The Interaction of Renewable Quotas and Emission Trading

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Europe in its 20s

20^5 means:

20% share of renewables in primary energy consumption (and 10% biofuels)

20% increase of energy efficiency

20% reduction of CO_2 (compared to 1990): -50-80% by 2050

- Current mindset: 450 ppm CO_2e, ~ 400 ppm CO_2

...by 2020

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European Emission Trading System

European Emission Trading System (EU ETS) started in 2005

Covers about 12.000 installations of energy producing and energy intensive industries

Classical cap-and-trade system:

- Set emission target
- Allocate emission permit to installations
- Allow trade of emission permits

Emission target: Reduction of 20% in 2020 (compared to 1990)

Permit allocation: Mainly grandfathering but also auctions

Promotion of Renewable Energies

Renewable energies are supposed to have learning effects

Thus, chicken and egg problem as well as social suboptimal investments

Target: 20% renewable energy of primary energy consumption

EU: 70s and 80s focused on support of research and development

Since 90s focus on implementation:

- *Quotas and tradable green certificates:* apply market mechanisms, higher investment risk, potential lower learning effects for high cost RES
- *Feed-In tariffs:* allow a differentiated treatment of RES, more costly, low investment risk

Source: EU, 2008

Overview of Instruments: Quotas or Tariffs, and supporting instruments

Country	Support Policies	Share in electricity generation excluding hydro in 2005
Austria	Feed-in tariffs, tax exemptions, investment incentives	5.1 %
Belgium	Obligatory targets and fallback prices, TGC, investment support	2.7 %
Czech Republic	Feed-in tariffs or Green Bonuses, investment support, biofuel quota	0.9 %
Denmark	Tendering system for offshore, environmental premium, subsidies, feed-in tariffs,	29.2 %
Finland	Tax subsidies, investment subsidies, grid access guarantee, feed-in tariffs, biofuel quota	13.8 %
France	Feed-in tariffs, tendering system, tax credits, investment subsidies, biofuel quota	1.1 %
Germany	Feed-in tariffs, subsidized loans, biofuel quota	7.3 %
Hungary	Feed-in tariffs, TGC planned, tax subsidies	4.8 %
Italy	Grid access guarantee, obligatory targets, TGC, feed-in tariffs, tax exemptions	4.6 %
Netherlands	Premium Tariffs with TGC, tax exemption and boni, biofuel quota, investment subsidies	8.8 %
Poland	TGC, obligatory targets, tax exemption	1.3 %
Portugal	Feed-in tariffs, tendering system till 2006, investment subsidies, tax reductions	8.2 %
Slovak Republic	Guarantees of origin, tax exemption, feed-in tariffs, investment subsidies	0.0 %
Sweden	Obligatory targets, TGC, premium tariff, biofuel quota, tax exemption	5.8 %
Spain	Feed-in tariff or premium, subsidized loans, tax exemption	8.3 %
United Kingdom	Obligatory targets, TGC, tax exemption, grant schemes, , biofuel quota	3.1 %

Source: EU, 2008

What are the Interactions of Renewable and Emission Quotas?

Pricing carbon increases the cost of fossil fuel based generation

➔Renewable generation becomes more competitive

Renewable quotas lead to less fossil fuel based generation

➔ Impact on carbon price

We use a static small open economy computable general equilibrium to analyze these interactions

The model includes detailed electricity generation technologies

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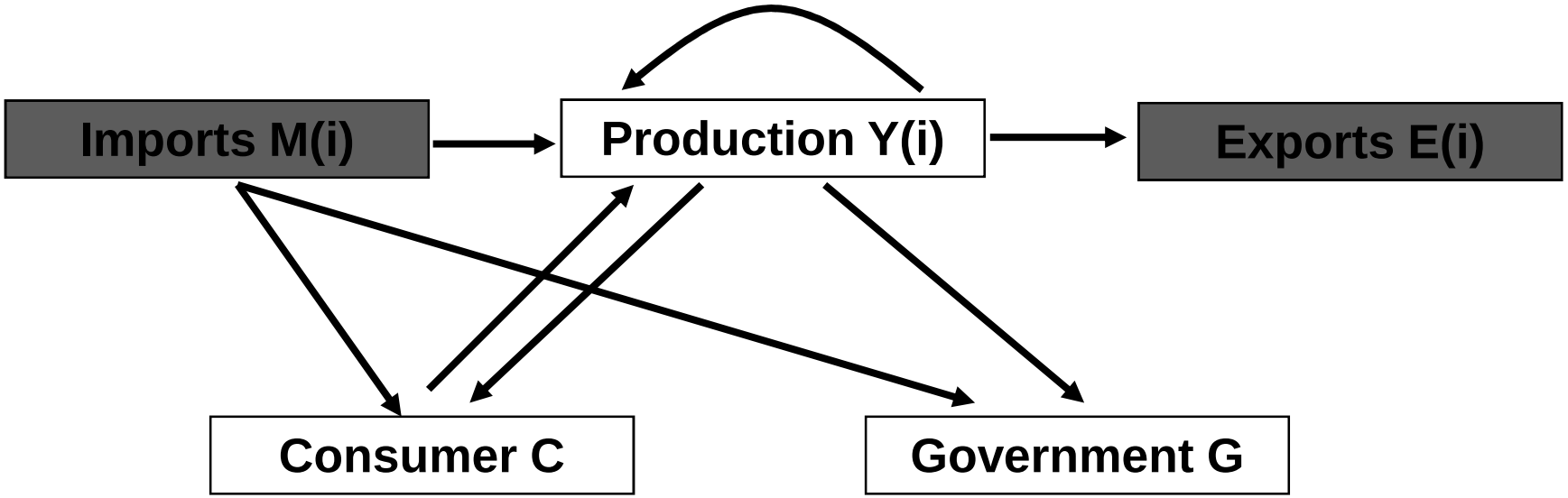
Small Open Economy Computable General Equilibrium Model



Industries are aggregate along NACE classification:

Agriculture, services, manufacture, mining, transport

Energy commodities are disaggregated represented:

Electricity, crude oil, refined oils, natural gas, coal, energy intensive industries

Trade flows: → **Domestic commodity flows:** → **Factor flows:** →

Bottom-Up Details

Electricity sector is modeled such that technological details of generation technologies are incorporated:

- 14 generation technologies
- 3 different load segments
- Technology data from various engineering studies
- Physical generation data based on Eurostat statistics
- Economies data based on 2004 German input-output table and OECD tax revenue statistics

Bottom-Up Electricity Generation Technologies

Base load:

- Biomass
- Nuclear
- Lignite
- Hard Coal
- CCGT

Medium Load:

- Hard Coal
- CCGT
- Waste
- Wind Onshore
- Wind Offshore
- Solar

Peak Load:

- OCGT
- Oil
- Hydro (+Pump)

Initially inactive technologies

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Scenarios

BAU:

Business-as-usual scenario; replicates benchmark equilibrium of the year 2004

20% CO_2:

20% reduction of emission by trading system including electricity generation and energy intensive industries

20% CO_2; 20% RES Quota:

Like 20% CO_2 with additional renewable electricity generation quota of 20% (without hydro)

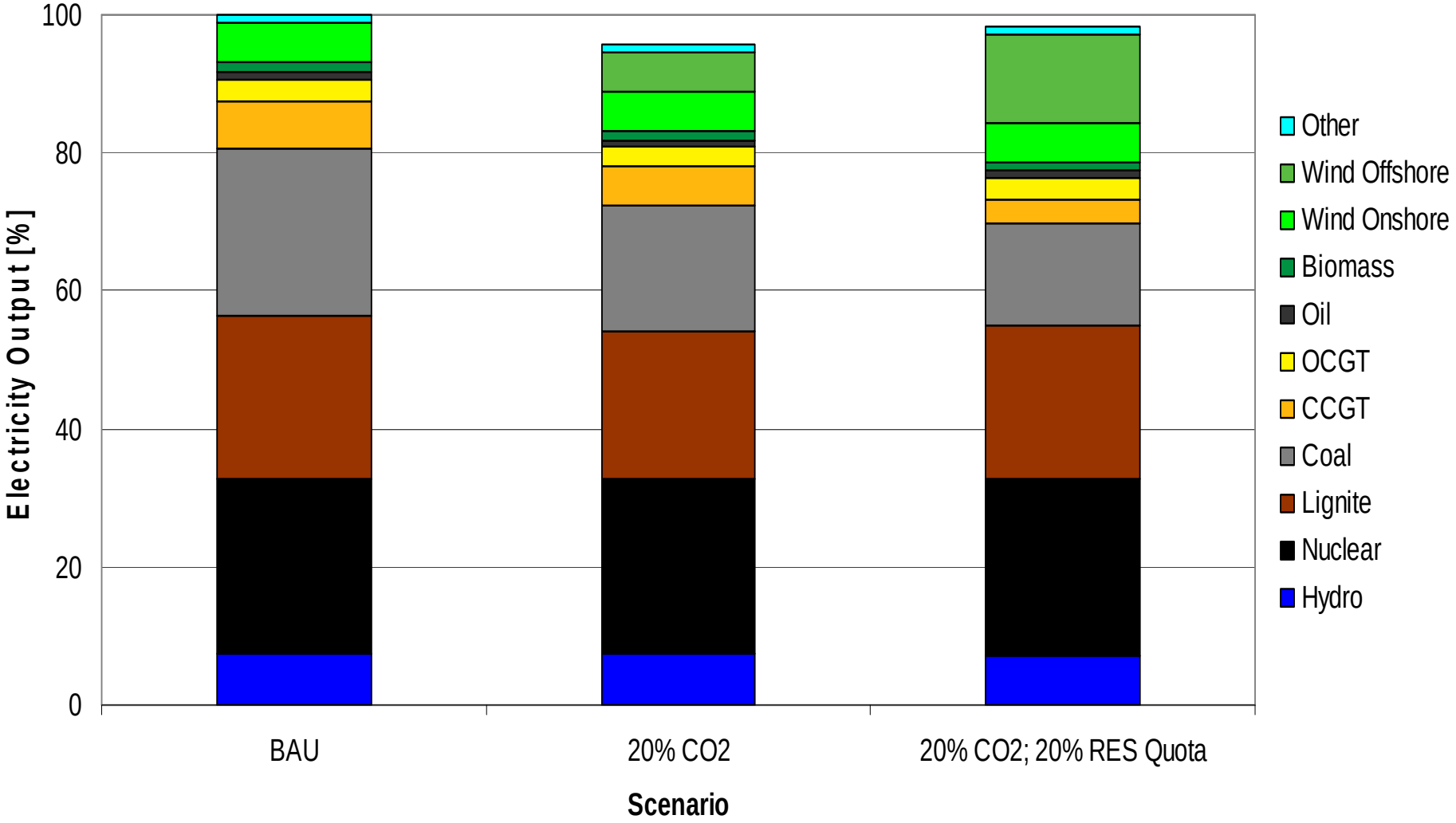
Common: Nuclear, hydro, other, and biomass are not allowed to increase

Results

	BAU	20% CO_2	20% CO_2; 20% RES Quota
Carbon Price (€/t CO_2)	**-**	**6.14**	**1.93**
Electricity Price	**100 %**	**+ 6.22 %**	**+ 2.21 %**
Electricity Output	**100 %**	**- 4.18 %**	**- 1.76 %**
Share of RES (without hydro)	**7.04 %**	**13.41 %**	**20 %**
Welfare (% Hicksian Equivalent Variation)	**100 %**	**- 0.008 %**	**- 0.011 %**

- **Lower price increase and output decrease with RES Quota**
- **Higher welfare loss with RES Quota due to technology mix**

Results – Technology Mix



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Conclusion

We analyzed the interaction of tradable carbon permits and renewable electricity generation

Compared to only carbon regulation case, RES quota causes

- Additional welfare loss
- Decreasing carbon permit and electricity price
- Increasing electricity output

Additional welfare loss of RES quota can not be justified by carbon regulation

However, static analysis: in a dynamic setting learning effects might decrease the cost of carbon regulation ➔ Justification of RES quota

Thank you very much for your attention!

Any questions or comments?

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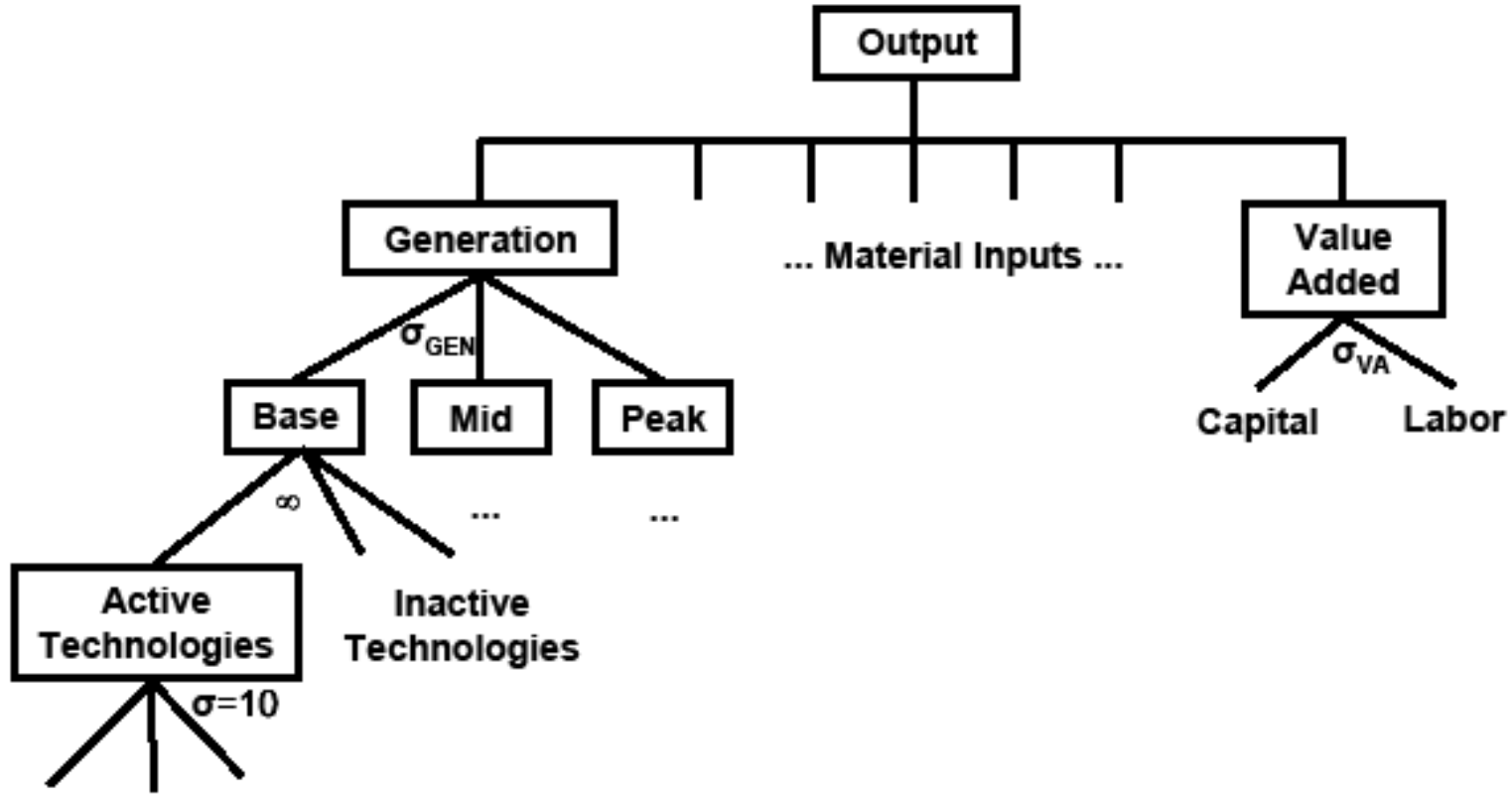
Back Up – Model Structure – Electricity Sector



Back Up – Model Structure Production