ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Sustainability, neutrality and beyond in the framework of Swiss post-2012 climate policy

André Sceia[1], Juan-Carlos Altamirano-Cabrera[1], Thorsten F. Schulz[2] and Marc Vielle[13]

[1]Research Lab on the Economics and Management of the Environment (EPFL)

[2]Energy Economics Group (PSI)

[3]Toulouse School of Economics

International Energy Workshop - Venice - 17-19 June 2009

Outline

1. Introduction
2. The models
   - GEMINI-E3
   - MARKAL-CHRES
   - Coupling rationale
3. Coupling methodology
4. Policy scenarios
5. Results
6. Summary and further research

Outline

1 Introduction

2 The models

3 Coupling methodology

4 Policy scenarios

5 Results

6 Summary and further research

Objectives and contributions

Objectives

- Assess ambitious Swiss post-Kyoto climate policy;
- Focus on the residential sector;
- Consider the international framework;
- Improve the coupling procedure.

Contributions

- Improved coupling of existing top-down and residential bottom-up models;
- Integrated assessment of post-2012 climate policies in various international frameworks.

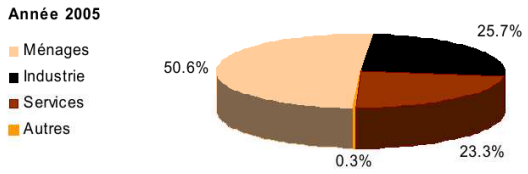
The share of the residential sector

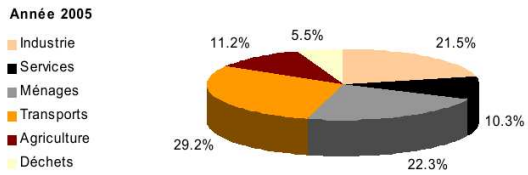
Households are responsible for 12 $MtCO_2$ in 2005 i.e. :

- more than 50% of the CO_2 emissions due to combustible fuels
- 22.3% of total GHG emissions

Modeling requirement

- Model precisely the residential sector
- Integrate the residential modeling in a global framework





Outline

1 Introduction

2 The models
- GEMINI-E3
- MARKAL-CHRES
- Coupling rationale

3 Coupling methodology

4 Policy scenarios

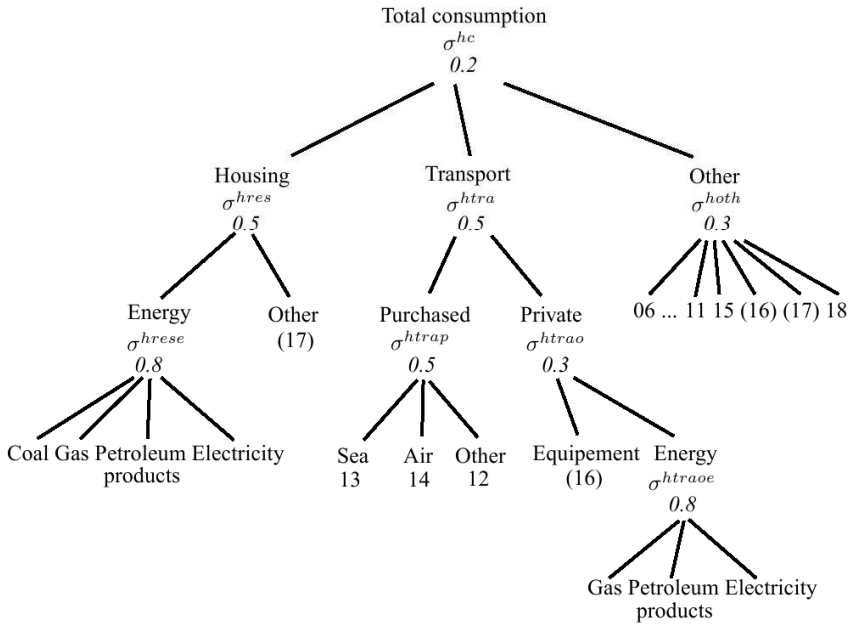
5 Results

6 Summary and further research

Main characteristics of GEMINI-E3

- Dynamic-recursive CGE model of the world economy;
- *Aggregated version in 6 regions (CHE, EUR, OEU, JAP, OEC and DCS);*
- 5 energy sectors;
- 13 non-energy sectors;
- All GHG Emissions (EMF 21);
- *2001 Swiss SAM prepared on the basis of the new Swiss IO table (ETH Zürich) and GTAP 6;*
- GTAP 6 (2001) for other countries;
- *Nested CES utility function;*
- Global GHG emission certificates market.

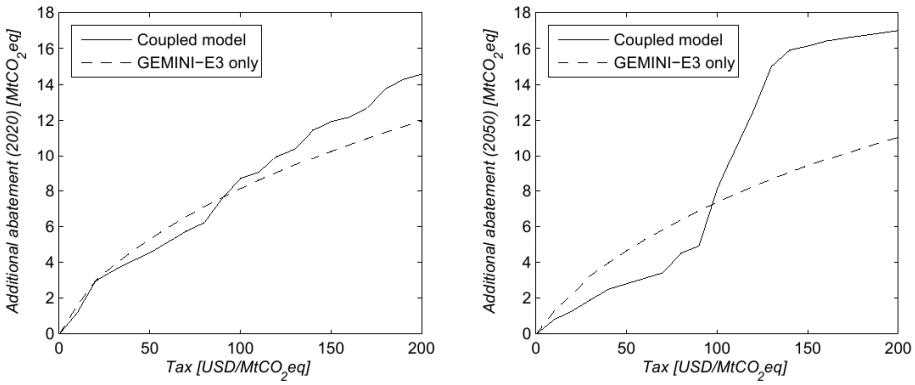
Nested CES utility function



Main characteristics of MARKAL-CHRES

- Linear programming model of the Swiss residential energy system (MARKAL family)
- Perfect information and perfect foresight
- 173 technologies (including energy saving technologies)
- 13 End-use demands exogenously set (drivers)
- Calibrated on Swiss statistics and IEA data (2000)
- 5% discount rate

Coupling rationale



Comparison of GEMINI-E3 with the coupled model
MAC curves in 2020 (left) and 2050(right)

A. Sceia, J.-C. Altamirano-Cabrera, L. Drouet, T.F. Schulz, and M. Vielle.
Integrated assessment of Swiss GHG mitigation policies after 2012 - focus on the residential sector.
NCCR-Climate Working Papers, 2008.

Outline

1 Introduction

2 The models

3 Coupling methodology

4 Policy scenarios

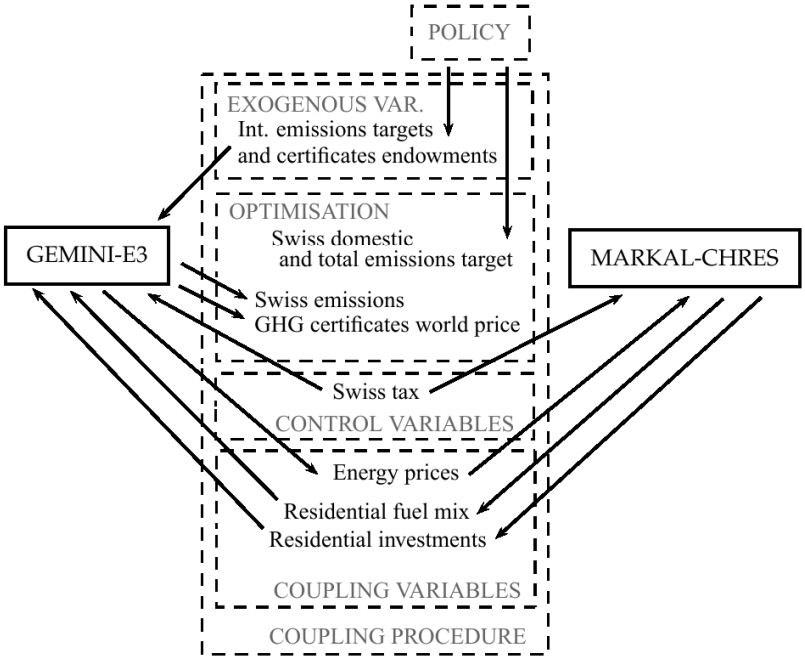
5 Results

6 Summary and further research

Coupling specifications

- Objective : find the tax that equalizes the tax revenue in the target year and the purchase of certificates ensuring to meet the total target, possibly ensuring a minimum domestic abatement (double target);
- 3 coupling variables : residential fuel mix, residential investments matrix and energy prices;
- CES residential nest changed to Leontief ($\sigma_{hres} = \sigma_{hrese} = 0$);
- the fuel mix and the annualized investments are used to define the fuels share parameters as well as the technical progress of residential energy and of the residential construction;
- The variation of energy prices are aligned between the models.

Coupling structure



Outline

1 Introduction

2 The models

3 Coupling methodology

4 Policy scenarios

5 Results

6 Summary and further research

Policy scenarios

- We analyze 4 scenarios implementing a progressive GHG tax :
  1. 50%;
  2. "sustainable" (75%);
  3. "neutral" (100%);
  4. "zero footprint" (180%).
- Scenarios are also considered with and without a minimum domestic GHG emissions abatement of 50% ($+$).
- 3 international abatement frameworks (low, mid and high).

Outline

1 Introduction

2 The models

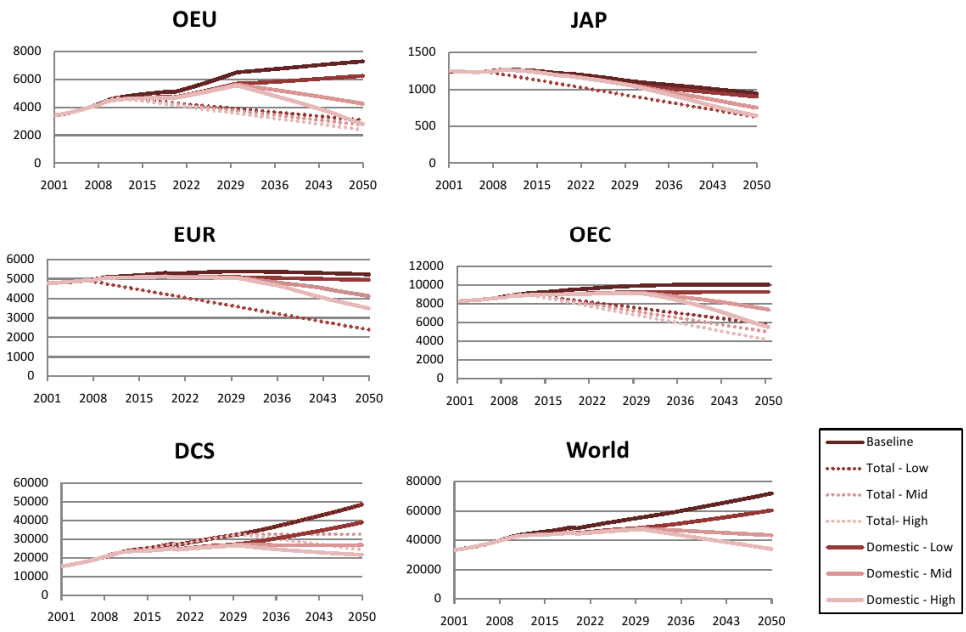
3 Coupling methodology

4 Policy scenarios

5 Results

6 Summary and further research

International GHG emissions ($MtCO_2eq$)

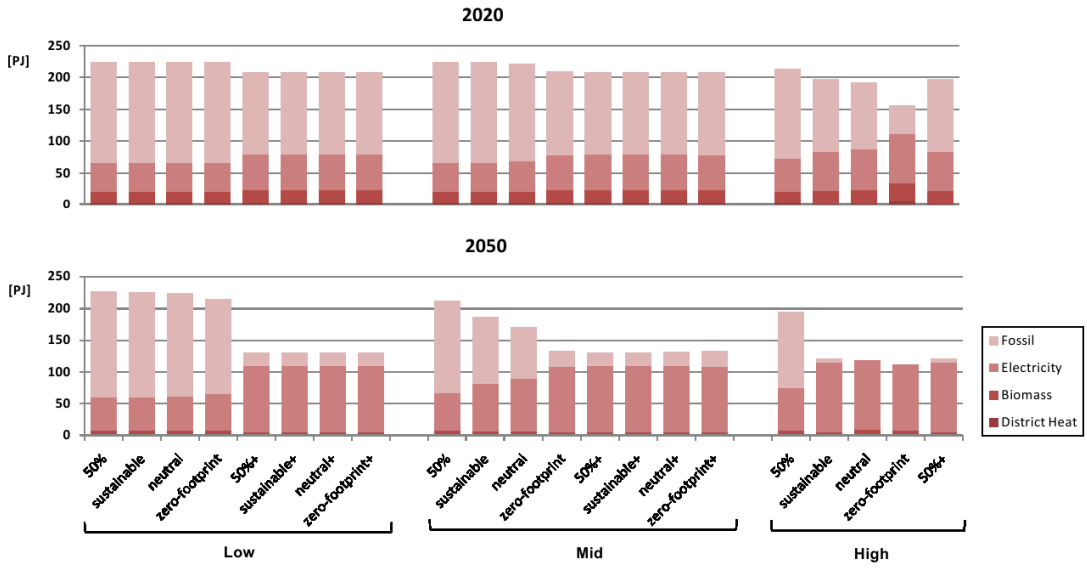


Summary results for Switzerland

Scenarios		Abatement in 2050[a]		Swiss	GHG	2008-2050[d]			
World	Switzerland	Domestic	Total	tax[b]	price[c]	WG	GTT	EC	DWL
Low	50%	-28	-50	1.2	3.8	-0.02	-0.02	-0.01	0.01
	neutral	-28	-100	3.8	3.8	-0.05	-0.04	-0.03	0.02
	50%+	-50	-50	102.4	3.8	0.26	0.35	0.00	-0.09
	zero-footprint+	-50	-180	**102.4**	3.8	0.20	0.33	-0.05	-0.08
Mid	neutral	-40	-100	34.8	34.8	-0.08	0.01	-0.09	0.00
	neutral+	-50	-100	**101.9**	34.7	0.14	0.27	-0.07	-0.06
High	50%	-39	-50	50.7	289.2	0.06	0.12	-0.05	-0.01
	sustainable	-50	-75	**143.7**	289.8	0.07	0.33	-0.13	-0.12
	neutral	-54	-100	290.7	290.6	-0.03	0.44	-0.26	-0.20
	zero-footprint	-63	-180	926.5	293.6	-0.64	0.82	-0.73	-0.72
	50%+	-50	-50	149.2	288.8	0.24	0.40	0.03	-0.19

[a] % of 2001 emissions
[b] Swiss tax in 2050 [USD_{2001}/tCO_2eq]
[c] World price of certificates in 2050 [USD_{2001}/tCO_2eq]
[d] Sum of discounted values as % of the sum of discounted final households consumption (5% discount rate)

Fuel consumption in the residential sector



Outline

1 Introduction

2 The models

3 Coupling methodology

4 Policy scenarios

5 Results

6 Summary and further research

Summary and further research

- High domestic abatement costs in Switzerland;
- Purchasing GHG certificates does not prepare Switzerland in case the contraction and convergence principle is retained in future international climate agreements;
- A progressive GHG tax of 100-150 USD/tCO_2eq is required to achieve a 50% domestic abatement by 2050;
- Ambitious policy targets ensuring a important domestic emission abatement are affordable even with stringent international policy agreement;
- The impact on GDP and welfare are limited.

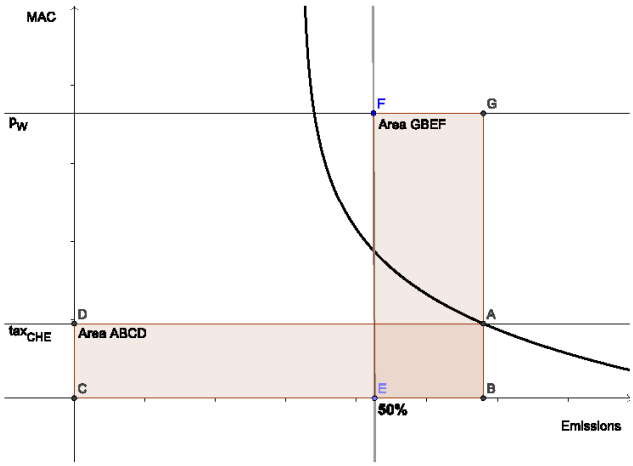
- Couple a bottom-up model for the transport sector.

Summary and further research

- High domestic abatement costs in Switzerland;
- Purchasing GHG certificates does not prepare Switzerland in case the contraction and convergence principle is retained in future international climate agreements;
- A progressive GHG tax of 100-150 USD/tCO_2eq is required to achieve a 50% domestic abatement by 2050;
- Ambitious policy targets ensuring a important domestic emission abatement are affordable even with stringent international policy agreement;
- The impact on GDP and welfare are limited.

- Couple a bottom-up model for the transport sector.

Coupling specifications (cont.)



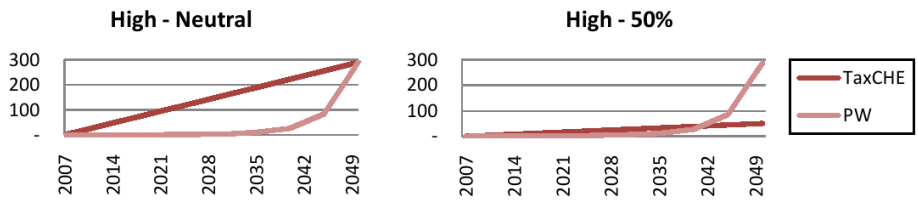
Tax revenue used to purchase GHG certificates for 50% total abatement

Policy scenarios (cont.)

Table: International emissions targets in 2050 (% of 2001 emissions)

Scenario	Low	Mid	High
EUR	50	50	50
OEU	10	20	30
JAP	50	50	50
OEC	30	40	50
DCS[a]	-[b]	0	25

[a] % of 2030 emissions
[b] baseline emissions



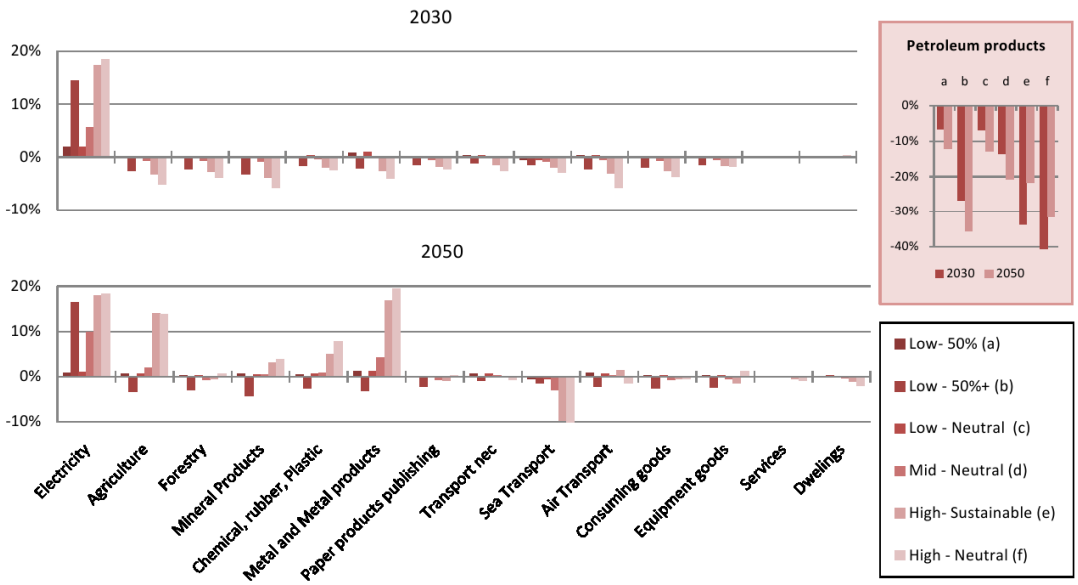
Dimensions of the complete GEMINI-E3 Model

Countries and Regions			Sectors/Products
Annex B			**Energy**
Germany	DEU		01 Coal
France	FRA		02 Crude Oil
United Kingdom	GBR		03 Natural Gas
Italy	ITA		04 Refined Petroleum
Spain	ESP	EUR	05 Electricity
Netherlands	NLD		**Non-Energy**
Belgium	BEL		06 Agriculture
Poland	POL		07 Forestry
Rest of EU-25	OEU		08 Mineral Products
Switzerland	CHE		09 Chemical Rubber Plastic
Other European Countries	XEU		10 Metal and metal products
Russia	RUS	OEU	11 Paper Products Publishing
Rest of Former Soviet Union	XSU		12 Transport n.e.c.
United States of America	USA		13 Sea Transport
Canada	CAN	OEC	14 Air Transport
USA Australia and New Zealand	AUZ		15 Consuming goods
Japan	JAP		16 Equipment goods
Non-Annex B			17 Services
China	CHI		18 Dwellings
Brazil	BRA		
India	IND		**Household Sector**
Mexico	MEX		
Venezuela	VEN		**Primary Factors**
Rest of Latin America	LAT	DCS	Labor
Turkey	TUR		Capital
Rest of Asia	ASI		Energy
Middle East	MID		Fixed factor (sector 01-03)
Tunisia	TUN		Other inputs
Rest of Africa	AFR		

MARKAL-CHRES Demand segments

RC1	Cooling
RCD	Cloth Drying
RCW	Cloth Washing
RDW	Dish Washing
REA	Other Electric
RH1	Room-Heating Single-Family Houses (SFH) existing building
RH2	Room-Heating SFH new building
RH3	Room-Heating Multi-Family Houses (MFH) existing buildings
RH4	Room-Heating MFH new buildings
RHW	Hot Water
RK1	Cooking
RL1	Lighting
RRF	Refrigeration

Sectoral production change due to the policy scenarios



Residential sector's contribution to domestic abatement