EV-model: an integrated top-down - bottom-up-model for Finland

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- Background
- EV-model
- Key elements of Finnish Climate change strategy
- Costs of Finnish Climate change strategy

The costs of Finnish climate change strategy

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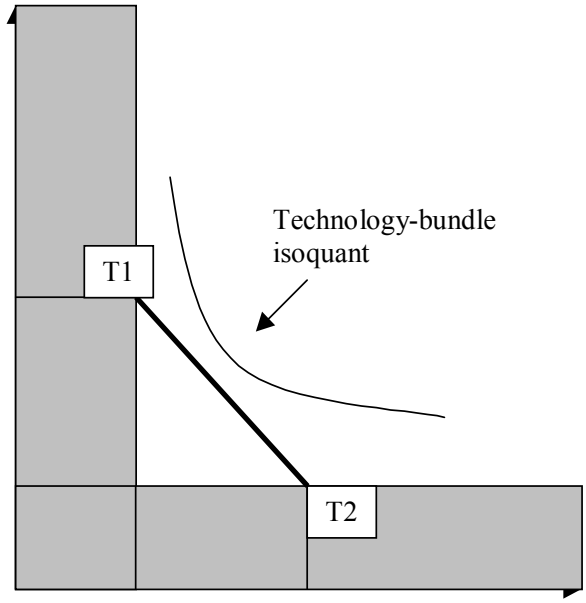
- Recent studies on Climate change policies in ETLA, VATT and VTT Energy
  - –Development of EV-model with VTT Energy
    - Forsström and Honkatukia (2002)
  - –Finnish climate change policies
    - Evaluation of national Climate change strategy with VTT
    - Several studies on Kyoto mechanisms
  - –International climate change policies
    - Several studies on energy taxes
    - Regional energy markets and climate change policies
    - Emission trade in the EU
- New initiatives
  - –Distributional effects on climate change policies
    - Regional
    - Income groups
  - –Further analysis on regional energy markets and climate change policies
    - Electrity markets in CGE-models
    - Finland
    - Northern dimension?

Background: climate policies

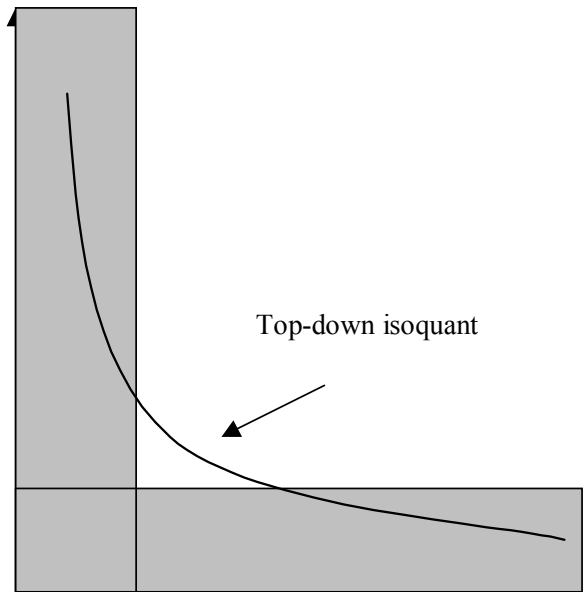
- Economic Instruments for Climate Policies
  - Carbon taxes
  - Kyoto mechanisms
  - Command and control policies
  - Voluntary agreements
- A great many questions
  - The effects of domestic economic measures
    - Price effects
      - Direct impact on demand for fossil fuels
      - Indirect effect on other sectors via relative price changes and the use of fuels as intermediate inputs
    - Macroeconomic effects
      - Effects caused by export price competitiveness
      - Income effects
      - Carbon leakage
    - The effects of other economic policies
      - Revenue recycling
    - Technology policies
    - Conflicts between climate and other policies
- The effects of the actions of other countries
    - Kyoto mechanisms
    - Price competitiveness
    - Changes in export demand
- Technology effects
  - Crucial, but often not covered in detail, or:
  - Only technology effects covered

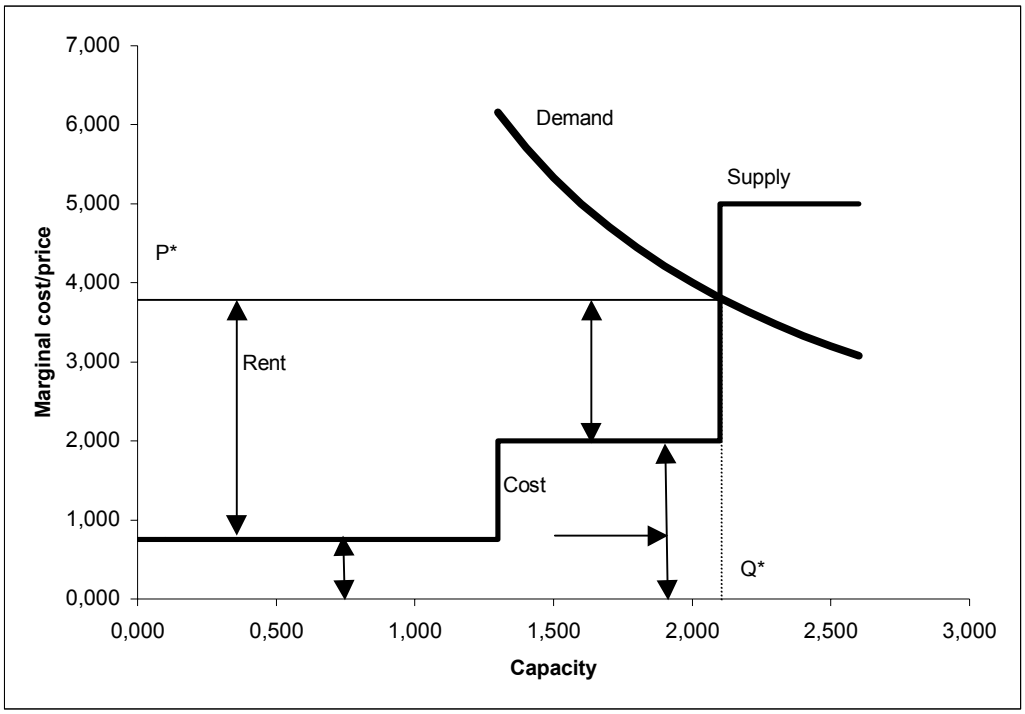
- Implementing Kyoto targets involves both technological and economic measures
  - –both need to be addressed
- Cost estimates for implementing Kyoto targets from technological and economic models seemingly stem from two different worlds
  - –Two approaches often create confusion and unnecessary debate
- The “conflict” stems from a misperception
  - –Technology models usually partial equilibrium
  - –Economical models usually general equilibrium
  - –Top-down: choice of technology exogenous and emissions endogenous
  - –Bottom-up: demand for energy services exogenous and technology choice endogenous
- Approaches can be combined to answer more questions
  - –Can answer specific technology questions
  - –Can introduce economic measures
- Hybrid also produces more answers
  - –Can handle broad cost concepts (GDP, utility, equivalent variations, replacement costs etc.)
- Hybrid has some real advantages
  - –“unrealistic” technology assumptions are ruled out
  - –scarcity rents are included

Isoquant for technology bundle



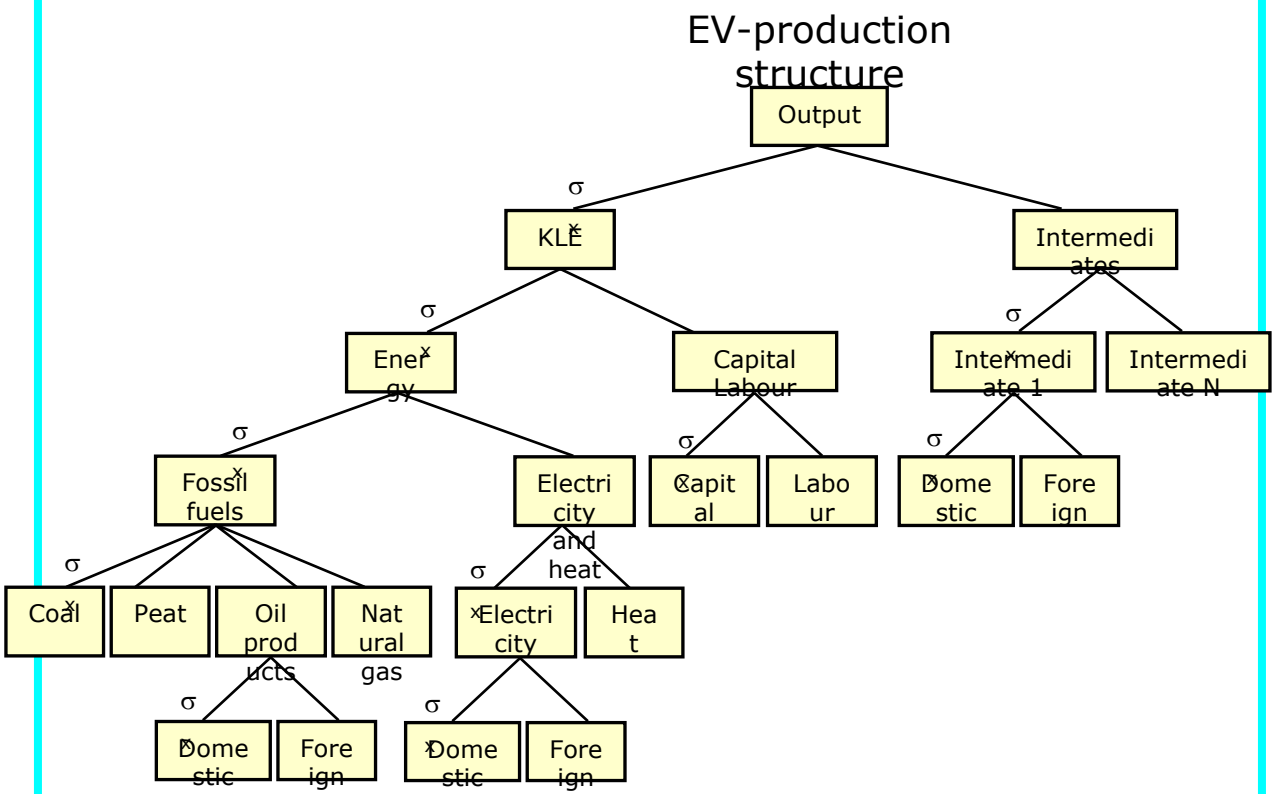
Isoquant for a top-down model




7,000
6,000
5,000
4,000
3,000
2,000
1,000
0,000
Marginal cost/price
Demand
Supply
P*
Rent
Cost
Q*
0,000
0,500
1,000
1,500
2,000
2,500
3,000
Capacity

EV-model

- Model takes into account
  - –Power production technologies (18 in all)
  - –Process technologies (forest, chemical and metal industries)
  - –Most fuels
    - •motor gasolines
    - •diesel fuels
    - •light fuel oil
    - •heavy fuel oil
    - •LPG
    - •coal
    - •peat
    - •natural gas
    - •wood
  - –Energy taxes
  - –Prices and competitiveness
  - –Labour markets
  - –Capital markets
  - –Energy efficiency
  - –Kyoto mechanisms (to an extent)
- Model does not account for
  - –Endogenous productivity gains
  - –Other countries' policies (only as scenarios)
  - –Spillovers from Kyoto mechanisms


EV-production structure
Output
σ
KLE
Intermediates
σ
Energy
Capital Labour
Intermediate 1
Intermediate N
σ
Fossil fuels
Electricity and heat
Capital
Labour
Domestic
Foreign
σ
Coal
Peat
Oil products
Natural gas
Electricity
Heat
σ
Domestic
Foreign
Domestic
Foreign

Utility in EV model

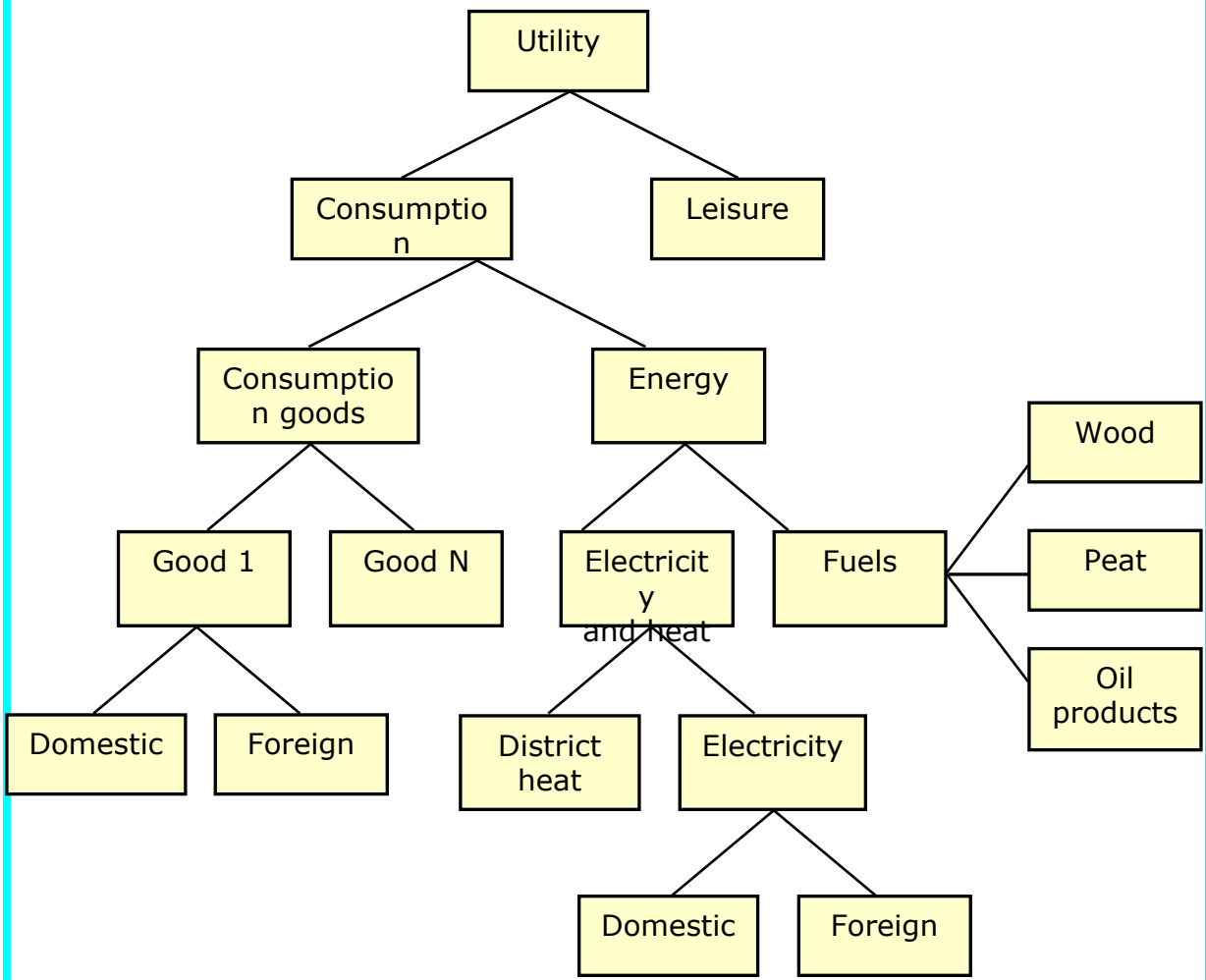


Table 3.3 Production sectors and parameters				
		σ_j^M	σ_j^{KL}	σ_j^{KLE}, σ_j^X
ISIC10	Agriculture and fisheries	5,6	0,56	0,25
ISIC12	Forestry	5,6	0,56	0,25
ISIC23	Mining and quarrying	5,6	1,12	0,25
ISIC291	Production of peat	5,6	1,12	0,25
ISIC292	Production of natural gas	5,6	1,12	0,25
ISIC293	Mining of coal		1,26	0,25
ISIC299	Other mining	5,6	1,26	0,25
ISIC31	Food, beverages and tobacco	4,4	1,26	0,25
ISIC32	Textiles, apparrel and leather	4,4	1,26	0,25
ISIC33	Wood products and furniture	5,6	1,26	0,25
ISIC341	Paper and pulp	3,6	1,26	0,25
ISIC342	Printing	3,6	1,26	0,25
ISIC351	Basic chemical industries	3,8	1,26	0,25
ISIC352	Chemical products	3,8	1,26	0,25
ISIC355	Rubber and plastics	3,8	1,26	0,25
ISIC3531	Gasolines, kerosene	3,8	1,26	0,25
ISIC3532	Diesel oils		1,26	0,25
ISIC3533	Light fuel oils	3,8	1,26	0,25
ISIC3534	Heavy fuel oils	3,8	1,26	0,25
ISIC3535	LPG	3,8	1,26	0,25
ISIC3539	Other oil products	3,8	1,26	0,25
ISIC361	Glas and cheramic products	5,6	1,26	0,25
ISIC362	Cement and construction elements	5,6	1,26	0,25
ISIC371	Iron and steel	5,6	1,26	0,25
ISIC372	Non-ferrous basic metals	5,6	1,26	0,25
ISIC381	Metal products	5,6	1,26	0,25
ISIC382	Machinery and equipment		1,26	0,25
ISIC383	Electrical machinery and equipment	5,6	1,26	0,25
ISIC384	Transport equipment	10,28	1,26	0,25
ISIC39	Other production	5,6	1,26	0,25
ISIC41	Electricity generation and distribution	5,6	1,26	0,25
ISIC42	Heat generation and distribution	5,6	1,26	0,25
ISIC43	Water supply	5,6	1,26	0,25
ISIC51	Construction of buildings	3,8	1,4	0,25
ISIC52	Construction of infrastructure	3,8	1,4	0,25
ISIC61	Retailing	3,8	1,4	0,25
ISIC63	Hotels and restaurants	3,8	1,4	0,25
ISIC7111	Railway transports	3,8	1,68	0,25

Table 3.3 Production sectors and parameters (cont.)				
ISIC7119	Road transports	3,8	1,68	0,25
ISIC7120	Water transports	3,8	1,68	0,25
ISIC7130	Aviation	3,8	1,68	0,25
ISIC72	Postal and telecommunications services	3,8	1,68	0,25
ISIC81	Finance and banking	3,8	1,26	0,25
ISIC83	Housing and business services	3,8	1,26	0,25
ISIC91	Other private services	3,8	1,26	0,25
	Public sevices			
σ_j^M	Import elasticity			
σ_j^{KL}	Labour-capital elasticity of substitution			
σ_j^{KLE}, σ_j^X	Value added energy – intermediate good elasticity of substitution			

Table 3.4 Utility function parameters		
σ_C	Elasticity of substitution between goods	.5
σ_{CEL}	Consumption-leisure elasticity of substitution	.52
σ_{FHEC}	Elasticity of substitution between energy and goods	.25
σ_{HE}, σ_F	Elasticity of substitution between heat, electricity, and between fuels	.25
σ_{FHE}	Elasticity of substitution between heat-electricity and fuels	.15

Table 1 3.2 Electricity and heat production	
X40111	Hydropower, wind
X40114	Nuclear
X40122	Distribution of heat and electricity
x401291	Peat-fired condensing plants
x401292	Coal-fired condensing plants
x401293	Natural gas-fired condensing plants
x4013534	Oil-fired condensing plants
X40212	Wood-fired CHP
x402291	Peat-fired CHP
x402292	Coal-fired CHP
x402293	Natural gas-fired CHP
x4023534	Oil-fired CHP
x40312	Wood-fired district heat
x403291	Peat-fired district heat
x403292	Coal-fired district heat
x403293	Natural gas-fired district heat
x4033534	Oil-fired district heat

Table Forest industries	
X3411	Newsprint
X3412	SC-paper
X3413	LWC-paper
X3414	Fine paper
X3415	Paperboard and pulp

Table Basic metal industries	
X3711	Basic oxygen fyrnace steel
X3712	Electric arc furnace steel
X3713	Stainless steel
X372	Non-ferrous metals and ferrochromium

Evaluating the costs of Finnish Climate Change Strategy

- Based on an "official" BAU
  - –Responsible ministries evaluated energy saving potential in their fields
  - –FM and MTI considered macroeconomic BAU
- EV-model used for analysis
  - –Bottom-up – part calibrated according to EFOM results
  - –Top-down – part follows economic BAU
  - –Point of reference: BAU in 2010
- Policy alternatives
  - –Energy saving programme and programme for renewable energy always included
    - Tax breaks and subsidies for green energy
    - CAC for energy saving
  - –Two electricity supply scenarios
    - Natural gas
    - Nuclear
  - –Most alternatives include increases in fuel and electricity taxes

- **Evaluating energy saving**
  - –Energy saving consists of detailed policies that increase energy efficiency
  - –Energy saving may benefit users of energy
  - –Costs evaluated on the basis of required investments
    - •Heating: CLIMTECH
    - •Electricity and fuels: EFOM
    - •Administrative costs: mostly n.a.
- •Renewable energy
  - –Goals:
    - •Wood-based CHP +15 %
    - •Wood-based HP +75 %
    - •Wind (and water) +15 %
  - –Costs stem from investment on new capacity
    - •EV estimate
  - –Tax breaks and subsidies for green energy must be financed
    - •Budgeted amounts
    - •Wood: around 100m € by 2010
    - •Wind, water 2-3m€ by 2010

- Energy taxes and subsidies
  - –Climate change policies are to be revenue neutral
  - –Energy tax scenarios
    - •CO2 and electricity taxes both raised
    - •Transport fuel taxes not raised
    - •CAC: more subsidies
  - –Revenue recycling
    - **•100% Income taxes/transfers**
      - **–Tax wedge -effect disregarded**
    - **•50% income taxes/transfers, 50 % social security payments**
    - •50% income taxes/transfers, 50 % social security payments
    - •100 % Income taxes
      - –Tax wedge –effect present
    - **•100 % VAT**

Some results

- Emissions reduced by 21-27 % from BAU (BAU: 69.5 Mt CO2 in 2010)

- GDP down by 0.2-0.7 % compared to BAU

- GDP loss 0.1-0.3 percentage points lower if electricity generation strategy is nuclear-based than if it is natural gas-based

- Employment down by 0.1-0.5 % from BAU
  - –Decline smaller in nuclear option
  - –Some scope for a green tax reform

- Private consumption falls by0.6-1.6 % from BAU
  - –Fall 0.6 points smaller in nuclear
  - –Fall smaller if transportation fuel taxes are not raised

- Energy intensive industries suffer more than labour intensive

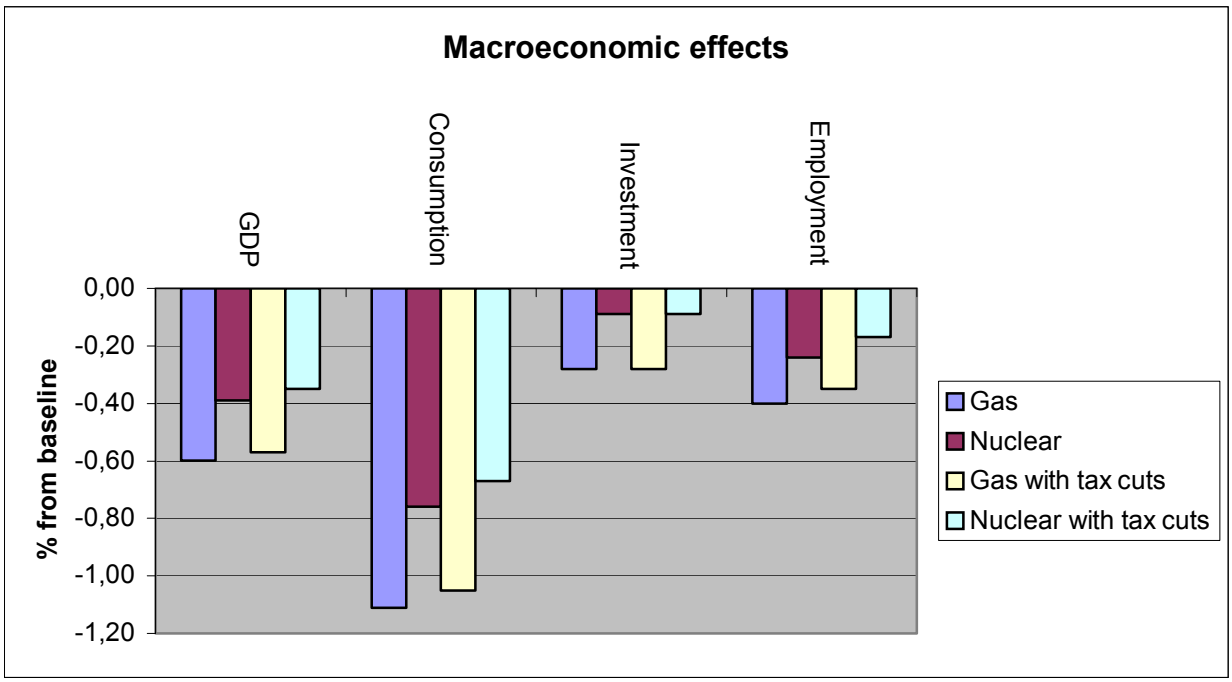
- Revenue-recycling can reduce costs – but not much

- **More: www.ktm.vn.fi,www.vatt.fi,www.vtt.fi**

Table 6 The macroeconomic effects of climate policies

	Gas	Nuclear	Gas with tax cuts	Nuclear with tax cuts
GDP	-0,60	-0,39	-0,57	-0,35
Consumption	-1,11	-0,76	-1,05	-0,67
Investment	-0,28	-0,09	-0,28	-0,09
Employment	-0,4	-0,24	-0,35	-0,17
CO2-emissions	-20,91	-21,17	-20,86	-21,1

Figure 8 The macroeconomic effects of climate policies



- GDP: falls more with gas
- Consumption: falls 0.6 % more with gas
- Employment: falls
- Emissions: both hit the target
- Effects smaller, if transport fuel taxes not raised
  - –Transport fuel taxes hit consumers relatively more, inducing labour supply and consumption effects