Environ. Res. Lett. **4** (2009) 044001 (6pp) doi:10.1088/1748-9326/4/4/044001

Mamizu climate policy: an evaluation of Japanese carbon emissions reduction targets

Roger A Pielke Jr

Center for Science and Technology Policy Research, University of Colorado, 1333 Grandview Avenue, UCB 488, Boulder, CO 80309-0488, USA

E-mail: pielke@colorado.edu

Received 28 July 2009
Accepted for publication 24 September 2009
Published 8 October 2009
Online at stacks.iop.org/ERL/4/044001

Abstract
This letter evaluates Japan's so-called 'Mamizu' climate policies proposed in mid-2009 in terms of the implied rates of decarbonization of the Japanese economy for short-term and long-term targets. The letter uses the Kaya identity to structure the evaluation, employing both a bottom up approach (based on projections of future Japanese population, economic growth, and technology) and a top down approach (deriving implied rates of decarbonization consistent with the targets and various rates of economic growth). Both approaches indicate that the Japanese economy would have to achieve rates of decarbonization of 2.6% to meet a 2020 target of reducing emissions by 15% below 2005 levels, and 5.0% to meet a 2050 target of an 80% reduction below 2005 levels. A target of 25% below 1990 emissions proposed by the opposition party (which subsequently formed a government following elections in August 2009) implies a rate of decarbonization of 4.6% annually to 2020. The letter argues that international criticism of Japanese Mamizu climate policy proposals as being too weak was unfounded, and if anything, the proposals may have been too ambitious. In either case, climate policy would be strengthened through the support of a diversity of approaches to decarbonization.

Keywords: climate policy, decarbonization, Japan, policy evaluation

1. Introduction

In June, 2009 Japanese Prime Minister Taro Aso announced that Japan would seek to reduce its greenhouse gas emissions by 15% from 2005 levels by 2020. The Prime Minister explained (Financial Times 2009):

> I would also like to explain that the target we are using is for 'genuine clear water' or 'mamizu' as we say in Japanese—truly a genuine net effect of our effort to save and conserve energy. Therefore, unlike the European Union, we do not include (purchased) emissions trading or credits in that calculation.

The word 'mamizu' is often used in Japanese politics to refer to budgeting and the difference between, for instance actual budget cuts and those that might simply be tricks of accounting. In the context of climate policy a 'mamizu' climate policy refers purely to domestic efforts, not counting on emission reductions accounted for using carbon offsets or land use changes.

Immediately upon announcing its proposed targets, the Japanese government was harshly criticized for its lack of commitment and vision. Yvo de Boer, director of the United Nations Framework Convention on Climate Change, commented that the commitment fell far short of what was needed, saying that the Japanese proposal left him speechless, 'I do not know what to say' (Kanter 2009). Facing a barrage of criticism, several weeks later Japan appeared to soften its stance on its mamizu climate policy when environment minister Tetsuo Saito announced that Japan would be willing to consider adding to its target by using international mechanisms such as offsets (Maeda 2009).

The Japanese government changed leadership following an election in August 2009, which at the time of this writing will have unknown implications for Japanese climate policies. Nonetheless, an evaluation of the policies proposed in mid-2009 can serve as a useful benchmark for evaluating future Japanese policy proposals. The letter will also briefly consider the emissions reduction targets proposed by the new government following the August 2009 election, when in the role as the opposition party. Thus, this letter provides a quantitative evaluation of Japan's proposed emissions reductions targets under its Mamizu carbon policies. Were criticisms of the Japanese objectives justified? More importantly, can Japan actually achieve the goals that it has set forth to reduce emissions in the short and long term?

This letter argues that the criticisms of the Japanese targets were unjustified, unless climate policy is to be simply an exercise in empty or symbolic exhortation. It argues further that the Mamizu targets are highly ambitious and would be extremely difficult to achieve. However, should Japan actually meet such targets, or make substantial progress toward them, it would represent a major advance in the practice of decarbonization of economic activity with broad relevance to countries around the world. The Japanese Mamizu climate policy proposals should be welcomed as a contribution to a diversity of approaches to decarbonization.

2. Methodology of evaluation

The methodology employed here was employed in Pielke (2009) to structure a similar analysis of the United Kingdom's Climate Change Act[1]. It draws upon Waggoner and Ausubel (2002) who argue that understanding the ability to influence environmental outcomes through policy requires 'quantifying the component forces of environmental impact and integrating them'. For carbon dioxide emissions, the relationship of forces leading to the emissions has been called the Kaya identity, and it can be used to decompose the factors that lead to emissions from the production and use of energy in the global economy. The identity is comprised of two primary factors: economic growth (or contraction), typically represented in terms of GDP, and changes in technology, typically represented as carbon dioxide emissions per unit GDP.

Each of these two primary factors is typically broken down into a further two sub-factors. GDP growth (or contraction) is comprised of changes in *population* and in *per capita GDP*. Carbon dioxide emissions per unit GDP is represented by the product of *energy intensity,* which refers to energy per unit of GDP and *carbon intensity,* which refers to the amount of carbon per unit of energy.

Together the four factors of the Kaya identity explain the various influences that contribute to increasing atmospheric concentrations of carbon dioxide, as follows:

(1) carbon dioxide emissions = population * per capita GDP * energy intensity * carbon intensity

(2) P = total population

(3) GDP/P = per capita GDP

  (a) GDP = economic growth (contraction) = P * GDP/P = GDP

(4) energy intensity (EI) = TE/GDP = total energy (TE) consumption/GDP

  (b) carbon intensity (CI) = C/TE = carbon emissions/total energy consumption

(5) EI X CI = 'carbon intensity of the economy' = TE/GDP * C/TE = C/GDP.

Thus, according to the logic of these relationships, carbon accumulating in the atmosphere can be reduced only by reducing (a) population, (b) per capita GDP, or (c) carbon intensity of the economy. Most proposals to address carbon dioxide emissions advanced by governments and in international negotiations focus on actions that will lead to the reduction of the carbon intensity of the economy (whether or not they are explicitly presented as such), which in this letter is referred to as 'decarbonization'. Policies to reduce population or that result in economic contraction are not generally considered by governments as a strategy of emissions reductions. Thus, the Kaya identity provides a straightforward and useful way to evaluate the proposed and actual performance of policies focused on decarbonization and which are typically called mitigation policies.

The factors of the Kaya identity can be used to evaluate in practical terms what is required to achieve the identified goals for emissions reductions. The factors can be integrated individually, in a 'bottom up' fashion based on independent projections for growth in population (2) and per capita GDP (3), to estimate implied rates of decarbonization (5). The overall goal can also be disaggregated in a 'top down' manner, starting with overall GDP growth (a) and deriving implied rates of decarbonization (5) consistent with a specified target. The following sections consider each approach from a base year of 2006, which in most cases is the latest year for which data necessary for the analysis are available.

3. Evaluating Japan's Mamizu climate policy: part 1, a bottom up analysis

The first factor in the Kaya identity is overall population, since more people means more emissions, all else being equal. In 2008, the UN published its World Population Prospects and projected a Japanese growth rate of -0.2% yr^{-1} to 2020 and -0.5% to 2050 (United Nations 2009). Japan is expected to see its population decline. If these rates were to occur up to 2020 and 2050, then Japan would have about 124 million people in 2020 and 102 million in 2050, representing a decrease of almost 4 and 26 million people respectively from 2005. Standard caveats about uncertainties in population projections apply.

In 2005 Japanese carbon dioxide emissions were just under 9.8 tonnes per person. If a 2050 population of 102 million had per capita emissions of 9.8 tonnes, then the total Japanese emissions would be about 997 mT of carbon dioxide, about 20% lower than 2005 values of about 1250 mT. A 2020

[1] The methodological description is reproduced in full here as this letter is intended as a stand-alone analysis. Readers familiar with Pielke (2009) can skip to the next section.

population of 124 million at 9.8 tonnes of carbon dioxide per person would result in about 1213 mT of carbon dioxide, about 2.7% below 2005 levels. So a declining population would mean that Japan's emissions will reduce, all else being equal. Even so, considerable additional effort would be needed to achieve more aggressive short- and long-term targets for emissions reductions.

The second factor in the Kaya identity is economic activity. All else being equal more economic activity means more emissions. From 1990 to 2006 Japan averaged 1.3% yr^{-1} annual GDP growth (in constant currency, i.e., inflation adjusted)[2]. If overall growth up to 2050 is expected to occur at a modest 1.0% per year, and population is shrinking by 0.5% yr^{-1}, then this implies a per capita GDP growth rate of 1.5% yr^{-1}. Of course, governments strive for higher growth rates and a vibrant economy, just as they are now doing around the world to stimulate economic growth. For purposes of the present discussion, let us assume that future per capita GDP growth in Japan increases modestly at 1.5% yr^{-1}, in line with its historical performance. This level of growth would add another 1150 mT of carbon dioxide to the 2050 total, for a total of about 2400 mT, almost two times 2005 emissions and about 9.6 times a 2050 target of 80% reduction from 2005 levels. In 2020 this rate of growth would add about another 289 mT of carbon dioxide emissions, for a total of 1536 mT, or 23% above 2005 emissions.

The third factor is technological change. As described above, technological change includes increased energy efficiency in the economy and in reduced carbon intensity of energy. According to data from the United States Energy Information Agency, from 2001 to 2006 Japanese energy efficiency[3] increased by about 1.25% per year, while the carbon intensity[4] of the energy decreased by about 0.9% yr^{-1} over the same period. According to Smil (2007), Japanese energy intensities of all major industries—after falling by 20–50% between 1973 and the late 1980s—had reached their lowest levels between 1988 and 1990, and had risen and stagnated afterward: by the year 2000, the energy intensity for the iron and steel industry, manufacturing, and ceramics were about 12%, 15%, and 17% above the 1989 level, respectively.

Smil explains that there were inter-related economic and technological reasons for the reversal in energy intensity trends. By contrast, the carbon intensity of Japanese energy was largely unchanged since the late 1980s (e.g., the values were about the same in 1987 and 2004). Thus, considering GDP growth in conjunction with changes in energy and carbon intensities, the decarbonization of the Japanese economy has occurred at a rate of less than 1% yr^{-1} in the current decade, and at only a slightly higher rate since 1980.

Using a bottom up analysis, assuming that population and economic growth combine to a net rate of a 1.5% increase in annual GDP implies that to meet a 2020 emissions reduction target of 15% below 2005 levels would require that the combined effects of increasing energy efficiency and reduced carbon intensity of energy occur at an average annual rate of 2.6% to 2020 and 5.1% to 2050.[5] These numbers also imply that meeting the 2020 target with a 2.6% annual rate of decarbonization implies a rate of about 6.1% per year from 2020 to 2050 to meet an 80% reduction target by 2050.

The newly elected government has stated an intention to reduce emissions by 25% from 1990 levels by 2020, rather than the 15% below 2005 levels discussed above. A 25% reduction in emissions from 1990s levels by 2020 is equivalent to about a 37% reduction from 2005 levels and implies a rate of decarbonization of 4.6% per year to 2020.

4. Evaluating Japan's Mamizu Climate policy: part 2, a top down analysis

A top down analysis begins with assumptions of future economic growth, which integrates future population growth and per capita economic growth, and then works backwards to determine what rate of decarbonization of the economy would be necessary to meet the future emissions target. In 2006 Japan produced 0.42 tonnes of carbon dioxide for every $1000 of GDP.[6] Figure 1 shows required rates of decarbonization of the Japanese economy from 2007 to 2050 (for various rates of assumed GDP growth) implied by a target of an 80% reduction in carbon dioxide emissions from 2005 levels.

The figure shows that the carbon intensity of the Japanese economy would have to reach a level of 0.02–0.06 tonnes of carbon dioxide per $1000 of GDP by 2050, from 0.44 in 2006. Figure 2 shows the same information for 2020 implied by a target of a 80% reduction in carbon dioxide levels from 2005. The figure shows that the carbon intensity of the Japanese economy would have to reach a level of 0.25–0.32 tonnes of carbon dioxide per $1000 of GDP by 2020, from 0.44 in 2006.

Figure 3 shows the actual rate of decarbonization of the Japanese economy from 1980 to 2006 as well as the rates of decarbonization implied by the 2020 and 2050 targets assuming an average 1.5% annual GDP growth. Higher rates of future GDP growth would result in higher implied rates of decarbonization.

The rates of decarbonization of the Japanese economy implied by the top down analysis are 2.6% yr^{-1} for the 2020 target and 5.0% for the 2050 target. These numbers are substantially higher than the rates of decarbonization observed from 1980 to 2006 and 2001 to 2006, as summarized in the table 1, along with the rates derived for the bottom up analysis.

5. Japanese targets in context

Japan faced a range of criticism when it announced its 2020 target to reduce its domestic emissions by 15% from 2005

[2] GDP data from A Maddison, available at http://www.ggdc.net/maddison/Historical_Statistics/vertical-file_09-2008.xls.

[3] International Energy Statistics, available at http://www.eia.doe.gov/emeu/international/contents.html. Energy efficiency is the inverse of energy intensity, so an increase in efficiency is the same as a decrease in intensity, and vice versa.

[4] http://www.eia.doe.gov/pub/international/iealf/tableh1pco2.xls.

[5] The calculation is arrived at by projecting GDP and carbon emissions (based on the targets) and then backing out the combined effects of EI and CI necessary to meet the target, following the Kaya identity.

[6] Carbon dioxide data is available at http://www.eia.doe.gov/pub/international/iealf/tableh1co2.xls. Data on GDP, converted to 1990 Gheary–Khamis dollars (to facilitate international comparisons) is available at http://www.ggdc.net/maddison/Historical_Statistics/vertical-file_09-2008.xls. The 1990 Gheary–Khamis dollars are the units used throughout this letter.

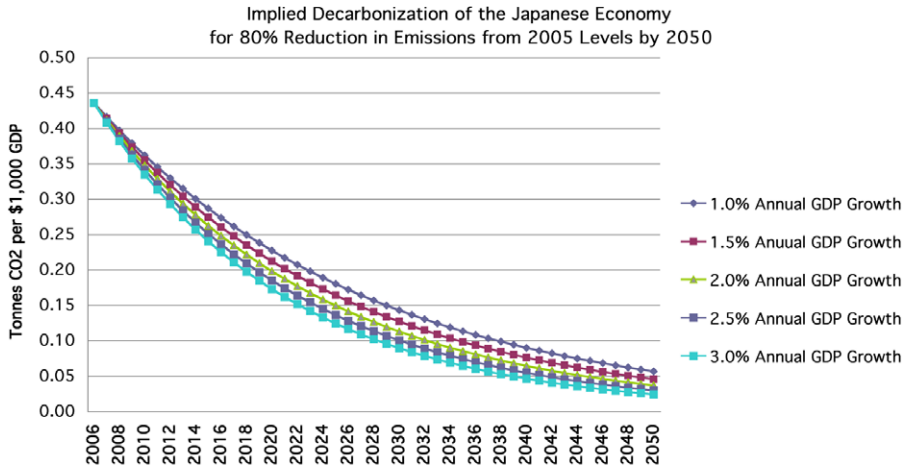

Figure 1. Implied rates of decarbonization of the Japanese economy for various rates of GDP growth, 2007–2050.

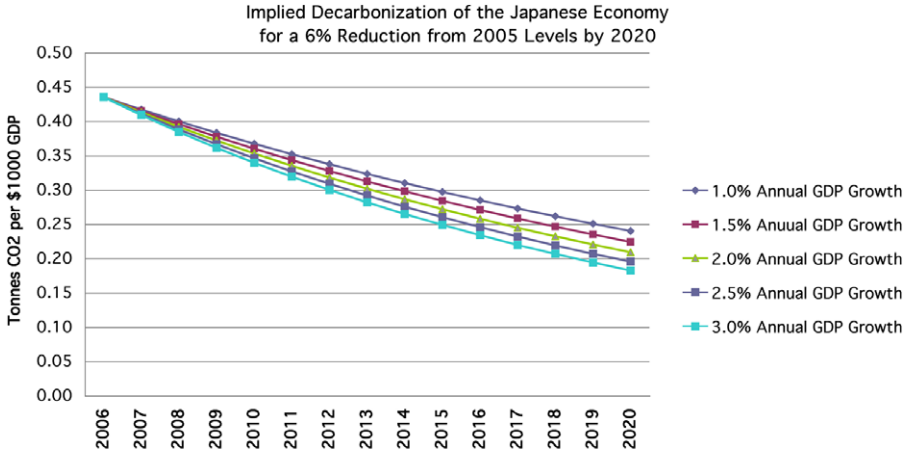

Figure 2. Implied rates of decarbonization of the Japanese economy for various rates of GDP growth, 2007–2022.

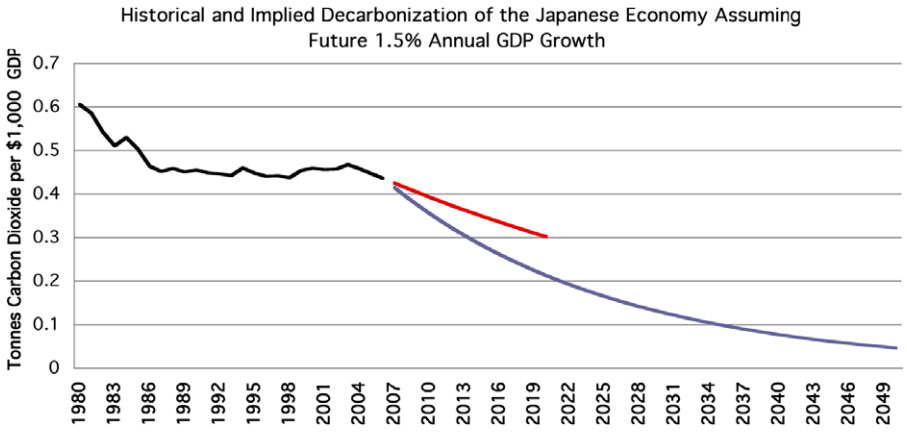

Figure 3. Past rates of decarbonization of the Japanese economy, 1980–2006, and implied rates of decarbonization assuming 1.5% annual GDP growth for the 2020 (red) and 2050 targets (blue).

levels by 2020. The analysis in this letter shows that such criticism was unfounded for several reasons.

First, the rate of decarbonization implied by the 2020 target is about 1.4–1.8% yr^{-1} less than that implied by the UK Climate Change Act (Pielke 2009) and that Act is certain to fail (e.g., it requires that the UK decarbonize its economy to French levels within 6 years, requiring an effort equivalent to the deployment of about 30 new nuclear power plants in that time). Because no one knows how fast a major economy can decarbonize there seems little point in arguing

Table 1. Rate of decarbonization of the Japanese economy observed (first two columns) for 1980–2006 and 2001–2006, and implied (third and fourth columns) by the 2020 and 2050 targets of 15% and 80% below 2005 levels respectively, for the bottom up and top down (assuming 1.5% future GDP growth) approaches.

	1980–2006	2001–2006	2007–2020	2007–2050
Actual	−1.3%	−0.9%		
Bottom up			−2.6%	−5.0%
Top down (at 1.5% GDP growth)			−2.6%	−5.0%

about proposed rates of decarbonization well outside historical experience. Policy implementation will be the ultimate arbiter of such proposals. There is essentially no qualitative difference between the Japanese and United Kingdom policies, as both are outside the range of experience.

Second, because the rate of decarbonization in the 2020 target is in excess of that which has been observed in any major economy in recent decades. However, Japan's experience the early 1980s provides a notable exception with annual average decarbonization of the Japanese economy of 4.4% from 1980 to 1986. Smil (2007) argues that this achievement was due to a preponderance of 'low hanging fruit' and is unlikely to be replicated much less sustained in the future (see figure 3). An anonymous reviewer further notes that the changing nature of Japanese industry from carbon intensive industries to less carbon intensive industries also played a role[7]. Today, Japan is already one of the most carbon efficient economies in the world, thereby making further gains more difficult and expensive that they would be in less efficient economies of North America and most of Europe. Japan may be an important test case in the limits to efficiency gains as a strategy of decarbonization (cf Smil 2007, Geller *et al* 2006).

Finally, if Japan's Mamizu targets are to be criticized it should be because they are too aggressive, not because they are too weak. Like the UK Climate Change Act, the proposed Japanese policy requires achieving a level of decarbonization equivalent to that of France (in 2006) by 2020 (for an emissions reduction target of 15% below 2005 emissions, assuming annual average 1.5% GDP growth) or 2014 (for an emissions reduction target of 25% below 1990 emissions, assuming annual average 1.5% GDP growth), which would represent a monumental achievement (cf Akimoto *et al* 2008, Sawa 2008, Oda *et al* 2007)[8]. For its part under the Mamizu climate policy Japan proposed the following actions toward meeting its 2020 target (Jun 2009).

- Construct nine new nuclear power plant plants, improve utilized capacity to 80% (from 60%).
- Install 5 million kW of wind power plants (equivalent to approximately 34 units).
- Install solar panels on 5.3 million homes (an increase of 2000% over current levels).
- Increase the share of houses satisfying stringent insulation standards out of total newly built houses from 40% today to 80%.
- Increase the share of next generation vehicle out of total sales of new vehicles from 4% (2005) to 50% (2020).

These are undoubtedly ambitious goals. For instance, the proposal to deploy nine new nuclear power plants within a decade appears to stretch the bounds of credulity, even though Japan does have the third most nuclear plants in the world (after the United States and France).[9]

6. Conclusion

If climate policy is to be about more than symbolic exhortation, then it will necessary for goals to be more than aspirational. Japan's Mamizu climate policy targets for 2020 and 2050 announced in mid-2009 were exceedingly ambitious, and if they are to be criticized, it should be for being too aggressive, not too weak. Should Japan actually succeed with respect to a short-term target of the magnitude implied by the Mamizu climate policy, then it will have achieved a carbon intensity of its economy lower than that of France in 2006 by the end of the decade, representing a decrease in emissions per unit of GDP of about 33%. If the world economy were to be as carbon efficient as implied by Japan's 2020 target, then global carbon dioxide emissions in 2006 would have been only 40% of their actual value.

Regardless of the nature of changes to the composition of the Japanese government in the future, there is considerable merit in encouraging Japan to actively seek to achieve its Mamizu climate policy because its successes and shortfalls will provide a valuable body of experience to other countries seeking to achieve similar goals. Should Japan choose to depart from its proposed Mamizu climate policy to one based on (even more) impossible targets and timetables than they may find themselves the subject of international applause rather than condemnation. At the same time such a shift would signify a desire to meet the symbolic needs of international climate politics while sacrificing the practical challenge of decarbonization policy. Conventional approaches to climate policy have thus far borne little fruit, but that is a topic that goes well beyond this brief analysis. Diversity in climate policy should be encouraged.

[7] Whether Japan can replicate the experience of the early 1980s and sustain it for a period of a decade or longer goes beyond the scope of the present analysis. Further discussion of the limits to efficiency gains can be found in Baksi and Green (2007).

[8] A reviewer notes that Japan and France have similar energy intensities, however Japan's carbon intensity is 50% higher.

[9] http://wna-members.org/uploadedFiles/members/Info_Servies/Publications/PG_reactor08.pdf.

References

Akimoto K, Sano F, Oda J, Homma T, Rout U K and Tomoda T 2008 Global emission reductions through a sectoral intensity target scheme *Clim. Policy* **8** S46–59

Baksi S and Green C 2007 Calculating economy-wide energy intensity decline rate: the role of sectoral output and energy shares *Energy Policy* **35** 6457–66

Geller H, Harrington P, Rosenfeld A H, Tanishima S and Unander F 2006 Policies for increasing energy efficiency: thirty years of experience in OECD countries *Energy Policy* **34** 556–73

Jun A 2009 Ministry of Economy, Trade and Industry, Government of Japan, 13 July, personal communication

Kanter J 2009 *Tsunami of Criticism for Japan's CO2 Goals* The New York Times Green Inc http://greeninc.blogs.nytimes.com/2009/06/10/tsunami-of-criticism-for-japans-co2-goals/

Maeda R 2009 *Japan Sees Extra Emission Cuts to 2020 Goal-Minister* Reuters, 24 June http://af.reuters.com/article/energyOilNews/idAFT19196720090624?sp=true

Oda J, Akimoto K, Sano F, Homma T and Tomoda T 2007 Evaluation of energy saving and CO2 emission reduction technologies in energy supply and end-use sectors using a global energy model *IEEJ Trans. Electr. Electron. Eng.* **2** 72–83

Pielke R A Jr 2009 The British climate change act: a critical evaluation and proposed alternative approach *Environ. Res. Lett.* **4** 024010

Sawa A 2008 A sectoral approach as an option for a post-Kyoto framework? *Discussion Paper 2008–23 (December)* (Cambridge, MA: Harvard Project on International Climate Agreements)

Smil V 2007 Light Behind the Fall: Japan's Electricity Consumption, the Environment, and Economic Growth *The Asia Pacific Journal: Japan Focus,* April http://www.japanfocus.org/-Vaclav_Smil/2394

The Financial Times 2009 Interview with Japanese Prime Minister Taro Aso, 10 June

United Nations 2009 *World Population Prospects: The 2008 Revision* http://esa.un.org/unpp/

Waggoner P E and Ausubel J E 2002 A framework for sustainability science: a renovated IPAT identity *Proc. Natl Acad. Sci.* **99** 7860–5