

Project Workshop *Green-X* Renewable Energy House, September 23rd 2003, Brussels

Green-X



The Dynamic Computer-model Green-X

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Overview

Introduction

State of the art – international simulation tools

Overview of the computer-model Green-X

Illustration of the computer-model Green-X



Green-X

Introduction

- The dynamic toolbox Green-X represents the main product of the project Green-X
 - A database, allowing dynamic changes and calculating potentials and costs of RES-E, CHP and conventional power
 - A dynamic computer model Green-X integrating RES-E, CHP generation, conventional electricity production and the most relevant demand-side activities
- The computer model allows a comparative and quantitative analysis of interactions between RES-E, CHP, DSM activities and GHG-reduction within the liberalised electricity sector both for the EU as a whole and individual Member States over time by simulating different scenarios



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Scenarios Output

- Advice on policy proposals at both EU and on national level e.g. to reach targets indicated by the EU RES-E Directive
- Demonstrate the consequences of a non-harmonised approach versus a harmonised RES-E policy
- Show the effects of *linked policies* for RES-E, CHP, important DSM activities and GHG-reduction versus separated and *individually adjusted strategies* for these areas, (demonstrating especially the impact on TGCs and GHG permits).
- Estimation of costs and benefits for the EU as a whole as for all 15 member states, producers and consumers.
- Recommendation for practical implementation of efficient strategies over time for each step



State of the art – international modelling tools

		linkage strategy for RES-E with					
		other RES-E technologies	liberalised electricity market	Demand- side activities	СНР	GHG- reduction	
statio	only tradable certificates	ElGreen, Rebus			IntraCert	IntraCert	
analysis	all relevant promotion strategies	ElGreen					
	only tradable certificates	ReCert			EcoCert		
dynamic analysis	all relevant promotion strategies	SAFIRE, Admire Rebus Green-X	Green-X	Green-X	Future Cogen Green-X	Green-X	



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Overview computer-tool Green-X



Results Costs and Benefits on a yearly basis (2000-2020)



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Country Selection

Individual countries or whole group of countries

EU-15 Member States

EU 10+ Accession Countries -- extended version

EU Candidate Countries (BU, RO, TR) -- extended version

Other European countries (CH, NO) -- extended version







Technology Selection

Considered Technologies						
Electricity generation						
10 (17) RES-E technologies						
4 (5) Thermal and nuclear power plants						
Combined heat and power generation						
4 (8) RES-E technologies						
3 (4) Thermal power plants						







Power generation (Database)

Cost-resource curve for each technology in each country





Electricity demand reduction (Database)







Policy strategy selection

Considered promotion strategy
General tax
Energy tax
Environmental tax
Electricity generation
Price-driven strategies
Capacity-driven strategies
Combined heat and power
Price-driven strategies
Capacity-driven strategies
DSM instruments
Climate Policy





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Social Behaviour

Individual behaviour can be selected per technology country and year

Investment decisions of investors (interest rate)

Technology

Policy instrument

Planning horizon / policy design

Strategic behaviour investors (tendering, bidding)

Social behaviour consumer (WTP green electricity)







Framework Conditions / Database

Different Scenarios available per country and year
Demand forecast
yearly electricity demand
yearly heat from CHP
peak demand electricity
reserve capacity
Price elasticity
Availability factor of each technology (yearly volatility)
Import / export restrictions electricity trade
Dynamic parameter restrictions
Technology cost forecast / learning factors
Prices
Primary energy price







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Externalities

Economic market and policy assessment

Cost-resource curves

for each technology in each country



Technology / country specific support schemes

Incentives / Barriers Investor / consumer behaviour



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Simulation of market interactions

Analysis of various interactions between RES-E, power market, CHP support, GHG goals, and DSM activities

= > Possible market separations, clearing prices







Expected Results (1/3)

Results per country and year					
General Results					
Installed capacity per technology [MW]					
Total Fuel input [TJ]					
Total energy generation [GWh]					
Total electricity generation [GWh]					
Electricity generation per technology [GWh]					
National electricity consumption [GWh]					
Import / export electricity balance [GWh, % of gen.]					
Total CO ₂ -emissions [Mt-CO ₂]					





Expected Results (2/3)

Results per country and year						
Impact Producer						
Total generation costs [M€, €/MWh]						
Gen. costs electricity generation[M€, €/MWh]						
Gen. costs electricity per techn. [M€, €/MWh]						
Total producer surplus (PS) [M€, €/MWh]						
PS electricity generation [M€, €/MWh]						
PS electricity per techn. [M€, €/MWh]						
Total profit [M€, €/MWh]						
Profit electricity generation [M€, €/MWh]						
Profit electricity per technology [M€, €/MWh]						
Marginal generation costs per technology electricity gen. [€MWh]						







Results per country and year
Impact Consumer
Additional costs due to RES-E strategy [M€, €/MWh]
Additional costs due to CHP strategy [M€, €/MWh]
Additional costs due to DSM strategy [M€, €/MWh]
Additional costs due to CO ₂ -strategy total [M€, €MWh, €t-CO ₂]
Prices
Market price electricity [€/MWh]

Market price Tradable Green Certificates [€MWh]

Market price Tradable Emission Allowances [€t-CO₂]



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Illustration of the computer-model Green-X



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Value €/MWh		
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Energy policy instruments - Electricity

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5 % So of total generation	
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Target year 2010	
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Tradable permits for GHG emission	
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Penalty:	40 €/t CO2 International © Yes Target year: 2010
Base year: 1990	Market price: €/t CO2
Business	as usual (BAU)
European Union 15 European Union 10+	Candidate countries Other
	Reduction target % Penalty €/t CO2
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Heat			
Transport			
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Project name: IR-UK (isolated market) + RES IV

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🗙 Electricity - Country table - General



Current Year: 2005

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General Results			
Total Electricity Consumption within the Country	349.948,63	GWh	
Share of Total Electricity Consumption within the Country	100,00	%	
Total Electricity Generation within the Country	352.576,64	GWh	
Share of Total Electricity Generation within the Country	100,75	%	
Import		GWh	
Share of Total Electricity Generation within the Country		%	
Export	2.628,00	GWh	
Share of Total Electricity Generation within the Country	0,75	%	
Market price for Electricity	31,65	€ per MWh	
Total installed capacity	68.049,68	MW	
New installed capacity	4.273,89	MW	
Generator / Production			
Total Outcome from National Generation			
Additional Outcome due to selected Strategy / Strategies from National Generation			



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General Results			l I
Total Electricity Consumption within the Country	337.136,34	GWh	
Share of Total Electricity Consumption within the Country	100,00	%	
Total Electricity Generation within the Country	337.125,63	GWh	
Share of Total Electricity Generation within the Country	100,00	%	
Import	10,72	GWh	
Share of Total Electricity Generation within the Country	0,00	%	
Export		GWh	
Share of Total Electricity Generation within the Country		%	
Market price for Electricity	31,65	€ per MWh	
Total installed capacity	56.780,89	MW	
New installed capacity	4.818,50	MW	
Generator / Production			
Total Outcome from National Generation			
Additional Outcome due to selected Strategy / Strategies from National Generation			

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_ 🗆 🗵 X 🗙 Electricity - Country table - Technologies 2005 United Kingdom Ŧ Ŧ Select United Kingdom Total Amount Share of Total -Share of Total Total Amount of Electricity Electricity Total installed New installed ۰ of Electricity Electricity Generation Technology Generation capacity capacity Generation Generation new plants new plants GWh % GWh % MW MW 27.832,00 8,24 6.124,49 Renewable power plants 100,00 20.761,55 4.110,19 0,00 0,00 0,00 0,00 0,00 0,00 Biogas 0,00 0,00 0,00 0,00 0,00 0,00 Biomass Forestry products 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 Forestry residues Agricultural products 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 Agricultural residues 0,00 0,00 0.00 0,00 0,00 0,00 0,00 0,00 0,00 Biogenic fraction of waste 0,00 Geothermal electricity 0,00 0,00 0,00 0,00 0,00 Hydro power 4.930,83 1,46 0,00 0,00 1.507,90 0,00 Small scale (< 10MW) 594,81 0,18 0,00 0,00 181,90 0,00 Large scale (> 10MW) 4.336,02 1,28 0,00 0,00 1.326,00 0,00 Landfill gas 2.300,65 0,68 0,00 0,00 418,30 0,00 382,50 0,00 0,00 85,00 0,00 Sewage gas 0,11 Solar 9.736,54 2,88 1.752,83 28,62 14.668,95 2.640,79 Photovoltaic 9.736,54 2,88 1.752,83 28,62 14.668,95 2.640,79 0,00 Solar thermal 0,00 0,00 0,00 0,00 0,00 Tidal 0,00 0,00 0,00 0,00 0,00 0,00 Wave 0,00 0,00 0,00 0,00 0,00 0,00 • Wind 10.481,47 3,10 4.371,65 71,38 4.081,40 1.469,40 7.201,47 2,13 1.091,65 17,82 3.081,40 469,40 onshore 3.280,00 0,97 3.280,00 53,56 1.000,00 1.000,00 offshore •

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XIIX 🗙 Electricity - Time series - General x Total electricity consumption Ireland Select Total electricity consumption Total electricity generation Total electricity import/export Ireland Electricity generation from new plants Total installed capacity New installed capacity Electricity price ٠ ۰ [GWh] Total electricity consumption 40.000 30.000 10.000 0 2002 2003 2004 2000 2001 2005 • 7.201,47 1.091,65 17,82 3.081,40 469,40 onshore 2,13 3.280,00 3.280,00 53,56 1.000,00 1.000,00 offshore 0,97 • Project name: IR-UK (isolated market) + RES IV Current Year: 2005 🚮 Start 📗 🖸 🥭 😒 🕑 🖄 🔣 🖪 W Claus Huber EEG (... 🖾 Green-X Descriptio... 🛛 🎢 Unbenannt - Paint Green-X \z{{**4**},**__**,**0 0 0 0 0**





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Contact Details

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Project web-site:

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