Asia-Pacific Economic Cooperation

APEC-ASEAN Harmonization of Energy Efficiency Standards for Air Conditioners: Phase 1

Final Report

APEC Energy Working Group

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Introduction

Room air-conditioners (RACs) consume a significant share of the electricity in the residential and commercial sectors. In the study conducted by International Copper Association (ICA) [1], approximately 50% or more of the total household electricity consumption in several ASEAN members, i.e. Brunei, Philippines and Thailand, is due to air-conditioning equipment. In Thailand, this represents approximately 5% of the economy's total electricity. It is obvious that improvement in energy efficiency of room air-conditioners in these South-east Asia economies can lead to great energy savings. In the same study [1], it has been estimated that 5,374 GWh of electricity energy savings can be realized by implementing a Minimum Energy Performance Standard (MEPS) cut-off of 3.2 W/W for these RACs.

By extension, a similar scenario would be expected for APEC economies. However, the diffusion of energy efficient air-conditioners is highly dependent on the existence of national energy efficiency standards and labeling (EES&L) programs. In the economies where such programs exist, the market share of higher efficient RACs increases regularly, Thailand being a very successful example. In another study conducted by SPIRE [2], the impact on the ASEAN regional growth of air-conditioner market is estimated at 4.55% if regional MEPS of 3.2 W/W were to be implemented, while the growth in Indonesia and Viet Nam is at 8.5% and 9.2% respectively. This proves that there is indeed a real potential to increase the energy efficiency of RACs, and that there is a need for experience sharing across economies.

It is in recognition of this potential that the "**APEC-ASEAN Harmonization of Energy Efficiency Standards for Air Conditioners: Part 1**" project is initiated with the funding from APEC. This project aims to develop the basis for harmonizing the testing method for room air-conditioners, starting from ASEAN members, which is then followed by the development of a roadmap for harmonizing the testing method for room air conditioners in APEC. With the coordination by METI, Japan and ICA, it forms the first of a projected three possible phases of a long-term step-by-step approach to achieve energy efficiency improvement in ASEAN for the purpose of energy security enhancement, job creation, and sustainable development. Part 2 of this work deals with the development of a roadmap for harmonized EE standards while Part 3 looks into capacity building of testing laboratories and consumer awareness. The report presented in this document deals with the work done in Part 1.

Objectives

The overall long-term goal of this project is to pave the way for a market transformation in favour of higher efficiency air conditioners and to remove non-tariff barriers to trade through the harmonization of EE standards for air conditioners. The specific objective of this project is to harmonize standards for testing methods for air conditioners among ASEAN members, as the necessary preliminary step towards achieving the long-term objectives.

Through the adoption of the "Strategic Framework for the Harmonization of EE Standards for Air-conditioners in ASEAN", which has been approved by the ASEAN EE&C SSN Steering Committee, two working groups have been established, i.e. Policy Working Group (**PWG**) and Technical Working Group (**TWG**), to work on delivering the specific objective. The PWG has the responsibility to work at policy level for the development of roadmaps for MEPS and HEPS in ASEAN, while the TWG has a specific objective to make recommendations to the Policy Working Group (PWG) regarding a harmonized standard of testing methods for air-conditioners. In terms of deliverables, the TWG is tasked to:

1. Agree on a common definition of room air-conditioners
2. Develop a harmonized standard of testing methods based on the existing sets of standards at ASEAN level.

These recommendations are made in conjunction with extensive stakeholders' consultation, e.g. air-conditioner equipment manufacturers and industry associations, which are then submitted to the EE&C SSN for approval.

This document serves to report to APEC the findings and recommendations for the harmonized testing method standard in ASEAN, which are given in **Part A**. **Part B** of this report gives recommendations on the way forward for a similar APEC-wide harmonization of testing standards.

Project timeline

This project was initiated by ICA and METI with the commission of a Market Study on the impact of harmonization of Energy Efficiency (EE) standards in South-East Asia (SEA). The report of this study was published on 15th November 2010. Subsequent to that, the Strategic Roadmap for regional harmonization was proposed and approved by the EE&C SSN Steering Committee on 27th May 2011 in Singapore. After a series of kick-off and round-table meetings with stakeholders, the Policy and Technical Working Groups were formed on early of 2013. The first kick-off meetings of the PWG and TWG were held in Bangkok on the 19th and 20th February 2013. This was then followed by the 2nd Combined PWG/TWG meeting in Jakarta on 2nd July 2013. The final recommendation of the TWG was then submitted to PWG, and subsequently to EE&C SSN, on 14th November 2013.

As can be seen from the timeline shown in Fig. 1, it took approximately 3 years for the first phase of this project to be completed.

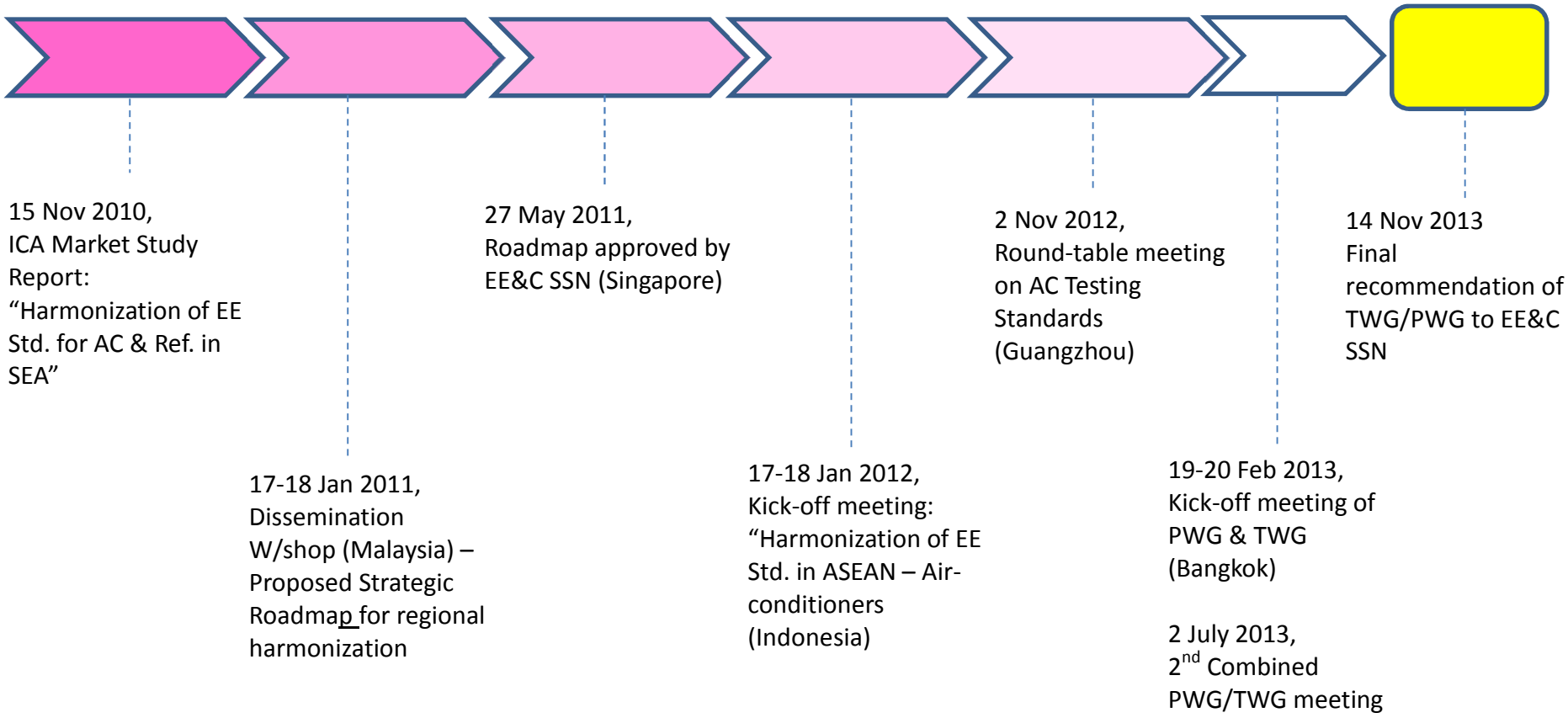


Fig. 1: Project timeline

PART A: RECOMMENDATIONS OF TWG

The Technical Working Group (TWG) is comprised of representatives from ASEAN members who are key technical experts involved in conducting performance rating tests on air-conditioners. Starting from the kick-off meeting in Bangkok on 20th February 2013, and through subsequent TWG meeting in Jakarta on 2nd July 2013, discussions were held among the representatives from Malaysia, Singapore, Thailand, Philippines, Indonesia, Viet Nam, Cambodia and Brunei, together with respective industry stakeholders. Unfortunately, there were no representation from Myanmar and Laos. The discussions and deliberations have been led by the Technical Consultant.

Methodology

Different work approaches have been used for each of the two deliverables required of the TWG. For the former, each representative and stakeholder was consulted on the scope of air-conditioners which should be included in the definition. All the responses were collated and the majority among the common consensuses were taken to develop the definition.

To work out the latter, the representatives were requested to make comparisons between their respective national testing standard with a reference benchmark standard. The TWG has agreed to benchmark the international ISO 5151:2010 "**Non-ducted air conditioners and heat pumps – Testing and rating for performance**" standard for this exercise. With the majority of the air-conditioner market share in ASEAN taken up by cooling- only equipment, the comparison study gives focus on the test method to determine the cooling capacity performance. Subsequently, each relevant clause in the benchmark standard was checked for compliance with the national testing standard. The clauses relating to heating capacity performance are not considered. The purpose of doing this comparative analysis is to examine the differences among these sets of national standards across ASEAN, and identify commonalities, which would then become the basis for the harmonized standard.

1. Common definition of room air-conditioners

The definition of room air-conditioners to be adopted in ASEAN was developed by benchmarking the definition established within the ISO 5151:2010 standard (Clause 3.1). By incorporating the common types of room air-conditioners found in the region, the recommended definition for RACs in ASEAN is given as follows:

A room air-conditioner is defined as an encased assembly or assemblies, designed primarily to provide non-ducted free delivery of conditioned air to an enclosed space, room or zone.

It can be either single-package (window or casement type) or single split-system and comprises a primary source of refrigeration for cooling and dehumidification that is delivered with mechanical compression, driven by single-phase electric power supply.

Such equipment can be provided in more than one assembly where the separated assemblies are intended to be used together.

2. Harmonized standard of testing methods

In June 2013, a comparative analysis was done with the following existing national test standards used in the ASEAN region:

a) Malaysia — MS ISO 2010:2004
b) Singapore — ISO 5151:1994
c) Thailand — TIS 1155-2536, TIS 385-2524
d) Indonesia — SNI 19-6713
e) Viet Nam — TCVN 6576:1999
f) Philippines — PNS 240:1998

Interestingly, all of these standards make reference to the older version ISO 5151:1994 standard. It is noted that Brunei, Myanmar, Laos and Cambodia do not have national test standards in place yet. It is also noted that Singapore has adopted the ISO 5151:2010 test standard since 1 September 2013.

The gap analysis has shown that about **80%** of the relevant clauses in the ISO 5151:2010 standard are common among the existing national test standards in the region. Nevertheless, 6 main differences have been identified which require closer scrutiny by the TWG, i.e.:

1) Differences in standard rating test condition
2) Test voltages according to Table 2 in ISO 5151:2010 vs. national power supply voltages
3) Duration of test data recording and interval of data recording
4) Allowable variation of entering air temperature readings during steady-state cooling capacity tests
5) Location of test unit in the outdoor test room, and the percentage of piping length in the two room chambers
6) Acceptance of both calorimeter and indoor air-enthalpy test methods

Standard rating condition

The difference in the standard rating test condition only affects Philippines who rates performance of the air-conditioning unit under the T4 temperature levels, which are summarized in the following Table 1. Other ASEAN members use the T1 conditions.

Table 1: Comparison between T1 and T4 test conditions

	ISO5151 T1	PNS240 T4
Air entering indoor side (^{o}C):		
Dry-bulb	27	27
Wet-bulb	19	19
Air entering outdoor side (^{o}C):		
Dry-bulb	35	35
Wet-bulb	24	27

Test voltage

Inasmuch as most of the ASEAN members comply with Table 2 of ISO 5151:2010 on the test voltages for the air-conditioner unit, Thailand uses a lower test voltage of 220V, which is contrary to the required 230V from Table 2. This test voltage follows the nameplate rating on the air-conditioner unit which corresponds to the national electrical power supply voltage.

Duration of test data recording and interval of data recording

Most of the laboratories in ASEAN have test data recording duration of 30 or 35 minutes. The only difference is with Thailand which records the data over an hour of time duration. However, this is still acceptable under the ISO 5151:2010 standard which specifies duration of at least 30 minutes. Nevertheless, the impact to Thailand is the longer testing time for one unit of air-conditioner.

One of the main differences among the test standards in ASEAN is the interval of data recording. It is apparent that almost all the economies are still following the requirements laid down in ISO 5151:1994 where data is recorded at 5 minutes interval providing 7 sets of readings. Thailand doubles the interval to 10 minutes in view of the

longer 1 hour test duration. But the ISO 5151:2010 standard specifies a much shorter interval of 1 minute, or less, for the entering air temperatures.

Allowable variation of air temperature readings

The allowable variation of entering air temperatures (dry-bulb, DB and wet-bulb, WB) during the steady-state cooling capacity test reflects the effectiveness of the control system used in the laboratory. Table 2 summarizes the different variations currently being practised among ASEAN members.

Table 2: Comparison of allowable variations during cooling capacity test

	Variation of arithmetic mean values			Maximum variation of individual readings		
	DB#	WB#	Voltage	DB#	WB#	Voltage
Malaysia	±0.3°C	±0.2°C	±1%	±1.0°C	±0.5°C	±2%
Singapore	±0.3°C	±0.2°C	±1%	±1.0°C	±0.5°C	±2%
Thailand	-	-	-	±1.0°C	±0.5°C	-
Indonesia	±0.3°C	±0.2°C	±1%	±0.5°C	±0.3°C	±2%
Viet Nam	-	-	-	-	-	-
Philippines	-	-	-	±0.1°C	±0.1°C	-
ISO 5151:1994	±0.3°C	±0.2°C	±1%	±1.0°C	±0.5°C	±2%
ISO 5151: 2010	±0.3°C	±0.2°C	±1%	±0.5°C	±0.3°C	±2%

Note #: For indoor air entering

Location and installation of test unit in the outdoor test room

There is a slight difference in the location of test unit in the outdoor room used by Singapore and Philippines, i.e. > 0.9m for the distance from any surface of the test unit to any other room surface. The other members comply with the ISO 5151:2010 standard which gives a distance of > 1.0m.

All members are favourable to a standard test pipe length of 7.5m which complies with the ISO5151:2010 standard. However, the difference is with the percentage of the total pipe length located in the outdoor room. This affects the location of installation for both the indoor and outdoor units in the laboratory. Most laboratories use at least 50% whereas the standard specifies not less than 40% of the pipe length to be in the outdoor room. In this respect, the TWG is recommending a proportion of 50% to be used.

Acceptance of both calorimeter and indoor air-enthalpy test methods

Most of the national laboratories in the ASEAN region use the calorimeter test method for the cooling capacity test. The only exception is Indonesia who uses the indoor air-

enthalpy method. Nevertheless, the ISO 515:2010 standard allows tests to be done with both methods.

The TWG has discussed in detail the impact of these six main differences to the harmonization exercise. In the interest to remove non-tariff barriers to trade, the group is recommending the following steps, summarized in Table 3, to close the gaps.

Table 3: Recommendations to overcome differences

Differences	ISO5151:2010 clause	Recommendations of TWG
Gap #1 Test condition T1 vs. T4 which is used in Philippines	5.1.2.1	T1 test condition to be used in the ASEAN region for determination of cooling capacity rating.
Gap #2 Test voltage of 220V used in Thailand vs. 230V as indicated in Table 2 of ISO 5151:2010	Table 2	The test voltages for capacity testing stipulated in Table 2 of ISO 5151: 2010 to be followed. Thai Industrial Standard Institute (TISI) has agreed to amend TIS1155 standard to change the test voltage to 230V, though time is required for implementation (2-3 years).
Gap #3 Differences in duration of test data recording and interval of data recording	5.1.4.3, 7.3.3, 7.3.5	The duration of test data recording and interval of data recording stipulated in ISO 5151: 2010 to be followed. Test data recording duration = 30 minutes (minimum), interval of data recording for air temperatures ≤ 1 min.; and others ≤ 5 min. Final reading averaged over the data recording duration.
Gap #4 Variation of entering indoor air temperature readings during steady-state cooling capacity tests	7.3.1, 7.3.2	The test tolerances of air entering temperatures stipulated in Table 11 in ISO 5151:2010 to be followed.

Gap #5 Location of test unit in outdoor room: - Distance of test unit from room wall surface - Percentage of pipe length in outdoor room	Annex A	The requirements of positioning the indoor and outdoor test units in the test chambers stipulated in Annex A of ISO 5151:2010 to be followed. Total pipe length = 7.5m with the percentage of total pipe length in the outdoor room set at 50%.
Gap #6 Acceptance of both calorimeter and indoor air-enthalpy test methods	7.1.1, 7.1.2, 7.1.3	With the exception of Thailand, ASEAN members accept the test results from both calorimeter and indoor air-enthalpy test methods. However, Thai Industrial Standard Institute (TISI) has agreed to amend TIS1155 standard to accept results from both methods, though time is required for implementation (2-3 years). In view of this, the TWG recommends that both methods to be accepted. The TWG is in agreement that the calorimeter method is more accurate with lower measurement uncertainties. Therefore, it is recommended that ASEAN national test laboratories should build balanced-type calorimeter rooms for the purpose of conducting cooling capacity rating tests on air-conditioners.

With the closure of these gaps, and high level of compliance among the national test standards, the TWG is in agreement for ASEAN to adopt directly the international **ISO 5151:2010** standard as the harmonized standard of testing method for air conditioners.

It is recognized by the TWG that the ISO 5151:2010 standard gives the testing method to determine the full load cooling capacity rating of air-conditioners at specific air temperature and humidity conditions. The energy efficiency of the air-conditioner is quantified with the index Energy Efficiency Ratio (EER). However, the standard is not able to provide the method to evaluate the part-load and seasonal energy efficiencies of air-conditioner equipment, e.g. multi-splits and inverter systems. The TWG also recognizes that the evaluation method of such seasonal performances requires another standard, e.g. ISO 16358 which uses the Cooling Seasonal Performance Factor (CSPF) index.

The calculation of the CSPF index can be accomplished by using test data obtained from two test conditions, one at standard rating, and the other at specified part load

conditions defined in the standard for particular types of unit (e.g. fixed speed, two-stage, multi-stage, etc.). Nevertheless, the ISO 16358 standard makes reference to ISO 5151 for the testing method.

However, the TWG is of the opinion that ASEAN is not ready yet to adopt this standard. Not only more understanding and evaluation of the CSPF index are required, the existing MEPS scheme currently enforced in most economies uses the EER or weighted EER indices. With the exception of Viet Nam, no EE criteria have been set yet with the CSPF. Therefore, the TWG is recommending that this evaluation method to be considered in the following next stages of the harmonization exercise.

Testing capabilities

A survey was also conducted among the TWG members on the availability of testing facilities in the region. This is summarized in the following table.

Table 4: Available air-conditioner testing facilities in ASEAN

	No. of facilities	Name of institute	Level N = National C = Commercial	Type of laboratory/ (Quantity)
Malaysia	1	SIRIM	N	Balanced type calorimeter (1)
Thailand	5	EEI	C #	Balanced type calorimeter (2) Air-enthalpy (1)
		U. Chulalongkorn, Faculty of Engineering	N	Calibrated room type calorimeter (1)
		Bitwise (Thailand) Company Limited	C #	Calibrated room type calorimeter (1)
		Intertek Testing Services Thailand Limited	C	Air Enthalpy (1)
		PPJ Engineering Co., Ltd.	C #	Balanced type calorimeter (1)
Indonesia	2	B4T	N	Air-enthalpy (1)
		Sucofindo	C	
Vietnam	1	TVCI	N	Calibrated room type calorimeter (1)
Singapore	0			
Philippines	1	Omni Solid Services Inc. (OSSI)	C	Air-enthalpy (1)

Brunei	0			
Cambodia	0			
Laos	0			
Myanmar	0			

Legend: # - Accredited to ISO/IEC 17025

It is obvious from the survey that there are not many national test facilities available in the ASEAN region. Some of the member economies do not have any laboratory set-up. For example, Singapore relies on external overseas laboratories and manufacturer's in-house laboratories to certify the capacity rating and energy consumption of their air-conditioning equipment. To help alleviate this shortage, commercial laboratories are engaged to support the testing activities. To ensure accuracy and competency, these commercial laboratories should demonstrate compliance to the ISO/IEC 17025 "General Requirements for the Competence of Testing and Calibration Laboratories" standard, as being practiced in Thailand.

The TWG recognizes the following situations:

- There are plans to build more laboratories (both calorimeter and air-enthalpy types) in the coming two years (2014-2015) in Malaysia, Thailand, Indonesia and Viet Nam to cater for the increase in demand of testing. A summary of this is given in the following Table 5.
- The testing capacity building plans is very much dependent on the demand from the local manufacturing companies. It is because of no local manufacturer presence that there are no testing facilities available in Singapore, Cambodia, Myanmar and Laos.
- The critical barriers to building more laboratories include:
  a) Lack of funding
  b) Lack of technical expertise to design, build and commission test facilities. This is especially prevalent in Cambodia, Myanmar and Laos.

  These barriers should be addressed in the subsequent phases of this harmonization project.

Table 5: Summary of capacity building plans (2014-2015)

	Name of institute	Building plans
Indonesia	B4T	In discussion to build 1 balanced-type calorimeter.
Malaysia	SIRIM	Additional 1 air-enthalpy room by early 2014 (up to 12kW).
Thailand	EEI	Upgrading of 2 units balanced-type calorimeter by 2014. Additional 1 balanced-type calorimeter by 2015.
Viet Nam	TVCI	Have decided to build 1 more laboratory, but not confirmed which type yet.

PART B: RECOMMENDATIONS FOR APEC-WIDE HARMONIZATION

The proposal for a harmonized test standard for air-conditioners in APEC is not a new endeavour. The need for this has been recommended to the APEC Energy Working Group by the Energy Efficient Strategies (EES) Australian consulting firm back in November 1999 [3]. In that work, EES has reviewed and compared the testing standards used in APEC economies for various types of electrical equipment, including air-conditioners.

Even though the report was published several years back, the main findings from this work would still be relevant today. It is pointed out in the report that there are many test procedures in use within APEC economies for the purpose of energy related regulations. The complexity of regulatory and testing requirements from these procedures and programs has the potential to restrict free trade between APEC economies. Alignment of testing procedures for electrical products helps to promote international trade, decrease testing and approval costs, allow free movement of the most energy efficient products, facilitate international comparisons and assist in the diffusion of advanced energy saving technologies.

With regards to air-conditioners, the study has noted small variations among the similar test standards regulated in APEC. In general, ISO test procedures, i.e. ISO 5151 and ISO 13253, are used or referenced, though these are not adequate to consider actual use in different climatic conditions or part loading. The recommended strategy put forward by EES was to provide resources to eliminate the arbitrary small differences in test conditions and tolerances for testing air-conditioners and heat pumps in APEC economies. Alignment with the ISO 5151 T1 condition would be a feasible option. Appendix A summarizes the agreement of the test conditions used among APEC economies with the T1 condition.

In a much later cooling benchmark study conducted by Econoler, Navigant, CEIS and ACEEE, done in partnership with CLASP [4], the Testing Component of the work has established the differences among test procedures used in major economies (i.e. the US, the EU, Japan, China, Korea and India) for measuring the capacity and efficiency of air-conditioners in cooling mode [5]. It was similarly noted that many economies base their own test procedures on the two international ISO 5151 and ISO 13253 standards, i.e. the former for non-ducted equipment while the latter is for ducted units. One of the recommendations from this study is the use of calorimeter room method, whenever possible, for the test to reduce the uncertainty of measurement as compared to the indoor air-enthalpy method.

It is apparent from these prior works that the background of the situation to harmonize the testing standard for air-conditioners is very similar between APEC and ASEAN. It is also observed that there is a need to review again the latest testing procedures used in APEC, and to critically re-evaluate the differences among them. Consequently, it is recommended that a technical working group to be established from experts in respective APEC economies to work through and close the gaps of these small differences. It is only logical that the international ISO standards should be the basis for harmonization.

The experiences gleaned from the ASEAN harmonization exercise would be insightful to the working group working on the APEC-wide harmonization. These experiences are given and explained in the following sub-sections:

1. Scope of work

The ASEAN harmonization work has started by looking at the definition of room air-conditioners. This was important as it sets the scope of products covered by the harmonization, namely cooling-only, window/casement and single split types. In general, this represents a majority of the air-conditioning market share in ASEAN. This range of products has the largest impact on the energy consumption due to air-conditioning equipment in the region.

It is imperative that APEC should also start the harmonization exercise on a similar footing by restricting the scope of study to household room air-conditioners. This will allow the working group to focus on harmonizing one set of testing standards among the economies for a start. However, most of the air-conditioning equipment in APEC economies is heat pump, i.e. with both cooling and heating modes. Following the recommendation by EES et al. [3], the latest version ISO 5151:2010 would be the preferred testing method standard as benchmark for harmonization in APEC.

With the successful harmonization of testing method for non-ducted room air-conditioners, further work can then be extended in later stages of the project to include ducted systems with the ISO 13253:2011 “Ducted air-conditioners and air-to-air heat pumps – Testing and rating for performance” standard.

In ASEAN, inverter products are not so widely used, comprising only about 14% of the total market for split type units. The exception to this is in Singapore and Vietnam. With the weaker demand for part loading performance, the Technical Working Group (TWG) did not give emphasis on harmonizing the evaluation method of seasonal energy efficiencies of these products during the first phase of the project. The situation may be different in APEC. If there is a need, the APEC working group could consider harmonizing the ISO 16358 standard to evaluate the seasonal and part load performances with the CSPF index. However, this should be done in a step-by-step approach where harmonization of the test method, e.g. ISO 5151, must be completed first. Nevertheless, the ISO 16358 standard makes reference to the ISO 5151 and ISO 13253 standards for the testing method.

2. Level of receptivity

Not all economies in the ASEAN region have the same level of receptivity towards harmonization of energy efficiency standards. This is especially so with less developed economies, e.g. Cambodia, Laos and Myanmar. In general, these economies do not have any air-conditioner test standards in place, nor do they have any test facilities.

In this respect, these economies will look towards their more advanced neighbours for direction and technical support. Hence, the harmonization exercise has been focused on key economies which have medium and high levels of energy efficiency receptivity to drive the programme. It is expected that similar situation will be encountered within the APEC region.

3. Agreement with ISO 5151

The successful harmonization of testing method in ASEAN is partly due to the referencing of existing national test standards to the ISO 5151:1994 standard. Hence, it is not difficult for the ASEAN economies to accept using the latest 2010 version of the standard. Nevertheless, changes are still needed in certain economies, as highlighted in Table 3, in order to comply with the revised requirements of the standard.

Credit must be given to the representatives of the TWG who are willing to compromise, in the interest of regional harmonization, to close the gaps causing the differences. Examples of such compromise include Philippines agreeing to the T1 test condition vs. T4 which resembles closer to their local climate, and Thailand agreeing to conduct the rating test at 230V instead of 220V which is their national power supply voltage.

It is recommended that the selection of members for the APEC working group(s) should involve personnel from respective national test laboratories, or appointed commercial laboratories, who have experience and knowledge on the intricacies of air-conditioner performance testing.

4. Test facilities

It is apparent from the harmonization exercise that there is a shortage of testing facilities in the ASEAN region to conduct performance rating tests for air-conditioners. Half of the member economies do not have any test laboratory. With the implementation of national energy efficiency standards and labelling (EES&L) programme and MEPS in the region, the demand on the existing facilities can only increase. New facilities must be built to continue support the aspiration to increase energy efficiencies of air-conditioners in the region.

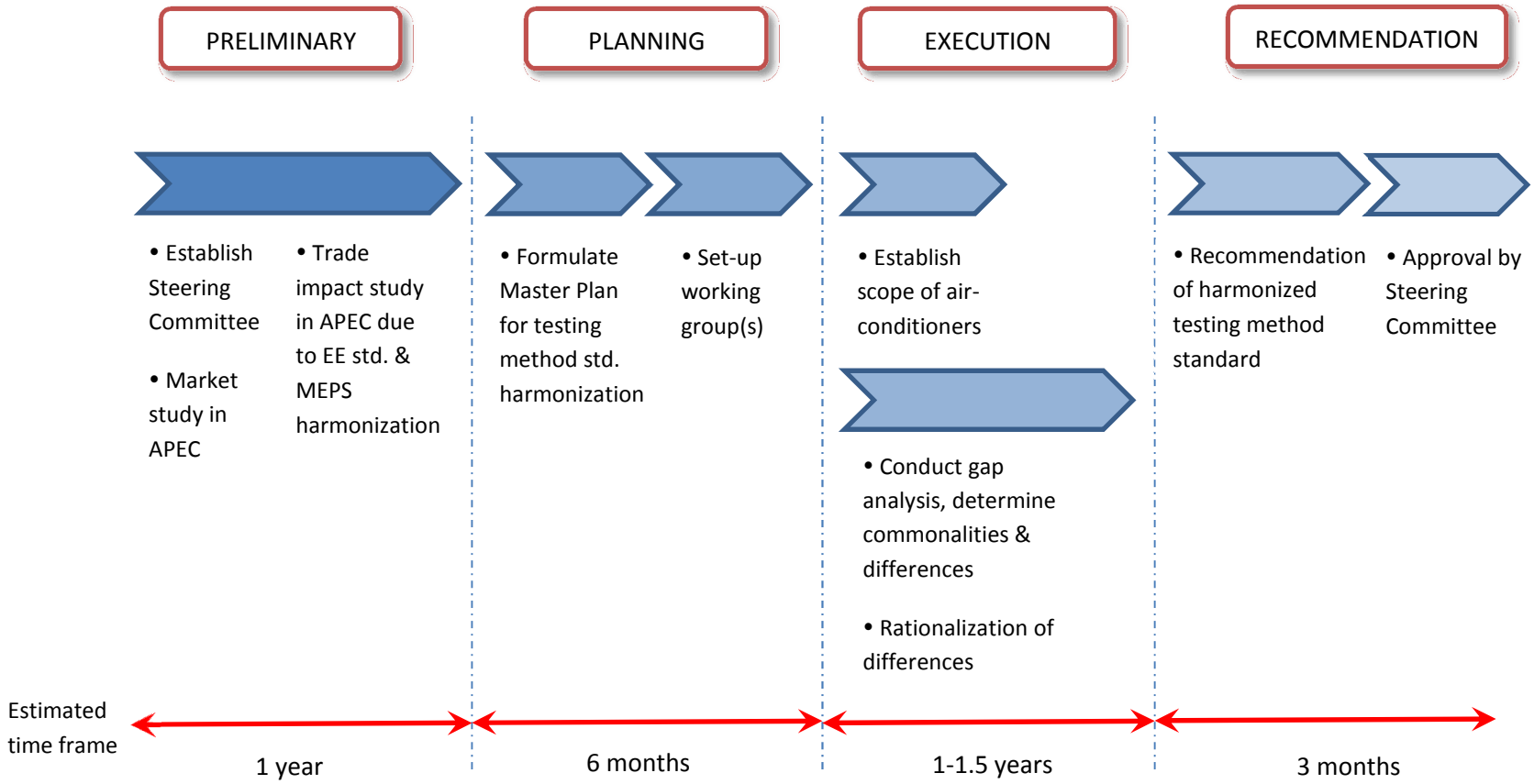
In the same manner, a review of the available testing facilities in APEC economies must be made. The working group(s) should understand the capacity building plans of member economies and examine the difficulties and barriers to increase the testing capacity. If possible, support should be given, in terms of technical expertise or providing advice in securing funding from relevant authorities. This is especially needed for less developed economies which do not have any test facilities.

One possible approach to help alleviate this problem would be to establish Mutual Recognition Agreement (MRA) to recognize test reports among APEC member economies. As a result, the demand for testing in the region, for example from the less developed economies, would form the market base for more commercial laboratories to be set-up to provide the testing services. These laboratories must be accredited to perform the test under the same protocol, i.e. ISO 5151, and provide the required test report.

It is recommended that new facilities to be built in APEC for the performance rating certification should be of the balanced-type calorimeter. The lower level of measurement uncertainty from this type of facility gives higher assurance of accuracy.

Proposed roadmap of APEC-wide harmonization

From the experience of the ASEAN harmonization exercise, the following roadmap is proposed for a similar APEC-wide harmonization of testing method. The formation of the Steering Committee is proposed to be mandated by the APEC Secretariat.



1) Preliminary

In this preliminary stage, a Steering Committee should be set-up to direct and monitor the progress of the harmonization project. The committee could then commission an air-conditioning market study in APEC and a trade impact study due to the harmonization of Energy Efficiency (EE) standards and MEPS level. From these studies, the benefits from the harmonization exercise can be identified and quantified, thus providing the justification for the project.

2) Planning

In this stage, the Steering Committee should prepare a Master Plan for the EE standards harmonization project in APEC, which includes harmonization of testing method standards. During this stage, the necessary working groups can be established to carry out the necessary work. It is expected that the working group(s) would look into harmonization of testing methods first.

3) Execution

In this stage, the scope of air-conditioners to be included in the study is identified. The working group(s) would then review the relevant testing standards used in APEC economies. A gap analysis should be done to identify areas of commonalities and differences among these standards with respect to the ISO 5151:2010 standard. Focus can then be given to the identified differences to determine possible countermeasures for harmonization. The agreement from the working group(s) would then form the recommended harmonized standard.

4) Recommendation

The last stage would involve submitting the recommendation by the working group(s) to the Steering Committee for final approval. With this completed, the committee could then proceed to the next phases of the EE standards harmonization work, as laid out in the Master Plan.

CONCLUSION

The Policy Working Group (PWG) and Technical Working Group (TWG), established by the ASEAN EE&C SSN Steering Committee, have successfully completed the first phase of the "**APEC-ASEAN Harmonization of Energy Efficiency Standards for Air Conditioners"** project. The major outcome from the working groups is the recommendation of the common definition for room air-conditioners and the adoption of the international ISO 5151:2010 standard as the harmonized testing method standard in ASEAN.

To arrive at this final recommendation, the TWG has done a comparative analysis between the respective national test standards used in ASEAN with the ISO 5151:2010 standard. The gap analysis has indicated a high level of agreement, i.e. 80%, among these standards. However, 6 main differences have been identified. After consultation, the TWG representatives have agreed to change their work procedures to follow the requirements of ISO 5151:2010 standard.

The TWG is recommending that harmonization of the evaluation method of part load and seasonal energy efficiencies to be the way forward in subsequent phases of the project. This can be done with the ISO 16358 standard.

In addition, the study has also revealed the shortage of testing facilities in ASEAN to meet the growing demand of testing with the intensification of energy efficiency programmes in the region. Two main barriers have been identified, i.e. funding and lack of technical expertise to build the facilities. These aspects must be taken into consideration in the next phases of this project. The TWG is also recommending that balanced type calorimeters should be constructed to give better accuracy of the test results.

The important experiences learnt from the ASEAN harmonization exercise have been summarized which can be used as guidelines for a similar APEC-wide exercise. From these experiences, a roadmap for the harmonization of testing method in APEC economies has been proposed.

Acknowledgment

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Appendix A

Agreement between test procedures in APEC economies with ISO 5151 T1 condition [3]

Economy	Test procedure name	Test point name	Similarity to ISO 5151 point T1
Australia	AS/NZS 3823.1.1-98	T1	T1 except wet-bulb tolerances
Canada	CAN/CSA-C368.1-M90	None	Close to T1 excluding water cooled units
	CAN/CSA-C273.3-M91	A	T1 excluding water cooled units
	CAN/CSA-C744-93	None	Close to T1 excluding water cooled units
China	GB 7725-96	T1	T1
Hong Kong, China	ISO 5151-94(E)	T1	T1
Japan	JIS C9612-94	None	T1 (except water temperature tolerances)
	JIS B8616-93		
Korea	KS C 9306-97	NA	T1
	KS B 6369-95	NA	T1
Mexico	NOM-073-SCFI-94	None	Close to T1 except for water condenser units
Philippines	PNS 240-89	D	Close to T1 except outdoor wet-bulb and differences for water condenser units
Chinese Taipei	CNS 3615–95	Cooling condition	Very close to T1
	CNS 2725-95	Cooling condition	Close to T1 except for water condenser units
Thailand	TIS 1155-2536 (1993)		T1 except for exclusion of arithmetic mean tolerances
USA	10 CFR 430 Subpart B, Appendix F, ANSI/AHAM RAC-1-82 & ASHRAE 16-83-RA88	None	Close to T1 except for water condenser units
	10 CFR 430 Subpart B, Appendix M &ARI 210/240-94	A	T1 excluding water cooled units
	ARI 310/380-93	None	Close to T1 excluding water cooled units
International	ISO 5151-94(E)	T1	T1

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