

# **EUSUSTEL**

## ***European Sustainable Electricity; Comprehensive Analysis of Future European Demand and Generation of European Electricity and its Security of Supply***

### **WP5.2 „Comparison and Evaluation of Simulation Models and Existing Scenarios for Electricity Generation“**

#### **Draft Results for *ACROPOLIS***

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## 5.2 Evaluation of models and scenarios for ACROPOLIS (1)

Main focus of the study:

- *Application and comparison of energy models to assess the impact of energy technologies and policy measures on greenhouse gases emissions and on sustainability in a global system analysis perspective. (Horizon: 1995 to 2030)*

Models applied in study:

- 7 global models
- 3 regional models (Western Europe, Nordic Regions, EU-15)
- 5 national models (Italy, Canada, USA, Germany, The Netherlands)

Scenarios analysed beside Baseline:

- Renewable Portfolio Schemes and Green Certificates
- International Flexible Mechanisms
- Efficiency Standards
- Internalisation of External Costs

## 5.2 Evaluation of models and scenarios for ACROPOLIS (2)

Baseline assumptions and harmonised data:

- IPCC B2 scenario assumptions on population and GDP
- GDP development: 2.86 % per annum for 1995 - 2030
- Population growth rate: 1.13 % per annum for 1995 - 2030
- Energy prices are obtained from POLES simulations

EUR95/GJ	1990	2010	2020	2030
Gas (American market)	1.69	2.79	2.87	2.54
Gas (European market)	2.38	2.38	3.11	3.58
Gas (Asian market)	3.23	3.44	3.66	3.95
Oil	3.73	2.65	3.15	3.61
Coal	1.57	1.40	1.51	1.60

- Energy-environmental related policy until June 30<sup>th</sup>, 2001
- General discount rate: 5 %

## 5.2 Evaluation of models and scenarios for ACROPOLIS (3)

Scenario assumptions:

### 1. Renewables

- EU-15: 22 % share of electricity consumption in 2010
- USA: 27 % share of electricity generation in 2020
- Minimum targets for other regions based on IIASA – 550 ppmv

### 2. International Flexible Mechanisms

- Soft Landing Scenario - 550 ppmv CO<sub>2</sub> concentration by 2150
- Annex B countries continue after first commitment period
- Non-Annex B countries targets based on GDP per capita and populations projections
- Hot Air from Russia and eastern Europe – only 50% by 2010
- No banking
- No Clean Development Mechanism

## 5.2 Evaluation of models and scenarios for ACROPOLIS (4)

Scenario assumptions:

### 3. Efficiency Standards for regions and sectors

- Energy efficiency improvement (%) against baseline

Sector/Region	2010	2020	2030	2040	2050
<b>Power Sector</b>					
Western Europe	3.75	7.50	11.25	15.00	18.75
N.America	3.44	6.88	10.32	13.76	17.20
Japan	1.25	2.50	3.75	5.00	6.25
EEFSU and ROW	2.50	5.00	7.50	10.00	12.50
<b>Industry sector</b>					
OECD & EEFSU	2.50	5.00	7.50	10.00	12.50
Developing World	3.75	7.50	11.25	15.00	18.75
<b>Service &amp; Residential</b>					
OECD & EEFSU	5.00	10.00	15.00	20.00	25.00
Developing World	3.25	6.50	9.75	13.00	16.25
<b>Transport - Road transport (car)</b>					
Western Europe	2.50	5.00	7.50	10.00	12.50
N.America	5.00	10.00	15.00	20.00	25.00
Japan	1.40	2.80	4.20	5.60	7.00
EEFSU and ROW	2.95	5.90	8.85	11.80	14.75

## 5.2 Evaluation of models and scenarios for ACROPOLIS (5)

Scenario assumptions:

### 4. Internalisation of external costs for electricity generation

External cost per t of pollutant					
		NO <sub>x</sub>	SO <sub>x</sub>	particulates	CO <sub>2</sub>
average cost	/t	<b>7000</b>	<b>8000</b>	<b>14000</b>	<b>19</b>

	DESOX (%)	DENOX (%)	Dedust (%)	External costs (Eurocents/kWh)
<b>Coal</b>				
type 1	0	0	0	16.6
type 2	0	50	80	5.3
type 3	90	50	99.5	2.1
type 4	99	75	99.5	1.9
<b>Gas</b>				
boiler	-	0	0	2.8
combined cycle	-	90	90	0.3
<b>Biomass</b>				
	n.a.	n.a.	n.a.	0.3
<b>Nuclear</b>				
	-	-	-	0.5
<b>Wind</b>				
	-	-	-	0.1
<b>Solar</b>				
	-	-	-	0.1

## 5.2 Evaluation of models and scenarios for ACROPOLIS (6)

Models covering EU-15 or Western Europe with detailed representation of electricity generation sector:

- AIM
- DNE 21
- POLES
- MARKAL-Matters
- PRIMES

## 5.2 Evaluation of models and scenarios for ACROPOLIS (7)

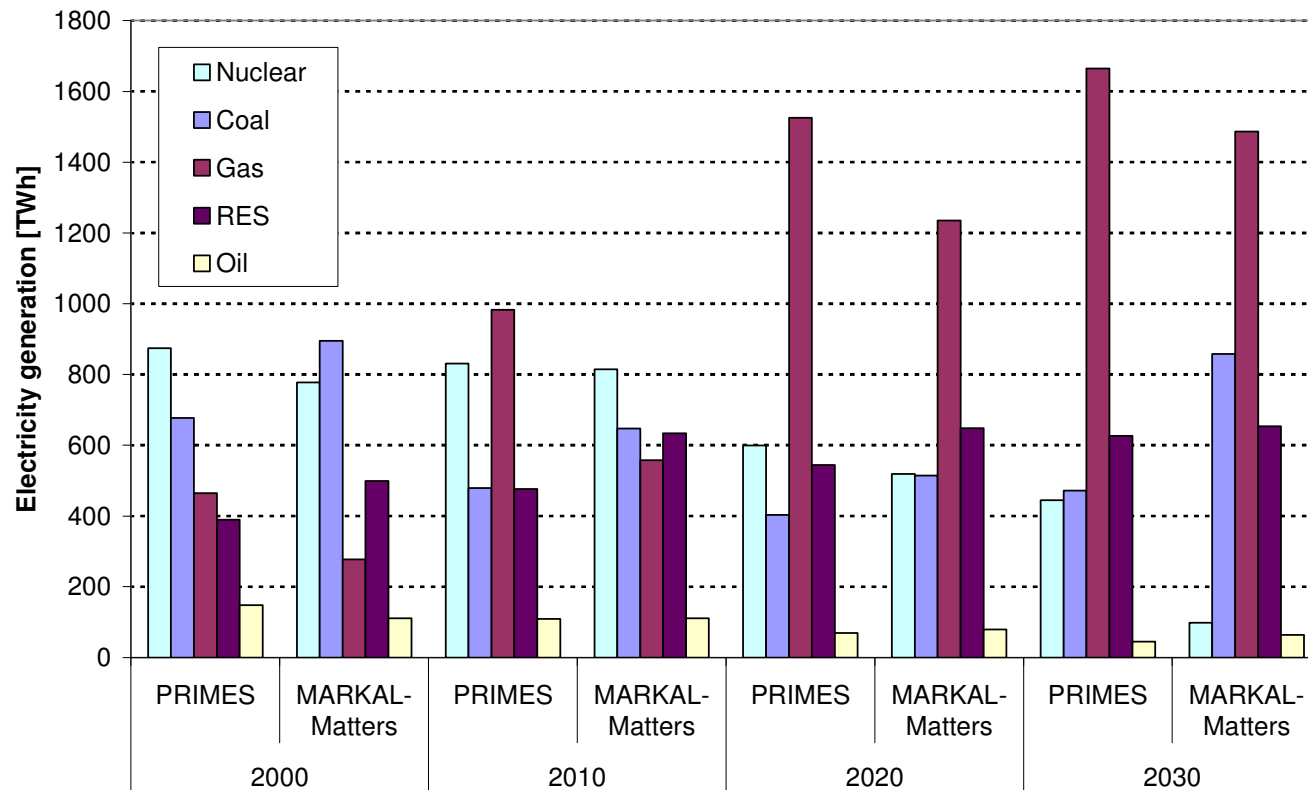
Exemplary model results of MARKAL-Matters for Baseline and RES:

Indicator	Fuel	Baseyear	2000	2010	2020	2030	
<b>Cost of Electricity Generation [Euro<sub>2000</sub>/MWh]</b>		28.04	21.70	37.47	42.02	41.25	
<b>Installed Electricity Generation Capacity and Production in Europe by Fuel</b>	<b>GW<sub>e</sub></b>	<b>Coal</b>	43.26	34.18	21.01	5.84	0.4
		<b>Gas</b>	26.45	45.92	37.13	41.76	31.64
		<b>Oil</b>	67.33	46.87	25.38	12.08	12.08
		<b>Nuclear</b>	118.41	126.66	124.03	78.99	15.09
		<b>RES</b>	168.86	186.19	215.49	218.58	220.44
<b>Installed Electricity Generation Capacity and Production in Europe by Fuel</b>	<b>TWh</b>	<b>Coal</b>	762.2	894.7	647.2	514.4	857.8
		<b>Gas</b>	118.6	277.0	557.6	1234.8	1486.1
		<b>Oil</b>	180.6	111.1	111.2	79.4	63.5
		<b>Nuclear</b>	701.9	777.8	814.9	519.0	98.8
		<b>RES</b>	455.4	499.2	633.5	648.4	653.4
<b>CO<sub>2</sub> Emissions by Electricity Generation [Mt]</b>		n.a	n.a	n.a	n.a	n.a	
<b>Share of Domestic Primary Energy Supply [%]</b>		55.8150	58.1477	50.4807	35.6193	32.0416	

Indicator	Fuel	Baseyear	2000	2010	2020	2030	
<b>Cost of Electricity Generation [Euro<sub>2000</sub>/MWh]</b>		28.04	21.66	33.50	34.32	42.39	
<b>Installed Electricity Generation Capacity and Production in Europe by Fuel</b>	<b>GW<sub>e</sub></b>	<b>Coal</b>	43.26	34.18	21.01	5.84	0.4
		<b>Gas</b>	26.45	45.92	35.87	70.13	64.98
		<b>Oil</b>	67.33	46.87	25.38	12.08	12.08
		<b>Nuclear</b>	118.41	126.66	124.03	78.99	15.09
		<b>RES</b>	168.86	187.19	280.42	334.31	400
<b>Installed Electricity Generation Capacity and Production in Europe by Fuel</b>	<b>TWh</b>	<b>Coal</b>	763.98	895.04	609.81	474.91	689.36
		<b>Gas</b>	118.59	273.91	464.24	935.52	1088.23
		<b>Oil</b>	180.56	111.11	106.84	79.39	63.53
		<b>Nuclear</b>	701.94	777.78	814.88	518.96	98.78
		<b>RES</b>	701.94	501.46	814.08	984.37	1163.06
<b>CO<sub>2</sub> Emissions by Electricity Generation [Mt]</b>		n.a	n.a	n.a	n.a	n.a	
<b>Share of Domestic Primary Energy Supply [%]</b>		55.82	58.21	52.20	39.56	38.03	

## 5.2 Evaluation of models and scenarios for ACROPOLIS (8)

Net electricity generation in Europe for the baseline: PRIMES: EU15 versus MARKAL-Matters: OECD90 WEU



## 5.2 Evaluation of models and scenarios for ACROPOLIS (9)

Domestic primary energy supply in Europe: PRIMES: EU15 versus MARKAL-Matters: OECD90 WEU

