ENERGY SECURITY, SUSTAINABILITY AND AFFORDABILITY IN DEVELOPING ASIA 2010—2035: A QUANTITATIVE ANALYSIS

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Overview

In 2010, Asia accounted for about 28% of the global GDP, and about 30% of the world's primary energy consumption. Among the countries in the region, China and India deserve special attention in the energy sector. China has recently surpassed the US as the leading primary energy consumer in the world in absolute terms. Its primary energy demand has more than doubled since 2002, an unparalleled trend elsewhere in the world. (Its primary energy intensity, and primary energy per capita, are however commensurate with its degree of development: its primary energy intensity is between 3 and 8 times as large as that of developed countries; per capita consumption is between 2 and 5 times smaller). China's energy dependence has increased in recent years: it was nearly independent at the turn of the millennium but it was importing about 10% of its primary energy in 2009. Critically, while the country is making an effort to resort to cleaner energy sources, its economy relies heavily on coal (both national and, increasingly, imported) as an energy source. China uses more coal than the US, Europe and Japan combined. Over the period 2013-2016, about 273 GW of new coal plants are planned, equivalent to a new large coal fired plant every week. As a consequence, China contributes with about 50% of the world CO2 emissions from coal. India's primary energy intensity is similar to China's, although its primary energy demand has increased since 2002 by a moderate (by comparison) 40%.

The above challenges are compounded by the expected growth of the Asian economies over the next three decades. Under some scenarios, energy demand is envisioned to increase by more than 40%-75% until 2035. These will undoubtedly change radically the energy security status quo, with Asian economies relying heavily on energy imports and shifting their emphasis to increasing their energy security. They are also likely to become a major contributor to Green House Gas emissions. Against this backdrop, a quantitative analysis can help answer some fundamental questions: Will energy self-sufficiency deteriorate severely, particularly compared with other regions of the world? Can regional cooperation in the energy sector increase resilience through diversification? Will energy affordability improve in Developing Asia? What is the cost-benefit balance of introducing increasing shares of more diverse and carbon-free (but expensive) energy technologies in these countries?

Methods

The aim of this paper is to quantify the current status of Developing Asia countries in respect of the security, sustainability and affordability of their energy systems, and their likely evolution up to 2035.

To do so, we build a system of indicators that can be used to extract information on the outcome of energy scenarios and policies. In building these indicators, we have sought a number of key properties: (i) They should be quantitative, because in our view qualitative information increases uncertainty, impairs comparativeness, and may result in loss of credibility; (ii) They should be simple, because it is easier to understand a simple indicator than to trust a complex one; (iii) They should be equally applicable to countries for which a wealth of reliable, public data (past, present or future) exists and to countries for which, on account of their size or other circumstances, there is scarce public data for their energy sectors; (iv) They should allow for comparisons among countries and along time to be developed; (v) They should be easy to aggregate at the regional scale to show the effects of regional integration.

We use a set of six indicators that can be readily calculated from available or forecast macroeconomic and energy data. These six indicators are representative of the three main axes of a modern national energy policy: sustainability, security and affordability.

For sustainability, we choose as main indicators the country's energy intensity (the primary intensity per unit GDP) and the CO2 intensity of the primary energy mix (the CO2 emissions per unit primary energy), the product of both being the CO2 intensity of the country's economy.

For the country's energy security we use as the first indicator the energy self-sufficiency (the fraction of final energy that can be met with indigenous primary resources), which we taper off using a type of logistic curve, as the primary resource nears depletion, to reflect the need to plan a shift to an alternative energy source. Our second security indicator is diversification (of both the primary energy supply and of the power system), which we take as a proxy for resilience.

The affordability issue is addressed through the computation of two indicators: the cost of a fixed amount of electricity based on present day's tariffs and of current Levelized Electricity Costs, and the same cost using future Levelized Electricity Costs.

The indicators so defined allow for both supra-national aggregation at regional levels (eg, for Central Asia) and also for international benchmarking using the same indicators for other countries and world regions.

Results

In respect of sustainability, our analysis concludes that the primary energy intensity of the Developing Asia economies will decrease generally as they develop, but particularly for countries where it is currently very high (Kazakhstan, Uzbekistan, Turkmenistan); and it will halve by 2035 in China and India. However, the CO2 intensity of the primary energy mix will continue to increase due to fuel substitution in many countries; noteworthy exceptions are Malaysia, Korea and China, where it will decrease.

Energy self-sufficiency will severely decrease by 2035 throughout Developing Asia due to the depletion of national reserves. Kazakhstan, Azerbaijan and Brunei Darussalam are noteworthy exceptions. However, energy diversification, one of the main contributors to the resilience of the energy systems, will not change significantly in the period. As an illustration of this performance, Figure 1 portrays the evolution of energy security on the self-sufficiency—diversification domain for the countries in Central Asia between 2010 and 2035. (Similar analyses have been performed for other countries and regions.)

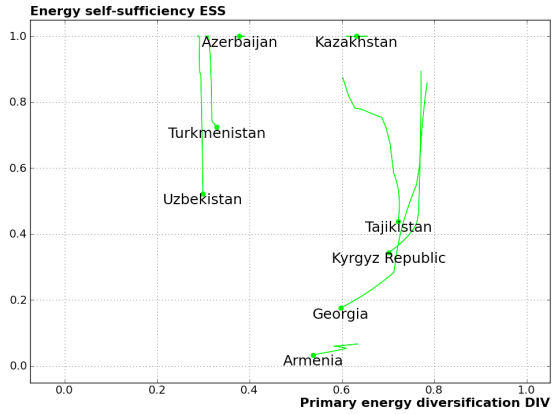

Figure 1. Energy self-sufficiency versus Primary energy diversification from 2010 to 2035 in Central Asia

Regarding the affordability of electricity, this will improve substantially as the economies in Developing Asia grow. By 2035, affordability will improve by more than 20% in most countries; and by around or more than 50% in Chinese Taipei, Vietnam, Kazakhstan, Maldives, Singapore, Tajikistan, India, Papua New Guinea, Turkmenistan, Georgia, Armenia, Lao PDR, Sri Lanka, Bhutan, Indonesia, China, Mongolia, Myanmar and Cambodia. It will nevertheless deteriorate slightly (by less than 10%) in the isolated systems of Fiji and other Pacific Islands. However, as a negative outcome, the gap in affordability between Developed and Developing Asia will remain.

For most countries, regional integration of their energy systems would increase either self-sufficiency or diversification. Several countries would improve both, notably: Uzbekistan, Turkmenistan, Afghanistan, China, Armenia and Georgia. For the power systems, the best opportunities for integration are in Central Asia, where a regional power system would be more diversified than any of the isolated national ones due to the complementariness of their individually dominant power generation technologies. In South East Asia, Lao PDR, Myanmar, Singapore, Vietnam, Cambodia and Indonesia would increase the diversification of their power systems through regional integration. Nepal and Bhutan would greatly benefit from integration in the South Asia region.