Wind power in the EC RES2020 project

Wind power in technology-rich energy system optimisation models

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Wind power in technology-rich energy system optimisation models

1. Flow optimisation models
2. TIMES demo or calibration model
   - Stepwise development of calibration model
   - Implementation of wind power in TIMES
3. Wind Power Integration in Liberalised Electricity Markets
   - EU 5th Framework Programme: WILMAR
   - Three cases for wind integration in Scandinavia and Germany
   - Integration costs
4. RES2020 Project
   - Intelligent Energy – Europe (IEE)
   - EU RES Directives
   - Project overview
   - Modelling issues of RES2020
5. Conclusion for model development in RES2020

Flow optimisation models

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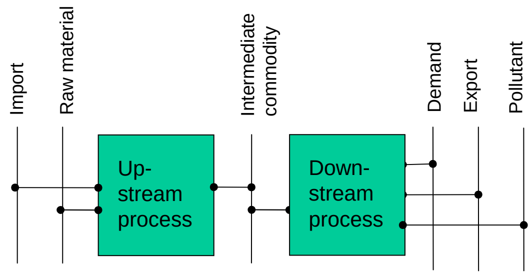
Variables:
Flows
Capacity investments

Objective function - options:
Min. total system costs
Max. contribution margin/utility

Constraints:
Demands
Commodity balances
Flow-capacity
Non-negative variables

Multi-period options
Myopic - period by period
Full foresight -
Discounted objective function



Basic parameters:
Initial capacities
Efficiencies
Prices

Optional parameters:
Price elasticities
Emission factors
Discount rate

Model systems:
Excel solver
EFOM
MESSAGE
MARKAL/TIMES
Balmorel

Selection of scenarios – Presentation of model results

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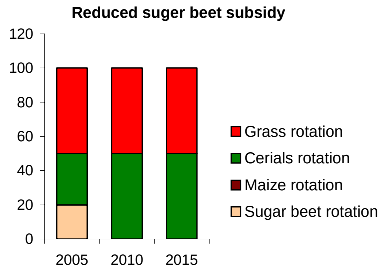
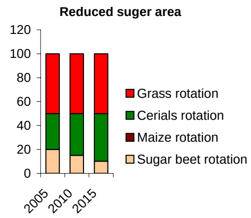
Current Scenario assumptions

	2005	2010	2015
Price index 2005=100		2010	2015
Sugar Beet		67	50
Sugar beet waste		100	100
Fodder crops		100	100
Straw		100	100
Seeds		100	100
Fertilizer		100	100
Plant protection		100	100
Mashine/labour cost		100	100
Max. % of area	2005	2010	2015
Sugar beet rotation	20	15	10
Cerial rotation	50	50	50
Other rotations	50	50	50
Discount rate	0.07		
Scenario name	Reduced suger beet subsidy		

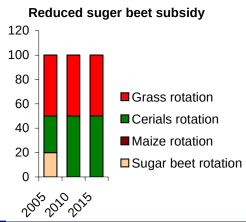


Archived results

Reduced suger area

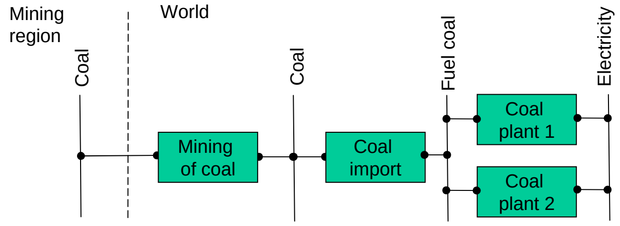


Reduced suger beet subsidy



Example of presentation from:
Crop rotation/Biomass module for TIMES
- implemented using the Excel solver.

TIMES: Four processes demo / calibration model



Start: Small demo model:

- GAMS file with sets and few data
- Two coal plants, import of coal
- Investment every year, plant lifetime: one year
- No time slices
- TIMES model running
- Excel user interface, results from Gdxviewer (GAMS tool)
- Excel solver model added

Stepwise development of calibration model

- Cost data from technology databases
- Residual capacities
- Plant lifetime
- Time slices, e.g. as NEEDS-TIMES
- Wind competing with coal or gas
- Test and calibration of technology, economic and system parameters
- Verification by comparing TIMES and Excel solver results

TIMES features for wind implementation

Objective function

- Investment costs (with taxes and subsidies)
- Fixed annual costs
- Variable annual costs – cost increase from wind
- Elastic demand – consumer response to spot prices (cost of demand reductions)

Time slices

- Contribution to peak demand
- 4 seasons: Spring, Summer, Fall, Winter
- 3 diurnal: Day, Night, Peak
- Additional time slices with wind availability: Full, average or no wind

Constraints

- Upper and lower limits for installed wind capacity and production
- Exogenous investments

Stochastic TIMES (Version 2.0, November 2005)

WILMAR: Wind Power Integration in Liberalised Electricity Markets

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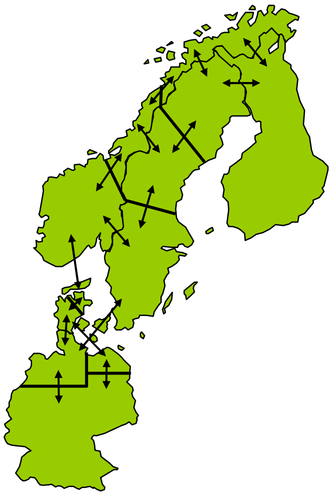
- EU 5th Framework Programme 2002-2005
- Description of the electricity system in 2010 with regional division to reflect spatial concentration of wind power and electricity demand and bottlenecks in the transmission system.
- Collection wind speed, wind power, hydro inflow, creation of stochastic models for wind power production
- Development of a strategic planning tool (hourly unit commitment model)
- Analysis of system stability (below one-hour time resolution)
- Analysis of emission-trading and green markets
- Distribution of the integration costs
- Dissemination: www.wilmar.risoe.dk
- New EU project: SUPWIND



WILMAR Planning Tool: Stochastic approach

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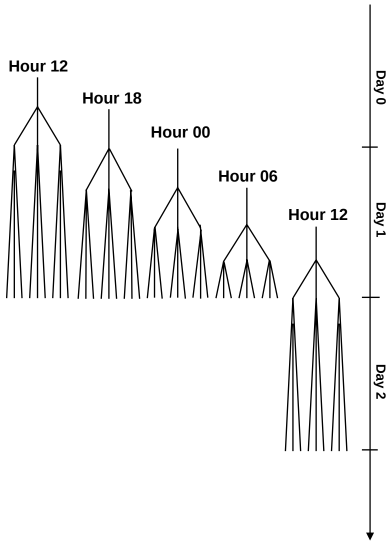
- Improve decision making by using information contained in scenario trees holding stochastic wind power production forecasts
- Information: Expected wind power production, but also precision of forecast, i.e. the distribution of the wind power production forecast errors
- Decisions before wind power is known: Trade on day-ahead market
- Decisions after wind power is known: Activation of regulating power



WILMAR Planning Tool: Calculation of integration costs

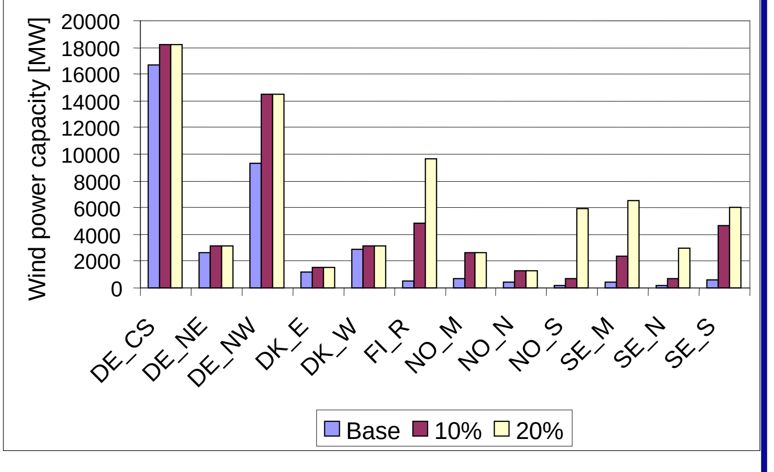
- The costs of integrating wind power are calculated by comparing variable system costs in two power system configurations:
  - with wind power production
  - with an alternative power production having “conventional” properties (predictable, less variable)
- The choice of alternative power production is not straight forward and will influence the resulting integration costs!
- Our choice: three model runs:
  - with stochastic wind power production forecasts
  - with perfectly predictable but still fluctuating wind power production
  - with constant wind power production
- Approach divide operational integration costs into two components:
  - costs related to partial predictability
  - costs related to variability

Wind power capacities for 3 WILMAR case scenarios

Base
- All: Forecasts for 2010

10 %
- DE+DK: Forecast for 2015
- FI+NO+SE 10 % of annual electricity demand

20 %
- DE+DK: Forecast for 2015
- FI+NO+SE 20 % of annual electricity demand



Operational costs induced by fluctuating wind power production in Germany and Scandinavia
Peter Meibom, Christoph Weber, Rüdiger Barth, Heike Brand, GreenNet-EU27 February 2006

Change of system operation costs per MWh wind power production

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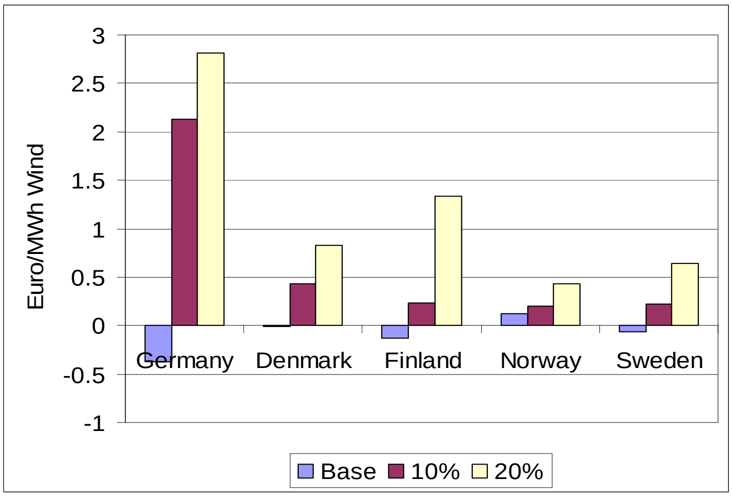
Conclusions

- Costs are lower in hydro dominated countries compared to thermal production dominated countries
- Costs increases when a neighboring country gets more wind power.
- Germany has the highest integration costs, but very unevenly distributed among regions.
- Denmark has the highest share of wind power among the countries, but also excellent excellent transmission possibilities to neighbouring countries



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RES2020 – Monitoring and Evaluation of the RES directives: implementation in EU27 and policy recommendations for 2020

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- EU research project within the programme “Intelligent Energy – Europe (IEE)”
- IEE funding 0.6 M€,
- Start October 2006, Duration 30 months,
- 14 partners, Coordinator; Center for Renewable Energy Sources, Athens, Greece

RES2020 aims at

- analysing the present situation in the RES implementation,
- defining future options for policies and measures,
- calculating concrete targets for the RES contribution that can be achieved by the implementation of these options and finally
- examining the implications of the achievement of these targets to the European Economy

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RES2020 - Workpackages

- **WP 1. Project Co-ordination** - CRES
- **WP. 2. Detailed description of RES framework for EU25 (and EU27**) - EREC
  Detailed description of the existing situation in EU25 (and EU27), regarding RES.
- **WP 3. Expansion of existing tools** - RISOE
  The TIMES model is being used in the framework of the NEEDS project, but it will need to be expanded and improved in order to include the modelling of RES in detail.
- **WP 4. Scenario Analysis** - ECN .
  A number of future options for policies and measures will be defined. These policies and measures will be studied with the use of TIMES.
- **WP 5. Future policy recommendations** - NTUA
- **WP 6. Dissemination – Regional workshops & Policy conference** - EREC
- **WP 7. Common Dissemination activities** – CRES
  These activities will consist of participation in workshops, meeting and conferences as well as providing documents and papers on request of the EC.

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Tasks in WP3: Expansion of existing tools

1. RES-E issues (coordination POLITO)
2. RES-Heat and Biofuels Issues (coordination ECN)
3. Development of the new templates for the Reference Energy System
4. Calibration and Testing

Outcome of this work package:

- Detailed description of renewable electricity, heat and biofuels in the energy system of the countries modelled.
- Extended country models with detailed representation of RES, both for electricity and heat production, and biofuels.

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NEEDS-TIMES model – improvements for RES2020

Harmonised national models:

- Starting from calibrated base year templates with no additional bounds and Adratios (user constraints).
- Bounds on selected technologies, e.g. nuclear, coal geothermal.
- Constraints on commodites in sectors, e.g. coal in residential sector,
- Further constraints

Reporting:

- Diagnostics tables in VEDA-BE (from KanORS)
- Reporting tables (from IER).
- Contents required for enhancement of national reports

RES2020 – Generic regional models

Decentralised/Distributed electricity:

- Subset of existing NEEDS-TIMES model
- Definition of generic regions, e.g. CHP regions, balancing of large wind capacity
- No or few additional technologies

Biofuels:

- Start from a subset of existing NEEDS-TIMES model
- Upstream processes for biofuels
- Possible additional technologies and commodities
- Definition of generic regions based on climate and potentials for biofuels.

Conclusion for model development in RES2020

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Generic sectoral / regional models

- Start: Small common model for biomass and distributed electricity
- Distributed electricity – with competition from central electricity and wind (POLITO and Risø)
- Biomass for heating and cooling (ECN)

National / Pan-European models

- Harmonised models developed within NEEDS RS2a for 29 countries – still pending
- Expanded after development and analyses of sectoral / regional models
- Exogenous development of wind capacity till 2020 as a first step