***Projecting long-term primarY energy consumption***

Zsuzsanna Csereklyei, Department of Economics, Vienna University of Economics and Business (WU),

<Tel:+43/6643238603>, E-mail: zsuzsanna.csereklyei@acceron.at

Stefan Humer, Department of Economics, Vienna University of Economics and Business (WU),

<Tel:+43/1313364509>, E-mail: shumer@wu.ac.at

## Overview

In this paper we use the long--term empirical relationship (cointegrating coefficients) between primary energy consumption, real income, capital, population and technology, obtained by averaged panel error correction models, to project the worldwide long-term primary energy consumption up to 2100.

## Methodology

The averaged coefficients are obtained by 33 panel error correction models estimated over the period 1965-2009 for 64 countries, assigning each country to an array of 3 X 3 equations, three different basic (composition) models, and three attribute (world, geopoliticial, and wealth level) models. The weights assigned in averaging, are based on the out-of-sample forecast performance of the individual models. In forecasting the long-term primary energy consumption, we work with four different Shared Socioeconomic Pathway Scenarios (SSPs) developed for the IPCC framework, assuming different challenges to adaptation and mitigation. The countries included in our dataset give as of 2010 approximately 90% of the worldwide primary energy usage.

## Results

#### We find that in all scenarios, China, the United States and India will be the largest energy consumers, while highly growing countries such as Indonesia might also significantly contribute to energy use. Whether the steady growth in primary energy consumption slows or even declines by the end of the century, or shows an increasing path is the function of the different assumptions behind the Shared Socioeconomic Pathways.

We observe for most scenarios a sharp mid-term increase in global energy consumption, followed by a levelling–out and a decrease towards the second half of the century. The reasons behind this pattern are not only slower population growth, but also infrastructure saturation and increased total factor productivity.

## Conclusions

As countries move towards more knowledge based societies, and higher energy efficiency, their primary energy usage is likely to decrease as a result. Global primary energy consumption is expected however to increase significantly in the coming decades, thus increasing the pressure on policy makers to cope with the questions of energy security and greenhouse gas mitigation at the same time.

## References

1. Australian Government Bureau of Resources and Energy Economics (2011), Australian Energy Projections to 2034-35, ISBN 978-1-921812-78-1 (Online), [www.bree.gov.au](http://www.bree.gov.au)
2. Bernanke, B.S., R.S. Gurkaynak. (2001). “Is Growth Exogenous? Taking Mankiw, Romer, and Weil Seriously,” NBER Macroeconomics Annual, 16: 11-57.
3. British Petrol (2011a) Statistical Review of World Energy (full report) [www.bp.com](http://www.bp.com), (2011b) Energy Outlook 2030, British Petrol, [www.bp.com](http://www.bp.com) (accessed December 2011)
4. Burke, P. J (2011) The National-Level Energy Ladder and its Carbon Implications, CCEP working paper 1116, Australian National University
5. Csereklyei Z., Humer. S. (2012) Modelling Primary Energy Consumption under Model Uncertainty, WU Working Paper in Economics, Nr. 147, <http://epub.wu.ac.at/3706/>
6. Davidson, R., MacKinnon, J.G., (2009): Econometric Theory and Methods, Oxford University Press 2009, ISBN 978-0-19-539105-3
7. Deffeyes K.S, MacGregor, I.D.(1980), World Uranium resources, Scientific American, Vol 242, No 1, January 1980, pp. 66-76.
8. European Commission (2011): Assessment of the Required Share for a Stable EU Electricity Supply until 2050, Directorate-General for Energy, EUR 24996 ; (2011b): Investment needs for future adaptation measures in EU nuclear power plants and other electricity generation technologies due to effects of climate change, Directorate-General for Energy, EUR 24769; (2008): Market Observatory for Energy, Europe’s Energy Position, ISBN: 978-92-79-10036-9
9. Eurostat (2009), Panorama of Energy, ISBN 978-92-79-11151-8
10. Hansen, J., Sato, M., Ruedy, R. (2012) Perception of climate change, PNAS, August 6, 2012, DOI: [www.pnas.org/cgi/doi/10.1073/pnas.1205276109](http://www.pnas.org/cgi/doi/10.1073/pnas.1205276109)
11. International Energy Agency (2011): World Energy Outlook 2011, ISBN: 978 92 64 12413 4
12. International Energy Agency (2008): Worldwide Trends in Energy Use and Efficiency
13. International Energy Agency (2012): Energy Technology Perspectives 2012, ISBN: 978-92-64-17488-7, www.iea.org/etp
14. IIASA (2012): Global Energy Assessment Scenario Database: <http://www.iiasa.ac.at/web-apps/ene/geadb/dsd?Action=htmlpage&page=about>
15. International Monetary Fund (2011): World Economic Outlook 2011, ISBN 978-1-61635-059-8
16. IPCC (2011): IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, ISBN 978-1-107-02340-6
17. Jakob M., Haller, M., Marschinski R. (2012) Will history repeat itself? Economic convergence in energy use patterns , Energy Economics 34 (2012), 95-104
18. Jakob M., Luderer, G., Steckel, J., Tavoni, M. and Monjon S. (2012) Time to act now? Assessing the costs of delaying climate measures and benefits of early action, [www.pik-potsdam.de](http://www.pik-potsdam.de)
19. Kriegler, E., O’Neill B.C., Hallegatte, S., Kram, T., Moss, R.H., Lempert, R., Wilbanks, T.J., (2010): Socio-economic Scenario Development for Climate Change Analysis, C.I.R.E.D Working Paper No 23-2010
20. Lopez, A., Roberts, B., Heimiller, D., Blair, N., and Porro, G., (2011): U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis, Technical Report , NREL/TP-6A20-51946, Prepared under Task Nos. SA10.1012 and SA10.20A4, [www.nrel.gov](http://www.nrel.gov)
21. Massachusetts Institute of Technology (2011): The Future of the Nuclear Fuel Cycle, an interdisciplinary MIT Study ISBN: 978-0-9828008-4-3
22. Massachusetts Institute of Technology (2003): The Future of the Nuclear Power, an interdisciplinary MIT Study ISBN: 0-615-12420-8
23. Massachusetts Institute of Technology (2007): The Future of Coal, ISBN 978-0-615-14092-6
24. Massachusetts Institute of Technology (2010) The Future of Natural Gas, ISBN 978-0-9828008-0-5
25. Rubinstein, J.L., Ellsworth W.L., McGarr A., (2012) Signficant (induced?) earthquakes in the Central and Eastern US since 2008, USGS
26. Schaeffer M., Hare, W., Rahmstorf, S., Vermeer M, (2012), Long-term sea-level rise implied by 1,5 °C and 2 °C warming levels, Nature Climate Change, PUBLISHED ONLINE: 24 JUNE 2012 | DOI: 10.1038/NCLIMATE1584
27. Stern, N. (2007) The economics of climate change, Cambridge University Press, ISBN:9780521700801
28. United States Energy Information Administration (2012) Annual Energy Outlook 2012 with Projections to 2035, DOE/EIA-0383(2012)
29. Vienna University of Technology (2011), Economic Perspectives of Renewable Energy Systems, Energy Economics Group, [www.eeg.tuwien.ac.at](http://www.eeg.tuwien.ac.at), accessed October 2011
30. Weitzman, M.L (2009) On Modeling and Interpreting the Economics of Catastrophic Climate Change, The Review of Economics and Statistics, Vol. 91, No.1, pp 1-19, doi:10.1162/rest.91.1.1
31. Zobak, M.D., Gorelick, S.M., (2012) Earthquake triggering and large-scale geologic storage of carbon dioxide, PNAS [www.pnas.org/cgi/doi/10.1073/pnas.1202473109](http://www.pnas.org/cgi/doi/10.1073/pnas.1202473109)