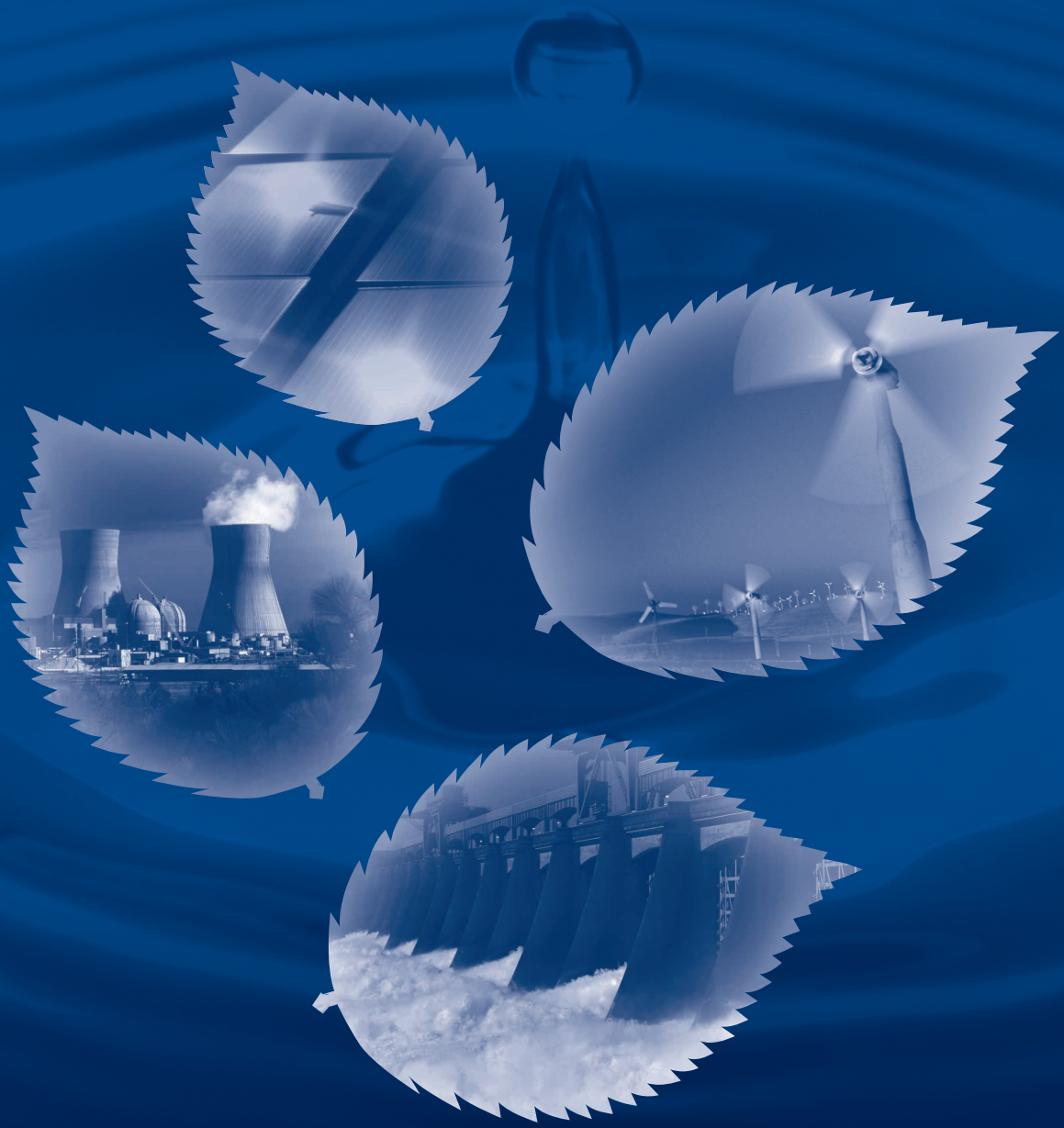
Pathways to Energy Sustainability:

Measuring APEC Progress in Promoting Economic Growth, Energy Security, and Environmental Protection



APERC
Asia Pacific Energy Research Centre

PATHWAYS TO ENERGY SUSTAINABILITY: MEASURING APEC PROGRESS IN PROMOTING ECONOMIC GROWTH, ENERGY SECURITY, AND ENVIRONMENTAL PROTECTION

Asia Pacific Energy Research Centre

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FOREWORD

We are pleased to present this report, *Pathways to Energy Sustainability: Measuring APEC Progress in Promoting Economic Growth, Energy Security, and Environmental Protection*. The report was prepared for the Ninth Meeting of APEC Energy Ministers in Fukui, Japan on 19 June 2010, and was designed to report progress on two initiatives previously agreed to by the APEC Leaders and Energy Ministers: to reduce energy intensity by at least 25% by 2030 (compared with 2005) and to facilitate and review progress through a voluntary APEC Energy Peer Review Mechanism.

The report discusses the impressive progress that has been made by APEC economies on both initiatives. It also reveals significant opportunities for additional APEC cooperation towards a more secure and sustainable energy future. These include opportunities for capacity-building and technical assistance in a number of APEC economies, a peer review for low-carbon energy supply similar to APEC's existing peer reviews on energy efficiency, and the potential for reducing the energy intensity of economic output in the APEC economies between 2005 and 2030 beyond the 25 percent aspirational goal already agreed by the APEC Leaders. The Energy Ministers wisely recognised these opportunities in their Fukui Declaration.

The APEC region and the globe face some significant energy challenges. The *APEC Energy Demand and Supply Outlook 4th Edition* concluded that oil security remains a major threat to the APEC region, and that business-as-usual is environmentally unsustainable. These conclusions are repeated here.

The final chapter suggests that this message is being heard. Specifically, if APEC economies keep the voluntary emission mitigation pledges they have already made, and if they continue to pledge emission reductions at the same rate once their current pledges expire, then the APEC region could make a very significant contribution to environmental sustainability. APEC, as a cooperative forum, is well-positioned to encourage and facilitate these voluntary actions. We hope this report helps to guide the way, and we look forward to contributing to the effort.

This report is the work of the Asia Pacific Energy Research Centre. It is an independent study, and does not necessarily reflect the views or policies of the APEC Energy Working Group or individual member economies. I would like to express special thanks to the many people outside APERC who have assisted us in preparing this report, as well as to the entire team here at APERC.

Kenji Kobayashi

President

Asia Pacific Energy Research Centre (APERC)

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The development of this report could not have been accomplished without the contributions of many individuals and organisations. We would like to thank all those whose efforts made this report possible, in particular those named below.

We would like to thank members of the APEC Energy Working Group (EWG), the APERC Advisory Board, the APEC Expert Group on New and Renewable Energy Technology (EGNRET), the APEC Expert Group on Energy Efficiency and Conservation (EGEEC), along with numerous government officials, for their helpful information and comments.

We would also like to thank our colleagues at the International Energy Agency, including Fatih Birol and Akira Yanagisawa, for their kind assistance through the use of the IEA's *World Energy Outlook* modelling results.

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EXECUTIVE SUMMARY

ES.1 Purpose of This Report

In their 2007 Sydney Declaration the APEC Leaders agreed to:

1. "facilitate and review progress through the voluntary APEC Energy Peer Review Mechanism, as established by APEC Energy Ministers in May 2007, with a report back to APEC Leaders in 2010;" and

2. "work towards achieving an APEC-wide aspirational goal of a reduction in energy intensity of at least 25 percent by 2030 (with 2005 as the base year)."

These two actions were part of a broader APEC action agenda outlined by the Leaders to achieve what has been called "the 3E" goals of energy policy: economic growth, energy security, and environmental protection. The Sydney Declaration began by stating the APEC Leaders agreement that "economic growth, energy security, and climate change are fundamental and interlinked challenges for the APEC region."

The Sydney Declaration is part of a series of declarations from APEC Leaders and Energy Ministers calling for initiatives and actions to promote the 3E goals. In this report, the term "energy sustainability" is used to refer to all three goals, as they require the development of capabilities to meet future energy needs reliably, without damage to the environment, and in a way that sustains the economy and the livelihood of its citizens.

This report is designed to examine APEC's progress on the two specific initiatives mentioned above, as well as the broader goal of energy sustainability. It does so in four ways.

First, it responds to the APEC Leaders' directive for a report on the voluntary APEC Energy Peer Review Mechanism in 2010. This report provides a detailed progress report on both programs that have been implemented as part of APEC's Energy Peer Review Mechanism: the Peer Review of Energy Efficiency (PREE) (including the Compendium of Energy Efficiency Policies) and the Cooperative Energy Efficiency Design for Sustainability (CEEDS).

Second, this report discusses APEC's progress to date in improving energy intensity, and the outlook for achieving the minimum 25% reduction goal by 2030. APERC's model results suggest that this 2030 APEC-wide aspirational goal will be exceeded by a wide margin, partly as a result of the purposeful actions of APEC economies in improving energy efficiency.

Third, despite the progress in improving energy efficiency, APERC's projections suggest that more action will be needed if the APEC Leaders' and Energy Ministers' energy sustainability goals are to be met. This report looks at these projections. It then provides some additional analysis of how APEC can measure its progress through comparisons with a more sustainable scenario.

Fourth, this report looks at the voluntary pledges that APEC economies have set for themselves to reduce emissions or improve energy intensity, and what impact these pledges would have on APEC greenhouse gas emissions if they could be achieved. Under optimistic assumptions, achievement of these pledges could substantially move the APEC region

toward energy sustainability. This conclusion highlights the important role that APEC, as a cooperative forum, can have in promoting energy sustainability.

ES.2 Report on the Voluntary APEC Energy Peer Review Mechanism

Two programs have been established under the voluntary APEC Energy Peer Review Mechanism.

1. *Peer Review on Energy Efficiency (PREE),* encompasses two activities.
    - *Peer Reviews of Volunteer Member Economies* ('Peer Reviews') are designed to produce policy recommendations for energy efficiency improvement one economy at a time. A Peer Review is conducted by a review team consisting of energy efficiency experts from APEC economies and APERC. The review team visits the economy for up to a week to interview relevant stakeholders.
    - *The Compendium of Energy Efficiency Policies of APEC Member Economies* ('*Compendium*') is a compilation of energy efficiency policies and action plans of the APEC economies presented under a common format. The *Compendium* is based on information provided by member economies, and is published on the APERC website.
2. *APEC Cooperative Energy Efficiency Design for Sustainability* (CEEDS) provides an in-depth review of energy efficiency policies and measures in a single sector for several economies. The process includes two workshops, which bring together experts on energy efficiency in the selected sector and delegates from participating economies. Between the two workshops, delegates prepare presentations on how their economies' energy efficiency policies in the selected sector could be improved.

The first four Peer Reviews for New Zealand, Chile, Viet Nam and Thailand, have been completed, and made a number of recommendations that have been welcomed by the participating economies. These reports have been published on the APERC website. Highlights of each Peer Review are summarised in this report. Chinese Taipei, Peru, and Malaysia have announced that they will host the next Peer Reviews in 2010.

The *Compendium of Energy Efficiency Policies of APEC Member Economies* has been published on the APERC website, including action plans and measures, for APEC economies. In consultation with APEC expert groups, APERC identified 15 key High Performance Energy Efficiency Policies. This report includes a summary table showing the current status of each economy in implementing these policies, as well as discussion of specific areas of strength and progress in the APEC region as a whole.

The first phase of CEEDS, involving two workshops on Appliance Efficiency Standards and Labelling, has also been completed, with six economies participating: Chile, China, Malaysia, Philippines, Thailand, and Viet Nam. An APERC analysis found that residential and commercial electricity demand in these economies could be reduced by 14% to 26% compared to business-as-usual through effective Minimum Energy Performance (MEPS) standards for appliances. Discussions at the workshops were broad-ranging and detailed, with some of the key topics summarised in this report. The workshops also identified some priority areas for future regional cooperation on Appliance Efficiency Standards and

Labelling, including capacity-building, test lab coordination, and harmonisation of standards.

Despite the apparent progress, there are some serious barriers—financial, technical, and political—that still exist to the improvement of energy efficiency in many economies and sectors. There is often a gap between the expectations and actual effect of a policy measure. Overcoming the barriers may require further concerted effort and a more integrated policy framework in APEC economies.

Several of the barriers APEC has identified reflect a lack of human resources in some areas especially end-use data collection, standard setting, and testing. These barriers could be countered by appropriate APEC cooperative follow-up projects. APERC recommends a follow-up capacity building and technical assistance program to ensure full implementation of high performance energy efficiency policies and practices.

Given the amount of experience APEC has now accumulated through the voluntary energy peer review efforts and the positive outcomes that have resulted, it is now appropriate for APEC to consider expanding these efforts. Renewable energy supply could benefit from an APEC peer review effort, as it is a topic of broad policy concern to APEC economies and, one where APEC has already made significant contributions through the APEC Expert Group on New and Renewable Energy Technologies (EGNRET) and the Biofuels Task Force (BTF). APERC recommends that APEC establish a *Peer Review of Low-Carbon Energy* initially focused on renewable energy.

ES.3 APEC's Progress in Improving Energy Intensity

APERC's *APEC Energy Demand and Supply Outlook 4th Edition* projected that the APEC Leaders' APEC-wide aspirational goal to reduce energy intensity by at least 25% by 2030 would be exceeded under business-as-usual, with a primary energy intensity improvement of around 38%. Because this finding is important, this report takes a closer look at it. While there are always many uncertainties regarding the future, the analysis shows that APERC's projected 38% improvement in APEC energy intensity between 2005 and 2030 is broadly consistent with both historical and recent trends in the APEC region, as well as with the modelling work of two other research organisations.

The energy intensity of the APEC region declined fairly steadily over the 25 years from 1980 to 2005. A simple continuation of these trends would be in-line with the APERC business-as-usual projection. Since 2005, the data suggests that the rate of decline in energy intensity has accelerated. Though data for only a limited set of economies is available so far for 2008 and 2009, the data suggests that energy intensity has continued to decline despite the economic crisis that began in 2008.

Business-as-usual projections for the APEC region by the International Energy Agency (IEA) and the US Energy Information Administration (EIA) show remarkably similar energy intensity reductions to those of APERC. At 38%, the intensity reduction in the IEA projection is the same as APERC's projection, while the intensity reduction in the EIA projection is slightly larger, at 40%. The fact that three independent modelling efforts have arrived at essentially the same conclusion about business-as-usual energy intensity reduction suggests that the APERC business-as-usual 38% intensity reduction projection is a reasonable one.

It may be argued that APERC's business-as-usual energy intensity projection is actually conservative, as there are two other trends driving energy intensity reductions that may not be fully reflected in business-as-usual. The first is that there are certain to be many government policy initiatives for improved energy efficiency throughout the APEC region that are not reflected in "business-as-usual". Second, the business-as-usual projection assumed technological progress at historical rates. However, both anticipated high energy prices and government policies are driving a push for accelerated technological improvement. Government spending on energy research, development, and demonstration efforts has begun to rise again after a long and relentless decline in the 1980s and 1990s. In the private sector, both anticipated higher energy prices and competitive pressures to respond to government policies, such as appliance energy efficiency standards, are also likely to accelerate energy-saving innovations.

ES.4 More Action Is Needed for Energy Sustainability

Despite the progress that individual economies are making in improving energy efficiency and the APEC-wide progress in reducing energy intensity, business-as-usual will still not result in energy sustainability as defined in this report: economic growth, energy security, and environmental protection. More action will be needed. The APEC *Energy Demand and Supply Outlook 4th Edition* identified two major energy-related threats to the future of the APEC region, oil security and growing greenhouse gas emissions.

Figure ES.1 shows APEC's historical and projected oil production and imports. Overall oil demand is expected to rise rapidly with the continuing growth in ownership and use of motor vehicles, as well as air travel and air freight. However, oil production in the APEC region is not expected to grow significantly. The result will be a growing gap between oil demand and oil production which must be met by imports from outside the region.

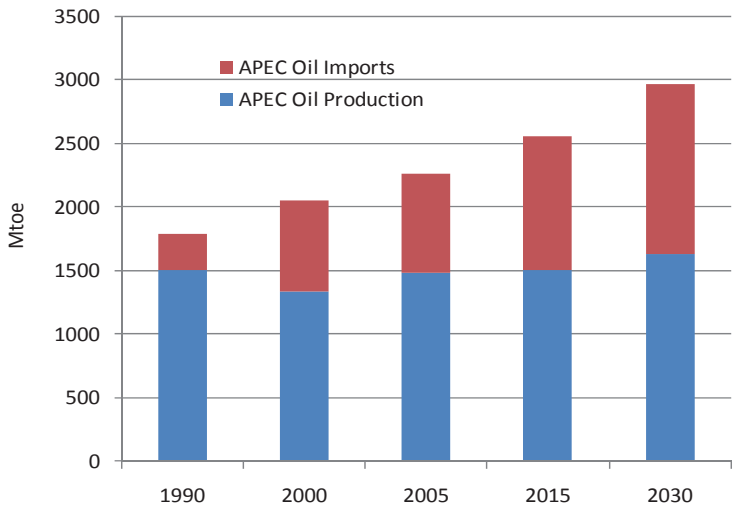

Figure ES.1 – APEC Oil Production and Imports

The increasing dependence on imported oil poses two threats. First, is the direct security-of-supply threat that a disruption would pose. Second, is the threat to the economy that would be posed by very high oil prices, either suddenly as a result of a disruption or more gradually as a result of underinvestment in oil production capacity.

Figure ES.2 shows projected APEC CO_2 emissions from fuel combustion. The figure shows that APEC region CO_2 emissions are expected to rise by around 40% between 2005 and 2030. Science suggests that this rising emissions path has a great probability of disastrous climate change consequences.

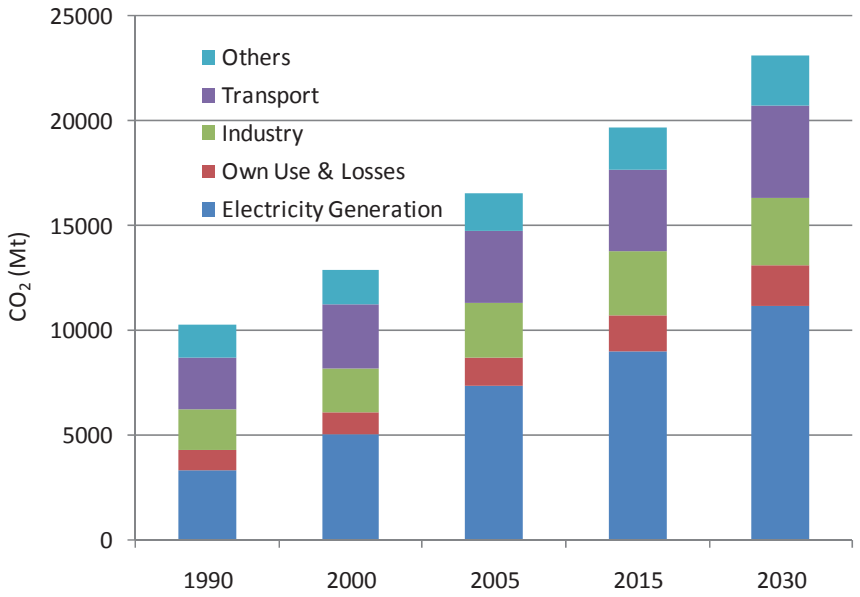

Figure ES.2 – APEC CO_2 Emissions from Fuel Combustion

Cooperative efforts to limit greenhouse gas emissions at the global level remain a work in progress. However, there does appear to be significant support for a limit of 2˚C. This support is reflected in the Copenhagen Accord, which calls for holding "the increase in global temperature below 2 degrees Celsius". [1] As of the end of May 2010, the UNFCCC website lists 125 UNFCCC member economies plus the European Union as "agreeing" to the Accord.[2] Because of the widespread support it has attracted, 2˚C is considered to be the limit on temperature rise that would be consistent with energy sustainability. According to the

[1] United Nations Framework Convention on Climate Change (2010H).

[2] APERC's count as of 27 May 2010 of economies shown on United Nations Framework Convention on Climate Change website (2010I) as listed in the chapeau of the Copenhagen Accord, or later expressing their intention to be listed, as agreeing to the Accord.

Intergovernmental Panel on Climate Change, a 2˚C temperature rise corresponds to a greenhouse gas concentration stabilisation level of roughly 450 PPM CO_2-equivalent.

Actions to limit emissions that go well-beyond business-as-usual are needed if the global temperature rise is to be limited to 2˚C. In order to determine what kind of actions are needed, this report includes an analysis of the *World Energy Outlook 2009* 450 Scenario developed by the IEA for the APEC region. The scenario illustrates the kinds of actions that can be effective in moving towards energy sustainability. The scenario also provides some indicators that APEC economies can use to measure their progress towards energy sustainability and to set voluntary goals for the future. The results suggest that by 2030 an energy intensity reduction of around 50% is required. In addition, the non-fossil fuel share of primary energy would need to be around 30% (compared with 18% in the business-as-usual scenario), and 'low-carbon' (non-fossil energy and carbon capture and storage) share of electricity generation would need to be around 59% (compared with 33% in the business-as-usual scenario).

These are challenging goals, but the evidence from the IEA's modelling results suggests that they could be affordably achieved, with the extra investment costs being largely offset by lower fuel costs. However, the IEA's 450 Scenario would not contribute much to reducing the APEC region's dependence on imported oil. More research is needed on this issue.

ES.5 Could APEC Economy Greenhouse Gas Emission Mitigation Pledges Move the APEC Region Toward Energy Sustainability?

APEC economies have made aggressive greenhouse gas mitigation pledges, which may include specific pledges to reduce greenhouse gas emissions and/or improve energy efficiency. If APEC economies actually implement the mitigation actions they have pledged so far, could this put the APEC region on a path to energy sustainability?

This report examines the mitigation actions pledged by each APEC economy and analyses the effect those pledges would have on overall APEC emissions, assuming each economy is able to keep their pledges. It then compares these emissions to the IEA 450 Scenario discussed above. It is concluded that emissions in 2030 would be close to the IEA 450 Scenario under optimistic assumptions where:

- each economy successfully implements their mitigation actions
- any contingencies (such as a requirement for similar action by other economies or availability of financial support) in each economy's pledges are met and
- pledges with termination dates prior to the year 2030 are assumed to be followed-up with subsequent pledges to continue improvement at the same rate out to 2030.

Although there are limitations to this kind of voluntary action, the results suggest that voluntary action has the potential to play a significant role in putting the APEC region on a path to sustainability. APEC, as a cooperative forum, is well-positioned to encourage and facilitate this voluntary action.

CHAPTER 1 - INTRODUCTION

1.1 Purpose of This Report

In their 2007 Sydney Declaration, APEC Leaders agreed to:

3. "facilitate and review progress through the voluntary APEC Energy Peer Review Mechanism, as established by APEC Energy Ministers in May 2007, with a report back to APEC Leaders in 2010" and

4. "work towards achieving an APEC-wide aspirational goal of a reduction in energy intensity of at least 25 percent by 2030 (with 2005 as the base year)."[1]

These two actions were part of a broader APEC action agenda outlined by the Leaders to achieve what has been called "the 3E" goals of energy policy: economic growth, energy security, and environmental protection. It was stated in the Sydney Declaration that "economic growth, energy security, and climate change are fundamental and interlinked challenges for the APEC region."

The Sydney Declaration, discussed in the next section, is part of a series of declarations made by APEC Leaders and Energy Ministers calling for initiatives and actions to promote the 3E goals. In this report, the term "energy sustainability" is used to refer to all three goals, as they require the development of capabilities to meet future energy needs reliably, without damage to the environment, and in a way that sustains the economy and the livelihood of its citizens.

This report is designed to examine APEC's progress on the two initiatives mentioned above, as well as the broader goal of energy sustainability. It does so in four ways.

First, it responds to the APEC Leaders' directive for a report on the voluntary APEC Energy Peer Review Mechanism in 2010. This report provides a detailed progress report on the programs that have been implemented as part of APEC's Energy Peer Review Mechanism: the Peer Review of Energy Efficiency (PREE) (including the Compendium of Energy Efficiency Policies) and the Cooperative Energy Efficiency Design for Sustainability (CEEDS).

Second, this report discusses APEC's progress to date in improving energy intensity, and the outlook for achieving the minimum 25% reduction goal by 2030. APERC's model results suggest that this 2030 APEC-wide goal will be exceeded by a wide margin, partly as a result of the purposeful actions of APEC economies in improving energy efficiency.

Third, despite the progress in improving energy efficiency, APERC's projections suggest that more action will be needed if the APEC Leaders' and Energy Ministers' energy sustainability goals are to be met. This report looks at these projections. It then provides some additional analysis of how APEC can measure its progress through comparisons with a more sustainable scenario.

Fourth, this report looks at the voluntary pledges made by APEC economies to reduce emissions or improve energy intensity, and what impact these pledges would have on APEC

[1] Sydney APEC Leaders Declaration (2007).

greenhouse gas emissions if achieved. Under optimistic assumptions, achievement of these pledges could substantially move the APEC region towards energy sustainability. This conclusion highlights the important role that APEC, as a cooperative forum, can have in promoting energy sustainability.

1.2 The APEC Leaders' and APEC Energy Ministers' Initiatives and Actions

This section discusses some of the key initiatives and actions agreed-upon by APEC Leaders and Energy Ministers regarding energy in their recent meetings. These initiatives and actions have been cited here, since collectively they define APEC's long-term sustainability goals for the energy sector which motivate this report.

- **APEC Energy Ministers 2007 Darwin Declaration on "*Achieving Energy Security and Sustainable Development Through Efficiency, Conservation and Diversity*".** Responding to the 2006 APEC Leaders' instructions, Energy Ministers laid out an ambitious agenda that included "promoting energy efficient transport and alternative transport fuels"; "improving energy efficiency"; "developing and deploying cleaner and more efficient energy technologies"; and "attracting energy investment and facilitating cross-border trade". There were also a series of initiatives and actions related specifically to oil security, including calls for emergency preparedness and data sharing. Finally, the Energy Ministers directed the APEC Energy Working Group (EWG) to "develop a voluntary Energy Peer Review Mechanism, with an initial focus on progress toward attaining energy efficiency goals."[2]

- **APEC Leaders' 2007 Sydney Meeting.** APEC Leaders now considered energy sustainability to be important enough that they issued a special declaration, separate from their main meeting declaration, titled "***Climate Change, Energy Security and Clean Development***". This declaration laid out an Action Agenda that included measures to promote "energy efficiency", "low emissions technology and innovation", and "alternative and low carbon energy uses", among others. The Leaders in Sydney also agreed on the two specific initiatives cited earlier:

    1. "To facilitate and review progress through the voluntary APEC Energy Peer Review Mechanism, as established by APEC Energy Ministers in May 2007, with a report back to APEC Leaders in 2010" and

    2. "To work towards achieving an APEC-wide aspirational goal of a reduction in energy intensity of at least 25 percent by 2030 (with 2005 as the base year)."[3]

- **APEC Leaders' 2008 Lima Meeting.** The Leaders' declaration included a full page discussing the topic of "Climate Change, Energy Security, and Clean Development". The declaration reaffirmed the Leaders commitment to their Sydney declaration on *"Climate Change, Energy Security and Clean Development"* and the Action Agenda that was included in it.[4]

[2] Darwin Energy Ministers Declaration (2007).
[3] Sydney APEC Leaders Declaration (2007).
[4] Lima APEC Leaders' Declaration (2008).

- **APEC 2009 Singapore Leaders' Meeting.** The Leaders' declaration included a section titled "Promoting Sustainable Growth", which began with the statement that "We will ensure that economic growth in our region is consistent with sustainable development". It went on to call anthropogenic climate change "one of the biggest global challenges". It concluded that "We will advance work on sharing best practices in energy efficiency with a view to deploying cleaner and more efficient technologies, and welcome the implementation of the voluntary APEC Peer Review on Energy Efficiency. We recognize the role of renewable energy in reducing emissions and encourage its development in the APEC region."[5]

1.3 Outline of the Report

- **Chapter 2** looks at progress under APEC's Energy Peer Review Mechanisms, including PREE and CEEDS, and recommends next steps to follow-up on PREE and CEEDS for a more secure and sustainable energy future. A significant recommendation is that APEC should build on the success of PREE and CEEDS by implementing a similar peer review process for low-carbon energy, such as renewables.

- **Chapter 3** looks more closely at the finding of the *APEC Energy Demand and Supply Outlook 4th Edition*[6] that the APEC-wide aspirational goal of a reduction in energy intensity of at least 25% by 2030 (with 2005 as the base year) is likely to be exceeded by a wide margin. It shows that this finding is broadly consistent with past trends in energy intensity improvement, both over the longer term as well as more recently. It is also consistent with the modelling work of two other independent research organisations.

- **Chapter 4** looks at the threat to the APEC region posed by rising oil imports and greenhouse gas emissions. It discusses the scientific case for limiting global temperature rise, the wide support for a 2°C limit on global temperature rise, and how this limit would imply that the concentration of CO_2-e in the atmosphere should be stabilised at no more than 450 parts per million.

- **Chapter 5** looks at a scenario which seeks to demonstrate one approach to putting the APEC region on a path to sustainability, as well as the kinds of policy goals and actions that will be required to achieve it. The scenario results provide some useful indicators that APEC economies can use to measure their progress towards energy sustainability and to set voluntary goals for the future.

- **Chapter 6** looks at the impact of the emission and energy efficiency pledges that APEC economies have announced, assuming they can be kept. Under optimistic assumptions, emissions would be similar to that of the sustainable scenario discussed in Chapter 5.

[5] Singapore APEC Leaders Declaration (2009).
[6] Asia Pacific Energy Research Centre (2009).

These results highlight the potential significance of voluntary action, which APEC as a voluntary forum is well-positioned to support.

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CHAPTER 2 – APEC ENERGY PEER REVIEW MECHANISMS – PROGRESS AND FINDINGS

2.1 Background on APEC Energy Peer Review Mechanisms

As discussed in Chapter 1, both the APEC Energy Ministers' in their 2007 Darwin Declaration and the APEC Leaders in their 2007 Sydney Declaration on "*Climate Change, Energy Security and Clean Development* "committed APEC to establishing a voluntary Energy Peer Review Mechanism. At the 35th APEC Energy Working Group (EWG) Meeting in Inquitos, Peru in March 2008, Japan proposed a detailed implementation plan for the *APEC Peer Review on Energy Efficiency (PREE),* which was endorsed by the EWG.[1]

The objectives of the APEC PREE, endorsed by APEC leaders at their 2007 meeting are to:

- share information on energy efficiency performance as well as on policies and measures for improving energy efficiency
- provide opportunities for learning from the experiences of other APEC member economies and for broadening the network among energy efficiency policy experts
- explore how energy efficiency goals on an overall and/or sectoral basis and action plans could be effectively formulated in each APEC economy under review, taking into account the diversity of possible strategies that could be used, according to the circumstances of individual economies
- monitor progress towards attaining energy efficiency goals on an overall and/or sectoral basis and implementing action plans, if goals and action plans have been formulated at the time of the review
- provide recommendations for voluntary implementation on how implementation of action plans could be improved with a view to achieving energy efficiency goals.

According to the PREE Guidelines, two activities were endorsed as part of the PREE:

(a) Peer Reviews of Volunteer Member Economies

(b) A *Compendium of Energy Efficiency Policies of APEC Member Economies*.

A Peer Review of Volunteer Member Economies ("Peer Review") is conducted by a team of experts from member economies jointly selected by the host economy and APERC. Any APEC economy may volunteer for a Peer Review. The goal of the Peer Review process is to produce useful policy recommendations for energy efficiency improvement. The review team visits the economy for up to a week and is expected to interview stakeholders such as ministry officials, research institutes, industry associations, energy companies, electricity and gas market regulators and operators, consumer associations, and local government. A draft review report prepared by the review team and agreed upon by the host economy is circulated to APEC EWG members for discussion at the following EWG meeting. After all

[1] See Asia-Pacific Economic Cooperation (2008). http://www.ieej.or.jp/aperc/PREE/PREE_guidelings.pdf

comments have been considered the draft review report will be officially released on the APERC website, with the consent from the reviewed economy.

The Compendium of Energy Efficiency Policies of the APEC Member Economies ("Compendium") is a compilation of energy efficiency policies and action plans for all APEC economies under a common format. The *Compendium* is designed to serve as a basis for information sharing on energy efficiency policies and measures. It will be published on the APERC website and periodically updated.

To supplement the progress made by PREE, a third activity under APEC's Energy Peer Review Mechanism was endorsed at the 37th EWG meeting in Santiago, Chile in April 2009, called the *APEC Cooperative Energy Efficiency Design for Sustainability* (CEEDS). CEEDS is designed to provide an in-depth peer review of energy efficiency policy measures in a single sector (such as appliance energy efficiency standards and labelling, energy management in industry, public transport, or building energy codes and labelling) for several economies. This approach complements the Peer Reviews, which provide a broad review of all energy efficiency goals, strategies, policies and measures for a single economy. The Peer Reviews and CEEDS are designed to be multi-year activities. The Peer Reviews will examine a sequence of volunteer APEC member economies, while CEEDS will examine a sequence of sectors.

CEEDS has two parts: (a) an energy saving potential study, which assumes the full implementation of policy measures, and (b) a series of workshops aimed at providing recommendations to each participating economy for the development of energy efficiency policy measures. Each phase of CEEDS includes two workshops scheduled with a few months between them. At the first workshop, experts on energy efficiency in the selected sector make presentations on how to plan and implement effective policies in the sector. Each of the delegates then discusses the current status of energy efficiency polices in the sector in their economy, and current plans for future policies. Each delegate may receive feedback on their plans from experts and fellow delegates. After the first workshop, delegates are expected to return to their economy and discuss potential improvements to their economy's policies with their colleagues.

At the second workshop, attended by the same experts and delegates, delegates are asked to present a refined proposal for improving their economy's policies in the selected sector. Again, there is ample opportunity for feedback from both experts and fellow delegates. This two-step process is designed to promote substantive improvements in policies.

2.2 Progress of APEC Energy Peer Review Mechanisms

As discussed above, the activities under APEC Energy Peer Review Mechanism —the Peer Reviews, the *Compendium of Energy Efficiency Policies of APEC Member Economies*, and CEEDS) — are now underway.

Peer Reviews

The first Peer Review reports for New Zealand, Chile, Viet Nam and Thailand, have been completed. The reports for New Zealand and Chile were completed in early 2009 and endorsed at the 37th EWG Meeting in Chile in April 2009; Viet Nam was completed in mid-2009 and endorsed at the 38th EWG Meeting in Bali, Indonesia in November 2009; and Thailand was completed in late 2009 and endorsed at the 39th EWG Meeting in Tokyo, Japan

in March 2010. These reports were published on the APERC website in accordance with the PREE Guidelines. Chinese Taipei, Malaysia, and Peru have announced that they will host Peer Reviews in 2010.

Compendium

APERC has collected and compiled a summary table and detailed information on the Energy Efficiency Policies of APEC Member Economies under a common format. The information is based on a comprehensive questionnaire completed by APEC economies. The first draft *Compendium* was discussed at the 38th EWG meeting in Bali in November 2009. The final draft was endorsed during the 39th EWG meeting in Tokyo in March 2010. The summary table and detailed *Compendium* were published on the APERC website. According to the PREE Guidelines, the *Compendium* is expected to be periodically updated

CEEDS

The chosen topic for CEEDS Phase I was Appliance Energy Efficiency Standards and Labelling (AEES&L). The first CEEDS Workshop was held in Chinese Taipei in October 2009, and the second Workshop was held in Tokyo in March 2010.

The first Workshop focused on developing proposals for advancing AEES&L programs in the six participating economies: Chile, China, Malaysia, The Philippines, Thailand and Viet Nam. Economy delegates worked closely with experts from the Alliance to Save Energy (ASE), Collaborative Labelling and Appliance Standards Program (CLASP), Institute of Energy Economics, Japan (IEEJ) and Lawrence Berkeley National Laboratory (LBNL). The second CEEDS Workshop focused on refining the proposals and recommendations. APERC also presented a study of the energy saving potential of AEES&L in the participating economies. The outcome of the workshops was reported at the 39th EWG (EWG39) meeting in Tokyo in March 2010. At the EWG39 meeting, Thailand and Hong Kong, China announced plans to host the next CEEDS workshops on Building Energy Codes and Labelling in 2010 and 2011.

2.3 Findings of the Peer Reviews[2]

2.3.1 New Zealand

The Peer Review team was impressed with the level of attention and resources allocated to energy efficiency policy and programs by the New Zealand government. Most of the work on energy efficiency carried out by New Zealand government agencies is high quality and some is world class. The recommendations made by the review team are intended to apply slight corrections to a regime of energy efficiency policy and programs which is essentially in good shape.

The review team identified some lack of flexibility in the ability of the Energy Efficiency and Conservation Authority (EECA) to design, develop and implement energy efficiency programs. This lack of flexibility may result in the development and implementation of programs that are not ideal for achieving their established objectives. In particular, EECA may be prevented from subsequently modifying a program after it has been implemented

[2] The four Peer Review reports may be found at http://www.ieej.or.jp/aperc/PREE.html.

even if the design of the program can be improved. Similarly, EECA may also be prevented from reallocating funds between existing programs or to new programs even if this would result in a more optimal achievement of specified objectives.

Consequently, the review team recommended that the New Zealand Government should review the method of funding EECA with the aim of providing it with more discretion about how its funding is expended. The review team also made a number of other detailed recommendations covering the institutional context for energy efficiency policy and programs in New Zealand; energy efficiency goals and strategies; energy data collection and monitoring; energy efficiency in the transport sector; energy efficiency in the residential sector; energy efficiency in the industrial sector; energy efficiency in the commercial sector; energy efficiency in the electricity sector; energy efficiency activities by local government and non-governmental organisations; and energy efficiency research and development.

2.3.2 Chile

The Peer Review team was impressed with the broad-based support for energy efficiency that exists in Chile. This support extends from the Minister for Energy who has a strong personal interest in promoting energy efficiency, to the general public who responded positively to an energy efficiency information and education campaign during an energy supply shortage in 2008.

In March 2009, the review team found that Chile has a range of government institutions working to achieve increased energy efficiency. The body directly responsible for developing and implementing energy efficiency policy and programs is the National Energy Efficiency Program (Programa País de Eficiencia Energética, or PPEE), a program of the National Energy Commission (Comisión Nacional de Energía, or CNE). In addition, significant policy and program development related to energy efficiency takes place within other government agencies responsible for transport, housing, economic development and technology transfer. These institutions, as well as local government and other bodies, need to work cooperatively to achieve a common energy efficiency vision and objectives.

The Government of Chile has recognised some inadequacies in the institutions currently responsible for energy efficiency. The Government has proposed to establish a new institutional structure involving the creation of a Ministry of Energy, an entity that will centralise the functions of developing, proposing and evaluating public policies in this area, including the definition of objectives, regulatory frameworks and strategies to be applied, as well as the development of public policy instruments. In addition, the Government intends to create a Chilean Energy Efficiency Agency (Agencia Chilena de Eficiencia Energética, or ACHEE). This agency is currently designed as a corporation in which the state and the private sector will participate, so that decisions will be shared among the persons or companies that use energy and the authorities in charge of promoting efficient use of energy.

The review team welcomed the proposed new arrangements as a very positive step that will see ACHEE and a proposed new Energy Efficiency Action Plan become the focus of much greater attention in Chile. However, the team cautioned that direct involvement of the private sector in ACHEE via a public/private governance structure creates a high risk that program design and implementation could be biased or even undermined by the commercial vested interests of private sector organisations represented on the governance board.

Consequently, the review team recommended that the Minister of Energy should keep the responsibility for governance of ACHEE entirely within the public sector.

The review team also felt that it is important that the ongoing development of energy efficiency policies and regulations by the Ministry of Energy be informed and shaped by 'real world' experiences and contact with stakeholders, which will occur during ACHEE's development and implementation of energy efficiency programs. Program implementation experience can keep broader energy policy (and related economy policies) closely linked to developments in the marketplace. This feedback also allows policy and program design to be modified on an ongoing basis to maximise the rate of energy efficiency improvement. Therefore, the review team recommended that ACHEE should have a mandate to provide advice to the Ministry of Energy on the development of energy efficiency policy and regulations.

The review team also made a number of other recommendations covering energy efficiency goals, targets and strategy; energy data collection and monitoring; energy efficiency in the commercial, public, residential, industrial, mining, transport, and electricity sectors; energy efficient appliances and equipment; energy efficiency retrofit projects and project financing; and energy efficiency education, capacity building and research and development.

2.3.3 Viet Nam

Since 2006, the Viet Nam government has strengthened the policy framework on energy efficiency improvement for various end users in the economy. A number of legal documents covering the planning and implementation of energy efficiency policy and programs have been approved by the government. The Viet Nam government has also strengthened the institutions for energy efficiency improvement by creating a special agency named the Energy Efficiency and Conservation Office (EE&CO) under the Ministry of Industry and Trade (MOIT) This agency is tasked to formulate, develop and implement energy efficiency and conservation policies and programs.

As part of its energy efficiency improvement strategy, the Government of Viet Nam developed and launched a comprehensive economy-wide energy efficiency and conservation program called the Viet Nam National Energy Efficiency Program (VNEEP). The VNEEP outlines energy efficiency programs to the year 2015. In addition, to coordinate and monitor the implementation of VNEEP programs, which involves various government agencies, a National Steering Committee chaired by the Minister of MOIT has been established. The National Steering Committee includes members from the Ministry of Construction (MOC), the Ministry of Transport (MOT), the Ministry of Science and Technology (MOST), the Ministry of Education and Training, Ministry of Culture and Information, Ministry of Planning and Investment, Ministry of Finance, Ministry of Justice and the Viet Nam Union of Science and Technology Assocations.

The review team welcomed the initial achievements of the energy efficiency activities generally and particularly the implementation of the National Energy Efficiency Programs. However, the team identified that there is a gap between planning and the implementation of energy efficiency improvement programs. One of the main reasons for the gap is the lack of information and data necessary to establish an effective monitoring and evaluation system for the energy efficiency improvement strategy and programs. In addition, the energy

efficiency programs of the various agencies are not aligned to achieve the larger objectives of the energy efficiency improvement strategy.

To further enhance the Vietnamese Government's efforts on energy efficiency improvement in the economy, the review team made a number of recommendations covering energy efficiency-related institutions; energy efficiency goals and strategy; energy data collection and monitoring; energy efficiency in the industrial, electricity, residential, commercial, and transport sectors; energy efficient appliances and equipment; and energy efficiency-related research and development.

2.3.4 Thailand

The Peer Review team was impressed with the efforts made by the Thai Government on energy efficiency improvement and energy conservation. Energy efficiency improvement and conservation is the main focus of Thailand's energy policy. The backbone of Thailand's energy efficiency improvement and energy conservation policy is the Energy Conservation Promotion Act, B.E. 2535 (1992), which has been in effect since 3 April 1992. The Act empowers the Thai Government to implement various efforts to improve the use of energy. Under this Act, the Energy Conservation Promotion Fund (ENCON Fund) has been established to provide financial support to government agencies, state enterprises, non-government organisations, individuals, and businesses that wish to implement measures to increase efficiency in energy utilisation.

The Peer Review team noted that energy efficiency improvement and energy conservation are very important energy policy objectives for Thailand's economic development. Energy efficiency improvement and energy conservation reduce the economy's heavy dependence on imported energy supply and also improve the security of supply. In this regard, most of the efforts for energy efficiency improvement and energy conservation undertaken by the Thai Government, especially in the industrial, commercial and residential sectors, are serving the economy's need to reduce energy demand and to improve the security of supply.

However, Thailand is having trouble promoting energy efficiency in the transportation sector. As in many other economies, especially developing economies, the focus of government agencies in the transport sector is mainly on their core function, to move passengers and freight smoothly, with limited focus given to improving energy use . Even though the existing traffic congestion easing program has produced some improvement in the energy efficiency of the sector, the real energy saving potential has remained untapped. The Peer Review team considered the current situation carefully and provided some suitable recommendations.

The review team identified some lack of cohesiveness in energy efficiency policy formulation and program implementation in the agencies under the Ministry of Energy. Even though the demarcation of functions among the agencies is generally well defined, some overlaps still exist. The overlaps may result in redundancy of efforts and waste of allocated resources. The grey areas created by the overlaps need to be clarified by the agencies.

The Peer Review team also felt that the monitoring and evaluation of energy efficiency programs should be given more focus. Monitoring and evaluation will provide valuable information on real progress, which will be needed for better program design in the future. Monitoring and evaluation should be implemented as a part of all energy efficiency

programs. An energy database that supports comprehensive monitoring and evaluation also should be developed.

The Peer Review team's overall impression was that Thailand's energy efficiency policies and programs are functioning well and in good shape. The recommendations made by the Peer Review team aim to strengthen the weakest links in the existing policies and programs. The Peer Review team's other recommendations cover energy efficiency-related institutions; energy efficiency goals, targets and strategies; energy data collection and monitoring; energy efficiency in the industrial, electricity, residential, commercial and transport sectors; energy efficient appliances and equipment; and energy efficiency-related research and development.

2.3.5 Barriers Identified in the Four Peer Review Reports

The challenges posed by market and institutional barriers to energy efficiency are a theme of all four Peer Review reports. The following barriers were deemed to be particularly significant:

- *inadequate processes for monitoring and evaluating energy efficiency programs*, making it difficult to know how effective energy efficiency programs really are, and how they can be improved. This barrier is often due to a shortage of appropriately trained people, as well as inadequate end-use energy data.
- *lack of infrastructure and human resources for technical tasks*, such as standards setting and testing of products.
- *financial barriers*, making it difficult to obtain loans for energy efficiency projects. Lenders often perceive these projects to be risky.
- *energy subsidies* may act as a disincentive for energy efficiency improvement.
- *lack of sufficient political will and support* for more ambitious energy efficiency improvement measures.

2.3.6 The Way Forward for Peer Reviews in Volunteer Economies

The feedback received from the volunteer economies is that the Peer Reviews have provided a very useful analysis of energy efficiency and conservation strategies, institutional setup, and policy measures. The fact that another three economies have volunteered for Peer Reviews during 2010, despite the significant commitment of time required by senior officials and experts in each economy, is evidence of the value the Peer Reviews provide. APERC recommends that Peer Reviews should be continued to cover more economies. In addition, APERC recommends that appropriate follow-up projects should be developed to assist APEC economies in overcoming the barriers that have been identified. These are discussed in Section 2.4.4.

2.4 Findings of the *Compendium*

As directed by APEC Energy Ministers and Leaders, APERC compiled a summary table and detailed information on energy efficiency policies, including goals, strategies, action plans and policy measures, for the APEC economies. After EWG endorsement, the *Compendium of Energy Efficiency Policies of APEC Economies* was published on the APERC website. In

accordance with the PREE Guidelines, APERC will periodically update the *Compendium* in cooperation with the Expert Group on Energy Efficiency and Conservation (EGEEC).

2.4.1 15 High-Performance Energy Efficiency Policies

To assess the scope and implementation of the energy efficiency policies summarised in the *Compendium*, APERC identified 15 High-Performance Energy Efficiency Policies in consultation with APEC expert groups including the EGEEC and the Expert Group on Energy Data and Analysis (EGEDA). In selecting the 15 policies, APERC carefully considered internationally-recognised high-performance energy efficiency policies including the International Energy Agency's 25 energy efficiency recommendations.[3] The 15 High-Performance Energy Efficiency Policies are shown in Table 2.1.

[3] See International Energy Agency (2009).

Table 2.1: 15 High-Performance Energy Efficiency Policies

15 High-Performance Energy Efficiency Policies
Cross-sectoral
1. Set energy efficiency **goals and action plans** for the overall economy and various sectors
2. Increase investment, facilitate **private sector involvement** and encourage financial institutions' participation and effort for energy efficiency improvement
3. **Monitor**, enforce and evaluate energy efficiency measures for successful implementation
Industry
4. Collect energy efficiency data for industry including **end use data** for various sub-sectors
5. Assist in developing **energy management capability** and encourage or require the implementation of these practices by major industrial energy users
6. Develop policies and measures to promote energy efficiency in small and medium-sized enterprises (**SMEs**).
7. Introduce minimum/high energy performance standards for **motors**
Transport
8. Establish mandatory **fuel efficiency standards and labelling requirements** for light-duty and heavy-duty vehicles
9. Encourage **Eco-driving**
Residential, Commercial and Public
10. Promote energy efficiency in **buildings** a. Establish and regularly update mandatory energy efficiency **building codes** for **new** buildings b. Develop policy packages to promote energy efficiency in **existing** buildings
11. Encourage the construction of **highly energy efficiency buildings** such as Passive Energy Houses and Net-Zero Energy Buildings
12. Encourage the introduction and update of **building certification** systems
Appliances and Equipment

13. Adopt and update **mandatory/voluntary high energy performance standards** and **labelling**
14. Adopt **international measurement standards and standards harmonisation**, where appropriate, to reduce compliance and administrative costs
15. **Phase-out incandescent bulbs** and introduce higher efficiency lighting systems

2.4.2 Comparison of 15 High-Performance Energy Efficiency Policies with Current Policies

In order to evaluate the extent of implementation of the 15 High-Performance Energy Efficiency policies throughout APEC, APERC compared current energy efficiency policies for each economy, as reported in the *Compendium,* with the 15 High-Performance Energy Efficiency Policies listed in Table 2.1. A three-category classification was used for this comparison:

- I for *Implemented (fully or partly)*
- U for *Underway or In-Planning*
- N for *Need more information*.

Table 2.2 summarises the comparison results.

Table 2.2: Comparison Table – Current Status of 15 High-Performance Energy Efficiency Policies in APEC Economies

COMPARISON TABLE 15 high performance EE Practices	AUS	BD	CDA	CHL	PRC	HKC	INA	JPN	ROK	MAS	MEX	NZ	PNG	PE	RP	RUS	SIN	CT	THA	US	VN
implemented (fully/partly) - I, *underway /planned* - U, *need more information* - N																					
23/02/10																					
Cross -sectoral																					
1. Setting Goal and/or Action Plan	I	I	I	I	I	I	I	I	I	I	I	I	N	I	I	I	I	I	I	I	I
2. Private sector participation for EE Investment	I	I	I	I	I	I	I	I	I	I	I	I	N	I	I	U	I	I	I	I	I
3. Monitoring mechanism	I	U	I	I	I	I	I	I	I	I	I	I	N	I	I	I	I	I	I	I	I
Industry																					
4. End Use Data collection	I	I	I	I	I	I	I	I	I	I	I	I	N	I	I	U	I	I	I	I	I
5. Energy management by major industries	I	I	I	I	I	I	I	I	I	I	I	I	N	I	I	N	I	I	I	I	I
6. Promotion of energy efficiency in SMEs	I	I	I	I	U	I	I	I	I	I	I	I	N	I	N	N	I	I	U	I	I
7. Minimum/high energy performance standards for motors	I	N	I	U	I	I	U	I	I	I	I	I	N	I	I	N	U	I	I	I	I
Transport																					
8. Fuel efficiency standards / labelling	I	U	I	U	I	U	U	I	I	N	U	I	N	N	U	N	I	I	U	I	U
9. Eco driving	I	U	I	I	I	I	I	I	I	U	I	I	N	U	N	U	I	I	I	I	N
Residential, commercial and public																					
10. Mandatory building codes for new buildings	I	U	I	I	I	I	I	I	I	I	I	I	N	U	I	I	I	I	I	I	I
11. Encourage construction of highly energy efficient buildings including passive energy houses and net-zero energy buildings	I	I	I	I	I	I	I	I	I	I	I	I	N	I	I	N	I	I	I	I	I
12. Building certification systems	I	N	I	U	I	I	U	I	I	I	I	I	N	U	I	I	I	I	I	I	U
Appliances and Equipment																					
13. MEPS / HEPS and labelling	I	U	I	U	I	I	I	I	I	I	I	I	N	U	I	I	I	I	I	I	U
14. International measurement standards for comparison of traded products	I	I	I	I	I	I	I	N	I	I	I	I	N	I	I	I	I	I	I	I	U
15. Phase out of incandescent bulbs and introduction of more efficient lighting	I	U	I	I	I	I	I	I	I	I	I	I	N	I	I	I	I	I	I	I	I

2.4.3 Summary of Energy Efficiency Policy Progress in APEC Economies

The comparison of energy efficiency policies as reported in the *Compendium* with the 15 High-Performance Energy Efficiency Policies indicates the following areas of strength in the APEC economies' energy efficiency policy portfolio.

Cross-Sectoral

- almost all APEC economies have some degree of economy-wide energy efficiency goal, strategy or action plan.
- many economies are developing policies to increase energy efficiency investment by promoting private sector participation and creating innovative financial instruments (for example in the US, China, Thailand and Singapore), such as a revolving fund.

Industry

- coverage of industrial energy statistics and data collection is improving in almost all APEC economies.
- almost all economies promote energy management by major industries.
- some economies have created policies and measures to promote energy efficiency in small and medium-size enterprises (SMSEs).
- well-developed energy efficiency policies for industrial electric motors exist in most APEC economies; Singapore, Chile and Indonesia have considered this measure in their economy-wide plan.

Transport

- some APEC economies are implementing fuel efficiency standards and/or vehicle fuel labelling policies including Australia, Canada, China, Japan, Korea, New Zealand, Singapore, Chinese Taipei, the United States; Korea sets regulatory vehicle standards on both fuel efficiency and greenhouse gas emissions.
- eco-Driving policies are active in many APEC economies with comprehensive policies in Japan, Australia, Singapore, and Canada.

Building

- almost all APEC economies have mandatory energy efficiency requirements for buildings, such as energy building codes for new buildings.
- most economies have policies promoting passive energy houses and net-zero-energy buildings.
- energy efficiency policies for existing buildings are in place in many economies.
- building certification is in place in several economies; Brunei Darrusalam, Chile, Indonesia, Peru, and Viet Nam are planning building certification schemes.

Appliances	• nearly all APEC economies have mandatory/voluntary minimum energy performance standards (MEPS) or high energy performance standards (HEPS) and associated labelling, while Brunei Darrusalam, Chile, and Peru are planning for MEPS and labelling schemes. Viet Nam's labelling program is included in its new EE&C law approved in June 2010. • most economies support the development of international test procedures and measurement standards.
Lighting	• nearly all APEC economies have policies to increase energy efficiency in the lighting sector. • nearly all economies are implementing policies to phase out conventional incandescent lamps while introducing more efficient lighting systems.

Despite the apparent progress, the comparison suggests that there are still some serious barriers to the improvement of energy efficiency in many economies and sectors. These barriers exist in the areas of human resources, finance, investment risk, information, energy pricing, and political support. Despite widespread adoption of many of the high performance energy efficiency policies, the Peer Review Mechanism has revealed that there is often a gap between the expectations and actual effect of a policy measure. Overcoming the barriers may require further concerted effort and a more integrated policy framework in APEC economies.

2.4.4 Recommended Follow-Up to PREE

Analysis of the Peer Reviews and the *Compendium* suggest two follow-up steps to PREE that would be appropriate.

1. Several of the barriers identified reflect insufficient human resources in some areas, especially monitoring and evaluation of energy efficiency programs, end-use data collection, standards setting, and product testing. These barriers could be countered by appropriate APEC cooperative follow-up projects. Therefore, APERC recommends a follow-up capacity-building and technical assistance program to ensure full implementation of the 15 High-Performance Energy Efficiency Policies.
2. The comparison between the current energy efficiency policies for each economy as reported in the *Compendium* and the 15 High Performance Energy Efficiency Policies needs to be updated and expanded. The goal of the effort should be to more specifically identify market or institutional barriers to energy efficiency improvement, and to suggest means to overcome them. A prerequisite to this effort is that the *Compendium* itself is kept up to date.

2.5 Findings of CEEDS

As discussed earlier, CEEDS was developed to provide an opportunity for in-depth peer review of the energy efficiency policies and measures in a single sector, combined with a study on energy saving potential. CEEDS Phase I focused on Appliance Energy Efficiency Standards and Labelling (AEES&L).

The discussions at the two workshops on AEES&L were broad-ranging and detailed. Some of the topics discussed included:

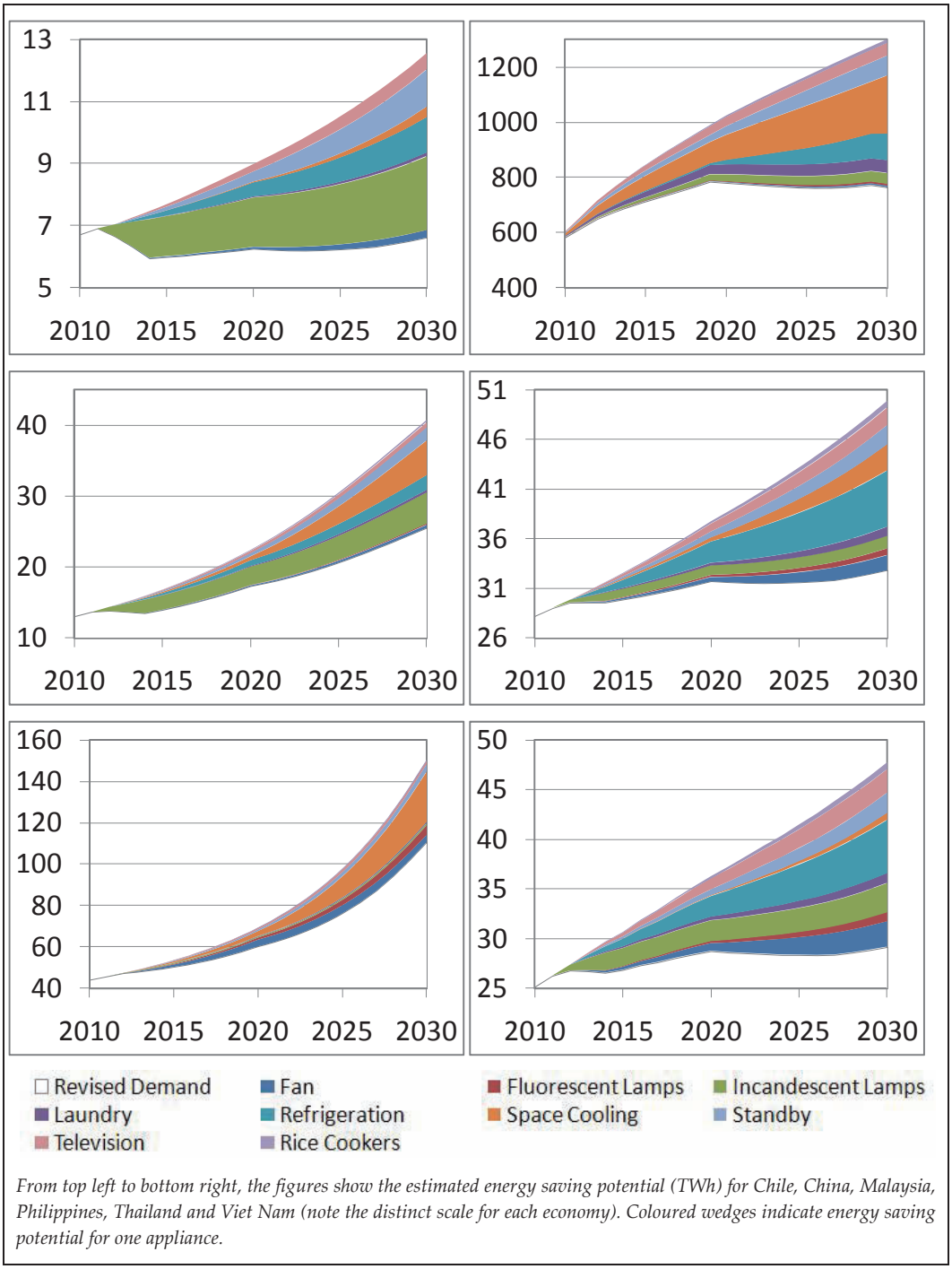
- how to set up the legal framework for an AEES&L program
- how to select appliance categories to include in the program
- how to decide whether to have appliance labels, standards, or both
- how to develop criteria for setting standards
- how to design the labels, including whether the labels should endorse the product or provide consumers with a basis for comparison
- how to set-up a testing and product certification system
- how to monitor and enforce the standards and labelling requirements
- when and how to review and update the standards
- how to involve stakeholders in the program design process
- how to inform consumers about appliance standards and labels and
- how to link AEES&L with other energy efficiency implementation efforts.

The discussion and findings are summarised in the Phase 1 CEEDS Final Report.[4] The findings of most interest relate to a) the energy saving potential of appliance energy efficiency standards, and b) priority areas for future regional cooperation on AEES&L. These are discussed in the next two sections.

2.5.1 The Energy Saving Potential of Appliance Energy Efficiency Standards

To aid economies in the design of effective standards and labelling policies, a team of researchers from APERC and the Lawrence Berkeley National Laboratory (LBNL) estimated the energy saving potential of implementing minimum energy performance standards (MEPS) for a set of household appliances. Energy saving potential estimates were made for the six participating economies for eight electric appliances: air conditioners, clothes washers, fans, lamps, refrigerators, rice cookers, standby power (for electronics), and televisions. Results are show in Figure 2.1 below.

[4] APERC (2010).



From top left to bottom right, the figures show the estimated energy saving potential (TWh) for Chile, China, Malaysia, Philippines, Thailand and Viet Nam (note the distinct scale for each economy). Coloured wedges indicate energy saving potential for one appliance.

Figure 2.1: Energy Saving Potential Estimates from Minimum Energy Performance Standards (MEPS) for Appliances, Annual Terawatt-Hours Saved in 2010-2030

Table 2.3: Year 2030 Electricity Saving Potential from MEPS for Appliances Compared to Business As Usual

	Projected Residential and Commercial Demand (TWh)*	Projected Appliance Demand (TWh)	Appliance Potential Savings (TWh)	Savings Compared to Projected Residential and Commercial Demand* (%)	Savings Compared to Appliance Demand (%)
Chile	**33**	**13**	**6**	**18**	**47**
China	**2483**	**1331**	**536**	**22**	**40**
Malaysia	**109**	**41**	**15**	**14**	**37**
Philippines	**70**	**51**	**17**	**24**	**33**
Thailand	**184**	**152**	**40**	**22**	**26**
Viet Nam	**71**	**49**	**19**	**26**	**38**

*Projected Residential and Commercial Electricity Demand from the *APEC Energy Demand and Supply Outlook 4th Edition* (see APERC (2009)).

As shown in Figure 2.1 and Table 2.3, the potential energy savings from the implementation of MEPS on the eight appliances grows to be quite large over the period modelled. By 2030, savings are estimated to be equivalent to 26% to 47% of the electricity demand by these appliances that would occur otherwise. More broadly, total residential and commercial electricity demand could be reduced by 14% to 26%. Another interesting result of the analysis is the evolution of the savings potential over the modelling period. In the near term, several economies have large potential energy savings in lighting and refrigeration. Over the longer term, as household wealth increases, air conditioning and electronics grow in importance.

The estimates of energy saving potential are based on certain assumptions about future available technologies, their diffusion in the market, and household behaviour. As with all potential studies, there is significant uncertainty in these estimates. The uncertainties of this exercise were compounded by a lack of data on current appliance sales and use. Therefore, one of the outcomes of this analysis is a proposal, welcomed by participating delegates, to build appliance data collection and analysis capacity. The next section discusses this issue more generally.

2.5.2 Priority Areas for Future Regional Cooperation on AEES&L

The discussions at the CEEDS workshops pointed to the need for increased regional cooperation on AEES&L. Cooperative action can reduce costs and implementation time, and facilitate trade in appliances.

CEEDS workshop participants identified the following priority areas of opportunity for future cooperation on AEES&L:

- capacity building, including training for:
  - data collection and analysis
  - test lab personnel
  - criteria and methods for setting standards
  - program impact evaluation.
- test laboratory coordination, including accreditation of test labs and mutual recognition of lab test results
- harmonisation of standards.

APERC is exploring the possibility of cooperative activities in these areas as part of the follow-up to PREE discussed in Section 2.4.4.

2.5.3 CEEDS Recommended Next Steps

Following the success of CEEDS Phase 1 on AEES&L, Thailand and Hong Kong, China announced at EWG39 that they will host the CEEDS Phase 2 workshops on Building Energy Codes & Labelling.

The results from the *Compendium* survey show that energy efficiency requirements for buildings are a key feature of energy efficiency policies in the residential and commercial sector in all APEC economies. Most economies have established stronger energy efficiency requirements for buildings such as mandatory building codes for new buildings and certification schemes to promote energy efficiency in existing buildings, as well as encouraging the construction of highly energy-efficient buildings such as Passive Energy Houses and Net-Zero Energy Buildings through demonstrations and show-case projects. Therefore, CEEDS Phase 2 will be addressing a topic of great interest to APEC economies.

There are many other topics where CEEDS could make a valuable contribution, as evidenced by the 15 High-Performance Energy Efficiency Policies discussed above. Future CEEDS phases may address energy efficiency measures in other sectors including industry (such as energy management) and transport (such as fuel economy standards), as well as further efforts in the residential and commercial sector (such as construction product testing and certification). Feedback on CEEDS Phase 1 from participating economies has been very positive, so APERC recommends that the program be continued.

2.6 Recommended Next Step–APEC Peer Review of Low-Carbon Energy

When APEC energy ministers originally directed the EWG to develop a voluntary energy peer review mechanism in their 2007 Darwin Declaration, they called for an 'initial focus on progress towards attaining energy efficiency goals'. As such, the focus of all the voluntary

energy peer review activities implemented by APEC to date—PREE, *Compendium* and CEEDS—has been on energy efficiency. However, this directive appeared as one of several under a broader heading titled "Promoting Clean and Efficient Energy Production and Use". It is clear from this context that the word 'initial' clearly implied that the ministers intended that the peer review mechanism should be expanded in the future to encompass other aspects of clean and efficient energy production and use.

The *APEC Energy Demand and Supply Outlook 4th Edition* showed that under business-as-usual, APEC will still face rising oil imports and greenhouse gas emissions despite exceeding the goal of a 25% APEC-wide reduction in energy intensity by 2030. Chapters 4, 5 and 6 in this report discuss these future challenges. Clearly, more efforts are still needed.

Given the experience APEC has accumulated through the voluntary energy peer review mechanism and the positive outcomes that have resulted, it is now appropriate for APEC to consider expanding these efforts. Low-carbon energy supply is widely recognised as the supply-side counterpart to improved energy efficiency for achieving energy sustainability and would be a logical focus for these efforts. Low-carbon energies include nuclear, carbon capture and storage, and renewables.

Building upon the success of PREE and CEEDS in the area of energy efficiency improvement, APERC therefore recommends that APEC establish a *Peer Review of Low-Carbon Energy* (PRLCE). The main purpose of PRLCE is to explore how government policies can accelerate the development and implementation of low-carbon energy supplies. The goals of PRLCE would include:

- sharing experience on policies, measures, and actions for promoting low-carbon energy
- identifying effective policies and best practices for low-carbon energy promotion, including encouraging technological innovations and promoting large-scale commercialisation and
- exploring ways that cooperative efforts through APEC could assist APEC member economies in formulating more effective policies for low-carbon energy promotion.

Since resources for peer reviews are limited, the PRLCE would need to be focused in a way that could deliver the greatest value. Renewable energy is an appropriate initial focus for PRLCE as it is both a topic of broad policy concern to APEC economies, and one where APEC has already made significant contributions through the APEC Expert Group on New and Renewable Energy Technologies (EGNRET) and the Biofuels Task Force (BTF).

PRLCE should have a focus on policy, including goal-setting, strategy design, and action plans, building on the more technology-focused activities of EGNRET and the BTF. Some examples of key policy challenges that might be addressed through PRLCE include:

- policies for encouraging entrepreneurial innovation and investment in renewables
- policies for promoting research, development, and deployment of renewable energy
- policies that promote international technology transfer for renewables
- policy objectives for the 'smart grid' (note that PRLCE should focus on the policy objectives of a smart grid, not technical standards)

- policies for improving grid access for renewables
- policies for improving the environmental permitting process for specific renewable energy technologies.

The development of renewable energy can benefit from innovations in government policy as much as from technical innovations. APEC's peer review mechanism is an ideal vehicle to help to promote this policy innovation in APEC member economies.

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CHAPTER 3 – APEC ENERGY INTENSITY TRENDS

3.1 Chapter Overview

At the 2007 Sydney meeting, APEC Leaders called for APEC economies to work towards achieving an APEC-wide aspirational goal of a reduction in energy intensity of at least 25% by 2030 (with 2005 as the base year).[1] In the *APEC Energy Demand and Supply Outlook 4th Edition*[2] it was projected that this goal would be exceeded under business-as-usual, with an energy intensity improvement of about 38%. Because this finding is an important one, it is explored further in this chapter. While there are always many uncertainties regarding what will happen in the future, a 38% improvement in APEC energy intensity between 2005 and 2030 is broadly consistent with both historical and recent trends in the APEC region, as well as with the modelling work of the International Energy Agency (IEA) and the US Energy Information Administration (EIA).

The first section of the chapter examines whether updates are needed to the GDP and oil price assumptions that underlie the conclusions of the *APEC Energy Demand and Supply Outlook 4th Edition*. After considering the current oil market situation and updated economic growth prospects, it concludes that these assumptions have not changed enough to affect the conclusions. The second section looks at historical trends in energy intensity improvement in the APEC region since 1980 and concludes that a continuation of these trends is in-line with APERC's business-as-usual projection. The third section looks at available data on energy intensity trends in the APEC region since 2005, the last year for which historical data was published in the *APEC Energy Demand and Supply Outlook 4th Edition,* and concludes that these recent trends are also in line with APERC's business-as-usual projection. The final section compares APERC's modelling results to those of the International Energy Agency and the US Energy Information Administration. These independent modelling efforts are in close agreement with the APERC business-as-usual projection.

3.2 Are Updates Needed to APERC's Oil Price and GDP Assumptions?

The oil price and GDP growth assumptions underpinning the *APEC Energy Demand and Supply Outlook 4th Edition* were set in February 2009. Clearly, there have been many changes in the outlook for both the oil market and the global economy since then. This section examines whether there has been enough change that the conclusions of the *APEC Energy Demand and Supply Outlook 4th Edition* need to be re-assessed.

The *APEC Energy Demand and Supply Outlook 4th Edition* was designed to be a long-term outlook to 2030. During this time period, if history is any guide, a great deal of fluctuation in both oil prices and economic growth rates is to be expected. Because short-term fluctuations are normal and expected, it is generally not wise to weigh them too heavily in setting assumptions for a long-term outlook. It is, therefore, unlikely that any changes in oil prices or economic growth that have happened in the short-term would have a major impact on the long-term projection. Nevertheless, a short survey of what has changed is appropriate.

[1] Sydney APEC Leaders Declaration (2007).
[2] Asia-Pacific Energy Research Centre (2009A), especially p. 4.

3.2.1 Oil Prices

Figure 3.1 compares Figure 1.3 from the *APEC Energy Demand and Supply Outlook 4th Edition* (which was based on data as of February 2009) with the same figure if APERC were re-doing it in May 2010. The oil prices in May 2010 was around US$80/barrel[3], which is considerably higher than in February 2009, when it was around US$40/barrel. However, the CME (formerly NYMEX) futures market price (nominal) for light sweet crude oil in 2015 has risen much less—from around US$70/barrel in February 2009 to around US$90/barrel in May 2010. In our view, futures market prices are a reasonable way to set oil price assumptions since they are not just results of a model, they are prices at which one can buy and sell oil, which have been determined by the actions of people risking money on them.

[3] CME Group (2010).

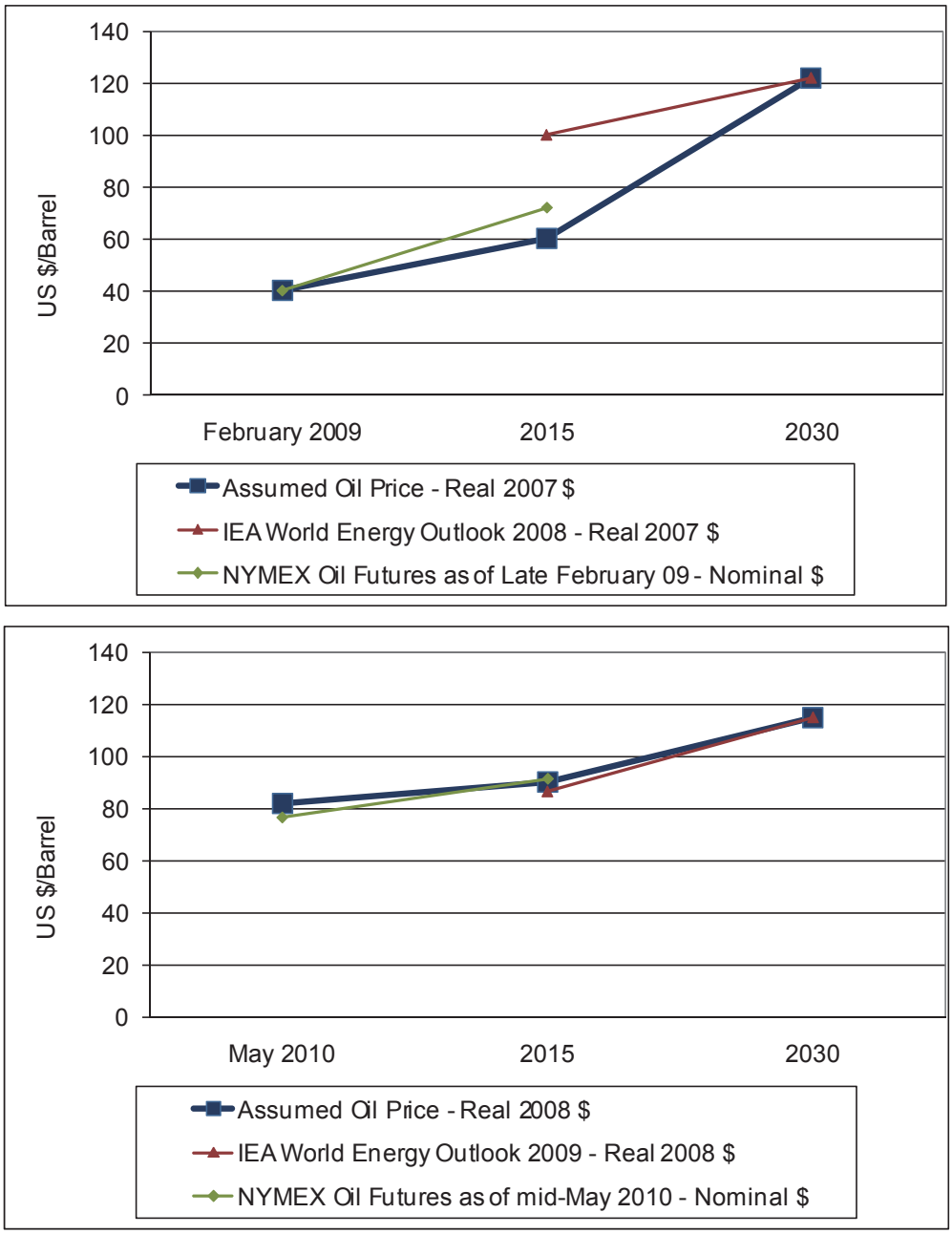

Figure 3.1: Comparison of Oil Price Assumptions from *Outlook 4th Edition Figure 1.3* (Top) with the Same Graph If It Were Recreated in Mid-May 2010 (Bottom).

Since futures market prices are not available for 2030, APERC relies on the extensive analysis of the oil market performed by the IEA for their *World Energy Outlooks* for 2030 oil price assumptions. The 2030 oil price as assumed in the IEA's *World Energy Outlook 2009* is

US$115/barrel (2008 $US).[4] In the IEA's *World Energy Outlook 2008,* which was used to set the assumptions for the *APEC Energy Demand and Supply Outlook 4th Edition*, it was US$122/barrel (2007 $US).[5] This is not a major change.

It is worth noting that APERC's model results are not very sensitive to oil price assumptions. Hence, the changes that APERC would make to the 2015 and 2030 oil price assumptions are not likely to have a major impact on oil supply or demand. This observation, as well as the earlier observation that it is not appropriate to weigh short-term changes too heavily in a long-term outlook, leads to the conclusion that changes in oil price expectations since February 2009 are not likely to have a material effect on the long-term model results.

3.2.2 GDP Growth

APERC has updated the GDP growth assumptions for 2009 and 2010, reflecting the latest projections by the International Monetary Fund (IMF).[6] The IMF now expects that the global economy contracted by 1.1% in 2009, revised down from a 0.5% increase. It expects the global economy will grow 3.1% in 2010, revised slightly up from 3.0% on the condition that announced stimulus measures will be implemented fully. For the APEC region, the IMF expects APEC GDP growth of 3.7%, suggesting that the economy will get back on a more normal track by 2011. The impacts of these changes on our assumptions are shown in Table 3.1.

APERC's GDP assumptions in the *APEC Energy Demand and Supply Outlook 4th Edition* assumed that APEC economies would get back on a more normal growth path by 2011 following the recession of 2008-2010 based on projections of the United Nations[7] and the IMF[8]. As such, there is no reason to chance the projections for 2011 and beyond.

[4] International Energy Agency (2009C), Table 4, p.64.
[5] International Energy Agency (2008), Table 1.4.
[6] International Monetary Fund (2009B).
[7] United Nations (2009).
[8] International Monetary Fund (2009A).

	APEC Energy Demand and Supply Outlook 4th Edition						Reflecting New Economic Outlook for 2009 and 2010								Difference
							Latest Projected IMF								
	GDP			Growth Rates (% per annum)			GDP Growth (%)		GDP			Growth Rates (% per annum)			%
	2005	2015	2030	05-15	15-30	05-30	2009	2010	2005	2015	2030	05-15	15-30	05-30	05-30
APEC Total	30931	43441	72500	3.5	3.5	3.5	-0.8	3.7	30930	43170	72255	3.4	3.5	3.5	0.0
Australia	696	851	1201	2.0	2.3	2.2	0.7	2.0	696	857	1208	2.1	2.3	2.2	0.0
Brunei Darussalam	6	7	9	1.5	1.7	1.6	0.2	0.6	6	7	9	1.3	1.7	1.6	-0.1
Canada	1130	1380	2068	2.0	2.7	2.4	-2.5	2.1	1130	1395	2090	2.1	2.7	2.5	0.0
Chile	200	274	438	3.2	3.2	3.2	-1.7	4.0	200	264	422	2.8	3.2	3.0	-0.2
China	5333	11214	23305	7.7	5.0	6.1	8.5	9.0	5333	11509	23918	8.0	5.0	6.2	0.1
Hong Kong, China	243	353	575	3.8	3.3	3.5	-3.6	3.5	243	327	532	3.0	3.3	3.2	-0.3
Indonesia	708	1090	2010	4.4	4.2	4.3	4.0	4.8	708	1097	2023	4.5	4.2	4.3	0.0
Japan	4141	4671	5582	1.2	1.2	1.2	-5.4	1.7	4141	4455	5324	0.7	1.2	1.0	-0.2
Korea	1027	1457	2304	3.6	3.1	3.3	-1.0	3.6	1027	1402	2216	3.2	3.1	3.1	-0.2
Malaysia	300	451	843	4.2	4.3	4.2	-3.6	2.5	300	416	779	3.3	4.3	3.9	-0.3
Mexico	1174	1556	2495	2.9	3.2	3.1	-7.3	3.3	1174	1482	2378	2.4	3.2	2.9	-0.2
New Zealand	102	120	162	1.7	2.0	1.9	-2.2	2.2	102	117	159	1.5	2.0	1.8	-0.1
Papua New Guinea	13	19	30	4.2	3.0	3.5	3.9	3.7	13	19	30	4.1	3.0	3.5	0.0
Peru	176	272	487	4.4	4.0	4.2	1.5	5.8	176	263	471	4.1	4.0	4.0	-0.1
The Philippines	250	382	711	4.3	4.2	4.3	1.0	3.2	250	370	690	4.0	4.2	4.1	-0.1
Russia	1697	2482	3942	3.9	3.1	3.4	-7.5	1.5	1697	2316	3679	3.2	3.1	3.1	-0.3
Singapore	125	186	313	4.1	3.5	3.8	-3.3	4.1	125	173	291	3.3	3.5	3.4	-0.3
Chinese Taipei	590	813	1261	3.3	3.0	3.1	-4.1	3.7	590	759	1176	2.5	3.0	2.8	-0.3
Thailand	426	650	1292	4.3	4.7	4.5	-3.5	3.7	426	608	1208	3.6	4.7	4.3	-0.3
United States	12416	14887	22674	1.8	2.8	2.4	-2.7	1.5	12416	15012	22864	1.9	2.8	2.5	0.0
Viet Nam	178	325	798	6.2	6.2	6.2	4.6	5.3	178	320	786	6.1	6.2	6.1	-0.1

Table 3.1. Comparison of *APEC Energy Demand and Supply Outlook 4th Edition* GDP Assumptions with Updated GDP Assumptions.

The average annual growth rate of GDP in APEC between 2005 and 2030 remains 3.5%, the same as it was in the *APEC Energy Demand and Supply Outlook 4th Edition*. For individual economies, the 2005-2030 impacts vary from -0.3% to 0.0% a year, which is small. For these reasons, the impact of the current global recession is not likely to have a material effect on the *APEC Energy Demand and Supply Outlook 4th Edition* model results.

3.3 Historical Trends in APEC Energy Intensity

It is interesting to compare the APEC Leaders' 25% energy intensity improvement goal and APERC's business-as-usual projection with historical trends in APEC. Would a simple continuation of past trends allow APEC to meet the APEC Leaders' aspirational goal?

Energy intensity can be measured in two ways: *primary energy intensity* is primary energy (raw fuels before conversion to electricity or refining of crude oil) divided by GDP; *final energy intensity* is final energy (energy in the form it is finally used) divided by GDP. The APEC Leaders did not specify which measure they had in mind, so both are considered. Primary energy intensity is the broader measure, as it can reflect improvements in the efficiency of electricity generation and oil refining, which final energy intensity does not. For this reason, primary energy intensity is probably the more appropriate measure to use in tracking the APEC region's performance against the APEC Leaders' goal.

The energy intensity of the APEC region has declined fairly steadily over the last 25 years. Figure 3.2 shows the trends in primary energy intensity, while Figure 3.3 shows the trends in final energy intensity. Between 1980 and 2005, the primary energy intensity of the region excluding Russia and Viet Nam (for which comparable data is unavailable prior to 1990) declined by 31%, an average annual rate of 1.5%. Over the same period, the final energy intensity of the region declined by 39%, an average annual rate of 1.9%. From 1990 to 2005, when data for all APEC economies is available, the primary energy intensity of the region declined by 20%, an annual average rate of 1.5%. Final energy intensity declined by 25%, an annual average rate of 1.9%.

A continuation of a 1.5% decline over the next 25 years would bring an overall decline of around 31%, while a continuation of a 1.9% annual decline would bring an overall decline of around 38%, both comfortably exceeding the APEC Leaders' goal and not far from APERC's business-as-usual projection.

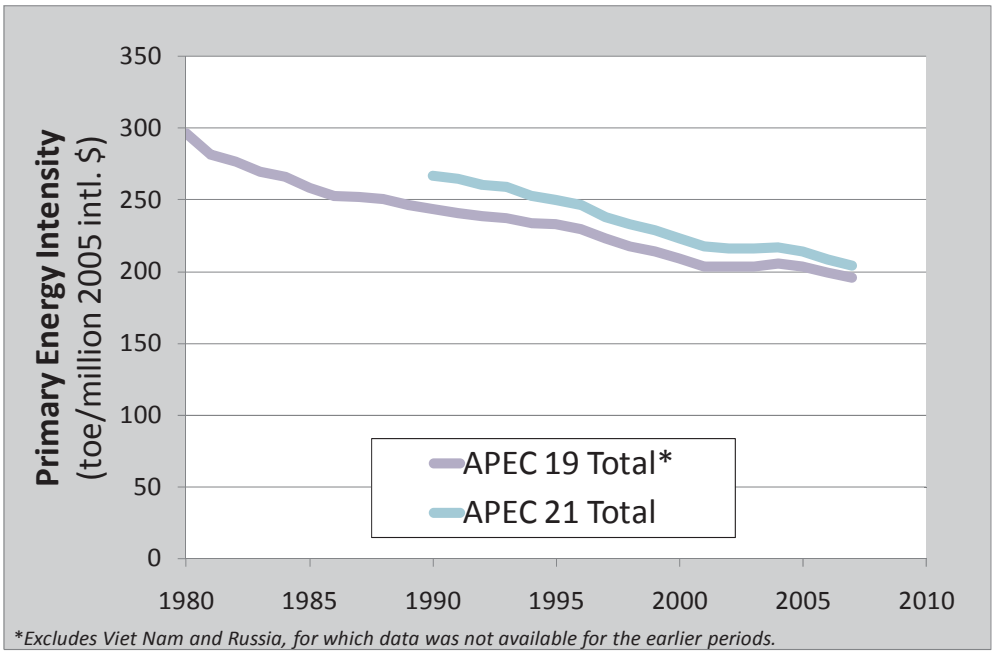

Figure 3.2: Primary Energy Intensity in the APEC Region[9]

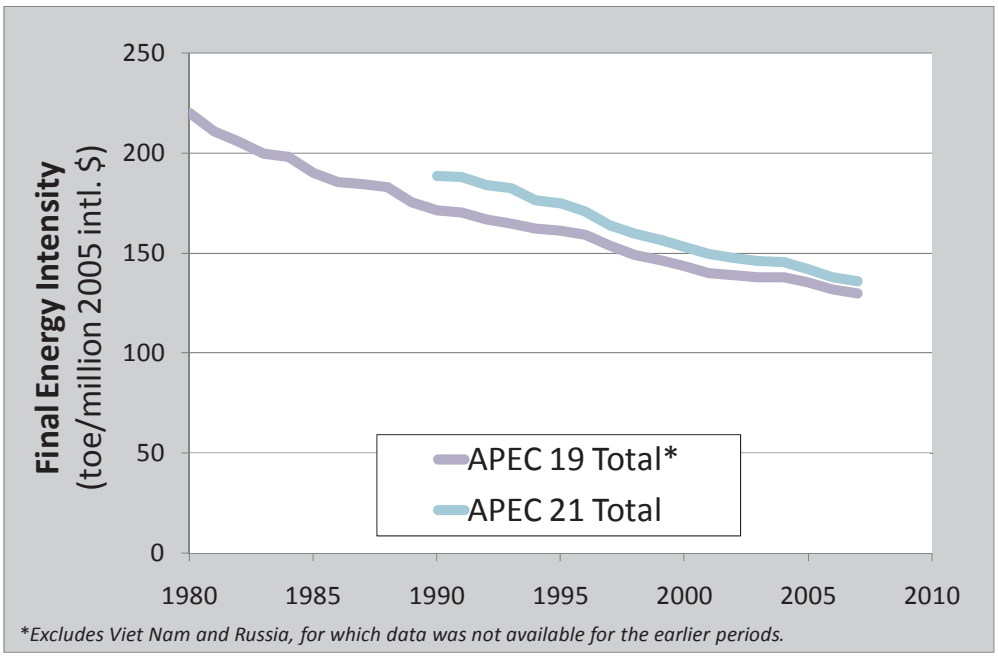

Figure 3.3: Final Energy Intensity in the APEC Region[10]

[9] From International Energy Agency (2009A), International Energy Agency (2009B), World Bank (2009), and International Monetary Fund (2009C).

[10] International Energy Agency (2009A), International Energy Agency (2009B), World Bank (2009), and International Monetary Fund (2009C).

The trend toward declining energy intensity is a robust one. It is worth noting that energy intensity in the APEC region declined during periods of both strong economic growth (such as the late 1990s) and recession (such as the early 1980s and early 1990s). Furthermore, the long-term decline in energy intensity occurred in many APEC economies at all stages of development (see Figures 3.4 and 3.5).

The introduction of modern, efficient processes and equipment is one driver of energy efficiency improvements. For example, China's improved energy intensity during the 1990s was driven by improved energy efficiency, particularly in the industry sector[11]. Changes in energy intensity can also result from changes in economic structure (when economic sectors with different energy intensities grow or contract at different rates). For example, in Brunei Darussalam, Malaysia, the Philippines, Singapore, and Thailand, the industrial sector in general has grown rapidly, leading to increases in energy intensity during either the 1980-2005 or 1990-2005 time periods.[12]

[11] International Energy Agency (2008), p 20.
[12] Asia-Pacific Energy Research Centre (2001), p. 28 (printed version) or p.38 (on-line version).

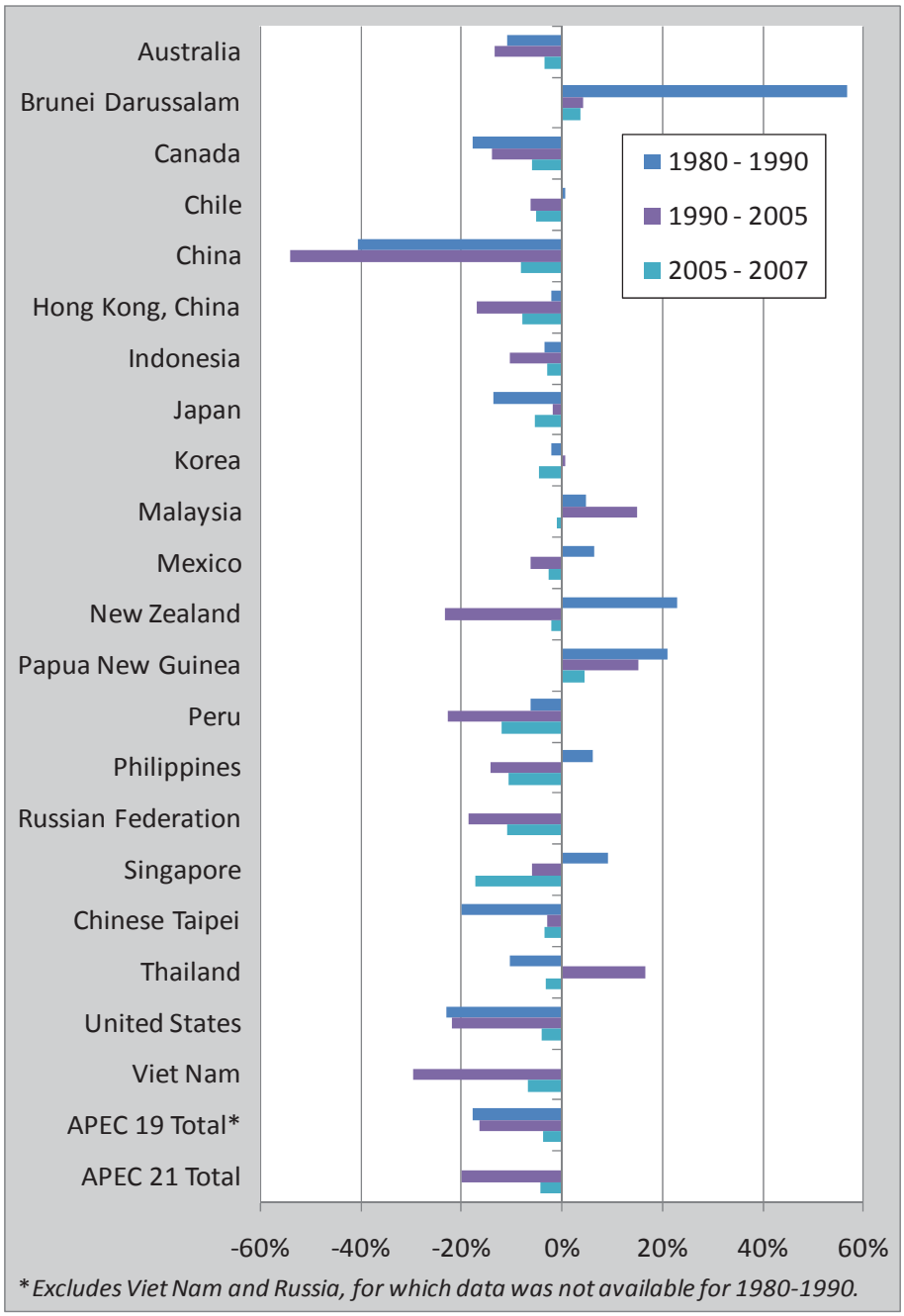

Figure 3.4: Percent Change in Primary Energy Intensity, APEC Economies[13]

[13] International Energy Agency (2009A), International Energy Agency (2009B), World Bank (2009), and International Monetary Fund (2009C).

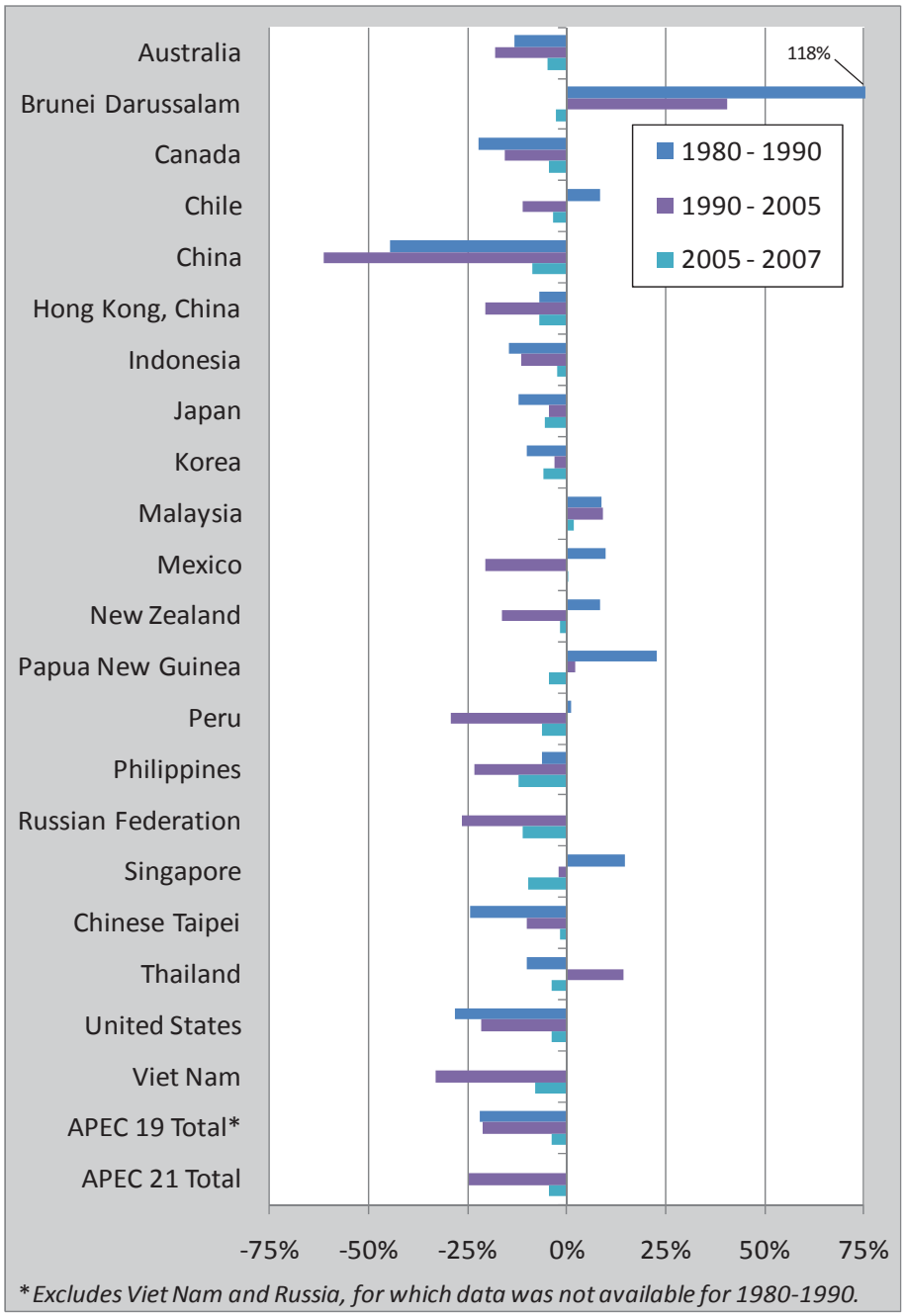

Figure 3.5: Percent Change in Final Energy Intensity, APEC Economies[14]

[14] International Energy Agency (2009A), International Energy Agency (2009B), World Bank (2009), and International Monetary Fund (2009C).

3.4 Energy Intensity Since 2005

2005 was the last year that historical data was published in the *APEC Energy Demand and Supply Outlook 4th Edition.* It is also the base year for the APEC Leaders' 2030 energy 25% intensity improvement goal. As such, it is worth examining what has happened to energy intensity since 2005. Historical data is now available for all APEC economies for 2006 and 2007. Data is available for some economies for 2008 and 2009.

Since 2005, the rate of improvement in energy intensity has accelerated. Figures 3.6 and 3.7 show that the annual rate of decline in energy intensity was generally higher between 2005 and 2007 than it was between 1980 and 1990 or between 1990 and 2005. For the region as a whole, the annual average reduction in primary energy intensity was 2.2% between 2005 and 2007 compared with 1.5% between 1990 and 2005. Similarly, the annual average reduction in final energy intensity was 2.3% between 2005 and 2007 compared with 1.9% between 1990 and 2005. The accelerated rate of decline in energy intensity in 2006 and 2007 is most likely the result of the strengthening of policies that promote energy efficiency in APEC economies; though further analysis is needed to determine the importance of other factors, such as higher energy prices.

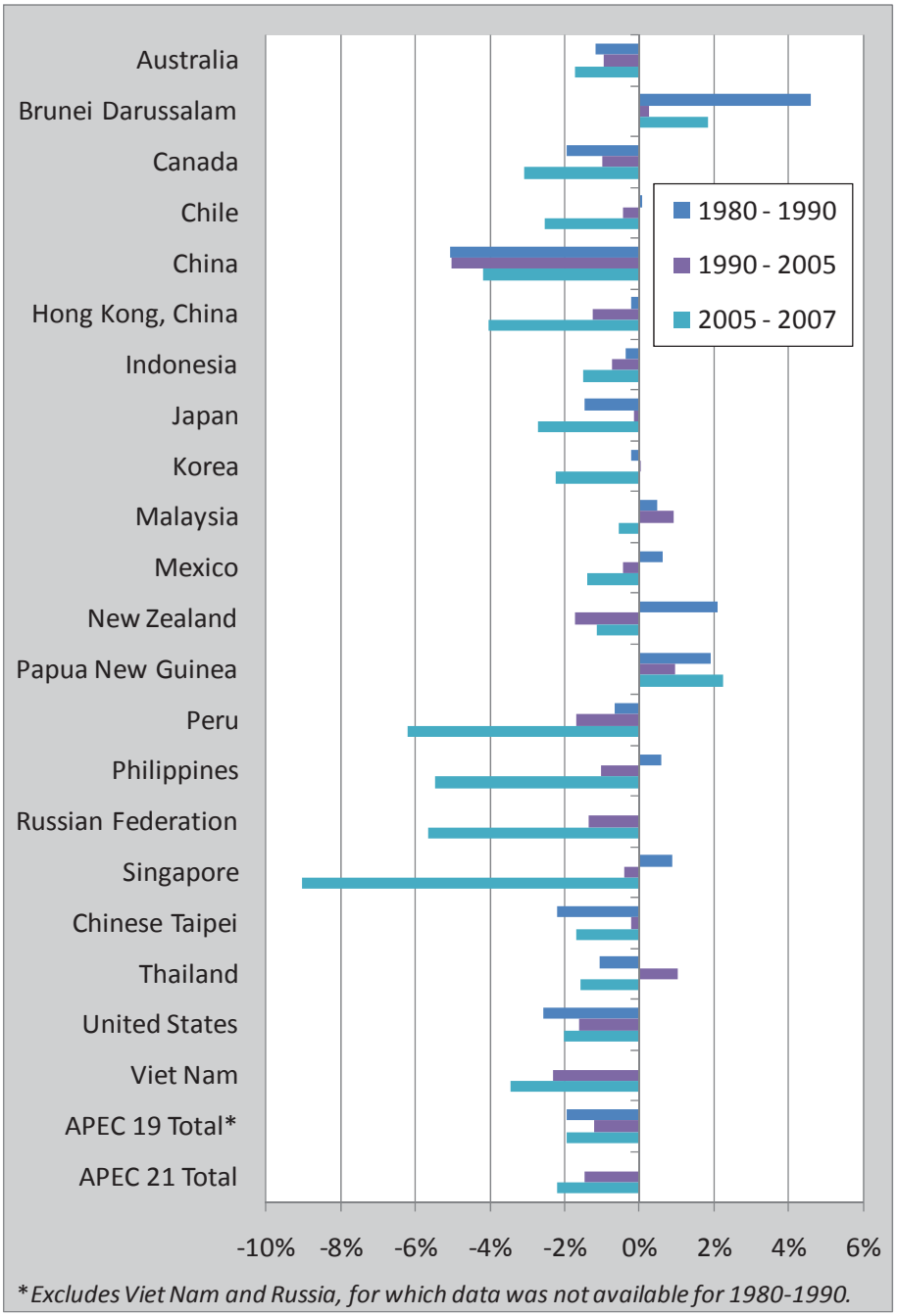

Figure 3.6: Annual Percent Change in Primary Energy Intensity, APEC Economies[15]

[15] International Energy Agency (2009A), International Energy Agency (2009B), World Bank (2009), and International Monetary Fund (2009C).

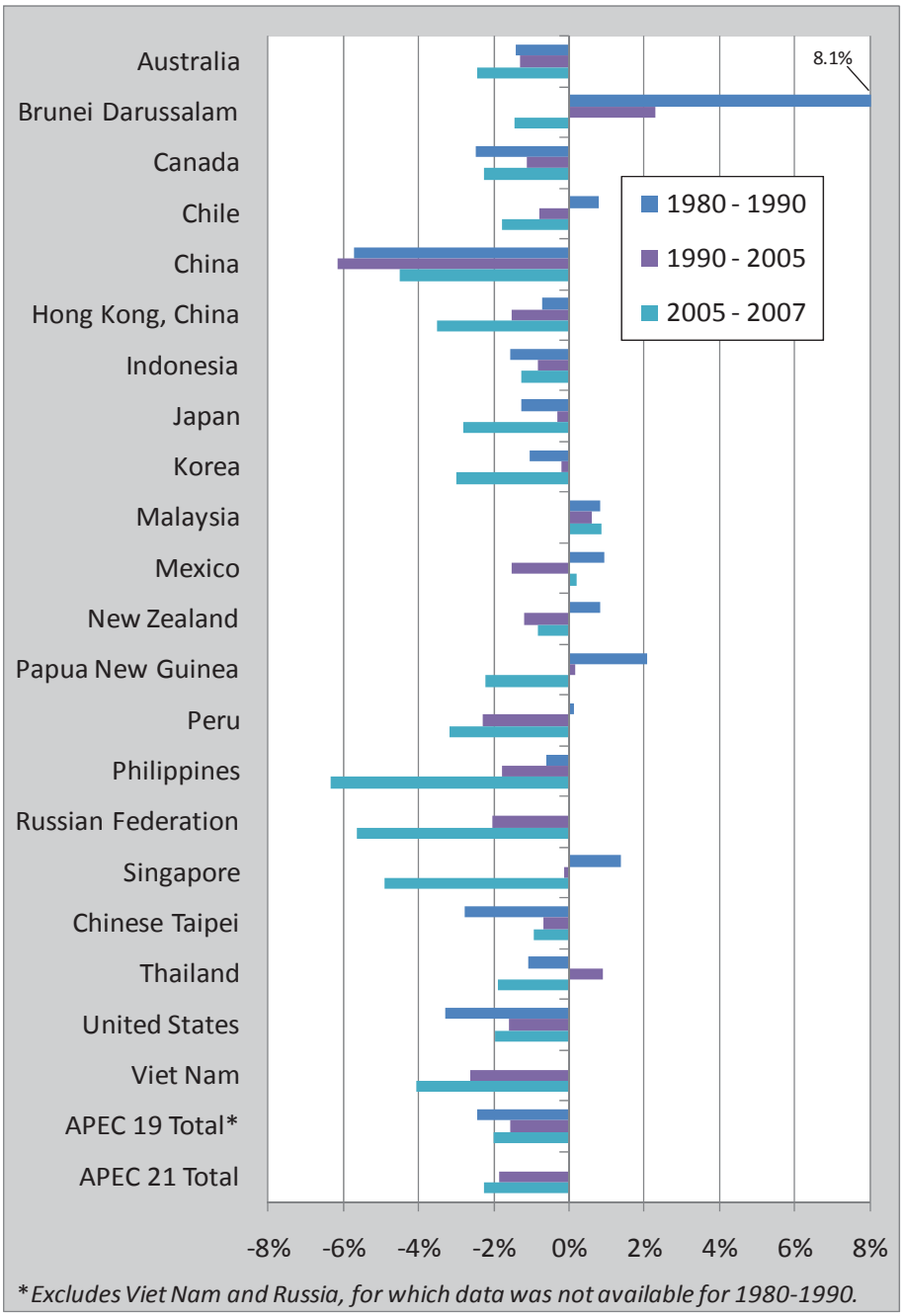

Figure 3.7: Annual Percent Change in Final Energy Intensity, APEC Economies[16]

As mentioned previously, the historical record shows that energy intensity in the APEC region declined through both periods of strong economic growth and recession. Thus, similar

[16] International Energy Agency (2009A), International Energy Agency (2009B), World Bank (2009), and International Monetary Fund (2009C).

resilience in the declining energy intensity trend through the economic crisis that began in 2008 and intensified in 2009 is expected. Though data for only a limited set of economies is available, it indicates that energy intensity continued to decline through 2008 and 2009.

As shown in Figure 3.8, data for the available economies shows primary energy intensity declined through 2008 and 2009 at rates similar to 2006 and 2007. Although New Zealand appears to have experienced a large increase in intensity in 2008, this is misleading. 2008 was a dry year in New Zealand, so there was less hydroelectricity generation (which is assumed to be 100% efficient),[17] while geothermal generation capacity (which is assumed to be only 15% efficient) expanded significantly.[18]

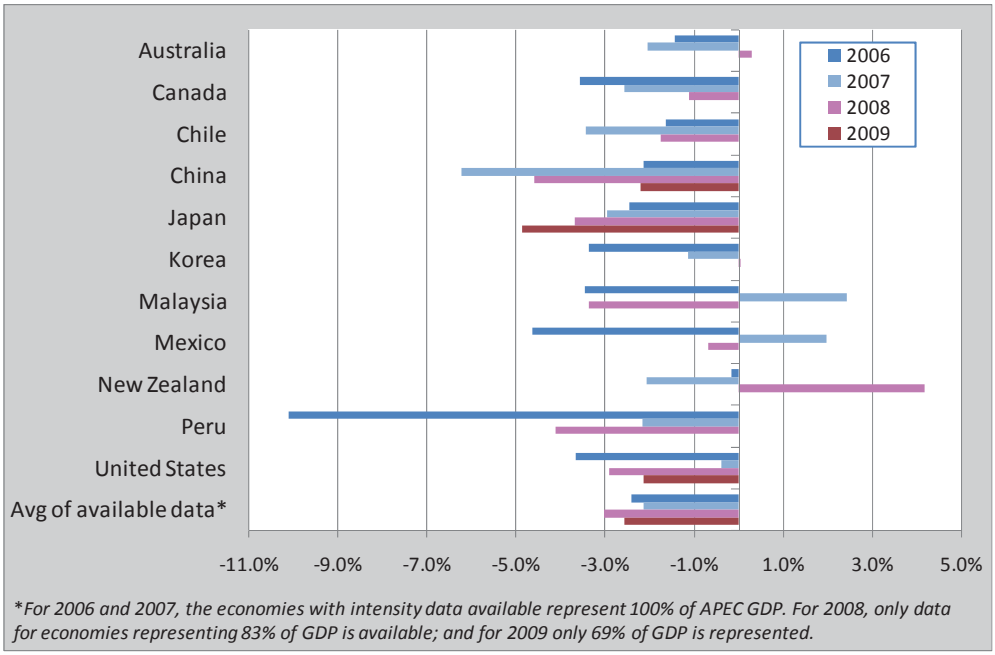

Figure 3.8: Annual Percent Change in Primary Energy Intensity for Economies with 2008 and 2009 Data[19]

Some large economies, such as the United States and Japan, fell into recession in 2009. Yet energy consumption in those economies experienced even larger declines than GDP, resulting in reduced energy intensity. China's economy continued to grow through 2009 at an annual rate of 8.5% (see Table 3.1), but also continued to reduce energy intensity, albeit at a slower pace than in 2007 and 2008. Noting that many economies are making large investments in clean energy through their stimulus packages, it seems reasonable to assume

[17] New Zealand Ministry for the Environment (2010), Section 3.3.1, p. 37.
[18] New Zealand Ministry of Economic Development (2009), p. 10, Table B.1 on p. 16, and p. 103.
[19] International Energy Agency (2009A), International Energy Agency (2009B), World Bank (2009), Chile Commission Nacional de Energia (not dated), Malaysia Ministry of Energy, Green Technology and Water (2009), National Bureau of Statistics of China (2010), Peru Ministereo de Energia y Minas (not dated), United States Energy Information Administration (2010), Institute for Energy Economics, Japan (2010).

that the recent economic crisis will not reverse the long-term decline in the energy intensity of the APEC region.

3.5 A Closer Look at the APEC Business-As-Usual Projection

As noted at the beginning of this chapter, APERC projected in the *APEC Energy Demand and Supply Outlook 4th Edition* that the APEC Leaders' goal will be exceeded under business-as-usual. Under the APERC business-as-usual projection, the goal will be substantially exceeded, with a 38% improvement in primary energy intensity and a 40% improvement in final energy intensity. The decline in primary energy intensity is a bit smaller than the decline in final energy intensity because of a shift in energy consumption towards electricity, resulting in increased transformation losses. This section argues that APERC's business-as-usual projection is a reasonable one and, given the likelihood of non-business-as-usual outcomes in energy policy and energy technology, perhaps even conservative.

Figure 3.9 shows APERC's business-as-usual projections of primary energy intensity and final energy intensity for the APEC region, along with similar independent projections of primary energy intensity from two other research organisations, the IEA and the EIA. Since the regional groupings of economies used by these organisations do not allow an exact match with the economies of the APEC region, there are a few discrepancies in the assumed definition of the APEC region (APEC economies excluded or non-APEC economies included).[20] However, these discrepancies account for only a few percentage points of total APEC GDP, and should not materially affect conclusions about the APEC region as a whole.

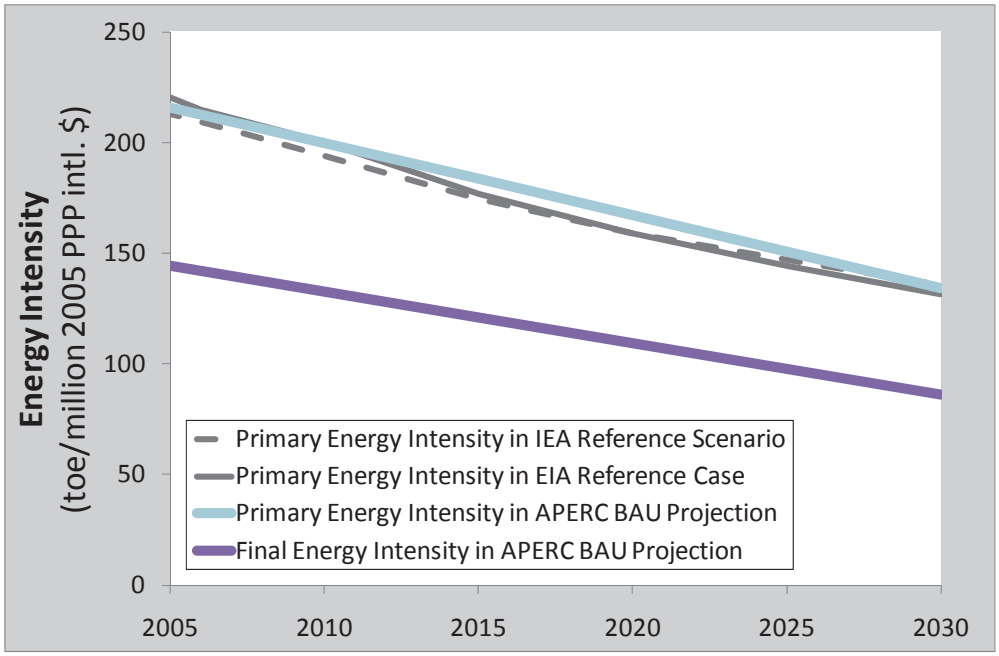

Figure 3.9: Comparison of Business-As-Usual Projected Energy Intensity Improvement for the APEC Region, 2005 to 2030[21]

As is clear from the figure, these independent projections show remarkably similar primary energy intensity reductions to APERC. In fact, at 38%, the intensity reduction in the IEA projection equals that of the APERC projection, and the intensity reduction in the EIA projection is slightly larger at 40%. The fact that three independent modelling efforts have arrived at essentially the same conclusion about business-as-usual energy intensity reduction suggests that APERC's projected 38% energy intensity reduction is a reasonable one.

As in the historical trends, the projected energy intensity improvement trend masks considerable variation among the economies. The percent change in primary energy intensity for APERC's business-as-usual projection is shown for each economy in Figure 3.10. Two-

[20] The assumed grouping of economies used for the the IEA projection is discussed in Section 5.4 below. The groupings of economies used for the EIA projection are OECD North America, OECD Asia, Russia, China, Other Non-OECD Asia, and Other Central and South America.

[21] Asia-Pacific Energy Research Centre (2009B), United States Energy Information Administration (2009), and International Energy Agency (2009C). Additional non-published data was provided by the International Energy Agency. Raw data for IEA primary energy intensity © OECD/IEA 2009, calculations by APERC.

thirds of the economies independently surpass the APEC Leaders' aspirational goal of a 25% energy intensity reduction by 2030 (shown by the dashed red line). In contrast, only two economies, Papua New Guinea and Brunei Darussalam show significant increases in energy intensity (the small increase for New Zealand is again a statistical anomaly owing to an expansion of 'inefficient' geothermal electricity generation). In both of these economies, the increase is largely driven by new, export-oriented, energy-intensive industrial projects that are planned to be completed during the outlook period.[22]

[22] See the sections on these economies in Asia-Pacific Energy Research Centre (2010).

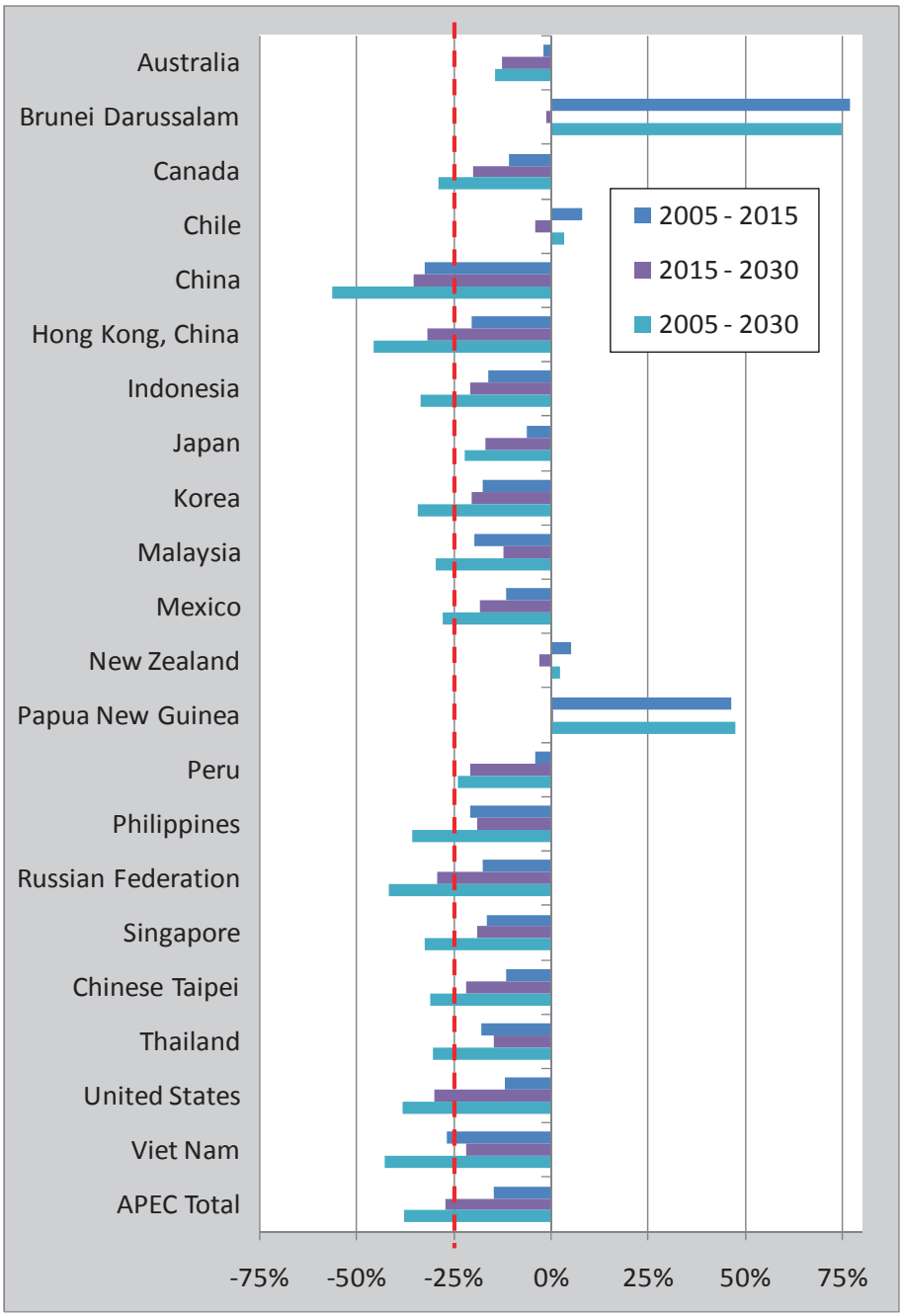

Figure 3.10: APEC Business-As-Usual Projection Total Percent Change in Primary Energy Intensity, APEC Economies[23]

Over next two decades, many factors are expected to drive up energy demand in the APEC region. Rapid growth of per capita income accompanied by improved infrastructure in

[23] Asia-Pacific Energy Research Centre (2009b).

developing economies will bring additional energy services within reach for hundreds of millions of people. By 2030, average per capita income in the region is expected to double.[24] In Russia and Thailand it is expected to nearly triple, in Viet Nam it is expected to triple, and in China it is expected to nearly quadruple.[25]

With all this economic growth driving energy consumption growth, it may seem surprising to see energy intensity steadily declining in the business-as-usual projections. However, it is important to bear in mind that energy intensity is energy *per unit of GDP*, not total energy. It is a widely observed pattern that energy intensity rises during the early stages of an economy's development, when people first begin to acquire the basics of modern living, such as climate controlled housing, hot water, appliances, and vehicles. However, as development continues, further income growth tends to be channelled into less energy-intensive areas, such as services, and energy intensity then declines.[26] The APEC region is already on the downward side of this curve.

It may be argued that APERC's business-as-usual projection is fairly conservative, as there are two other factors driving energy intensity reductions that are not be fully reflected in 'business-as-usual'. The first are the many government policy initiatives for improved energy efficiency throughout the APEC region, such as those discussed in Chapter 2. APERC's business-as-usual projection assumed only policies that were already implemented or being implemented (that is, legislation already passed) as of early 2009. However, there were and are many additional proposed policies under consideration, some of which will certainly be implemented by 2030, that are not reflected in APERC's business-as usual.

Second, technological progress is likely to provide further opportunities to reduce energy intensity. The APERC business-as-usual projection assumed technological progress at historical rates. However, both anticipated high energy prices and government policies are driving a push for accelerated technological improvement. Government spending on energy research, development, and demonstration efforts has begun to rise again after a long and relentless decline in the 1980s and 1990s.[27] In the private sector, both higher energy prices and competitive pressures to respond to government policies, such as appliance energy efficiency standards, are also likely to accelerate energy-saving innovations.[28]

The finding that there appears to be room for further energy intensity improvement beyond the APEC Leaders' aspirational goal, and beyond APERC's business-as-usual projection, is good news, as this further improvement will definitely be needed to ensure energy sustainability in the APEC region. As already pointed out, energy intensity is just *energy per unit of GDP*. Even with the improvements in energy intensity that APERC is projecting under business-as-usual, total energy demand and total greenhouse gas emissions will continue to rise. Much larger improvements in energy intensity will be needed to move the APEC region toward a sustainable energy path.

It would, therefore, be worthwhile for the APEC economies to reassess their APEC-wide goals for energy intensity improvement. The next chapter looks at the energy challenges the

[24] Asia-Pacific Energy Reserach Centre (2009A), p. 13.
[25] Asia-Pacific Energy Reserach Centre (2009B), 'Outlook Results by Economy' section.
[26] United Nations Development Programme (2000), Chapter 11, p. 399.
[27] International Energy Agency (2009C), pp. 290-291.
[28] Newell (1999).

APEC region faces, while Chapter 5 examines the question of how much improvement in energy intensity is needed to move the APEC region toward a sustainable path.

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CHAPTER 4 - GOALS FOR SUSTAINABILITY

4.1 Why More Action Is Needed

Chapter 2 discussed the efforts of APEC economies to improve energy efficiency both through voluntary cooperation and though individual economy policies. Chapter 3 discussed the continuing trend in APEC economies towards lower energy intensity (energy per dollar of GDP). Progress has been impressive and should be welcomed. The key energy challenge the APEC region still faces is that business-as-usual is not likely to result in a sustainable energy future; that is, economic growth, energy security, and environmental protection. More action will be needed. But what kind of action? To determine which actions are appropriate a deeper understanding of what a sustainable energy future might look like is required. This chapter and chapter 5 address this topic. This chapter focuses on general energy sustainability goals. It focuses on appropriate goals for dealing with climate change, as these tend to be difficult and complex to analyse.

The *APEC Energy Demand and Supply Outlook 4th Edition*[1] identified two major energy-related threats to the future of the APEC region: oil security and growing greenhouse gas emissions.

[1] Asia Pacific Energy Research Centre (2009), Chapter 1.

4.2 The Oil Security Threat

Figure 4.1 shows APEC's historical and projected oil production and imports. Overall oil demand is expected to rise rapidly with more than half the growth in the transport sector. However, oil production in the APEC region is not expected to grow significantly. The result will be a growing gap between oil demand and oil production which must be met by imports from outside the region.

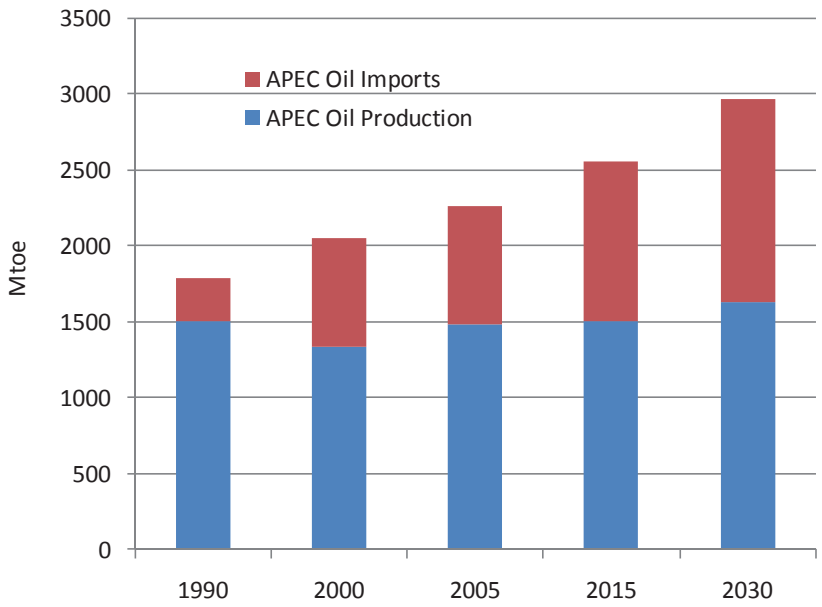

Figure 4.1: APEC Oil Production and Imports[2]

The increasing dependence on imported oil poses two threats. The first is the direct security of supply threat that a disruption would pose. The second, is the threat to the economy that would be posed by very high oil prices, either suddenly as a result of a disruption or more gradually as a result of underinvestment in oil production capacity.

Over the longer-term, some analysts raise questions about whether the world's oil resources are adequate to support such rapid growth in demand. The IEA, which has modelled oil production in some detail, has concluded that the world's oil resources should be adequate to meet demand to 2030 and well beyond.[3] However, this assumes adequate investment is

[2] Asia Pacific Energy Research Centre (2009), Figure 1.4.
[3] International Energy Agency (2009A), pp. 79-80.

made, and that unconventional oil resources including Canadian oil sands, extra-heavy oil, gas-to-liquids, and coal-to-liquids can make up an increasing share of production.[4]

These security of supply threats can be mitigated, to some degree, through cooperation between oil producing and oil consuming economies[5], especially improving the quality of energy market data[6], and also through oil emergency response planning, including the holding of emergency stockpiles.[7] However, given the high and rising share of oil import dependency, the threats are likely to persist.

Growing greenhouse gas emissions are the second concern. As shown in Figure 4.2, APEC region CO_2 emissions from fuel combustion are expected to rise by around 40% between 2005 and 2030. As discussed in the next section, this rising emissions path has a great probability of disastrous climate change consequences.

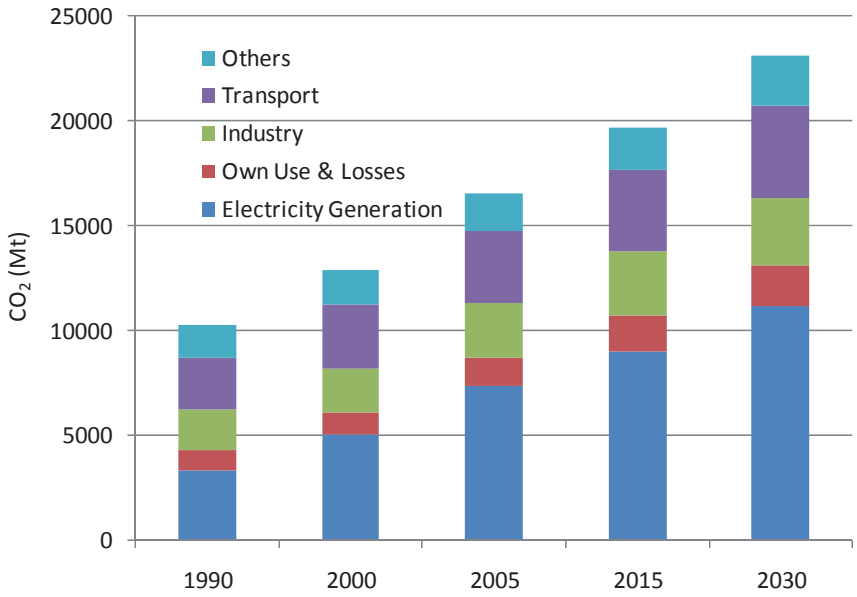

Figure 4.2: APEC CO_2 Emissions from Fuel Combustion

[4] International Energy Agency (2009A), p. 87.
[5] Hamel (2007).
[6] Joint Oil Data Initiative (2010).
[7] See Samuelson (2008), Section 7.2.

4.3 The Greenhouse Gas Emissions Threat

Scientists hold a broad range of views on scientific issues related to climate change. The scientific data on climate change, as well as the discussion of scientific findings, discussed in this chapter are drawn mainly from the work of the Intergovernmental Panel on Climate Change (IPCC). The IPCC was established by the United Nations Environment Program (UNEP) and the World Meteorological Organization (WMO). The objective of the IPCC has been "to provide the world with a clear scientific view on the current state of climate change and its potential environmental and socio-economic consequences".[8]

Human activities have been releasing greenhouse gases into the atmosphere since at least the beginnings of industrialisation, with carbon dioxide from the combustion of fossil fuels being the most significant (see **Box 4.1 – Greenhouse Gases and Climate Change** and **Box 4.2 – Global Warming Potentials (GWP) and CO_2-equivalents**). The concentration of CO_2 in the atmosphere has increased from a pre-industrial value of about 280 parts per million (ppm) to 379 ppm in 2005.[9]

[8] Intergovernmental Panel on Climate Change (2010A).
[9] Intergovernmental Panel on Climate Change (2007A), Section 2.2.

Box 4.1 The Greenhouse Gases and Climate Change

Four classes of gases are primarily responsible for climate change[10].

Carbon dioxide (CO_2) is the most important greenhouse gas by far, accounting for about 76% of global greenhouse gas emissions in 2005 on a carbon dioxide-equivalent basis. [11] On a worldwide basis, about 80% of man-made carbon dioxide emissions come from the energy sector, with about 79% coming from the combustion of fossil fuels. The remaining roughly 1% comes from 'fugitive' sources, which include the flaring of unmarketable natural gas,[12] and carbon dioxide produced with natural gas and extracted in gas processing plants.[13]

Methane (CH_4) is the second most important greenhouse gas, accounting for about 16% of global greenhouse gas emissions in 2005 on a carbon dioxide-equivalent basis. Methane is the principle component of natural gas.[14] On a worldwide basis, about 35% of man-made methane emissions come from the energy sector, mainly coal and gas production and transmission. Cattle, sheep, and other grazing animals produce methane during digestion, so agriculture is the largest emitter of methane, accounting for about 43% of methane emissions on a worldwide basis. Methane is also produced by landfills and in waste water treatment.[15]

Nitrous Oxide (N_2O) is the third most important greenhouse gas, accounting for about 7% of global greenhouse gas emissions in 2005 on a carbon dioxide–equivalent basis. It can be produced by combustion, but on a worldwide basis only about 8% of man-made nitrous oxide comes from the energy sector. A major contributor of nitrous oxide is agricultural soils, especially those treated with fertilisers[16], so agriculture accounts for about 64% of nitrous oxide emissions on a worldwide basis.

Halocarbons, which are industrial gases containing fluorine, chlorine, or bromine[17], account for the remaining 2% of greenhouse gas emissions in 2005 on a carbon dioxide-equivalent basis.

A final greenhouse gas that should be mentioned is **water vapour**, as there is confusion about its role in climate change. Water vapour is a potent greenhouse gas. However, given that much of the earth's surface is covered by water, there are huge natural sources of water vapour. In addition, when there is excess water vapour in the atmosphere, it falls out as rain. As a result, man-made emissions of water vapour are not believed to be a significant contributor to climate change. Water vapour is still a concern with regard to climate change. This is because the amount of water vapour in the atmosphere is largely determined by temperature. As atmospheric temperature rises, the atmosphere will naturally absorb more water vapour, and this will compound the impact of the other greenhouse gas emissions further.[18]

[10] Intergovernmental Panel on Climate Change (2007A), Section 2.2.
[11] Unless otherwise indicated, statistics of worldwide emissions discussed in this box are from International Energy Agency (2009B), pp. III.44 and III.45.
[12] International Energy Agency (2009B), p. III.12.
[13] New Zealand Ministry of Economic Development (2009), p. 32.
[14] Samuelson (2008), Section 1.1.
[15] US Environmental Protection Agency (2010A).
[16] US Environmental Protection Agency (2010B).
[17] Intergovernmental Panel on Climate Change (2007A), Section 2.2.
[18] Intergovernmental Panel on Climate Change (2007A), Section 2.3 and National Institute of Water & Atmospheric Research (2006).

Box 4.1 – Continued from Previous Page

Table 4.1 summarises worldwide man-made greenhouse gas emissions on a CO_2-equivalent basis for 2005.

Table 4.1 – 2005 Greenhouse Gas Emissions[19]
(million tonnes of CO_2-equivalent using GWP-100)

Gas	From Fuel Combustion	From Energy Sector	From All Sources
Carbon Dioxide (CO_2)	27,147	27,487	34,438
Methane (CH_4)	-	2,548	7,319
Nitrous Oxide (N_2O)	-	234	2,953
Halocarbons	-	-	715
Total	27,147	30,269	45,426

Greenhouse gas emissions from energy are overwhelmingly (about 90%) accounted for by carbon dioxide from fuel combustion. Carbon dioxide emissions from fuel combustion can also be easily estimated with reasonable accuracy, since CO_2 emissions per quantity of fuel combusted are a fixed chemical property of each fuel. Hence, the only data required to calculate CO_2 emissions from fuel combustion is the volume of fuel combusted. Estimating non-fuel combustion CO_2 energy emissions or energy emissions of other gases requires additional data, more complicated modelling and may yield less accurate results.[20] For these reasons, reporting of CO_2 emissions in the energy sector often focuses on CO_2 emissions from fossil fuel combustion.

[19] Data from International Energy Agency (2009B), pp. III.44 and III.45.
[20] Intergovernmental Panel on Climate Change (2006), Volume 2 – Energy, Chapter 1 – Introduction.

Box 4.2 – Global Warming Potentials and CO_2-equivalents

The calculation of the CO_2-equivalents discussed in this report deserves some explanation. Greenhouse gases differ quite dramatically in their ability trap heat in the atmosphere. Therefore, global warming potentials (GWPs) are used to compare the abilities of different greenhouse gases to trap heat in the atmosphere. The GWP of a given gas describes its warming influence relative to a similar amount of CO_2. This comparison is made more complicated by the fact that different gases have different lifetimes in the atmosphere. Table 4.2 below shows GWPs for major greenhouse gases as prescribed for international reporting by the United Nations Framework Convention on Climate Change (UNFCCC). For example, after 100 years, one kilogram of HFC-23 (one of the halocarbons) will have a similar warming impact to 14,800 kilograms of CO_2.

Table 4.2 – Global Warming Potentials for Some Greenhouse Gases[21]

Gases	Lifetime (years)	GWP time horizon		
		20 years	100 years	500 years
Carbon Dioxide	>100	1	1	1
Methane	12	56	21	6.5
Nitrous Oxide	120	280	310	170
HFC-23	264	9100	11,700	9800
HFC-134a	14.6	3,400	1,300	4320
Sulfur Hexafluoride	3200	16,300	22,900	34,900

To calculate CO_2-equivalent emissions of a particular gas, actual emissions should be multiplied by its GWP. A 100 year time horizon has been adopted as the standard for reporting to the UNFCCC.[22]

[21] United Nations Framework Convention on Climate Change (2010A) except for the lifetime of Carbon Dioxide which comes from Blasing, T.J. (2010).
[22] United Nations Framework Convention on Climate Change (2000).

As shown in Figure 4.3 below, the earth's surface temperatures have been rising fairly steadily since 1850, with a temperature rise of about 0.74°C over the last 100 years.[23] This trend is expected to continue as long as the concentration of greenhouse gases continues to rise in the atmosphere.[24]

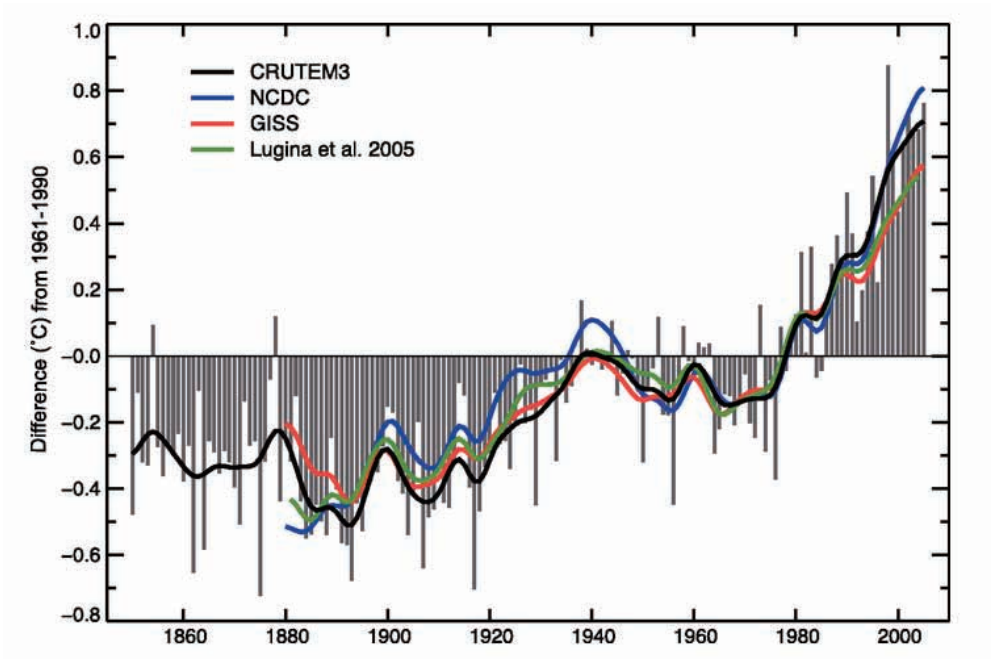

Figure 4.3: Annual anomalies of global land-surface air temperature (°C), 1850 to 2005[25]

The rising temperature is expected to have a number of damaging effects on the APEC region. Some examples include:

- rising sea levels: by the 2080s millions of people are likely to experience coastal flooding each year, especially in the low-lying mega deltas of Asia[26]
- declines in global food production potential[27]
- tropical cyclones (typhoons and hurricanes) becoming more intense[28]

[23] Intergovernmental Panel on Climate Change (2007B), p. 237.
[24] Intergovernmental Panel on Climate Change (2007A), Section 3.2.
[25] Intergovernmental Panel on Climate Change (2007A), Figure 3.1. The annual anomalies are shown relative to the 1961-1990 mean and are from CRU/Hadley Centre gridded land-surface air temperature version 3 (CRUTEM3) of Brohan et al. (2006). The smooth curves show decadal variations (see Intergovernmental Panel on Climate Change (2007A), Appendix 3.A). The black curve from CRUTEM3 is compared with those from NCDC (Smith and Reynolds (2005); blue), GISS (Hansen et al. (2001); red) and Lugina et al. (2005); green). Most of the differences arise from the diversity of spatial averaging techniques.
[26] Intergovernmental Panel on Climate Change (2007A), Section 3.3.
[27] Intergovernmental Panel on Climate Change (2007A), Section 3.3.
[28] Intergovernmental Panel on Climate Change (2007A), Section 3.2.2 and Table 3.2.

- widespread loss of glaciers and snow cover, reducing water availability, hydro potential, and changing the seasonality of water flows in regions supplied by melt water from major mountain ranges (Hindu-Kush, Himalaya, Andes) where one-sixth of the world population currently lives[29]
- adverse health impacts, including increased diarrhoeal, cardio-respiratory, and infectious diseases[30]
- increases in rainfall in some wet, tropical areas, including East and Southeast Asia, accompanied by decreases in rainfall in many semi-arid areas including the western United States; the extent of drought in drought-affected areas is expected to increase[31]
- widespread damage to coral reefs and their dependent species, including Australia's Great Barrier Reef, because of ocean acidification[32]
- greater frequency of extreme weather events, including heat waves and heavy precipitation[33]
- widespread extinction of wildlife.[34]

[29] Intergovernmental Panel on Climate Change (2007A), Figure 3.5 "Climate Change and Water", p. 49.
[30] Intergovernmental Panel on Climate Change (2007A), Figure 3.6 "Examples of Impacts Associated with Global Average Temperature Change", p. 51.
[31] Intergovernmental Panel on Climate Change (2007A), Figure 3.5 "Climate Change and Water", p. 49.
[32] Intergovernmental Panel on Climate Change (2007A), Figure 3.6 "Examples of Impacts Associated with Global Average Temperature Change", p. 51.
[33] Intergovernmental Panel on Climate Change (2007A), Table 3.2.
[34] Intergovernmental Panel on Climate Change (2007A), p. 54.

These effects depend on the amount of temperature rise. Figure 4.4 summarises the IPCC's analysis of the environmental impacts at various levels of temperature rise.

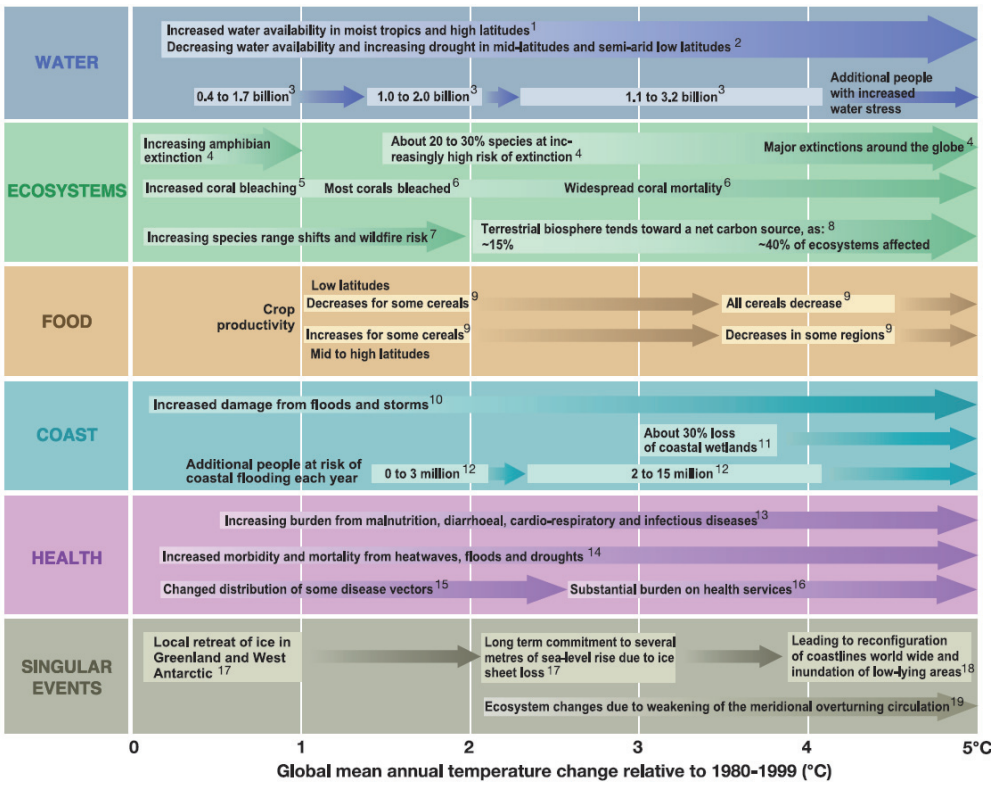

Figure 4.4: Impacts of Climate Change[35]

Science can provide estimates of the effect of greenhouse gas emissions on global temperatures and the effects of the temperature rises. However it can not provide a definitive answer about the acceptable temperature rise. This is a matter of public policy, and depends on the trade-off between the long-term benefits of limiting temperature rise against the immediate and continuing costs of limiting greenhouse gas emissions.

4.4 Emission Limits Implied by a 2°C Limit on Temperature Rise

Global cooperative efforts are a work in progress. However, there does appear to be significant support for a limit of 2°C. This is reflected in the Copenhagen Accord, which calls for holding "the increase in global temperature below 2 degrees Celsius". [36] As of the end of May 2010, the UNFCCC website lists 125 UNFCC member economies plus the European

[35] Intergovernmental Panel on Climate Change (2007C), Technical Summary, Table TS.3.
[36] United Nations Framework Convention on Climate Change (2010H).

Union as "agreeing" to the Accord.[37] Because of the widespread support it has attracted, 2°C is considered to be the limit on temperature rise that would be consistent with energy sustainability.

If 2°C or less is the limit on temperature rise, what does this imply about what needs to happen to emissions? Since temperature rise is a function of the concentration of greenhouse gases in the atmosphere, and since these gases tend to be very long-lived (see Box 4.2), it means that emissions will need to be reduced considerably. The need to reduce emissions contrasts strongly with the business-as-usual scenario for APEC shown in Figure 4.2.

[37] APERC's count of economies shown on the United Nations Framework Convention on Climate Change website (2010I) as listed in the chapeau of the Copenhagen Accord as of 27 May 2010, or later, expressing their intention to be listed, as agreeing to the Accord.

The maximum concentration of greenhouse gases in the atmosphere required to limit temperature rise to 2°C is a scientific question. Figure 4.5 shows the IPCC's best estimate of the relationship between the concentration of greenhouse gases in the atmosphere, as measured in parts-per-million (PPM) of CO_2-equivalent (see Box 4.2 for an explanation of CO_2-equivalents), and temperature rise. The purple curve in the centre represents the 'best estimate', while the lower (blue) curve and upper (red) curve represent lower and upper bounds, respectively. Taking the best estimate, it can be seen that a 2°C temperature rise corresponds to a greenhouse gas concentration stabilisation level of roughly 450 PPM CO_2-equivalent.

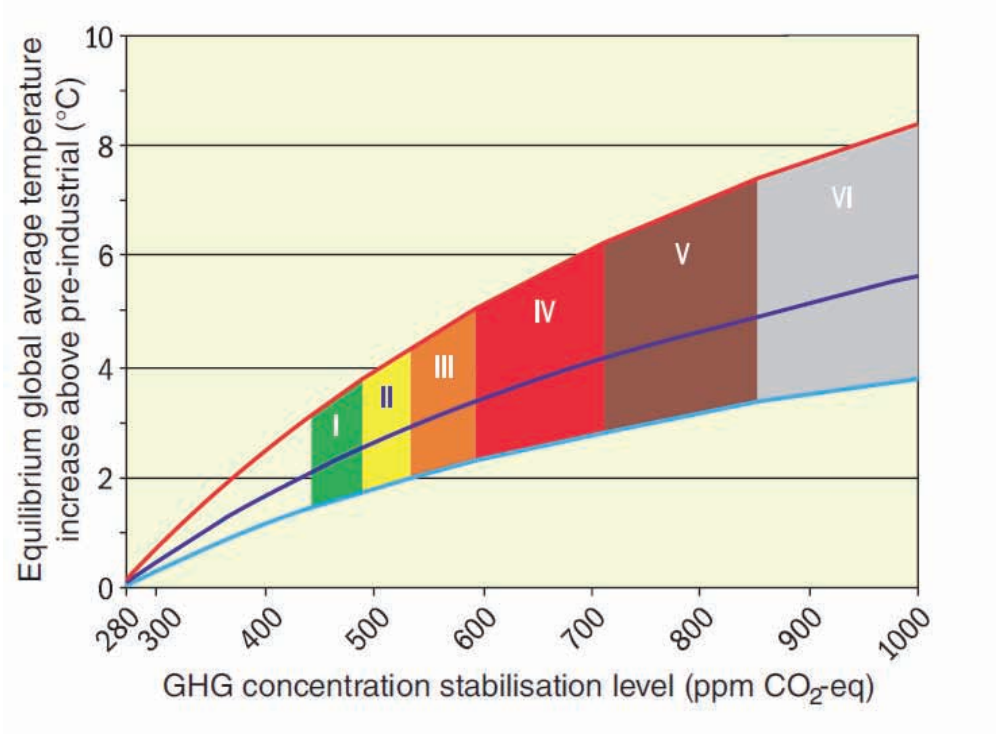

Figure 4.5. Relationship of Greenhouse Gas Concentration Stabilization Level and Temperature Rise[38]

So if the goal is to limit the global temperature rise to 2°C, then it follows that around 450 PPM of CO_2-equivalent should be the prudent limit on greenhouse gas concentrations. In this report, 450 PPM of CO_2-equivalent is considered to be the maximum greenhouse gas concentration stabilisation level that could put APEC (and the world) on a path to energy sustainability. Chapter 5 looks at a scenario where the energy sector in the APEC region contributes to achieving stabilisation at 450 PPM CO_2-equivalent.

[38] Intergovernmental Panel on Climate Change (2007A), Figure 5.1, p. 66.

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CHAPTER 5 - A SUSTAINABLE SCENARIO FOR APEC

5.1 Chapter Overview

In setting voluntary goals and plans for cooperative action for energy sustainability, it is helpful to have an understanding of what a scenario for energy sustainability might look like, and the actions that will be necessary to achieve it. There are many possible scenarios for energy sustainability. However, one example can illustrate actions that can be effective in moving energy towards sustainability. This chapter examines one possible scenario. The scenario also provides some indicators that APEC economies can use to measure their progress towards energy sustainability and to set voluntary goals for the future.

Chapter 1 discussed the definition of energy sustainability. This definition includes environmental protection, economic growth and energy security. In particular, 'sustainability' must allow APEC economies to continue their economic and social development, and allow everyone to share the benefits of commercial energy at affordable prices. In terms of environmental protection, the previous chapter discussed the scientific case for limiting global temperature rise, the wide support for a 2°C limit on global temperature rise, and how a 2°C limit would imply the need to stabilise the concentration of greenhouse gases in the atmosphere at less than 450 PPM.

This chapter makes the case that energy sustainability, using the broad definition of sustainability discussed in Chapter 1, is possible. However, to achieve it will require actions by APEC economies (and non-APEC economies) that go well beyond business-as-usual.

5.2 What Path of Emissions is Environmentally Sustainable?

Before designing an APEC energy system that can achieve energy sustainability, a path of energy emissions for the APEC region that can contribute to limiting global temperature increases to 2°C needs to be defined. To establish this path, three questions must be answered:

1. What worldwide path of total CO_2-equivalent emissions is required to limit the concentration of CO_2-eqivalent to 450 PPM?
2. What is the share of energy-related CO_2 emissions in this total?
3. What is APEC's fair share of worldwide energy-related CO_2 emissions?

To answer the first two questions, an analysis performed by the IEA for their *World Energy Outlook 2009*[1] has been used. The IEA used the OECD's ENV-Linkages model[2], a general equilibrium model designed for analysing the economic impacts of climate change mitigation policy, to establish a trajectory for greenhouse gas emissions from all sources (both energy and non-energy) which achieves long-term 450 PPM stabilisation. Results were checked for compatibility with the target using the Model for the Assessment of Greenhouse-gas Induced

[1] International Energy Agency (2009a), Chapter 5.
[2] Burniaux and Chateau (2008).

Climate Change (MAGICC) developed at the US National Center for Atmospheric Research.[3] MAGICC is a climate model that estimates the volume of greenhouse gases in the atmosphere resulting from emissions trajectories.

The assumed emissions path is shown in Figure 5.1. In the early years, emission reductions are largest for methane (CH_4), nitrous oxide (N_2O), and F-gases (halocarbons), because of the lower cost of abatement for these gases. Emissions of these gases are assumed to peak soon after 2010. The low-cost abatement potential for these gases is soon fully utilised and further emission reductions must focus on energy-related CO_2.

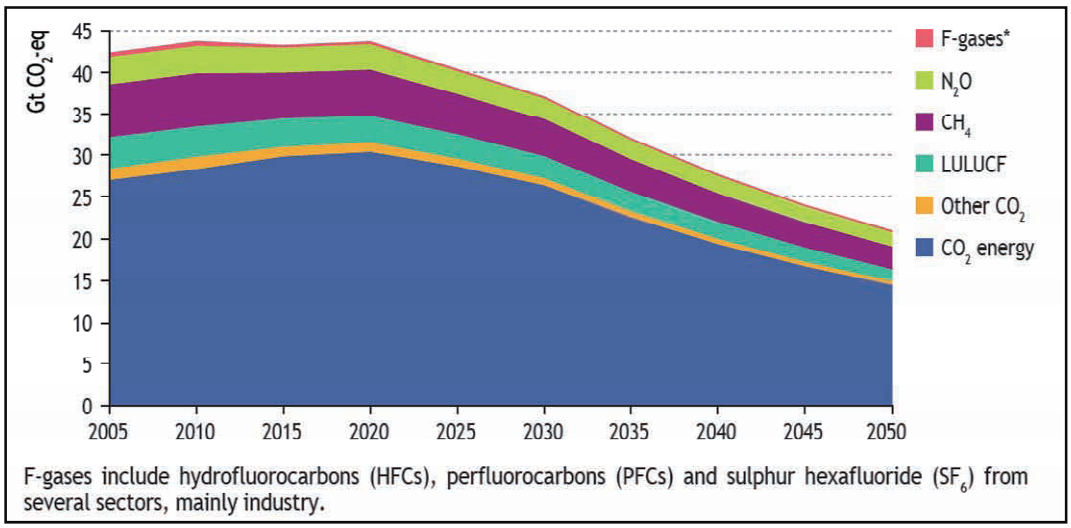

Figure 5.1: Assumed World Greenhouse Gas Emissions – Sustainable Scenario[4]

Total CO_2-equivalent reductions of all greenhouse gases

- peak just before 2020 at about 3% above 2005 levels
- decline to 12% below 2005 levels by 2030
- continue to decline to about 50% of 2005 levels by 2050.

Energy-related CO_2-emissions

- peak just before 2020 at around 14% above 2005 levels
- decline to 2% below 2005 levels by 2030
- continue to decline to about 46% below 2005 levels by 2050.[5]

The concentration of greenhouse gases in this scenario actually overshoots 450 PPM, peaking at 510 PPM in 2035, remaining flat for about 10 years, then declining to the long-term target of 450 PPM.[6]

[3] National Center for Atmospheric Research (2010).
[4] International Energy Agency (2009a), Figure 5.2. *World Energy Outlook 2009* © OECD/IEA 2009.
[5] International Energy Agency (2009a), Table 5.1.
[6] International Energy Agency (2009a), p. 199.

Regarding the third question—APEC's fair share of global energy-related CO_2 emissions—the model assumed that three sets of mitigation policies will be applied globally, depending on the development status of each economy. These policies will be

- most stringent for the OECD economies
- less stringent for China, Russia, Brazil, South Africa, and the Middle East
- least stringent for all other economies, including India.

APEC's share of worldwide energy-related CO_2 emissions is the result of modelling these policies worldwide.

5.3 Fairness

As explained earlier, the goal of this chapter is to provide one example of a sustainable energy scenario. This chapter should not be viewed as a proposal for allocating emission reductions to economies. In fact, research alone cannot provide the correct allocation of emission reductions.

- the allocation of emissions between economies is a result that would best be worked out through global negotiations
- APEC's efforts for sustainability need to be achieved through voluntary actions in any case.

The allocation of emission reductions discussed here could be part of a fair and widely acceptable global response to the climate change problem. This is because, in addition to deciding how to allocate emission reductions, a global response to the climate change problem may involve the payment of other types of compensation for emission reductions. Although compensation is not examined in this report, the ability to negotiate a response involving elements other than emission reductions has the potential to make almost any reasonable allocation of emission reductions into one that could be a basis for negotiations.

5.4 The Modelling Approach

The modelling approach results discussed here are drawn from the '450 Scenario' developed by the IEA for their *World Energy Outlook 2009*[7]. For this chapter, APERC has calculated results for the APEC region, and provided other analysis.

APERC has chosen to use the IEA's 450 Scenario results for the sustainable scenario presented in this chapter for two reasons:

- the IEA has already modelled a 450 PPM scenario in great detail
- the time available to provide results prior to the APEC Energy Ministers meeting in June 2010 was very short, and did not allow the development of an APERC 450 PPM scenario from the ground-up.

The results presented here have been prepared with the full cooperation of the IEA.

[7] International Energy Agency (2009a), Chapters 5-9.

The IEA's model[8] is very detailed and sophisticated, having been developed over 16 years, and includes over 16,000 equations. The model takes into account:

- demand at a very disaggregated level
- specific supply-side technologies
- investment costs
- macro-economic impacts
- field-by-field oil production
- refinery characteristics
- access to electricity in developing economies.

It should be noted that the matching between the regions used in the IEA's modelling and the APEC region is close, but not perfect. Regions in the IEA's model included

1. Australia and New Zealand
2. Canada
3. China and Hong Kong, China
4. Indonesia
5. Japan
6. Korea
7. Mexico
8. Russia
9. United States
10. "ASEAN 9": Brunei Darussalam, Cambodia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam
11. "Rest of Asia": including Chinese Taipei, Papua New Guinea, and a number of other non-APEC Asian economies
12. "Rest of Latin America": including Chile, Peru, and a number of other non-APEC Latin American economies.

[8] International Energy Agency (2010).

Given these constraints, regions 1-10 above were taken as the best available representation of the APEC region for purposes of comparing scenarios. These regions include 17 of the 21 APEC economies, about 97% of APEC's GDP, and about 98% of APEC's emissions for both 2005 and anticipated for 2030.[9] Where totals for the APEC region are presented, APERC's business-as-usual projections for Chinese Taipei, Papua New Guinea, Chile, and Peru were added in order to provide a complete representation of the region. Because of their inclusion in the "ASEAN 9", all of the results will include the non-APEC economies of Cambodia, Laos, and Myanmar. However, these economies together accounted for less than 1% of APEC's GDP and primary energy supply in 2005.[10]

5.5 The Assumed Policy Framework

As noted earlier, the model assumes three sets of mitigation policies will be applied globally, which depend upon the development status of the economy. Figures 5.2 and 5.3 show the policy framework for the 2013-2020 and 2021-2030 timeframes, respectively.

- The OECD economies (in APEC, this includes Australia, Canada, Japan, Korea, Mexico, New Zealand, and the United States) are assumed to put a price on carbon in their electricity generation and industrial sectors starting in 2013
- In the "Other Major Economies" (which include the APEC economies of China and Russia, as well as Brazil, South Africa, and the Middle East) are assumed to put a price on carbon starting in 2021
- Sectoral agreements are assumed to limit emissions globally in industry, transport, aviation, and shipping
- Emissions in other sectors are limited by individual economy measures.

[9] Asia Pacific Energy Research Centre (2009b).

[10] Asia Pacific Economic Cooperation (2009) gives the following 2005 statistics for these economies:

	GDP (billion 2000 US$)	Primary Energy Supply (Mtoe)
Cambodia (p.364-365)	5.7	4.8
Laos (p. 372-373)	2.4	1.9
Myanmar (p. 380-381)	13.3	14.3
Total	21.4	21.0

In 2005, the APEC region GDP was $20,610 in billion 2000 US$ (Asia Pacific Energy Research Centre (2007), obtained by summing GDP's reported for each economy) and primary energy supply was 6679 Mtoe (Asia Pacific Energy Research Centre (2009B), p, 136).

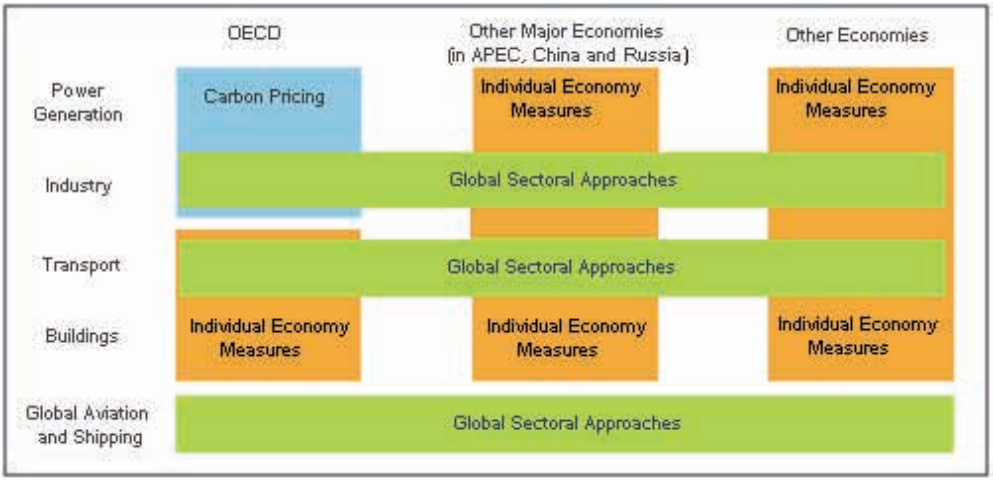

Figure 5.2: Policy Framework 2013-2020.[11]

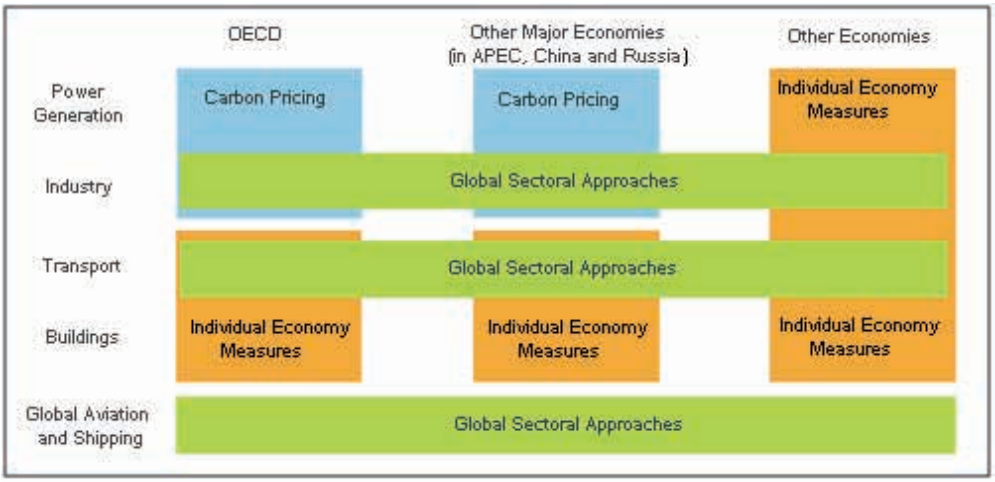

Figure 5.3: Policy Framework 2021-2030.[12]

The major shifts in energy use in the 450 Scenario resulting from these policies are discussed in detail in Chapter 6 of the IEA's *World Energy Outlook 2009*[13]. Some of the key changes are as follows:

- By 2030, about 60% of electricity in the APEC region is generated from renewables, nuclear, or fossil fuels with carbon capture and storage. This share is 30% in the IEA Reference Scenario and 33% in the APERC Business-as-Usual case. There is also a shift towards more efficient generation plants. Many of these changes are driven by

[11] Adapted from International Energy Agency (2009a), Figure 5.3. *World Energy Outlook 2009* © OECD/IEA 2009.
[12] Adapted from International Energy Agency (2009a), Figure 5.3. *World Energy Outlook 2009* © OECD/IEA 2009.
[13] International Energy Agency (2009a).

the assumed introduction of carbon pricing in the OECD economies starting in 2013 and in China and Russia starting in 2021.

- By 2030, on a worldwide basis, the share of car sales accounted for by conventional internal combustion engines drops to 40%, compared with more than 90% in the IEA Reference Scenario. Hybrids account for about 30%, with plug-in hybrids and electric cars accounting for the remainder.
- Also in the road transport sector, global sectoral agreements drive a shift towards more efficient petroleum vehicles. A phase-out of subsidies on vehicle fuel (gradually, and at varying rates across regions[14]) helps to reduce demand. The use of biofuels increases.
- Although oil prices decline in the 450 Scenario because of lower oil demand, increases in fuel taxes are assumed to offset this decline.
- Global sectoral agreements in the aviation sector lead to increased use of biofuels, as well as technical, operational, and infrastructure efficiency improvements, which result to emission reductions of 6.6% by 2020 and 13.2% by 2030 compared with the IEA Reference scenario.
- Direct CO_2 emissions from industry are 27% lower on a worldwide basis than in the IEA Reference Scenario. Industry sector changes are driven by global sectoral agreements to deploy available technology to reduce CO_2 intensity in the iron and steel and cement sectors (which deliver more than half the savings on a worldwide basis). Savings are also driven by carbon pricing and use of more energy- efficient motors.
- In the building sector, worldwide energy demand is about 30% lower in 2030 compared with the IEA Reference Scenario. About two-thirds of the reduction is attributable to energy efficiency measures, while the remaining savings are driven by higher electricity prices as a result of carbon pricing.

[14] International Energy Agency (2009a), p. 63-64.

5.6 Emission Results

Figure 5.4 compares the emission results for three scenarios for the APEC region.

- APERC's Business-as-Usual Scenario from the *APEC Energy Demand and Supply Outlook 4th Edition*[15]
- the IEA Reference Scenario from their *World Energy Outlook 2009*, which also assumes business-as-usual
- the IEA 450 Scenario from their *World Energy Outlook 2009*, which is the sustainable scenario examined in this chapter.

It can be seen that APEC emissions in the sustainable scenario are, as expected, sharply lower than both of the business-as-usual cases.

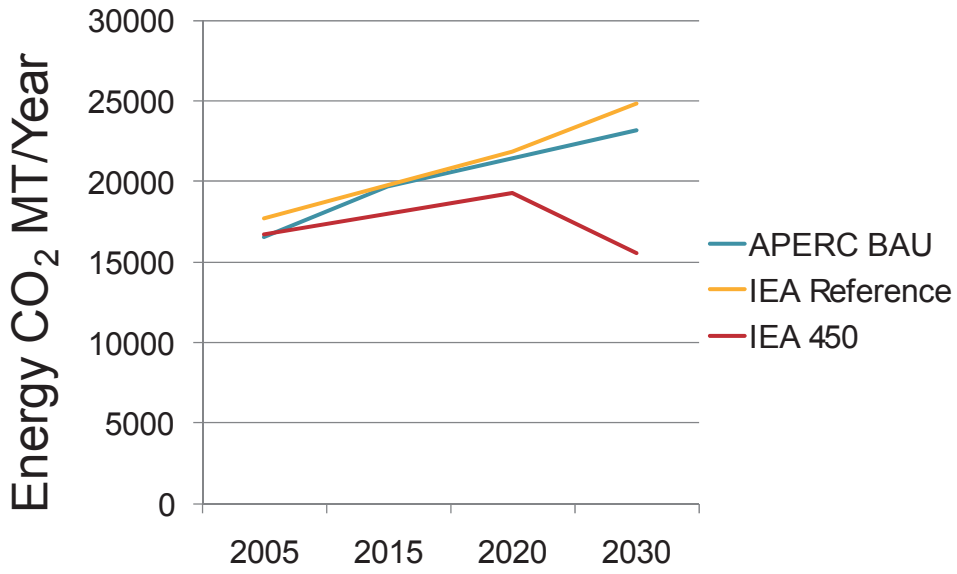

Figure 5.4: APEC Region Emission Results[16]

[15] Asia Pacific Energy Research Centre (2009b).
[16] Raw data for IEA cases © OECD/IEA 2009, calculations by APERC.

Where did the emission reductions achieved in the 450 Scenario come from? Figure 5.5 gives a breakdown by source for the APEC region. Note that in order to facilitate comparison, this diagram compares emissions in the IEA 450 Scenario to the IEA Reference Scenario. If the IEA 450 Scenario was compared with the APERC Business-As-Usual case, there would be many differences stemming from differences in modelling assumptions, modelling techniques, and policies. As a result it would not provide any useful conclusions. As shown in Figure 5.4 the overall emission results of the IEA Reference Scenario and the APERC Business-As-Usual case are similar.

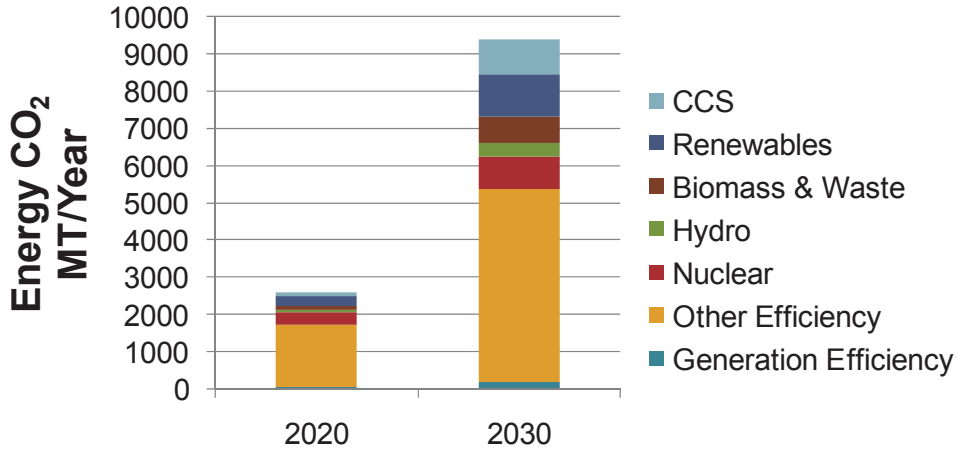

Figure 5.5: APEC Region Emission Mitigation Results by Source (vs. IEA Reference Scenario)[17]

The methodology behind this figure attempts to trace the reductions in fossil fuel use to increases in the use of non-fossil fuels, carbon capture and storage (CCS), or reductions in demand (efficiency improvement). Implicit in this methodology is the assumption that changes in demand are met with changes in fossil fuel use only, since they are assumed to have no impact on non-fossil use or CCS.

It can be seen that energy efficiency is the largest contributor to emission mitigation in both 2020 and 2030. This is as expected, since many energy efficiency measures are already economic, even without a price on carbon. Energy efficiency is also an attractive policy since it contributes to emission reductions while lowering costs to energy consumers. The figure also shows that by 2030 there are also significant contributions to emission mitigation through carbon capture and storage (CCS) and non-fossil energy (renewables, biomass and waste, hydro, and nuclear).

[17] Raw data © OECD/IEA 2009, calculations by APERC.

Figure 5.6 shows a breakout of the energy efficiency results by sector (that is, just the yellow portions of Figure 5.5). Note that the figures in this chart allocate the emissions in generating electricity to the final demand sectors that consume the electricity except for own use in power plants, as well as distribution and transmission losses, which are included in the energy conversion sector.

Viewed from this perspective, the largest emission reductions are in the industry and residential and commercial sectors. This graph understates the degree of emission reductions in the transport sector for two reasons.

1) Much of the emission mitigation that occurs in the transport sector is due to conversion to biofuels, which are counted in the 'Biomass and Waste' category of Figure 5.5 above, and not included in Figure 5.6.
2) The additional electricity used to power plug-in hybrids and electric cars is assumed in Figure 5.6 to come from fossil fuels, since any change in demand is met with changes in fossil fuel use only. To the extent that additional electricity in transport comes from non-fossil energies or CCS, the mitigation will be counted as part of the mitigation from these sources shown in Figure 5.5, not efficiency.

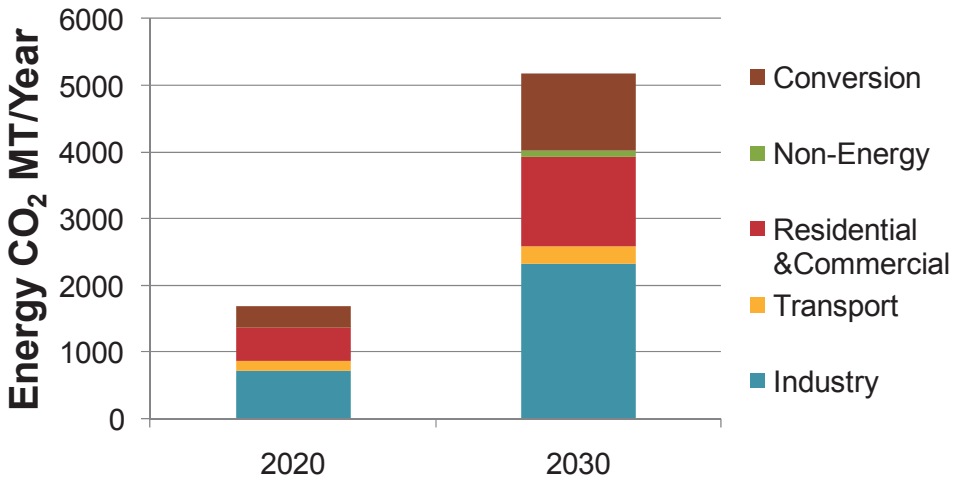

Figure 5.6: Breakout of APEC Region Energy Efficiency Results by Sector (vs. IEA Reference Scenario)[18]

[18] Raw data © OECD/IEA 2009, calculations by APERC.

Figure 5.7 shows a breakout of the emission mitigation results by fuel. It can be seen that coal is the major source of the emission reductions. This is as expected because coal produces about 30% more emissions per unit of energy than oil products and about 80% more emissions per unit of energy than natural gas.[19] However, coal is typically used much less efficiently in electricity generation than gas, resulting in a much wider discrepancy in practice: coal typically produces about 120% more emissions per unit of energy than gas in OECD economies.[20] Therfore, reducing the use of conventional coal is a likely key measure in any sustainable scenario (see Box 5.1).

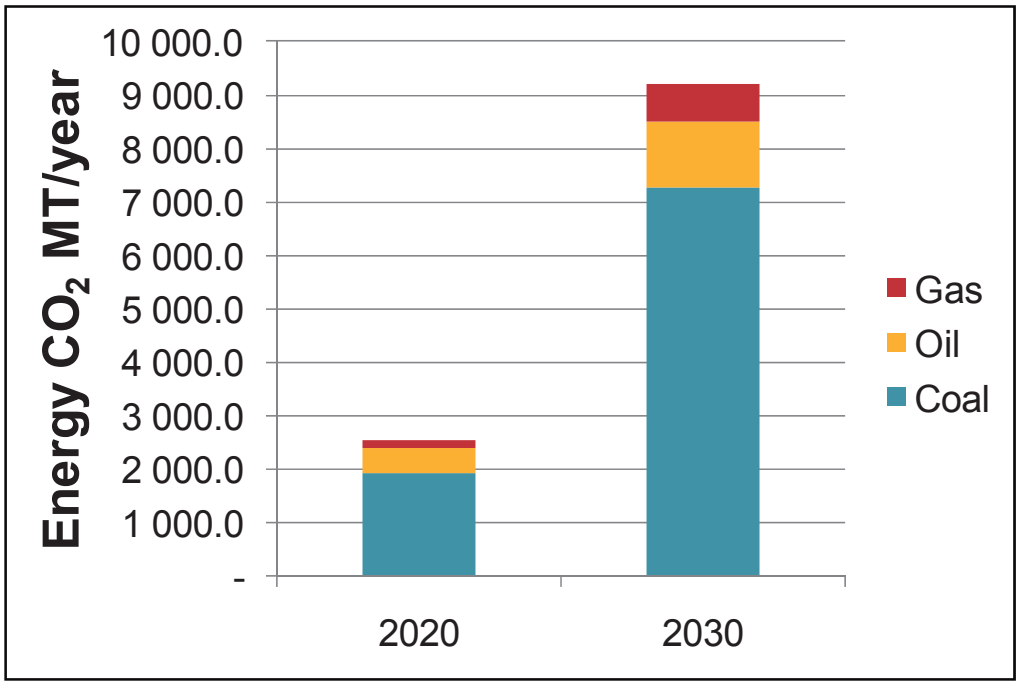

Figure 5.7: Breakout of APEC Region Energy Efficiency Results by Fuel (vs. IEA Reference Scenario)[21]

[19] US EIA (2010).
[20] International Energy Agency (2009b), Box 1, p. xxiv.
[21] Raw data © OECD/IEA 2009, calculations by APERC.

Just how important reducing coal use is to the IEA 450 Scenario can be seen in Table 5.1 below.

Table 5.1 Change in APEC Primary Energy Consumption, IEA 450 Scenario Compared with IEA Reference Scenario [22]

Change in 2030 Total Primary Energy Demand	-1580.8 Mtoe
Change in 2030 Primary Coal Supply	-1680 Mtoe
2030 Change in Nuclear and Renewables Primary Energy Supply	+720.5 Mtoe

It can be seen that the reduction in primary coal supply exceeds the total reduction in primary energy demand. In other words, all energy efficiency improvements in the IEA 450 Scenario are taken out of coal supply and some of the increase in nuclear and renewables supply is also taken out of coal supply.

[22] Raw data © OECD/IEA 2009, calculations by APERC.

Box 5.1 - A Simple Conceptual Hierarchy Scheme for Reducing Emissions

As suggested in the text, conventional coal is the most emission-intensive fossil fuel, so reducing conventional coal use should have the highest priority in planning to reduce emissions. But how is this best accomplished? A simple calculation of emission reductions suggests that the following hierarchy of options should be considered.

Note that a kilowatt-hour of electricity generated in a typical conventional coal generating plant produces about 1000g of CO_2-equivalent on a life-cycle basis.[23]

Energy efficiency improvement is the most preferable alternative, since each kilowatt-hour of conventional coal generated electricity saved results in a roughly 100% (1000g) reduction in emissions. It may actually be a little more than 100%, since reductions in final demand may result in further reductions in transmission and distribution losses.

Substitution of non-fossil fuels is the next most preferable option, since each kilowatt-hour of conventional coal use avoided through the use of nuclear power or renewables results in a roughly 90-99% (900-990g) reduction in emissions on a life-cycle basis. Emissions from renewables are around 25-80g of CO_2-equivalent for biomass, 35-60g of CO_2-equivalent for solar photovoltaics, 25-50g of CO_2-equivalent for wave energy, and less than 10g of CO_2-equivalent for hydro, wind, and nuclear.

Substitution of coal with carbon capture and storage is the next most preferable option, since each kilowatt-hour of conventional coal use avoided through the use of carbon capture and storage results in a roughly 90% (900g) reduction in emissions on a life-cycle basis. However, this technology has not yet been demonstrated in the electric power industry.

Substitution of natural gas generation is the next most preferable option, since each kilowatt-hour of conventional coal use avoided through the use of natural gas generation results in a roughly 50% (500g) reduction in emissions on a life cycle basis.

Improvements to the technology of conventional coal generation, such as use of coal gasification, is the least preferable option, although it still could result in an emission reduction of around 20% (200g) on a life-cycle basis. This reduction would be higher if the conventional coal plant being replaced were particularly inefficient.

5.7 Economics

The IEA estimates that the extra investment required under the 450 Scenario compared with the Reference Scenario is substantial: around US$10.5 trillion from 2010 to 2030 worldwide. However, energy bills are reduced by US$8.6 trillion over the period 2010-2030, and by US$17.1 trillion over the lifetime of the investments. There are also other co-benefits, such as reduced spending on air pollution controls. The benefits and costs of the 450 Scenario are discussed in some detail in the IEA's *World Energy Outlook 2009* Chapter 7.[24]

In terms of macroeconomic impacts, the IEA estimates that GDP in 2020 would be reduced under the 450 Scenario by 0.1% to 0.2% in 2020 and by 0.9% to 1.6% in 2030 compared to the

[23] All CO_2-equivalent/kWh figures in this box are drawn from United Kingdom Parliamentary Office of Science and Technology (2006).
[24] International Energy Agency (2009a).

IEA Reference Scenario. As the global GDP is assumed to double between 2007 and 2010, this reduction is equivalent to a few months growth over 23 years. Furthermore, these impacts do not take into account the benefits that a lower increase in global temperature will bring. The overall impact on GDP is hard to quantify, but is probably quite small. [25]

5.8 Oil Security

Improved energy efficiency, especially in transportation, is a key measure for both reducing emissions and improving oil security. However, as discussed earlier, a focus on reducing emissions should lead policymakers to focus on reducing coal use, not reducing oil use. This would appear to be the case with the IEA 450 Scenario, as the impacts on oil demand and oil imports for the APEC region as a whole are relatively small.

A key driver in the 450 Scenario is the policy of putting a price on carbon. This has a big impact on the price of coal and, therefore, on the use of coal, but a much smaller impact on the use of vehicle fuels. This is because coal is a relatively inexpensive fuel with a high carbon content. On the other hand, vehicle fuels are considerably more expensive than coal on an energy basis, and have less carbon content. Furthermore, the elasticity of demand for vehicle fuels is relatively low,[26] meaning that consumers tend not to reduce their demand for vehicle fuels much in response to increases in price.

The IEA 450 Scenario also implemented other policies to reduce oil demand in the transport sector, including a shift towards more efficient petroleum vehicles, a phase-out of subsidies on vehicle fuel, and increased use of biofuels and electric vehicles. However, these appear not to have had a large impact on oil demand in the APEC region.

Adding to the relatively small impact of carbon pricing on oil demand is the small negative impact of carbon pricing on oil production in the APEC region. Carbon pricing tends to inhibit development of the more emission-intensive oil resources in the APEC region, especially Canadian oil sands.

[25] International Energy Agency (2009a), p. 203.
[26] Samuelson (2008), Section 6.1.

Figure 5.8 shows the effect of the 450 Scenario on oil demand in the APEC region and oil imports. The IEA Reference Scenario is projecting slower growth in oil demand to 2030 than the APERC Business-as-Usual (BAU) case because of differing model assumptions. It can be seen that oil demand in 2030 under the IEA 450 Scenario declines modestly compared with the IEA Reference Scenario. However, APEC oil imports in 2020 and 2030 are essentially unchanged between the two scenarios, and higher in 2020 and 2030 than in 2005 because of an almost equal reduction in APEC oil supply .

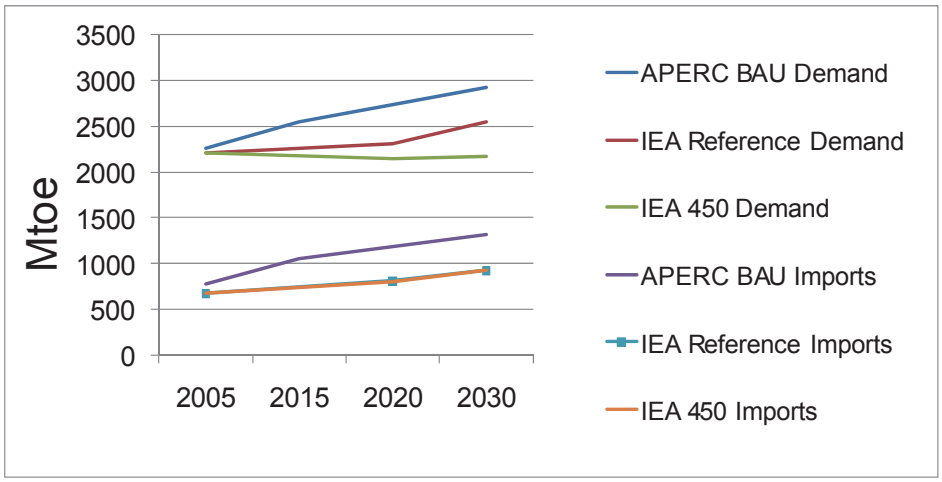

Figure 5.8: Impact of the Comparison APEC Oil Demand and APEC Oil Imports[27]

The IEA's 450 Scenario falls short of achieving APEC's goal to improve oil security. More research is required on this topic. Improved oil security, along with affordability and environmental sustainability, should be achievable. Long-term solutions that need to be examined further include greater use of alternative fuel vehicles, improving alternative modes of transport, and better urban planning. One approach that should be researched further, at least in the medium-term, might be increasing the use of natural gas as a vehicle fuel. As noted in the *APEC Energy Demand and Supply Outlook 4th Edition*[28], APEC is nearly self-sufficient in gas, and the outlook for future natural gas supply in the APEC region is good. Natural gas could be especially attractive as a fuel for heavy trucks and fleet vehicles, where the fuelling infrastructure requirements would be more limited than for passenger cars. In addition, there could also be modest emission reduction benefits.[29]

5.9 Key Indicators

In this section, three key indicators from the sustainable scenario presented in this chapter are examined. APEC economies can use these indicators to measure progress towards energy sustainability and to set voluntary goals for the future.[30] Note that these indicators are for the

[27] Raw data for IEA cases © OECD/IEA 2009, calculations by APERC.
[28] Asia Pacific Energy Research Centre (2009a), pp. 66-68.
[29] Krupnick (2010).
[30] Raw data for IEA case discussed in this section © OECD/IEA 2009, calculations by APERC.

APEC region as a whole; there will be considerable variation between individual economies based on the circumstances for each economy.

The first key indicator is energy intensity improvement. As discussed in Chapter 1, in 2007 APEC leaders established an aspirational goal for APEC to improve energy intensity, which is taken to mean primary energy per constant US dollar of GDP, by at least 25% by 2030 compared to 2005. In the APERC Business-As-Usual Scenario, this goal will be exceeded, with a 38% improvement by 2030. In the IEA 450 Scenario discussed in this chapter, intensity improvement would be even greater: around 50% by 2030.

The second key indicator is the share of non-fossil energy (that is, nuclear and renewables) in the primary energy mix. In 2005, the share of non-fossil primary energy in the APEC region was 16%. In the APERC BAU scenario, this will rise to 18% by 2030. In the IEA 450 Scenario, the non-fossil share will rise to around 30% by 2030.

The third key indicator is the share of low-carbon electricity (that is, nuclear, renewables, and carbon capture and storage) in electricity output. In 2005, the low-carbon electricity share in the APEC region was 29%. Under the APERC BAU scenario, this share will rise to 33% by 2030, none of which would be carbon capture and storage. Under the IEA 450 Scenario discussed in this chapter, the low carbon electricity share will rise to around 60% (7% of which would be carbon capture and storage) by 2030.

5.10 Conclusions

This chapter has presented an example of how a sustainable scenario for energy development in the APEC region could be achieved. The scenario shows how the energy sector in the APEC region could contribute towards limiting global warming to 2°C by limiting greenhouse gas concentrations in the atmosphere to 450 PPM of CO_2-equivalent. Although energy investments will be considerably higher in the 450 Scenario, these investments will pay off in the form of lower energy costs, lower climate adaptation costs, as well as health and other benefits. The scenario was not effective in reducing APEC oil imports. Further research is needed on how to improve APEC's oil security.

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CHAPTER 6 - AN ANALYSIS OF ECONOMY MITIGATION ACTION PLEDGES

6.1 Chapter Overview

In response to concerns about climate change, APEC economies have made a number of voluntary greenhouse gas mitigation action pledges, which include specific pledges to reduce greenhouse gas emissions and/or improve energy efficiency. Chapter 5 presented a sustainable scenario in which the APEC economies contribute toward stabilising the concentration of greenhouse gases in the atmosphere at no more than 450 PPM of CO_2-equivalent. If the APEC economies actually implement the mitigation actions they have pledged so far, how will their greenhouse gas emissions compare to those in the sustainable scenario?

This chapter seeks to answer that question. It examines the mitigation actions pledged by APEC economies and analyses what impact those pledges would have on overall APEC emissions, assuming each economy is able to keep their pledges. It then compares these emissions to emissions under the 450 Scenario. It is concluded that emissions in the APEC region in 2030 would be close to the level of the sustainable scenario under optimistic assumptions, where:

- each economy effectively implements their mitigation actions
- any contingencies in each economy's pledges are met and
- pledges with termination dates prior to 2030 are assumed to be followed-up with subsequent pledges to continue improvement at the same rate out to 2030.

While this conclusion is a positive one, it does not mean that the APEC economies are already on a path to energy sustainability. The ability of APEC economies to keep these pledges will require harmonious cooperation between economies:

- some pledges are contingent on outcomes (such as availability of financing or similar emission reductions by other economies) that require the cooperation of other economies
- keeping the pledges will, in most cases, require changes to the policies or legislation of the pledging economies; the ability of each economy to implement these changes hinges in part on their perception that other economies are also doing their fair share.

These conditions could, in principle, be met through voluntary action. However, a comprehensive global agreement on climate change, with the role of each economy resolved through constructive negotiations, would provide greater certainty that pledged reductions would be achieved. Not only could such an agreement provide greater assurance that the conditions necessary for harmonious cooperation will be met, but it could also allow for the implementation of a global market for emission reductions, which could help to lower the cost of reducing emissions. Nevertheless, a key message of this chapter is that until there is a

comprehensive global agreement, voluntary actions, such as those through APEC, will be of critical importance.

6.2 Summary of the Pledges Made by APEC Economies

Greenhouse gas emission mitigation action pledges were collected for APEC economies. All APEC economies have made energy efficiency improvement pledges, emission reduction pledges, or both. The nature of the pledges are diverse. Pledges may be stated in terms of emission reductions, emissions intensity, energy demand, energy intensity, or various specific actions. Emission pledges are stated in different ways, such as total greenhouse gases or carbon dioxide only, and may cover all sources or only specific sectors. The pledges are also framed using different base years and different target years. Some pledges are not stated as reductions relative to a base year, but rather as the extent of emission reduction below a business-as-usual case.

One key categorisation of the pledges is between those that are 'contingent' and those that are 'uncontingent'. Uncontingent pledges are commitments that the economy makes without conditions—the economy plans to satisfy the pledge regardless of what other economies do. In contrast, contingent pledges include conditions, typically similar cuts in emissions by other economies or the provision of international financial support. If the conditions on a contingent pledge are not met, then the economy will not be bound by the pledge. Within APEC, five members' pledges are contingent: Japan, Malaysia, New Zealand, Papua New Guinea and Russia. Three economies – Australia, Indonesia and Mexico – have made both uncontingent and contingent pledges. The pledges of the remaining economies are uncontingent.[109]

Here is a summary of each economy's pledges. Emission pledges may be contingent or uncontingent, as indicated. All energy efficiency pledges are uncontingent.

Australia: Four separate pledges have been made. **(1)** reduce greenhouse gas emissions by 5% by 2020 relative to 2000 levels (uncontingent); **(2)** reduce greenhouse gas emissions by 15% by 2020 relative to 2000 levels, contingent on a global agreement under which major developing economies commit to substantially restrain emissions and advanced economies take on commitments comparable to Australia's; **(3)** reduce greenhouse gas emissions by 25% by 2020 relative to 2000 levels, contingent on the world agreeing to an ambitious global deal capable of stabilising levels of greenhouse gases in the atmosphere at 450 PPM CO_2-equivalent or lower; **(4)** reduce emissions by 60% by 2050 relative to 2000 levels (uncontingent).

Brunei Darussalam: Pledges to contribute to the 25% regional improvement in energy intensity by 2030 compared to 2005 levels, as agreed by APEC Leaders in the 2007 Sydney Declaration (see Section 1.2).

[109] For emission pledges, unless otherwise noted, the information here comes from the United Nations Development Programme (2010). This information is primarily drawn from the Copenhagen Accord submissions shown on United Nations Framework Convention on Climate Change (2010A) and United Nations Framework Convention on Climate Change (2010B), but in some cases includes additional information from other sources. For energy intensity pledges, unless otherwise noted, the information here is taken from information collected for the *Compendium of Energy Efficiency Policies of APEC Economies,* Asia-Pacific Energy Research Centre (2010).

Canada: Has made two separate pledges. **(1)** reduce greenhouse gas emissions by 17% by 2020 relative to 2006 levels (or 3% by 2020 relative to 1990 levels), a target that is aligned with the United States target and is subject to adjustment to remain consistent with the US target[110] (uncontingent); **(2)** reduce greenhouse gas emissions 60% to 70% by 2050 relative to 2006 levels (uncontingent).

Energy efficiency goals were also adopted at the provincial level in 2008, which amount to a 20% improvement in energy efficiency by 2020. Canada uses decomposition analysis to estimate improvements in energy efficiency.[111]

Chile: Pledges to reduce its greenhouse gas emissions 20% below the business-as-usual case by 2020 (uncontingent). Chile has started with specific mitigation programs, such as energy efficiency; renewable energies; forestation, reforestation, and natural forest conservation; and improvements in public transport.[112]

Chile is also developing an Action Plan on Energy Efficiency for 2010-2020, which will contain overall and sector energy efficiency goals.

China: Pledges to reduce the intensity of carbon dioxide emissions per unit of GDP by 40% to 45% by 2020 relative to 2005 levels (uncontingent). China will take the following specific measures: intensify effort to conserve energy and improve energy efficiency; vigorously develop renewable energy and nuclear energy and increase the share of non-fossil fuels in primary energy consumption to around 15% by 2020; energetically increase forest carbon sinks by increasing forest coverage by 40 million hectares and forest stock volume by 1.3 billion cubic metres by 2020 compared to 2005 levels; step up efforts to develop a green economy, low-carbon economy and circular economy; and enhance research, development and dissemination of climate-friendly technologies.

As part of the 11th Five Year Plan (2006-2010), China previously adopted an overall energy efficiency goal of reducing energy consumption per unit of GDP by 20% by 2010 relative to year 2005 levels.[113] In order to accomplish this goal, China has deployed a series of policy, legal and economic measures.

Hong Kong, China: Pledges to reduce energy intensity of GDP by 25% by 2030 relative to 2005 levels, and to reduce electricity consumption in government buildings by 5% by 2013-14 relative to 2009-10 levels.

In addition, according to Hong Kong, China's Secretary of the Environment, Hong Kong, China will actively make efforts in support of China's target to reduce carbon intensity.[114]

Indonesia: Has made two separate pledges. **(1)** reduce greenhouse gas emissions 26% below the business-as-usual scenario (uncontingent); and **(2)** reduce emissions by as much as 41% below business-as-usual, contingent on the provision of international support.

Indonesia has also set an overall energy efficiency goal of achieving an energy elasticity of GDP of less than 1.0 from 2005 to 2025, while realising an energy saving potential of as much as 41% compared to business-as-usual.

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[110] Government of Canada (2010).
[111] Natural Resources Canada (2009)
[112] Chile Comision Nacional del Medio Ambiente (2009).
[113] Asia Pacific Energy Research Centre (2009C), p. 9.
[114] Hong Kong, China (2010).

Japan: Pledges to reduce greenhouse gas emissions by 25% by 2020, and 60-80% by 2050 relative to 1990 levels, contingent on the establishment of a fair and effective international framework in which all major economies participate and agreement is made by those economies on ambitious targets.

Japan has set an overall energy efficiency goal of reducing primary energy intensity (total primary energy/GDP) by 30% by 2030 relative to the 2003 levels. Specific industrial sector energy efficiency goals during fiscal years 2008-12 are as follows:

a) Federation of Electric Power Companies should reduce CO_2 emissions intensity (emissions per unit of end-use electricity) by an average of approximately 20%

b) Petroleum Association of Japan should improve CO_2 emissions efficiency by 20%

C) Japan Iron and Steel Federation should reduce energy consumption by 10%

d) Japan Cement Association should improve energy efficiency by 3.8%

e) Japan Chemical Industry Association should improve energy efficiency by 20% and

f) Japan Paper Association should improve energy efficiency by 20% and improve CO_2 emission efficiency by 16%.

Korea: Pledges to cut greenhouse gas emissions to 30% below the business-as-usual scenario by 2020 (uncontingent).

Korea also has an overall energy efficiency goal for reducing primary energy intensity by 46% by 2030 compared to 2006 levels (from 0.341 tonnes of oil-equivalent per US$'000 in 2006 to 0.185 tonnes of oil-equivalent per US$'000 in 2030), as well as specific sector energy efficiency goals for all sectors during the period 2007-2030. The following are the sectoral energy efficiency goals, which are stated as reductions below the business-as-usual scenario in 2030: reduce energy use by 16.7 Mtoe (12.5%) in industry; reduce energy use by 7.0 Mtoe (15.1%) in transport; reduce energy use by 12.0 Mtoe (20.3%) in residential and commercial; and reduce energy use by 1.9 Mtoe (31.5%) in public and other.

Malaysia: Pledges to reduce carbon dioxide emissions per unit of GDP in 2020 by up to 40% relative to 2005 levels contingent on the provision of international finance.

Malaysia is in the process of instituting a renewable energy law and one of the mechanisms of the law are feed-in tariffs to promote the use of renewable energy. Malaysia also plans to include nuclear energy in the electricity generation fuel mix after 2020.

Mexico: Has made two separate pledges. **(1)** reduce greenhouse gas emissions to 21% below the business-as-usual scenario in 2020 and 50% below the business-as-usual scenario in 2050 (uncontingent); **(2)** reduce emissions by as much as 30% below the business-as-usual scenario in 2020 contingent on international finance and technology transfer.

Mexico has set an overall energy efficiency goal of achieving cumulative savings in electric power consumption of 43,416 GWh from 2006 to 2012 compared with its demand in the business-as-usual scenario.

New Zealand: This economy pledges to reduce greenhouse gas emissions by 10-20% by 2020 compared to 1990 levels and 50% by 2050 compared to 1990 levels[115] contingent on a comprehensive global climate change agreement. This means:

- the global agreement sets the world on a pathway to limit temperature rise to no more than 2°C
- developed economies make comparable efforts to those of New Zealand
- advanced and major emitting developing economies take action fully commensurate with their respective capabilities
- there is an effective set of rules for land use, land-use change and forestry (LULUCF) and
- there is full recourse to a broad and efficient international carbon market.

It is expected that New Zealand would meet its target through a mixture of domestic emission reductions, the storage of carbon in forests, and the purchase of emissions reductions in other economies.

New Zealand also has overall energy efficiency goals and sector goals for energy savings during the period 2007-2025, including annual energy savings of 30 petajoules (PJ) in non-transport energy by 2025, 9.5 PJ of additional direct use of renewable energy per year from 2007-2025, and cumulative energy savings of 20 PJ in the transport sector between 2007 and 2015, all compared with business-as-usual.

Papua New Guinea: Pledges to reduce greenhouse gas emissions by at least 50% by 2030 (75% is technically possible subject to enabling finance) while becoming carbon neutral before 2050, contingent on international support.

Peru: Pledges to reduce greenhouse gas emissions from deforestation to zero by 2020. Deforestation represented 47% of Peru's emissions in the 2000 (uncontingent).[116] This pledge was not considered in this analysis as it is not an energy sector pledge.

Peru has also set an overall energy efficiency goal of reducing energy demand by 15% and CO_2 emissions by 35.63 million tonnes during the period 2007-2018 compared with business-as-usual. Sectoral goals for reducing energy demand through energy efficiency programs in the period 2009-2018 include: residential (143.6 PJ), commercial/services (147.1 PJ), public (0.9 PJ), transport (80.9 PJ); all are cumulative and compared with business-as-usual. The total cumulative energy demand reduction in all sectors will reach 372.6 PJ by 2018.

Philippines: The primary goal of the government is to make energy efficiency and conservation a way of life. Consistent with this, the Philippines has set the goal of improving energy utilisation through the National Energy Efficiency and Conservation Program (NEECP) launched in August 2004. The government estimates this program will save a cumulative 9.08 million barrels of fuel oil equivalent during the period 2007-2014 compared with business-as-usual. Sector energy efficiency goals are to reduce final energy demand by 10% (under the 2009-2030 Philippine Energy Plan) in each sector: industry, residential, commercial, transport, and agriculture.

Russia: Pledges to reduce greenhouse gas emissions by 15% to 25% by 2020 compared to 1990 levels, and 50% by 2050 compared with 1990 levels.

[115] New Zealand Ministry for the Environment (2009).
[116] Perú Ministro del Ambiente (2009).

These emission reductions are contingent on the following conditions:

a) appropriate accounting of the contribution of emissions reductions from Russia's forestry activities and

b) all major emitters undertaking legally binding obligations to reduce anthropogenic greenhouse gas emissions.

In addition, an overall goal of a minimum 40% reduction in energy intensity of the Russian economy (defined as Total Final Energy Consumption/GDP) between 2005 and 2020 was set by Presidential Decree N. 889 entitled "Concerning some measures for improving the energy and ecological efficiency of the Russian economy".

Singapore: Pledges to reduce greenhouse gas emissions to 16% below the business-as-usual scenario by 2020 (uncontingent).

Singapore has also set an overall energy efficiency goal of reducing energy intensity of GDP by 20% by 2020 and 35% by 2030 compared with 2005.

Chinese Taipei: Pledges to reduce economy-wide CO_2 emissions to the 2008 level during the period 2016-2020, and then further reduce emissions to the 2000 level by 2025 (uncontingent). The main measures to achieve this goal are to develop carbon-free renewable energy, to increase the utilisation of low carbon natural gas, and to promote energy conservation schemes in various sectors.[117]

Chinese Taipei has overall energy efficiency goals to reduce energy intensity by 20% by 2015 and by 50% by 2025 compared with 2005. All sectors have specific energy efficiency goals, such as: reducing the CO_2 intensity of industry by 30% by 2025, raising new car energy efficiency standards 25% by 2015, improving the energy efficiency of appliances and devices by 10% to 70% by 2011, and a 7% reduction of government energy use by 2015. All of the sectoral energy efficiency improvement goals are compared to 2008 levels.

Thailand: Pledges to reduce energy intensity by 8% by 2015 and 25% by 2030 compared with 2005. To reduce greenhouse gas emissions, Thailand will also increase the use of renewable energy and nuclear power.

United States: Pledges to reduce greenhouse gas emissions by 17% by 2020 compared with the 2005 (equal to 3% by 2020 compared with 1990), and by 83% by 2050 compared with 2005 (uncontingent).

The United States has adopted the APEC energy efficiency goal of reducing energy intensity of GDP by at least 25% by 2030 compared with 2005. More specific sector goals are as follows:

a) residential: reduce new home energy use by 50% by 2015 and by 70% by 2020 compared with benchmark home energy use

b) commercial: to achieve marketable net-zero energy new buildings by 2025

c) industry: voluntary agreements with industrial partners are established to reduce energy intensity (energy/physical output) by 2.5% a year over a period of 10 years, with the baseline defined in each agreement

[117] Chinese Taipei (2008).

d) public: federal government facilities are required to reduce energy intensity (energy/floor space) by 30% by 2015 compared with the 2005

e) transport: corporate average fuel economy standard of 35.5 miles per gallon by 2016.

Viet Nam: Pledges to reduce total energy consumption by 3% to 5% by 2010 and by 5% to 8% by 2015 compared with 2006. The government has also approved the following targets for renewable energy and the development of nuclear power plants:

a) achieve a 3% share of renewable energy in total commercial primary energy by 2010, 5% by 2025 and 11% by 2050

b) introduce the first nuclear power plant in 2020 and then quickly increase the contribution of nuclear energy to the energy structure.[118]

6.3 Methodology for Estimating the Impact of the Pledges

As noted in the previous section, the economies' pledges exhibit a great diversity of approaches towards furthering sustainability. Understanding the aggregate impact of all these pledges is not a simple matter. However, given that these pledges could have a significant impact on emissions in the APEC region, an estimation of the total emissions impact, on a common basis, has been developed.

For comparability with the discussion of the IEA 450 Scenario in Chapter 5, focus is placed on the impact the pledges would have on carbon dioxide (CO_2) emissions from fuel combustion. As noted in Box 4.1, CO_2 emissions from fuel combustion account for about 99% of all energy-related CO_2 emissions, which in turn account for about 90% of all energy-related greenhouse gas emissions. A methodology was developed to estimate the estimated impact of the pledges on CO_2 emissions from fuel combustion in the years 2015 and 2030.

To estimate the impact of the pledges, they were first categorised according to whether they specify a goal in terms of emissions or energy intensity. Four economies had only energy intensity pledges. Note that some economies with emissions pledges also had energy intensity pledges, but in all cases the emissions pledges appear to require a greater level of effort than the energy intensity pledges.

To estimate the impact of the emission pledges, it was first necessary to estimate the portion of the pledged greenhouse gas emission reduction that would be met by reducing CO_2 emissions from fuel combustion. None of the emissions pledges specifically refer to reducing CO_2 emissions from fuel combustion. For many economies, it was simply assumed that CO_2 emissions from fuel combustion would share equally in the overall emission reduction; for example, a 17% overall emission reduction would imply a 17% reduction in CO_2 emissions from fuel combustion. However, some economies have clearly expressed their intention to obtain a large share of emissions reductions from the agriculture or forestry sectors, and in these cases CO_2 emissions from fuel combustion were assumed to contribute a much smaller share towards the overall emission reduction.

Once the overall emission reduction goals were converted to goals for CO_2 emissions from fuel combustion, it was then necessary to interpolate, and in some cases to extrapolate, the results in order to assess the impacts in the years of interest, 2015 and 2030. The interpolation

[118] Viet Nam, The Prime Minister (2007).

approach was simple. To estimate the 2015 impact of a goal for 2020, a straight-line interpolation between historical emissions (such as in 2005) and the 2020 emissions goal was made. Similarly, if an economy expressed both a 2020 and a post-2030 goal (such as 2050), then straight-line interpolation between those two values was used to estimated the 2030 emissions impact. The actual path that economies take to reduce emissions will almost certainly not be a straight line, and the cumulative emissions from each economy will depend on the actual emission reduction path that is followed. Therefore, the simple approach used in this study provides only a rough indication as to how close the emission pledges would bring the APEC economies to the IEA 450 Scenario discussed in Chapter 5.

A more complicated situation arose for economies whose pledge terminates in some year prior to 2030—that is, economies that have no goal for 2030 or any later year. In these situations, a 2030 value had to be extrapolated using knowledge of the pre-2030 goals and the business-as-usual emissions from the *APEC Energy Demand and Supply Outlook 4th Edition*[119]. Two possibilities were considered for the period after fulfilment of the pre-2030 goal:

1) the economy could return to the rate of emissions increase/decrease in the business-as-usual scenario or

2) the economy could continue to achieve the rate of emissions reductions that was being achieved in order to meet the pre-2030 goal.

Exploring both of these possible trajectories result in a range of possible pledge-fulfilling emission levels that are presented in this chapter.

Further adding to the range of possible emissions is the fact that some economies have specified goals that are contingent upon the actions of other economies. For the most part, contingent goals express the economies' willingness to pursue more aggressive goals in the context of an international agreement to reduce emissions or (for developing economies) the availability of international financial support. Impacts of both contingent and uncontingent pledges were estimated and the results are presented in the following section. The difference between the contingent and uncontingent outcomes demonstrates the APEC economies' willingness to pursue a more sustainable path within a cooperative framework.

Estimating the emission impacts of the energy efficiency goals poses a greater challenge because these impacts depend on the type of fuel use that is avoided. In this study, it has been assumed that the efficiency goals are achieved while generally preserving the business-as-usual structure of energy supply and demand in the economy. This means, for example, that if an economy sourced one-third of its final energy consumption from oil, gas and electricity, then roughly one-third of the energy savings would be achieved in each of these energy sources. Similar proportional sharing of savings was used to allocate the electricity savings to primary fuel consumption. Once the fuel savings are allocated to specific fuels, it is relatively straightforward to estimate the emissions reduction.

This interpretation of the energy efficiency pledges represents only one of many ways that the pledges could be met. Many other scenarios can be imagined. If, for example, energy savings were focused on reducing coal consumption (as is the case in the IEA's 450 Scenario, as discussed in Section 5.6), then the emissions saving would be larger. But if the energy savings were achieved, while shifting to a greater reliance on coal-fired electricity generation,

[119] Asia Pacific Energy Research Centre (2009B).

then there may be no net emissions reduction. These scenarios illustrate the uncertainties inherent in emissions saving estimates based on energy efficiency pledges.

Ultimately, of the four economies that have expressed only energy efficiency goals, the preliminary analysis showed that for three of the economies those goals were surpassed in the business-as-usual scenario. Therefore, no additional greenhouse gas emissions could be attributed to those goals. The fourth economy, Brunei Darussalam represents only a small share of APEC-wide fuel combustion CO_2 emissions. Thus, the uncertainty present in the emission saving estimates for energy efficiency pledges is unlikely to have a large impact on the estimate of total APEC emissions.

6.4 Estimated Impacts of the Pledges for Specific APEC Economies

Table 6.1 shows estimates of future CO_2 emissions from fuel combustion for each APEC economy, considering the impact of both contingent and uncontingent pledges. In this table, "CO_2 Emissions" refers to CO_2 emissions from fuel combustion. The business-as-usual case CO_2 emissions are taken from the *APEC Energy Demand and Supply Outlook 4th Edition*.[120] The estimates of "CO_2 Share of Total Greenhouse Gas Emissions" are based on data for 2005, presented in the IEA's *CO_2 Emissions from Fuel Combustion, 2008 Edition*.[121] Estimates of "Pledge Case" CO_2 emissions in 2015 and 2030 are calculated as described in the previous section. The contingency of each pledge estimate is also shown in the table, with "No" meaning that the result given is for an uncontingent pledge and "Yes" meaning the result is for a contingent pledge. Some economies have both uncontingent and contingent pledges. Finally, for economies that pledged a range of emissions, for example a 15% to 20% greenhouse gas reduction, it was consistently assumed that the larger reduction is made. The results, therefore, represent an optimistic interpretation of the pledges.

[120] Asia-Pacific Energy Research Centre (2009B).
[121] International Energy Agency (2008).

Table 6.1: Impacts of Pledges on CO_2 Emissions from Fuel Combustion, by Economy

Economy	CO_2 Emissions in 2005	CO_2 Share of Total Greenhouse Gas Emissions	BAU Case:		Pledges Case:		Deviation:	
			CO_2 Emissions		CO_2 Emissions		BAU Case - Pledges Case	
	Mt	%	2015 Mt	2030 Mt	2015 Mt: Contingent (Yes/No)	2030 Mt: Contingent (Yes/No)	2015 Mt	2030 Mt
Australia	391	61.1	430	506	178 No	142 No	252 No	364 No
					151 Yes	117 Yes	279 Yes	389 Yes
Brunei Darussalam	6	39.5	11	13	11 No	13 No	0	0
Canada	545	74.6	574	666	510 No	360 No	60	310
Chile	61	61.6	95	148	79 No	106 No	16	42
China	5,131	67.6	7,271	9,225	7,271 No	6,788 No	0	2,437
Hong Kong, China	42	95	48	54	48 No	54 No	0	0
Indonesia	328	48.5	447	688	419.9 No	562.8 No	27.1 No	125.2 No
					404.2 Yes	365.3 Yes	42.8 Yes	197.5 Yes
Japan	1,238	85.7	1,207	1,148	953 Yes	664 Yes	254	484
Korea	464	84.1	495	594	404 No	310 No	88	228
Malaysia	150	63.4	205	339	81.7 Yes	203.3 Yes	123.3	135.7
Mexico	401	57.8	493	644	407 No	327 No	85 No	317 No
					389 Yes	296 Yes	102 Yes	348 Yes

Notes: "CO_2 Emission" refers to CO_2 emissions from fuel combustion; "n/a" means not available; "No" means uncontingent, and "Yes" means contingent. Where both contingent and uncontingent pledges are shown (e.g. Australia), the estimated impact of the contingent pledge includes the estimated impact of the uncontingent pledge.

Table 6.1: Impacts of Pledges on CO_2 Emissions from Fuel Combustion, by Economy

Economy	CO_2 Emissions in 2005	CO_2 Share of Total Greenhouse Gas Emissions	BAU Case: CO_2 Emissions		Pledges Case: CO_2 Emissions		Deviation: BAU Case - Pledges Case	
	Mt	%	2015 Mt	2030 Mt	2015 Mt: Contingent (Yes/No)	2030 Mt: Contingent (Yes/No)	2015 Mt	2030 Mt
New Zealand	34	38.5	37	50	32 Yes	32 Yes	4	18
					8 Yes	11.9 Yes	1	3.1
Peru	29	29.9	47	67	42.2 No	60.7 No	4.5	6.5
Philippines	74	35.3	107	173	88 No	162 No	19	11
Russia	1458	69.6	1557	1590	1672 Yes	1408 Yes	-105	182
Singapore	38	47.9	48	71	43.3 No	51.2 No	4.7	20
Chinese Taipei	255	43.1	297	338	255 No	183 No	42	155
Thailand	206	57.2	255	425	255 No	425 No	0	0
United States	5,744	77.9	5,953	6,084	5,400 No	3,600 No	600	2500
Viet Nam	81	35.4	140	312	140 No	312 No	0	0
APEC	16,682		19,725	23,148	(See Table 6.2)			

Note: Data was not available for Papua New Guinea.

6.5 Summary of Emission Impacts for the APEC Region

To summarise the overall potential impact of the pledges for the APEC region, a scenario where only the uncontingent pledges are fulfilled and the scenario where both uncontingent and contingent pledges are fulfilled have been considered. Some economies have both uncontingent and contingent pledges which required care when summing the pledges so as to avoid double-counting. In other words, the overlap between contingent and uncontingent pledges is attributed only to the uncontingent category. Table 6.2 shows the net impact the pledges would have on overall APEC emissions assuming each economy is able to keep their pledges. Table 6.2 shows that uncontingent pledges dominate the estimate of CO_2 emission reductions from fuel combustion, accounting for 78% of the total reduction in 2015 and 87% in 2030.

Table 6.2: Deviation of CO_2 Emissions from Fuel Combustion Between BAU Case and Pledges Case

Year	**2015**	**2030**
Uncontingent (Mt)	1198	6515
Net Contingent (Mt)	337	951
Total (Mt) (If all pledges are kept)	1535	7466

Notes: "Uncontingent (Mt)" is the summarised impact of uncontingent pledges; "Net Contingent (Mt)" is the impact of contingent pledges in addition to the uncontingent pledges; "Total (Mt)" is the total net impact of all pledges.

In addition to the different potential outcomes suggested by contingent and uncontingent pledges, there is also a range of possible outcomes stemming from the existence of pledges that terminate prior to 2030. As described in Section 6.3, a range of possible post-pledge scenarios have been considered for this analysis. Combining the contingent/uncontingent outcomes with the range of outcomes of pledges that terminate prior to 2030 gives the four possible outcomes described below:

- *Total, Continued (TC)* – All pledges, uncontingent and contingent, are achieved and, for pledges that terminate prior to 2030, the economies continue to achieve the same rate of emission reduction that was required by the pledge.
- *Total, Discontinued (TD)* – All pledges, uncontingent and contingent, are achieved and, for pledges that terminate prior to 2030, the economies return to the rate of emission increase/decrease in the BAU scenario.
- *Uncontingent, Continued (UC)* – Only uncontingent pledges are achieved and, for pledges that terminate prior to 2030, the economies continue to achieve the same rate of emission reduction that was required by the pledge.
- *Uncontingent, Discontinued (UD)* – Only uncontingent pledges are achieved and, for pledges that terminate prior to 2030, the economies return to the rate of emission increase/decrease in the BAU scenario.

Figure 6.1 shows the estimated impact of the pledges for the APEC region considering the range of possible outcomes described above. In the figure, "APERC BAU" shows the Business-as-Usual Scenario of the *APEC Energy Demand and Supply Outlook 4th Edition*. Clearly, the achievement of all pledges and the continuation of pledge-achieving efforts beyond the termination of current pledges gives the largest reduction in emissions. In the Total, Continued scenario about one-third of APEC's BAU emissions for 2030 are avoided. If only uncontingent pledges are achieved and economies discontinue pledge-achieving efforts after the termination of their current pledges, then avoided emissions are much lower. In the Uncontingent, Discontinued scenario around one-fifth of APEC's BAU emissions for 2030 are avoided. The estimates for the other two possible outcomes are between these two extremes.

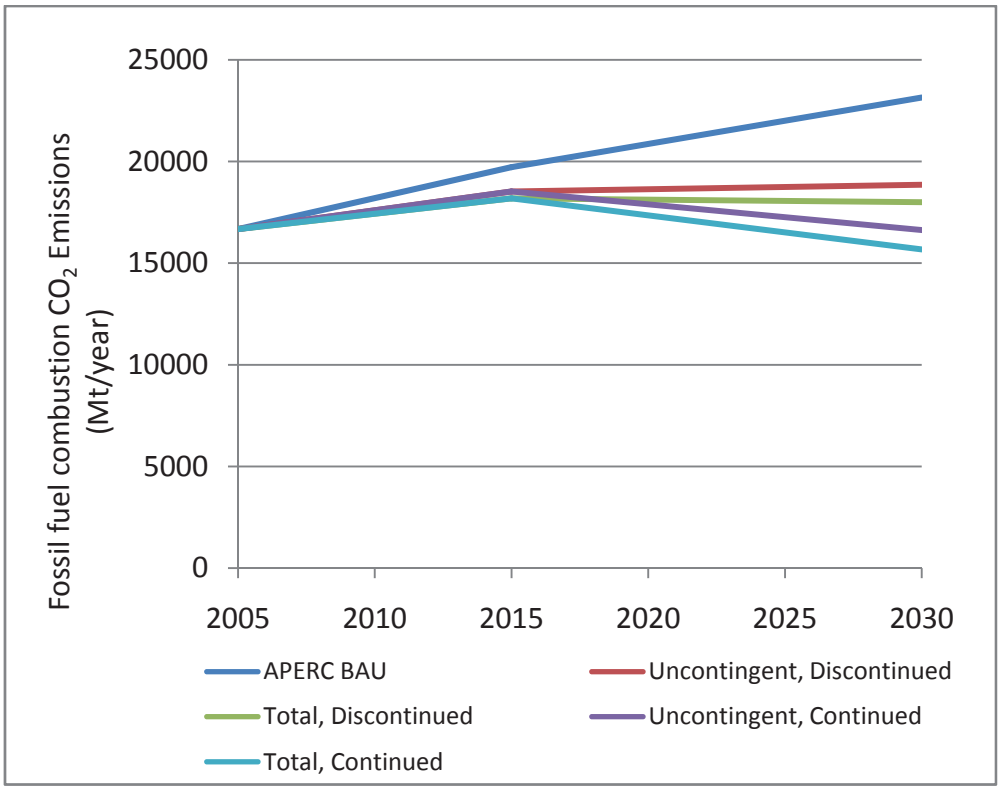

Figure 6.1: Estimated Pledge Impacts for a Range of Possible Outcomes

6.6 Comparing the IEA 450 Scenario Emissions and the Pledges Cases

Comparing the IEA 450 Scenario discussed in Chapter 5 with the estimated impacts of the pledges provides some indication as to whether APEC, as a region, is pledging a level of effort required for a sustainable path. This comparison is presented in Figure 6.2 and Table 6.3 below.

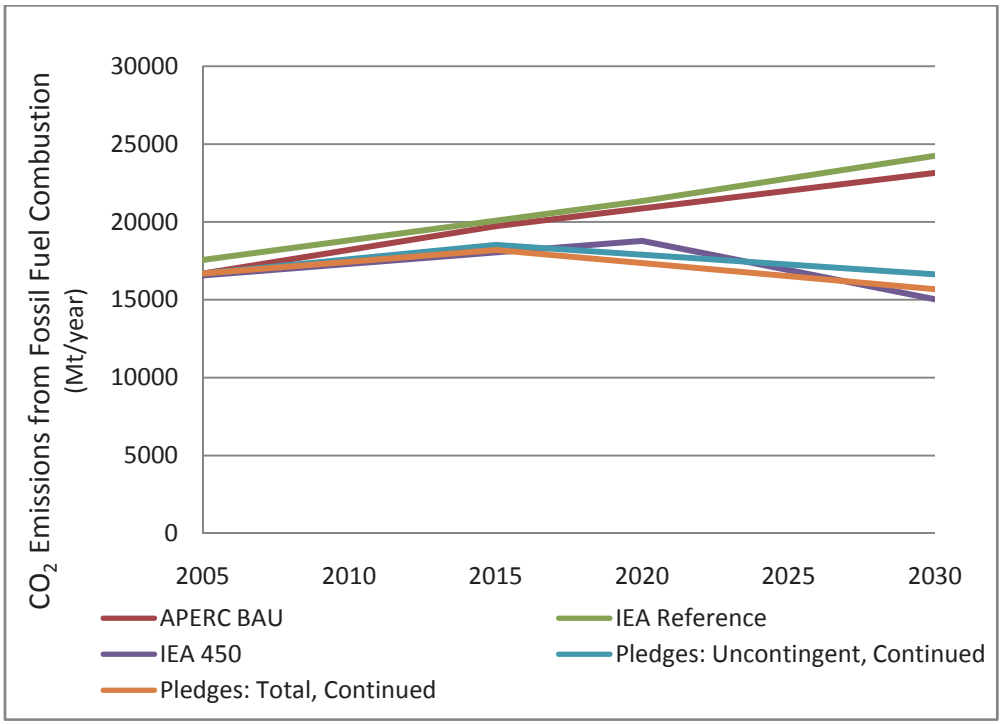

Figure 6.2: Comparison of Pledge Impacts[122]

Table 6.3: CO_2 Emissions from Fuel Combustion in APEC (Mt/year)[123]

Year	APERC BAU	IEA Reference	IEA 450	Pledges: Uncontingent, Continued	Pledges: Total, Continued
2005	16682	17555	16562	16682	16682
2015	19725	n/a	n/a	18526.7	18190
2020	n/a	21338	18785	n/a	n/a
2030	23148	24241	15028	16632	15681

Note: "n/a" means not available.

[122] Raw data for IEA Cases ©OECD/IEA 2009, calculations by APERC.
[123] Raw data for IEA Cases ©OECD/IEA 2009, calculations by APERC.

Figure 6.2 shows the CO_2 emissions from fuel combustion for the APEC region under different scenarios, including APERC's APEC BAU case, the IEA Reference Scenario, the IEA 450 Scenario, Uncontingent, Continued Pledges, and Total, Continued Pledges. Several important points emerge from this comparison:

- the APERC BAU case is quite similar to the IEA Reference Case.
- the trend of the Uncontingent, Continued Pledges case is similar to Total, Continued Pledges case, but the gap between the two will grow gradually, reaching 5.6% in 2030.
- The results of IEA 450 Scenario and the two pledges cases in 2030 are very similar, with emission reductions under the most optimistic pledge assumptions approaching those of the IEA 450 Scenario. This indicates that it may be possible to put APEC on a path to energy sustainability if all pledges made are kept, if contingencies can be satisfied, and if pledges with termination dates prior to 2030 are followed-up with subsequent pledges to continue improvement at the same rate out to 2030.
- However, approaching 2030, emissions in the IEA 450 Scenario are declining faster than those in the pledges scenarios. This indicates that while the current pledges represent a good beginning, efforts will need to be intensified after 2020.

Although there are limitations on this kind of voluntary action, the results suggest that voluntary action has the potential to play a significant role in putting the APEC region on a path to sustainability. APEC, as a cooperative forum, is well-positioned to encourage and facilitate this voluntary action.

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