12.

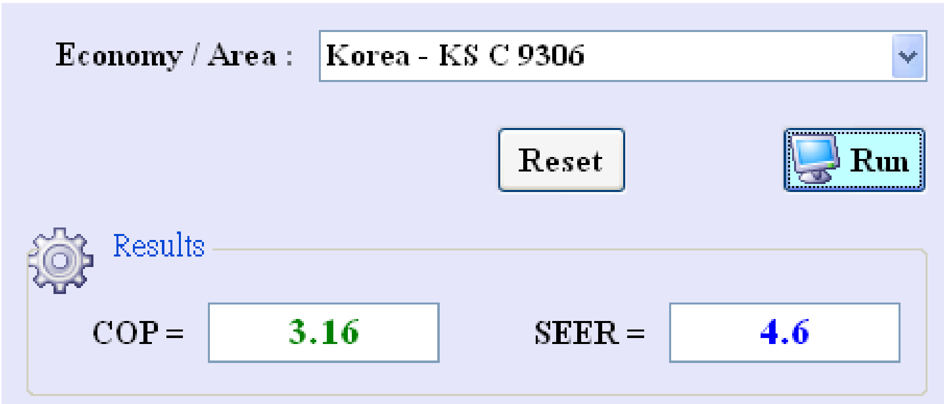


Figure 12. The COP and SEER of a sample AC which operates in Korea

If the AC operates in Christchurch, New Zealand, the COP of the AC is 3.16, and the SEER is 5.39 as shown in Figure 13.

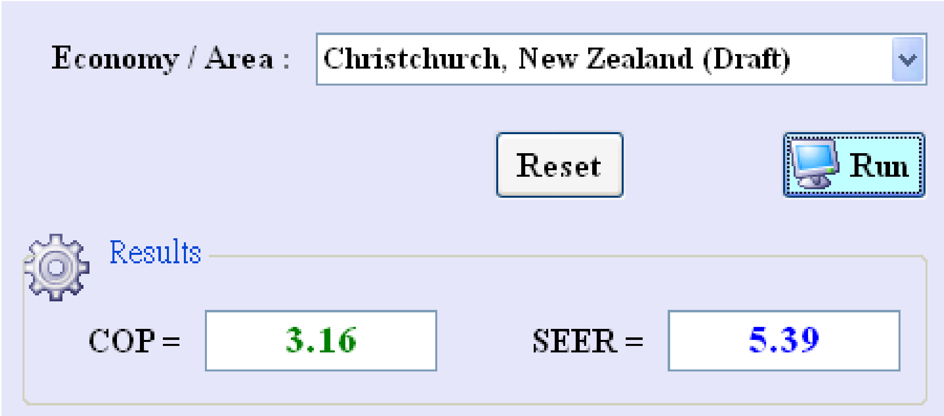


Figure 13. The COP and SEER of a sample AC which operates in Christchurch, New Zealand

If the AC operates in US, the COP of the AC is 3.16, and the SEER is 5.15 as shown in Figure 14.

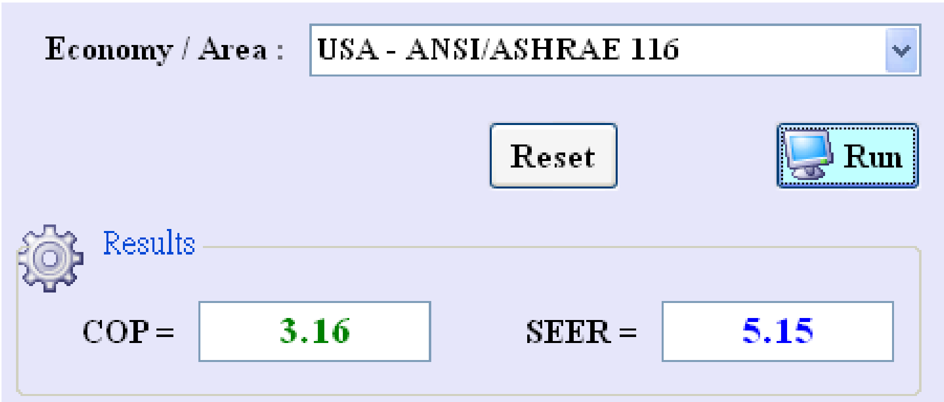


Figure 14. The COP and SEER of a sample AC which operates in US

Table 4. Comparison with SEER in different economies for the same AC

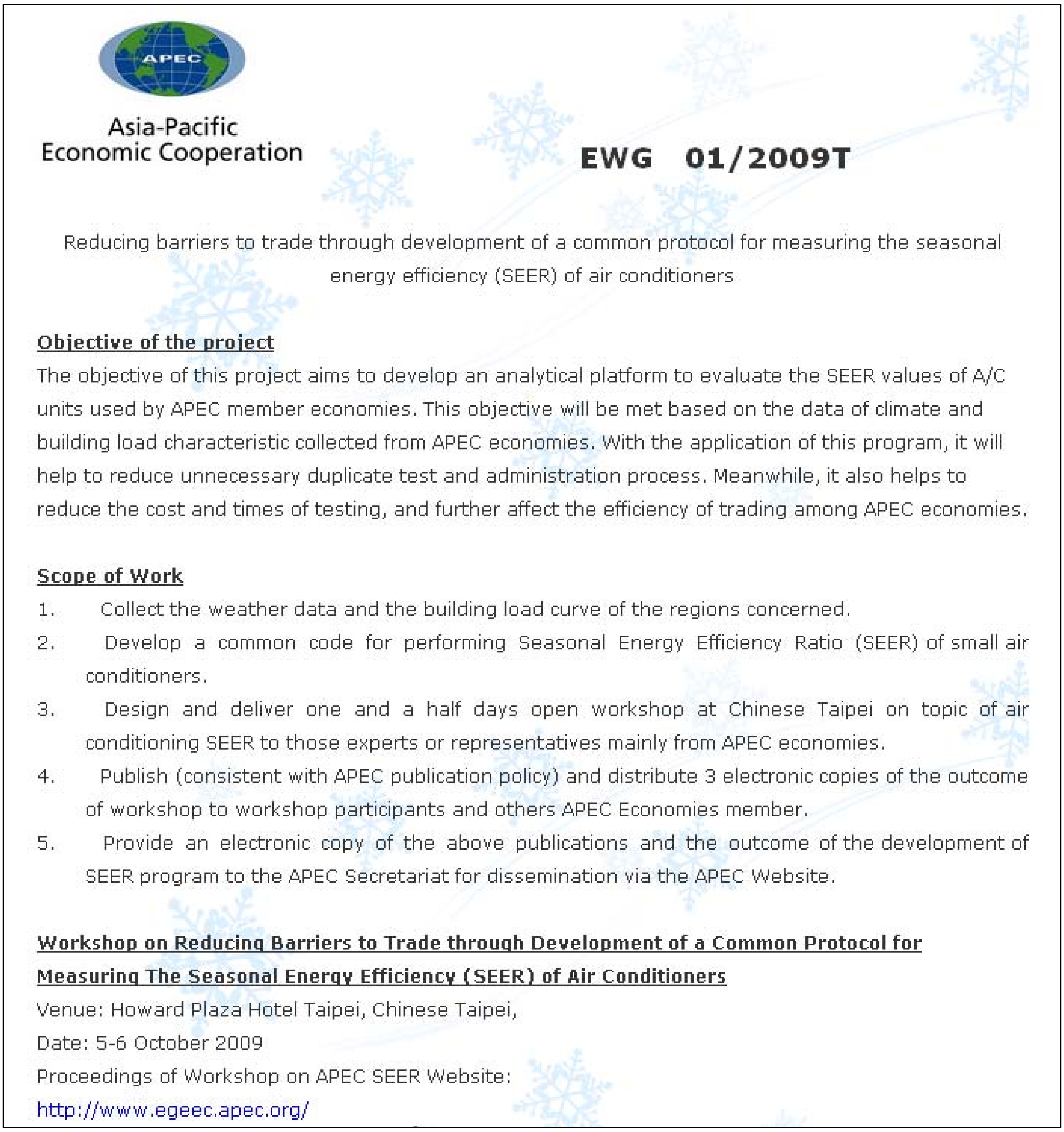
Economy / Area	COP	SEER
Chinese Taipei	3.16	4.86
China		4.95
Japan		5.02
Korea		4.60
New Zealand		5.39
USA / Canada		5.15

Table 4 shows the comparison with SEER in different economies for the same AC. Basically for the same AC, if the economy locates in the hotter climate zone, for example in Chinese Taipei, the calculating SEER value is lower. If the economy locates in the cooler climate zone, for example in Canada, the calculating SEER value is higher.

4. Conclusions

An electronic copy of the above publications and the outcome of the development of SEER calculation program will be send to each APEC economy member by mail. They also can be downloaded from the website: http://www.hvac-net.org.tw/action/?parent_id=14

Figure 15 shows part of the web page where to download the outcome of the project.



APEC

Asia-Pacific
Economic Cooperation

EWG 01/2009T

Reducing barriers to trade through development of a common protocol for measuring the seasonal energy efficiency (SEER) of air conditioners

Objective of the project

The objective of this project aims to develop an analytical platform to evaluate the SEER values of A/C units used by APEC member economies. This objective will be met based on the data of climate and building load characteristic collected from APEC economies. With the application of this program, it will help to reduce unnecessary duplicate test and administration process. Meanwhile, it also helps to reduce the cost and times of testing, and further affect the efficiency of trading among APEC economies.

Scope of Work

1. Collect the weather data and the building load curve of the regions concerned.
2. Develop a common code for performing Seasonal Energy Efficiency Ratio (SEER) of small air conditioners.
3. Design and deliver one and a half days open workshop at Chinese Taipei on topic of air conditioning SEER to those experts or representatives mainly from APEC economies.
4. Publish (consistent with APEC publication policy) and distribute 3 electronic copies of the outcome of workshop to workshop participants and others APEC Economies member.
5. Provide an electronic copy of the above publications and the outcome of the development of SEER program to the APEC Secretariat for dissemination via the APEC Website.

Workshop on Reducing Barriers to Trade through Development of a Common Protocol for Measuring The Seasonal Energy Efficiency (SEER) of Air Conditioners

Venue: Howard Plaza Hotel Taipei, Chinese Taipei,

Date: 5-6 October 2009

Proceedings of Workshop on APEC SEER Website:

http://www.egeec.apec.org/

Figure 15. Part of the web page where to download the outcome of the project

With SEER platform, as the worldwide users enter the parameters required, the SEER can be simply calculated based upon weather data and the test results of the air conditioners. SEER calculation program helps promote the concept of part-load efficiencies of air-conditioners and finally contributes to energy saving. With the application of this program, it will help to reduce unnecessary duplicate test and administration processes. Meanwhile, it also helps to reduce the cost and time of testing, and further affects the efficiency of trading among APEC economies.

Appendix A

1. Policy and standards for the rational use of energy in Japan

Policy and standards for the rational use of energy in Japan

Chaobin Dang
Assistant Professor, the University of Tokyo

Eiji Hihara
Professor, the University of Tokyo

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Outline

1. Energy Situation in Japan
2. The Basic Energy Plan
3. Law concerning the Rational Use of Energy
    - A) Measures for factories
    - B) Measures for buildings
    - C) Measures for equipment
4. Top Runner Program
    - A) Distinctive Features of the Top Runner Program
    - B) Results of Introducing the Top Runner Program
    - C) Labeling Program
5. Japanese Industrial Standard for Packaged Air-Conditioners
    - A) Heating and Cooling Load of Buildings and Duration time of Outdoor Temperature
    - B) Test Conditions
    - C) Evaluation method for the seasonal performance factor
6. Conclusion

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Changes in Final Energy Consumption in Japan

- Japan's final energy consumption has <u>increased almost continuously</u>, except immediately after the two oil crises and during the recent economic recession.
- The ratio of industrial: commercial/residential: transportation uses shifted <u>from 4:1:1 (oil crisis)</u> to <u>2:1:1 (FY2003)</u>.

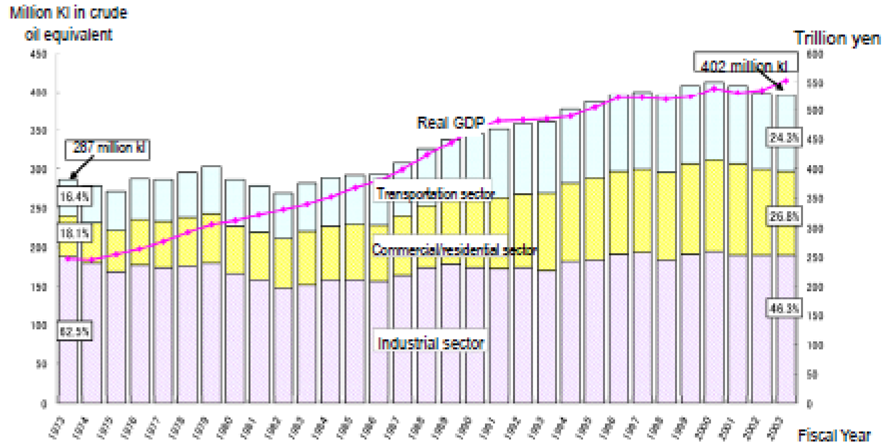

Figure 1 Transition of Japan's final energy consumption and real GDP

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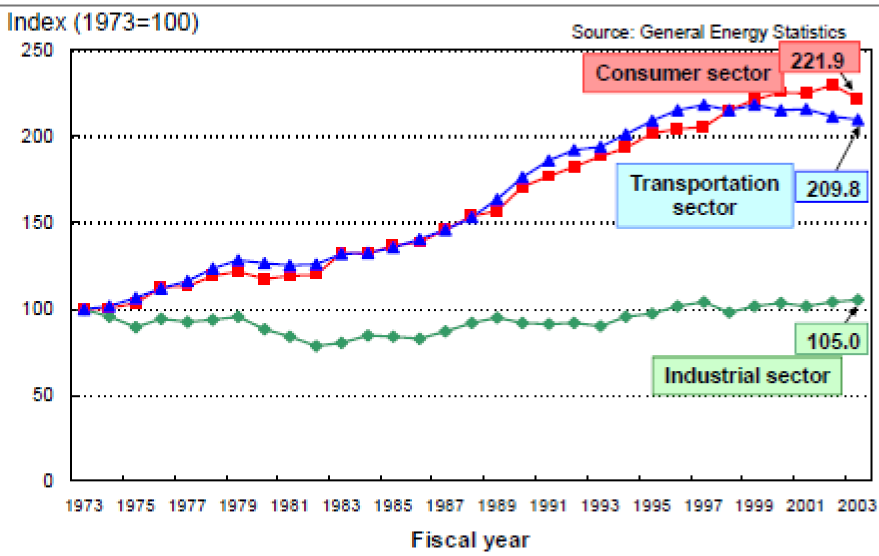
Changes in Final Energy Consumption by Sector

- Final energy consumption in the industrial sector has remained generally steady since the oil crisis.
- On the other hand, those of the commercial/residential and transportation sectors have increased significantly.



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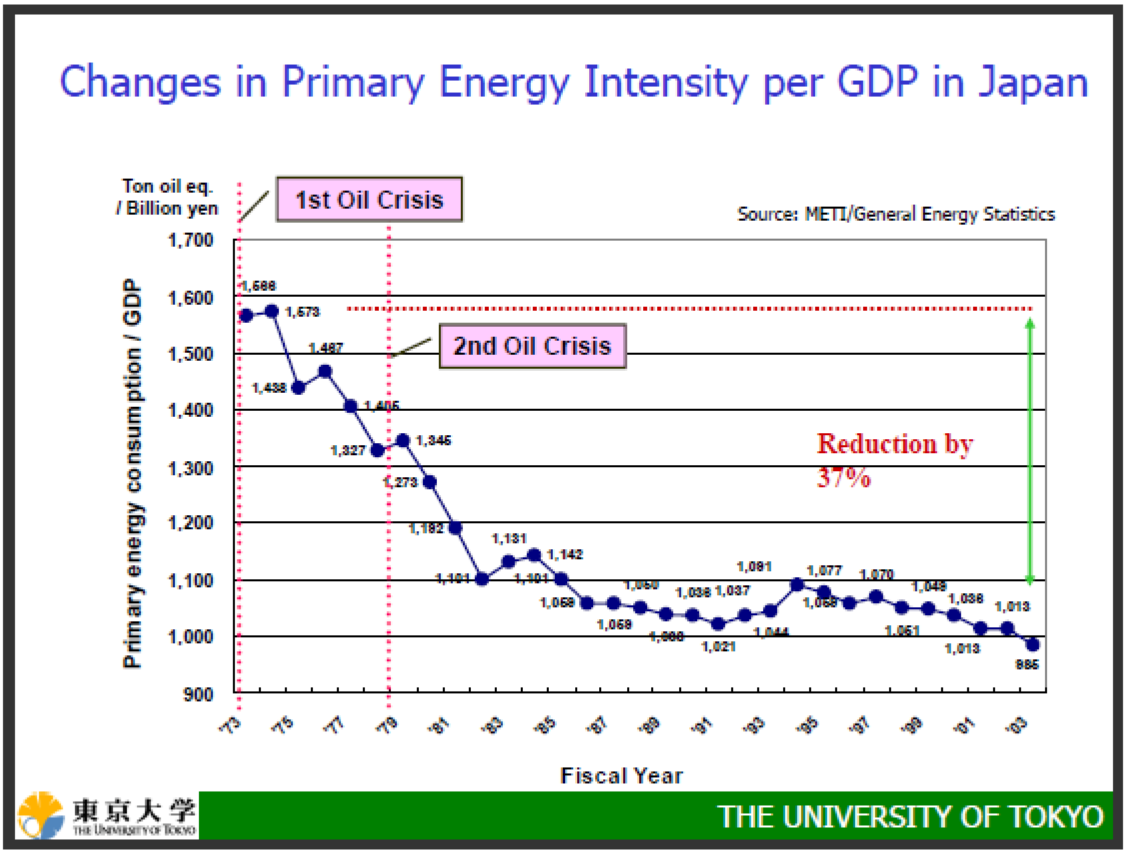

Changes in Primary Energy Intensity per GDP in Japan
Ton oil eq. / Billion yen
1st Oil Crisis
2nd Oil Crisis
Source: METI/General Energy Statistics
Primary energy consumption / GDP
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
1,573
1,487
1,438
1,327
1,346
1,273
1,131
1,142
1,091
1,077
1,070
1,021
1,013
Reduction by 37%
'73
'75
'77
'79
'81
'83
'85
'87
'89
'91
'93
'95
'97
'99
'01
'03
Fiscal Year
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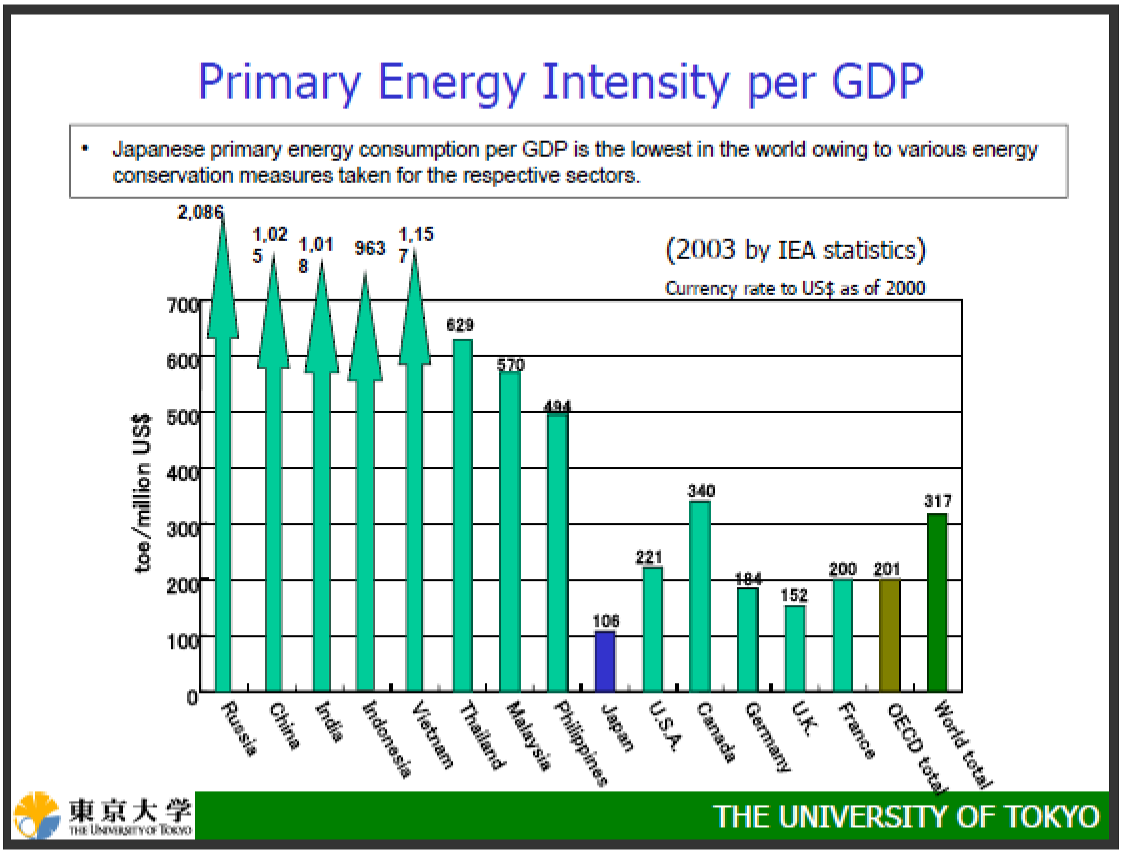

Primary Energy Intensity per GDP
• Japanese primary energy consumption per GDP is the lowest in the world owing to various energy conservation measures taken for the respective sectors.
(2003 by IEA statistics)
Currency rate to US$ as of 2000
toe /million US$
0
100
200
300
400
500
600
700
2,086
1,025
1,018
963
1,157
629
570
494
106
221
340
184
152
200
201
317
Russia
China
India
Indonesia
Vietnam
Thailand
Malaysia
Philippines
Japan
U.S.A.
Canada
Germany
U.K.
France
OECD total
World total
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The Basic Energy Plan

In October 2003, the Agency for Natural Resources and Energy (ANRE) submitted the Basic Energy Plan to the Diet. This plan defines the direction of measures on demand and supply of energy for the next 10 years based on the three principles set in the Fundamental Law on Energy Policy Measures.

(1)Securing stable energy supply

- i. energy conservation
- ii. diversifying imported energy resources and strengthening the relationship with major oil exporting nations
- iii. diversifying energy resources, such as developing domestically produced fuels
- iv. securing oil and LP gas reserves

(2)Environmental sustainability

- i. energy conservation
- ii. use of non-fossil energy and switch to gas energy
- iii. development and introduction of clean fossil fuel systems and energy efficient technology

(3)Utilizing the market mechanism

Moreover, to ensure "securing stable supply of energy" and "environmental sustainability," institutional reforms will be promoted, and plans will be designed to utilize market principles in the framework that meets Japan's actual conditions.

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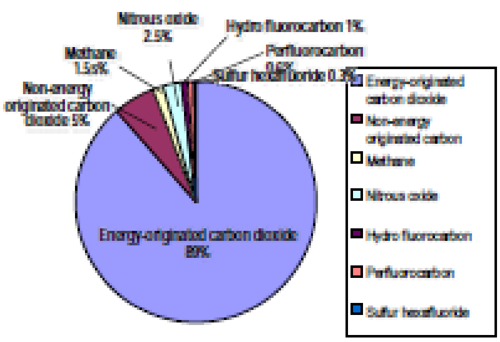
Law concerning the Rational Use of Energy

- The COP3 (the 3rd Conference of Parties of UN Framework Convention on Climate Change) held in December 1997 agreed reduction targets of Greenhouse Gas (GHG) emissions assigned to each developed country and issued the agreement as the "Kyoto Protocol." Japan is responsible for reducing the average value of its total GHG in 2008 to 2012 by 6% in comparison with that in the 1990s. (US=-7%, EU=-8%)
- Approximately 90% of Japan's GHG is energy-originated CO_2.

Breakdown of Japan's greenhouse gasses (2003)



Source: FY2005 inventory

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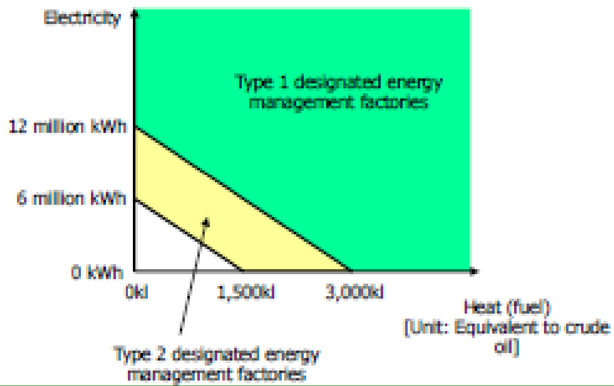
Energy Conservation Measures in the Industrial Sector

Designated energy management factories (Heat and electricity are integrated)

- Type 1: 3,000 kl or more
- Type 2: 1,500 kl or more

- Type 1 designated energy management factories must assign a licensed energy manager who has expert knowledge of both heat and electricity.
- Type 2 designated energy management factories must assign a licensed energy officer who has completed a training program for knowledge of both heat and electricity.



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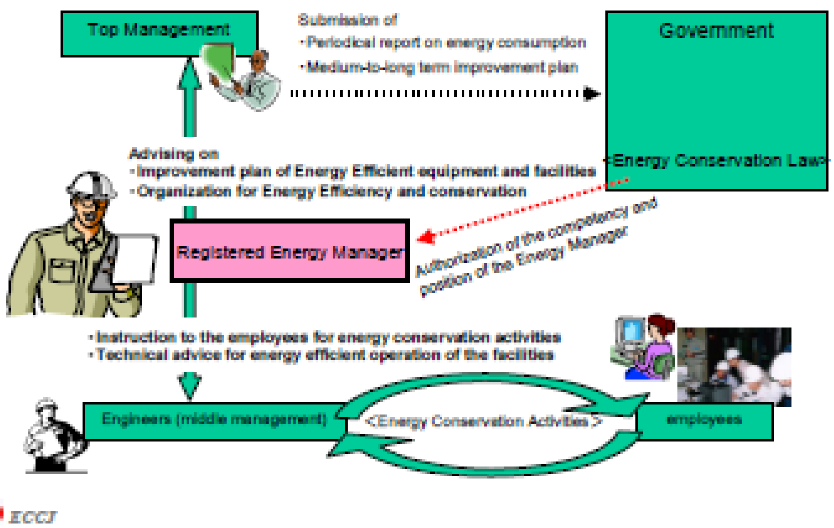
Energy Manager System

Energy Manager is "Key Person" for achieving the E-C activity in a factory/building



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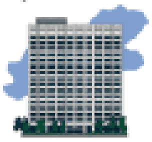
Energy Conservation Measures in Residence & Building Sector

「Building」



Buildings with a total floor of 2,000 m² or larger (non-residential buildings)

- Submission of notification related to energy conservation measures upon new construction, extension or rebuilding, or extensive repair
- If the energy conservation measures are found to be significantly insufficient, instructions shall be given and the status shall be announced to the public.

「Residence」

Residences with a total floor of 2,000 m² or larger

- Submission of notification related to energy conservation measures upon new construction, extension or rebuilding, or extensive repair
- If the energy conservation measures are found to be significantly insufficient, instructions shall be given and the status shall be announced to the public.

- Those who have submitted the notifications mentioned above shall periodically report the maintained status of energy conservation measures to the competent authorities. (If the maintained status is found significantly insufficient, the authorities shall advise the concerned parties.)

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Energy Conservation Measures in Residence & Building Sector

Promotion of Commercial Building Energy Management System (BEMS)

- Use IT technology to promote and facilitate a system that supports energy demand management for commercial buildings (e.g., a system that ensures recognizing real-time room conditions in buildings by temperature sensors and/or the optimal operation of lighting and air-conditioning responding to conditions in the room).

BEMS Image

Equipment Control

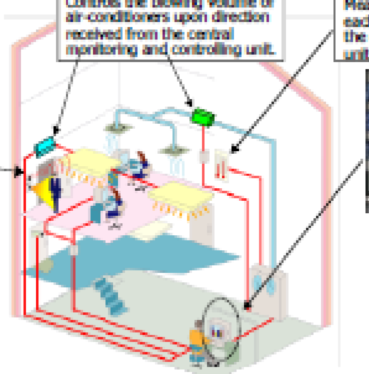
Controls the blowing volume of air-conditioners upon direction received from the central monitoring and controlling unit.

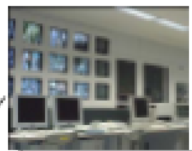
Humidity & Temperature Sensor

Measures humidity & temperature in each floor/room and sends the data to the central monitoring & controlling unit.

Human Detective Sensor

Detects human presence/absence in each floor/room and sends the data to the central monitoring & controlling unit.





Central Monitoring & Controlling Unit

- Based on data from the humidity & temperature sensor and human detective sensor, adequately controls air conditioning and lighting
- Aggregates and analyzes energy use data and estimates future energy demand to adjust the air-conditioning control.

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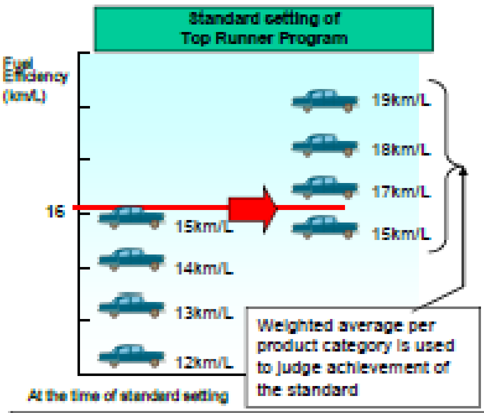
Top Runner Program

- Energy conservation law stipulates energy conservation standards for domestic appliances and vehicles according to the Top Runner method. Manufacturers and the law designated entities are under the obligation to comply with the standards. For incompliance, recommendation, publication of the name of the company, order, penalty (under one million yen penalty) are executed.
- LCDs and plasma TVs, microwave ovens, electric rice cookers, microwave ovens were added in FY 2006, now the target products account for 21 products.



"Top Runner Program:
The concept of the program is: Standards are set exactly the same as or higher than the best performance value of each product item currently on sale in the market.

Target products (21 products)

1. Passenger vehicles (※1)
2. Freight vehicles (※1)
3. Air-conditioners
4. TV sets (※2)
5. Video-cassette recorders
6. Fluorescent lights
7. Copiers
8. Computers
9. Magnetic disc units
10. Electric refrigerators
11. Electric freezers
12. Space heaters
13. Gas cooking appliances
14. Gas water heaters
15. Oil water heaters
16. Electric toilet seats
17. Vending machines
18. Transformers
19. Electric rice cookers
20. Microwaves
21. DVD recorders

※1: Heavy vehicles weighing over 3.5ton (buses, trucks) were added for the target products in April 2006.

※2: LCDs and plasma display TVs were added for the target products in April 2006.

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What is Top Runner Program? (Example: TV Sets)

(1) Target standard value (standard energy consumption efficiency):
It is product's annual energy consumption, expressed as energy consumption efficiency. Taking the best annual energy consumption (kWh/year) as a base, target standard values are decided with an allowance for technological improvement.

(2) Category:
For TV sets, products are classified by display device (CRT, LCD, or plasma), aspect ratio, number of pixels, TV receiver size, with/without DVD play function, and other additional functions.

(3) Target fiscal year:
For CRT TV sets, the target fiscal year is FY 2003 and every fiscal year after that (the standard was developed in FY 1999).
For LCD and plasma TV sets, the target fiscal year is FY 2008 and every fiscal year after that (the standard was developed in FY 2005).

(4) Method for evaluation of achievement:
Achievement is judged based on a weighted average for each category per manufacturers (vendors).

(5) Measurement method:
Measurement method which takes into account hours of use based on the actual status is adopted.

(6) Display:
Product's annual energy consumption is required to be displayed in catalogs, on product bodies, etc.

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Energy-saving Effects from Top Runner Program

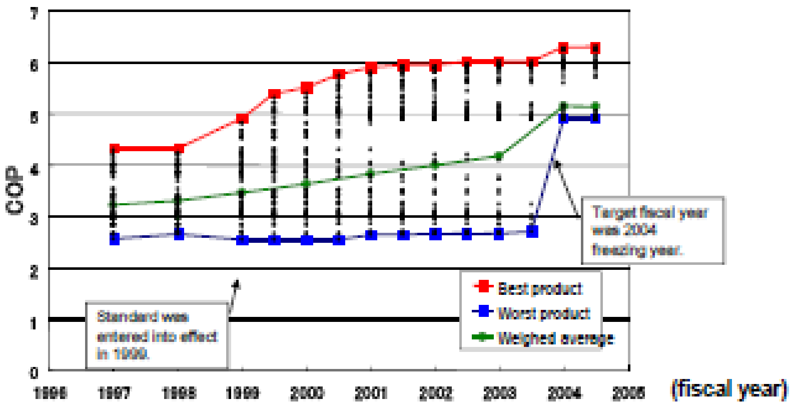
Equipment	Improvement of energy consumption efficiency (Results)	Improvement of energy consumption efficiency (Initial expectation)
TV sets (CRT-based television)	25.7% (FY1997→FY2003)	16.4%
Videocassette recorders	73.6% (FY1997→FY2003)	58.7%
Air conditioners*	67.8% (FY1997→FY2004)	66.1%
Electric refrigerators	55.2% (FY1998→FY2004)	30.5%
Electric freezers	29.6% (FY1998→FY2004)	22.9%
Gasoline passenger vehicles*	22.8% (FY1995→FY2005)	22.8% (FY1995→FY2010)
Diesel freight vehicles*	21.7% (FY1995→FY2005)	6.5%
Vending machines	37.3% (FY2000→FY2005)	33.9%
Computers	99.1% (FY1997→FY2005)	83.0%
Magnetic disk units	98.2% (FY1997→FY2005)	78.0%
Fluorescent lights*	35.6% (FY1997→FY2005)	16.6%

Energy-saving standards for equipments with ※marks are defined by energy consumption efficiency per unit (ex: km/l), and those for equipments without ※marks are defined by energy consumption quantity (ex: kWh/year). "Improvements of energy consumption efficiency" in the above Table are judged by standards of each equipment (ex: If 10km/h changes to 15km/h, this is 50% improvement. (It is not calculated by fuel quantity of 10 liter/100km and improved quantity of 6.7 liter/100km to say the improvement is 33%.). And if 10kWh/yr changed to 5kWh/yr, this is also 50% improvement.)

Improvement of Energy Efficiency (Air-Conditioner)

- Energy efficiency performance of air conditioner has been significantly improved since the introduction of Top-Runner standard (1999).
- Manufacturers' efforts for energy efficiency technology improvement by the competition each other, the introduction of Energy-Saving Labeling Program , etc., contribute to this improvement.
- Though the Top-Runner Program legislates the achievement of energy efficiency performance at the target fiscal year, the maximum performance and weighted average performance has been improved year by year, by the results of above-mentioned reasons.

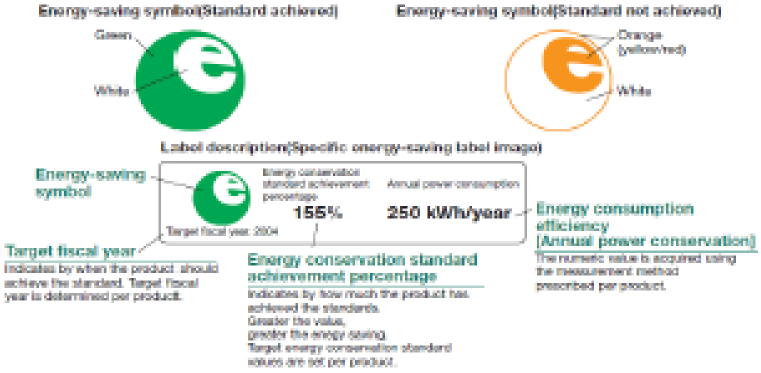
Transition of energy efficiency performance (Air Conditioner - cooling capacity:2.8kW)



Source: The Japan Refrigeration and Air Conditioning Industry Association

Energy-Saving Labeling System

The energy-saving labeling system has been introduced to inform consumers of energy efficiency of home appliances and to promote energy-efficient products.



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Energy-Saving Labeling System for Retailers

- The Revised Energy Conservation Law enforced in April 2006 stipulates that retailers shall make efforts to provide information. In light of this, a guideline was formulated, including providing information by using uniform energy-saving labels.
- The system started in October 2006. Uniform energy-saving labels shall be attached to TV sets, air conditioners and refrigerators.

Uniform Energy-saving Label

[Multi-stage rating system]
- Energy-saving performance is indicated in 5 stages, from 1 to 5 stars, from low to high performance of products offered on the market.
- In order to clarify the compliance level with the Top Runner standard, arrows are placed under the stars, showing achievement and non-achievement.

[Energy-saving labeling system]
- Products which achieved the Top Runner standard carry a green "e" mark, while others carry an orange "e" mark.
- Achievement level and energy consumption efficiency (annual electricity consumption) are also indicated.

[Estimated annual electricity rates]
- The estimated annual electricity rates are indicated to show the energy consumption efficiency (annual electricity consumption) clearly.

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Energy Efficiency Product Retailer Assessment Program

- For promotion of popularization of energy efficient products, measures for "retailers" who act as go-betweens for manufacturers and consumers are vital.
- This program acclaims retailers who actively promote sales of energy efficient products and who provide relevant information on energy saving.
- "Energy Efficiency Product Retailer Assessment Program" has been implemented since FY 2003.

Logo of Outlet that Excel at Promoting Energy-Efficient Products

2005年度

Shop

省エネ型製品普及推進優良店

Eligible outlets

Any appliance outlets, whose sales of appliances accounts for 50% or more of the total sales.

Expanded in FY 2005

- Large-scale (800 m² and over) mass sales appliance outlets, whose sales of appliances accounts for 50% or more of the total sales.

"Outlets that Excel at Promoting Energy-Efficient Products" are selected every fiscal year and published along with a ranking list. Awards such as "Minister of Economy, Trade and Industry Award" and "Minister of Environment Award" were established in FY 2004.

The excellent outlets are allowed to display the logo.

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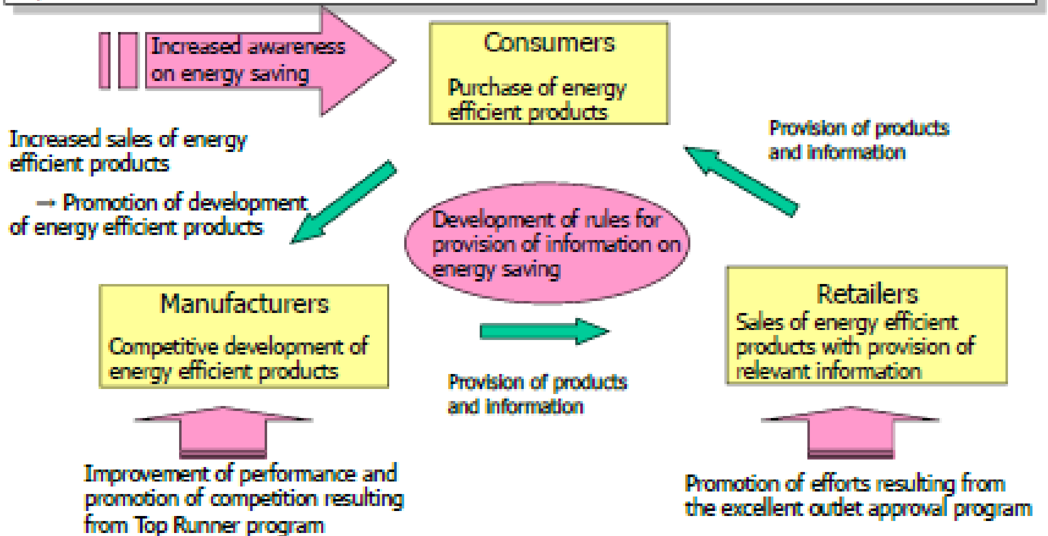
Positive Growth Cycle in Popularization of Energy Efficient Products

- By providing relevant information to consumers, encourage them to select energy efficient products.
- Popularization of energy efficient products will act as incentives for development of further energy efficient products.



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Japanese Industrial Standard (JIS) for Packaged Air-Conditioners

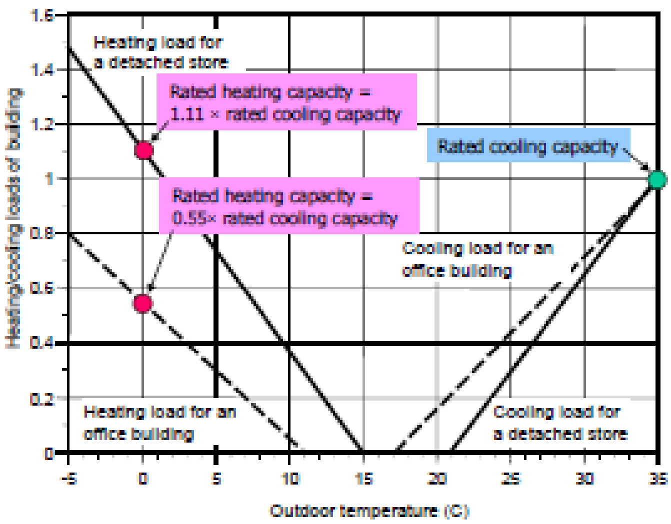
For air-conditioners, whose target for achieving the JIS is the fiscal year 2010, the annual performance factor (APF) is used as an energy consumption efficiency indicator, which is a numeric value calculated using the method stipulated by JIS B 8616 (2006), Appendix 3.

1. Heating and cooling loads of building and duration time of outdoor temperature
2. Testing conditions
3. Evaluation method for the seasonal performance factor

* JIS C 9612 (2005) Room air conditioners
JIS B 8616 (2006) Package air conditioners

Heating/Cooling Loads of a Building

- Three types of buildings are concerned.
  - A detached store
  - A building tenant
  - An office building
- Heating load is largely dependent on the application of the building.
- Outdoor temperature corresponding to the half load:
  - Cooling: 26–28°C
  - Heating: 6–7°C



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Duration Time of Outdoor Temperature

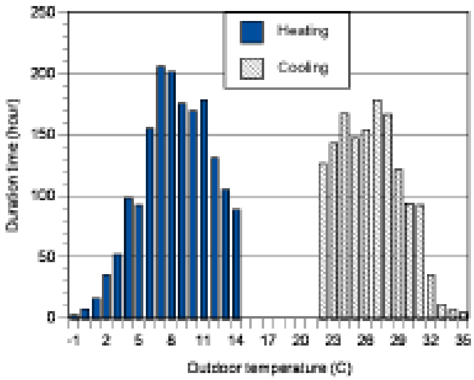

Figure 5 Duration time of a detached store

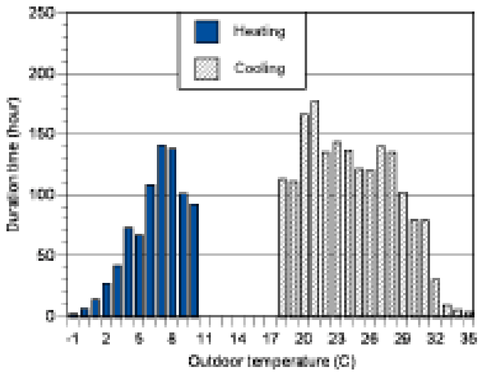

Figure 6 Duration time of an office building

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Annual Heating/Cooling Load

- Annual heating/cooling load at each outdoor temperature = heating/cooling load of building × duration time of outdoor temperature
- Heating/cooling loads are obtained by multiplying vertical axis value by the rated cooling capacity.

Total heating load : Total cooling load=1.47:1

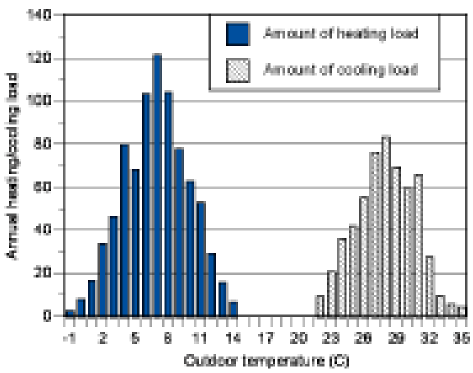

Figure 7 Annual heating/cooling load of a detached store

Total heating load : Total cooling load=0.24:1

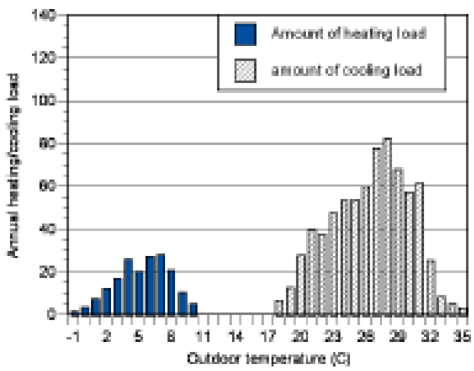

Figure 8 Annual heating/cooling load of an office building

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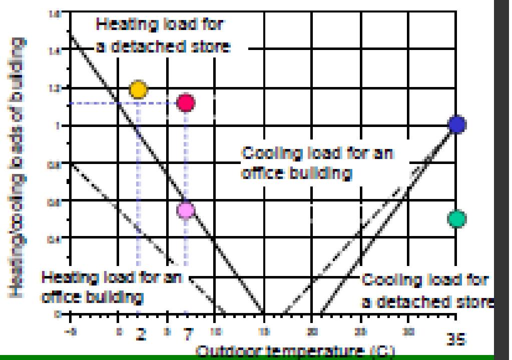
Testing Conditions for Packaged Air-Conditioners

	Indoor air temperature*	Outdoor air temperature*	Symbol
Rated cooling performance	27 / 19	35 / 24	● (blue)
Half load cooling performance	27 / 19	35 / 24	● (green)
Rated heating performance	20 / 15	7 / 6	● (red)
Half load heating performance	20 / 15	7 / 6	● (pink)
Heating performance at low temperature	20 / 15	2 / 1	● (yellow)

* Dry-bulb temperature/Wet-bulb temperature in °C



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Calculation Method of Cooling Seasonal Performance

Dependence of cooling coefficient of performance (COP) on the outdoor temperature for an inverter-controlled air-conditioner.

- Rated cooling performance: A
- Half load cooling performance: B
  - Extrapolate from point B using the prescribed temperature coefficient. Point C is the intersection of the performance line with the cooling load line.
- The air-conditioner is assumed to operate intermittently for the part load smaller than 50% capacity.
  - At an outdoor temperature of 21°C, at which the cooling load approaches to zero, the cooling capacity is assumed to increase by 18% of point B and the electricity consumption to decrease by 20% of point B.
  - Degradation coefficient is assumed that C_D=0.

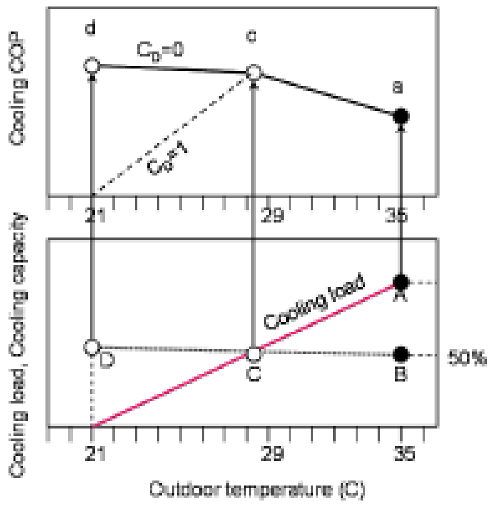

Fig. 9 Estimation of cooling COP

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Calculation Method of Heating Seasonal Performance

- Three compressor speeds are tested.
  - maximum capacity
  - rated capacity
  - half capacity
- Frost may form at an outdoor temperature lower than 5.5°C.
- Outdoor temperature dependent operation
  - Point A: intermittent operation with half capacity
  - Point B: continuous operation between rated capacity and half capacity
  - Point C: continuous operation between maximum capacity and rated capacity
  - Point D: continuous operation with maximum capacity

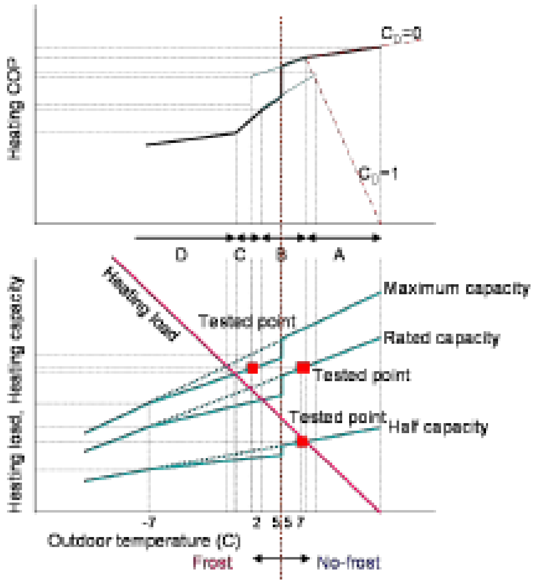

Fig. 10 Estimation of heating COP

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Benefits Brought about by APF and Remaining Problems

- Annual Performance Factor: APF

$$APF = \frac{CSTL + HSTL}{CSTE + HSTE}$$

  - where CSTL and HSTL denote the cooling seasonal total load and heating seasonal total load, while CSTE and HSTE denote the cooling seasonal total energy and heating seasonal total energy, respectively.
- JIS B 8616 (2006) is the evaluation method near the actual use of packaged air-conditioners.
  - Improvement of part load performance has a considerable effect on the reduction in the annual energy consumption.
- Remaining problems
  - Improvement of the evaluation method for the COP when a compressor drives intermittently.
  - Heating/cooling load of a building is not sometimes determined by the outdoor temperature.
  - Evaluation method for a VRV system is not established.

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Conclusion

- Since the introduction of the Top Runner Program in 1999, the energy efficiency performance of appliances and vehicles has improved significantly more than expected.
- In Japan, it is easy to implement the decision making for the improvement of energy efficiency between the government and manufacturers or among manufacturers.
- Once the standard is established, manufacturers do their best to improve the energy efficiency performance by competing with each other, because they recognize that consumers accept products with higher energy efficiency performance.
- The JIS for packaged air-conditioners was revised in 2006. Before the revision of the JIS, the performance of air-conditioners based on the rated cooling and heating COP was tested and presented. Because the performance at the rated conditions is not related to actual use and therefore does not allow the estimation of annual energy consumption, a new JIS in which the annual performance factor is defined has been issued. The Top Runner Program for air-conditioners is based on the JIS.
- The industrial standards are used for formulating policies, and thus, they influence the specification of new product development.

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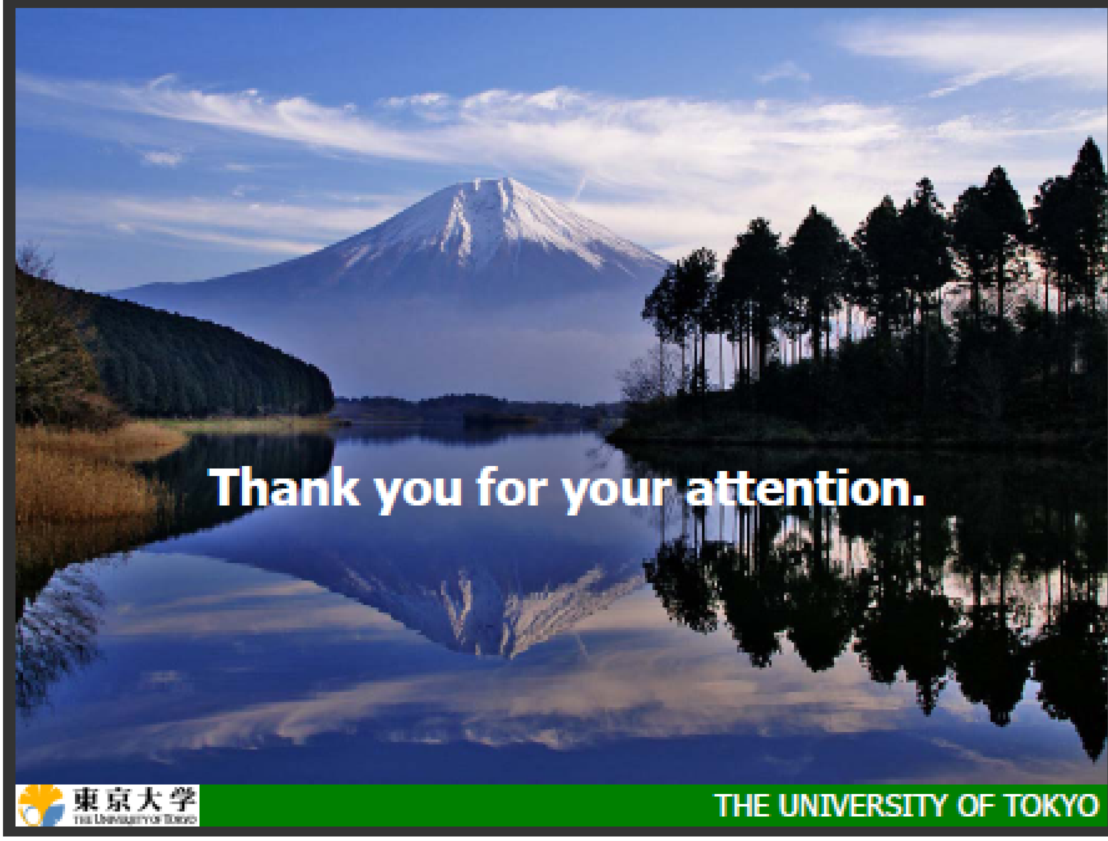


2. CSPF & HSPF for air-conditioner and heat pump in Korea

Asia-Pacific Economic Cooperation

CSPF & HSPF for Air-conditioner and Heat pump in Korea

Asia-Pacific Economic Cooperation
Workshop on Reducing Barriers to Trade through Development of a Common Protocol for Measuring The Seasonal Energy Efficiency (SEER) of Air Conditioners

5 October 2009

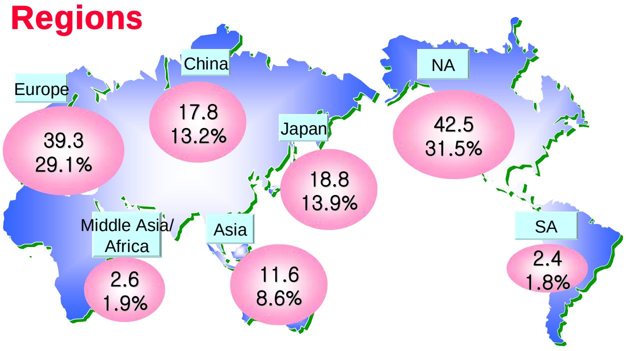
Jun Choi
Korea Testing Laboratory

Asia-Pacific Economic Cooperation

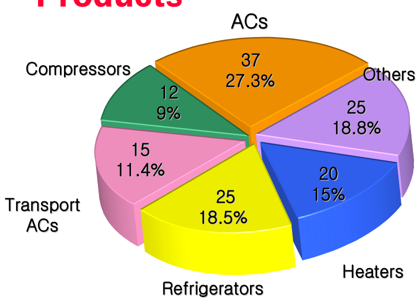
Global Market

World market : US$ 135 B in 2005

Regions



Products



Sources : JARN and BSRIA report

Units : Billion US$

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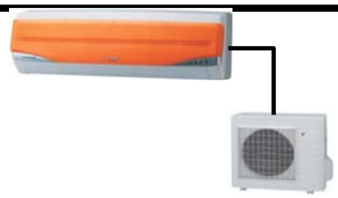
Air-conditioner / Heatpump



- **Air-conditioner / Heat Pump**
  - *Most popular in APEC economies*
  - *Big market in APEC economies*
  - *Big trade among APEC economies*
  - *Aligning to ISO 5151 (ISO 13253 and ISO FDIS 15042 as applicable) would appear to be a feasible option*
  - *Need a actual usage under a range of climates, and more realistically and accurately assessing the performance of variable-speed drive compressor systems under conditions of actual use. (e.g. a range of part load conditions)*
  - *Some member countries already introduced*

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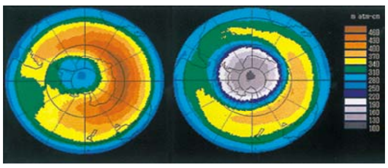
Environments

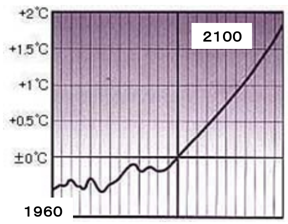
Global Warming

Depletion Ozone layer

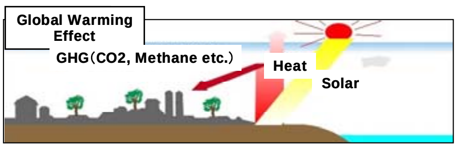


Oct. 1979 Oct. 1999

Ozone layer at Antarctic



Forecast of Erath Surface temperature (Variation at 1990, ℃)



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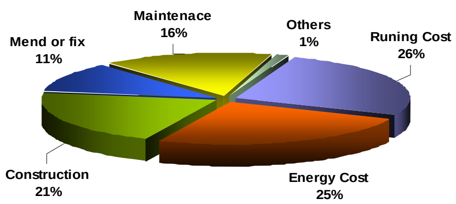
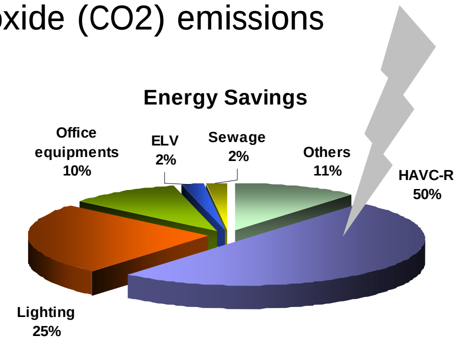
Why is important ?

- Residential appliances and equipment use 30% of all electricity generated in OECD countries, producing 12% of all energy-related carbon dioxide (CO_2) emissions





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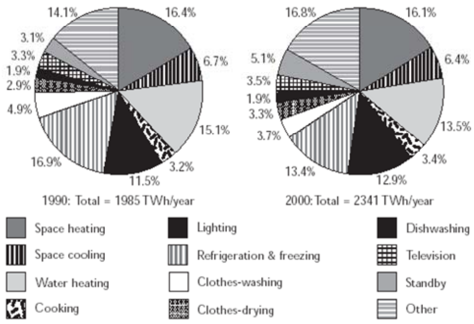
- **HVAC-R covers 50 % electricity consumption in 2000**
  - *Space heating : 376.9 TWh*
  - *Space cooling : 149.8 TWh*
  - *Water heating : 316.0 TWh*
  - *Refrigeration & Freezer : 313.7 TWh*
- **More rooms for energy saving and reduce CO2**

Figure 1.1 Share of residential electricity consumption by major end-use in 22 IEA Member Countries in 1990 and 2000



1. This figure does not include standby power consumption associated with the other major end-uses already discussed.

Asia-Pacific Economic Cooperation

High Efficiency

- **What is high efficiency ?**
  - *Cooling*
    - EER = Cooling Capacity / Effective Power Input
    - Large is Efficient
  - *Heating*
    - COP = Heating Capacity / Effective Power Input
    - Large is Efficient
  - *Averaged COP = (EER + COP)/2*
    - Japan
- **But, COP and EER at one point is not real usage**
  - *Part load efficiency is necessary*
  - *SEER (CSPF and HSPF) is using in some countries, but complicated*
  - *New high efficiency products are adopted with inverter-driven compressor and 2 or 3 combined compressors*

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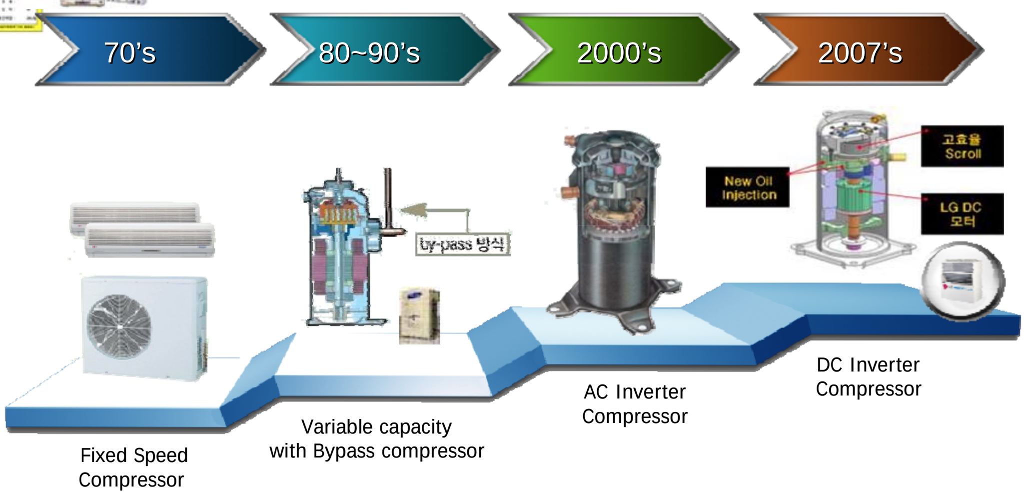
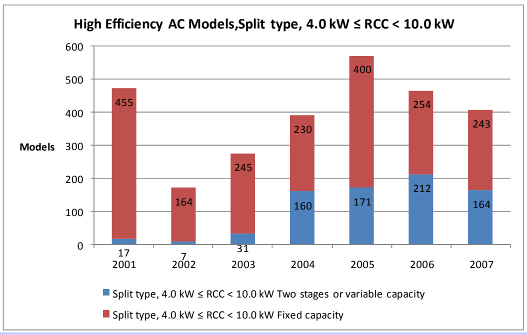
Improved Technology Trend

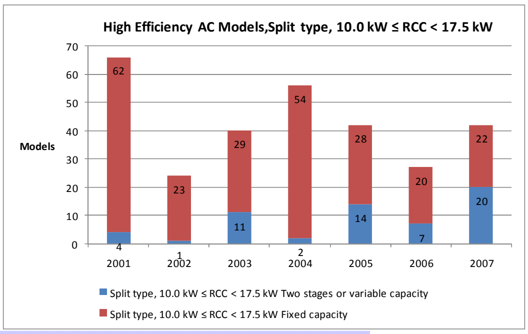


Asia-Pacific Partnership on Clean Development and Climate 8

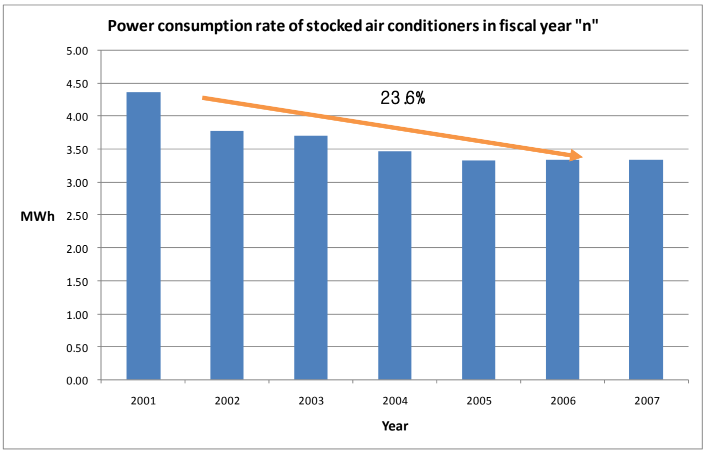
High Efficiency Air conditioners

- **Korean Market**
  - ✓ a new model adopted with a new technology, two stage or variable capacity models in order to meet a new high EELSP in a market even a high price





- ✓ Power consumption rate of stocked AC in fiscal year has reduced 23.6% from 2001 to 2007



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Energy efficiency for Part loads

- **SEER (Seasonal Energy Efficiency Ratio)**
  - *Annual energy use for the appliances or system, unitary AC*
    - Variable-speed, two-speed systems
  - *SEER was developed by NIST, US (Parken et al 1977; Kelly & Parken 1978; Parken et al 1985)*
  - *Based on a bin analysis that calculated the cooling load, capacity and efficiency over a range of ambient temperature*
  - *CSPF (Cooling Seasonal Performance Factor) & HSPF (Heating Seasonal Performance Factor)*
  - *US, Japan, Korea*
- **IPLV (Integrated part load value)**
  - *For Chiller developed in 1986, US*
  - *IPLV (Integrated part load value)*

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Standards for part load

Nation	Title	Standards No.
ISO	Non - Ducted A/C and HP	ISO 5151
	Ducted A/C and HP	ISO 13253
USA	Room A/C	AHAM RAC-1, ASHRAE 16
	Unitary A/C	ARI 210/240, ASHRAE 116
JPN	Room A/C (Power<3kW, Capacity<10kW)	JIS C 9612
	Package A/C (Power>3kW, Capacity <28kW)	JIS B 8616
KOR	Ductless A/C and HP	KS B ISO 5151 (IDT)
	Air conditioner	KS C 9306
SINGAPORE	Non - Ducted A/C and HP	JIS C 9612
	Ducted A/C and HP	ISO 13253
CHINA	Room A/C and HP	GB/T 7725-1996
	Multi-connected air-condition (heat pump) unit	GB/T 18837-2002

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KS standards for CSPF & HSPF

- **KS C 9306-2007 is available for SEER (CSPF & HSPF)**
  - ✓ Annex 5 provides the guidelines to define CSPF & HSPF
- **Originally it come from ARI, and ASHRAE (US) standards, and developed in 1992**
- **It was effective for Energy Efficiency Label and Standard**
- **Three types**
  - ✓ Fixed–Speed Compressor
  - ✓ Multi-speed & 2-Compressor
  - ✓ Variable speed compressor

KS C 9306-2007 Appendix 5

Table 1. Temperature and humidity conditions and default values - for cooling and heating

Tests		Test Descriptions	Test Condition (℃)				Remarks
			Indoor		Outdoor		
			DB	WB	DB	WB	
Fixed–Speed Compressor	Cooling (1 or 2)	Standard	27	19.5(19.0)	35	24(1)	–
		low temperature	27	19.5(19.0)	29.0	19.0	Replaced with Table 2
	Heating (2 or 3)	Standard	20	15↓	7	6	
		Defrost			2	1	
		Low temperature	20	15	-8.5(-7.0)	-9.5(-8.0)	Replaced with Table 3
Multi-speed & 2-Compressor	Cooling (2 or 3)	Minimum	27	19.5(19.0)	35	24(1)	
		Standard					
		low temperature	27	19.5(19.0)	29.0	19.0	Replaced with Table 2
	Heating (3 or 4)	Minimum	20	15↓	7	6	
		Standard					
		Defrost			2	1	
		low temperature	20	15	-8.5(-7.0)	-9.5(-8.0)	Replaced with Table 3

Variable speed compressor	Cooling (2 or 3)	Minimum	27	19.5(19.0)	35	24	
		Intermediate					If min. capacity ＞0.5Ｘrated capacity, this test can be waived
		Standard					–
		low temperature	27	19.5(19.0)	29.0	19.0	Replaced with Table 2
	Heating (5 or 6)	Minimum	20	15↓	7	6	
		Intermediate					If min. capacity ＞0.5Ｘrated capacity, this test can be waived
		Standard					
		Maximum			-8.5 (7.0)	-9.5 (−8.0)	
		Defrost			2	1	
		Non-defrost					
		low temperature	20	15	-7	-8	Replaced with Table 3

• Remark :
1) The default values for calculation shall be specified in Table 2 for cooling and Table 3 for heating.
2) The letter in Red are a revised version which will be effective from Jan 2010.

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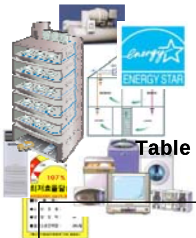

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Table 2. Cooling Capacity, Power input – Correction factor, cyclic degradation coefficient

Classification			Cooling Capacity (W)	Power Input (W)
Fixed Speed Compressor	Cooling Standard		Φ_{cr}	P_c
	Cooling low temp.		$\Phi_{cr(29)} = 1.077\Phi_{cr}$	$P_{c(29)} = 0.914P_c$
	Degradation coefficient		C_D = 0.25	
Multi-Speed & 2 compressors	Cooling Standard	Minimum	Φ_{cr1}	P_{c1}
		Standard	Φ_{cr2}	P_{c2}
	Cooling low temp.	Minimum	$\Phi_{cr1(29)} = 1.077\Phi_{cr1}$	$P_{c1(29)} = 0.914P_{c1}$
		Standard	$\Phi_{cr(29)} = 1.077\Phi_{cr2}$	$P_{c2(29)} = 0.914P_{c2}$
	Degradation coefficient		C_D = 0.25	
Variable speed compressor	Cooling Standard	Minimum	Φ_{cr1}	P_{c1}
		Intermediate	Φ_{crm}	P_{cm}
		Minimum	Φ_{cr2}	P_{c2}
	Cooling low temp.	Minimum	$\Phi_{cr1(29)} = 1.077\Phi_{cr1}$	$P_{c1(29)} = 0.914P_{c1}$
		Intermediate	$\Phi_{cr1(29)} = 1.077\Phi_{crm}$	$P_{c1(29)} = 0.914P_{cm}$
		Minimum	$\Phi_{cr1(29)} = 1.077\Phi_{cr2}$	$P_{c1(29)} = 0.914P_{c2}$
	Degradation coefficient		C_D = 0.25	

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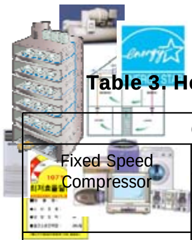

Table 3. Heating Capacity, Power input – Correction factor, cyclic degradation coefficient

Classification			Heating Capacity (W)	Power Input (W)
Fixed Speed Compressor	Heating Standard		Φ_{hr}	P_h
	Heating Defrosting		Φ_{def}	P_{def}
	Heating low temp.		$\Phi_{hr(-8.5)} = 0.601\ \Phi_{hr}$	$P_{h(-8.5)} = 0.801 P_h$
	Degradation coefficient		$C_D = 0.25$	
Multi-Speed & 2-compressors	Heating Standard	Minimum	Φ_{cr1}	P_{h1}
		Standard	Φ_{cr2}	P_{h2}
	Heating Defrosting	Minimum	Φ_{def1}	P_{def1}
		standard	Φ_{def2}	P_{def2}
	Heating low temp.	minimum	$\Phi_{hr1(-8.5)} = 0.601\ \Phi_{hr1}$	$P_{h1(-8.5)} = 0.801 P_{h1}$
		standard	$\Phi_{hr2(-8.5)} = 0.601\ \Phi_{hr2}$	$P_{h2(-8.5)} = 0.801 P_{h2}$
	Degradation coefficient		$C_D = 0.25$	
Variable speed compressor	Heating Standard	minimum	Φ_{hr1}	P_{h1}
		intermediate	Φ_{hrm}	P_{hm}
		standard	Φ_{hr2}	P_{h2}
	Heating Defrosting		Φ_{def}	P_{def}
	Heating non-frosting		Φ_{nof}	P_{nof}
	Heating low temp.	minimum	$\Phi_{hr1(-8.5)} = 0.601\ \Phi_{hr1}$	$P_{h1(-8.5)} = 0.801 P_{h1}$
		intermediate	$\Phi_{hrm(-8.5)} = 0.601\ \Phi_{hrm}$	$P_{hm(-8.5)} = 0.801 P_{hm}$
		standard	$\Phi_{hr2(-8.5)} = 0.601\ \Phi_{hr2}$	$P_{h2(-8.5)} = 0.801 P_{h2}$
		maximum	$\Phi_{hr3(-8.5)}$	$P_{h3(-8.5)}$
	Degradation coefficient		$C_D = 0.25$	

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- **Cooling seasonal performance factor (CSPF)**

$$CSPF = \frac{\sum Q_c}{\sum P_c}$$

$$\sum Q_c = \sum_{j=1}^{n} X(t_j)\cdot \dot{\Phi}_{cr}(t_j)\cdot n_j \qquad \sum P_c = \sum_{j=1}^{n} \frac{X(t_j)\cdot \dot{P}_c(t_j)\cdot n_j}{PLF(t_j)}$$

$P(t_j)$: Cooling power input (W) applicable to any capacity at outdoor temperature t_j

$X(t_j)$: Ratio of building load to capacity at outdoor temperature t_j

$PLF(t_j)$: Part load factor at outdoor temperature t_j

$\Phi(t_j)$: Cooling capacity (W) applicable to any capacity at outdoor temperature t_j

n_j : Occurring period of time (h)

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● Heating seasonal performance factor (HSPF)

$$HSPF = \frac{\sum Q_h}{\sum P_h}$$

$$\sum Q_h = \sum_{j=1}^{n} BL_h(t_j)\cdot n_j \qquad \sum P_h = \sum_{j=1}^{n} \frac{X(t_j)\cdot \dot{P}_h(t_j)\cdot n_j}{PLF(t_j)} + \sum_{j=1}^{n} P_{RH}(t_j)$$

$P(t_j)$	: Heating power input (W) applicable to any capacity at outdoor temperature t_j
$P_{RH}(t_j)$	: Backup Heating power input (W) applicable to any capacity at outdoor temperature t_j
$BL(t_j)$	: Building cooling load (W) at outdoor temperature t_j
$X(t_j)$	: Ratio of building load to capacity at outdoor temperature t_j
$PLF(t_j)$	: Part load factor at outdoor temperature t_j
$\Phi(t_j)$	: Heating capacity (W) applicable to any capacity at outdoor temperature t_j
n_j	: Occurring period of time (h)

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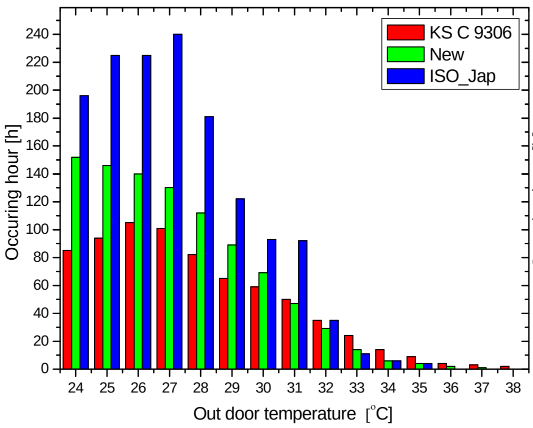
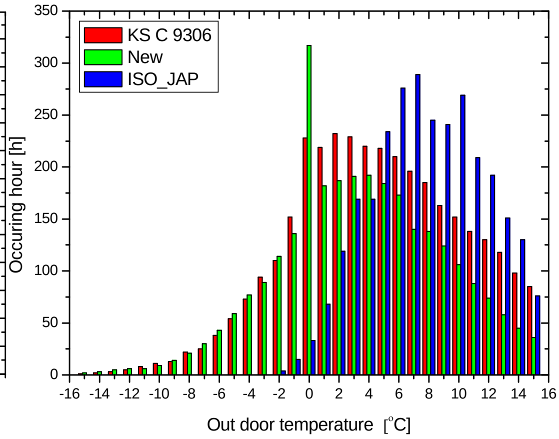
● Occurring period of time which requires cooling and heating





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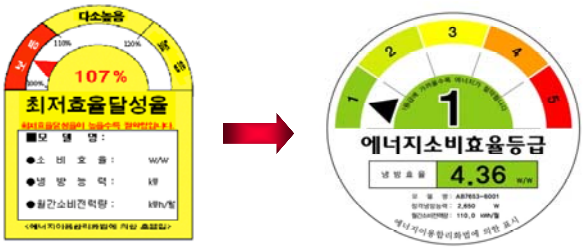
New Label for EELSP

- New energy efficiency label starts from 2008



Energy Efficiency Label and Standard Program (Mandatory)

Refrigerators, Freezers, Kimchi refrigerators, Air Conditioners, Washing machines, Drum washing machines, Dish washers, Dish driers, Rice cookers, Vacuum cleaner, Electric fans, Air cleaners, Incandescent lamps, Fluorescent lamps, CFLs, Ballasts, Heatpump, Automobiles and more

Electric Motors, Gas Boilers

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- **From Jan. 2010**
- **CO2 calculation is considering in energy label**
- **CO2 g/hr**

CO2 calculation

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- **Calculation** CO_2 emission : 1Wh = 0.425g
  - *Fixed capacity*

$$\frac{Monthly \cdot power \cdot consumption(kWh) \times 1000}{0.6(running \cdot rate) \times 12(hrs) \times 30(days)} \times 0.425(g)$$

  - *Two stages and variable capacity*

$$\frac{Monthly \cdot power \cdot consumption(kWh) \times 2 \times 1000}{732(hrs)} \times 0.425(g)$$

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Energy Efficiency Level for cooling only

- **Scope**
  - rated cooling power consumption of not more than 7,500W and rate cooling capacity of not more than 17,500W (23,000W will be expanded from 2010)
  - Exclude water cooling, duct-type, portable, multi-split type
  - Air conditioners subject to standby power after 1st of January, 2010.
  - For a fixed speed compressor type EER(Cooling Energy efficiency ratio) shall be used according to KS C 9306, and for a variable capacity and 2 and more compressors type and a inverter driven compressor type CSPF(Cooling Seasonal Performance Factor)) shall be used according to KS C 9306.

Type		Energy Efficiency Ratio(EER)	
		MEPS	1st Grade
Window air conditioner		2.88	3.94 & Standby Power
Split type	RCC < 4.0 kW	3.37	4.36 & Standby Power
	4.0 kW ≤ RCC < 10.0 kW	2.97	4.40 & Standby Power
	10.0 kW ≤ RCC < 17.5 kW	2.76	4.62 & Standby Power
	10.0 kW ≤ RCC < 17.5 kW	2.63	4.11 & Standby Power

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Energy Efficiency Level for heatpump

- **Effective from Jan. 2009**

$$R = \frac{\text{Cooling EER(CEER)} + \text{Heating EER(HEER)}}{2}$$

Non-ducted and ducted unitary (Including window type)

R	Level
3.20 ≤ R	1
2.90 ≤ R < 3.20	2
2.60 ≤ R < 2.90	3
2.30 ≤ R < 2.60	4
2.00 ≤ R < 2.30	5

Split type, RCC < 4kW

R	Level
4.00 ≤ R	1
3.60 ≤ R < 4.00	2
3.20 ≤ R < 3.60	3
2.80 ≤ R < 3.20	4
2.40 ≤ R < 2.80	5

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Split type, 4kW ≤ RCC < 10kW

R	Level
3.80 ≤ R	1
3.40 ≤ R < 3.80	2
3.00 ≤ R < 3.40	3
2.60 ≤ R < 3.00	4
2.20 ≤ R < 2.60	5

Split type, 10kW ≤ RCC < 23.0kW

R	Level
3.20 ≤ R	1
2.90 ≤ R < 3.20	2
2.60 ≤ R < 2.90	3
2.30 ≤ R < 2.60	4
2.00 ≤ R < 2.30	5

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Update

- **Rate cooling capacity**
  - *17,500W → 23,000W*
- **CO2 Calculation should be shown**
- **Energy Efficiency Level is considering more higher**
  - *10% ~ 15% higher*
- **Standby power should be met to get 1st Grade**
  - *Less 1W or 3W*
- **It will be effective from 2010**

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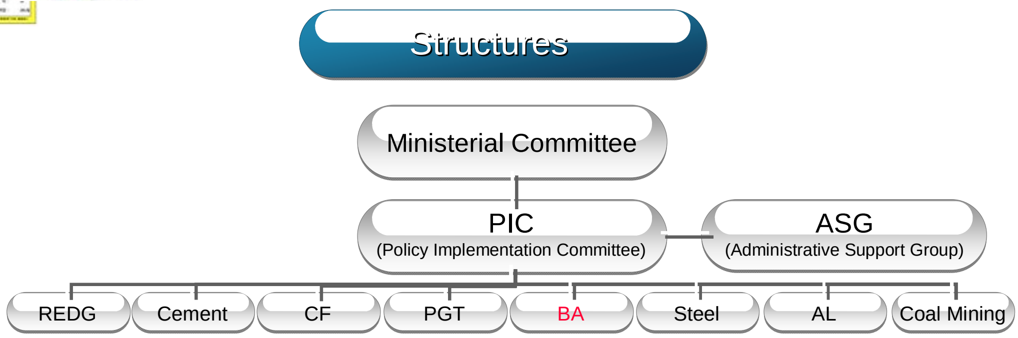
Revision

- **KS provides information to calculate SEER**
- **Two stage capacity units and variable capacity units should be adopted with CSPF method**
  - *But, KS is a little bit different with proposed ISO method*
    - Temperature bin
    - Temperature conditions, and etc..
  - *KS is being considered to revise with ISO*

Asia-Pacific Partnership on Clean Development and Climate

- **The purposes of the Partnership are to:**
  - *Create a voluntary, non-legally binding framework for international cooperation to facilitate the development, diffusion, deployment, and transfer of existing, emerging and longer term cost- effective, cleaner, more efficient technologies and practices among the Partners through concrete and substantial cooperation so as to achieve practical results;*
  - *Promote and create enabling environments to assist in such efforts;*
  - *Facilitate attainment of our respective national pollution reduction, energy security and climate change objectives; and*
  - *Provide a forum for exploring the Partners' respective policy approaches relevant to addressing interlinked development, energy, environment, and climate change issues within the context of clean development goals, and for sharing experiences in developing and implementing respective national development and energy strategies.*
  - *The Partnership will be consistent with and contribute to Partners' efforts under the UNFCCC and will complement, but not replace, the Kyoto Protocol.*



New TF Road Transportation TF is being considered, but not yet approved

More information : http://www.asiapacificpartnership.org

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BATF Mission & Goals

- Use cooperative mechanisms to support the further uptake of increasingly more energy efficient appliances, recognizing that extensive cooperative action is already occurring between Partner countries.
- Promote best practice and demonstrate technologies and building design principles to increase energy efficiency in building materials and in new and existing buildings.
- Support the integration of appropriate mechanisms to increase the uptake of energy efficient buildings and appliances into broader national efforts that support sustainable development, increase energy security and reduce environmental impacts.
- Systematically identify and respond to the range of barriers that limit the implementation of end-use energy efficiency practices and technologies.

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History

- **1st BATF meeting, Berkeley, US, April 2006**
- **2nd BATF meeting, Canberra, AU, Nov. 2006**
- **3rd BATF meeting, Seoul, Korea, July 2007**
- **4th BATF meeting, Washington DC, US, Nov. 2007**
- **5th BATF meeting, Seoul, Korea, 23-24 June 2008**
- **6th BATF meeting, Melbourne, AU, 21-24 Sep 2008**
- **7th BATF meeting, New Delhi, IN, 8-10 April 2009**
- **8th BATF meeting, Tokyo, JP, 7-8 Oct 2009**

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Approved Projects

	Project Theme	Ongoing Projects
Appliances	**Harmonization of Test Procedures** (Korea Lead) *- Flagship 1. Quality Assurance and Harmonization of CFLs (USA-Australian lead)*	*8 projects*
	Alignment of National Standby Power Approaches (Australia Lead)	*1 project*
	Market Transformation (Japan Lead)	*6 projects*
Buildings	**Building Certification** (China Lead)	*5 projects*
	Improvements to Existing Buildings (USA Lead)	*11projects*
	Role Enhancement of Building Energy Codes (Korea Lead)	*3 projects*
	High Performance Buildings and Developments (Australia Lead) *- Flagship 2. Green Buildings Flagships in China (USA lead)* *- Mayors' Training Center* *- Buildings Center of Excellence* *- Olympic Micro-Energy Building (Completed)* *- Flagship 3. Green Spaces™ (India Lead)*	*8 projects*
	Utility Regulation and Incentives (USA Lead)	**2 projects**
	Smart Systems (Australia Lead)	**1 projects**
	Green Leases (Australia Lead)	**1 projects**
	Commercial Financing (USA Lead)	**1 projects**

**** 54 BATF Projects: 47 ongoing, 1 completed, 6 cancelled or hibernating***

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APP BATF Projects

- **Project Number & Title:**
  - BATF 06-04, Harmonization of Test Procedures for HVAC
- **Lead Partner Country and manager**: Korea, Jun Choi(KTL)
- **Participating Partner Countries and Organizations**
  - Australia, India, Japan, USA, China(potentially)
- **Objectives**
  - To develop a process for arriving at methodology for test procedure of AC/HP that measure product energy efficiency and/or energy consumption that are harmonized among the participant countries
  - To share the developed new methodology, and to recommend the formal standards by an economy's standards-setting agency or by an international agency such as the International Standards Organisation (ISO)
  - To develop a process for establishing a base on which mutual acceptance of accreditation of energy efficiency testing facilities and the results of test performed at these facilities can be achieved

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ISO TC86 SC6 WG1

- **Japan proposed APF(Annual Performance factor) NWIP in 2006, and it was accepted in 2007**
- **ISO TC86 SC6 WG1 is running to develop a new test method for AC/HP**
  - *First WG meeting was held at Paris 19-20 September 2007, and then 6 times meetings*
- **Convenor is Mr. Bernard Hugh from England**
  - *Japan, USA, Korea, France, and Spain are participated*
- **In the next meeting WD will be finalized, and next couple of years will be released hopefully, it could be expanded globally**

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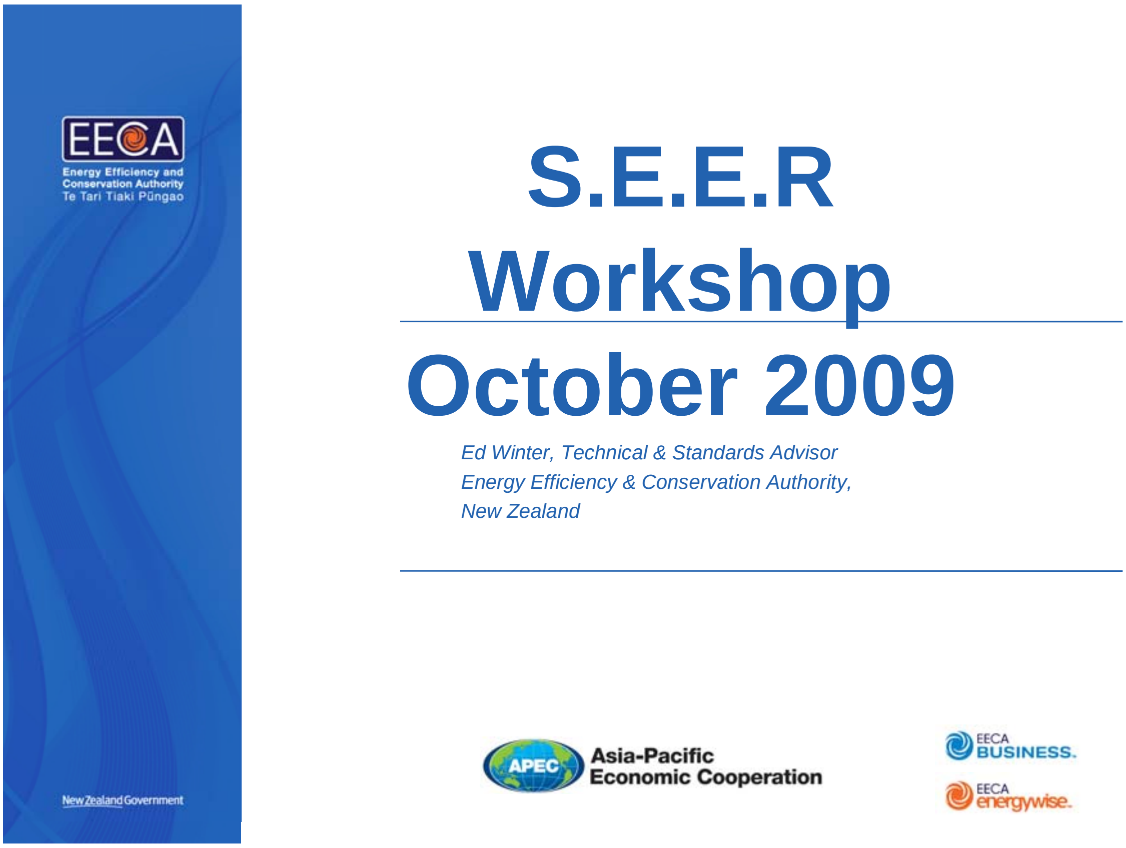
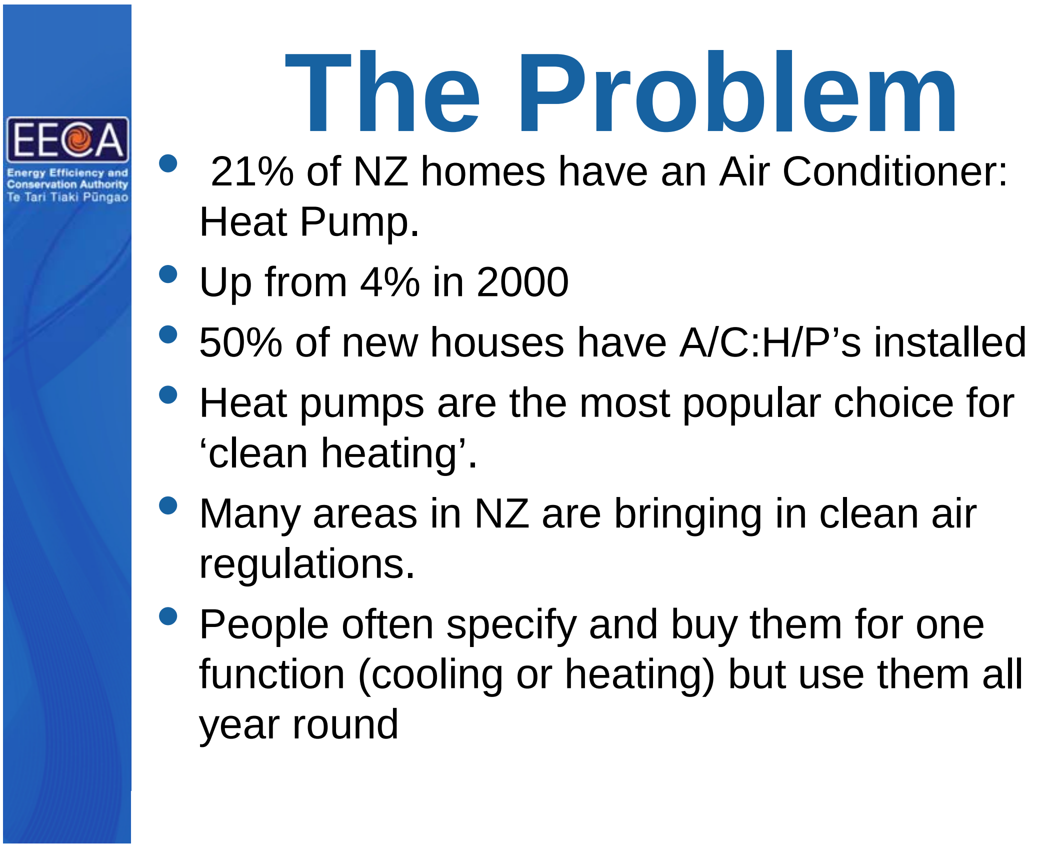
- 谢谢听

3. SEER for air conditioners in New Zealand





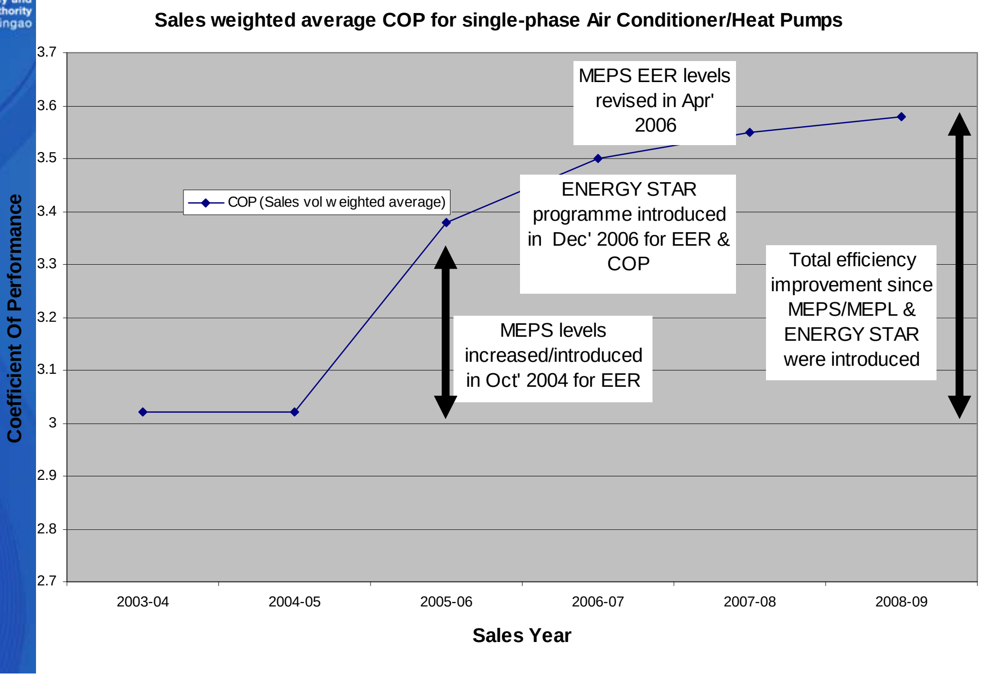
Standards &Testing

- AS/NZS 3823.1 Methods of testing (for non-ducted & ducted reverse-cycle air conditioners)
- AS/NZS 3823.2 Registration, MEPS & labelling
- A Joint program with Australian Gov't - Minimum Energy Performance Standards have been in place since 2001(3 Phase) & 2004 (single Phase)

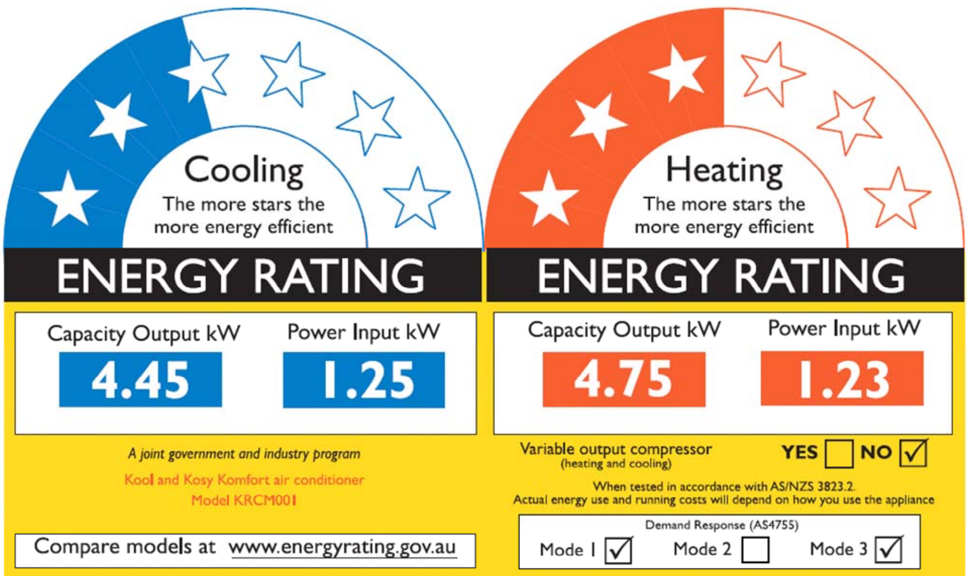
Why we need Standards?

- Customer information - *"Buy by the Stars"* - the more 'stars' the better
- Government information and monitoring
- Removes worst performers from market and ensures NZ is not a "dumping ground" for poor performing products
- Drives improvements in technology

Benefits of doing this?



Energy Rating Label



Star Rating Index

SRI. Algorithm =

$$\frac{[(EER/COP \times 8) - 18]}{4}$$

But, this is based on "Rated" capacity (i.e. at 100%), for heating or cooling operations

Star Rating	EER/COP
1	2.75
1.5	3.00
2	3.25
2.5	3.50
3	3.75
3.5	4.00
4	4.25
4.5	4.50
5	4.75
5.5	5.00
6	5.25

Test points

- A/C products **must** be tested at *"T1"*
- = 35°C Dry-bulb/24°C Wet-bulb. Can also be tested at other temps for hotter and cooler climates.
- Heat-pumps **must** be tested at *"H1"*
- = 7°C Dry-bulb/6°C Wet-bulb. Can also be tested at other temps for colder and very cold climates.

Meteorological Statistics

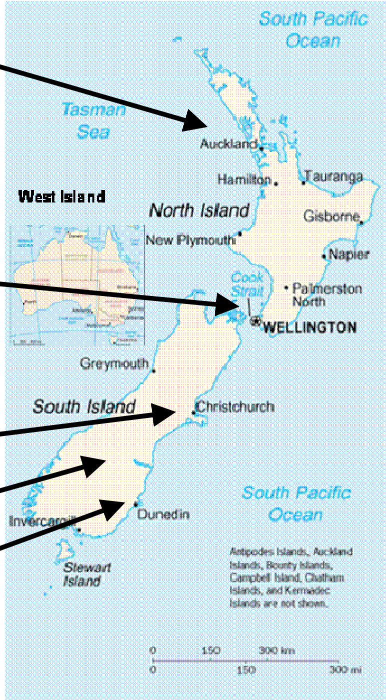
Auckland (15^{0}C)

Wellington (12^{0}C)

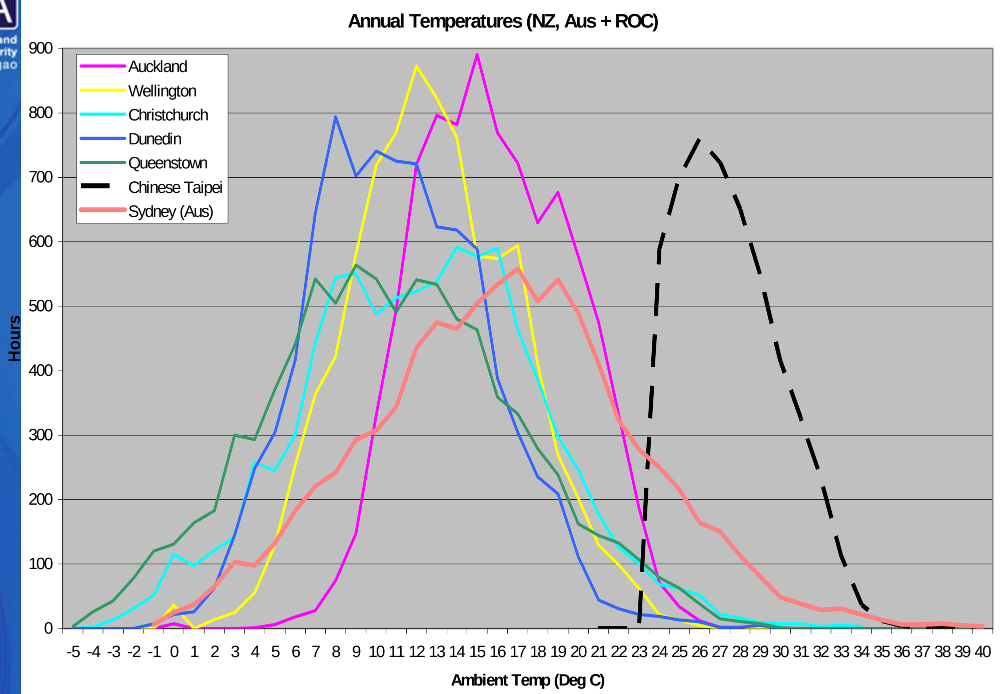
Christchurch (14^{0}C)

Queenstown (9^{0}C)

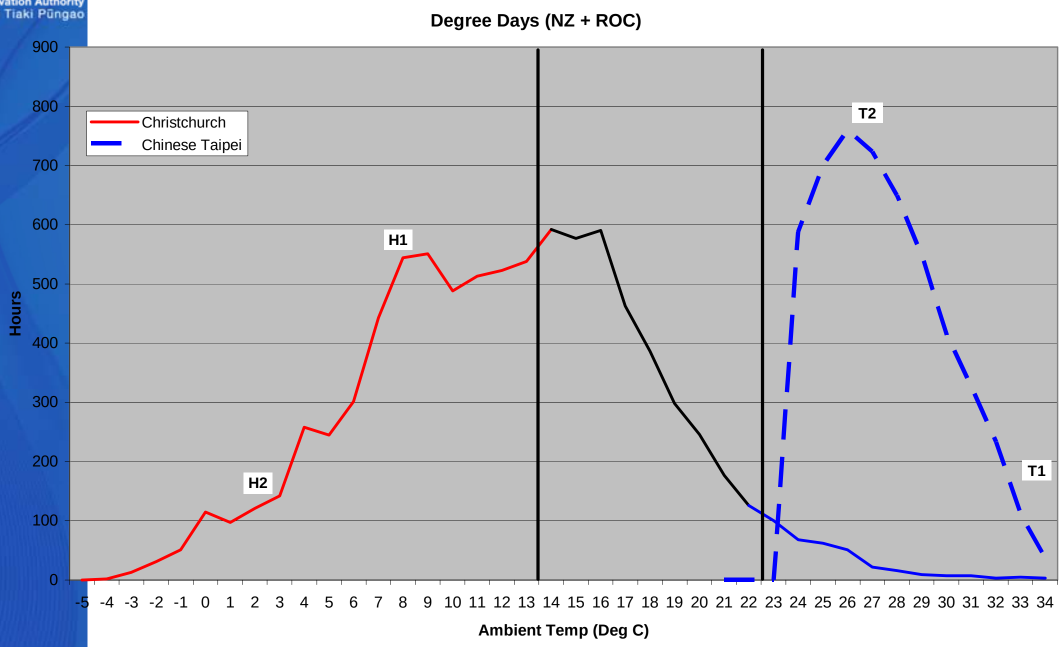
Dunedin (13^{0}C)



Meteorological Statistics



Metereorological Statistics



Annualised Performance

$$\frac{2{,}000 \times \text{Cooling/heating}}{(2{,}000 \times P_E) + (6{,}760 \times E_S)}$$

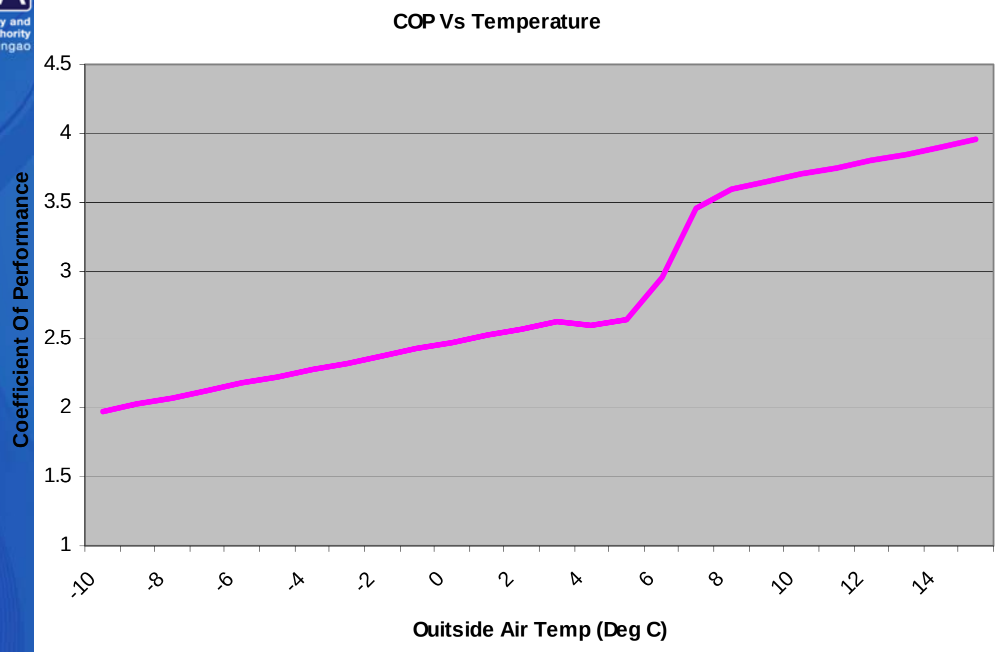
•Uses tested “rated” (i.e. 100%) output for cooling/heating (kW)

*P_E = "Effective Power Input = Energy used in "Operational Mode“ (kW)

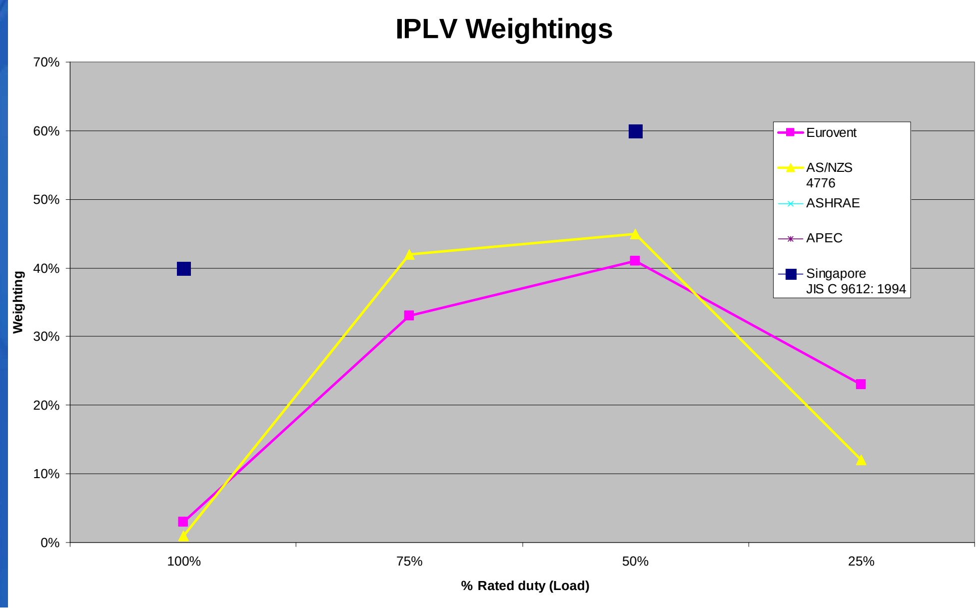
* E_S = Energy used in "Standby" or "Non-Operational Mode“ (kW)

* Assumes 2,000 hours of operation

Performance Vs Temperature.



Integrated Part Load Values (Chillers)



Energy Efficiency and Conservation Authority
Te Tari Tiaki Pūngao

SEER =

$$\frac{(P_{OUT\text{-}COOL100\%} \times Hrs_{COOL100\%})+(P_{OUT\text{-}COOL50\%} \times Hrs_{COOL50\%})}{(P_{IN\text{-}COOL100\%} \times Hrs_{COOL100\%})+(P_{IN\text{-}COOL50\%} \times Hrs_{COOL50\%})+(8760-Hrs_{COOL100\%} - Hrs_{COOL50\%}) \times P_{IN\text{-}NOP}}$$

Desc.	***Example***
$P_{IN\text{-}COOL100\%}$	*1.82*
$P_{IN\text{-}COOL50\%}$	*1.35*
$P_{OUT\text{-}COOL100\%}$	*5.00*
$P_{out\text{-}COOL50\%}$	*4.50*
$P_{IN\text{-}COOL\text{-}NOP}$	*0.001*
$Hrs_{COOL100\%}$	*50*
$Hrs_{COOL50\%}$	*800*

EER = 2.75

SEER = 3.27

Energy Efficiency and Conservation Authority
Te Tari Tiaki Pūngao

SCOP (HSPF) =

Desc.	***Example***
$P_{IN\text{-}HEAT100\%}$	*2.51*
$P_{IN\text{-}HEAT50\%}$	*1.49*
$P_{OUT\text{-}HEAT100\%}$	*8.00*
$P_{OUT\text{-}HEAT50\%}$	*5.50*
$P_{IN\text{-}HEAT\text{-}NOP}$	*0.002*
$Hrs_{HEAT100\%}$	*155*
$Hrs_{HEAT50\%}$	*1,000*
Hrs_{NOP}	*6,737*

COP = 3.19

SCOP = 3.61

SHCPF

(Seasonal Heating & Cooling Performance Factor) =

$$\frac{(P_{OUT\text{-}HEAT100\%} \times Hr_{\text{-}HEAT100\%}) + (P_{out\text{-}HEATL50\%} \times Hr_{\text{-}HEAT50\%}) + (P_{OUT\text{-}COOL100\%}\ Hrs_{COOL100\%}) + (P_{out\text{-}COOL50\%} \times Hrs_{COOL50\%})}{(P_{IN\text{-}HEAT100\%} \times Hrs_{HEAT100\%}) + (P_{IN\text{-}HEAT50\%} \times Hrs_{HEAT50\%}) + (P_{IN\text{-}COOL100\%} \times Hrs_{COOL100\%}) + (P_{IN\text{-}COOL50\%} \times Hrs_{COOL50\%})\ (8760 - Hrs_{HEAT100\%} - Hrs_{\text{-}HEAT50\%}) - Hrs_{COOL100\%} -}$$

Desc.	*Example*
$P_{IN\text{-}COOL100\%}$	*1.82*
$P_{IN\text{-}COOL50\%}$	*1.35*
$P_{OUT\text{-}COOL100\%}$	*5.00*
$P_{out\text{-}COOL50\%}$	*4.50*
$P_{IN\text{-}COOL\text{-}NOP}$	*0.001*
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$Hrs_{COOL50\%}$	*800*

Desc.	*Example*
$P_{IN\text{-}HEAT100\%}$	*2.51*
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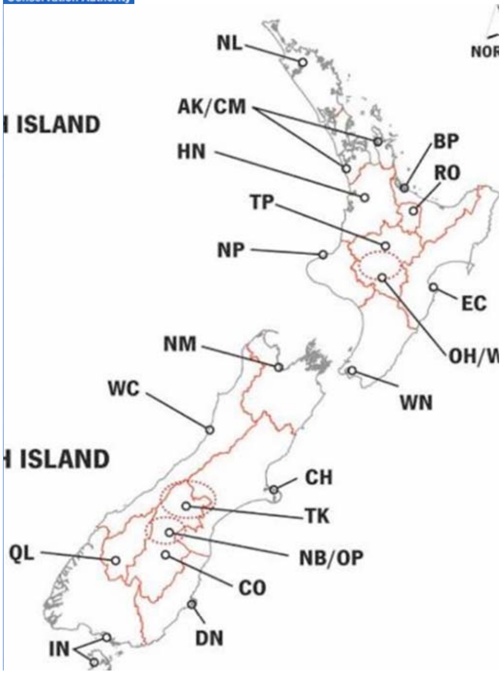
$Hrs_{HEAT100\%}$	*155*
$Hrs_{HEAT50\%}$	*1,000*
Hrs_{NOP}	*6,737*

Sizing



SIZING YOUR HEAT PUMP

EECA energywise THE POWER TO CHOOSE

(A)	Region		**Wellington**
	Climate Index		**3**
	Design temperature		**1 Degrees C**
(B)	Room Type (Design Temperature)		**Lounge (20 Deg C)**
	Bed Rm/Hall (16 Deg C)	0	**2**
	Dining Rm (18 Deg C)	1	
	Lounge (20 Deg C)	2	
(C)	Insulation		**Good (2008 onwards)**
	High/Best Practice	1	**2**
	Good (2008 onwards)	2	
	OK (NZBC 1978 - 2008)	3	
	Poor/none	4	
(D)	Windows - Size in Rm		**Large - 60%**
	Small - 25% of wall space	1	**3**
	Medium - 40%	2	
	Large - 60%	3	
	Very Large - 80%	4	
(E)	Number of outside walls		**Two**
	One	1	**2**
	Two	2	
	Three	3	
(F)	Total score = (A) + (B) + (C) + (D) + (E) +		**12**
(G)	Room area X 8		**160**
	Length (m)		**5**
	Width (m)		**4**
(H)	= (G) + 100		**260**
	Heater size (W) = (F) X (H)		**3,120 W**
	Heat size (kW) = (F) X (H)		**3.12 kW**

But remember, this must be sized at the Heat Pump's "Design Temperature" for **1 Degrees C**

Also allow for local variation (i.e. valleys, rivers etc)

ENERGY STAR

- In New Zealand, you'll find the ENERGY STAR mark on leading heat pumps, dishwashers, fridge/freezers, washing machines, TVs, DVD players, home theatre systems, computers and office equipment.
- By choosing to buy products and appliances that have earned the ENERGY STAR mark, you'll save money on your power bill, plus you'll be helping to protect our environment.
- ENERGY STAR is awarded to the most energy efficient products available, typically the top 25% of each class
- However, incorrect sizing or installation can **still** reduce performance and undermine efficiency

The Future??

- Ver 1 – based on rated EER & COP only
- Ver 2 - "annualised" EER & COP, with standby power consumption included in the calculation
- Ver 3? – "Regional" capacity & power consumption?
- Ver 4 - "Regionalised" annualised capacity & power consumption, based on Seasonal Heating & Cooling Performance

4. The Seasonal Energy Efficiency (SEER) of Air conditioners in China

Content

☞ **Present status of SEER in China**

◆ **Implementation approaches of China's EE promotions**

1.1 Market of RAC in China

------Types of Air-conditioners

1. Room air-conditioner
   - variable-speed
   - single-speed

2. Uniteriy air-conditioner (commercial sector)

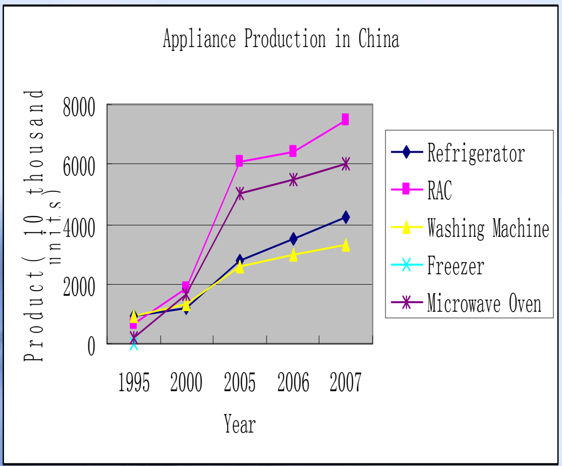
3. Muti-connected air-conditioner

4. Watre Chiller

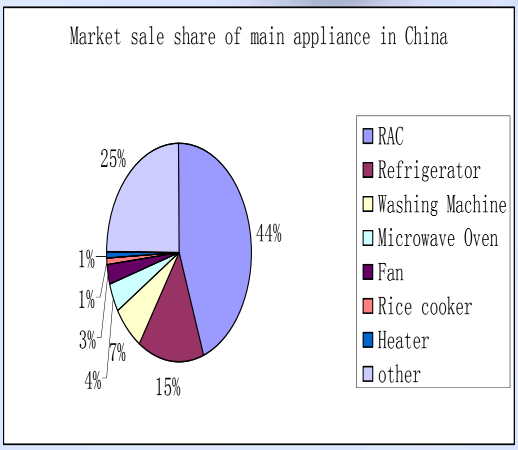
China National Institute of Standardization

Production and Sale of RAC in China

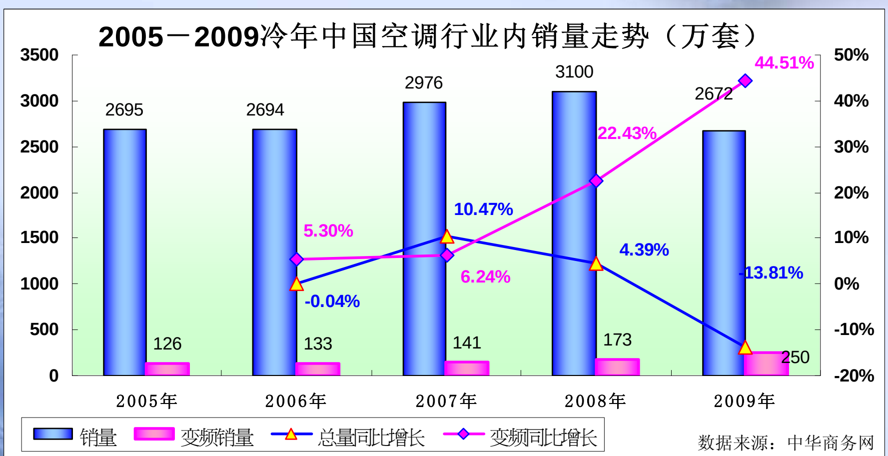
Production about 70 million units



Sale about 200 billion RMB



Market share of single-speed RAC and variable-speed RAC in China



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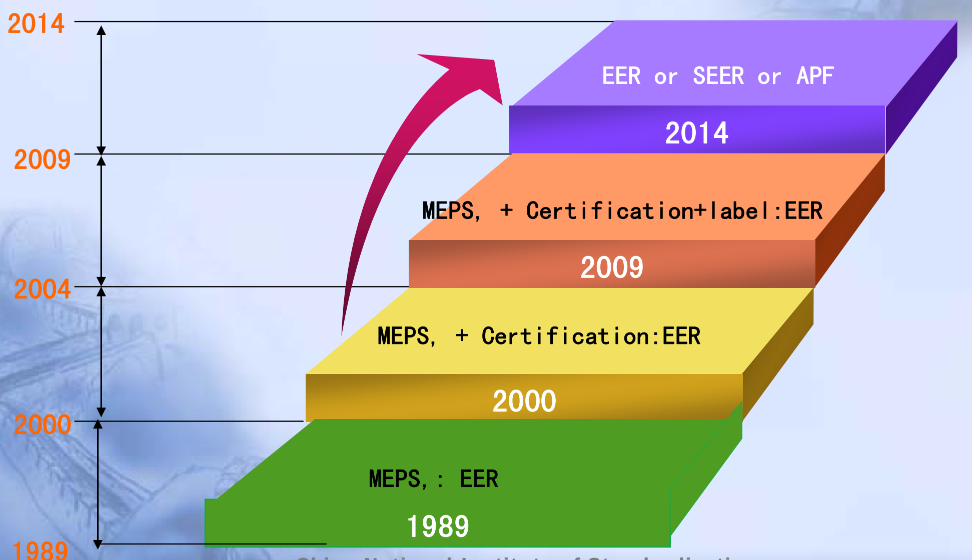
1.2 MEPS Published

TYPE	Stand No.	Title	Efficiency Index	Future
Room Air-conditioners	GB12021.3-2004	The minimum allowable values of energy efficiency and energy efficiency grades for Room Air-conditioners	EER	APF (cooling +heating)
Unitary Air-conditioners	GB19576-2004	The minimum allowable values of energy efficiency and energy efficiency grades for unitary Air-conditioners	EER	APF
Water Chiller	GB19577-2004	The minimum allowable values of energy efficiency and energy efficiency grades for water Chiller	COP	IPLV
Multi-connect Air-conditioners	GB21454—2008	The minimum allowable values of energy efficiency and energy efficiency grades for Multi-connect Air-conditioners	IPLV	IPLV
Variable-speed Room air-conditioner	GB21455-2008	The minimum allowable values of energy efficiency and energy efficiency grades for Variable-speed Room air-conditioner	SEER	APF (cooling +heating)

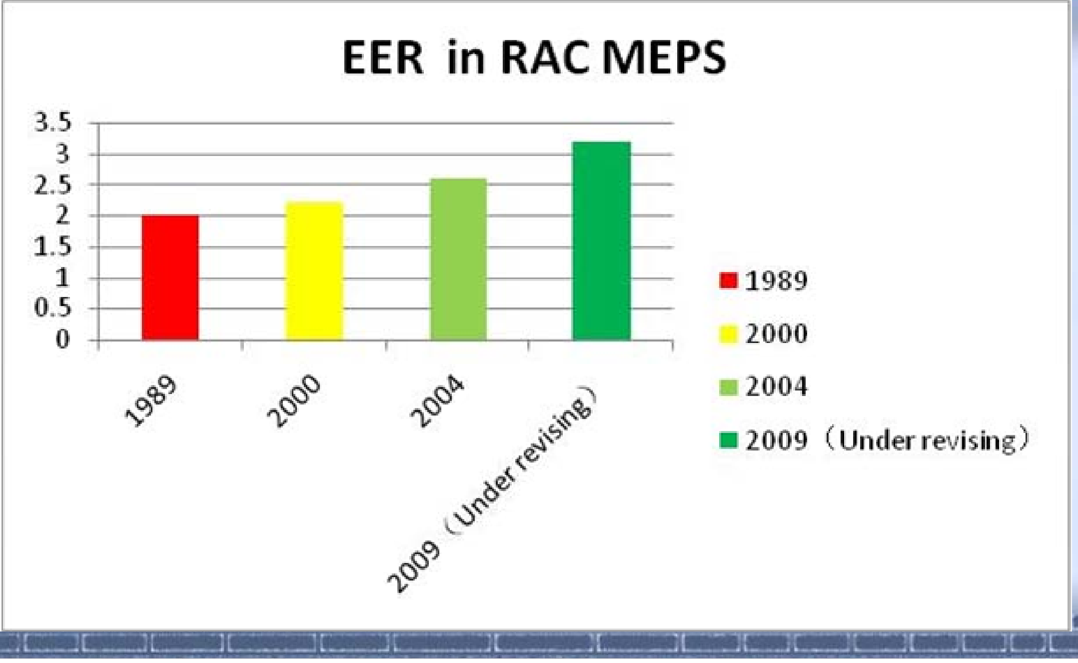
1.2.1 History of MEPS for single-speed Room Air-conditioner



Content of MEPS for single-speed RAC now

- Limited value of energy efficiency (or energy consumption), mandatory requirement.
- Evaluating value of energy conservation, voluntary index. China's energy conservation products;
- Energy grade, products are divided into 5(or 3) grades. Grade 1 is of the highest efficiency. China's energy label system;
- Test methods and inspecting rules

Limited value of MEPS

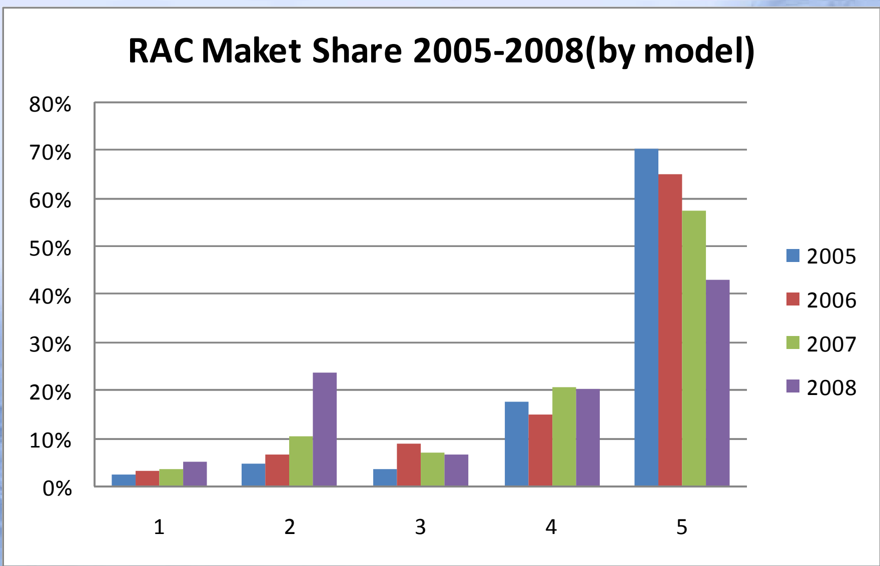


Energy Efficiency Ratio（EER）

- Test standard: GB12021.3, GB/T7725 (equivalent to ISO 5151)

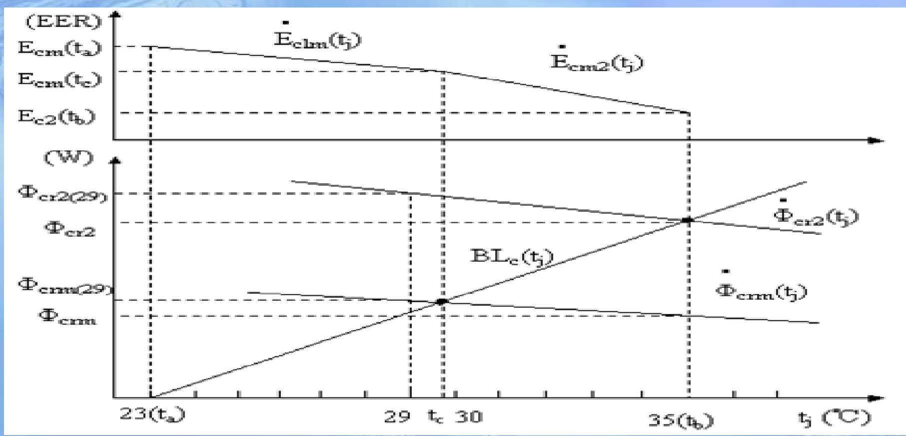
	T1	
	Cooling	heating
Temperature of air entering indoor side		
dry-bulb	27	20
wet-bulb	19	15
Temperature of air entering outdoor side		
dry-bulb	35	7
wet-bulb	24	6

Energy efficiency level of RAC



1.2.2 Content of MEPS for variable-speed RAC

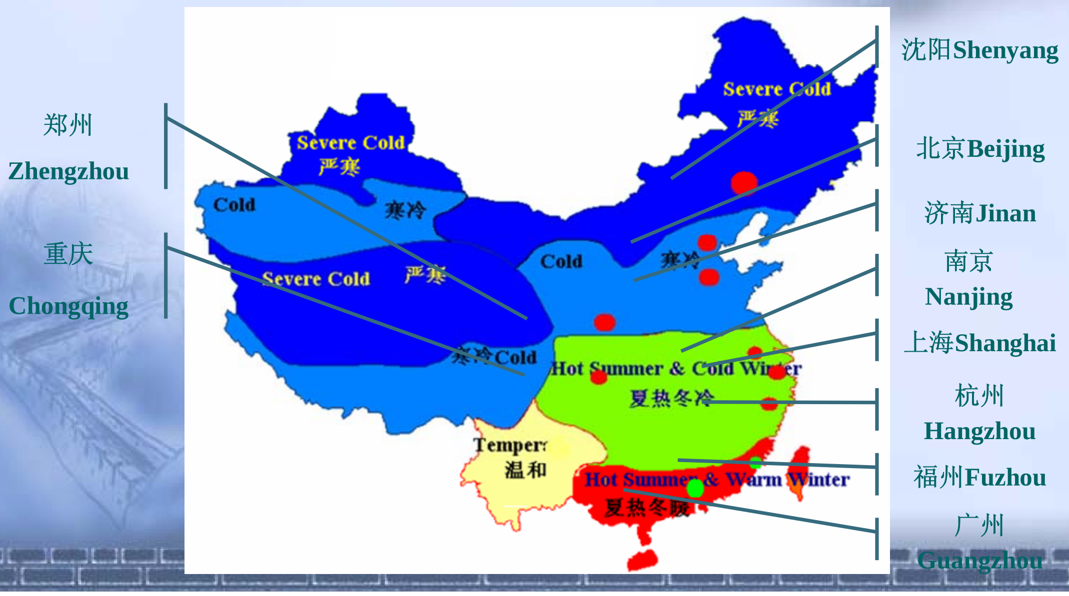
- **SEER (Seasonal Energy Efficiency Ratio ）**
  - **SEER=CSTL/CSTE**
  - **Two points for testing: 100%、50%**
  - **Running time**



1.3 Main Problem

- **Which is better in China? *single-speed or variable-speed air-conditioners***
  - single-speed air-conditioners are evaluated by EER standard, while variable-speed air-conditioners are evaluated by SEER standard.
  - consumers not to differentiate the energy efficiency between these two types of air-conditioners.
- **Add require for heating mode of RAC**
  - Only develop Requirement for air-conditioners in cooling mode, but not for heating mode.

Weather and consumers' habit in Each City



Possible Technical Trends of EE Standards for Air-conditioners

- Add the requirements for the efficiency in heating
- study the possibility of using SEER standard to evaluate single and variable-speed air-conditioners
- APF—annual performance factor

$$\mathrm{APF} = \frac{cooling + heating}{energy(cooling) + energy(heating)}$$

- annual Energy consumption (cooling +heating)

1.4 Workplan for Survey of family energy-consumption & Running-hour of RAC in China

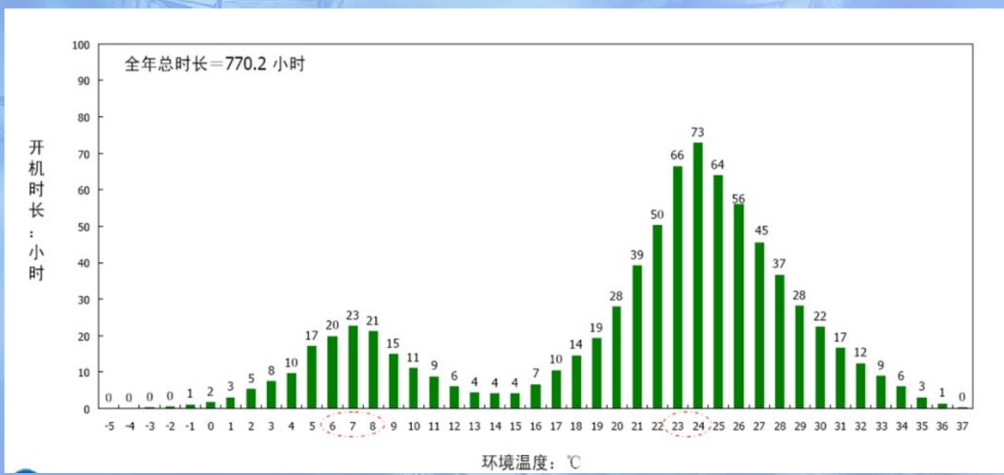
- Goal
  - Meter for whole family energy-consumption
  - Meter for RAC
  - Habit of consumers
  - Analysis energy demand & Energy-saving potential

Schedule

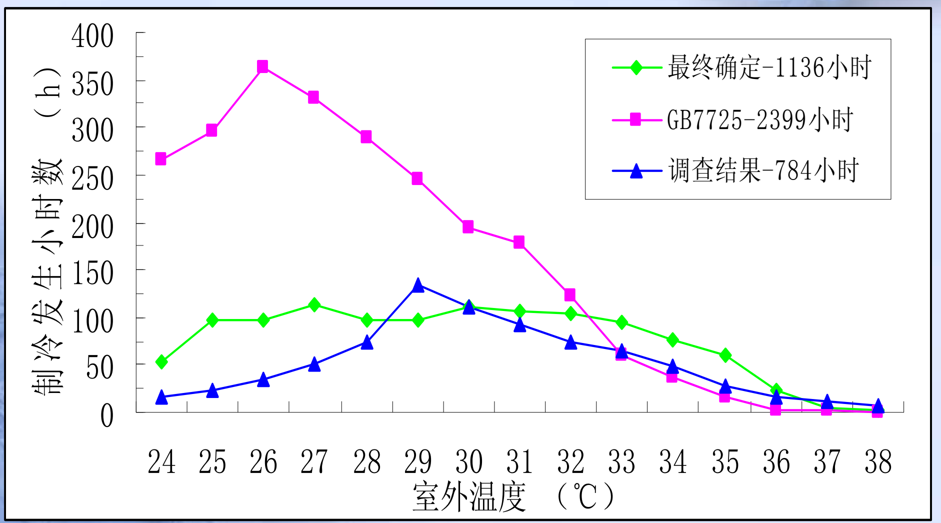
- 2009.3-2010.5
- CNIS, IEEJ, CLASP

1.4.1 Research on Running Hour Curve of Room Air Conditioner in China

The running hour curve of room air-conditioners are the fundamental data for SEER calculation.



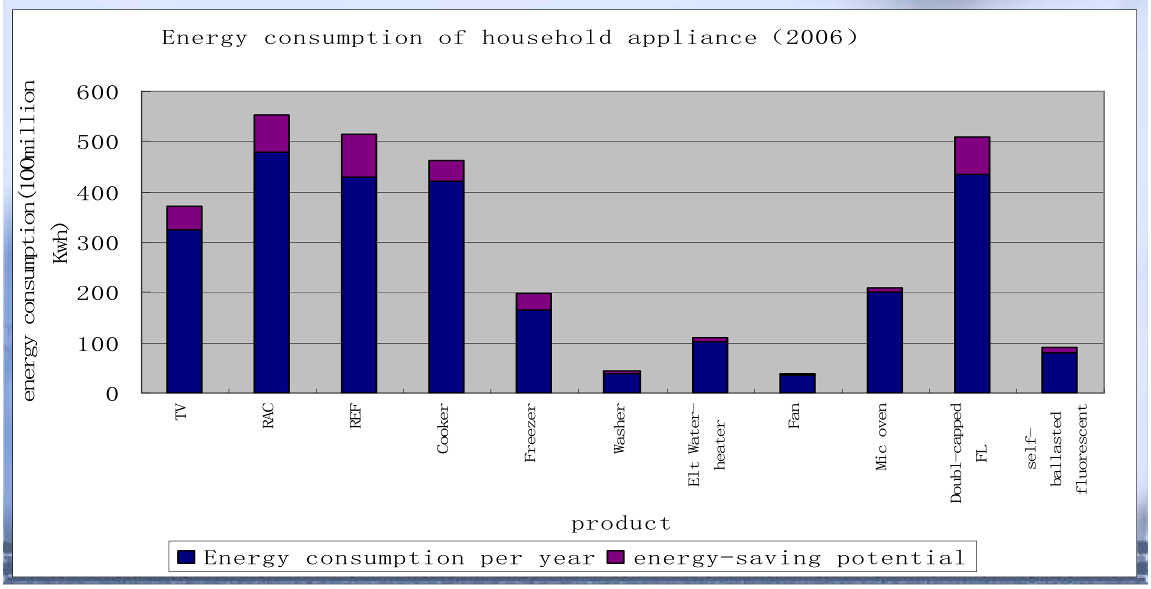
Running time of RAC in China



1.4.2 Survey

---- Family energy-consumption

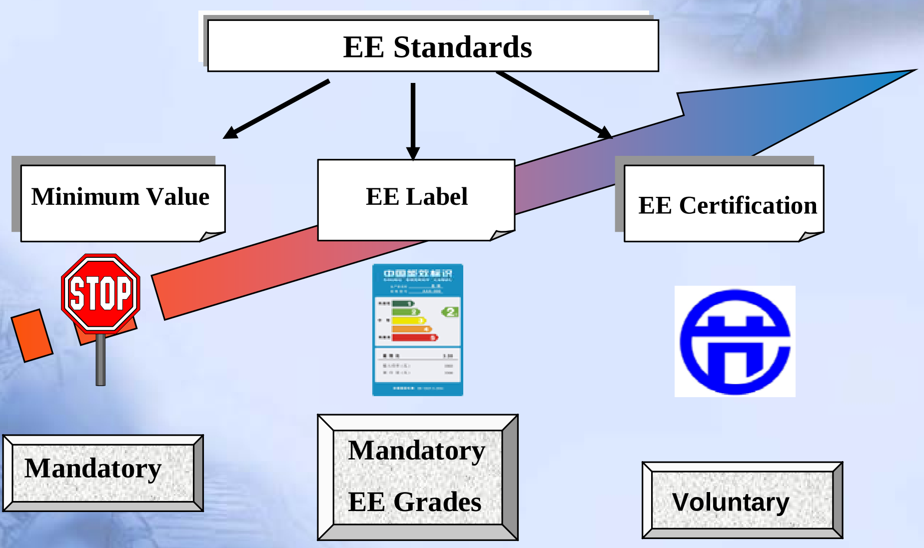
---- Load of RAC



Content

- Present status of SEER in China
- ☞**Implementation approaches of China's EE promotions**

2.1 China's EE standards, Labels



2.2 Policies and enforcement

- China Government Procurement(Mandatory)
- Tax reduction
  - value added tax
  - income tax of company
- Consumer price-support subsidy
  - appliance price reduce by 13% in countryside (TV, REF, Mobile phone, Washer, RAC, heater, motorcycle,computer,etc)
  - Subsidy for high-energy efficient product (RAC)

Thanks!

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5. The Role of SEER of air conditioners in Energy Efficiency Management in Chinese Taipei

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The Role of SEER of air conditioners in Energy Efficiency Management in Chinese Taipei

Shin-Hang Lo

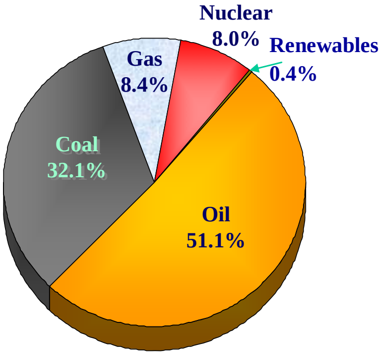
October 5th, 2009

Energy & Environmental Research Lab., Industrial Technology Research Institute

工業技術研究院 Industrial Technology Research Institute

Energy Supply in Chinese Taipei

Chinese Taipei (2007) 147.24 Million KLOE



(1) Due to the shortage of indigenous energy, 99.2% of total energy supply is imported.

(2) Imported crude oil is the major portion of energy supply about 51.1%.

(3) Fossil fuels account for 91.6% of total energy supply.

(4) The concentration of energy types is 61.5%.

Dependence on Imported Energy：	93.5%	98.2%	99.2%
	1987	1997	2007

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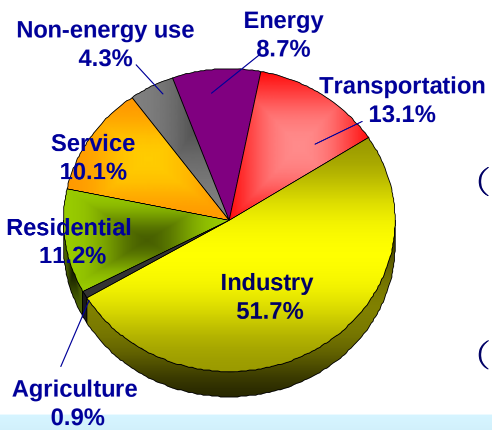
Energy Consumption in Chinese Taipei

Chinese Taipei (2007)
121.03 Million KLOE



（By Sectors）

（1）During 1987~2007, average annual growth rates of energy consumption and GDP were 5.5% and 5.7 %, respectively, economic growth had not yet decoupled with energy consumption.

（2）Industry sector is the largest portion of energy consumption (51.7%), followed by transportation sector (13.1%).

（3）The shares of energy consumption in service and residential sectors increase .

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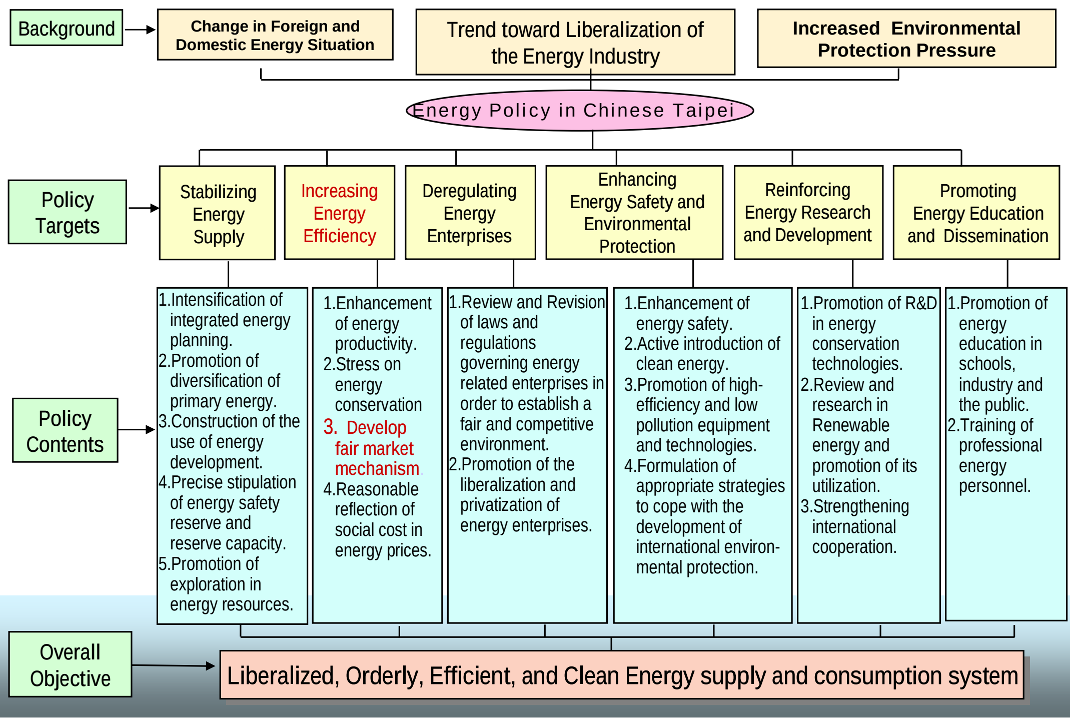
Energy Policy in Chinese Taipei

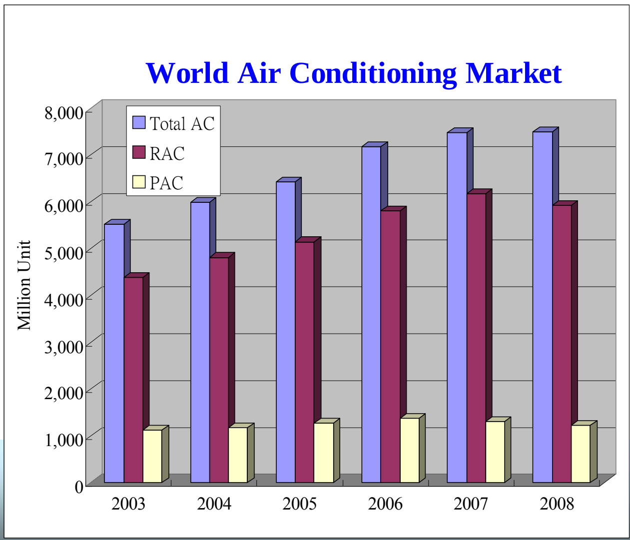
Policy Framework and its implementing Measures



World Air Conditioner Market

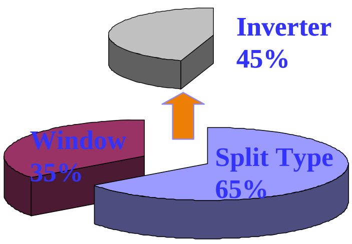
- The total sales volume of air conditioners of the world increases from 55 million in 2003 to 75 million units in 2008。

36% for 5 years



RAC Domestic shipments of Chinese Taipei

- The domestic shipments of room air conditioners (RACs) in Chinese Taipei is around 1 million units a year. However, there is 20% fluctuation depending on the weather and economic situation.
- Sales of split type units are estimated about 60% of the overall air conditioner market in 2008. Additionally, inverter units takes about 45% of RAC market , while more than 80% of inverter units use R410A.



Air conditioner market share of Chinese Taipei

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RAC Domestic shipments of Chinese Taipei

Type \ Year		2006			2007			2008			2009/01~08		
RACs	RACs (Window)	424000	37%	37%	383000	34%	33.5%	292000	30%	29.1%	212000	39%	38.0%
	RACs (Split)	710600	63%	61.9%	746800	66%	65.3%	696300	70%	69.4%	333200	61%	59.8%
	• split system AC (with one indoor unit)	632000	56%	55.1%	662000	59%	57.9%	608000	62%	60.6%	296000	54%	53.1%
	• Multi-split (those having two indoor unit with two independent indoor controls)	67200	6%	5.9%	66600	6%	5.8%	65900	7%	6.6%	27700	5%	5.0%
	• Multi-split (those having more than two indoor unit with more than two independent indoor controls)	11400	1%	1.0%	18200	2%	1.6%	22400	2%	2.2%	9500	2%	1.7%
	RACs Total	1134600	100%	98.9%	1129800	100%	98.8%	988300	100%	98.6%	545200	100 %	97.8%
Commercial AC	SKY AIR	8700		0.8%	9000		0.8%	8900		0.9%	5600		1.0%
Central AC	VRV	4100		0.4%	4500		0.4%	5600		0.6%	6500		1.2%
Total		1147400		100%	1143300		100%	1002800		100%	557300		100%

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Home Electricity Consumption in Chinese Taipei

	Type of appliance	units owned per home	Energy consumption (kWh/year)	% of total energy consumption
Home appliances	Room Air Conditioner	2.7	3646	45.1
	refrigerator	1.3	875	10.8
	Water dispenser	1.1	634	7.8
	Electric water boiler	1.1	584	7.2
	TV	2.0	403	5.0
	Electric Pots	1.1	341	4.2
	Heater	1.3	246	3.0
	dehumidifier	1.3	200	2.5
	Electric fan	3.2	152	1.9
	Clothes washer	1.1	53	0.7
	microwave	1.0	72	0.9
	Hair dryer	1.0	48	0.6
	Kitchen fan	1.0	42	0.5
	Clothes dryer	1.0	40	0.5
	iron	1.0	29	0.4
	Acoustic stereo	1.3	23	0.3
	Rice cooker and others	1.4	85	1.1
	subtotal		7503	92.8
Lighting	Lighting bulbs	20	584	7.2
Total			8087	100.00

source: Chinese Taipei power co.

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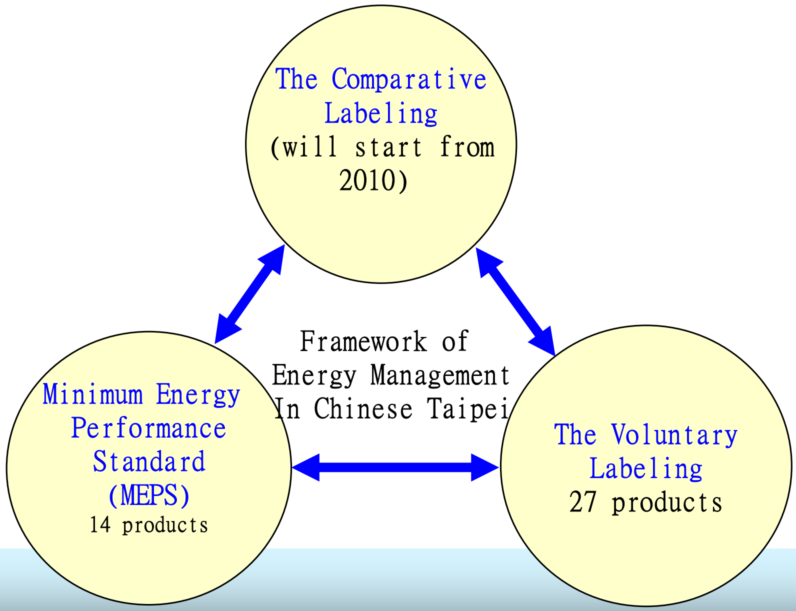
The Framework of Energy Efficiency Management in Chinese Taipei



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The Minimum Energy Performance Standard

- Manufacturers and importers are obliged to apply in advance for compliance certification; compliance with Minimum Energy Performance Standard (MEPS) and fuel economy requirements is mandatory before the regulated items can be put on the market

Minimum Energy Performance Standard (MEPS) in Chinese Taipei

Effective Year	Categories (MEPS)	New Criteria effective date
2002	Non-conductive Air-Conditioners（EER）	Stage 1： Jan. 1, 2011 Stage2： Jan. 1, 2016
2002	1 & 3 phased Induction motors	--
2003	Refrigerators	Jan. 1, 2011
1987	Automobile & motorcycle	Aug. 2009
2001	Fluorescent lamps	--
2007	Self-ballasted fluorescent lamps	Jan. 1, 2010
2009	Ballast	Mar.1,2009
2010	Compact fluorescent lamps	Jan. 1, 2010
2011	Dehumidifiers	Mar.1,2011
2012	Incandescent bulb	

Note: Boiler (2003), Consenser (2004)

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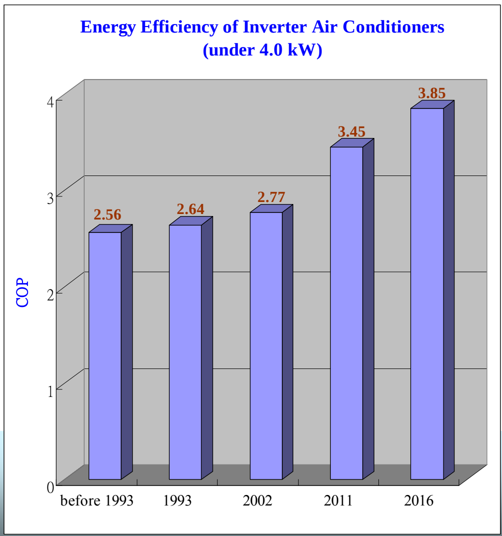
Progress of MEPS of Inverter AC (under 4.0 kW)

- The progress of MEPS of inverter air conditioners under 4.0 kW of Chinese Taipei upgrades 24.5% and 38.9% from current standard to 2011 and 2016 respectively.



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MEPS of RAC for Different Economies

type	Cooling capacity (kW)	Chinese Taipei 2010 MEPS	Japan 2007 Target Standard	Japan 2007 1 star Standard	Korea 2008 MEPS	China 2004 MEPS	China 2009 MEPS	Australia 2010 MEPS
Single type	Less than 2.2	3.15	2.67	2.14	2.88	2.30	2.90	2.75
	2.2 ~4.0	3.20						
	4.0 ~7.1	3.00						
	7.1 ~10.0	2.95						
Split type	2.2~3.2 (for Japan) Less than 4.0	3.45	3.64 3.08	2.91 2.46	3.37	2.60	3.20	3.05
	4.0 ~7.1	3.20	2.91	2.33	2.97	2.50	3.10	2.75
	7.1~10(for Korea) 10.0~ (others)	3.15	2.81	2.25	2.97 2.76	2.40	3.00	

Note: The test conditions of different economies are not considered in this table.

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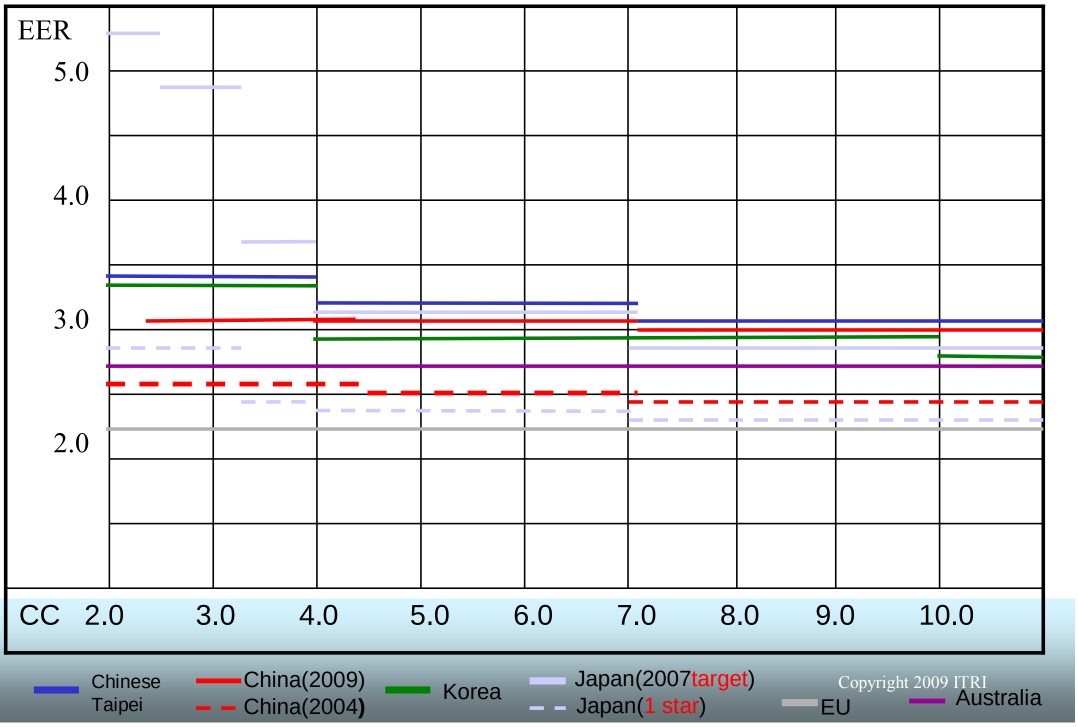
MEPS of split type RAC for Different Economies



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MEPS & Effective date for proposed products

Type of Device	Proposed MEPS Effective date	Efficiency increased (%)	Expected saving (100 milliom kWh)
Storage water heater	2013	10~20%	0.2
Electric Pot	2013	10~20%	0.24
Electric water dispenser	2013	10~20%	0.24
Clothes washer	2013	10%	0.05
Clothes dryer	2013	10%	0.05
Conductive Air conditioner	2014	15%	0.67
Emergency exit sign	2014	50%	0.2
Split type air conditioner (SEER)	2014	10%	0.1

Note: The proposed MEPS effective date has not been finalized.

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The Energy Standard & Labeling Programs

Energy Conservation Labeling program --Endorsement Labels

- A voluntary program to encourage the manufacturers/importers to develop/import the high energy efficiency products
- To encourage the consumers to buy high-efficiency products and to enhance the high-efficiency products market transformation.
- It has been implemented since 2001, and its targeted products are the home appliances, lightings, office equipments, gas burning appliances and vehicles.
- The top 15% to 30% efficient products on the market will receive this label accreditation. Chinese Taipei's Energy Label (Energy Conservation Labeling) is similar to the United States' Energy Stars programs.

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The Energy Voluntary Labeling Programs

Benchmarks for Energy Label Products(27 product Categories)

Year	Categories
2001	(1)air-conditioners (2) refrigerators (3) dehumidifiers (4) clothes dryers
2002	(5)TVs (6) clothes washers (7) electric (8) fans, fluorescent lamps (≥ 32 W)
2003	(8)fluorescent lamps (<32W) (9)hair dryers (10) hand dryers
2004	(11)warm-hot water dispensers (12) chilled-warm-hot water dispensers
2005	(13) chilled-warm-hot drinking fountains (14) automobiles & light trucks (15) motorcycles (16) self-ballasted fluorescent lamps
2006	(17) thin film transistor-liquid crystal display (18) instant gas burning water heaters (19) gas burning cooking appliances (20) electric rice cookers
2007	(21)Electric Storage Water Heaters (effective on Jan. 1, 2008)(22) Electric Pots (23) Exit Lights and Emergency Direction Lights(24) DVD Products
2008	(25)Warm-hot drinking fountains (26) Luminaires (27) Integrated Stereo

812 Energy Conservation Labeling certified RAC models with 33 brand names on Sep. 16, 2009

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Progress of standards of Voluntary labeling program

type	Cooling capacity (kW)	Chinese Taipei 2001 standard	Chinese Taipei 2006 standard	Chinese Taipei 2009 standard	Korea 2008 4 -star
Single type	Less than 2.2	2.98	3.15	3.30	3.31
	2.2 ~4.0	3.05	3.20	3.35	
	4.0 ~7.1	2.86	3.00	3.10	
	7.1 ~10.0	2.86	2.95	3.05	
Split type	2.2~3.2 (for Japan) Less than 4.0	3.19	3.45	3.85	3.88
	4.0 ~7.1	3.14	3.20	3.55	3.42
	7.1~10(for Korea) 10.0~ (others)	3.14	3.15	3.40	3.42 3.17

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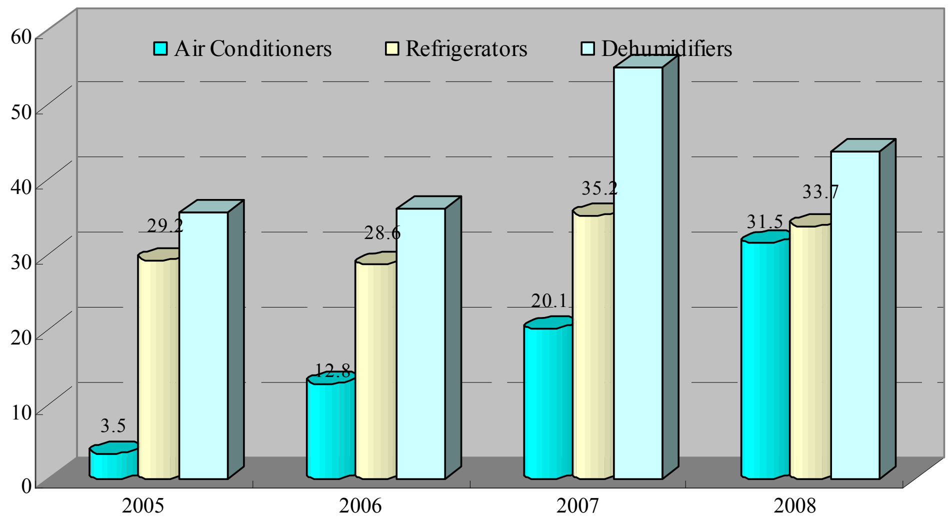
The Achievement of Voluntary labeling program

Market Share for Air Conditioners, Refrigerators and Dehumidifiers



The of Information labeling program

Informative Voluntary Energy Efficiency Label

- **Purpose**
  By recognizing the Voluntary Energy Efficiency Label which unveils the information of energy efficiency and annual energy consumption for both the product itself and equivalent products, consumers are encouraged to purchase products with high energy efficiency and low annual energy consumption, and the objective of energy saving can be achieved.
- **Scope**
  Priority labeling items include air conditioners, refrigerators, and clothes washers, which together account for 50% of the household energy consumption (lighting equipments excluded).
- **Partnership**
  19 manufacturer voluntarily participate in this program, while 7 major chain stores also commit to assist the promotion activities by posting the promotion posters and exhibiting certified products with Voluntary Energy Efficiency Labels.
- **Promotion**
  - ✓ Holding “the Voluntary Energy Efficiency Label Initiation Ceremony” on March 13, 2009, days before the World Consumer Right Day.
  - ✓ Promoting the label via poster, print media, and TV media.

Voluntary Energy Efficiency Label Illustration

The Voluntary Energy Efficiency Label Initiation Ceremony. From left to right, Mr. Johnsee Lee, President of ITRI, Mr. Chen-Chung Deng, Deputy Minister, MOEA, Mr. Cheng-hsiung Chiu, Vice Premier, Mr. Huey-Ching Yeh, Director - General, BOE, MOEA, and the representatives of manufacturers and chain stores.

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The Establishment of Comparative labeling program in Chinese Taipei

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Energy Management Law Article 14

Article	Scope	Target
The energy utilization facilities or apparatus, which are designated by the central competent authority, manufactured by local manufacturers or imported by merchants for domestic using should conform to the permit standards of energy consumption set up by the central competent authority. Meanwhile, the said facilities or apparatus should be provided with a label which indicates its energy consumption and the energy efficiency. If the designated facilities or apparatus fail to conform to the permit standards of energy consumption, such facilities or apparatus should be prohibited from importing or selling on domestic market. If designated facilities or apparatus fail to put on the label, such facilities or apparatus should be prohibited from display or selling on domestic market. The central competent authority should announce the appropriate MEPS and its monitor method, and the labeling, verification and test method for energy consumption amount and energy efficiency.	❶ MEPS of designated energy utilization facilities or apparatus ❷ Mandatory energy efficiency labeling of designated energy utilization facilities or apparatus	❶ Use MEPS to eliminate low energy efficiency products ❷ Use Mandatory energy efficiency labeling to lead the customers to choose high energy efficiency products, to achieve save energy and reduce carbon emission target.

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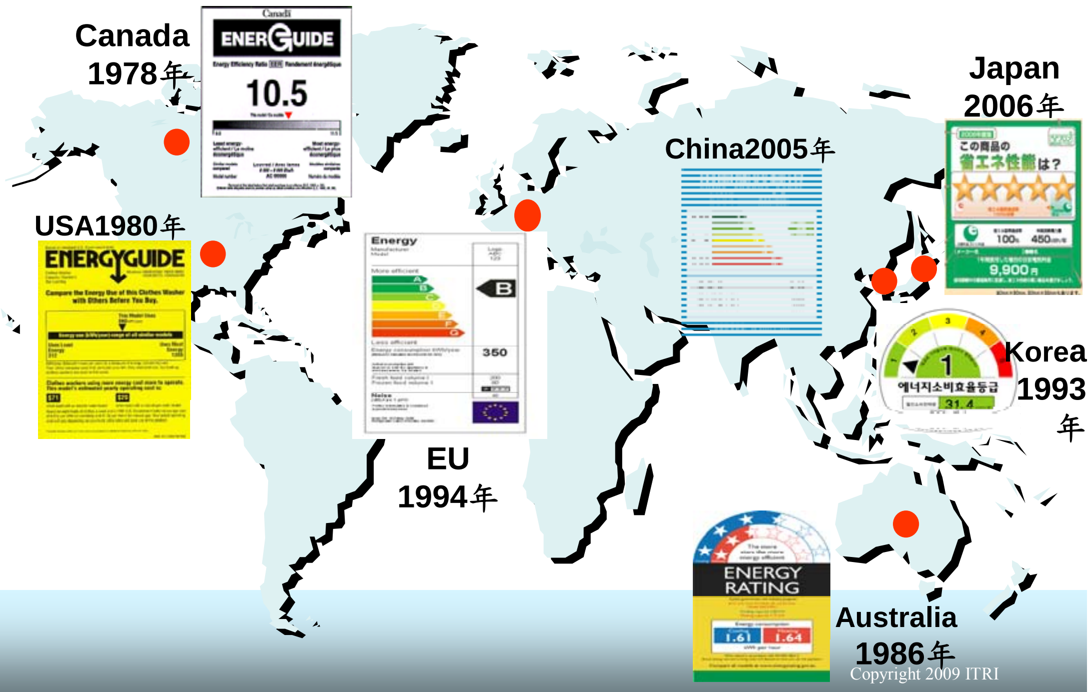
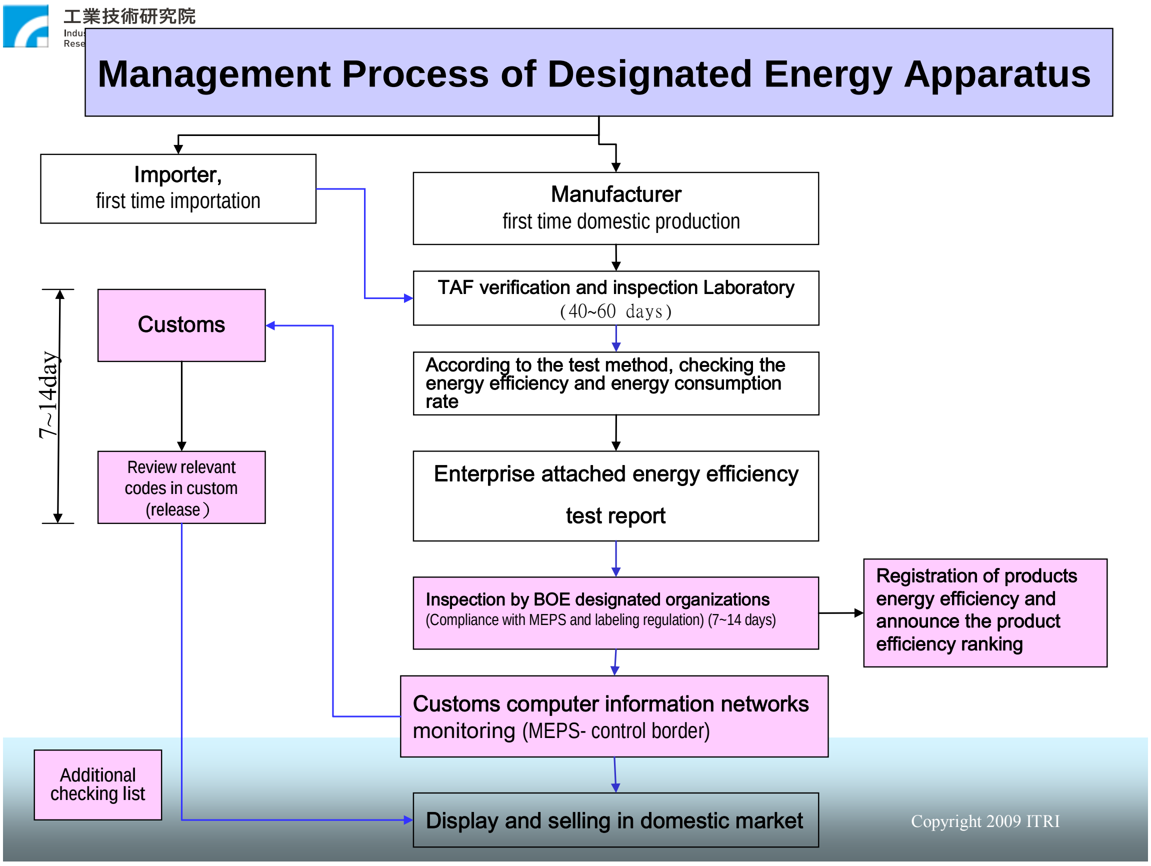
International Comparative Labeling Program

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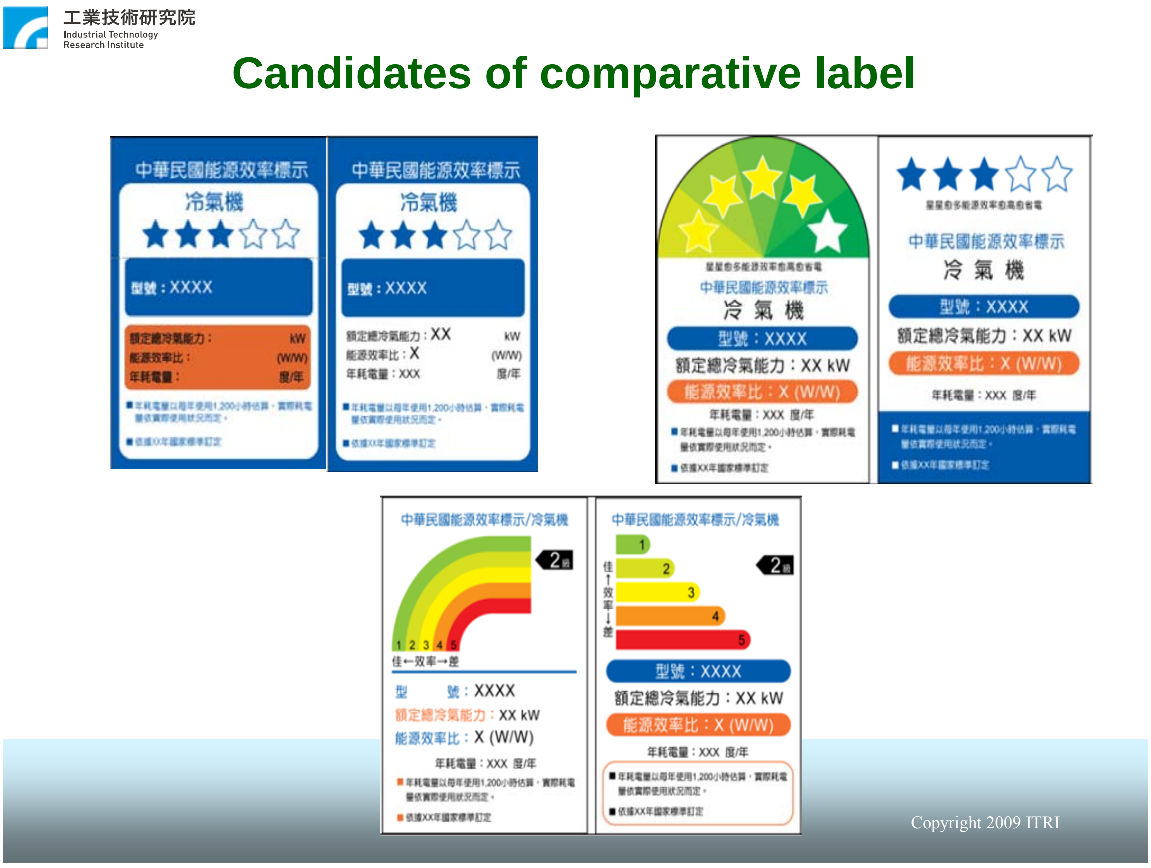
Management Process of Designated Energy Apparatus
Importer,
first time importation
Manufacturer
first time domestic production
TAF verification and inspection Laboratory
(40~60 days)
Customs
7~14day
According to the test method, checking the energy efficiency and energy consumption rate
Review relevant codes in custom (release)
Enterprise attached energy efficiency test report
Inspection by BOE designated organizations
(Compliance with MEPS and labeling regulation) (7~14 days)
Registration of products energy efficiency and announce the product efficiency ranking
Customs computer information networks monitoring (MEPS- control border)
Additional checking list
Display and selling in domestic market
Copyright 2009 ITRI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Industrial Technology Research Institute
Candidates of comparative label
中華民國能源效率標示
冷氣機
型號：XXXX
額定總冷氣能力：XX kW
能源效率比：X (W/W)
年耗電量：XXX 度/年
中華民國能源效率標示/冷氣機
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Effective Schedule for promoted products

Comparative labeling

products	effective
Non conducted air conditioner (EER)	2010.7
refrigerator	2010.7
Self-ballasted fluorescent lamps	2011.1
Fluorescent lamp	2011.1
dehumidifier	2011.1
Water dispenser	2011.1
Electric Pot	2011.1
3 phase induction motor	2012.7
Single phase induction motor	2012.7

Clothes washer	2013.1
Clothes dryer	2013.1
Electric storage water heater	2014.1
Conducted air conditioner	2014.1
Compact fluorescent lamp	2014.7
TV	2015.1
LCD Monitor	2015.1
Drinking water fountain	2015.1
Non conducted air conditioner (SEER)	2016.1
Electric fan	2016.1
Condenser	2016.1

Note: The effective schedule for promoted products have not been finalized.

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Closing Remarks

- **New MEPS for RAC will be effective in 2011 and 2016 based on EER in Chinese Taipei.**
- **The current voluntary labeling and upcoming comparative labeling of room air conditioner will still be based on EER.**
- **The Draft of SEER will be proposed in 2011 and expected to be effective in 2016.**
- **In 2016, EER and SEER dual system or SEER single system for room air conditioner energy efficiency standard has not been finalized yet.**
- **The benefits of energy Standard and Labeling programs for room air conditioner have been proved to be cost-effective in Chinese Taipei.**

6. SEER Testing Method and Standard Development in US

Intertek

SEER Testing Method
and
Standard Development in US

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APEC/Energy SEER Workshop
October 5, 2009

Intertek

AHRI Contract Test Laboratory

- 4 decades of HVAC Testing Experience
- Proven accuracy & reliability of facilities over time
- State-of-the-art automation technology
- Customized designs
- On-site training
- Facility upgrades available
- Clients from around the world

Contents

- EER - Energy Efficiency Ratio
- SEER - Seasonal Energy Efficiency Ratio
- HSPF - Heating Seasonal Performance Factor
- Regulations and Organizations Involved
- SEER Cd Explanations
- Issues Related to Variable Speed Testing

EER Background

- Energy Efficiency Ratio (EER)
- EER = Cooling capacity/input power (Btu/watt-hour)
- Measures steady-state efficiency at one condition
- Steady-state system efficiency rating at 95°F outdoor ambient per ARI Standards 210/240 was used prior to 1978 in U.S. No Federal Government regulation
- Utility Rebate Incentives In Some Local Areas to reduce summer electrical demand
- ARI Certification Compliance Requires Meeting 95% Of Both Capacity And EER When Testing A Unit At Random From An OEM Warehouse

EER Background (continued)

- EER Only Rating Drawbacks :
  - Not Representative Of Seasonal Energy Usage
  - <5% Cooling Season Hours Are At > 95˚F Ambient
  - >70% Cooling Season Hours Are At < 82˚F Ambient where System Cycles On/Off
  - On/Off Cycling Has Losses Not Reflected In EER Rating

SEER Concept

- Seasonal Energy Efficiency Ratio (SEER) Introduced By U.S. Department Of Energy (DOE) Late 1979
  - Better Representation Of Real System Energy Usage
  - Provides Better Standard For Comparing Equipment Performance
- Procedures Originally Developed By NIST (National Institute Of Standards And Technology) In 1977
  - Recognition Of On/Off Cyclic Loss
  - Summation Of Energy Consumption
    - 5˚F Outdoor Temperature Increments (Bins)
    - Weighted By Hours
    - Uses either national or regional weather Hours

SEER Concept (continued)

- 10.0 SEER Minimum Federal Standard Effective Since 1992
- 13.0 SEER Minimum Effective Since January 2006
- Energy Labeling Law FTC (Federal Trade Commission)
- Applies to air conditioners and heat pumps <19kw rated capacity
  - Ducted systems - Packaged and Split systems
  - Non-ducted split systems – Procedure is slightly different for these samples however ON time still 6 Minutes OFF 24
  - Variable speed samples ON time is 12 minutes OFF 48

SEER Test/Rating Requirements ARI 210/240

- All Indoor Conditions Are 80˚F Dry-Bulb/ 67˚F All include Wet-Bulb Except For Cyclic Tests which run Dry Coil

- Single-Speed Requirements (Outdoor Ambient)
  - Test-A Steady-State At 95˚
  - Test-B Steady-State At 82˚
  - Test-C Steady-state At Same 82˚ Except With Dry-Coil Indoor Conditions To Assure Test Repeatability (<57˚F Wet-Bulb)

SEER Test/Rating Requirements AHRI 210/240

- Test-D same temperatures as Test C but cycling
  - 6-Minutes On And 24-Minutes Off Per Cycle
  - 3 Cycles Required, Take Data On Last Cycle
- Derive Cyclic Loss (Cd Coefficient) from Tests C & D
- Can Use Default Cd Of 0.25 Instead Of Testing
- Can Use Alternative Formula Below Instead Of Temperature Bin Procedure (accurate within ± 0.5%)
- SEER = (1-0.5*Cd)*EERb
- Using Default Cd: SEER = (0.875 * EERb)

HSPF Test/Rating Requirements AHRI 210/240

- Heating Seasonal Performance Factor (HSPF) for heat pumps
- Heating capacity/input power (Btu/watt-hour)
- Similar To SEER Concept

Recognition Of On/Off Cyclic Loss, Frost/Defrost Loss, And Auxiliary Heat requirement

HSPF Test/Rating Requirements AHRI 210/240

- All Indoor Conditions At 70°F Dry-Bulb, No Wet bulb except for cases when indoor coil rejects moisture.

- Single-Speed Requirements (Outdoor Ambient)
  - Steady-State At 47°DB/43°WB
  - Cyclic Loss (Cd Coefficient) At Same 47°DB/43°WB
    - 6-Min ON And 24-Minutes OFF
  - Variable speed 12 min ON 48 Min OFF
    - 3 Cycles Required, Take Data On Last Cycle
    - Test is Optional can Use Default Cd=0.25

HSPF Test/Rating Requirements AHRI 210/240

- Outdoor 35°DB/33°WB
- Must Integrate One Complete Frost/Defrost Cycle
- Low Temp Steady-State At 17°DB/15°WB Ambient
- Results averaged by computer according to bin procedure for one of six regions of country
- Region IV (middle U.S.) used for published rating

Intertek

Key Organizations

- ➢Program Administration: DOE
- ➢Testing and Rating Procedures: NIST
- ➢Minimum Efficiency Analysis: LBNL
- ➢Product Labeling: FTC
- ➢Certification: AHRI
- ➢Testing: Intertek

NOTE:

This program addresses energy performance, not noise or safety

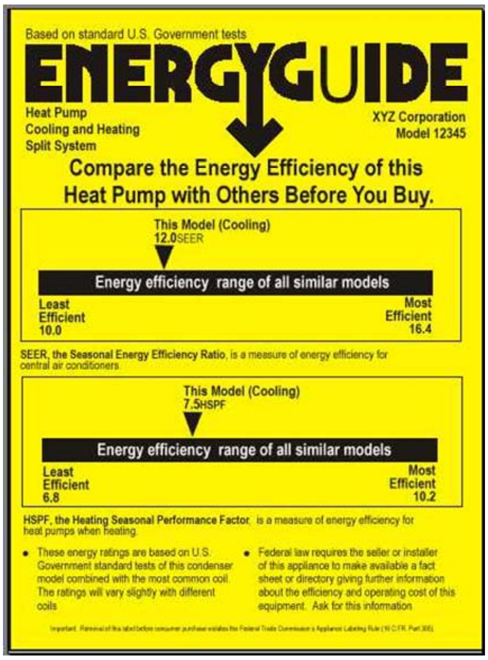
Intertek

Rating Certification/Compliance

- Mandated by the U. S. Department of Energy (DOE)
- Compliance indirectly administered by Air Conditioning Heating and Refrigeration Institute (AHRI), the industry trade association
- Certification Requires
  - Capacity At 95°F, 47°F, 17°F
  - SEER And HSPF
- Based On Average Of Statistical Minimum Of Two Units
- For Split Systems, Highest-Sales Volume Combinations of indoor and outdoor units are tested
  - Other Mix-Match Combinations of units Can Be Submitted By Certified Computer Simulations
- One third of basic models tested each year

Rating Certification/Compliance

- All Audit Testing at Independent Lab (Intertek)
- Compliance Requires Meeting 95% Of Ratings For Capacity & Efficiency When Randomly Testing Units From An OEM Warehouse
- Forced to Re-Rate or Stop Production If Fail To Resolve Test Failures
- OEM Pays Cost of all Testing Failures
- ARI Directory of ratings published on-line
- Printed tags attached to outdoor units show ratings for consumer



Benefits of Seasonal Energy Efficiency Rating AHRI 210/240 method

- Additional test points indicate actual capacity curve, rather than a calculated slope.
- Cyclic testing may offer further improvements based on actual simulated use testing.
- Provides better indication of true performance under real world test conditions.
- Additional test points do not impose a great increase in time or expense as the unit is already setup.
- More differentiation between models
- More technical credibility with Government

System Types

- Air conditioners and heat pumps having a rated capacity less than 19 kW
  - Ducted systems (packaged and split systems)
  - Non-ducted, split systems
- Units having single-speed, two-capacity, and variable-speed components (compressor and/or indoor fan)

Rating Highlights

Focus on seasonal performance over steady-state performance seek estimate of seasonal operating costs

Divide USA into 6 climatic regions but use one region 4 for most comparisons

DOE sets minimum allowed seasonal rating

Testing Highlights

Steady-state and Cyclic testing

	Cooling	Heating
Single-speed	**2/2**	**3/1**
Two-capacity	**4/4**	**7/2**
Variable-speed	**5/2**	**5/3**

(required/optional)

Psychrometric test facilities (calorimeter is not used)

Testing Highlights

- Primary test method: Indoor Air Enthalpy
- Confirming test method required for steady-state tests => require 6% energy balance
- Outputs: capacity, power, part-load efficiency descriptor

Testing Highlights

- Sampling Plans
  - Test 2 to 4 units of the same model as required to meet statistical confidence
  - For split-systems, test highest sales volume combination; use verified algorithm to estimate performance of other combinations (called "mixed systems")
- Testing generally performed by manufacturers who then submit results to DOE and FTC

Calculation Highlights

- Lab data provides performance map:
- capacity and power consumption as a function of outdoor temperature and compressor capacity

- Test procedure provides estimate of “typical” building load
  - assumed to depend only on outdoor temp.
  - assumes a zero building load at 18.3 C

Calculation Highlights

- Estimate percent on-time to meet building load at each outdoor temp.
- Estimate energy consumption for each corresponding percent on-time
- Increase energy consumption to account for cyclic losses
- Weight-average the results for each outdoor temperature based on typical frequency of the each temperature.

Enforcement

- DOE may elect to:
  - review test results
  - observe testing
  - require additional testing by manufacturer or third party (manufacturer pays)

- Trade Association (AHRI)
  - Random testing each year
  - Fines & more random selections for failures
  - Another manufacturer may challenge a competitor's numbers (loser pays)

Calculating SEER for Single-Speed Systems

Early on, found that:

SEER(Short-cut Method) ≅ SEER(Bin Method)

Short-cut Method adopted for Single-speed systems

Short-cut Method Parameters

Only Need EERB and the Part Load Factor (PLF) corresponding to a 50% load factor

Use C_D^c to get PLF(50%)

What is C_D^c ?

Used in quantifying part load performance

C_D^c is the slope (linear fit) of the PLF (= EER_{cyc}/EER_{ss}) versus CLF curve*

Used to calculate SEER,

For single-speed systems, use a short-cut calculation:

$$SEER = EER_B * \left(1 - \frac{C_D^c}{2}\right)$$

For two-capacity and variable-speed systems, use a "bin" calculation:

$$SEER = f\left\{EER_{ss}^k(T_j), C_D^c, \frac{\dot{Q}^{k=2}(T_j)}{\dot{Q}^{k=1}(T_j)}, BL(T_j)\right\}$$

Calculating SEER for Single-Speed Systems

- **Equation Derivation,**

$$SEER = EER_B * PLF(CLF = 0.5)$$

$$= EER_B * 1 - C_D^C(1 - CLF)$$

$$= EER_B * 1 - C_D^c(1 - 0.5) = EER_B * \left(1 - \frac{C_D^c}{2}\right)$$

Intertek

Calculating C_D^c and Using It To Determine Cyclic Efficiency

Calculate based on 2 tests

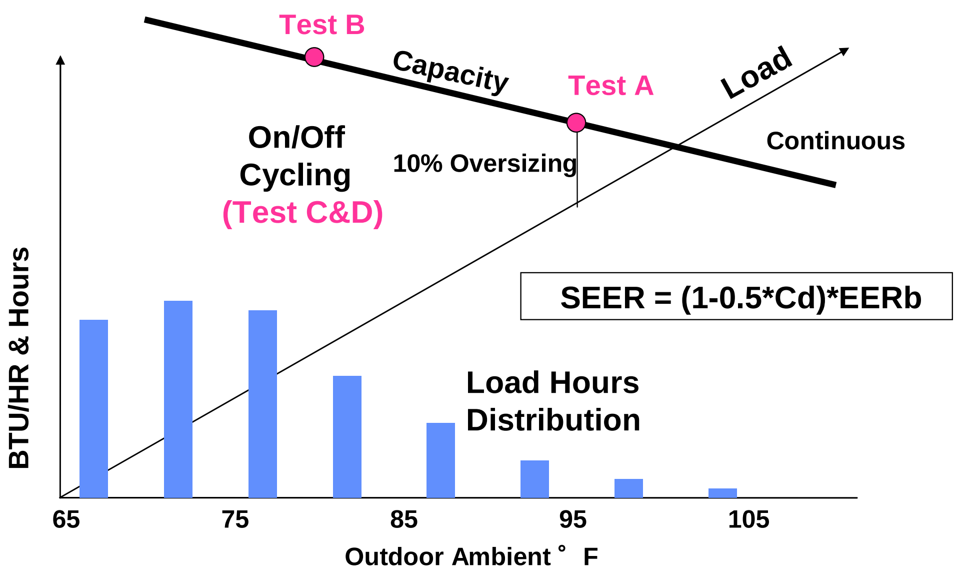
$$C_D^c = \frac{\Delta Y}{\Delta X} = \frac{1 - \dfrac{EER_{cyc,dry}(20\%\ \text{On Time})}{EER_{ss,dry}(100\%\ \text{On Time})}}{1 - CLF(20\%\ \text{On Time})}$$

Apply to estimate performance at multiple operating conditions

$$EER_{cyc} = EER_{ss}\left\{1 - C_D^c(1 - CLF)\right\}$$

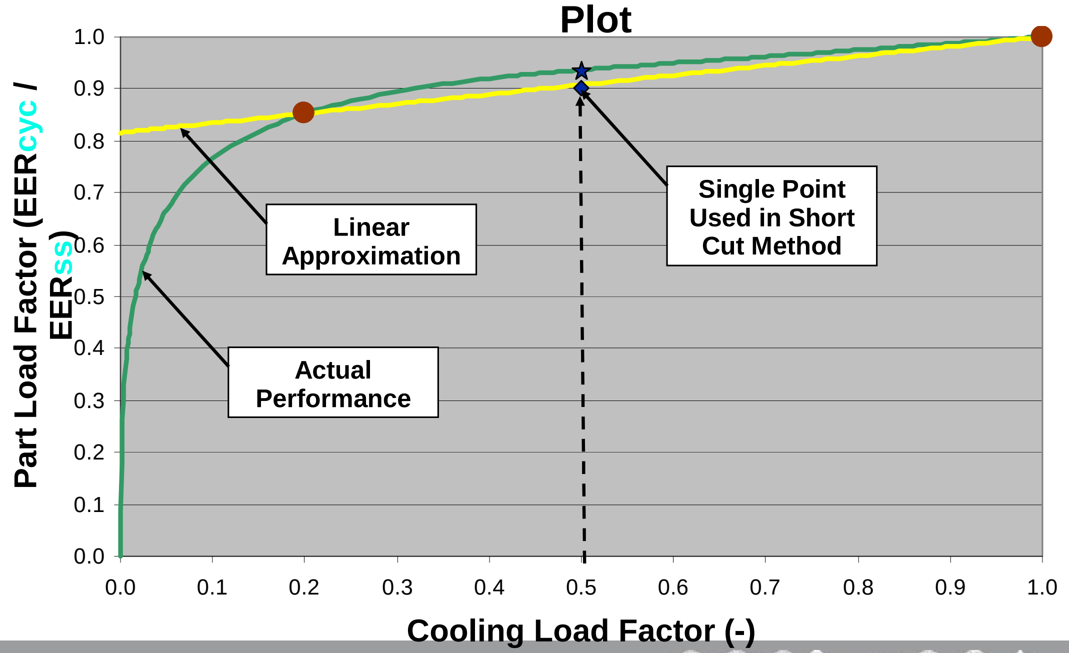
Intertek

Single-Speed SEER Procedures

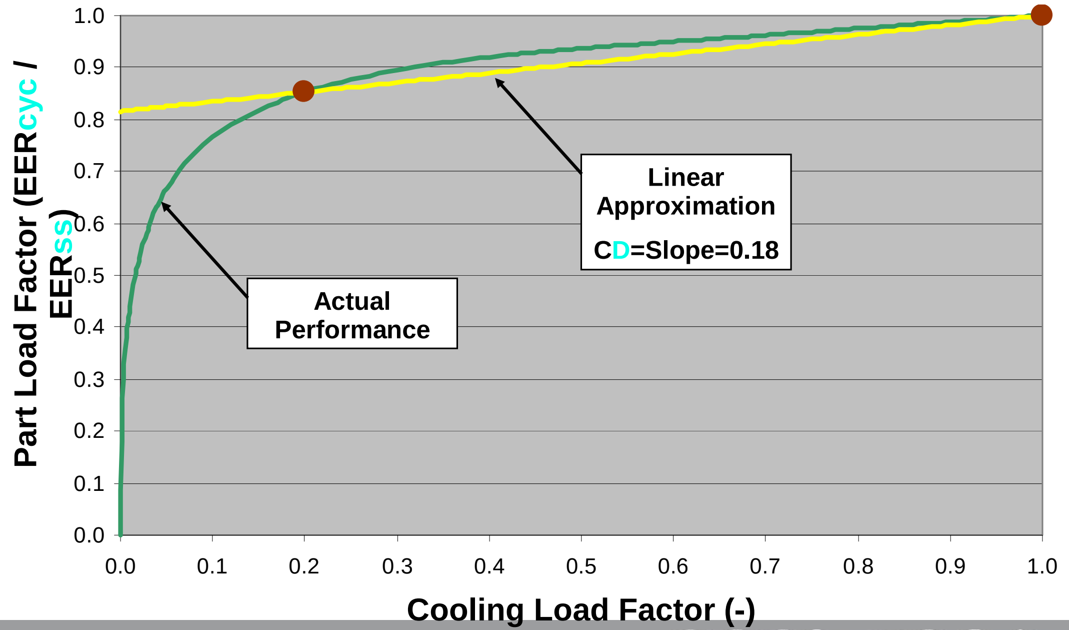


SEER For Single-Speed Systems:

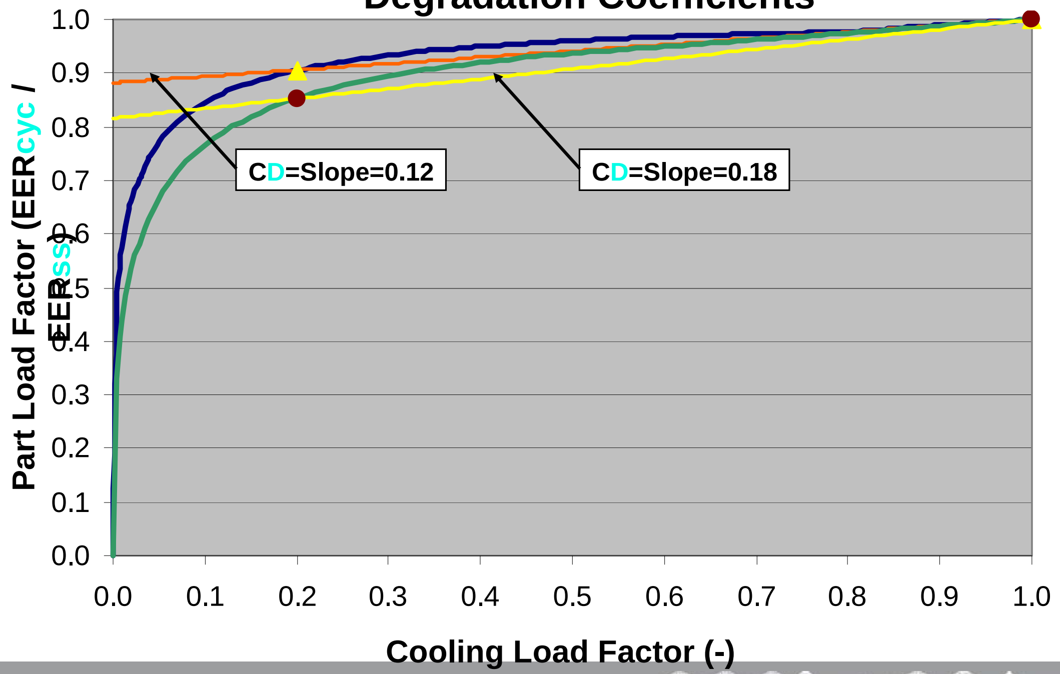
The Single Point Used From the PLF vs CLF Plot



Interpreting the Cyclic Degradation Coefficient, C_D^c



Comparison of Two PLF Curves Corresponding to Two Different Cyclic Degradation Coefficients



How much does C_D^c affect SEER?

- C_D^c has a bigger effect on single-speed units versus two-capacity and variable-speed units

- SEER Gain for single-speed systems

C_D^c = 0.25 versus:	<u>0.20</u>	<u>0.15</u>	<u>0.10</u>	<u>0.05</u>	<u>0.00</u>
SEER Improvement	2.9%	5.7%	8.6%	11.4%	14.3%

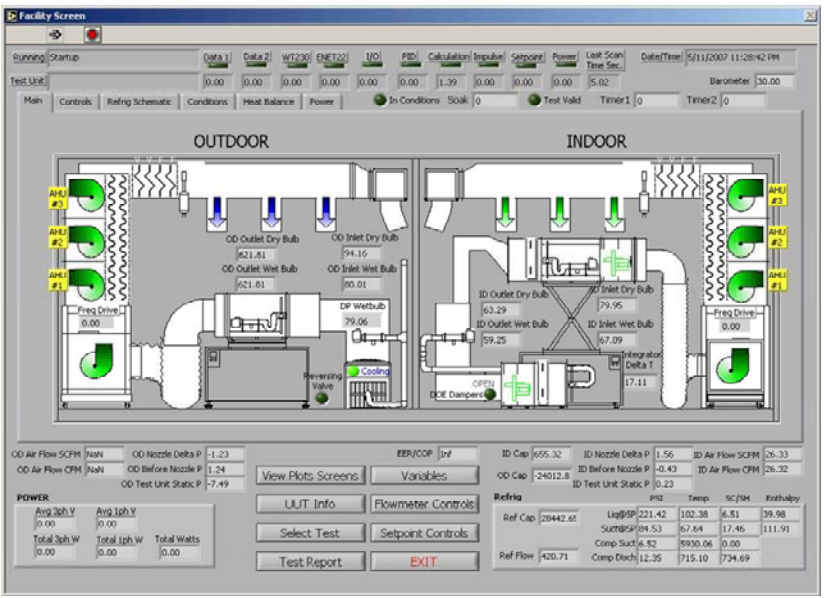
- SEER Gain for modulating systems depends on the degree of unloading (Below example: 47% unloading at 82° F)

C_D^c = 0.25 versus:	<u>0.20</u>	<u>0.15</u>	<u>0.10</u>	<u>0.05</u>	<u>0.00</u>
SEER Improvement	0.9%	1.9%	2.7%	3.6%	4.4%

Issues Related to Variable Speed Samples

- Variable Compressor Speed Testing
- 2-speed with Variable Airflow Testing
- Cyclic Testing
- Setting and Maintaining Airflow rates
- Minimum Static Pressure
- Integrated Temperature Measurements
- Additional Temperature Test Points

Psychrometric Test Facility



Variable Speed Tests AHRI 210/240 - 2008

VARIABLE SPEED COMPRESSOR COOLING TESTS						
TEST	*ID*		OD		***Comp** speed*	***Blower** speed*
	DB	*WB*	*DB*	*WB*		
A2 (ss,wet)	80.0 / 26.7	67.0 / 19.4	95.0 /35.0	75.0 / 23.9	Max	Full-Load
B2 (ss,wet)	80.0 / 26.7	67.0 / 19.4	82.0 / 27.8	65.0 / 18.3	Max	Full-Load
Ev (ss,wet)	80.0 / 26.7	67.0 / 19.4	87.0 / 30.6	69.0 / 20.6	Int	Int
B1 (ss,wet)	80.0 / 26.7	67.0 / 19.4	82.0 / 27.8	65.0 / 18.3	Min	Min
F1 (ss,wet)	80.0 / 26.7	67.0 / 19.4	67.0 / 19.4	53.5 / 11.9	Min	Min
G1* (ss,dry)	80.0 / 26.7	dry	67.0 / 19.4	N/A	Min	Min
I1* (cyc,dry)	80.0 / 26.7	dry	67.0 / 19.4	N/A	Min	G1(△Pnoz)

Minimum External Static – AHRI 210/240 - 2008

Table 2. Minimum External Static Pressure for Ducted Systems Tested with an Indoor Fan Installed

Rated Cooling[1] or Heating[2] Capacity (Btu/h)	Minimum External Resistance[3] (Inches of Water) All Other Systems	Small-Duct, High-Velocity Systems[4,5]
Up Thru 28,800	0.10	1.10
29,000 to 42,500	0.15	1.15
43,000 and Above	0.20	1.20

[1] For air conditioners and heat pumps, the value cited by the manufacturer in published literature for the unit's capacity when operated at the *A* or A_2 Test conditions.

[2] For heating-only heat pumps, the value the manufacturer cites in published literature for the unit's capacity when operated at the *H1* or $H1_2$ Test conditions.

[3] For ducted units tested without an air filter installed, increase the applicable tabular value by 0.08 inch of water.

[4] See Definition 1.35 to determine if the equipment qualifies as a small-duct, high-velocity system.

[5] If a closed-loop, air-enthalpy test apparatus is used on the indoor side, limit the resistance to airflow on the inlet side of the indoor blower coil to a maximum value of 0.1 inch of water. Impose the balance of the airflow resistance on the outlet side of the indoor blower.

Measurements

Attachment of Connecting Ducts and Pressure Taps

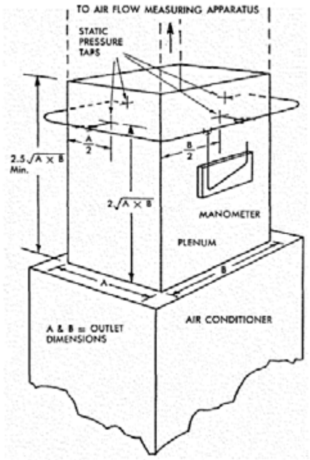


Figure 7a External static pressure measurement.

Note: The following statements apply to Figures 7 and 8.
For circular ducts, substitute $\pi D_i^2/4$ for C × D and $\pi D_o^2/4$ for A × B.
The length of the inlet duct, $1.5\sqrt{C \times D}$, is a minimum dimension. For more precise results, use $4\sqrt{C \times D}$.

< with fan

without fan >

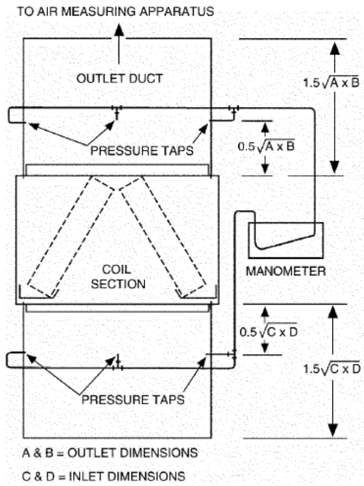


Figure 8 Air static pressure drop measurement for coil (without fan).

Ducted Airflow Determination

Variable Speed vs Variable Volume

Minimum Static Pressure vs Rated Airflow must be looked at closely to determine proper airflow control setting for the tests.

Non-Ducted Airflow Determination

All tests are run at ZERO static pressure at airflow setting selected by test sample.

Measurements

The following slides will cover the key measurements required and the sensors we would typically use to acquire those measurements:

Key measurements required for testing Heating Ventilating and Air Conditioning (HVAC) products include:

1. Temperature
2. Pressure
3. Power
4. Flow

Measurements

Temperature measurements can be made with a number of different sensors:

Resistive Temperature Detectors (RTD)
Thermocouples (T type, J type etc.)
Thermistors
Thermometers

However for SEER and HSPF testing
Cyclic and Defrost Test etc.

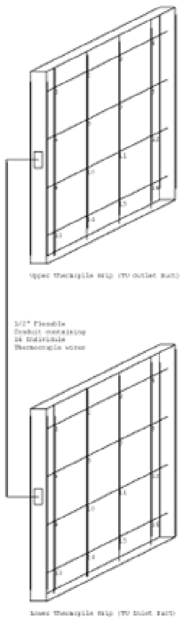
Special Purpose Delta-T Integrators are required.

Measurements

Differential Temperature Integrators

Temperature measurements can be made with a number of different sensors:

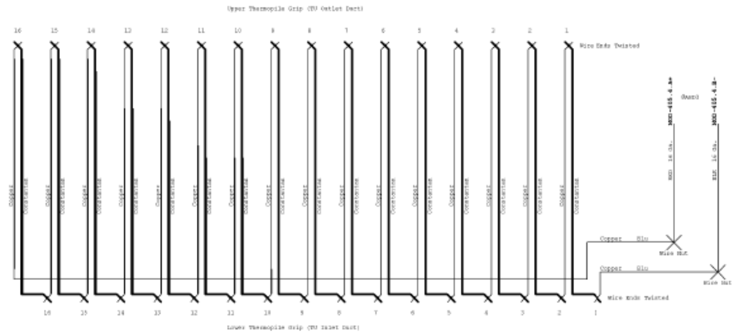
Resistive Temperature Detectors (RTD)
Thermocouples (T type, J type etc.)
Thermistors
Thermometers
Special Purpose Delta-T Integrators



Measurements

Differential Temperature Integrators

This differential temperature is represented by a DC voltage. With curve fit equations we can convert this to a very accurate indication of Delta-T.



Key Reference Material

10CFR430 - Subpart B DOE Testing Methods

16CFR305 - Appliance Labeling Rules

ASHRAE 116 - Methods of Test SEER/HSPF

ASHRAE 37 - Testing Methods

AHRI 210/240 - Certifications Testing

Thank You !

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7. Establishment of the CNS Standards and Development of SEER Measuring Method for Air Conditioners in Chinese Taipei

Workshop on Reducing Barriers to Trade through Development of a Common Protocol for Measuring the Seasonal Energy Efficiency (SEER) of Air Conditioners

Establishment of the CNS Standards and Development of SEER Measuring Method for Air Conditioners in Chinese Taipei

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October 5~6 , 2009,Taipei,Chinese Taipei

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Contents

(Some information of this presentation is supplied by BSMI and ITRI)

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1.Background

- Bureau of Standards, Metrology and Inspection (BSMI), MOEA is the government agency authorized to establish the CNS standards in Chinese Taipei.
- Over 98%of energy is imported from oversea in Chinese Taipei and electricity is the most common energy used (about 50%).
- About 30%of electricity is consumed by air-conditioners in Chinese Taipei and which turn to be more important to raise the energy efficiency of said products.
- The penetration rate of inverter type air-conditioners is increasing in Chinese Taipei and result in much concern about SEER issue.
- The proposal of SEER measuring method of air conditioners was submitted to BSMI by ITRI for CNS standards establishment.

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2. Standardization system in Chinese Taipei (1/2)

- The BSMI establish the CNS Standards Review Council and CNS Standards Technical Committees based on different categories of specialties. They will be responsible for reviewing and making suggestions on matters relevant to CNS standards.
- In order to conform to the WTO/TBT agreement various levels standard organization to be suitable the principle, and promotes the standard development, Chinese Taipei standardization system to divide into 3 levels: CNS Standard, Group Standard and Company Standard.

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2. Standardization system in Chinese Taipei (2/2)

- CNS standards usually are implemented on a voluntary basis. Where all or part of a CNS standard has been referenced in regulations by the competent authorities of jurisdiction over specific business, such CNS standards turn to be mandatory.
- According to WTO/TBT that handles positively to aligning international standard. By the end of April 2009
  - Total CNS： 14329
  - Existence of international standards：3499
  - Completed alignment：2595
  - Rate of alignment：74.16%

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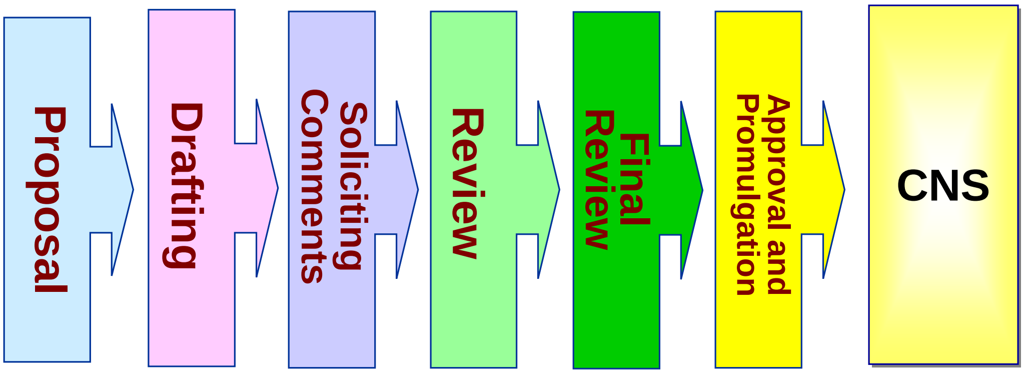
3.The procedure of establishing CNS standards(1/12)

「The Standards Act」 Article 7



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3.The procedure of establishing CNS standards(2/12)

(1).proposal

- Person, legal entity, government agency or organization may submit a proposal to the government agency in charge of standards for the establishment, amendment, or rescission of CNS standards.
- Any proposals for CNS standards shall be reviewed by the CNS Standards Review Council, and the party who submitted the proposal shall be notified of the results of the review.

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3.The procedure of establishing CNS standards(3/12)

(2).Drafting (1/3)

- The proposal draft for the establishment or amendment of CNS standards shall be prepared by the standards authority.
- The draft preparation of CNS standards shall be referred to the following items in addition to the proposal for CNS standards:
  - **Technical specifications or standards applied domestically or in foreign countries.**
  - **Comments from domestic and foreign production and manufacturing, public institution, and academy.**
  - **The situation of domestic production, manufacturing and consumption.**

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3.The procedure of establishing CNS standards(4/12)

(2).Drafting(2/3)

- In the process of preparing draft of CNS standards, on-site investigation and survey or testing, if needed, may be arranged.
  - **Such on-site investigation and survey or testing may be entrusted to other governmental institutes, organizations or experts.**
- Risk assessment shall to be conducted
  - **Any involvement in legitimate objectives such as security requirements, the prevention of deceptive practices, protection of human health or safety, animal or plant life or health, or the environment.** 9

3.The procedure of establishing CNS standards(5/12)

(2).Drafting(3/3)

The following factors shall be taken into account

- **Scientific and technical information that are available;**
- **Relevant processing procedures and technology, including production processes or production, operation, inspection, sampling or testing methods;**
- **The envisioned end use of the product.**

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3.The procedure of establishing CNS standards(6/12)

(3).Soliciting comments

- The BSMI shall solicit comments from interested parties, members of the Technical Committees and Review Council, experts, industries, government bodies, institutions, and educational institutes, once the CNS standards draft has been prepared.
- In respect of the individual notice and public announcement, the commenting period shall not be less than sixty (60) days. The commenting period may be shortened in case of actual or potential emergencies volved in public safety, health or environment.

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3.The procedure of establishing CNS standards(7/12)

(4).Review (1/2)

- The CNS standards draft shall be reviewed by the relevant Technical Committee.
- The review shall be conducted by reference to the compilation of review comments and related documentation, and considered to achieve the following objectives from the aspect of technology:
  - **To reflect the domestic production capability and technological level;**
  - **To improve quality of products and enhance production efficiency;**
  - **To maintain a rational balance between production, use and consumption;**
  - **To conform to relevant international standards; and**
  - **To establish the standards based on requirements in terms of performance rather than design or descriptive characteristics.**

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3.The procedure of establishing CNS standards(8/12)

(4).Review (2/2)

- Under any of the following conditions found by the Review Council, the standards authority may terminate the establishment or amendment of CNS standards:

  1. The proposals for the establishment or amendment of CNS standards, adopted by the Review Council, are unable to be included in the draft of CNS standards.

  2. The CNS standards draft fails in the review of the Technical Committee, and cannot be revised, or be passed in the review of the Technical Committee within 2 years since the day it was sent to the Technical Committee for review.

- The proposals for establishment or amendment of CNS standards, abandoned due to the above procedure, shall be notified to the proposal holders.

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3.The procedure of establishing CNS standards(9/12)

(5).Final review

- **The CNS standards review drafts shall be finally reviewed by the Review Council with reference to the excerpt of review and relevant documentation.**
- **Committees of the Review Council may be invited to describe the reviewing items for the review stipulated in the previous paragraph. Only can editorial corrections be applied except for matters concerning technical items that are found self-contradictory in contents or conflicting with the policies, acts, or other regulations or CNS standards, which shall be sent to the Technical Committee for review.**
- **The draft of CNS standards passed in the review, shall be granted with CNS symbol and general numbers, and compiled to the final draft of CNS standards. Where the draft of CNS standards fails to pass the review, it shall be returned to the Technical Committee for review along with the conclusions from such final review.**

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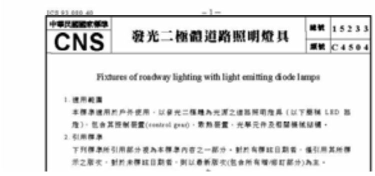
3.The procedure of establishing CNS standards(10/12)

(6). Approval and promulgation

- The standards authority shall submit the final draft of CNS standards to the Ministry of Economic Affairs (MOEA) for approval and promulgation as the CNS standards.
- The title of the promulgated standards referred in the previous paragraph shall be announced in the official Standards Gazette and notified the proposal holder.



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3.The procedure of establishing CNS standards(11/12)

(7) CNS publishment

- Information Center
  - Collection and provision of information relating to CNS standards and the standards of other nations
- In 1999, building online service system
  - Supply online search
  - Free online preview
  - Online download function and sales service

CNS online service system
http://www.cnsonline.com.tw

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3.The procedure of establishing CNS standards(12/12)

(8) CNS standards work programme

- Once every six months（ March and September ）, BSMI shall publish a work programme in the Standards Gazette, a monthly publication of the BSMI.
- Before work programme, notification the existence thereof to the ISO/IEC Information Center in Geneva.

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4. Air conditioners market in Chinese Taipei

- About one million of room A/C and 80 thousand of unitary A/C are sold annually In Chinese Taipei .
- In room A/C, the sale quantity of single package type and split type is about 40% and 60% respectively.
- Average over 50% of split type A/C using inverter-controlled technology.
- The production of inverter-type A/C is expected to grow further owing to the need of the energy savings and the raise of MEPS in Chinese Taipei .

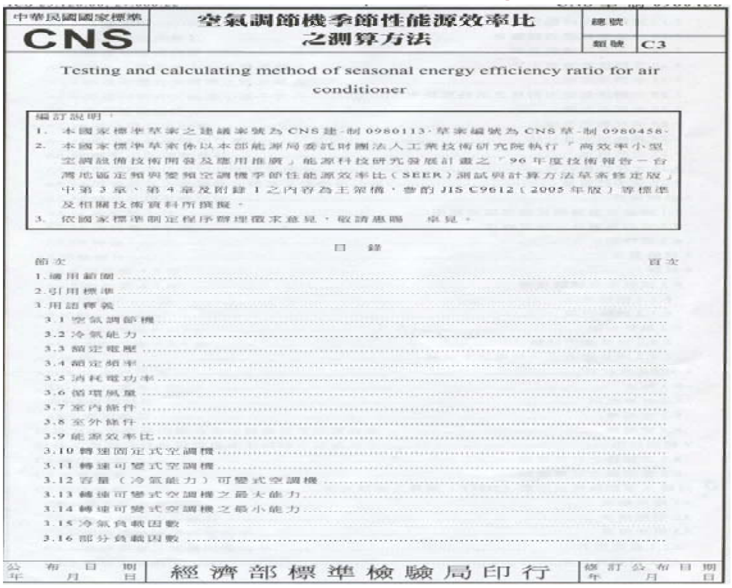
5.Development of SEER measuring method for air conditioners(1/15)

(1).Motivation for development

- The annual sale quantity of Inverter-type air conditioners in Chinese Taipei is increasing rapidly in recent years.
- It is more realistic to use SEER instead of EER to evaluate the energy performance of Inverter-type air conditioners.
- For the purpose of protecting consumers' rights and interests, It is reasonable to develop suitable testing method to evaluate the real energy performance of Inverter-type air conditioners.
- SEER measuring methods of Inverter-type air conditioners have been developed in some APEC economic members.

5.Development of SEER measuring method for air conditioners(2/15)

(2)CNS draft of SEER measuring method by BSMI



中華民國國家標準 CNS	空氣調節機季節性能源效率比之測算方法	總號	
		類號	C3

Testing and calculating method of seasonal energy efficiency ratio for air conditioner

編訂說明：
1. 本國家標準草案之建議案號為 CNS 建-制 0980113，草案編號為 CNS 草-制 0980458。
2. 本國家標準草案係以本部能源局委託財團法人工業技術研究院執行「高效率小型空調設備技術開發及應用推廣」能源科技研究發展計畫之「96 年度技術報告－台灣地區定頻與變頻空調機季節性能源效率比（SEER）測試與計算方法草案修定版」中第 3 章、第 4 章及附錄 1 之內容為主架構，參酌 JIS C9612（2005 年版）等標準及相關技術資料所撰擬。
3. 依國家標準制定程序辦理徵求意見，敬請惠賜 卓見。

目 錄

公布日期 年 月 日	經濟部標準檢驗局印行	修訂公布日期 年 月 日

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5.Development of SEER measuring method for air conditioners(3/15)

(3).Contents of the CNS draft of SEER measuring method

- Scope;
- Normative references;
- Definitions (Including EER, SEER,CFL, PLF, C_D, Rated middle cooling capacity, etc.);
- Test Conditions;
- Test Requirements;
- Testing (Including testing facility and testing method) :
- Marking;
- Calculation of SEER;
- Example of SEER Calculation.

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5.Development of SEER measuring method for air conditioners(4/15)

(4). Definitions of key word

- EER (Energy Efficiency Ratio) : Ratio of the cooling capacity (W) to the power input (W).
- SEER (Seasonal Energy Efficiency Ratio) : Ratio of the total heat removed (Wh) from the conditioned space during the annual cooling season to the total electrical energy input (Wh) during the same season.
- CFL (Cooling Load Factor) : Ratio of the total cooling of a complete cycle for a specified period consisting of an“ on” time and “off” time to the steady-state cooling done over the same period at constant ambient conditions.

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5.Development of SEER Measuring Method for Air Conditioners(4/15)

(4).Definitions of key word (continued)

- PLF (Part Load Factor) : Ratio of the cyclic energy efficiency ratio to the steady-state energy efficiency ratio.
- C_D (Degradation Coefficient) : Factor of efficiency loss due to the cycling of the air conditioner. $C_D = (1 - PLF)/(1 - CLF)$
- Rated middle cooling capacity : 1/2 ±10% of the rated cooling capacity.

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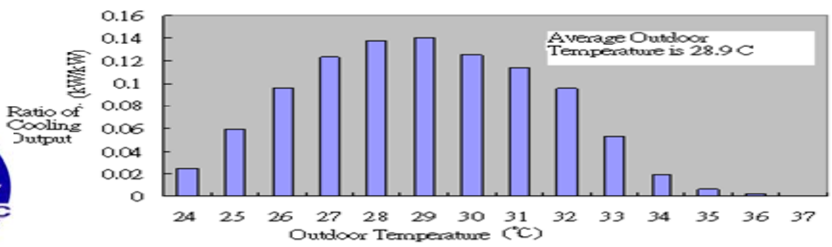
5.Development of SEER Measuring Method for Air Conditioners(5/15)

(5).Weather data analysis for cooling season in Chinese Taipei

Temp.Bin(nj)	Temp(℃)	Time(h)	Temp.Bin(nj)	Temp(℃)	Time(h)
1	24	580	9	32	248
2	25	695	10	33	124
3	26	751	11	34	41
4	27	722	12	35	13
5	28	645	13	36	4
6	29	550	14	37	1
7	30	419	15	38	0
8	31	334	Total Bin hours		5128



5.Development of SEER measuring method for air conditioners(6/15)

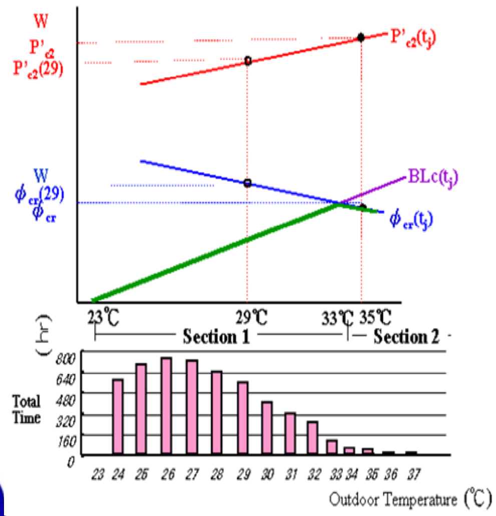
(6).Test conditions for determining the SEER

Test description	Air Entering Indoor Unit Temperature (℃)		Air Entering Outdoor Unit Temperature (℃)	
	Dry Bulb	Wet Bulb	Dry Bulb	Wet Bulb
A Test (Standard Test Condition)	27	19	35	24
B Test (Low Temp. Test Condition)	27	19	29	19
C Test (Low Humidity Test Condition)	27	< 16	29	-
D Test (Cyclic Test Condition)	27	< 16	29	-

25

5.Development of SEER measuring method for air conditioners(7/15)

(7).Calculation procedure for determining the SEER of a constant speed A/C



Curve of cooling capacity & power input

Curve of Building load (BL)

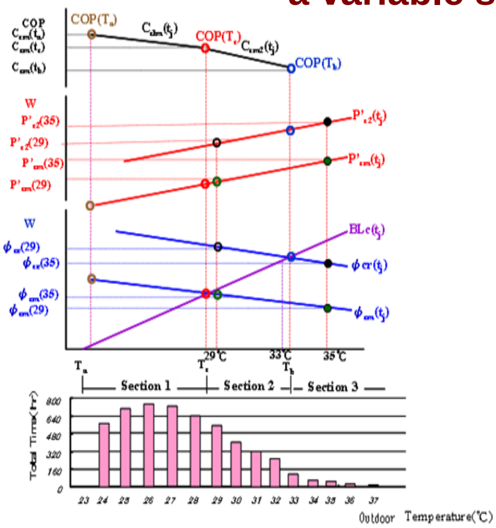
Degradation C_D (ON-off cycling)

Bin temperature (Weather data of region)

26

5.Development of SEER measuring method for air conditioners(8/15)

(8).Calculation procedure for determining the SEER of a variable speed A/C



Curve of cooling capacity & power input (Including middle capacity & power input)

Curve of building load (BL)

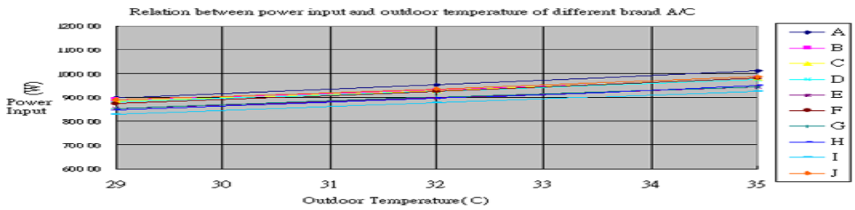
Degradation C_D (ON-off cycling)

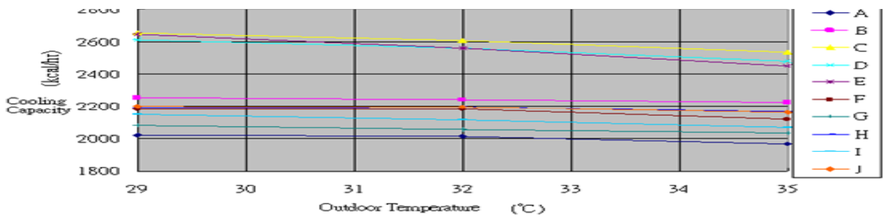
Bin temperature (Weather data of region)

27

5.Development of SEER measuring method for air conditioners(9/15)

(9).Performance comparison of domestic made A/C





5.Development of SEER measuring method for air conditioners(10/15)

(10).Performance comparison of domestic made A/C

Power Input

$$\dot{P}_c(29) = 0.901\dot{P}_c(35)$$

Constant

Rated Power Input and Cooling Capacity

Cooling Capacity

$$\phi_{cr}(29) = 1.074 \cdot \phi_{cr}(35)$$

For harmonization with Japan and China,we use 0.914 instead of 0.901;use 1.077 instead of 1.074.

Comparison of power input

	Dry Bulb	29.0℃	35.0℃	Ratio (29/35)
Japan：0.914	A	969.34	1072.53	0.904
	B	935.60	1038.81	0.901
	C	920.33	1018.24	0.904
	D	907.53	989.99	0.917
	E	853.17	944.59	0.903
	F	952.10	1058.73	0.899
	G	944.10	1033.09	0.914
	H	899.43	1008.20	0.892
	I	856.20	971.97	0.881
	J	928.17	1032.40	0.899
	Average			0.901

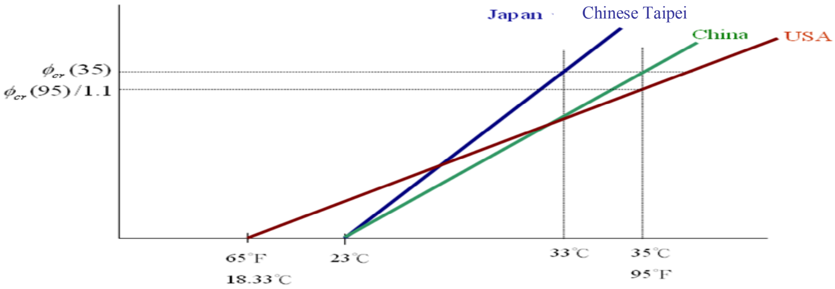
Comparison of cooling capacity

	Dry Bulb	29.0℃	35.0℃	Ratio (29/35)
Japan：1.077	A	2452.653	2226.09	1.102
	B	2535.83	2310.11	1.098
	C	2720.39	2507.99	1.085
	D	2584.33	2344.11	1.102
	E	2587.79	2331.16	1.110
	F	2403.36	2216.58	1.084
	G	2368.15	2160.86	1.096
	H	2540.42	2503.44	1.015
	I	2453.25	2412.10	1.017
	J	2388.34	2325.28	1.027
	Average			1.074

5.Development of SEER measuring method for air conditioners(11/15)

(11).Definition of building cooling load curve ,BL

- BL usually is a straight line, and the outdoor temperature is as the horizontal axis. The intersection between air conditioner cooling capacity and building load curve can be used to decide the operation mode of the air conditioner, i.e. on-off cycle state, continuous operation mode or variable speed operation mode.



Where ϕ_{cr} is the cooling capacity of the air conditioner.

5.Development of SEER measuring method for air conditioners(11/15)

(11).Definition of building cooling load curve ,BL (continued)

1.(1)Building load (BL)= 0 as outdoor temperature =23℃ ，(for Japan、 China and Chinese Taipei)

(2)Building load (BL)= 0 as outdoor temperature =65°F(18.3 ℃) ，(for USA)

2.(1)Building load (BL)= rated capacity as outdoor temperature =33℃ ，(for Japan and Chinese Taipei)

(2)Building load (BL)= rated capacity as outdoor temperature =35℃ ，(for China)

(3)Building load (BL)= rated capacity /1.1 as outdoor temperature =95°F(35 ℃)，(for USA)

	USA	Japan	China	Chinese Taipei
Standard	ASHARE 116-1995 AHRI 210-240 2008	JRA 4046：2004 JIS C 9612：2005	GB/T 7725-2004	CNS draft-2009
Definition	BL(65°F)=0 BL(95°F)=Cooling capacity／1.1	BL(23℃)=0 BL(33℃)=Cooling Capacity	BL(23℃)=0 BL(35℃)=Cooling capacity	BL(23℃)=0 BL(33℃)=Cooling capacity
Degradation C_D	**0.25**	**0.25**	**0.25**	**0.25**

5.Development of SEER measuring method for air conditioners(12/15)

(12).Test points for SEER measurement

Constant Speed A/C

Test Conditions	Rated Cooling Capacity	Rated Power Input
A Test（Indoor 27/19、Outdoor 35/24）	●	●
B Test（Indoor27/19、Outdoor29/19）	○	○

※C_D=0.25
※● Test value ○ Calculated value

Variable speed A/C

Test Conditions	Rated Cooling Capacity	Rated Power Input
A Test（Indoor 27/19、Outdoor 35/24）	●	●
B Test（Indoor 27/19、Outdoor 29/19）	○	○
	Rated Middle Cooling Capacity	Rated Middle Power Input
A Test（Indoor 27/19、Outdoor 35/24）	●	●
B Test（Indoor 27/19、Outdoor 29/19）	○	○

※C_D=0.25
※● Test value ○ Calculated value

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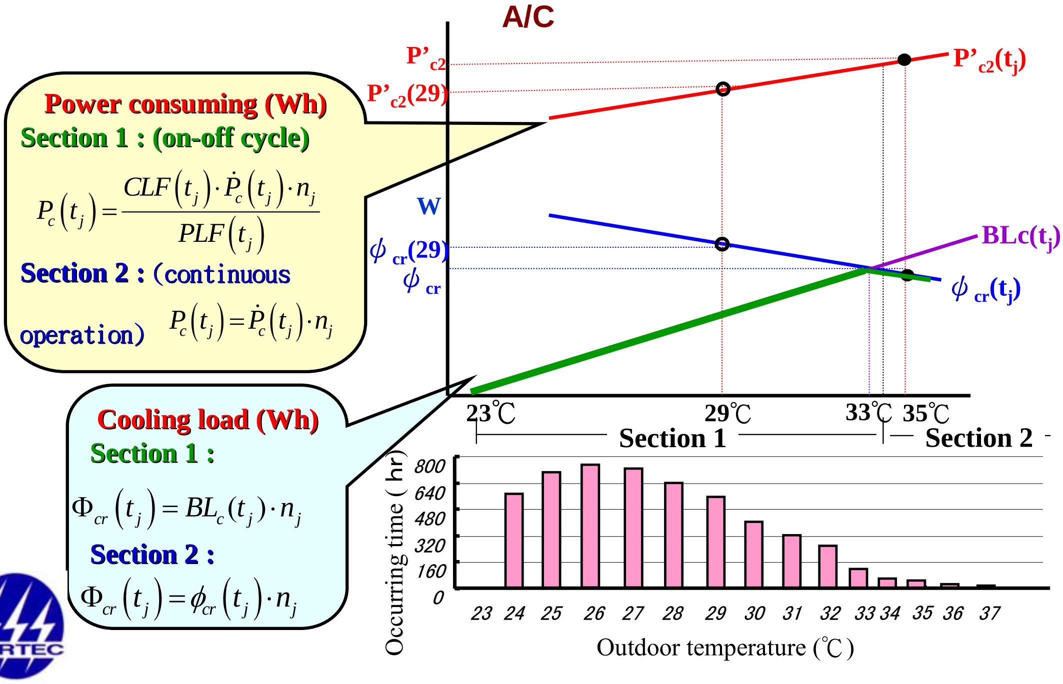
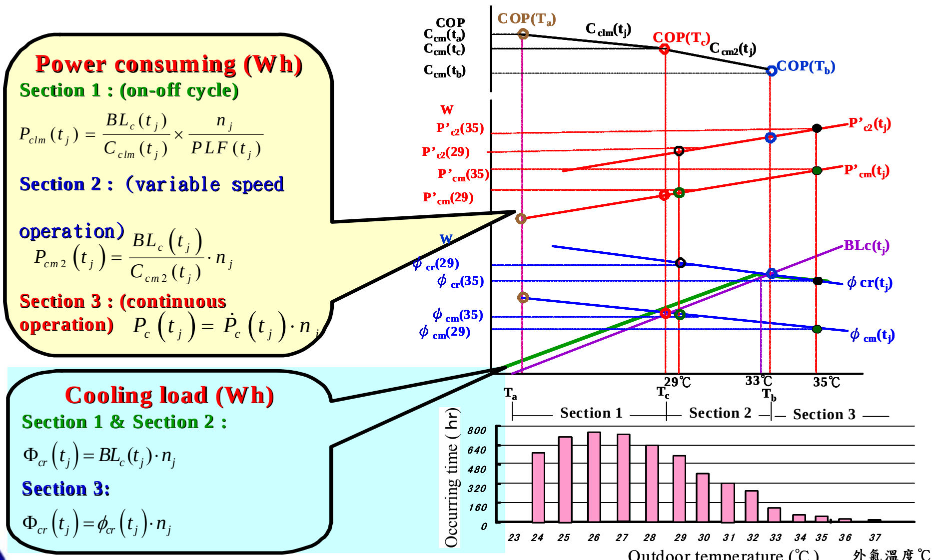
5.Development of SEER measuring method for air conditioners(13/15)

(13).Calculation equation for determining SEER of constant speed A/C



5.Development of SEER measuring method for air conditioners(14/15)

(14).Calculation equation for determining SEER of variable speed A/C



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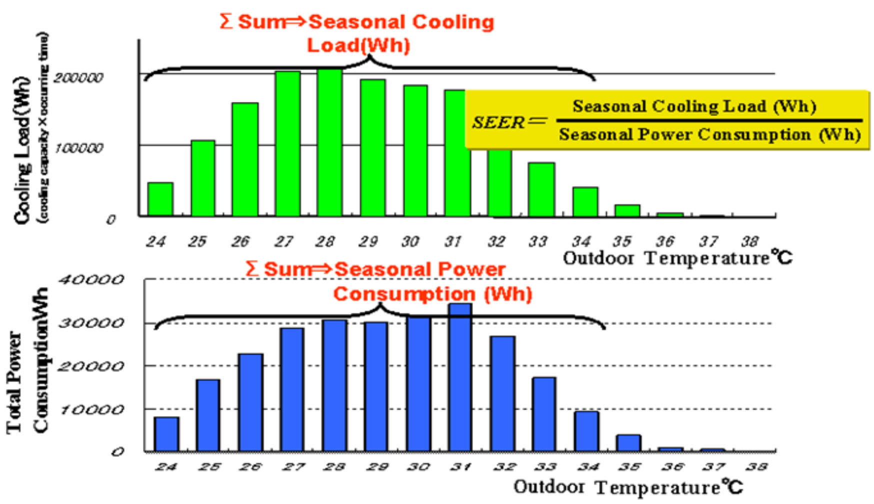
5.Development of SEER measuring method for air conditioners(15/15)

(15).Calculation equation for determining SEER of A/C



35

6.Conclusions

- Inverter-type (variable speed) A/C is becoming more popular in APEC economies market .
- Harmonization to common test procedure of SEER for inverter-type A/C will have benefit to reduce barriers to trade.
- MEPS (EER) for A/C have been implemented over 25 years in Chinese Taipei and result in significant energy savings.
- Study of using SEER to evaluate the energy performance of inverter-type A/C will be the next topic in Chinese Taipei.

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Appendix：Energy performance testing facilities for air-conditioners in TERTEC




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8. The measures of promoting SEER for air conditioners from manufacturer's point of view

1.

The measures of promoting SEER for air conditioners from manufacturer's point of view

Speaker: Rung Chuan Chang
Institute: Taiwan Refrigeration & Air-Conditioning Engineering Association of Chinese Taipei

2.

Outline

1. Introduction
2. Background
3. SEER Technology Promotion
4. Conclusions

Introduction

Outline

1. Introduction
2. Background
3. SEER Technology Promotion
4. Conclusions

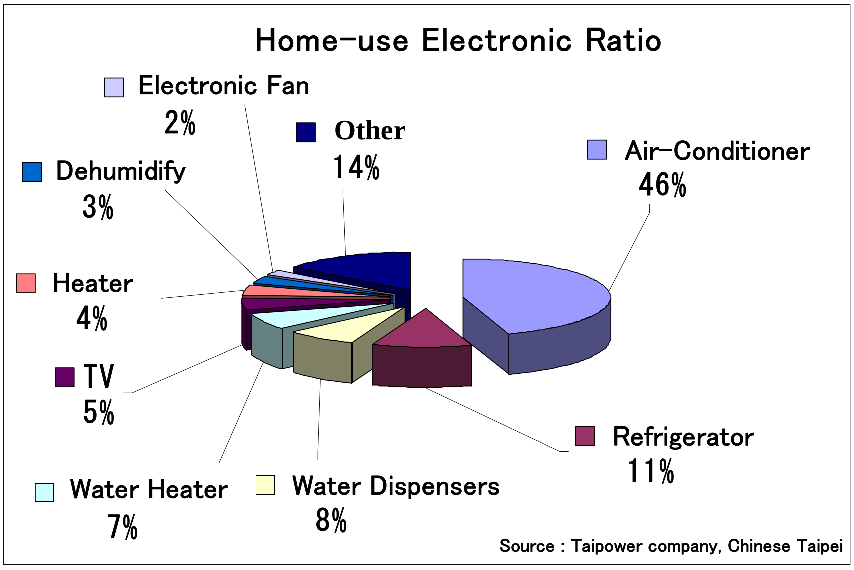
Background

Industry Issue

Stop Global Warming

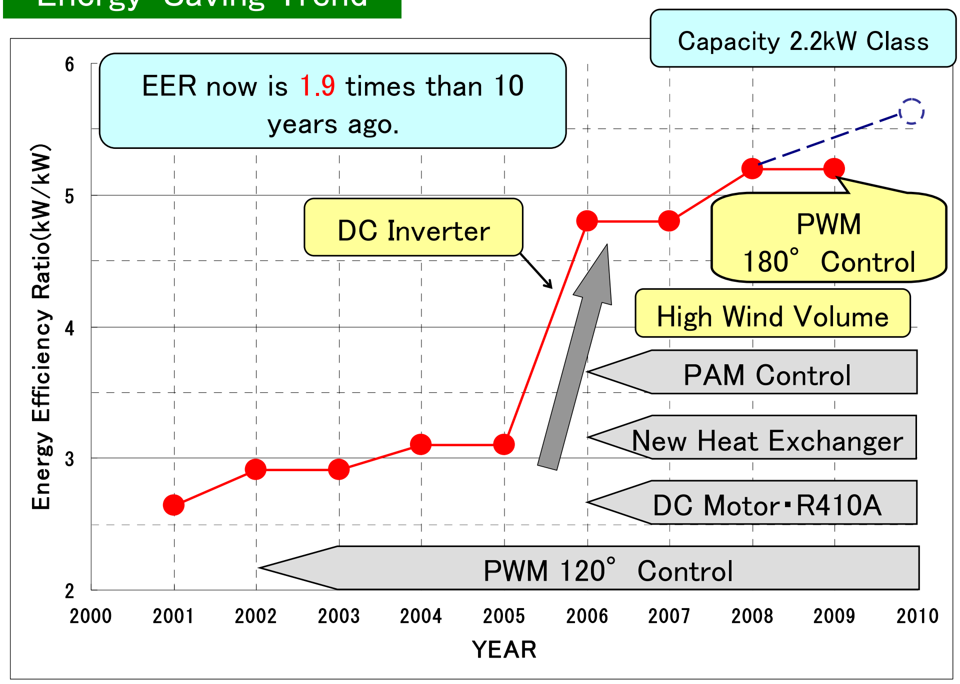
Air Conditioning Issue

Energy Saving



Background

Energy-Saving Trend



7.

Background

SEER Standards for APEC Economies

Chinese Taipei
…EER · SEER(On Working)

Korea
… EER

China
… EER · SEER(Shanghai)

The United States
… EER · SEER

Thailand
… EER

Japan
… EER · APF

Australia/New Zealand
… EER

8.

Background

EER VS SEER

- EER

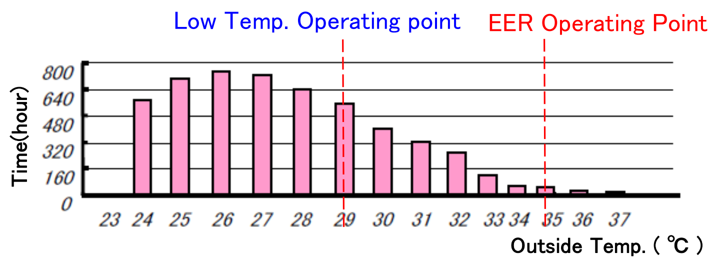
$$EER = \frac{\text{Cooling Capacity}}{\text{Power Consumption}}$$

	Indoor Temperature DB/WB	Outdoor Temperature DB/WB
Cooling	27℃(19℃)	35℃(24℃)

Background

EER VS SEER

SEER



	EER	SEER
Operating Point	Single-point	Mutli-point
Separate Temp. Zone	None	Consider
On/Off	None	Concider
Characteristic	Static	Dynamics
Calculation	Easy	Complicated
Actual Efficiency	Underestimate	Match

Source : Industrial Technology Research Institute

Outline

1. Introduction
2. Background
3. SEER Technology Promotion
4. Conclusions

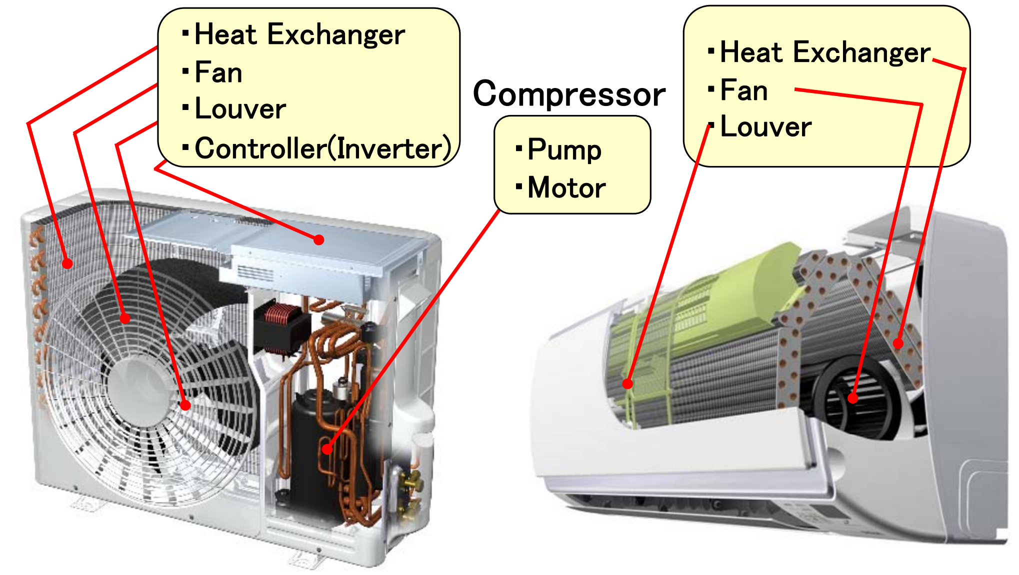
11.

SEER Technology Promotion

Air conditioner Structure

Condenser Unit (Outside Unit)

Air Handler (Inside Unit)



12.

SEER Technology Promotion

Energy Saving Technology

Component

Compressor … Compressor Structure
Reduce Energy Loss
Motor Optimization
Inverter Optimization

Heat Exchanger … High Efficiency Tube
High Efficiency Fin
Heat Exchanger Shape

Fan … High Efficiency・Low Noise

Controller … Energy-Saving
New Vector Control

Integration

Refrigerant Loop … Refrigerant Loop Optimization

Air Distribution System
Heat Exchanger … Optimization
Air Distribution Integration

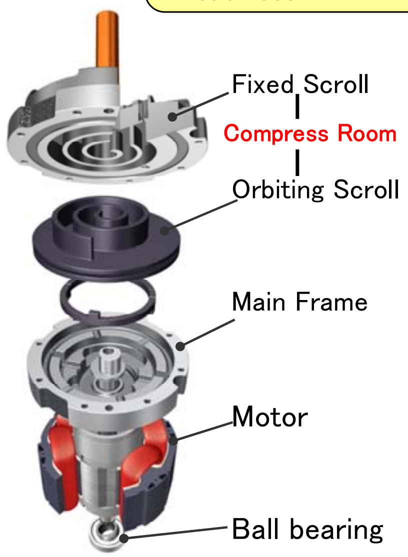
Compressor

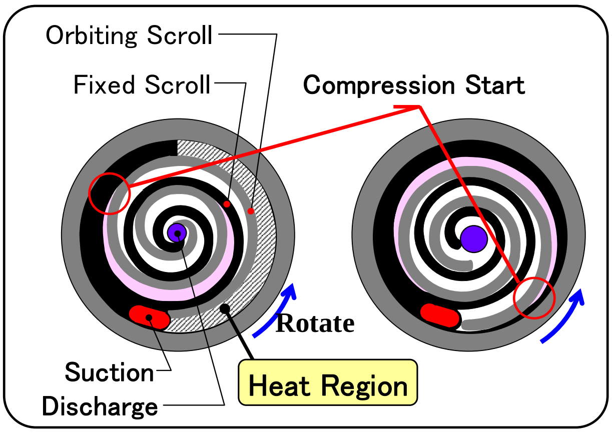
Compressor(scroll) Optimization

Challenge

- ・Ineffective compression
- ・Mechanical Loss
- ・Heat Loss

} Efficiency Up ⇨ **Compressor Structure Bearing Optimization**

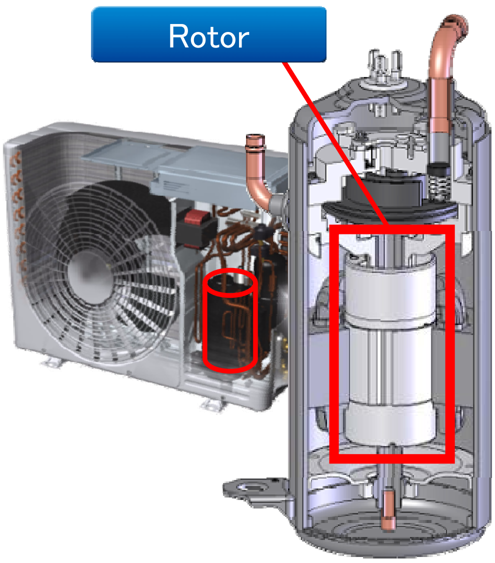


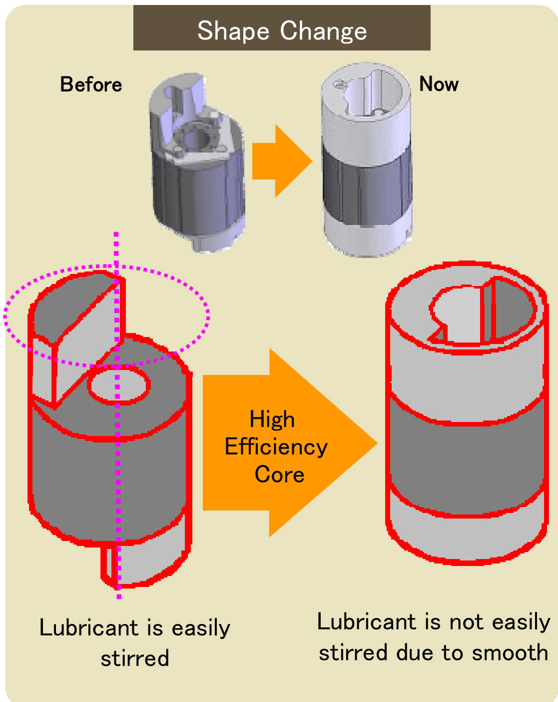


Symmetric scroll ⇨ Non-symmetric scroll

Compressor

Reduce Energy Loss



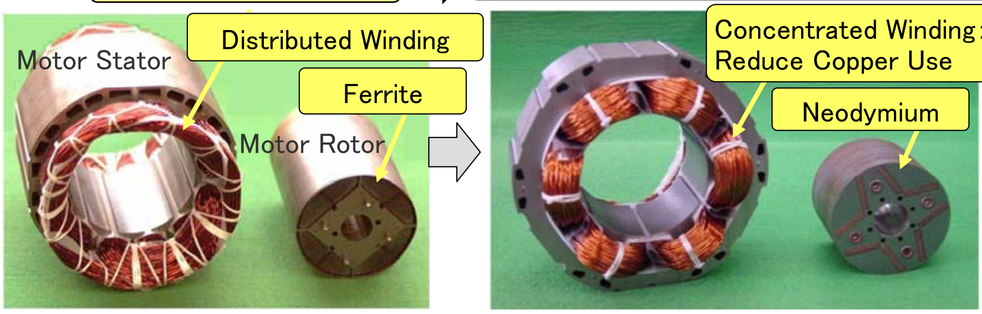


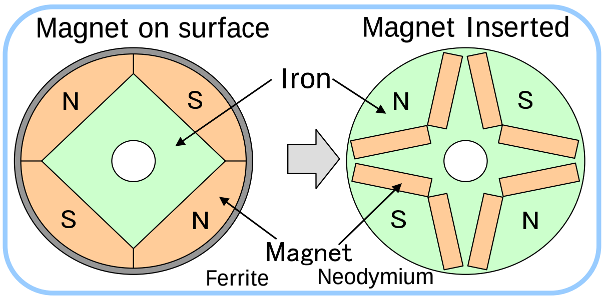
Compressor

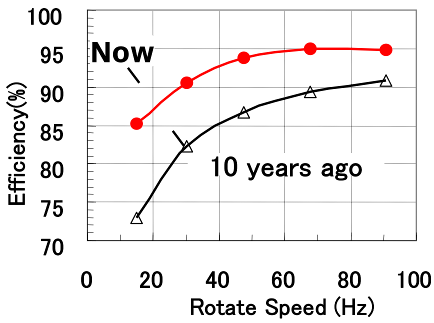
15.

Motor Optimization

Challenge: Reduce Material Loss → Winding Type, Magnet Material, Rotor type





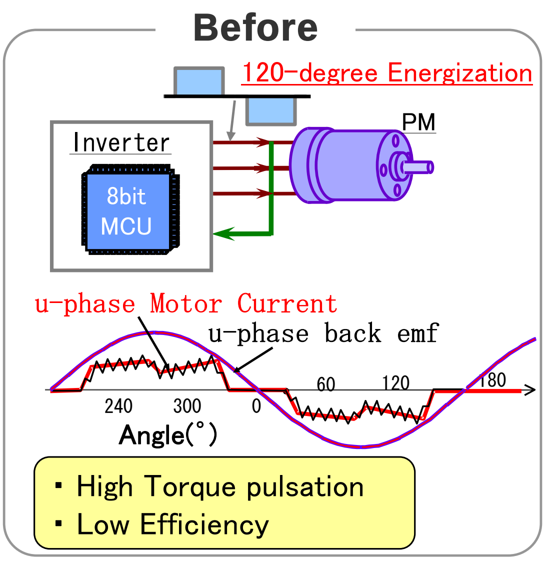


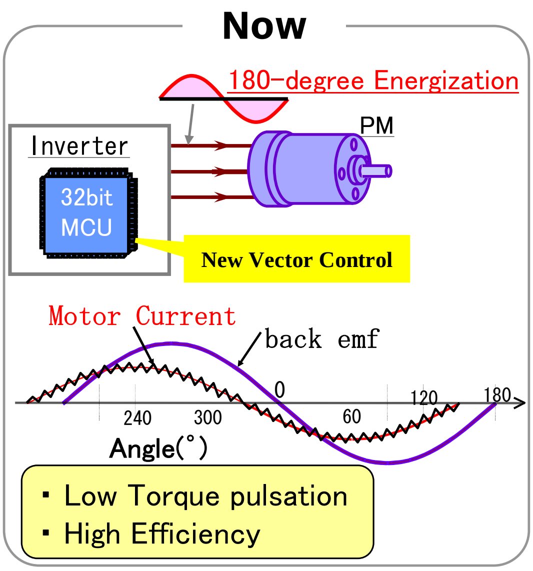
Compressor

16.

Inverter Optimization

Challenge: Reduce Torque pulsation and Motor Loss → 180-degree Energization





17.

SEER Technology Promotion

Energy Saving Technology

Element

Compressor … Compressor Structure
Reduce Energy Loss
Motor Optimization
Inverter Optimization

Heat Exchanger … High Efficiency Tube
High Efficiency Fin
Heat Exchanger Shape

Fan … High Efficiency・Low Noise

Controller … Energy-Saving
New Vector Control

Integration

Refrigerant Loop … Refrigerant Loop Optimization

Air Distribution System
Heat Exchanger … Optimization
Air Distribution Integration

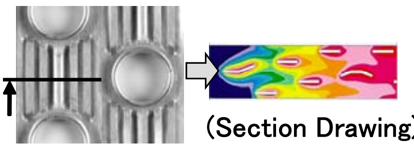
18.

Heat Exchanger

High Efficiency Fin

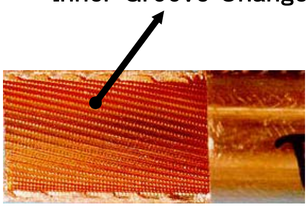
High Efficiency Tube

Split Fin

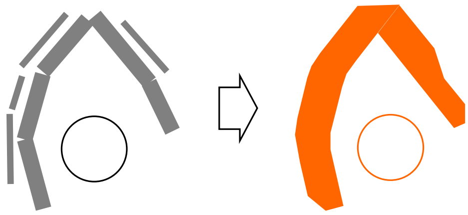


(Section Drawing)

Inner Groove Change



Heat Exchanger Shape



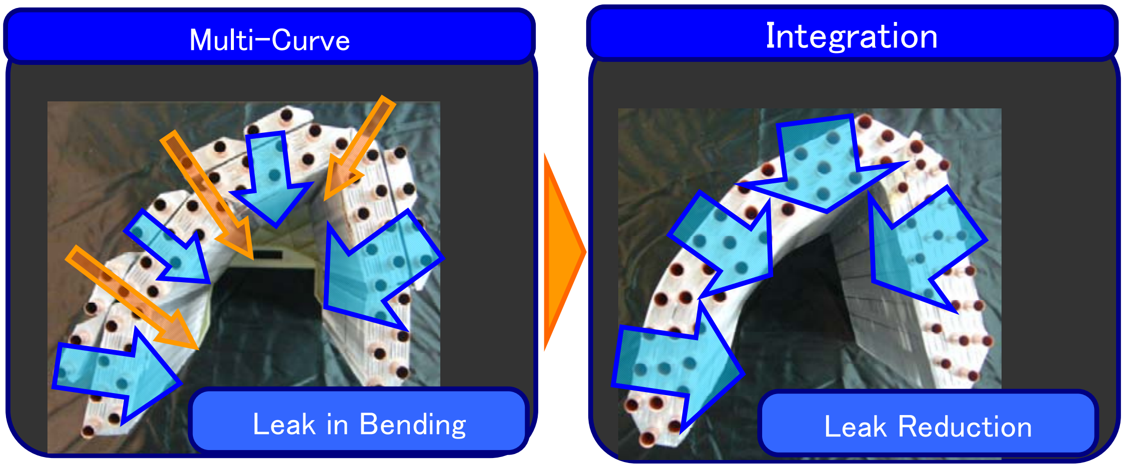
① Advantages
・Identical Wind Speed
・Reduce Leak
} Efficiency Up

② The Other Application Skills
・Reduce The Gap between Tubes
・Diameter Reduction

19.

Heat Exchanger

Heat Exchanger Shape



20.

SEER Technology Promotion

Energy Saving Technology

Component

Compressor … Compressor Structure
Reduce Energy Loss
Motor Optimization
Inverter Optimization

Heat Exchanger … High Efficiency Tube
High Efficiency Fin
Heat Exchanger Shape

Fan … High Efficiency・Low Noise

Controller … Energy-Saving
New Vector Control

Integration

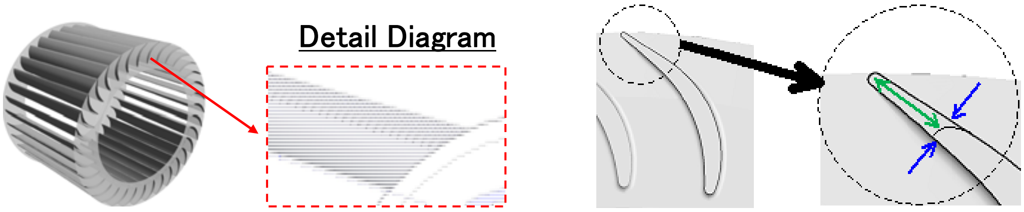
Refrigerant Loop … Refrigerant Loop Optimization

Air Distribution System Heat Exchanger … Optimization
Air Distribution Integration

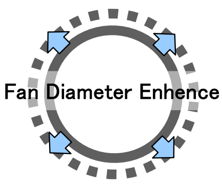
Fan

High Efficiency ・ Low Noise

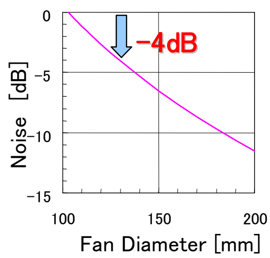
Surface Roughness



Fan Diameter



Ex, ϕ103 → ϕ130 － 4dB



SEER Technology Promotion

Energy Saving Technology

Component

Compressor … Compressor Structure
Reduce Energy Loss
Motor Optimization
Inverter Optimization

Heat Exchanger … High Efficiency Tube
High Efficiency Fin
Heat Exchanger Shape

Fan … High Efficiency･Low Noise

Controller … Energy-Saving
New Vector Control

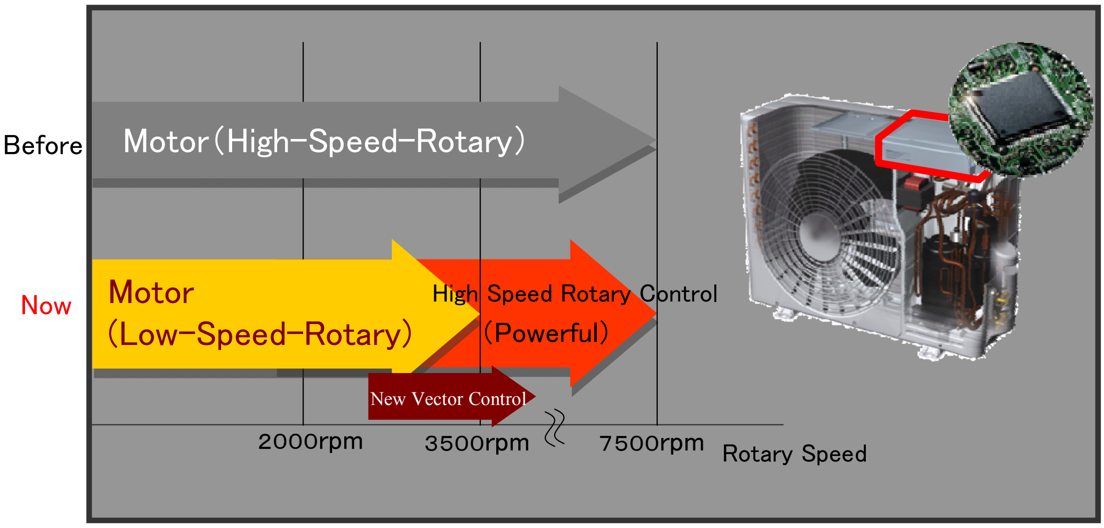
Integration

Refrigerant Loop … Refrigerant Loop Optimization

Air Distribution System
Heat Exchanger … Optimization
Air Distribution Integration

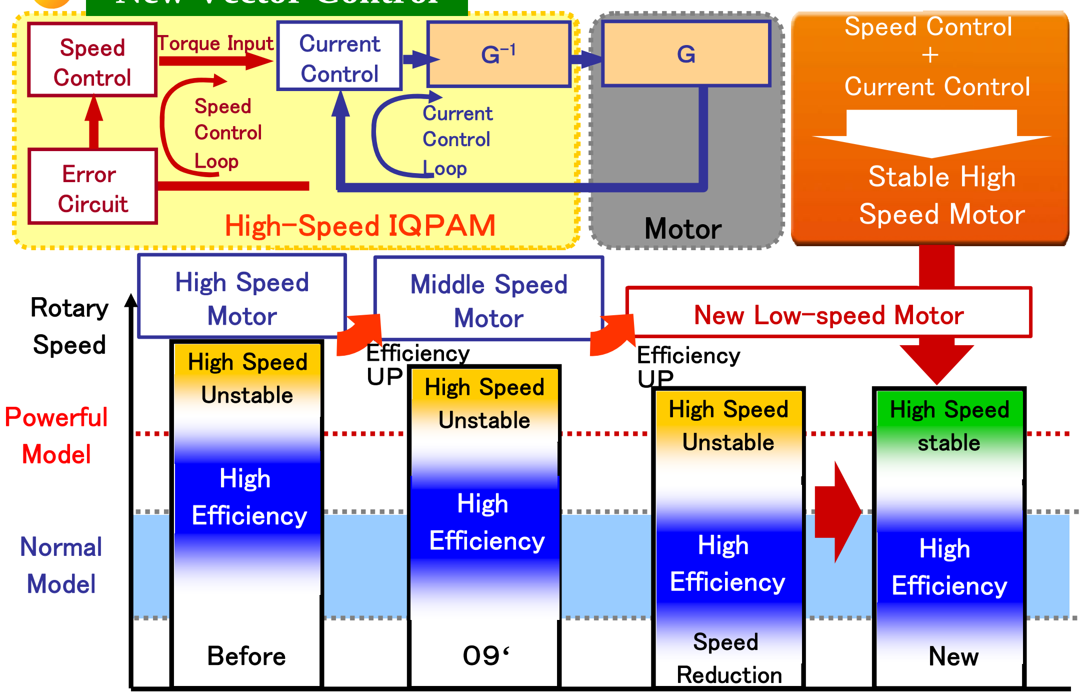
Controller

Energy-Saving Technology



Controller

New Vector Control



SEER Technology Promotion

Energy Saving Technology

Component

Compressor
… Compressor Structure
Decrease Energy Loss
Motor Optimization
Inverter Optimization

Heat Exchanger
… High Efficiency Tube
High Efficiency Fin
Heat Exchanger Shape

Fan … High Efficiency･Low Noise

Controller … Energy-Saving
New Vector Control

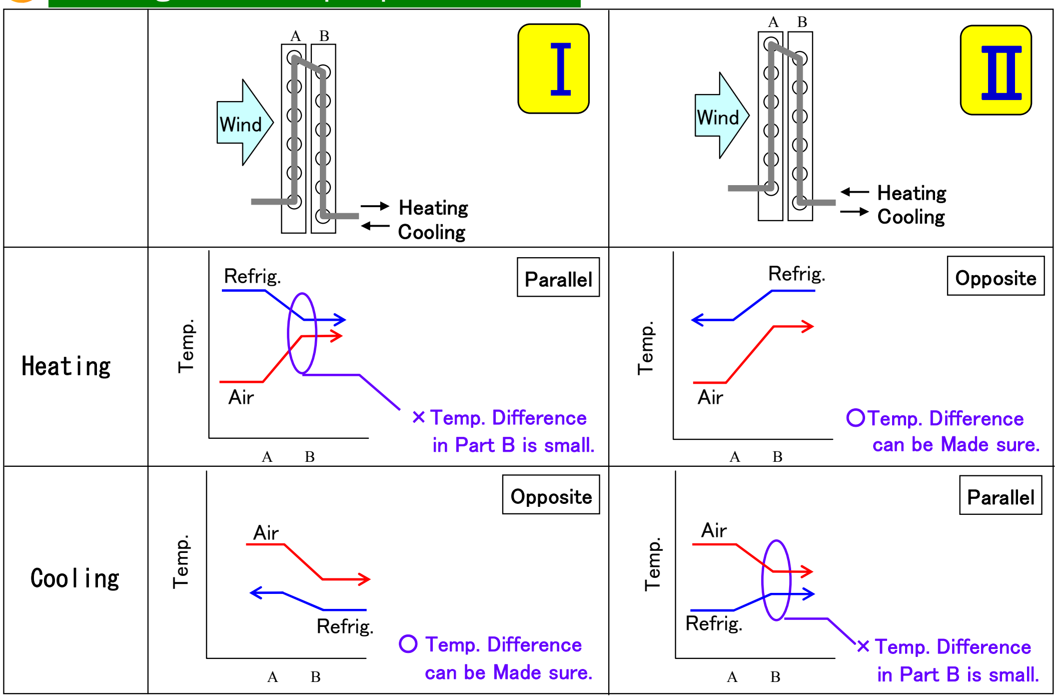
Integration

Refrigerant Loop
… Refrigerant Loop Optimization

Air Distribution System
Heat Exchanger
… Optimization
Air Distribution Integration

Refrigerant Loop

Refrigerant Loop Optimization



Promote SEER Technology
27.

Energy Saving Technology

Component

Compressor
… Compressor Structure
Reduce Energy Loss
Motor Optimization
Inverter Optimization

Heat Exchanger
… High Efficiency Tube
High Efficiency Fin
Heat Exchanger Shape

Fan … High Efficiency・Low Noise

Controller … Energy-Saving
New Vector Control

Integration

Refrigerant Loop
… Refrigerant Loop Optimization

Air Distribution System
Heat Exchanger
… Optimization
Air Distribution Integration

Air Distribution System ・ Heat Exchanger
28.

Optimization

Challenge

Analysis for
Air Distribution System

⇩

・Simplify the Shape
・Reduce Mesh Number

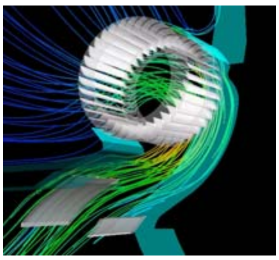
⇩

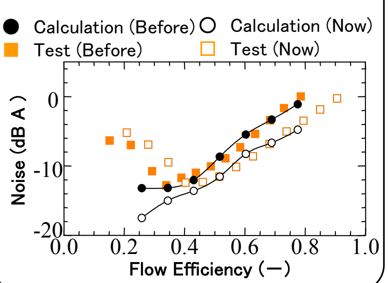
Input Relative Data in CFD

⇩

Analysis for the Result

Fan CFD

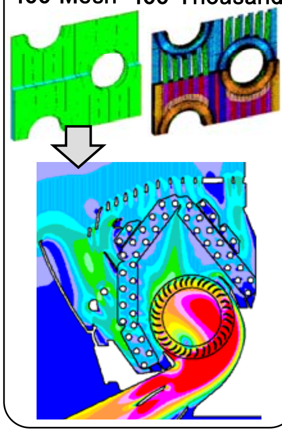




Integration CFD
・**Simple**
・**Reduction**

Simple
400 Mesh

Complicated
400 Thousands



29.

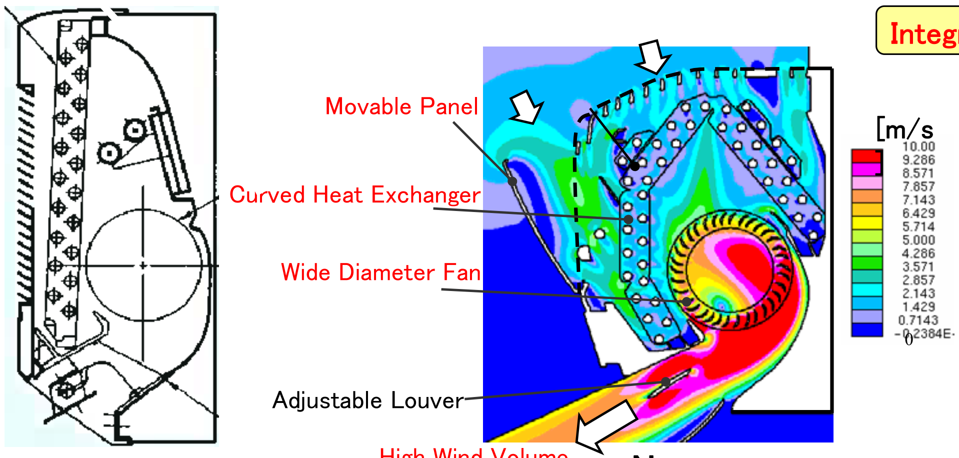
Air Distribution System · Heat Exchanger

Air Distribution Integration

Challenge

- Compressor Input ↓
  - Heat Conduction Efficiency → Heat Exchanger Shape
  - Heat Conduction Surface → Curved Heat Exchanger
  - High Wind Volume → Air Distribution System

Curved Heat Exchanger + Air Distribution System → Integration



90' s Air conditioner   Now

30.

Conclusions

- Energy-Saving is the most important issue for the world.
- SEER can really reflect the energy efficiency.
- Greener energy.

9. Introduction of the development of an analytical platform for measuring the SEER of air conditioners in APEC member economies

Asia-Pacific Economic Cooperation

ITRI Industrial Technology Research Institute

Introduction of the development of an analytical platform for measuring the SEER of air conditioners in APEC member economies

Hsiao-Chi Hsu

E-Mail：HsiaoChiHsu@itri.org.tw

Energy & Environmental Research Lab.,
Industrial Technology Research Institute, Chinese Taipei

APEC-SEER Workshop, October 5th-6th 2009

 1

Asia-Pacific Economic Cooperation

ITRI Industrial Technology Research Institute

Contents

1. Objectives
2. Testing and performance standards for air conditioners in APEC member economies
3. Procedures of SEER calculation
4. Key parameters of SEER
5. Introduction of SEER calculation program
6. Examples of using SEER calculation program
7. Conclusions

 2

1. Objectives of the project

The objectives of this project aim to develop an analytical platform to evaluate the SEER values of air conditioners according to the proposed test standards of APEC member economies.

This platform is an analytical program adopted the data of climate and building load characteristic collected from APEC economies.

With the application of this program, it will help to reduce unnecessary duplicate test and administration processes. Meanwhile, it also helps to reduce the cost and time of testing, and further affects the efficiency of trading among APEC economies.

2. Testing and performance standards for air conditioners in APEC member economies

Testing / Performance Standards of AC in APEC Economies

Economy	Energy Standard
Australia	AS/NZS 3823.1.1-1998 Performance of household electrical appliances - Room air conditioners - Non-ducted air conditioners and heat pumps - Testing and rating for performance
Brunei Darussalam	—
Canada	CAN/CSA-C 273.3-M 91 Performance standard for split-system central air conditioners and heat pumps CAN/CSA C 656-M 92 Performance Standard for Single-package central air conditioners and heat pumps (Test Standard: ARI 210/240-94 ASHRAE 37-1988)
Chile	—
Chinese Taipei	CNS 3615-2009 Room Air Conditioners
Hong Kong, China	ISO 5151 Non-ducted air conditioners and heat pumps - Testing and rating for performance - RACs Split -HK
Indonesia	ISO 5151 Non-ducted air conditioners and heat pumps - Testing and rating for performance
Japan	JIS C 9612 Room Air Conditioners RACs Split
Malaysia	—
Mexico	NOM-021-ENER/SCFI-2008 Energy Efficiency of and User Safety Requirements for Room Air-conditioners, Limits, Test Methods and Labeling

Note：Several standards may be used in one particular economy, and only one or two of them are listed above.

Economy	Standard
New Zealand	AS/NZS 3823.1.1-1998 Performance of household electrical appliances - Room air conditioners - Non-ducted air conditioners and heat pumps - Testing and rating for performance
Papua New Guinea	—
People's Republic of China	GB/T 7725-1996 Room air conditioners
Peru	—
Philippines	PNS 240:1998 Non-ducted air conditioners and heat pumps - Testing and rating for performance - RACs Window -Philippines
Republic of Korea	KS C 9306-2007 Room air conditioners
Russia	GOST 26963-86 Self-contained room air-conditioners. General specifications
Singapore	ISO 5151 Non-ducted air conditioners and heat pumps - Testing and rating for performance
Thailand	TIS 385-2524 Room air conditioners - RACs Window
USA	ANSI/ASHRAE 116-1995 Methods of Testing for Rating Seasonal Efficiency of Unitary Air Conditioners and Heat Pumps (ANSI approved) - Central AC Split type ARI 210/240-94, ANSI/ASHRAE 16 …
Viet Nam	TCVN 6576:1999 Non-ducted air conditioners and heat pumps. Testing and rating for performance - Viet Nam

Reference : APEC ESIS, http://www.apec-esis.org/index.php

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Standard Test Condition of Air Conditioners

- COP (Coefficient of Performance) or EER (Energy Efficiency Ratio) expresses only the performance of the system in a particular environmental condition.

$$COP = \frac{\text{Cooling Capacity (w)}}{\text{Power Consumption (w)}}$$

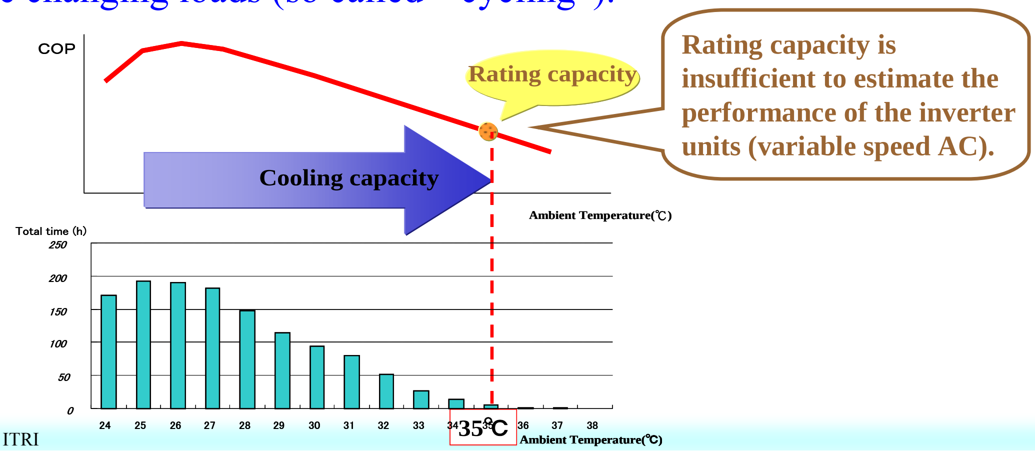
	Indoor Temperature DB/WB	Outdoor Temperature DB/WB
Cooling	27℃(19℃)	35℃(24℃)

CNS 3615, JIS C 9612, GB 7725, ISO 5151, KS C 9306, ARI 210/240, AS/NZS 3823.1.1 …

 8

Performance Characteristic of Inverter Air Conditioners

- The air conditioner normally operates in a dynamic state and its performance changes with outdoor temperature and indoor thermal loads.
- Additionally, the ON-OFF cycling of the compressor is subject to the changing loads (so called " cycling").



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SEER Standards in APEC Economies

Economies	USA	Canada	Japan	China	Korea	Australia & New Zealand	Chinese Taipie
Standard	ASHARE 116-1995	CAN/CSA C656-M92	(1)JRA 4046：2004 (2)JIS C 9612：2005 Appendix 3	GB/T 7725-2004 Appendix E	KS C 9306-2007	AS/NZS 3823-2001	CNS 14464 & CNS 3615
Reference	ANSI/ASHRAE 116, Methods of testing for seasonal efficiency of unitary air-conditioners and heat pumps	(1) All types of central air conditioners are rated using SEER (2) test procedure for central air conditioners：ARI 210/240-89 & ASHRAE 37	(1) JRA 4046, Room air conditioners, 2004 (2) JIS C 9612, Room air conditioners, 2005	GB/T 7725-2004, Room Air Conditioners	KS C 9306-2007, Room air conditioners	Working on it	Draft

3. Procedures of SEER calculation

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Measurement Points of Air Conditioners for SEER

Constant speed AC

Cooling	Cooling Capacity	Power Consumption
Capacity Measurement (Indoor 27/19℃ ， Outdoor 35/24℃)	●	●

※Cd：0.25

※●Measurement

Variable speed AC (inverter type)

Cooling	Cooling Capacity	Power Consumption
Capacity Measurement (Indoor 27/19℃ ， Outdoor 35/24℃)	●	●
	Intermediate Capacity	Power Consumption
Capacity Measurement (Indoor 27/19℃ ，Outdoor 35/24℃)	●	●

※Cd：0.25

※●Measurement。●Measurement 。

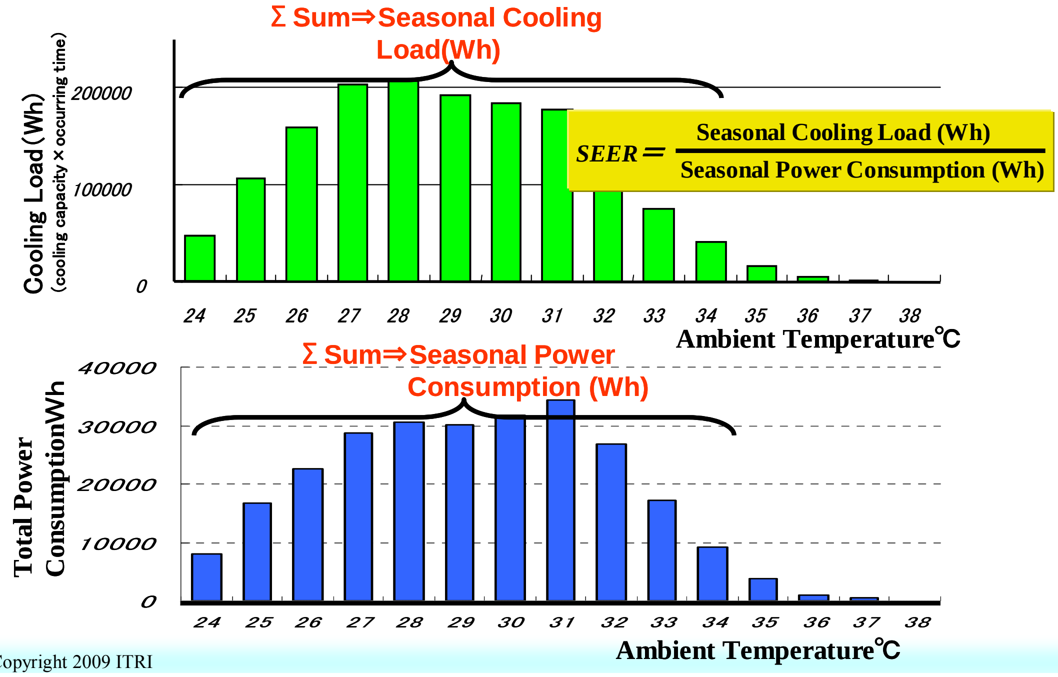
Approach to the Calculation Procedure of the SEER

1. Establish the calculation method for constant-speed AC units and variable –speed (Inverter type) AC units.
2. Obtain the cooling capacity and power consumption of the system from the standard test condition. For inverter AC unit, the additional test of intermediate cooling capacity and power consumption are necessary.
3. Establish the average bin temperatures for the climatic region concerned.
4. Estimate the cooling (or heating) capacity and power consumption of the system in each bin temperature.
5. Make a summation to generate Cooling Seasonal Total Load (CSTL) and Cooling Seasonal Energy Consumption (CSEC), respectively.
   Then, divide CSTL by CSEC to obtain SEER, as expressed by

$$SEER = \frac{\sum_{j=1}^{n} \phi(t_j) \cdot n_j}{\sum_{j=1}^{n} \dot{P}(t_j) \cdot n_j}$$

6. Construct the interface of the SEER evaluation program.

SEER for Air Conditioner



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4. Key parameters of SEER

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1. Information needed：

- The **weather data** of the regions concerned.
- The **cooling capacity** and **power consumption** of the system obtained from standard tests.
- the curves of cooling capacity and power consumption under different ambient temperature.
- The curve of building load.

2. Degradation Coefficient (C_D)：

- When the air conditioner operates in on-off cycle state, the degradation coefficient is needed to be included to modify the real power consumption.
- The United States and Canada proposed to use $C_D = 0.2$； Japan, China, Korea and Chinese Taipei used $C_D = 0.25$.

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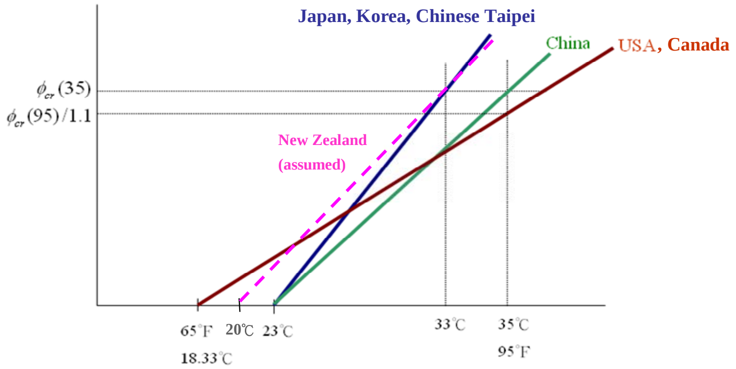
3. Building load curve (BL)：

- Usually is a straight line, and the outdoor temperature is used as the horizontal axis. The intersection between cooling capacity and building load curve can be used to decide the operation mode of the air conditioner, i.e. on-off cycle state, continuous operation mode or variable speed operation mode.



Where ϕ_{cr} is the cooling capacity of the air conditioner.

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Comparison with Building Load (BL) & Degradation C_D

1.(1)Building load (BL)= 0 as outdoor temperature =23℃, (for Japan, China, Korea and Chinese Taipei)
(2)Building load (BL)= 0 as outdoor temperature =65˚F, (for USA, Canada)
(3)Building load (BL)= 0 as outdoor temperature =20℃, (for New Zealand, assume that when T_{out}＞20℃ is cooling mode)

2.(1)Building load (BL)= rated capacity as outdoor temperature =33℃, (for Japan, Korea, New Zealand and Chinese Taipei)
(2)Building load (BL)= rated capacity as outdoor temperature =35℃, (for China)
(3)Building load (BL)= rated capacity /1.1 as outdoor temperature =95˚F, (for USA, Canada)

Economy	USA, Canada	Japan	Korea	Chinese Taipei	China	New Zealand
	ASHARE 116-1995 ARI 210/240	JRA 4046：2004 JIS C 9612：2005	KS C 9306-2007	Draft-2008	GB/T 7725-2004	Working on it (assumed)
BL	BL(65˚F)=0 BL(95˚F)=Cooling capacity／1.1	BL(23℃)=0 BL(33℃)=Cooling Capacity			BL(23℃)=0 BL(35℃)=Cooling capacity	BL(20℃)=0 BL(33℃)=Cooling capacity
C_D	0.2	0.25				

Climate Conditions

1. Average yearly outdoor temperature in Chinese Taipei from 1999 ~ 2006

Outdoor Temperature (℃)	Time (hour)	Outdoor Temperature (℃)	Time (hour)
21	0	31	326
22	0	32	233
23	0	33	112
24	587	34	37
25	700	35	12
26	760	36	4
27	723	37	1
28	650	38	0
29	548	39	0
30	414	40	0

Total cooling period is 5,105 hours (58.28% of a whole year)

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2. Average yearly outdoor temperature in China

Outdoor Temperature (℃)	Time (hour)	Outdoor Temperature (℃)	Time (hour)
21	0	31	177
22	0	32	122
23	0	33	59
24	267	34	37
25	295	35	16
26	362	36	2
27	331	37	3
28	288	38	0
29	246	39	0
30	194	40	0

Total cooling period is 2,399 hours (27.39% of a whole year)

3. Average yearly outdoor temperature in Korea (provided by Dr. Jun-Young Choi, Korea Testing Laboratory, Energy Technology Center)

Outdoor Temperature (℃)	Time (hour)	Outdoor Temperature (℃)	Time (hour)
21	0	31	50
22	0	32	35
23	0	33	24
24	85	34	14
25	94	35	9
26	105	36	4
27	101	37	3
28	82	38	2
29	65	39	0
30	59	40	0

Total cooling period is 732 hours (8.36% of a whole year)

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4. Average yearly outdoor temperature in Japan

Outdoor Temperature (℃)	Time (hour)	Outdoor Temperature (℃)	Time (hour)
21	0	31	92
22	0	32	35
23	0	33	11
24	196	34	6
25	225	35	4
26	225	36	0
27	240	37	0
28	181	38	0
29	122	39	0
30	93	40	0

Total cooling period is 1,430 hours (16.32% of a whole year)

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5. Average yearly outdoor temperature in New Zealand (cooling season in Christchurch, provide by Mr. Ed. Winter, EECA)

Outdoor Temperature (℃)	Time (hour)	Outdoor Temperature (℃)	Time (hour)
20	246	30	7
21	177	31	3
22	126	32	5
23	100	33	3
24	68	34	7
25	62	35	0
26	51	36	0
27	22	37	0
28	16	38	0
29	9	39	0

Total cooling period is 656 hours (7.49% of a whole year)

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Comparison with Bin Temperature for SEER Standards

	USA	Japan	China	Korea	Chinese Taipei	New Zealand
Standard	ASHARE 116-1995	JRA 4046：2004 JIS C 9612：2005 Appendix 3	GB/T 7725-2004	KS C 9306-2007	Draft-2008	Working on it (assumed)
Temp. range	64°F～102°F	24℃～38℃	24℃～38℃	24℃～38℃	24℃～37℃	21℃～34℃
Bin temp.	8 bins (5°F/bin)	15 bins (1℃/bin)	15 bins (1℃/bin)	15 bins (1℃/bin)	14 bins (1℃/bin)	14 bins (1℃/bin)
Reference	Weather data in America	1. JRA 4046:2004－weather data in Tokyo 2. JIS C 9612:2005－weather data in Japan	Weather data in China	Weather data in Korea	Weather data in Chinese Taipei (1999~2006)	Weather data in Christchurch
Period	Based on ASHRAE Handbook	Cooling period：3.6 months (Jane 2 to September 21) Heating period：5.5 months (October 28 to April 14)	－	－	Cooling period：T_{out}＞24 ℃	Cooling period：T_{out}＞20 ℃
Time		Operating time：18 hours(6:00 to 24:00)			Operation time：24 hours	

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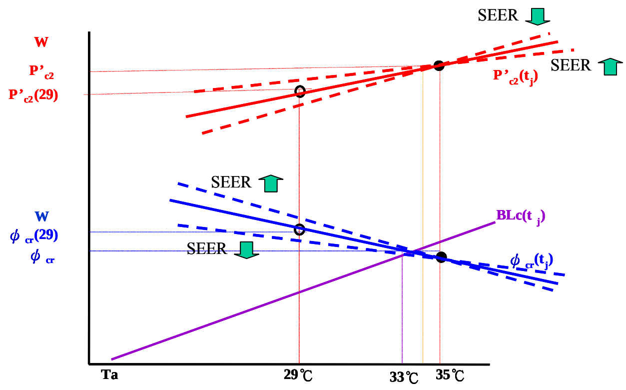
Influence of Key Parameters on SEER Evaluation

Item	C_D	Slope of cooling capacity curve	Slope of power consumption curve	SEER (Wh/Wh)	comment
1	*0.25	*1.074	*0.901	4.573	base
2	0.25	1.3	0.901	5.491	SEER increases as slope of cooling capacity increases
3	0.25	1.0	0.901	4.265	SEER decreases as slope of cooling capacity decrease
4	0.25	1.074	1.0	4.105	SEER decreases as slope of power consumption increases
5	0.25	1.074	0.84	4.929	SEER increases as slope of power consumption decreases
6	0.3	1.074	0.901	4.534	SEER decreases as Cd increases
7	0.2	1.074	0.901	4.610	SEER increases as Cd decreases



* : the slopes of cooling capacity and power consumption cures are used by Japan, China, Korea, and Chinese Taipei. It's assumed that the values are the same for the SEER standards of USA, Canada and New Zealand to simplify the procedures of SEER calculation.

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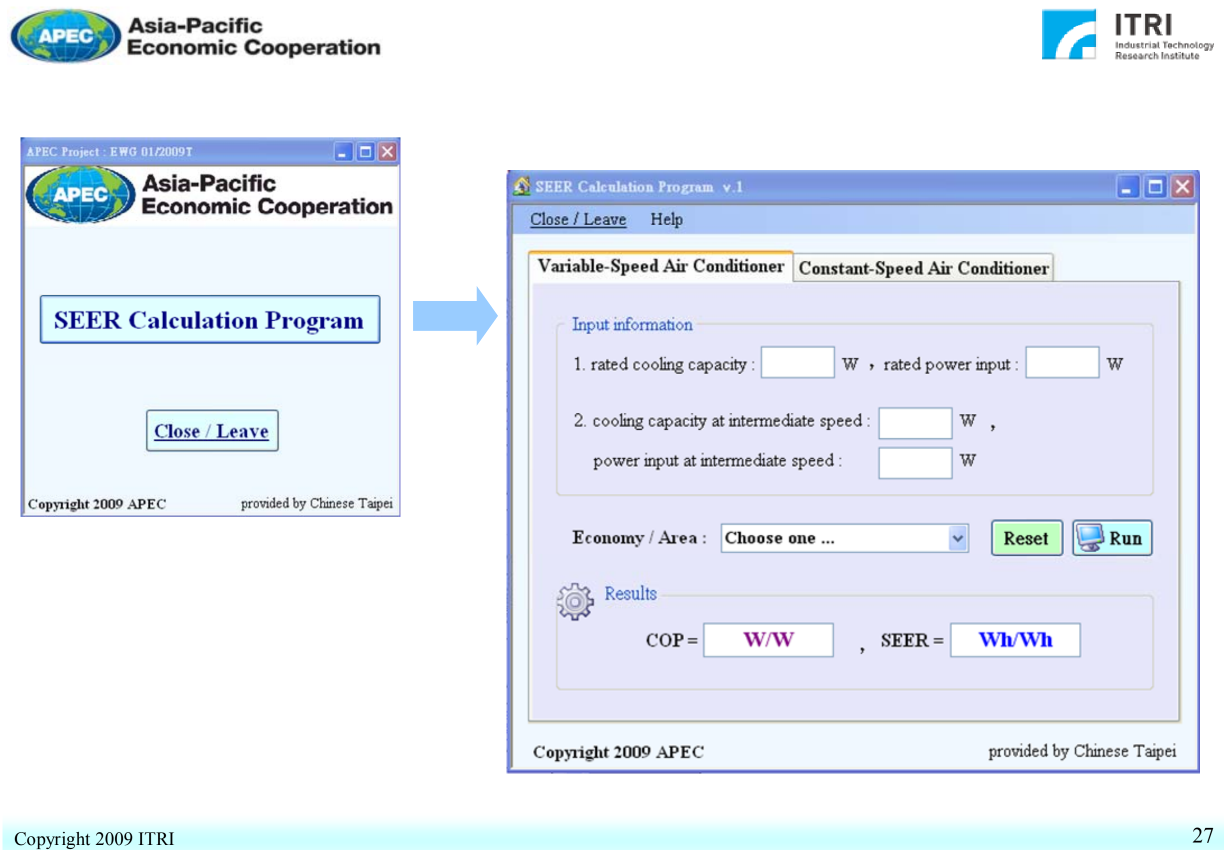
5. Introduction of SEER Program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APEC Project : EWG 01/2009T
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SEER Calculation Program
Close / Leave
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SEER Calculation Program v.1
Close / Leave
Help
Variable-Speed Air Conditioner
Constant-Speed Air Conditioner
Input information
1. rated cooling capacity : W , rated power input : W
2. cooling capacity at intermediate speed : W ,
power input at intermediate speed : W
Economy / Area : Choose one ...
Reset
Run
Results
COP = W/W , SEER = Wh/Wh
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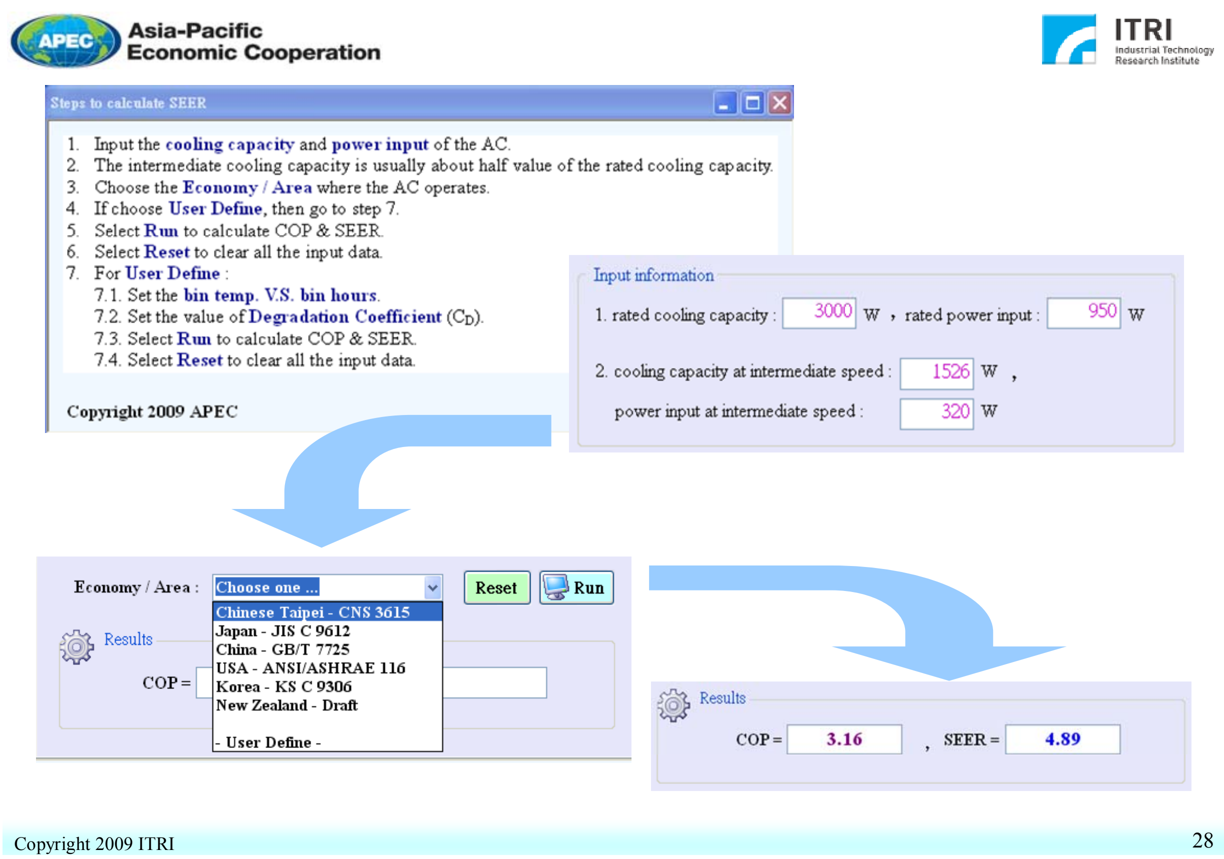
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Steps to calculate SEER
1. Input the cooling capacity and power input of the AC.
2. The intermediate cooling capacity is usually about half value of the rated cooling capacity.
3. Choose the Economy / Area where the AC operates.
4. If choose User Define, then go to step 7.
5. Select Run to calculate COP & SEER.
6. Select Reset to clear all the input data.
7. For User Define :
7.1. Set the bin temp. V.S. bin hours.
7.2. Set the value of Degradation Coefficient (C_D).
7.3. Select Run to calculate COP & SEER.
7.4. Select Reset to clear all the input data.
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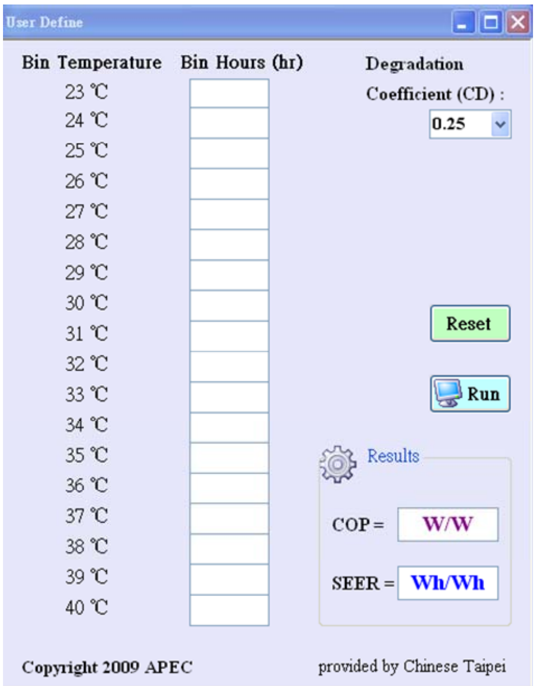
Input information
1. rated cooling capacity : 3000 W , rated power input : 950 W
2. cooling capacity at intermediate speed : 1526 W ,
power input at intermediate speed : 320 W
Economy / Area : Choose one ...
Reset
Run
Chinese Taipei - CNS 3615
Japan - JIS C 9612
China - GB/T 7725
USA - ANSI/ASHRAE 116
Korea - KS C 9306
New Zealand - Draft
- User Define -
Results
COP =
Results
COP = 3.16 , SEER = 4.89
Copyright 2009 ITRI
28



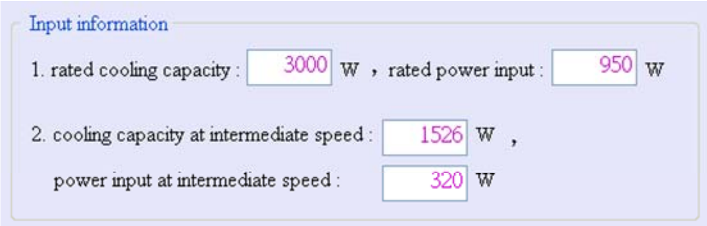
This program so far includes 6 economies' standards (or drafts) about SEER.

The 「User Define」 function is currently under construction.

User can try different bin temp. V.S. bin hours to simulate the SEER value in different area.

An electronic copy of the above publications and the outcome of the development of SEER program will be provided to the APEC Secretariat for dissemination via the APEC Website.

6. Examples of Using SEER program



Economy / Area	COP	SEER
Chinese Taipei	3.16	4.89
China		4.97
Korea		4.63
Japan		5.05
USA / Canada		5.15
New Zealand		5.40

Basically for the same AC, if the economy locates in the hotter climate zone, the calculating SEER value is lower.

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7. Conclusions

❑ Advantages of SEER calculation platform：

1. With SEER platform, as the worldwide users enter the parameters required, the SEER can be simply calculated based upon weather data and the test results of the air conditioners.
2. SEER platform program helps promote the concept of part-load efficiencies of air-conditioners and finally contributes to energy saving.
3. With the application of this program, it will help to reduce unnecessary duplicate test and administration processes. Meanwhile, it also helps to reduce the cost and time of testing, and further affects the efficiency of trading among APEC economies.

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Thanks for Your Attention!

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