



Energy Indicators: Capacity Development and Application in APEC Economies

A report to APEC Energy Working Group (EWG), summarising the work and findings of EWG Project; EWG 03/07 'Application of Energy Indicators in APEC Economies.

Executive Summary

Energy in APEC at a glance

APEC economies have a vast range of development paths, energy intensities, resource endowments, structures, and efficiencies. In particular they;

- Grew energy demand faster; +34% APEC cf +25% non-APEC (1990 to 2005)
- Consumed 58% of the worlds energy, produced 60% of GDP and CO₂ emissions yet include only 41% of the worlds population
- 4 out of the 21 APEC economies are becoming more self-sufficient, 13 economies increased their reliance on imported energy over the past decade.
- APEC average Energy–GDP (PPP) intensity is about 0.2 toe/USD_{2000PPP}. Intensities range from 0.1 to 0.5 toe/USD_{2000PPP} highlighting variety of economic structure across APEC:
- 14 APEC economies improved energy intensity. APEC’s rate of improvement over the past 5 years is marginally better than the rest of the world’s.
- Significant end-use data gaps limit efficiency indicator analysis across APEC.

Sound Information is Indispensable for Sound Policy Making

- Both basic and specific policy-relevant indicators are critical to planning and monitoring any energy saving policies or programmes. Robust indicators are essential tools to addressing the rapidly increasing challenges of economic and social development, energy security and the global impacts of climate change.

APEC EWG is asked to recommend that economies;

- develop processes to monitor and understand their energy use trends and the policy implications of their own development and global changes
- pay special attention to the development of energy data statisticians and analysts
- identify energy data gaps and invest in improved energy data gathering and analysis
- offer their experts to assist developing economies to establish indicators systems that meet their needs
- develop energy efficiency and conservation strategies and supporting energy end-use data collection and energy indicators systems
- continue to support the coordinating agency of the EGEDA to liaise with and assist APEC economies with energy data, maintain consistent datasets and liaise with other international energy statistics groups.
- use the newly adopted APEC energy data template to ensure consistency

A vision for the next steps

APEC, G8 Members and OECD cooperatively develop both the annual reporting of data and the development of effective energy and energy efficiency indicators. Integrate APEC, Eurostat, and IEA initiatives into common global platforms. The Joint Oil Data Initiative, JODI, has already set an example - we are more resilient when we work together to address global challenges.

Introduction

The objective of this report is twofold:

- To report on an APEC EWG-funded project to develop capacity in energy indicators in APEC economies;
- To provide APEC EWG economy representatives with policy informing indicators of energy use, implications, and opportunities that have been developed as outputs of this project.

Acknowledgements

The work reported here is the result of a cooperative effort that rapidly expanded beyond the initial scope of the project. Indeed, the results presented here are due to the efforts and contributions of the following organizations and individuals:

- *APEC Expert Group on Energy Efficiency and Conservation (EGEE&C);*
- *APEC Expert Group on Energy Data and Analysis (EGEDA);*
- *The Institute of Energy Economics Japan (IEEJ); sponsors of the 2nd background workshop and leading data management activities;*
- *The International Energy Agency (IEA);*
- *Asia Pacific Energy Research Centre (APEREC) - sponsors of the 1st background workshop;*
- *Mr. Shigeru Kimura and Dr Harbans S Aulakh who led data collection, workshop and reporting activities – this project would not have succeeded without the leadership of these two experts;*
- *Mr. Editor Barcelona (IEEJ) and Ms Marion Pahalawatta (EECA) who analysed and prepared trends and indicators from economy data;*
- *Energy experts, analysts and statisticians of APEC economies who contributed to the success of the workshops. They are the foundation of this project and are individually listed in workshop proceedings - collective acknowledgement here reiterates the appreciation extended at the individual workshops;*
- *APEC EWG for supporting this project.*

Summarising this significant amount of work from so many contributors is all but impossible. It is not easy to express adequately our appreciation to such a broad base of effort. I therefore extend my thanks to all who have contributed in whatever way to this effort – it is truly a composite of every individual's input.

I encourage economy experts to ask questions and dig down into the various report proceedings.

Robert Tromop
Project Overseer

Project Background

The aim of this project is to provide policy-informing insights from energy indicators to empower a co-operative approach by APEC economies. Specifically, the project aims at focusing on the following aspects of energy indicators:

- Capacity development for improved data collection, analysis and use;
- Aligning energy indicators for policy development, monitoring and reporting purposes; and
- Selection and production of indicators to support policy needs.

The project covered a topical theme. Total world consumption of marketed energy is projected to increase from 447 quadrillion Btu¹ in 2004 to 559 quadrillion Btu in 2015 and then to 702 quadrillion Btu in 2030 - a 57% increase compared to 2004. The largest projected increase in energy demand is in non-OECD countries, where energy demand is projected to grow at an average annual rate of 2.6% from 2004 through 2030. The corresponding figure for OECD countries is 0.8% pa. Energy use in non-OECD countries is projected to surpass that of OECD countries by 2010, and is projected to be 35% greater than the OECD total by 2030.

Much of the growth in energy demand among non-OECD economies is projected to occur in non-OECD Asia, including China and India. Energy demand in the non-OECD Asia region is projected to grow at an average rate of 3.2% pa. In 2004, energy consumption in non-OECD Asia made up just over 48% of the non-OECD total; in 2030 this share is projected to be above 56%.

Strong growth in energy demand is also projected for the other non-OECD regions. In the BAU case projections, energy consumption increases at average annual rates of 2.4% in Central and South America, 2.3% in the Middle East and in Africa, and 1.4% in non-OECD Europe and Eurasia.

There are an increasing number of challenges faced by all economies:

- *Rising global energy demand poses a real and growing threat to world energy security*
- *Growing reliance on oil and gas imports from a decreasing number of producing countries threatens to exacerbate short term energy-security risks. Longer-term risks to energy security are also set to grow*
- *Urgent action is needed if greenhouse gas concentrations are to be stabilised at a level that would prevent dangerous interference with the climate system*
- *All countries need to start taking decisive actions to curb rising energy demand.*
- *Although new oil-production capacity additions from greenfield projects are expected, it is very uncertain whether they will be sufficient to compensate for the decline in output at existing fields and keep pace with the projected inelastic increase in demand. Oil prices rise, including abrupt escalations, cannot be ruled out.*

¹ One quadrillion Btu is equal to 1055 Peta Joules (PJ) or 25.2 million tonne of oil equivalent (Mtoe)

Clearly, APEC economies include those that are already developed energy users and those with developing economies and energy systems. However, both will contribute to ongoing demand growth and the environmental, social and economic implications of that growth. All economies must therefore seek to understand how to best address the challenges.

Reducing the use of energy and realising energy efficiency opportunities is one of the most direct ways of increasing the sustainable use of energy. Reduced energy use has numerous positive effects as it improves energy services, reduces pollution, cost and it can offer social benefits in the form of increased energy security (through the reduced reliance on imported fossil fuels).

Most world economies and particularly the APEC economies have become very conscious of designing appropriate policies for their sustainable energy future, with a focus on energy efficiency and renewable energy. APEC as a group, as well as its individual member economies need to develop further the understanding of the magnitude of their changing energy use in order to devise rational policy initiatives.

It is believed that APEC economies' current energy use profile offers significant potential for large-scale reduction efforts. Technological breakthroughs and government-sponsored programmes (e.g. energy audits for the industrial sector) are imperative to achieving that energy-savings potential. Information programmes, which seek to encourage energy efficiency and conservation and offer technical assistance, are also important elements to reducing energy use. It is necessary to identify and strategically select the most effective opportunities and measures.

Despite the differences across APEC economies, a common thread remains, namely that we cannot plan for what we have not identified and cannot manage what we do not measure. Minimising energy impacts and maximizing social and economic wealth is a challenge where APEC EWG as a group can cooperate on discovering how we can best make a difference.

The following two self-funded workshops formed the background of this project:

Indicators and Data Requirements; Tokyo Oct 2006, sponsored by APERC & IEEJ.

Indicators and Policy Issues; Canberra Nov 2006, sponsored by IEEJ.

Appendix 1 summarises the findings of these two workshops

Report Scope and Structure

This report is organized into two main parts:

Part One is about the five day "Capacity Building Workshop" held in Singapore. The focus is on the areas covered, workshop format, key findings and the major recommendations made.

Part Two provides an overview of APEC economies' energy use dynamics through energy indicators and policy perspectives. The focus is on energy sustainability, security of supply and affordability indicators.

Part ONE

Capacity Development Workshop: Key Findings and Conclusions

The Workshop was held in Singapore from 18-21 September 2007. It was jointly organised by the Asia-Pacific Economic Cooperation - Energy Working Group (APEC EWG), the Institute of Energy Economics of Japan (IEEJ) with assistance from the International Energy Agency (IEA) and New Zealand as the overseer for this project.

World leading experts provided hands-on training for 41 participants from 17 APEC economies.

1 Approach and Format

Topics included; identifying the key factors that explain energy use and energy efficiency variations over time and across APEC economies, setting relevant targets and collecting and analysing energy data to support policy development and monitoring. The Workshop focused on identifying, conceptualizing and, finally, putting into operation "lead indicators" that will highlight problems, and identify options to improve the situation. The mechanics of developing detailed end-use data and closer collaboration among APEC economies was also discussed.

The workshop focused on the approaches, methodologies, the "how to" develop the tools and applications of energy indicators. Its format was a more formal training approach. It provided participating economies with steps to define an approach to organize the efforts to address the data challenges to support the development of energy indicators.

Data being the essential foundation to indicator development and analysis, attendees were guided through the issues around data gathering and survey activities, the benefits of using a solid and detailed energy balance as a starting point toward energy indicators, drilling down into the details of managing and the information.

Participants were also guided through different conceptual and methodological issues/approaches to defining energy efficiency, setting targets and measuring them through a suite of energy indicators including Divisia decomposition. The workshop incorporated a significant portion of hands-on training at producing examples of indicators for setting and measuring energy efficiency progress.

Workshop proceedings are at:

http://www.iea.org/textbase/work/workshopdetail.asp?WS_ID=340

2 Key Findings

2.1 Capacity-Building in Economies

- All economies (especially developing economies) need to pay more attention to addressing data gaps, determining their data priorities and end-use data (demand side) needs, and maintaining reliable trend data sets. In developing this report we found inconsistencies in APEC economy data that reflect a need to improve many aspects of data collection and management. We reverted to using alternative data sources to fill gaps. Production of indicators requires more consistent data and capacity building is necessary. EGEDA leads coordination of this work in APEC; it is an ongoing task requiring ongoing support for EGEDA and consistency at economy level in data development.

The need for capacity building is particularly high in two areas, namely:

- The development of data and indicators for developing economies. An agreed set of priority indicators has been developed but lack of consistent data prevented the production of indicators.
 - The development of end-use data to support energy efficiency indicators where only those economies that are IEA members had effective datasets that enable the production of such indicators;
- Establish networking for economy analysts; coordination, networking, skill-sharing, and knowledge-sharing are important development tools.

2.2 Developing the Science of Indicators

- Harmonise APEC data processes and indicator techniques with other international data definitions and standards;
- Set up a group to develop the science of indicator techniques. Tasks could cover:
 - A template for energy statistical review (e.g. NZ's Energy Domain Plan for energy stakeholders)
 - Disaggregation techniques – especially for tricky sectors like the commercial sector, for end-use and for sub sectors
 - What can we get out of other commonly collected data as data is collected for many reasons
 - Translate IEA guidebooks into key languages (note the IEA Energy Statistics manual is now in English, Spanish, Chinese, and Russian.)
 - Describe techniques to validate and check data.
 - Create models for economies that show linking of data - energy balances – indicators.
 - Need high quality end-use efficiency data to really understand end-use opportunities – how to develop end-use data collection systems
 - How to identify and fix data gaps - be open to blue skies approaches.
- Develop guidelines on how to address the problems that the indicators highlight. What are effective policy responses to common problems identified by indicators?

- Develop more effective tools that maximize the information we can get from basic data. (Why apply sophisticated analysis to variable data?)
- Identify the limits of effectiveness for specific indicators. When are you reading too much into an indicator?
- Keep on developing consistency in data/indicators.
- Create online training options, especially for new analysts & those without any experience. Set up an online training course based on the material from this and related workshops so that new analysts can take themselves through a self-learning process, and get recognition for completing a prescribed course.
- Provide training on how to communicate indicators in a policy setting – how to get a Minister’s attention. ‘How it can improve the lives of citizens’? How to make international comparison?

3 Key Conclusions

It is important to recognise:

- 3.1** Energy Efficiency = Energy Savings + Service Improvements. [Service improvements are always less clear but just as important for quantifying both take-back and value to consumers]
- 3.2** Indicators are dependant on high-quality data.
- 3.3** No single key indicator provides all answers – suites of indicators are needed. One size does not fit all – customising indicators according to policy needs is essential.
- 3.4** Common frameworks are important, common methodologies, data standards, reporting templates etc. However, these frameworks need to cover general to specific needs.
- 3.5** Context: The objective not to achieve a level of energy efficiency *per se*, energy efficiency is not an end in itself – we do it for a wide range of social, economic and environmental reasons, thus, indicators must respond to this broader sustainability policy context.
- 3.6** Wider goals – it is critical to understand future energy needs and challenges so we need to keep a wide perspective on society’s needs, and develop leading or forward-looking indicators.
- 3.7** Maintain independence – we are analysts (diagnosticians not physicians), and thus need to avoid too much distraction from policy decisions and keep independence from political processes.
- 3.8** Top-down approaches to end-use are poor substitutes for basic end-use data, but are often the best or only option. It is better to have robust essential end-use data than sophisticated models based on estimates or weak data.

- 3.9 Communication is key – there is little point in having perfect indicators if they are not communicated effectively.
- 3.10 Balance supply and demand data/analysis, too much emphasis is placed on supply data, which usually is easier to obtain.
- 3.11 Don't neglect “basic” or “ordinary” indicators e.g. energy-GDP, energy-population intensities, energy import dependence, etc indicators
- 3.12 Efficiency indicators need specialist attention. Economy-wide and sector level energy efficiency indicators are derived from energy intensity indicators which are influenced by a number of factors, including behavioural, structural and technical factors. To obtain a measure of energy efficiency we must separate out the influence of such factors, such as economic or sector structure, activity growth change and weather. Energy efficiency indicators rely on strong end-use data and good analytical techniques.
- 3.13 Indicators must meet a policy need. Therefore, it is important that we:
- Determine clear policy objectives that indicators can be designed to support through the development of quantifiable targets and progress monitoring;
 - Ensure that indicators are described as policy issues, questions and answers;
 - Understand the forces behind indicators so we can identify effective policy actions;
 - Develop indicators that highlight and inform policy risks.

4 Recommendations to APEC EWG

4.1 ***Recommend that all economies develop processes to monitor and understand their energy use trends and the policy implications of their own development and global changes***

If energy policy is imperative to an economy, then the data and indicators to understand and develop sound policies and programmes are just as important.

4.2 ***Recommend that economies pay special attention to the development of energy data statisticians and analysts***

All economies felt they need to build up data gathering and analytical expertise. There are big gaps globally in the pools of experts and analysts and some economies have very little expertise to undertake data gathering and energy analysis tasks. In other economies there is an over-reliance on senior experts without skilled successors. It is thus a priority to nurture junior analysts to achieve a high level of expertise in energy analysis over time. These problems are faced by developed as well as developing economies. Training for statisticians is important to ensuring data-gathering ability and data quality. Note that this project is the only current APEC-funded workshop and event internationally in this area of energy analysis.

4.3 *Recommend that economies identify energy data gaps and invest in improved energy data gathering and analysis*

Many economies face significant data gaps. It will take time and investment to fill these gaps. Improved management of data and analysis is required. The newly adopted APEC energy data template (based in IEA data questionnaire) is a critical tool for ensuring data quality and identifying data gaps.

4.4 *Encourage developed economies to offer their experts to assist developing economies to establish indicators systems that meet their needs*

A basic, agreed set of priority indicators for developing economies needs to be developed. EWG should prioritise assisting expert groups to assist those data-poor economies to complete their basic indicators. There is great potential to improve the current situation in developing economies. Additional, similar workshops will help but greater collaboration between economies is essential. Economies have a strong desire to improve through:

- Training workshops
- Closer guidance from APEC and other international experts
- Voluntary assistance with data analysis

4.5 *Recommend that economies develop energy efficiency and conservation strategies and supporting energy end-use data collection and energy indicators systems*

Energy efficiency and conservation are just as important as energy supply options, thus each economy should have an energy efficiency and conservation strategy with supporting demand side energy data and research plans.

Energy efficiency and conservation indicators are important tools for any economy to understand the opportunities, priorities and progress in energy policy.

4.6 *Recommend economies actively support and cooperate with the coordinating agency of the EGEDA*

Continue to support the coordinating agency of the EGEDA to liaise with and assist APEC economies with energy data, maintain consistent datasets and liaise with other international energy statistics groups.

4.7 *Endorse the use of the newly adopted APEC energy data template by APEC economies*

The energy data template has been accepted by workshop participants and expert groups as the standard for maintaining energy data consistency within economies and across APEC.

Part Two

APEC Economies' Energy Sustainability Indicators

This section provides an overview of the APEC economies' energy use dynamics through energy indicators and policy perspectives. The focus is on indicators for energy sustainability, security of supply and affordability. APEC economies' energy use dynamics have changed significantly in the past decade or so compared with the rest of the world.

Data to postulate this analysis is constrained; few economies have comprehensive data sets and it does take time and resources to gather and correct data gaps. Our analysis has been constrained by the availability of data. We have used a range of sources – APEC, IEA and US Department of Energy.

The report shows how APEC economies' position has changed vis-à-vis each other and the rest of the world with regard to:

- Primary energy produced;
- Total energy consumed;
- Total electricity generation;
- Renewable electricity; and
- Energy related emissions.

The indicators used for this comparison are:

- Energy (primary and consumer) and CO₂ emissions per unit of production (GDP);
- Energy and CO₂ emissions per capita;
- Total primary energy to total final energy ratio;
- Energy self sufficiency ratio;
- Energy prices.

The indicator report is organized in 4 sections:

Section One provides APEC aggregate level energy indicators.

Section Two quantifies and compares energy use and energy-related emission dynamics across APEC economies. This highlights recent changes in key energy, sustainability and emission trends.

Section Three is about energy efficiency indicators for selected APEC economies. Key indicators of energy efficiency of APEC economies with sufficiently disaggregated sectoral data (i.e. those engaged in IEA data reporting processes) are provided here as an example to highlight the range and opportunity present at end-use efficiency policy options.

Section Four outlines a suite of priority indicators for use by developing APEC economies.

Section One: APEC Aggregate Level Energy Indicators

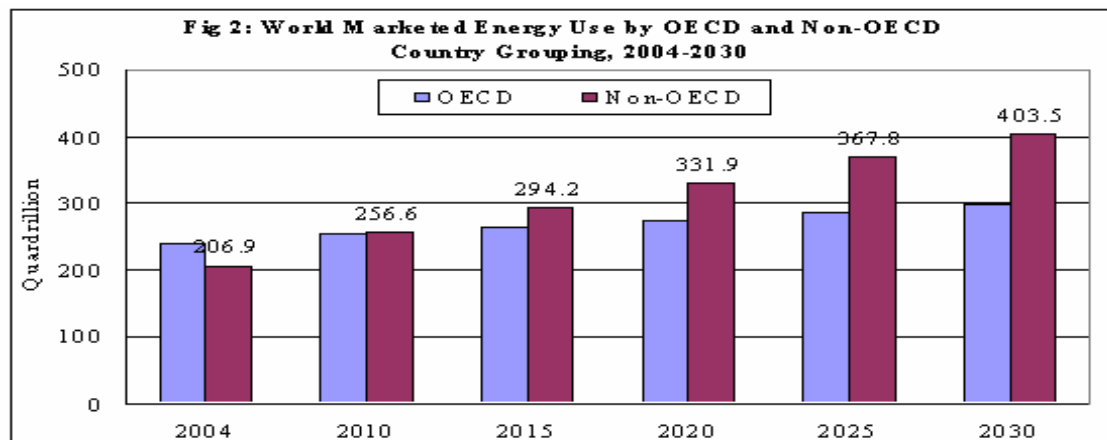
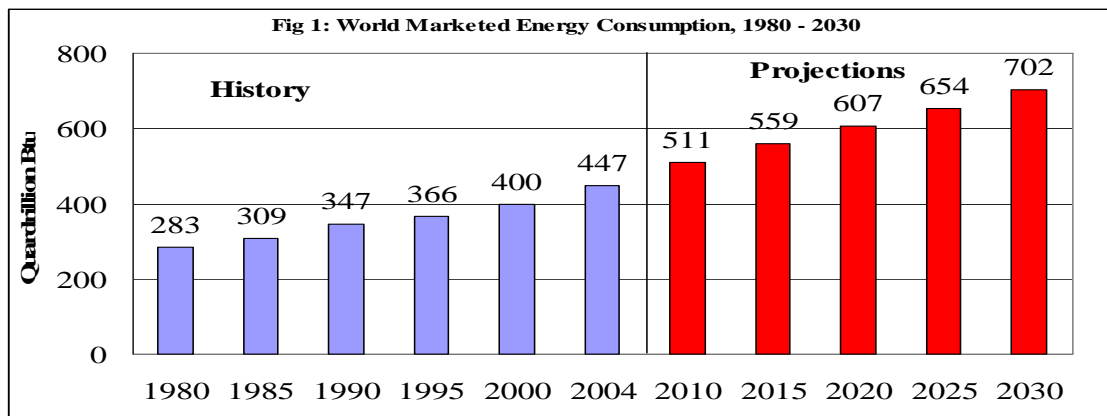
Clarifying Intensity and Efficiency

The concept of energy intensity is not the same as energy efficiency. They are often used interchangeably but shouldn't be. Energy intensity is a statistical ratio of energy use relative to an energy service index, e.g. GDP, population or physical output.

Energy indicators/intensities (distinguished from energy efficiency indicators) are influenced by a number of factors, including behavioural, structural and technical factors. To obtain a pure measure of economy-wide or sector level energy efficiency, however broadly it is defined, we have to separate out the influence of non-energy efficiency factors such as economic or sector structure, activity growth change and weather, all which impinging on energy intensity. It is only then that the trends in energy-intensity indicators can become a good proxy for energy efficiency change. However, at a process level, physical output energy intensity is a reasonable proxy for energy efficiency.

Only in the third section of this report we develop indicators that sufficiently factor out these non-efficiency factors that they adequately identify efficiency.

Is global energy consumption increasing?



World energy consumption continues to increase. Furthermore, projections (Energy information Administration/International Energy Outlook 2007, US department of Energy, p 85: www.eia.doe.gov/oiaf/ieo/index.html.) show an ongoing increase in consumption (Fig1) particularly in non-OECD countries.

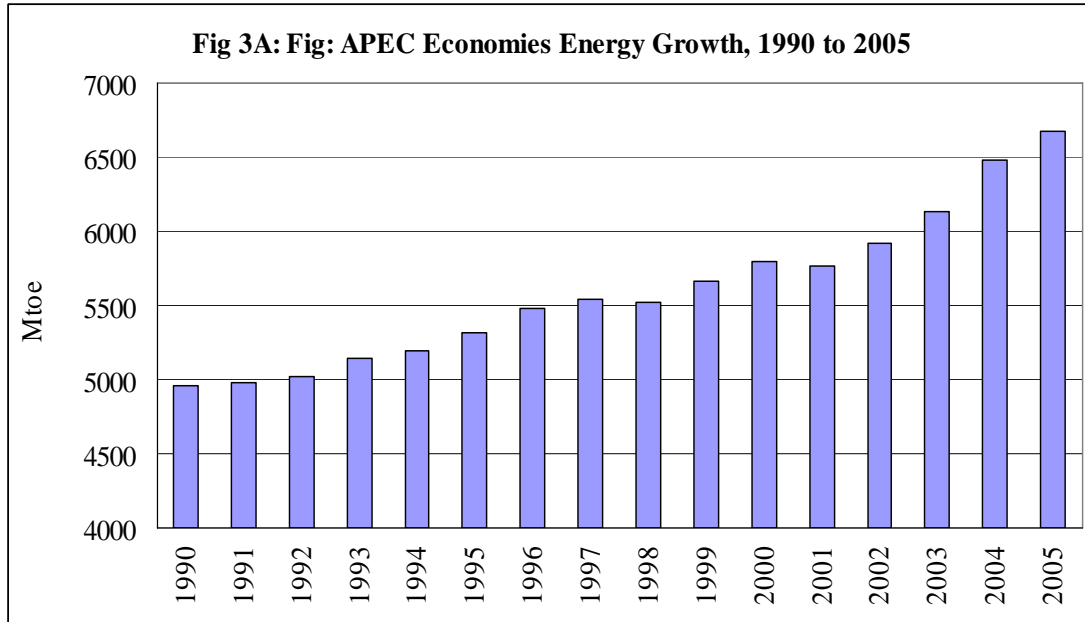
Table 1. World Marketed Energy Consumption by Country Grouping, 2004-2030
(Quadrillion Btu)

Region	2004	2010	2015	2020	2025	2030	Average Annual Percent Change, 2003-2030
OECD	239.8	254.4	265.2	275.1	285.9	298.0	0.8
North America	120.9	130.3	137.4	145.1	153.0	161.6	1.1
Europe.....	81.1	84.1	85.8	86.1	87.5	89.2	0.4
Asia	37.8	39.9	42.1	43.9	45.4	47.2	0.9
Non-OECD	206.9	256.6	294.2	331.9	367.8	403.5	2.6
Europe and Eurasia.....	49.7	54.7	59.4	64.4	68.7	71.5	1.4
Asia	99.9	131.0	154.7	178.8	202.5	227.6	3.2
Middle East	21.1	26.3	29.5	32.6	35.5	38.2	2.3
Africa	13.7	16.9	19.2	21.2	23.1	24.9	2.3
Central and South America	22.5	27.7	31.5	34.8	38.0	41.4	2.4
Total World	446.7	511.1	559.4	607.0	653.7	701.6	1.8

Note: Totals may not equal sum of components due to independent rounding.

Sources: **2004:** Energy Information Administration (EIA), *International Energy Annual 2004* (May-July 2006), web site www.eia.doe.gov/iea. **Projections:** EIA, *System for the Analysis of Global Energy Markets* (2007).

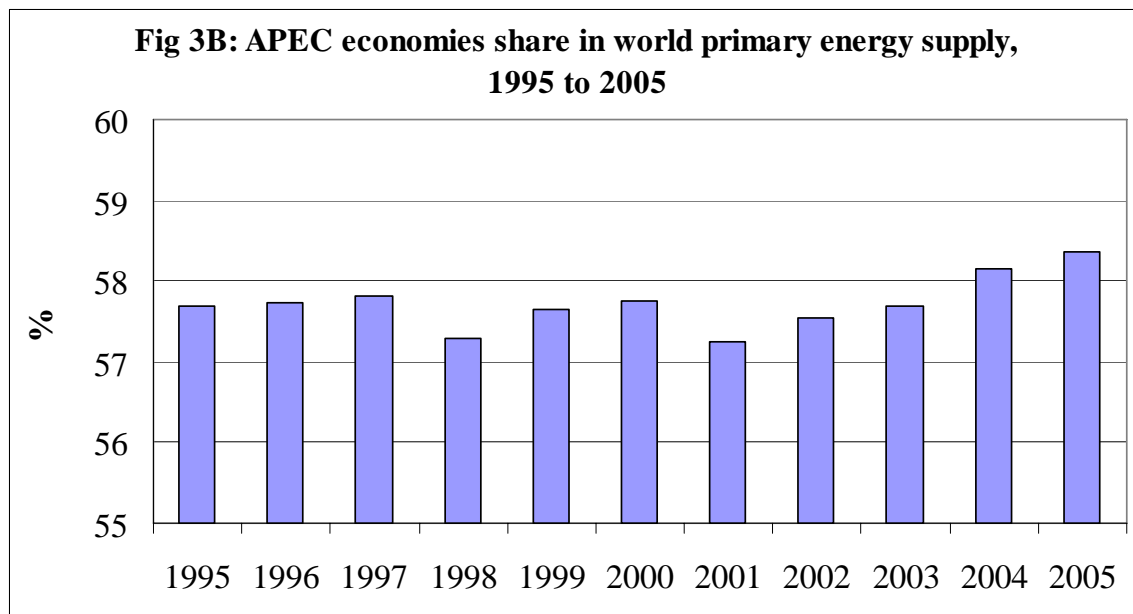
Is APEC energy primary energy supply requirement increasing?



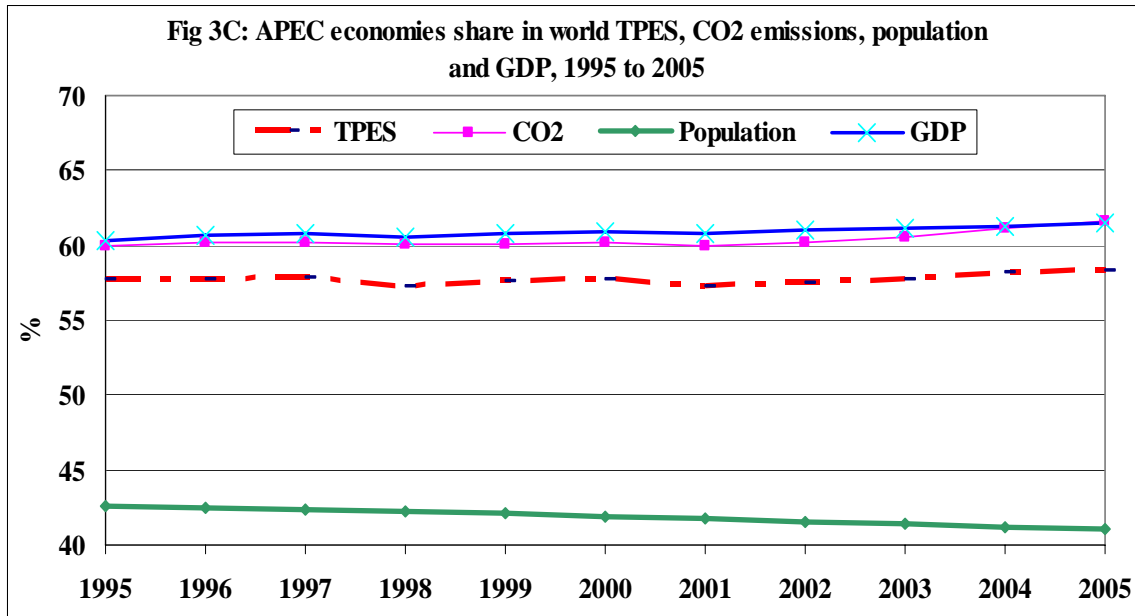
Between 1990 and 2005 energy supply growth across region was:

- 34.5% across APEC economies;
- 25.4% for Non-APEC economies; and
- 30.6% for the world.

How significant is APEC primary energy supply internationally?

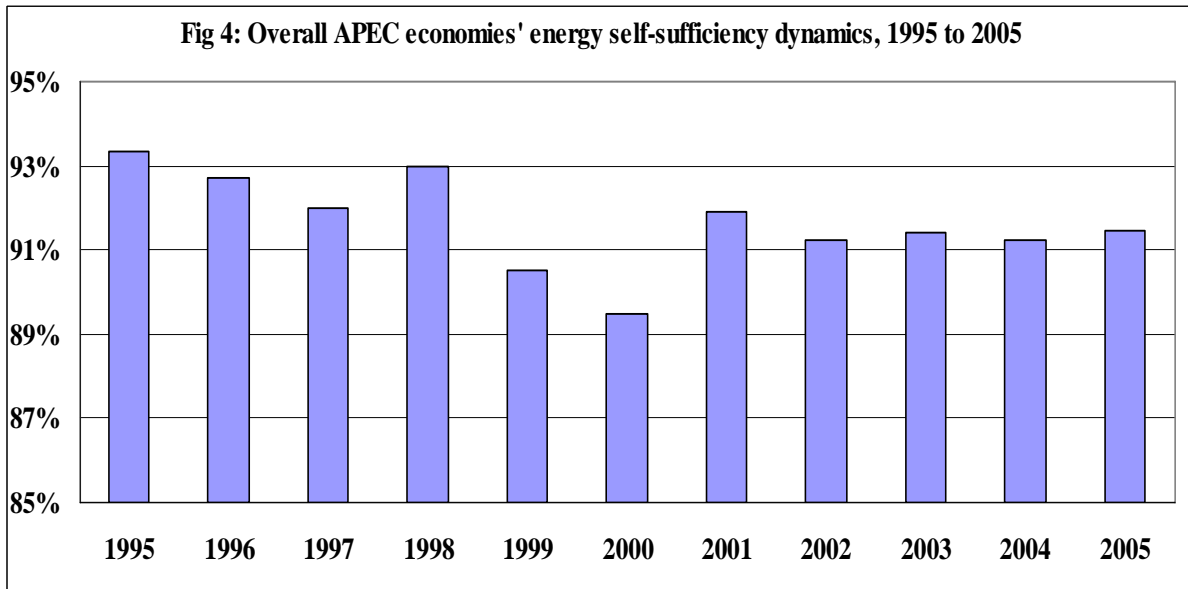


What factors drive primary energy supply growth?



APEC economies consume over half (58%) of the worlds energy (Fig2) produce over 60% of GDP and CO2 emissions yet include only 41% of the worlds population (Fig3).

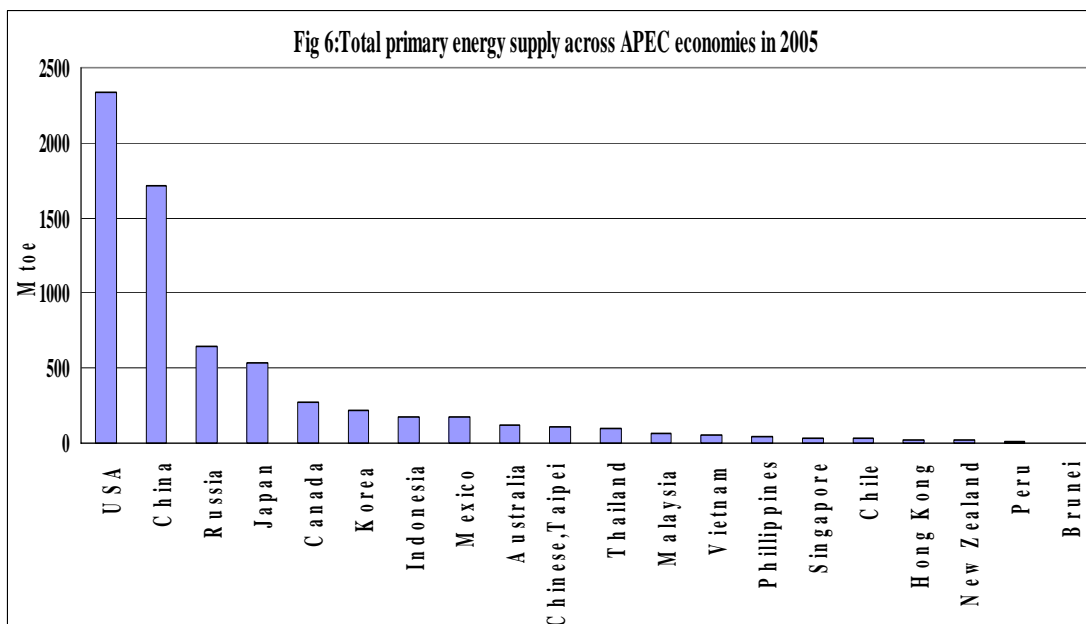
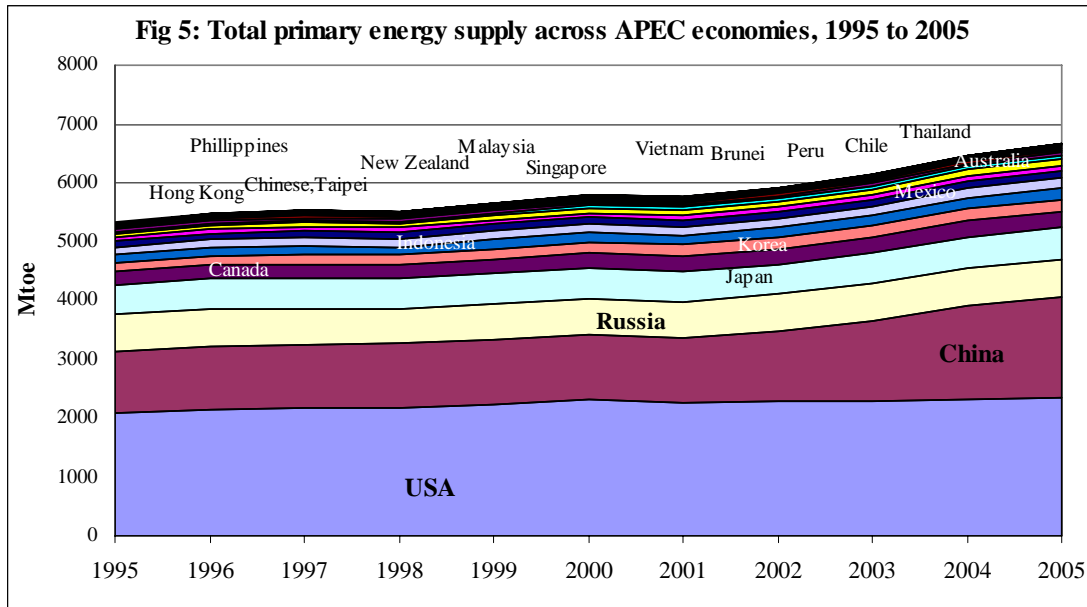
How dependent are APEC economies on the rest of the world for energy supply?



APEC economies have provided up to 93% of their own energy but this is slowly declining (Fig 4) The amount of energy considered here is the net amount exported to non-APEC economies.

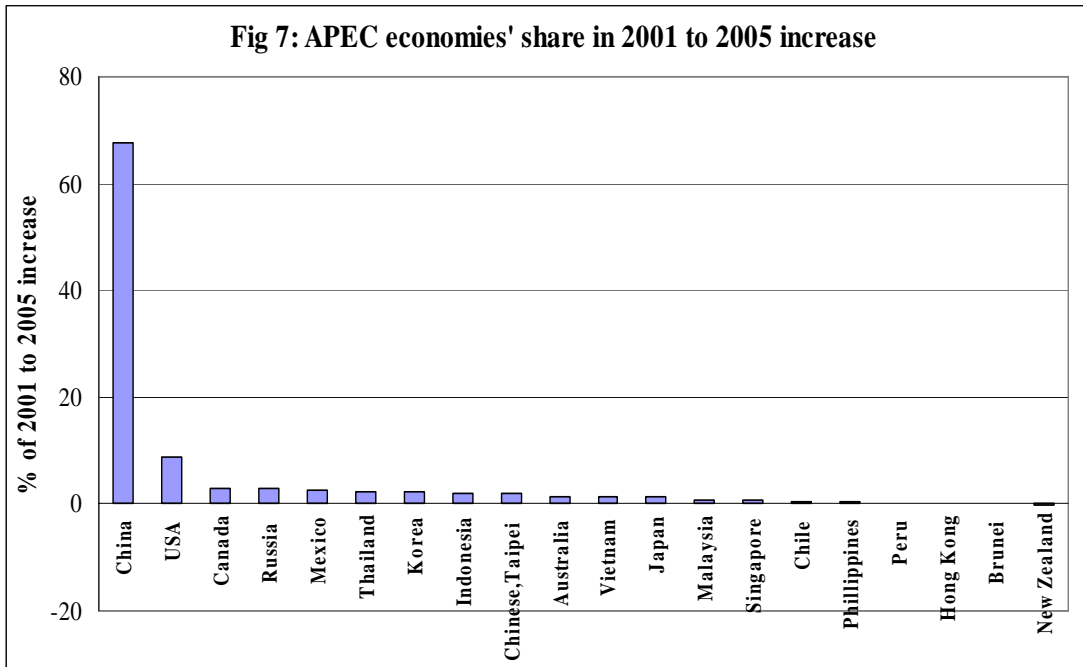
Section Two: Energy and Energy Related Indicators Across APEC Economies

How do the demand for energy from APEC economies' contribute to APEC's total energy demand?

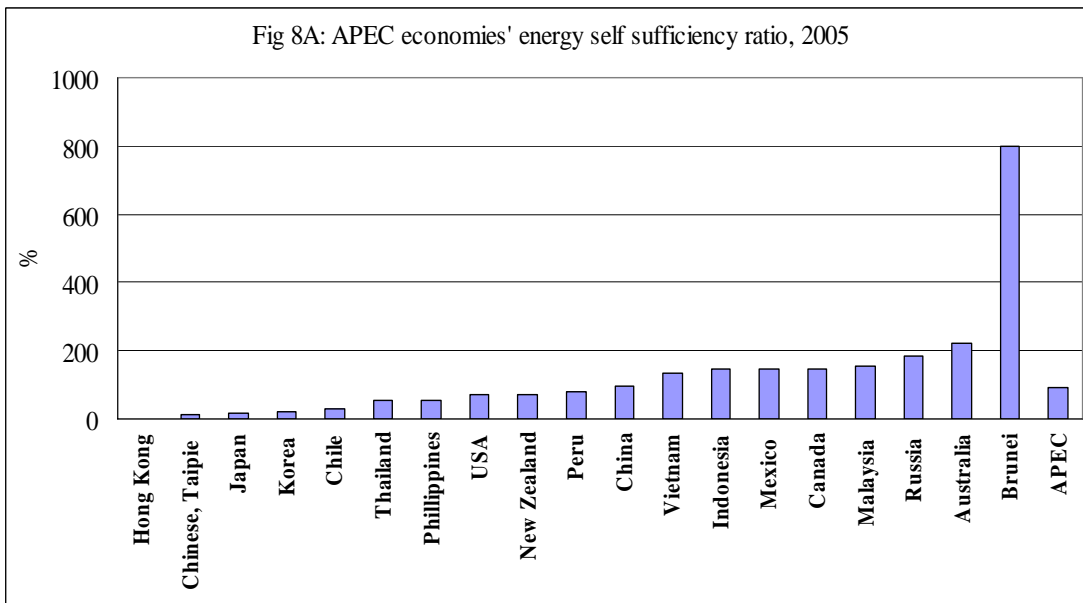


75% of APEC's energy demand lies in the 4 largest economies (Fig 5 & 6). There is significant diversity in the amount of energy consumption across APEC economies.

How have APEC economies' energy consumption rates changed over time?

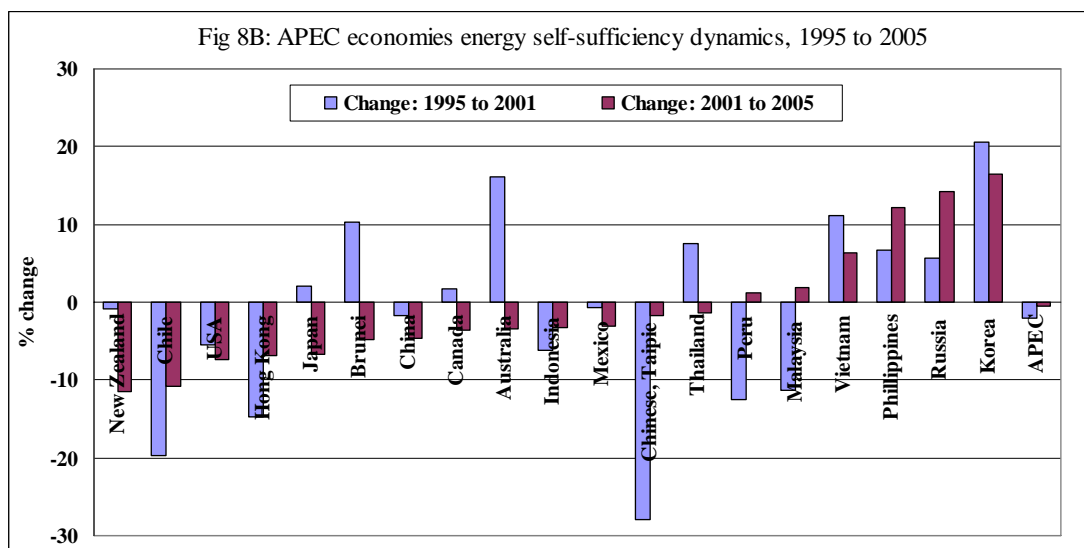


During the past 5 years, 4 economies have maintained stable energy consumption rates, however, most have grown by about 3-4%, while increasing demand in the USA and China has led to overall APEC energy demand growth.

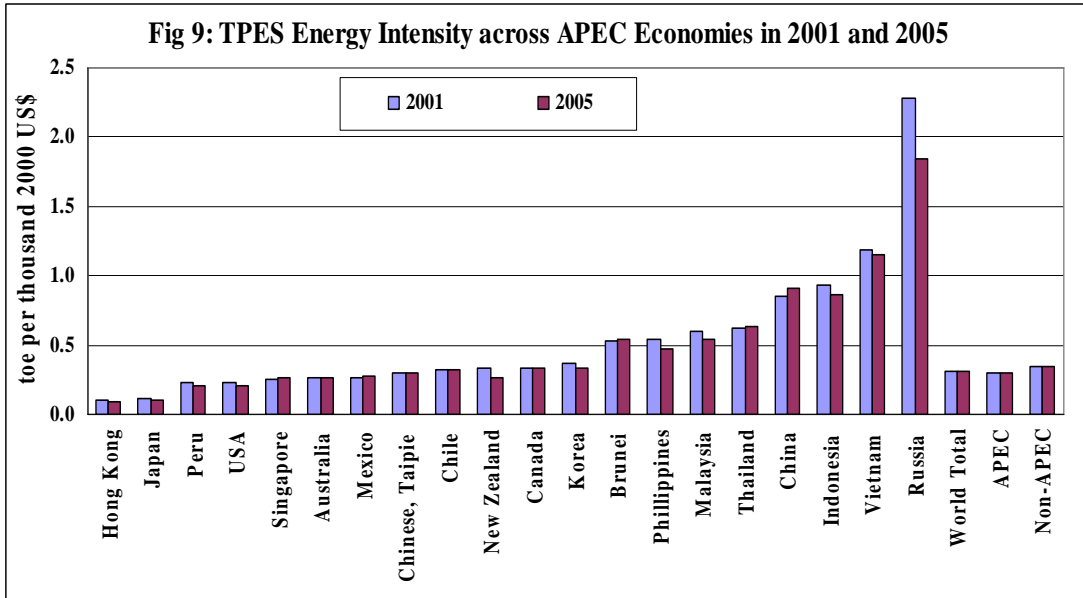


Energy self sufficiency = energy production/net energy imports, where
 Energy production = Primary energy supply which includes imports but excludes exports, stock changes and international transport.

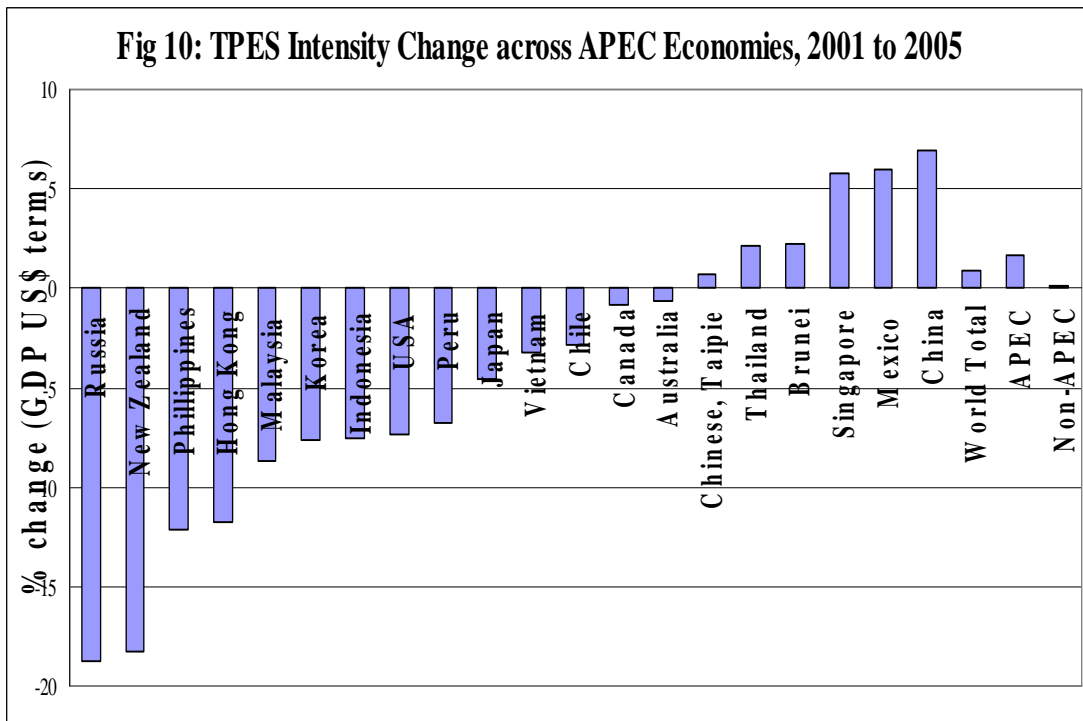
Have APEC economies become more or less self sufficient with that growth?

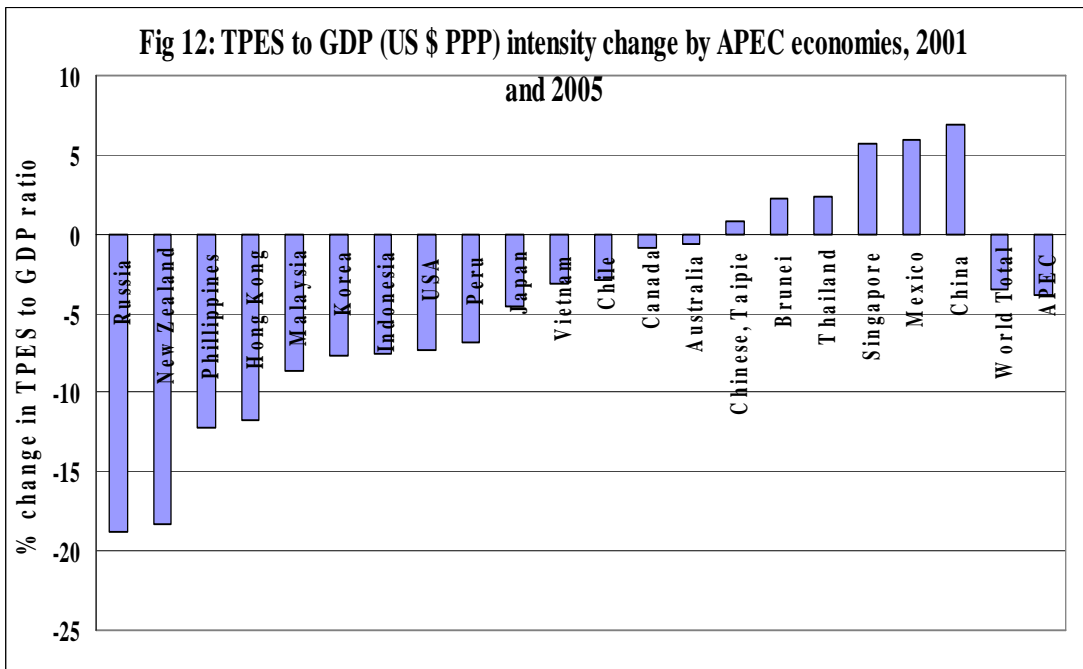
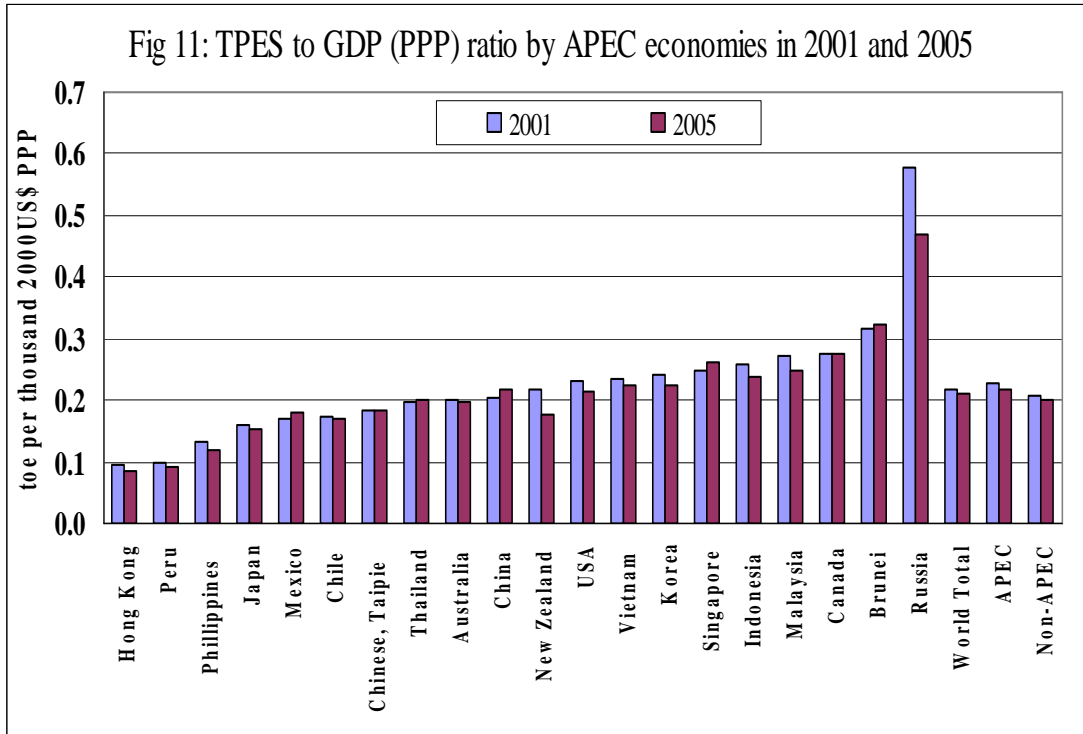


6 economies are becoming more self-sufficient – reducing their dependency on imported energy. However, only 4 of these economies have increased their rate of becoming more self-sufficient over the past ten years. 13 economies have increased their reliance on imported energy over the past decade. 9 of these economies have increased their rate of dependency (Fig 8). Across APEC, self-sufficiency declined over the past decade but the rate of decline has decreased in the past 5 years. In summary, while 4 out of the 21 APEC economies are becoming more self-sufficient, many APEC economies are increasingly exposing themselves to international energy market volatility. Improving self-sufficiency should be a priority for APEC economies; given the issues raised in the background of this report and the vast majority of traded energy being in oil and gas products.



How has the value that APEC economies derive from energy changed?





Care is required when assessing energy–GDP intensity rates. Energy-GDP intensity is widely used as a prime indicator of economic performance. However it reflects a wide range of issues: economies’ resource endowment, their historical development

trends, production mix, economic structure, technical efficiency and currency values. In order to normalise out the latter, significant factor, we apply purchase power parity (PPP) factors for each economy so that the economic value is treated as a constant across the range of economies examined. This discussion is therefore based on Fig's 11 and 12, the unadjusted data (Fig 9 and 10) are provided for reference.

While most economies energy–GDP (PPP) intensity is around the APEC average of 0.2 toe/USD_{2000PPP} the extremes highlight the real variety of economic structure across APEC:

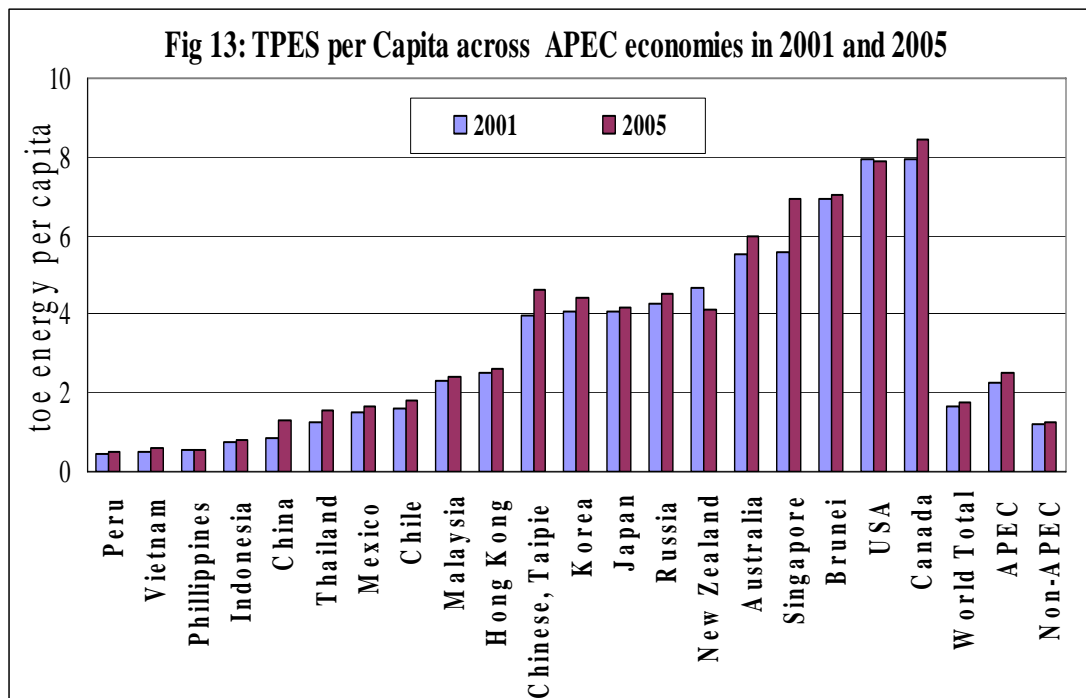
- The lowest economies' intensities of 0.1 toe/USD_{2000PPP} (Hong Kong and Peru); and
- The highest economies' intensities of 0.3–0.5toe/USD_{2000PPP} (Brunei and Russia), span a full range of developed to developing economies, highlighting the real limits of intensity as an indicator of economic energy utility.

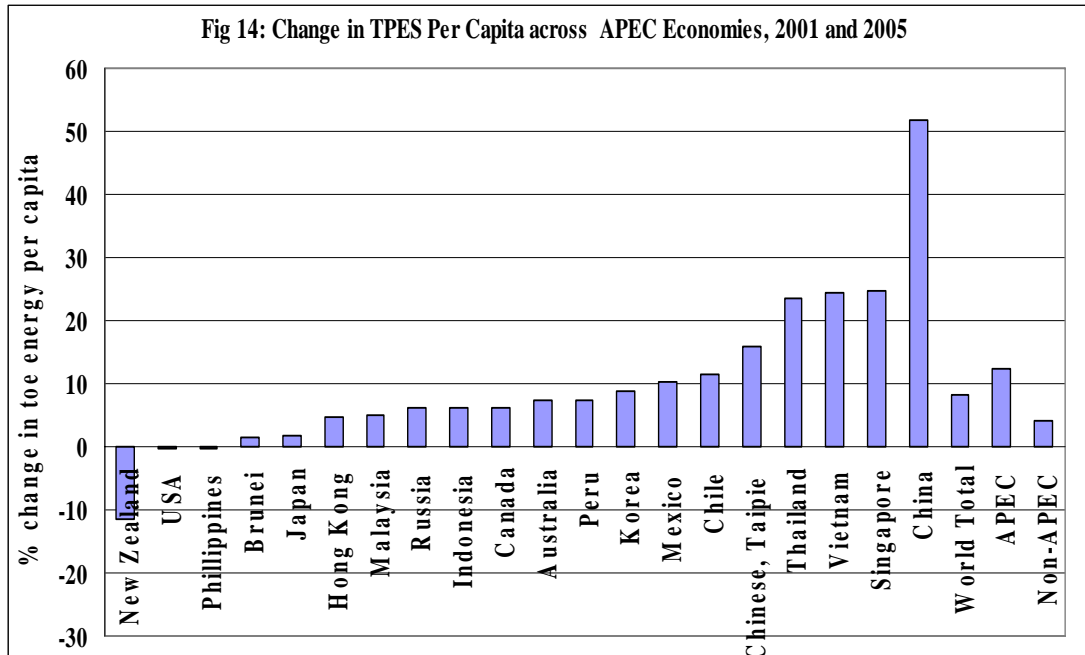
APEC's energy intensity is slightly higher than the rest of the worlds.

It should be noted that most (14) APEC economies are showing improvement (ie decline) in energy intensity (Fig 12). APEC's rate of improvement over the past 5 years is marginally better than the rest of the world's.

All economies (but particularly those with high average energy intensity) should further explore the resource, structural, and technical reasons behind their intensities.

How has energy-population intensity changed?





Energy-population intensity varies considerably across APEC economies. It is a prime indicator of the development status of a population. As with energy-GDP intensity there is a range of underlying drivers for energy-population intensity.

While most APEC economies' energy-population intensities span from less than 1 toe/capita to over 8 toe/capita, the extremes highlight the real variety of economic structure across APEC:

- The lowest economies' intensities of 0.1 toe/capita (Peru, Vietnam, Philippines, Indonesia) highlight the situation of developing tropical economies – low levels of industrialisation relative to their population bases, low energy usage by citizens;
- The highest economies' intensities of 0.8toe/capita (Canada) highlights the impact of geographical location and population density – Canada's sparsely populated continental economy demands high levels of space heating and transport energy.

As with energy-GDP intensity, the range of energy-population intensities highlight the real limits of population intensity as a indicator. All economies (but particularly those with high average energy-population intensity) should further explore the structural, geographic and technical reasons behind their intensities.

Almost all APEC economies increased their energy-population intensity over the past 5 years. APEC economies' rate of increase is twice that of non-APEC economies.

Have APEC economies CO₂ emission intensities improved?

Fig 15: CO2 to GDP Ratio across APEC Economies in 2001 and 2005

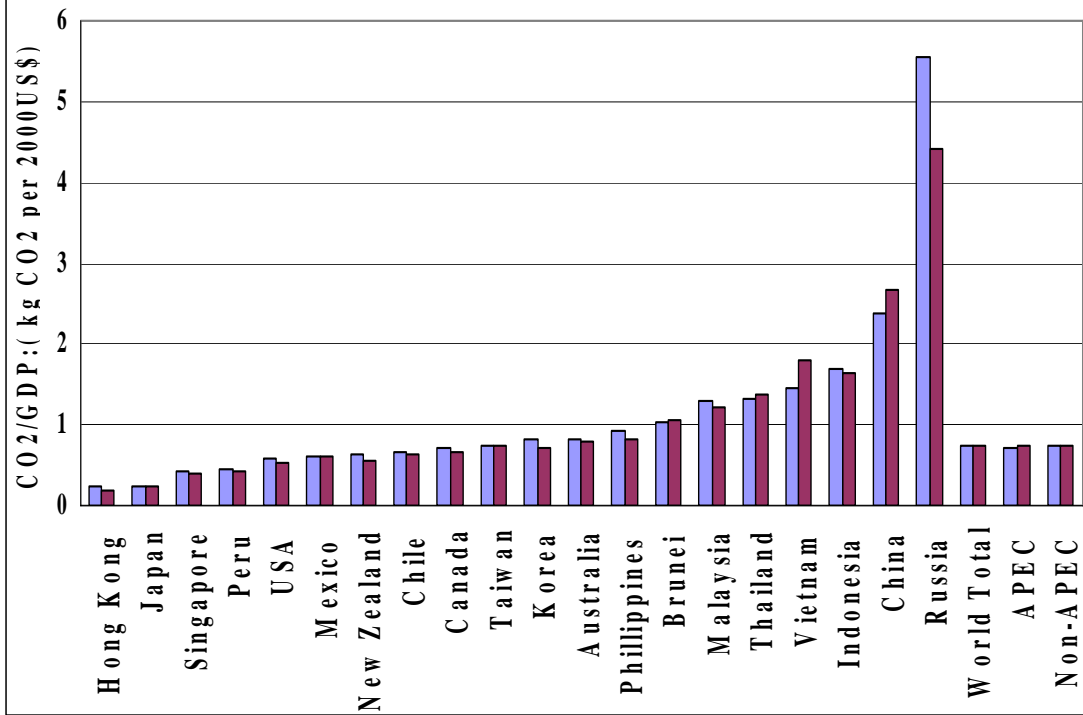
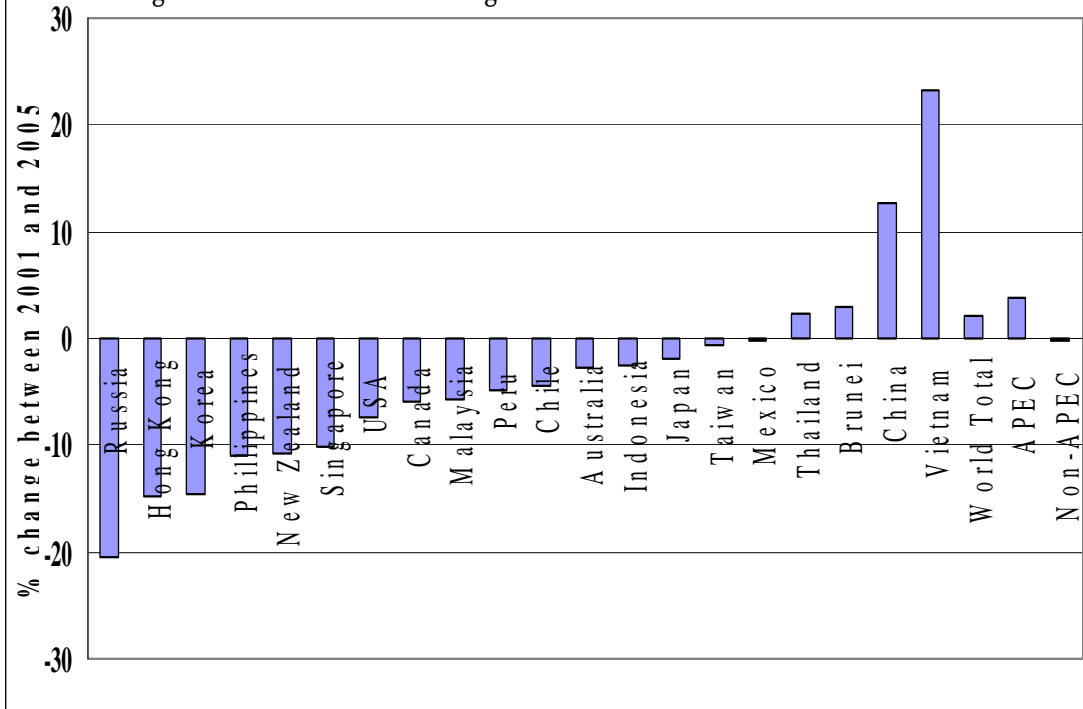
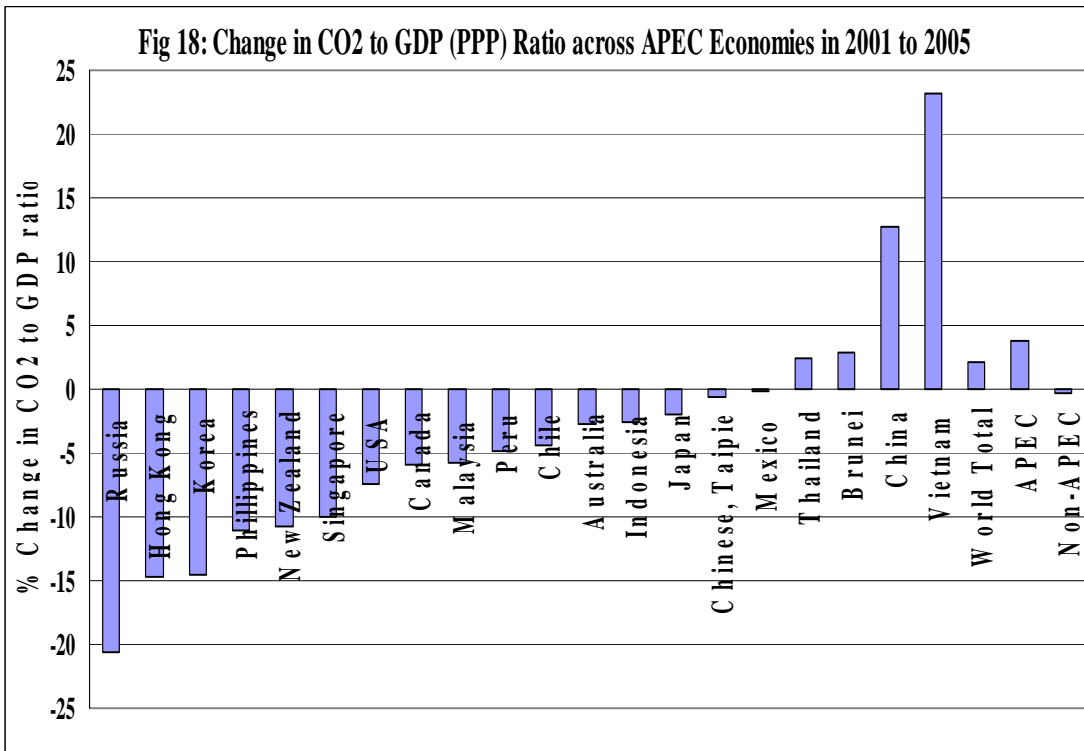
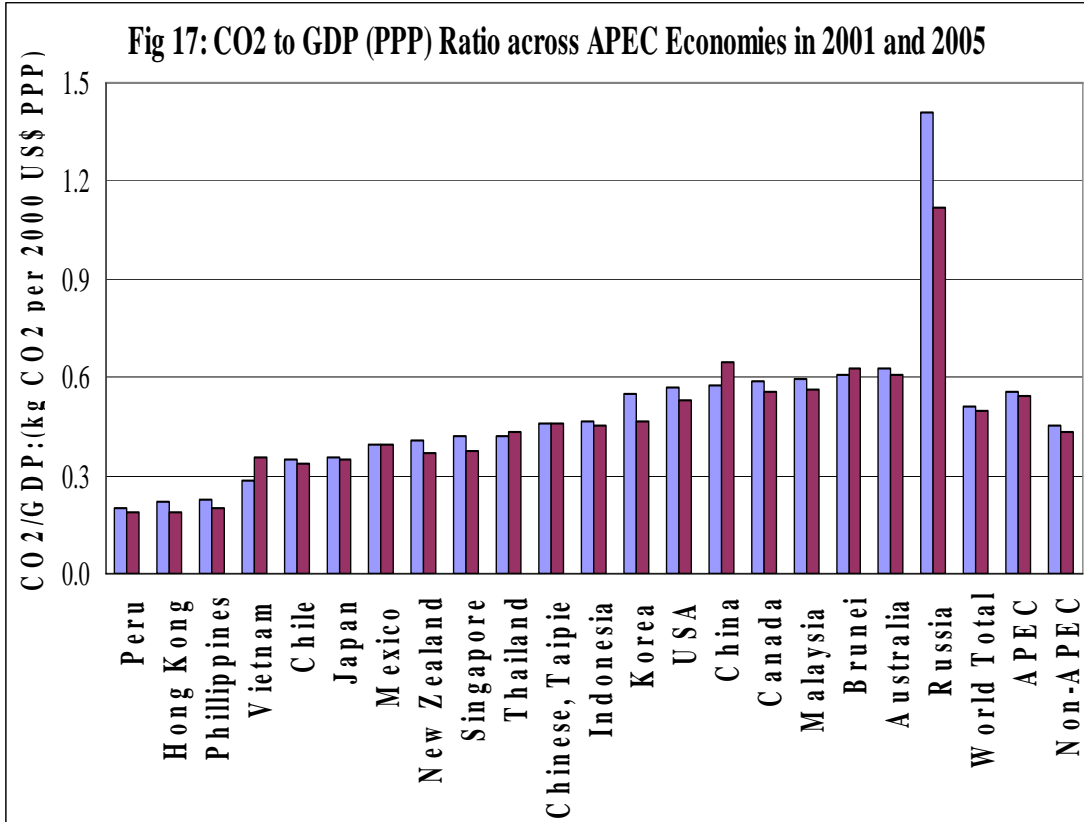
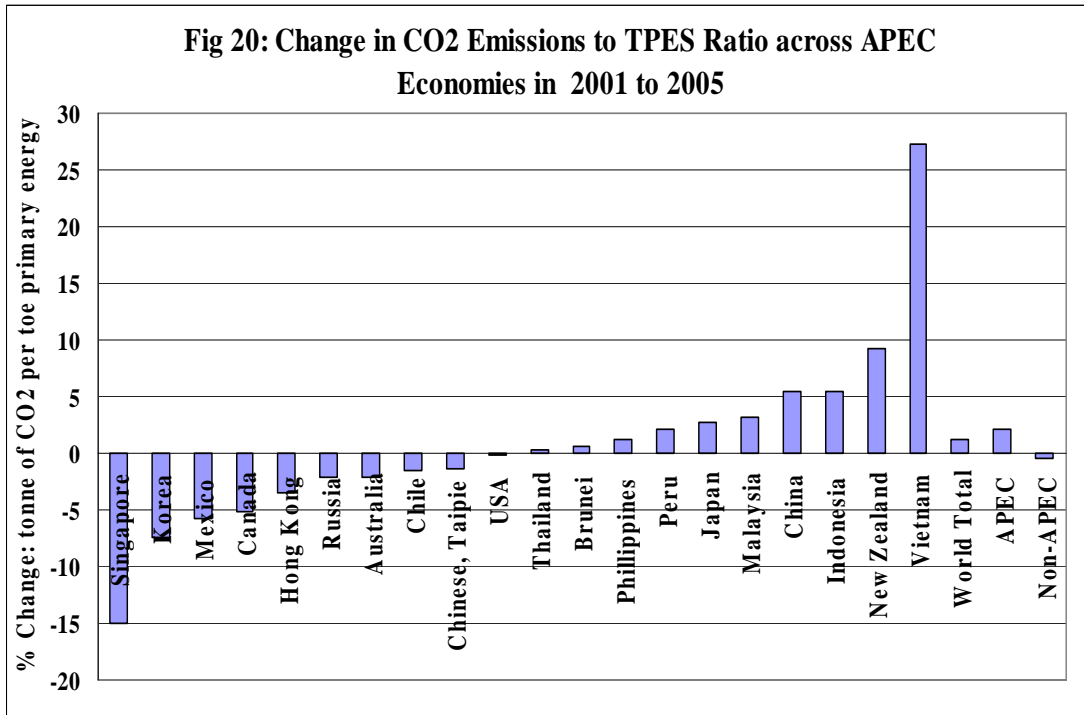
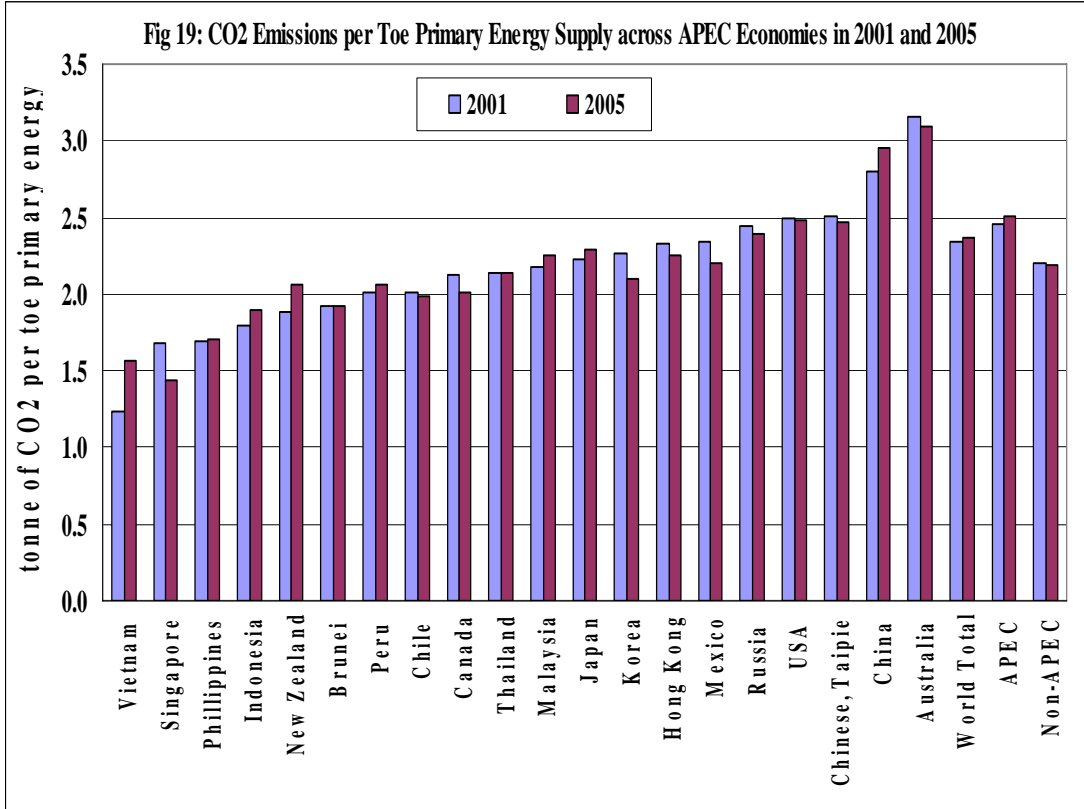
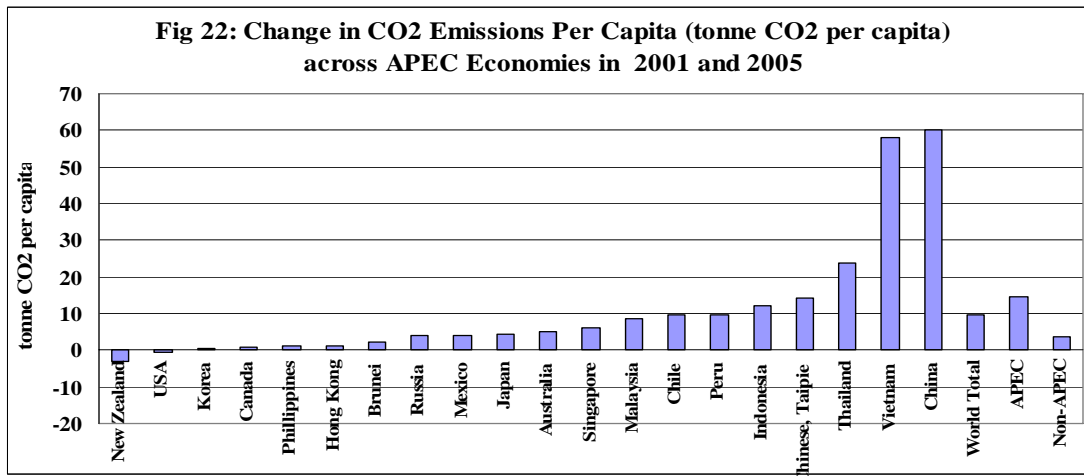
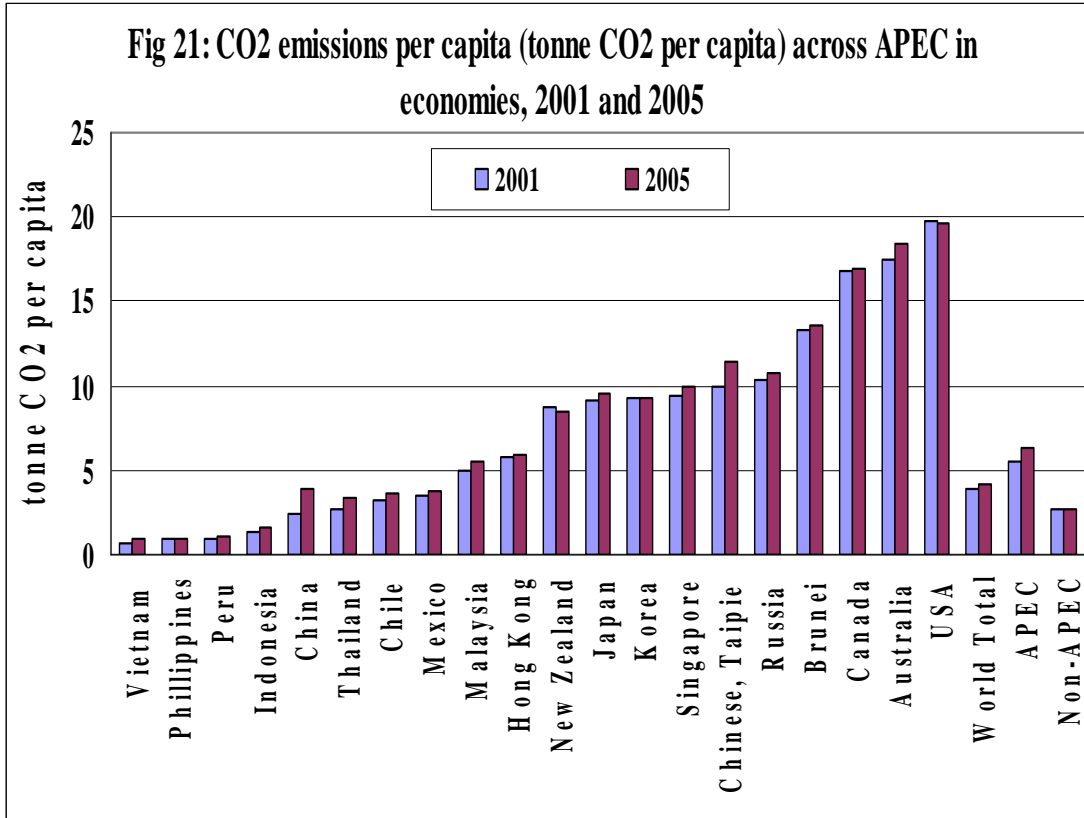


Fig 16: CO2 to GDP Ratio Change across APEC Economies in 2001 and 2005









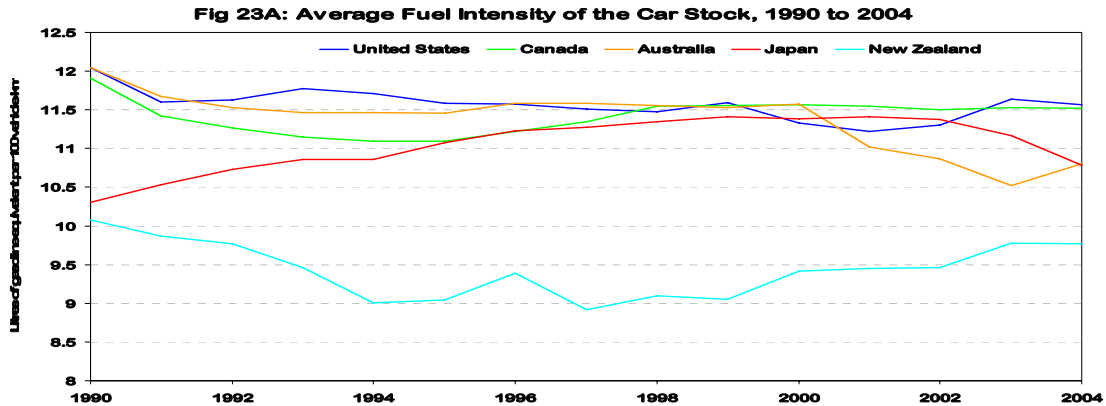
Section Three: Sectoral End-Use Energy and Efficiency Indicators

This section reproduces key energy efficiency indicators for those APEC economies with sufficiently disaggregated sector data. Only a few of the APEC economies collect such information, and such it was not possible to compute such indicators for all APEC economies. This lack of end-use data limited this analysis to a subset of APEC economies. This highlights the need to establish and maintain ongoing data gathering and consistent management systems. These indicators are important as

they transcend the limitations of intensity indicators to highlight the key technological efficiencies that underpin the effective utilization of energy in specific activities.

Transport Sector

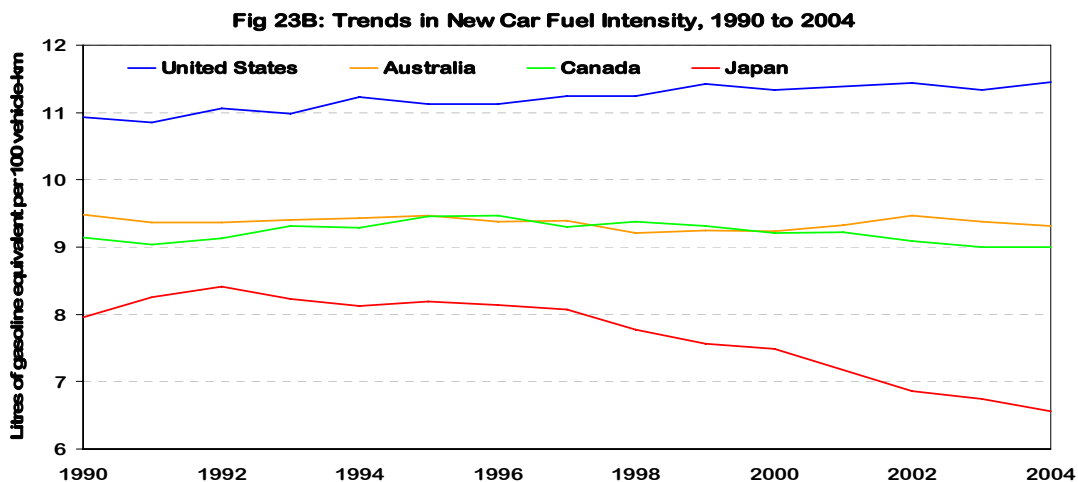
Has the fuel efficiency of our existing fleet of cars improved?



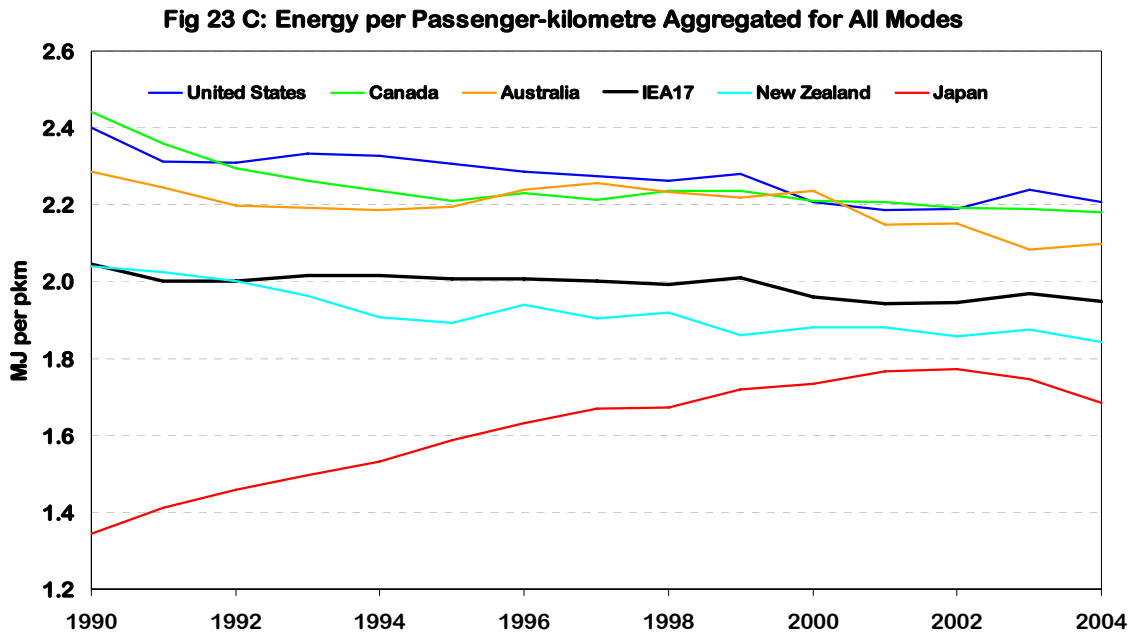
The fleet average fuel intensity in an economy provides a key indicator of the efficiency of the ‘in-use’ passenger car stock. Fig 23 A shows that between 1990 and 2004, average fuel intensity of the car stock declined 10.3% in Australia, 4% in US, 3.3% in Canada and 3.1% in New Zealand, it increased in Japan by 4.7%.

It should be noted that the classifications and definitions of “passenger car” vary from economy to economy and these fuel intensities may vary in reality. It is worth noting that Italy’s ‘in-fleet’ fuel intensity is 7L/100km.

Fleet stock average fuel intensity (Fig 23A) is usefully complemented by fuel intensity information for the new vehicles entering the fleet (Fig 23B). This is a forward indicator of the efficiency implications that the economy will face over the nominal life of the fleet.



How fuel efficient is our use of our car fleet?



Energy intensity per passenger kilometre adds a behavioural factor to the fuel intensity indicator. Here the energy use per passenger kilometre includes factors such as the passenger loading of the vehicles, and drive cycle characteristics, the degree to which cars can travel smoothly or are stuck in congestion as well as the fundamental technical efficiency of the vehicles. Between 1990 and 2004, energy intensity per passenger kilometre declined 10.6% in Canada, 9.7% in New Zealand, 8.0% in US and 4.7% in overall IEA17 economies, while Japan witnessed an increase of 25.2% during the same period, it still has the lowest intensity per p-km.

How intensive is our car ownership?

Simply the ratio of cars to population this indicator highlights an economies dependence on cars as a mode of transport.

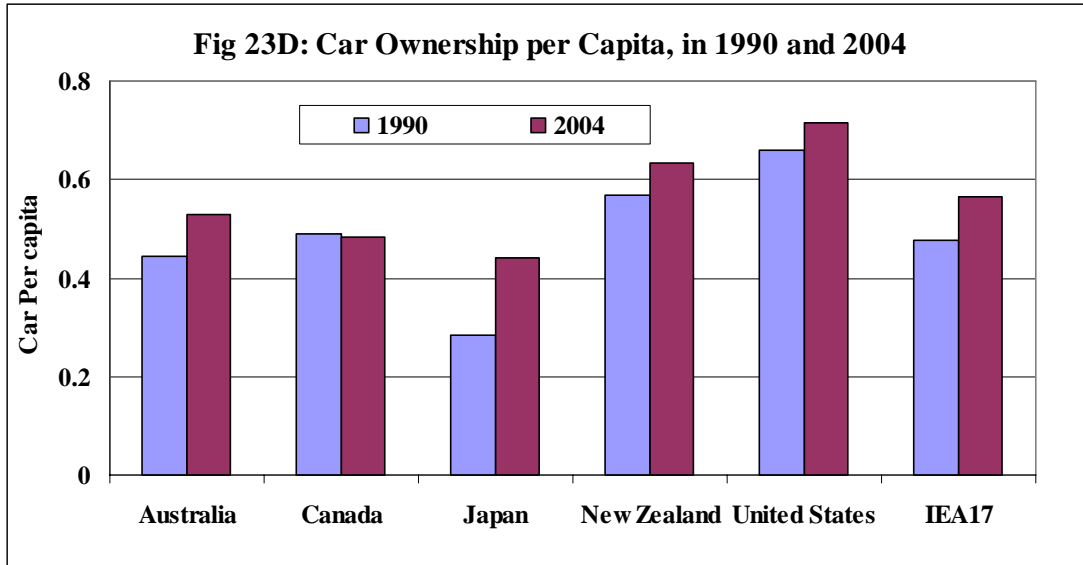
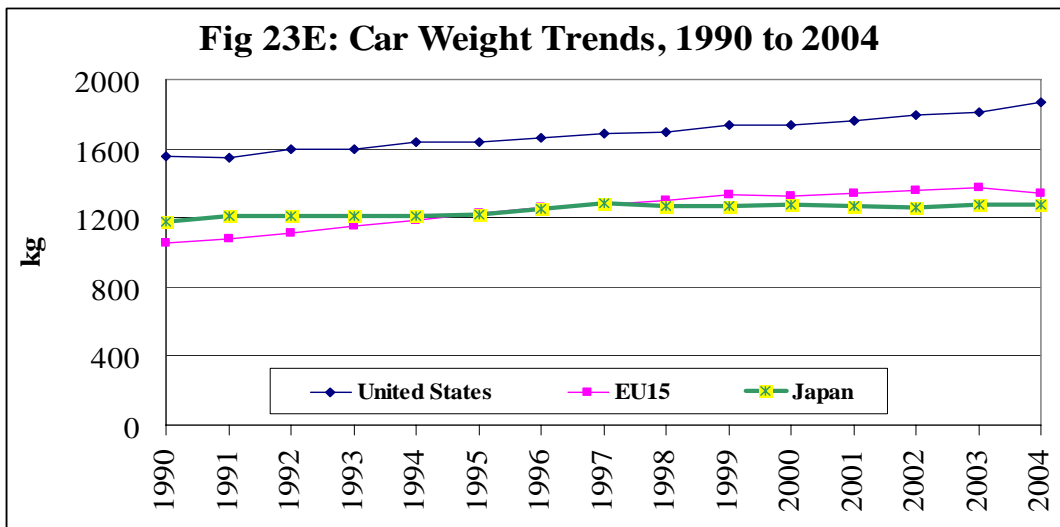


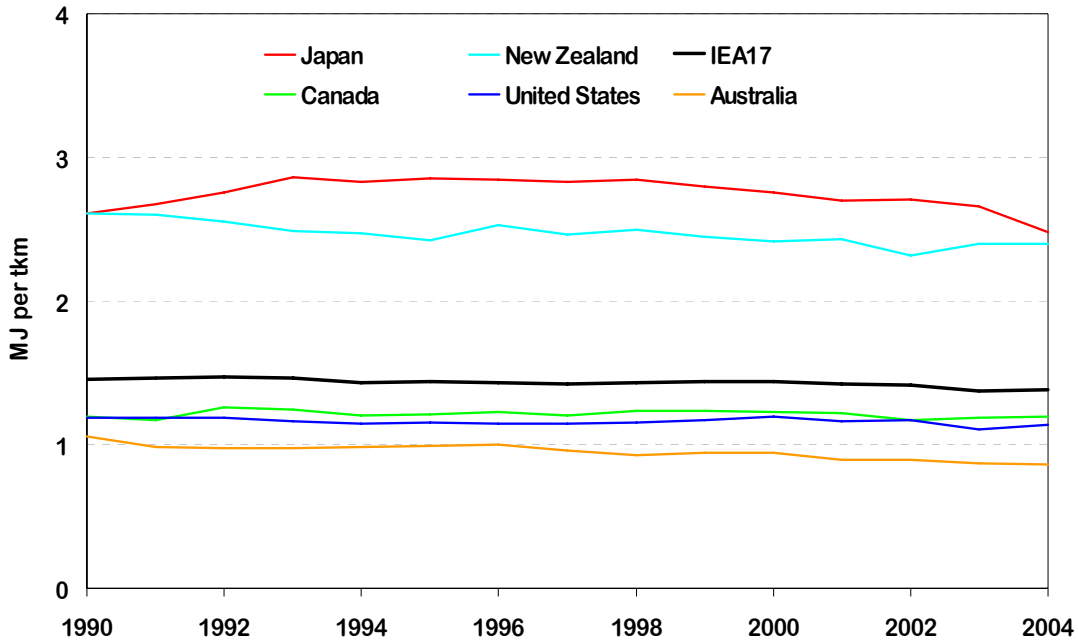
Fig 23D shows our dependency on cars which is a function of geography, settlement, availability of efficient alternatives.



A key factor in vehicle fuel intensity is vehicle weight. Here a trade off between vehicle size, vehicle design, fuel efficiency, payload efficiency, is expressed. It should be noted that a growing range of vehicle safety rules create opportunities to trade off smart design against weight. Despite advances in design, vehicle weights have increased by 5 to 20% over the past 10 years.

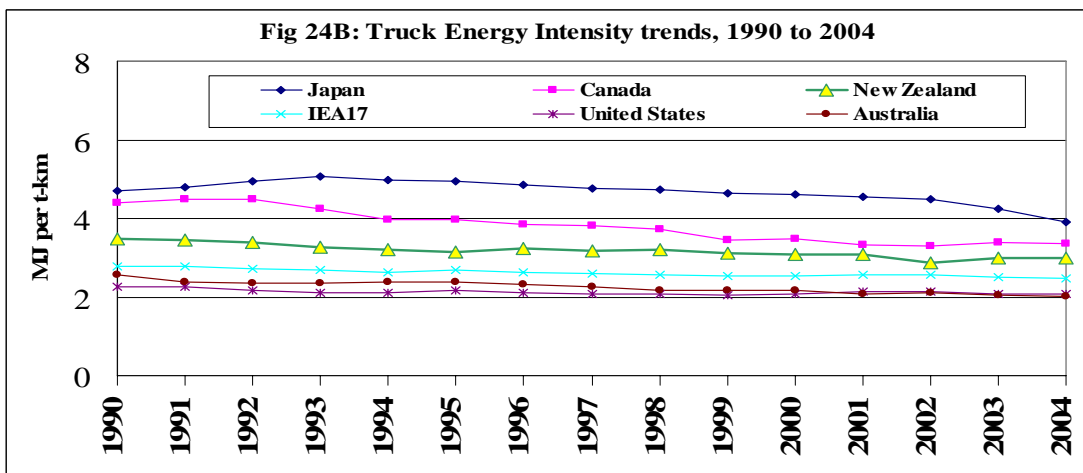
How energy intensive are our freight systems?

Fig 24A: Freight Transport Energy Use per Tonne-kilometre by Country, 1990 to 2004



These indicators look at overall freight system energy intensity i.e. energy required to carry a tonne of good one kilometre. A range of factors contribute to these indicators: the modal composition or structure of freight systems in an economy, the type of goods conveyed, the nature of the economies geography, the technical efficiency of the vehicles and logistics systems. Examples in this plot of indicators highlight how these can be quite significant – while Australia conveys large quantities of minerals these tend to be in coordinated high carrying capacity road trains or rail systems. New Zealand has more diversified goods, limited capacity for rail to carry significant amounts of freight with a narrow gauge rail system, constraints on road freight vehicle capacities due to hilly geography.

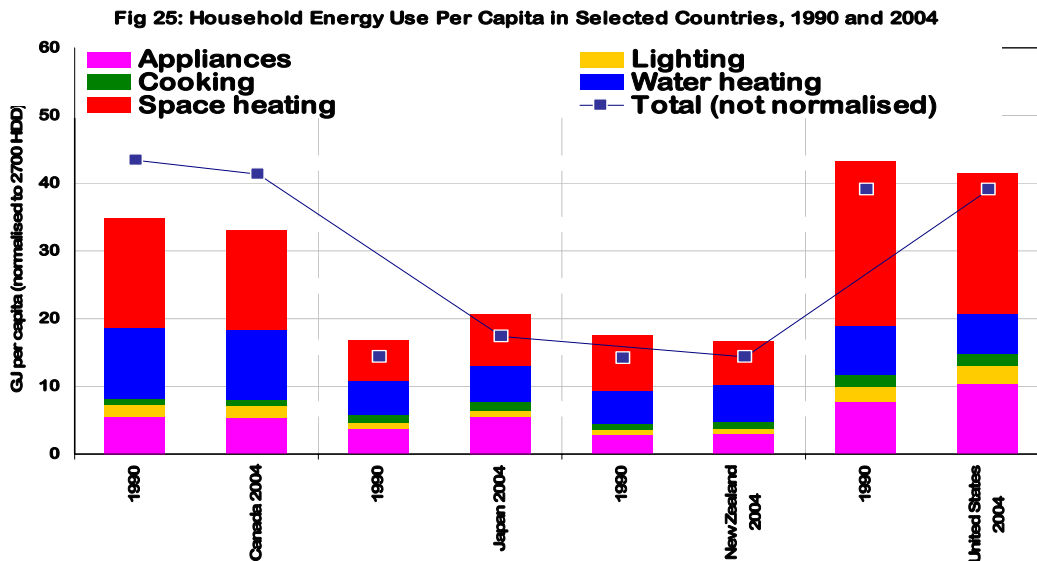
How efficient are our trucks?



This indicator separates out trucks from other freight modes, highlighting the degree to which freight vehicle technical efficiency is a component of overall freight system intensity.

Household/Residential Sector

How much energy is used in households and how is it used?



This plot of indicators shows a rich information set about household sector energy use by components over two periods – indicating not only the scale of energy use but also its components.

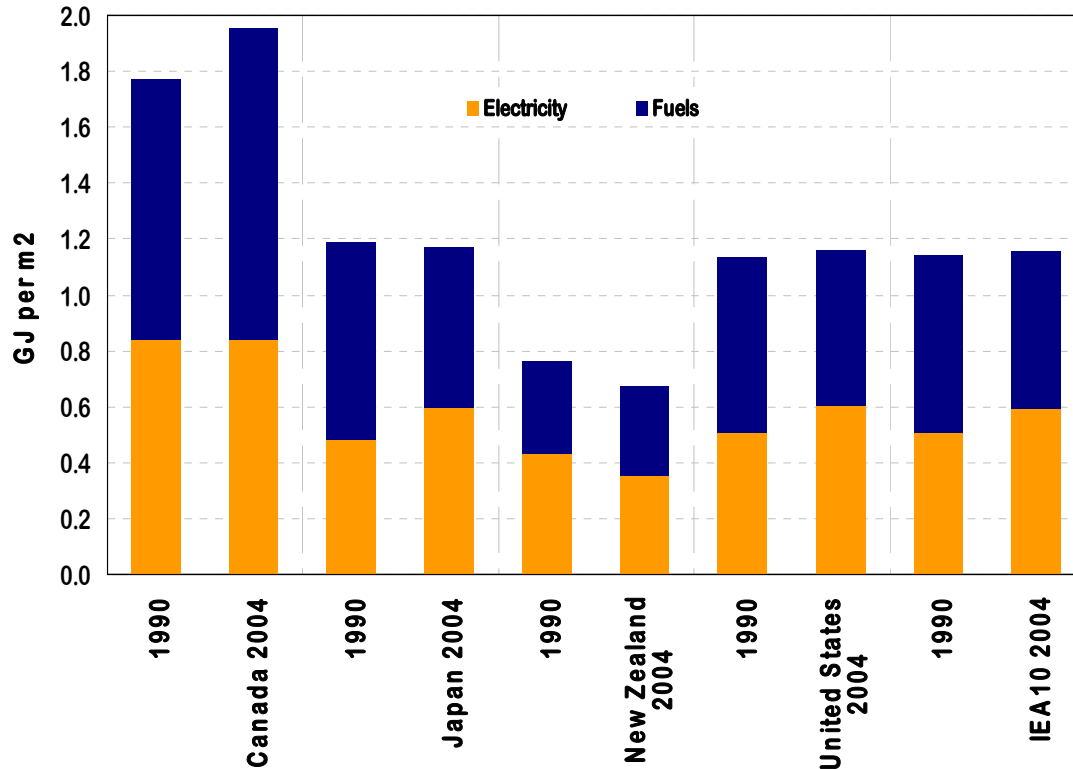
The indicator is normalised by household occupancy and is therefore represented as household energy use per capita. This factors out occupancy rates, but better highlights the energy use for shelter and comfort in a population.

Geographical and behavioural differences are included in these indicators. Notably both Japan and New Zealand are island countries located in temperate climates – heating requirements are less extreme than in continental climates. The indicators are normalised to account for this climate variability by compensating for heating degree days. New Zealanders tend to heat to lower levels than householders in other economies, this partly explains the lower heating energy.

Commercial/Service Sector

How energy intensive is our commercial building stock?

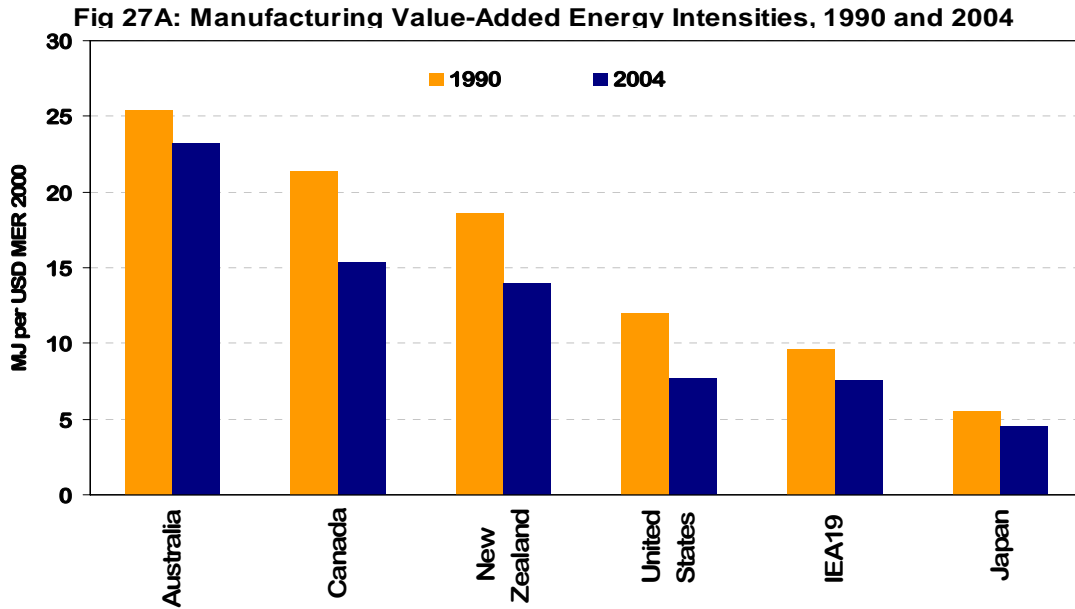
Fig 26A: Commercial Electricity and Fuel Use per Floor Area, 1990 and 2004



This indicator shows the energy used across the fleet of commercial sector buildings as a key indicator of commercial building energy intensity. These indicators are not normalised for climate, so reflect increased energy requirements for colder continental climates.

Manufacturing Sector

How energy intensive is our manufacturing sector?



Indicators for heterogenous sectors like manufacturing (where output cannot be measured in one physical unit e.g. tonnes, meters, etc) almost invariably utilise GDP output from the sectors as the basis for indicators. The structural mix within the manufacturing sectors of economies is one of the key factors behind the differing energy- GDP intensities of economies. Simply put, economies with resource endowments that enable processing of energy intensive manufacturing outputs must necessarily be more energy intensive than economies that do not process these goods. A common currency must be used and ideally PPP normalisation will be used for inter-country comparisons. This indicator is not a measure of efficiency.

Section Four: Priority Indicators for APEC Economies in the Process of Developing Energy Information Systems

Energy policy design is now widely considered as an effective instrument for promoting economy-wide and sector-level energy efficiency, renewable energy and energy conservation measures. An essential part of this role is developing advice on the status and opportunities for sustainable energy.

Reducing energy use or realising energy saving opportunities is one of the best and most effective ways to increase energy sustainability. Reduced energy use has many positive effects as it improves energy services, reduces pollution and costs and also offers social benefits in the form of increased energy security (through the reduced reliance on imported fossil fuels).

It is believed that APEC economies' current energy use profile offers significant potential for large-scale reduction efforts. Technological breakthroughs and government-sponsored programmes are imperative to achieving that energy savings potential. Information programmes, which seek to increase productivity, encourage energy efficiency and conservation and offer technical assistance, are also important

elements to reduce energy use. It is necessary to identify and strategically select the most effective opportunities and measures.

A realistic estimation of energy savings potential - and particularly, identification of those potentials across sub-sector levels, fuel type and regional end-use - is problematic. Differences in the nature of sectors and the nature of potentials within those sectors are the principal cause of difficulties. For example, the industrial sector is more concentrated than the residential sector and efficiency gains in the industrial sector are mainly measured as energy and cost savings, whereas in the residential sector, service improvements are paramount.

Despite the sectoral difference, a common thread remains, namely that we cannot plan for what we have not identified and can not manage what we do not measure. Energy indicator analysis is the best way of closing these gaps. However, for an energy potential analysis to provide necessary insights it requires an in-depth understanding of energy-related data issues: sources, access, gaps, breaks and termination etc.

Quality analysis and robust data are essential for developing such estimates. Currently, most APEC developing economies have serious data gaps, especially with regard to where energy is used, how this energy use is changing, what is driving these changes and where and in what form the energy saving opportunities are available.

Energy indicator analysis is an important tool as it will provide a sound basis for policy development and private investment in energy efficiency - including energy savings potential assessment and accurate targeting; tracking progress towards the set targets; and raising the energy efficiency profile.

It is essential, however, that such an analysis recognises and accounts for the major differences in numerators and denominators between years and across economies, especially with respect to factors such as climate, fuel mix, activity mix etc. For example, a shift in activity mix (production) towards more energy-intensive activities, whilst other parameters remain unchanged, leads to increased energy intensity. Good quality data with respect to these parameters is crucial for the quality and accuracy of the analysis.

The proposed priority list of indicators is given below.

It is recommended that economies seeking to develop their energy data gathering and information systems in the first instance develop the suite of priority indicators, and build from that indicator base according to economy and policy needs.

Proposed Priority Energy Indicators for APEC Developing Economies with little energy data		
IAEA Social Dimension Indicators		
SOC1	% households or Population without electricity or heavily dependant on non-commercial energy	% households, % pop
SOC2	Share household income spent on fuel and electricity	% of household income
IAEA Economic Dimension Indicators		
ECO1	Energy use per capita measured by total consumer energy (TCE)/population and represented as GJ/capita/pa;	GJ
ECO2	Energy use per unit GDP measured by TCE/GDP million (price adjusted GDP) or \$PPP, and represented as TJ/million.	GJ / \$PPP
ECO3	Efficiency of energy conversion and distribution measured by total consumer energy/total primary energy and represented as %.	%
ECO10	Transport Energy Intensities	Cars/1000 pop Ann. km /car
ECO11	Fuel Shares in energy and electricity	% fuel
ECO12	Non-carbon energy share: (Nuclear+Hydro+Geothermal+Solar+Wind+Other (Biomass+Wood))/TPES and electricity : (Nuclear+Hydro power+Geothermal Power+Solar Power+Wind Power+Other power(Biomass+Wood))/Total Electricity production	% PJ
ECO13	Renewable energy ² share in energy and electricity ¹	% RE
ECO14	End-use energy prices by fuel and by sector	\$ by fuel & sector
ECO15	Net energy import dependency	% imports
IAEA Environmental Dimension Indicators		
ENV1	GHG emissions from energy production and use, per capita and per unit GDP	tCO ₂ , tCO ₂ /capita, tCO ₂ /\$GDP

^{1 1} Renewable electricity share:

$$\frac{(\text{hydro power} + \text{geothermal power} + \text{solar power} + \text{wind power} + \text{other power}(\text{biomass} + \text{wood}))}{\text{total electricity production/generation}}$$

² Includes energy received in direct, cogeneration and electrical forms from all renewable sources such as geothermal used directly, cogeneration from it and used for electricity generation.

Appendix 1.

Notes from Tokyo and Canberra Background Workshops

1. Background

At Auckland in March 2006, EGEE&C28 supported a proposal for developing APEC economies' ability to develop their own energy indicators. The objective is to report on energy and energy efficiency indicators for the APEC region and build capacity related analysis. The project proposal built on previous EGEE&C led conferences (Manila 2003 and Moscow 2006) where the need to progress APEC economy's ability to understand the characteristics of their energy use and energy efficiency were emphasised. The key features of the project are;

- It acknowledges the need for cooperation with the IEA, EGEDA, EGEE&C, APERC and APEC economies to advance this area,
- It proposes a capacity building workshop as a key tool to advancing APEC economies' ability to undertake energy indicators data management and analysis,
- It targets to publication of a report¹ on energy indicators.

The project responds strongly to APEC EMM8 declaration, EWG objectives, and the G8's objectives on energy efficiency, and has been approved by EWG.

2. Activities and Findings

Two self-funded background meetings have been held, both with the objective of determining the unique issues that need to be addressed in this project.

The first workshop sponsored by APERC, and held alongside the APERC mid-year workshop in Tokyo on 27-28 October 2006, was attended by 40 economy representatives and assessed the data and technical support needs for APEC economies in developing this work.

Key findings from the workshop are:

- The IEA's energy reporting template is supported as a universal data template and should be used as the basis to coordinate energy data and international harmonization.
- EWG and energy policy makers should be aware that there is concern that comparison of intensity can be misinterpreted; i.e. economies with high energy intensity are misperceived as wasteful¹. It is felt this can be managed with explanation of context and meaning of indicators and a focus on energy efficiency indicators.
- There is an ongoing role for EGEDA, and EGEE&C to assist economies with this work.
- 8 APEC economies are capable of developing a comprehensive set of indicators
- Most have some data that can be developed over time, some have little experience. Funding is required to support such developing economies with training.

The second workshop, sponsored by IEEJ, and held alongside the EGEE&C 29 meeting in Canberra, was attended by 20 economy representatives and assessed the policy needs from the indicators project.

Key findings from the workshop are:

- While we need to monitor basic energy trends in economies, energy efficiency is increasingly a priority policy option. Energy efficiency policy developments will require activity, end-use and programme level indicators.
- Policy issues shape indicators and provide the structure for data and indicators.
- Leading indicators that tell us in advance of problems, and indicate what will improve performance are particularly valuable.

The project should focus its support on those economies that need the most assistance, but the workshop should also provide value for all APEC economies i.e. we need to provide value for all APEC economies.

3. Meeting Notes

Capacity Development must cover the needs of all Economies

The proposed workshop should have something for each type of economy

Focus should be to support those with data but some gaps as well as those with no data

Economies with established energy data and indicators are happy to assist others but economies need internal commitment first

Capacity development must Focus on Developing Economies

Developing economies will need assistance at many levels

Funding will be required to attend training and develop economy databases in developing economies

There is an ongoing role for EGEDA / IEA to assist developing economies. e.g. Technical support from experienced economies directly helps those without skills – mentors, e.g. Canada assists Peru.

Australia / NZ / PNG could do a prototype support project like an IFAT

Need to bid in now for funds to enable experienced economies to support less experienced economies

Actions and Milestones for expert groups

EGEDA should send the IEA template to economy focal points along with data already held by APERC and request they start completing the template.

IEA & APERC should send us the data they hold on our economies – we don't know what they have – we lose people that knew – this will save collecting new data.

ASEAN have an indicators project funded by EU money - what indicators are they using?

Indicators work is a good opportunity for EGEDA to strengthen energy data statistics

Assistance with Other Things

Sharing experiences & knowledge, especially for the economies that are not here

Create regional support groups e.g. South America

A manual covering everything; definitions and methodologies, data surveys, data management, energy balances, developing indicators etc.

Modeling and demand forecasting

International support for efficiency programmes, labelling

Commitment

From Tokyo workshop survey;

8 economies with energy balance may be able to start now,

Some others have basic data they can develop,

some have no data or systems and need assistance

Commitment by economies is essential

We seek commitment on a “best endeavors basis” to join this project from all economies, regardless of existing capability

We all do our best to cooperate to assist each other

We each endeavor to contribute according to our ability

An observation

Economies with many years experience in this field still struggle with:

heterogeneous sectors (services)

end use data and allocations

methodology and interpretation

Economies with indicator experience have as much to gain from cooperating as less experienced economies.

Policy Drivers for Successful Indicator Development

Policy is the Essential Driver of Indicators

Policy leads this work; can't just start from scratch with bottom up data – need to structure data around policy needs

Need indicators to:

identify what will make things better

tell us in advance of problems / instability in energy systems

Significant benefits for individual economies as well as improved global understanding

The price, environment and security policy drivers for indicators are not going away

Energy Efficiency is a preferred option – buys time in long supply side capital turnover cycles

We need to be able to explain basic energy and economy dimensions & patterns to understand what's going on in each economy

Misperceptions and Misunderstandings

“Some Ministers and others do not like indicators which can make sectors or nations look ‘inefficient’ We need to manage this issue

- Many indicators are intensity indicators. Intensity indicators are most problematic
- Efficiency indicators, which exclude structural effects, are less contentious.

Already TPES, GDP data is available, used and misunderstood. Researchers already do comparisons. By moving down to efficiency indicators we will expose more detail and explanation and enable fairer comparisons, e.g. correcting for climate

Programme level indicators are increasingly important

A widespread interest in government leadership policies points to a need to separately identify public from private activity in the service / commercial sector

Ongoing development of energy efficiency policies is starting to require programme level indicators

Most policies are being driven by CO₂ responses

What do policy makers want?

Trends over time & comparisons

To be able to say; “we are not doing so well overall but these bits are better, and if we want to improve we need to focus at those bits”

Indicators that ‘explain why’ and highlight purpose and behaviour; e.g. leisure trips vs commuter vs emergency trips.

Explanation to support indicators

A service focus (service is having stuff not moving stuff) – products actually delivered, not tonne km’s

The drivers of transport, purpose, densities, economics of vehicle ownership, cost of time in transport etc

Indicators of settlement as a driver of energy demand impact of future change like ageing populations

Need to keep a focus on consumption trends

From policy objectives; What indicators are needed?

Training on what policy questions to ask would be useful

What are the policy drivers for indicators?

What policy and technical drivers and needs do we have in common?

Our policy and technical drivers may be sufficiently different from IEA countries to require different indicators.

Policy Questions and Priorities – examples from Australia

Has the pace of energy intensity reduction slowed? since the last study?

Which sector and sub-sectors have the largest current growth in energy use, and in projected energy use?

Does an international comparison of energy intensity performance provide a reliable indicator of potential savings of energy and saved costs to business?

What data is required to determine if energy saved by energy efficiency practices is the least cost path to provision of additional capacity (E.g. through savings from deferring investment required for additional generating capacity?)

In the industrial sector, do the energy use trends differ between the more intensive sub-sectors and the less intensive ones?

Commercial sector: Has growth in electricity use continued with the same trends as in 2003 study? What are effects of building type, climate?

What are the drivers for energy efficiency in the economy? What factors may place energy efficiency at the forefront of government attention? What are the impediments to the uptake of energy efficiency?

Are any physical studies of energy use by sub-sector possible? E.g. cement industry, IEA suggested refining. Do these indicate potential for more efficient energy use?

IEA suggest building survey data to detail heating use, fuel use, etc. This would enable some comparison with international practice and indicate areas for improvement.

How can energy transmission losses be reduced?

How do we help those economies struggling with policy clarity?

We need to manage political risks around policy and indicator sensitivities

is there a set of common or core policies that require a common set of indicators?

4. What would be our priorities?

Collecting the right data

The survey showed 10-12 economies have sub-sectoral data, industry energy data tends to be by GDP rather than physical output, with typically poor end-use data in residential / service sectors.

IEA template is supported – noted that ASEAN has indicator project

Capacity building in primary data is essential.

Starting – How to develop a energy data survey? Nations without data need to know how other nations undertake energy surveys

Gathering non-energy data for indicators

Basic energy end use data should be a priority activity for policy

Policy should require data collection investment in all interventions

Developing – Ensuring Harmonised Data and Classifications

In the future, ideally, we will have 1 integrated IEA / APEC set of data

Classifications need to be aligned – not everyone uses ISIC

The IEA template is recognized as a sound universal data template – something to work toward, but is not necessarily right for all APEC economies

Shows how far you can go and where you should develop data

Must tailor it to APEC needs and priorities

How to complete templates?

Essential data sets into detailed end use data

Disaggregated data is necessary for disaggregated efficiency indicators but will require (new) surveys for many economies

Collaboration helps identify data and methodological issues

Some cross-country data e.g. cement industry energy intensity already exists.

How will we use that data?

Advancing – gathering advanced end-use databases and systems

Developing better end-use data for indicators.

5. Managing Data for Indicators

Starting - Designing and operating data management systems:

How to validate and manage supply side and sectoral end-use survey data

Setting up essential energy databases for an economy

How to establish and operate a basic energy balance

Developing – Case studies and techniques from advanced energy databases and balances

Analysing data, statistical techniques

Validating data, ensuring consistency

Interpolating – fixing data gaps

Interpreting data

Software and databases to manage data

Advancing - creating advanced end-use databases and systems

Developing better end use information for indicators.

6. Essential Indicators for Policy Analysis

There are many indicators – policy needs determine which ones should be developed

Need to define necessary indicators – different needs for different levels of development – what indicators are needed and valued?

Need to be careful with misinterpretation of intensity results

Activity and end use service levels will become increasingly important.

Indicators need to inform; funding priorities, reallocations of fixed intervention budgets, and when programs succeed.

Starting – Developing the Core Indicators for Group C economies

Developing - Moving beyond Essential Energy Indicators

What indicators do we need as our energy efficiency policies develop?

“To get an answer from indicators you need a policy question!”

Buildings, transport and service sector policy questions seem less clear than industry where CO₂ intensity reduction is a clear objective

Understand where Aggregation/Desegregations is Effective;

e.g. need to consider light industry as well as heavy industry

Large factory complex – physical indicators become important

Small factories – sector aggregates are ok

Physical activity variables are closer to efficiency than economic activity

Energy Efficiency Indicators from your data.

Decomposition techniques – what are they, how do they produce efficiency indexes

Overview of key methodologies

How to set up a decomposition indicators system

Understanding and explaining Indicators

Indicators need to be ‘minister friendly’ how do we train policy makers to understand indicators and their implications

We must explain context and data for indicators as well as why economies are different;

individual countries cannot do this, the burden of explanation rests with cross-country organisations like IEA and EGEDA, APERC

If we cannot explain indicators we must not be surprised if others misunderstand.

Build transparency - present indicators with data, and explanations, help users of indicators to understand

Understanding will improve as indicators are used

Advancing - The Road Forward for Energy Efficiency indicators

What indicators will we need in the future? more detail? or less detail?

What international, national and sectoral indicators are required to support policy?

Pushing the envelope – decomposition at increasingly disaggregated levels

Improving how we account for service issues like rebound
