

New Features in TIMES Versions 1.5 & 2.0

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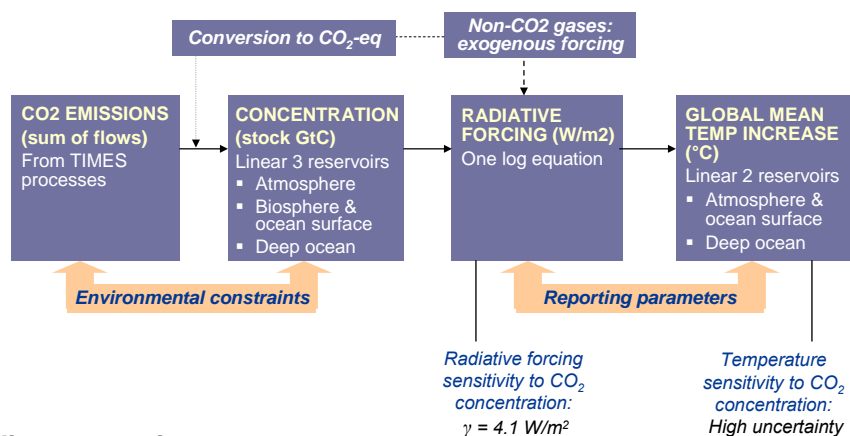


Enhancements introduced in 2005

- ▼ Climate Module (October 2004; revised May 2005)
- ▼ TIMES-VEDA interface (April–June 2005)
- ▼ TIMES-MACRO (October 2005)
- ▼ TIMES Damage Functions (November 2005)
- ▼ Stochastic TIMES (November 2005)
- ▼ Various minor improvements and bug fixes



Climate Module – Main features



Climate equations:

- Adapted from Nordhaus and Boyer (1999)
- Well documented, good approximation of those in more complex climate models



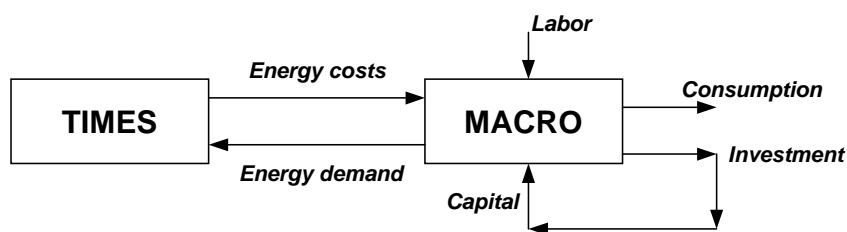
TIMES-VEDA – Main features

- ▼ **Simplified process transformation attribute**
 - Can be used instead of FLO_FUNC / FLO_SUM
- ▼ **Attribute for combining commodities into an aggregate commodity; useful for e.g. emissions**
- ▼ **Commodity-specific availability factors**
- ▼ **Improved approach for CHP modeling**
 - Efficiencies modeled by a new EQ_ACTEFF equation
 - Other characteristics: NCAP_CHPR, VDA_CEH, NCAP_AFAC
- ▼ **Attribute for residual capacities of processes**
- ▼ **Attribute for emissions from process flows**
- ▼ **Automatic generation of standard emission factors**



TIMES-MACRO – Main features

- ▼ Interconnects TIMES to the rest of the economy
- ▼ Same approach as in MARKAL-MACRO
- ▼ Single-sector dynamic equilibrium model
- ▼ Neoclassical optimal growth model
- ▼ Maximizes discounted utility of consumption



Damage functions – Main features

- ▼ Primary Substances, emissions & transport
 - ↗ Secondary substances
 - ↗ Impacts (air quality, health, environment)
 - ↗ Monetization (damage costs)

- ▼ **Input to TIMES: Damage cost per unit of emission of each primary substance emitted**

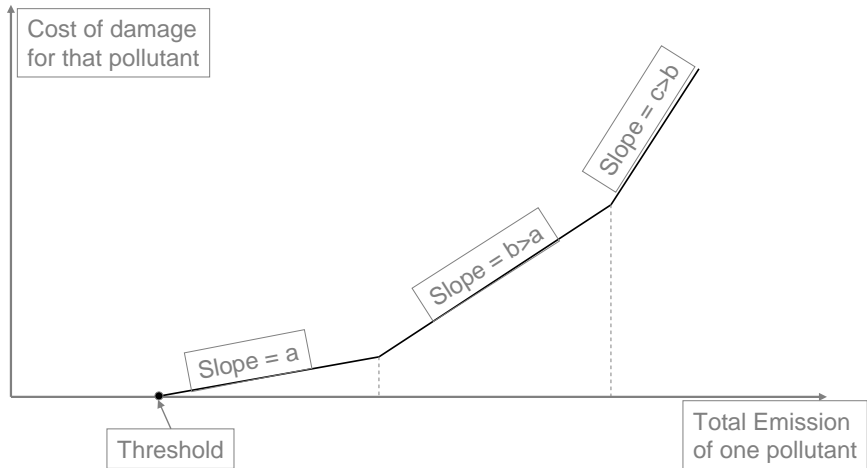
- ▼ **Requirements for damage cost function:**

- Cost is a (locally) linear convex function of emissions
- Non-linear convex function is also OK

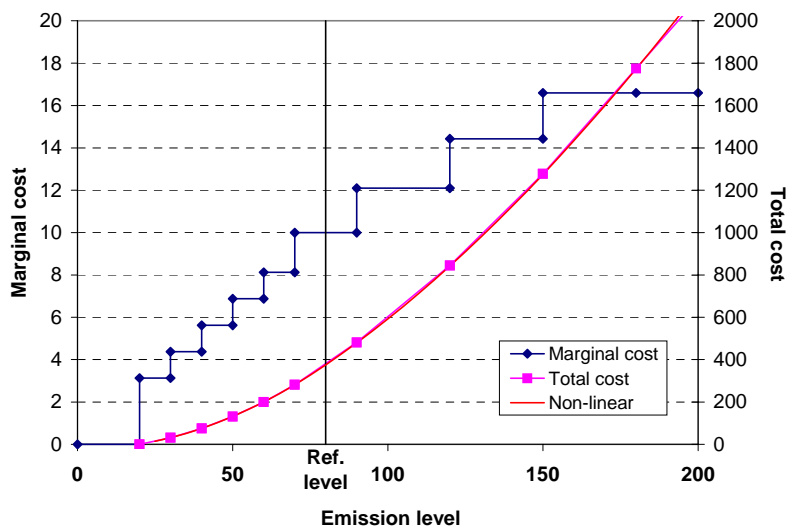
- ▼ **Formulation in TIMES:** $MC(EM) = MC_0 \cdot \left(\frac{EM}{EM_0} \right)^\beta$

- Cost elasticities β can be different below and above reference level, but must be ≥ 0
- Threshold emission level can also be specified
- Both linearized and non-linear formulation available

Damage functions – Convexity



Damage functions – Example



Stochastic TIMES – Main features

- ▼ Multi-stage stochastic programming
- ▼ Any number of stages up to 50
- ▼ Number of scenarios up to 64
- ▼ Five uncertain parameters available, as a starter
- ▼ Cloning of event tree and parameters possible
- ▼ Full result parameters for all scenarios
- ▼ Option for running deterministic scenarios:
 - Assessment of value of perfect information
 - Convenient tool for sensitivity analysis

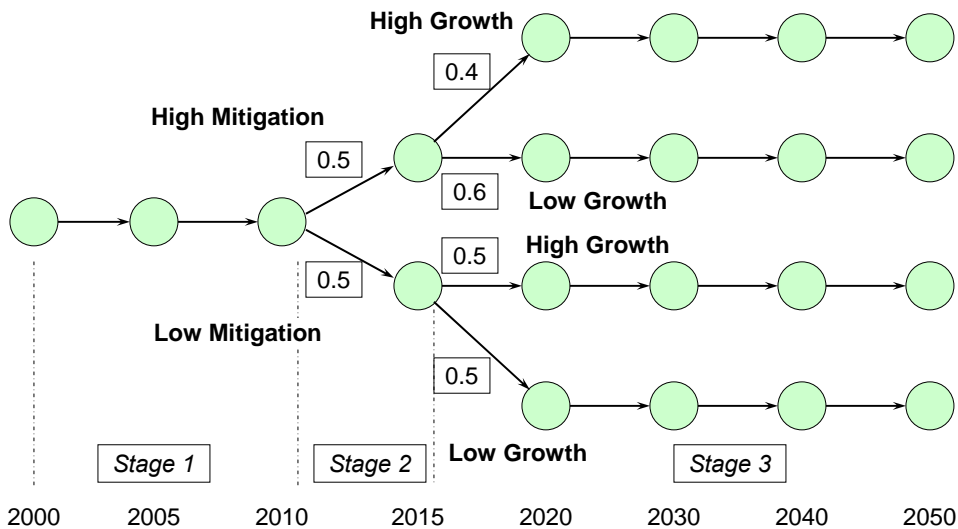


Stochastic TIMES – Uncertain parameters

- ▼ Demand projection (COM_PROJ)
- ▼ Bounds on total installed capacity (CAP_BND)
- ▼ Bounds on cumulative commodity production (COM_CUMPRD); e.g. for resource constraints
- ▼ Bounds on cumulative commodity net amount (COM_CUMNET); e.g. for emission constraints
- ▼ Bounds on atmospheric CO₂ concentration (CM_MAXCO2C)



Stochastic TIMES – Example



Stochastic TIMES – Model variants

▼ Can be used with the following model extensions:

- Elastic demands (ED)
- Climate Module (CLI)
- Lumpy investments (DSC)
- Endogenous Technology Learning (ETL)
- Damage Functions (DAM)
- VEDA extension (VDA)
- IER extension (IER)

▼ Can not be used with TIMES-MACRO

Other minor improvements

- ▼ **Shaping of efficiencies and emissions introduced**
- ▼ **Attribute for process-wise market-share constraints**
- ▼ **Several new interpolation options introduced:**
 - Inter-/extrapolation within each period but not across periods
 - New default method for bound and RHS parameters
 - Asymmetric extrapolation options with and without migration
 - 🔗 Enhanced MODEL / DATA year independency
- ▼ **Vintaging of inter-period storage introduced**
- ▼ **Many new QA checks introduced**
- ▼ **Additional performance improvements
(most benefits with latest GAMS versions)**



Summary

- ▼ **Wide range of new features introduced in 2005**
- ▼ **Almost all MARKAL model variants supported**
- ▼ **Performance of model generator at satisfactory level**
- ▼ **User interfaces have also been improved:**
 - VEDA-FE has reached good level of robustness
 - New ANSWER-TIMES interface may enlarge user base
- ▼ **Expanding model applications:**
 - NEEDS, EFDA, EMF22, various national studies**
 - ➔ **TIMES Version 1.5 (special release)**
 - NEEDS deliverable; Stochastics and MACRO not included
 - ➔ **TIMES Version 2.0 (official ETSAP release)**

