

Technical-economic modelling with the TIMES model generator: Training course

Draft Program (as of January 6, 2010)

Date: January 18-20, 2009
 Venue: TERI, The Energy and Resources Institute
 Darbari Seth Block, IHC Complex,
 Lodhi Road, New Delhi – 1100 03 (India)
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 GianCarlo Tosato; gct@etsap.org; skype: gctosato1

Monday, January 18

9.00-9.15 All participants
 Presentation of the program and round table

9.15-10.15 GianCarlo Tosato, IEA-ETSAP
 Presentation: Elements of Energy Technology Systems Analyses
 Software installation: ANSWER-TIMES and VEDA-TIMES

10.15-11.00 GianCarlo Tosato, IEA-ETSAP
 Presentation: Linear Economic Models
 Software installation: ANSWER-TIMES and VEDA-TIMES

11.00-11.30 Coffee/tea break

11.30-12.00 Maurizio Gargiulo, E4SMA srl, Italy
 Hands-on: From an energy balance to final consumption split by end-use

12.00-13.00 Maurizio Gargiulo, E4SMA srl, Italy
 Presentation: Overview of a simple TIMES model
 Hands-on: Building a tutorial TIMES model from scratch with VEDA-FE

13.00-14.00 Lunch

14.00-15.00 Maurizio Gargiulo, E4SMA srl, Italy
 Hands-on: Results analysis with VEDA-Back End

15.00-15.45 Maurizio Gargiulo, E4SMA srl, Italy
 Presentation: The TIMES model generator, base components:
 Variables and equations

- 15.45-16.00 Coffee/tea break
- 16.00-16.45 Maurizio Gargiulo, E4SMA srl, Italy
Hands-on: Building scenarios for the tutorial TIMES model
- 16.45-17.15 Maurizio Gargiulo, E4SMA srl, Italy
Hands-on: Scenario results analysis with VEDA-Back End
- 17.15-17.30 Amit Kanudia, KanORS Consultants, India
Presentation: The VEDA-TIMES support web-site

Tuesday, January 19

- 9.00-10.00 Maurizio Gargiulo, E4SMA srl, Italy
Presentation: Objective functions of TIMES: cost components and shadow prices
Hands-on: Use of VEDA-BE to read the results, including prices and costs
- 10.00-11.00 Maurizio Gargiulo, E4SMA srl, Italy
Hands-on: Use of VEDA-TIMES to build the 2 regions tutorial model
Hands-on: Results analysis with VEDA-BE
- 11.00-11.30 Coffee/tea break
- 11.30-12.00 Maurizio Gargiulo, E4SMA srl, Italy
Presentation: Year (time) slices, peak equations, CHP and storage processes
- 12.00-13.00 Maurizio Gargiulo, E4SMA srl, Italy
Presentation: The VEDA-TIMES DEMO
- 13.00-14.00 Lunch
- 14.00-15.00 Maurizio Gargiulo, E4SMA srl, Italy
Hands-on: How to run and update the VEDA-TIMES DEMO
- 15.00-16.00 Maurizio Gargiulo, E4SMA srl, Italy
Hands-on: How to use the VEDA-TIMES DEMO to build a new model
- 16.00-16.30 Coffee/tea break
- 16.30-17.30 Amit Kanudia, KanORS Consultants, India; Maurizio Gargiulo, E4SMA srl, Italy
Open questions (if necessary, to be continued in small groups on Wednesday)

Wednesday, January 20, 2010

- 9.00-11.00 Ken Noble, Noble-Soft Systems, Pty Ltd, Australia
Introduction to ANSWERv6 for TIMES
Hands-on: Building a tutorial TIMES model from scratch with ANSWERv6
- 11.00-11.20 Coffee/tea break
- 11.20-13.00 Ken Noble, Noble-Soft Systems, Pty Ltd, Australia
Hands-on: Building a 2-region tutorial TIMES model with ANSWERv6
- 13.00-14.00 Lunch
- 14.00-14.15 All participants
Open questions
- 14.15-15.40 Ken Noble, Noble-Soft Systems, Pty Ltd, Australia
Hands-on: More advanced features of ANSWERv6 for TIMES
- 15.40-16.00 Feedbacks – Conclusion
- 16.00-16.30 Coffee/tea break

Documentation

Before the training, please familiarise with the topics illustrated by the following references.

Priorities: **You must do**...; *I would do*...; You could do...

Energy Systems Analysis, Linear Economic Models

1. Nebojsa Nakicenovic (IIASA), Energy Primer, Excerpt from CLIMATE CHANGE 1995, Impacts, Adaptation and Mitigation of Climate Change: Scientific – Technical Analyses Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel for Climate Change, WMO – UNEP, Cambridge University Press, 1996, 878 pages, Chapter B., pages 75-92
2. Gargiulo M., 2008. Getting started with TIMES-VEDA. Draft 2.1., chapter 4: Getting Started with Problem, GC Tosato; http://www.etsap.org/Docs/Files_Times_Tutorial.zip
3. Dorfman R., Samuelson P. A., Solow R. M.: Linear Programming and Economic Models, McGraw-Hill Book Company, New York 1958; Dover Publications, New York, 1987 (passim)
4. Gale D.: The Theory of Linear Economic Models, The University of Chicago Press, Chicago and London, 1960, 1989

The MARKAL/TIMES models generators

5. Loulou R., U. Remne, A. Kanudia, A. Lehtila and G. Goldstein. 2005. Documentation for the TIMES Model. Energy Technology Systems Analysis Programme (ETSAP).
 - Part I. 78 p. <http://www.etsap.org/Docs/TIMESDoc-Intro.pdf>
General description of the TIMES paradigm, general structure, economic significance, simplified mathematical formulation of TIMES, model options.
 - Part II. 349 p. <http://www.etsap.org/Docs/TIMESDoc-Details.pdf>
 Comprehensive reference manual intended for the technically minded modeller or programmer looking for an in-depth understanding of the complete model details, model mathematics, full description of the sets, attributes, variables, and equations of the TIMES model.
 - Part III. 20 p. <http://www.etsap.org/Docs/TIMESDoc-GAMS.pdf>
 Description of the GAMS control statements required to run the TIMES model
6. Gargiulo M., 2008. Getting started with TIMES-VEDA. Draft 2.1. Energy Technology Systems Analysis Programme 180 p. With contributions of G. Goldstein, A. Kanudia, A. Lehtila, Uwe Remme, GC Tosato. http://www.etsap.org/Docs/Files_Times_Tutorial.zip
 This very complete manual explains how to start building a technical-economic model of your energy system, and its possible developments over time, with TIMES-VEDA. This Users' Guide is intended for beginners who want to represent their energy systems with a TIMES model. It illustrates step-by-step how to build an energy model, from the simplest case with one commodity and one technology to a complex model encompassing the entire energy system with hundreds of technologies.
7. Specific notes¹
 - Interpolation rules: <http://www.etsap.org/Docs/TIMES-Interpolate.pdf>
 - New VDA parameters: <http://www.etsap.org/Docs/TIMES-VDA.pdf>
 - Elastic demands: <http://www.etsap.org/Docs/TIMES-ED-Shaping.pdf>
 - Climate module: <http://www.etsap.org/Docs/TIMES-Climate-Module.pdf>

¹ Information on these topics is also available in the “Getting started” guide or in the MARKAL/TIMES documentation reports.

Data management systems

“ANSWER-TIMES user manual” downloadable from <http://www.noblesoft.com.au/answer/ANSWERv6-TIMES-User-Manual.zip>

Getting_Started_TIMES-VEDA_V2p7.pdf, downloadable from <http://www.etsap.org>

VEDA training material at www.kanors.com/vedasupport

Applications: models built with MARKAL-TIMES (non-exhaustive list)

Global Models

<http://www.etsap.org/applicationGlobal.asp>

8. Labriet, M., R. Loulou, A. Kanudia. 2008. Is a 2 degrees Celsius warming achievable under high uncertainty? Analysis with the TIMES integrated assessment model. Cahier du GERAD, G-2008-30, 29 p.
<http://www.gerad.ca/fichiers/cahiers/G-2008-30.pdf>
Stochastic analysis of climate policies with ETSAP-TIAM (TIMES Integrated Assessment Model).
9. Drouet L., Vielle M., Labriet M. and R. Loulou. 2008. A master program that will drive the coupling of GEMINI-E3 and MARKAL/TIMES models. Working paper.
<http://gemini-e3.epfl.ch/webdav/site/gemini-e3/shared/A%20master%20program%20that%20will%20drive%20the%20coupling%20of%20GEMINI-E3%20and%20MARKAL%20TIMES%20models>
Discussion on the coupling of techno-economic MARKAL/TIMES model to a computable general equilibrium GEMINI-E3 model.
10. Vaillancourt, K., Labriet, M., Loulou, R. and J-P. Waaub. 2007. The Role of Nuclear Energy in Long-Term Climate Scenarios: An Analysis with the World-TIMES model. Cahier du GERAD, G-2007-29, 26 p.
<http://www.gerad.ca/fichiers/cahiers/G-2007-29.pdf>
Analysis of the future role of nuclear energy with the World TIMES model.
11. Syri S., Lehtilä A., Savolainen I. and T. Ekholm. 2007. Global energy and emissions scenarios for effective climate change mitigation - Modelling study with the ETSAP/TIAM model. VTT Technical Research Centre of Finland.
http://www.etsap.org/Applications/VTT_scenarioreport.pdf
12. International Energy Agency (Gielen D). 2006. Energy Technology Perspectives 2006, Scenarios & Strategies to 2050 (2008 version will be available on June 6th)
<http://www.iea.org/Textbase/npsum/enertech2006SUM.pdf> (summary)
<http://www.iea.org/Textbase/nptoc/enertech2006TOC.pdf> (table of contents)
Use of MARKAL for policy analysis based on a detailed representation of technology options.
13. Biberacher M. 2006. Fusion in the global energy system – GIS and TIMES
<http://www.etsap.org/Docs/Fusglob.pdf>
Example of linkage between TIMES and a Geographic Information System
14. Labriet M. 2005. Greenhouse Gas Abatement: Techno-Economic Modeling of Global Cooperative and Non-Cooperative Scenarios. PhD Thesis, UQAM, Canada.
Last chapter available at: <http://www.gerad.ca/fichiers/cahiers/G-2005-07.pdf>
Full thesis available upon request.
Example of linkage between the World integrated MARKAL and game theory in order to define globale climate policies.

Regional Models (<http://www.etsap.org/applicationRegional.asp>)

15. Pan European TIMES model (PEM) used within the New Energy Externalities Development for Sustainability (NEEDS) project. <http://www.needs-project.org/>
<http://www.etsap.org/Applications/NEEDS-TIMES-PEM-summary-MB.pdf>
16. Alfstad T. 2005. Development of a least cost energy supply model for the Southern African Development Community region. Thesis, University of Cape Town.
<http://www.etsap.org/Docs/ERC%20SADC%20energy%20supply%20model.pdf>
17. Mäkelä J. 2000. Development of an Energy System Model of the Nordic Electricity Production System. Thesis, Hlesinki University of Technology.
<http://www.etsap.org/Docs/Times-Nordic-DiplArbeit-Jussi-1.pdf>

National Models (<http://www.etsap.org/applicationNational.asp>)

18. System for the Analysis of Global Energy Markets (SAGE) used by the Energy Information Administration, US Dept of Energy, for the International Energy Outlook. <http://www.eia.doe.gov/oiaf/ieo/>
19. Strachan N., Kannan R., and S. Pye. 2007. Final report on DTI-DEFRA scenarios and sensitivities, using the UK MARKAL and MARKAL-MACRO energy system models. Prepared for the Dept of Trade and Industry (DTI) and the Dept of Environment, Food and Rural Affairs (DEFRA). Policy Studies Institute & UK Energy Research Centre http://www.ukerc.ac.uk/Downloads/PDF/U/UK_MARKAL_3rd_final_report_FINAL.pdf
20. Labriet M, Cabal H., Caldés N. and Y. Lechón. 2007. Future Energy Policies in Spain given the European Energy and Climate Policy Framework. International Energy Workshop, Stanford, USA, June 25-27, 2007. <http://www.ciemat.es/portal.do?TR=A&IDR=1&identificador=2089>
21. Simões S., Cleto J., Fortes P. And J. Seixas. Estimate of CO2 Marginal abatement costs for Portugal using the TIMES_PT model. <http://www.etsap.org/Applications/PortugalMAC.ppt>
22. Das A. and E. Ahlgren. 2007. Analysis of the impact of enhanced use of renewable and advanced fossil fuel technologies for power generation in Indonesia, Philippines and Vietnam and development of appropriate policies and institutional frameworks. Chalmers University of Technology, Sweden, 33 p.
<http://www.etsap.org/Docs/Chalmers-EC-Asean-2007-summary.pdf>
23. Blesl M. 2006. The role of CHP and district heating in Europe (CASCADE-MINTS).
http://www.etsap.org/Applications/Blesl_Seoul-role-of-CHP-DH.pdf
24. Chen W. 2005. The costs of mitigating carbon emissions in China: findings from China MARKAL-MACRO modeling. <http://www.etsap.org/Applications/cwyEPMarkalMacro.pdf>
25. Barreto L. 2001. Technological Learning in Energy Optimisation Models and Deployment of Emerging Technologies. PhD. Swiss Federal Institute of Technology.
<http://www.etsap.org/Docs/BARRETO-thesis.pdf>

ETSAP Reports

26. *Final Report of Annex X (2005-2008): Global Energy Systems and Common Analyses*,
<http://www.etsap.org/index.asp> (passim)
27. Final Report Annex VIII (2002-2005): Exploring Energy Technology Perspectives
http://www.etsap.org/FinReport/ETSAP_Annex8_FinalReport_Rev5.pdf
28. Final Report Annex VII (1999-01): Contributing to the KYOTO Protocol
<http://www.etsap.org/reports/annex7.pdf>