Improving the model of training – view from the outside

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Workshop to Exchange Experience among Trainers on the IAEA's Models for Energy System Planning

Vienna, July 2016

A. **Recent training process – how to maximize the long-term effect from new knowledge**

B. Sharing the experience from decision making process

C. Some experiments with self-training

Recent results of training activity – view from outside

Quantitative results are impressive:

- MESSAGE is distributed in near 40 countries
- Hundreds of people know about the model and have modeling skills (at different level)
- IAEA provides unique opportunities of free access to the model supplemented by well-developed the system of learning and training

But there is high risk at the country level that modeling skills will be dissappeared with a time

Trained people may stop to use MESSAGE and share the knowledge if they will lost scientific or/and financial motivation

To eliminate these risks, it is extremely important to integrate the model into the regular system of energy planning at the national/regional level.

Training courses may <u>partially</u> help to improve the attractiveness of the model to decision makers

How many people/teams use the MESSAGE on a regular basis as an investigation tool? Can this long-term effect of training be increased?

How the situation can be changed to make the model more attractive as a tool for the decision making process?

How to improve the competitiveness and credibility of the MESSAGE as a future investigation tool in the member states?

What can be done by PESS office
(taking into account labor and financial resources)

- Enhance capabilities of the model in new versions (e.g. cloud calculations)
- Improve the input-output interface (like for WASP and MAED)
- Finalize the model manual
- Provide the more (and more open) access to the training materials and simple cases
- Make the assistance tool (TSES) more effective in terms of faster reply.

What can be done during the training activity

- More attention to the enhanced trainings that allow to obtain and apply new skills to the real energy system planning tasks
- Focusing on the professional background and position of the trainees
- Speak more about the general energy planning issues to show the real role of the modeling
- Teach to present not the optimization results only but the model logic, rationale for the obtained optimal solutions as well as boundary and risks issues
- Extended application of the model to model other production chains outside of energy sector (A.Galinis 2015)

How to improve the competitiveness and credibility of the MESSAGE as a future investigation tool in the member states?

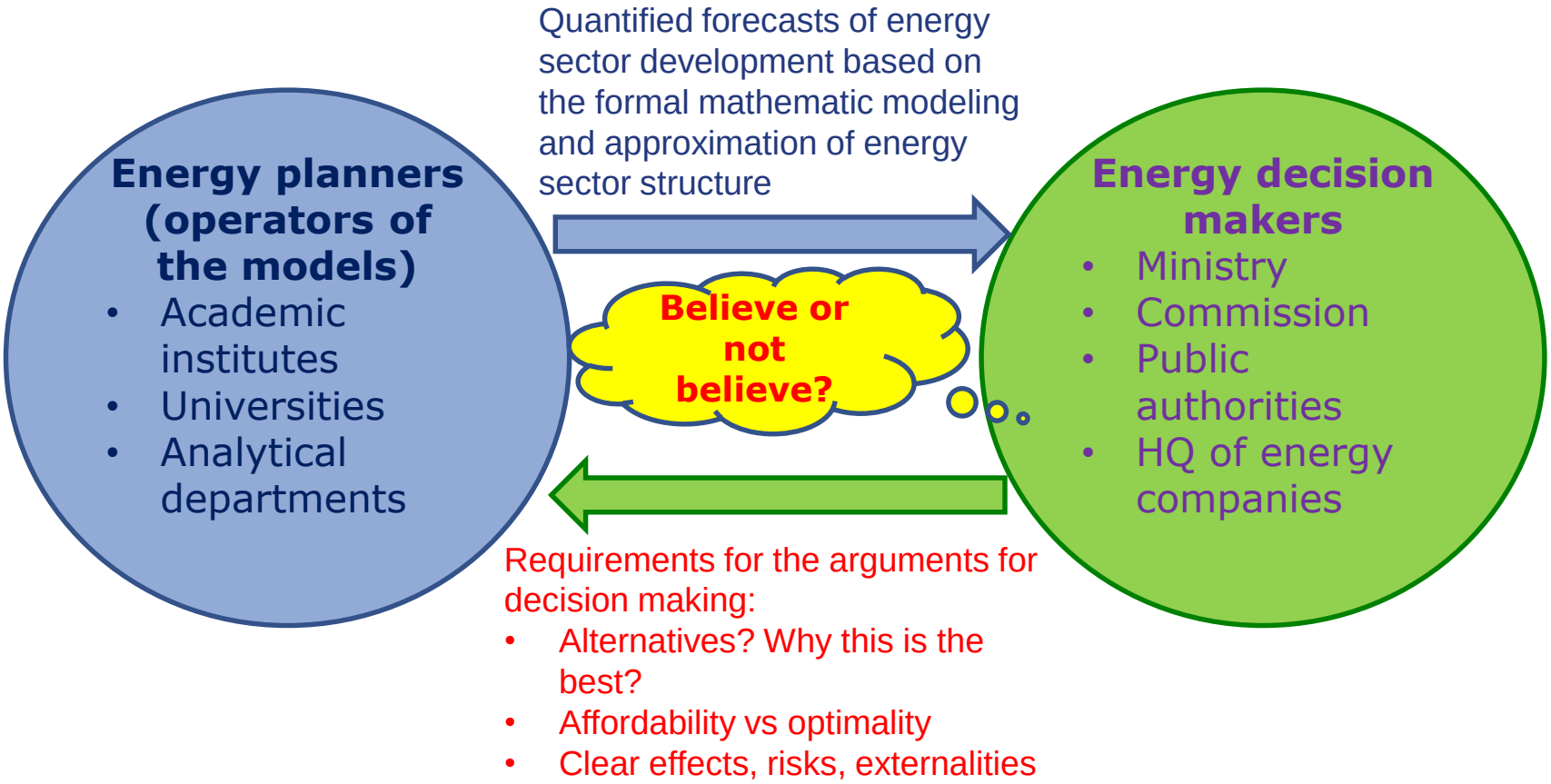
- E
- D

Speak not only about the model operation issues, but also about its logic as well as the nature of energy planning

- Model operator skills (start/run/cases/input /output/errors)
- Model data preparation and input skills
- Reference data and information resources
- Examples to improve experience
- Model mathematics, model and matrix structure
- Different technologies of system studies (multi-case analysis, sensitivity analysis, risk assessment, marginal cost analysis, etc.)
- "What if…" grounds for decision makers – how to make the results credible for them?

Building the bridge between energy modelers and decision makers

In may cases main problem is to overcome the gap between the energy planners and energy authorities/companies. It is critically important for the future maintaining of the acquired modeling capacity and its integration in the real decision making process. And it may be a part of training!



A. Recent training process – how to maximize the long-term effect from new knowledge

B. Sharing the experience from decision making process

- Simple economic comparison of energy technologies based on the discounted (or levelized) generation costs
- Multi-scenario analysis of the alternative investment strategies: savings of resources and impact on total costs of energy supply
- Analysis of price effects based on primal and dual solution

C. Some experiments with self-training

Staged approach to the generation capacity structure forecasting

Screening analysis of the typical decisions of existing plant rehabilitation and new construction options (selection of the preferred generating technologies)

Modeling tool	Criterion
Modeling tool – spreadsheet calculator of discounted costs of construction, operation and decommissioning	Criterion – per kWh discounted generation costs for each technology (LCOE, EGC)

It may be FINPLAN or simple spreadsheet calculator

System evaluation of energy balanced and economically efficient variants of power sector development (optimization of scales for preferred generating technilogies)

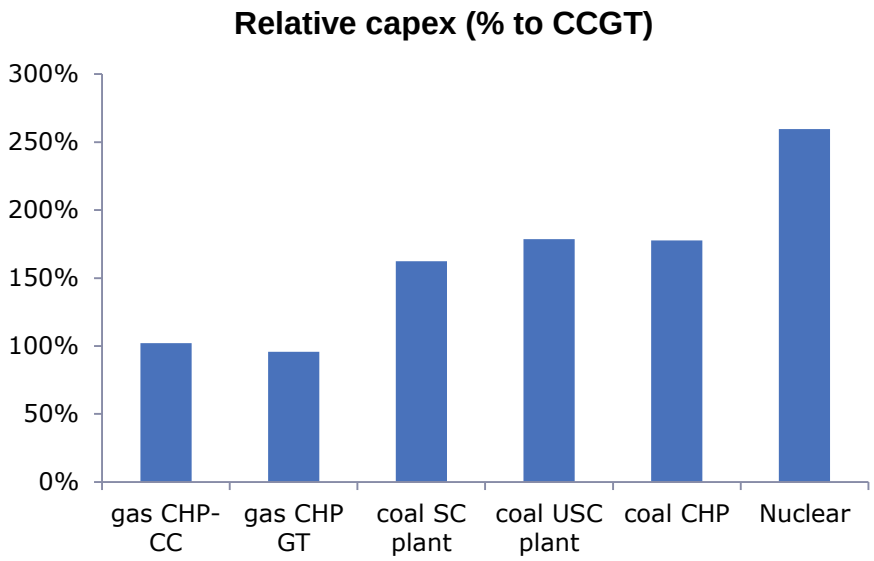
Modeling tool	Criterion
Modeling tool – long-term optimization model of power sector integrating all generating technologies and grid expansion (fuel supply as an option)	Criterion – minimum of total discounted costs of forecasted balance requirements supply in the planning period (+aftereffects in 15 years)

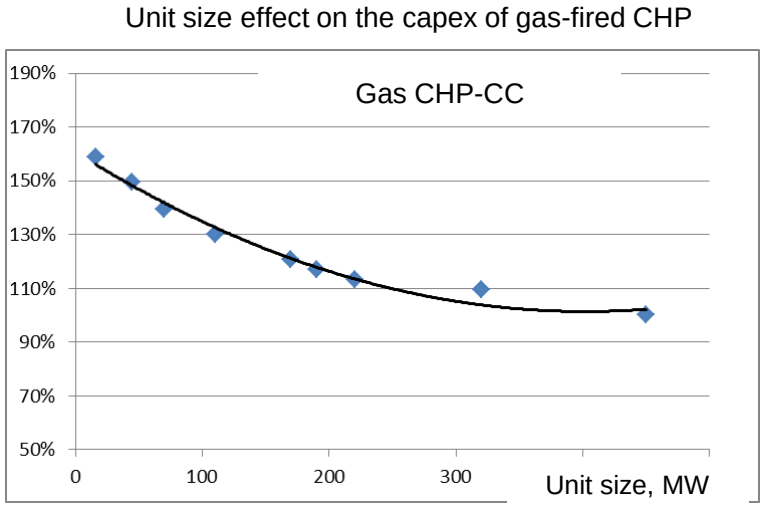
It may be MESSAGE or WASP

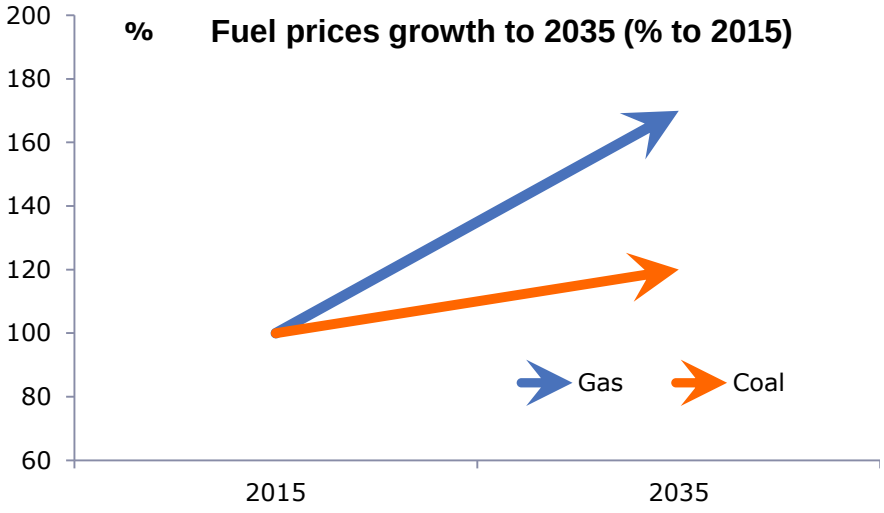
Formulation of the rational generation capacity structure variant

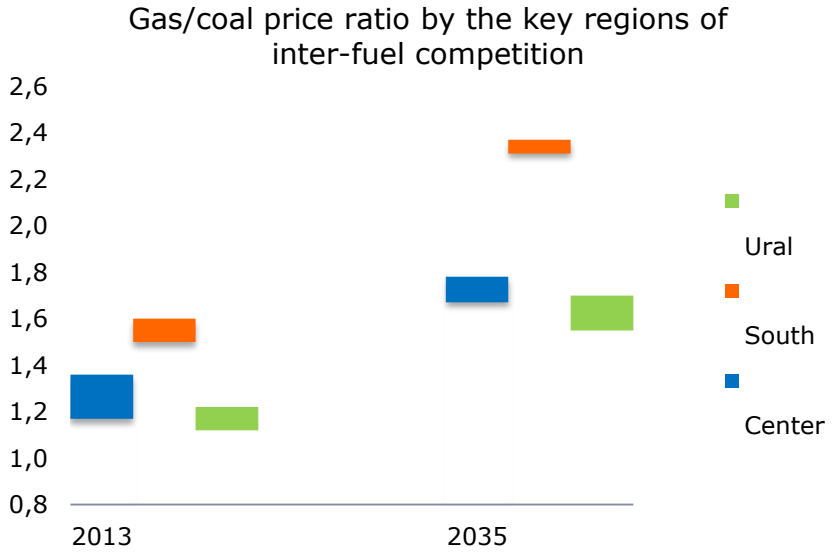
Modeling tool	Criterion
Modeling tool – simulation models for balance calculations, seasonal and daily operation of power system	Criterion – least deviations from optimal structure caused by the variants and costs of grid projects, system reliability constraints, unit capacities, predefined (must be built) projects as well as fuel and capital resource limitations

Input data: cost and price ratios are more important rather than values



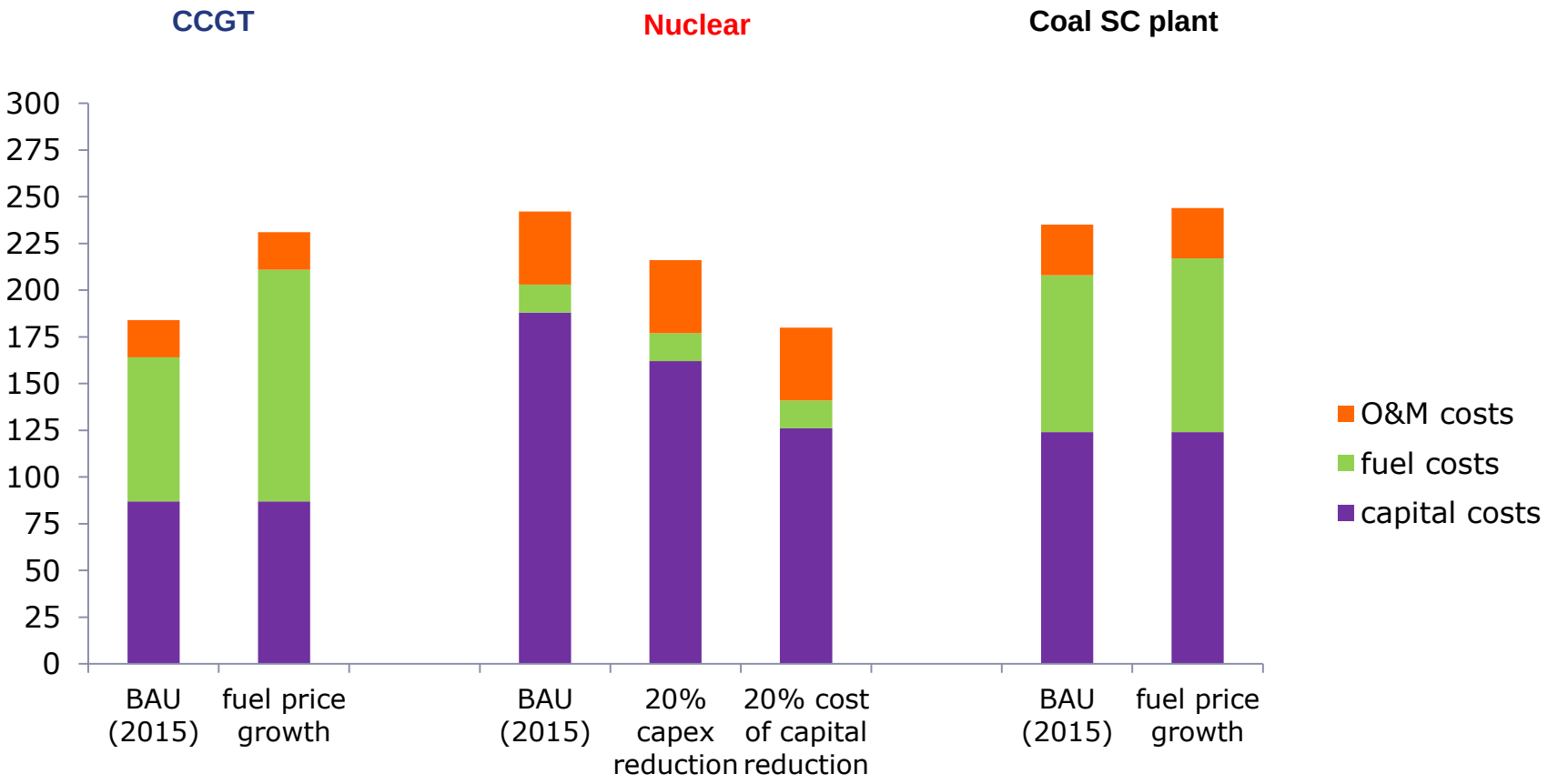






Cost-based screening analysis: inter-fuel competition between conventional plant types

Changes of electricity generation costs for new generation capacity options (Center integrated power system), 0,01 RUR/kWh

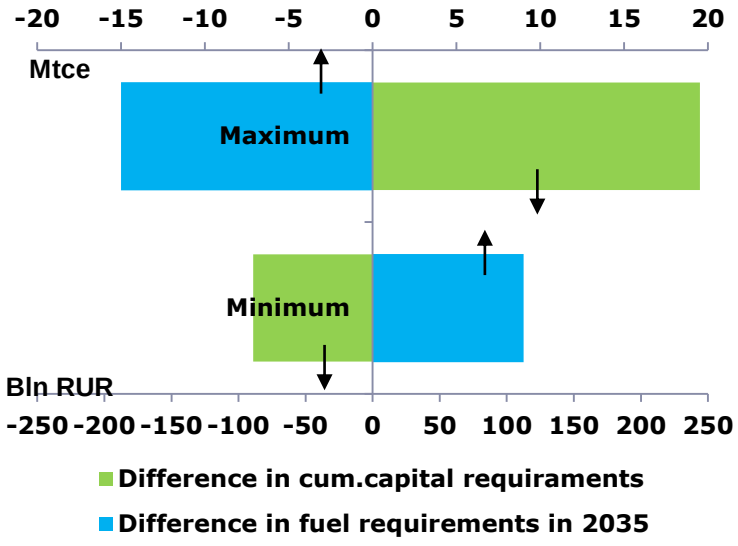


Assessment of the alternative nuclear generation development strategies

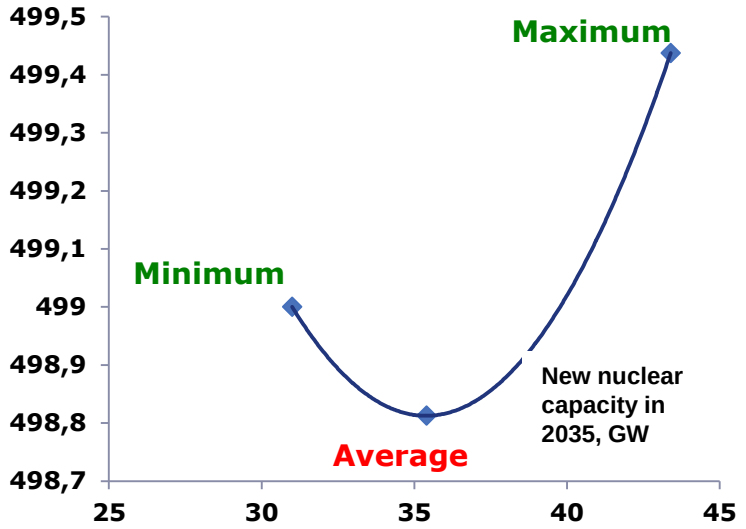
Nuclear development strategies

Strategy	Content	Nuclear capacity to 2035, GW
Minimum	Substitution of existing units only	**31**
Average	Substitution of existing units and new additions limited by the balance conditions	**35.4**
Maximum	100% performance of Rosatom roadmap	**43.4**

Changes in the fuel and capital requirement options (Δ from Average strategy)

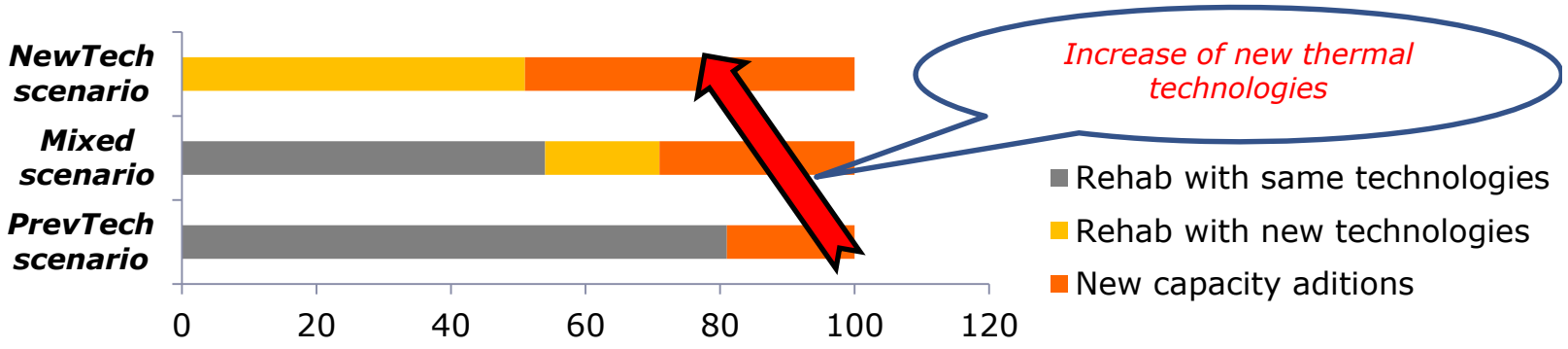


Change in cumulative discounted energy supply costs for different nuclear development strategies, bln USD

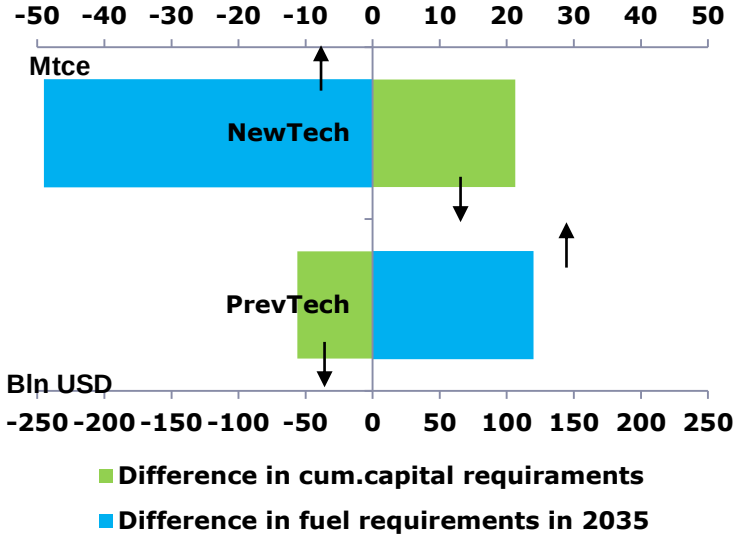


Assessment of the alternative thermal generation rehabilitation strategies (resource/cost saving estimations from modeling)

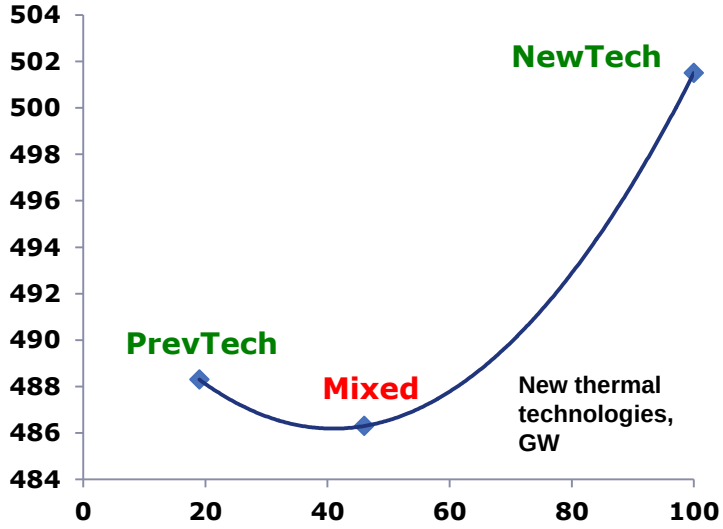
Thermal capacity additions by the rehabilitation scenarios, GW



Changes in the fuel and capital requirement options (delta from Mixed scenario)

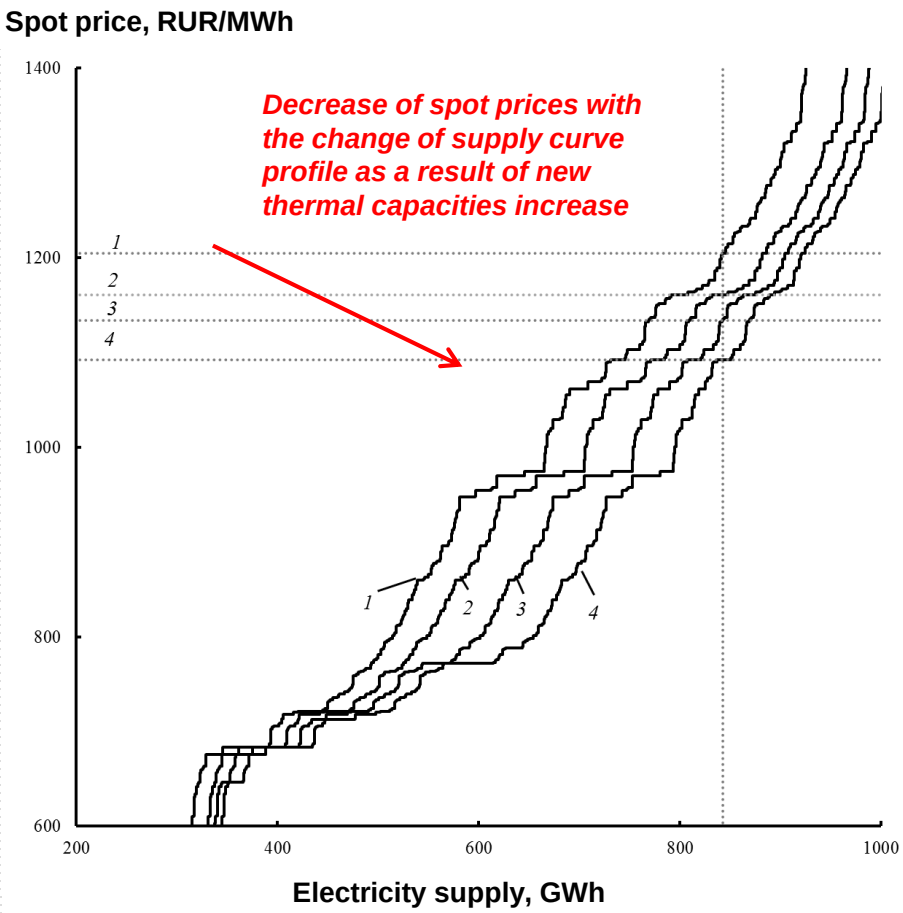


Change in cumulative discounted energy supply costs for different thermal plants rehabilitation scenarios, bln USD



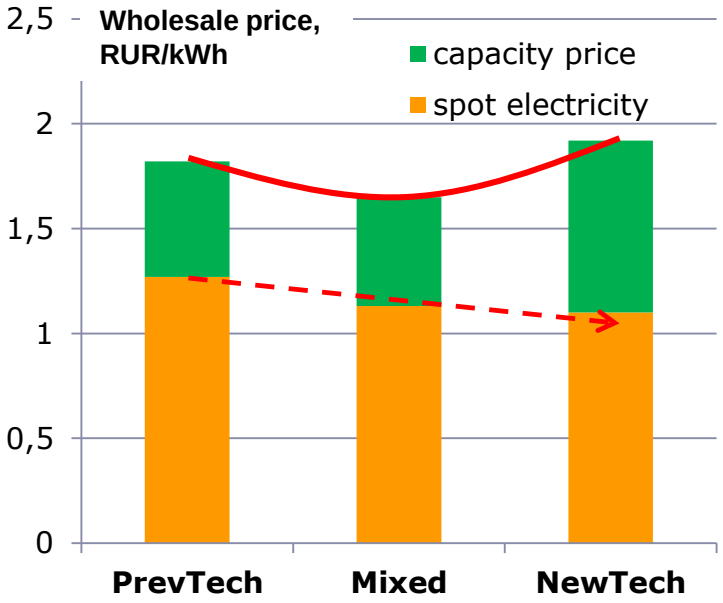
Assessment of the alternative thermal generation rehabilitation strategies (prices estimation based on economic analysis of model primal and dual solution)

Increasing volumes of new thermal capacities with lower heat rates (and fuel costs) will change the supply curve and tend to lowering spot electricity prices. But this effect must be compared with the change of capacity payments.



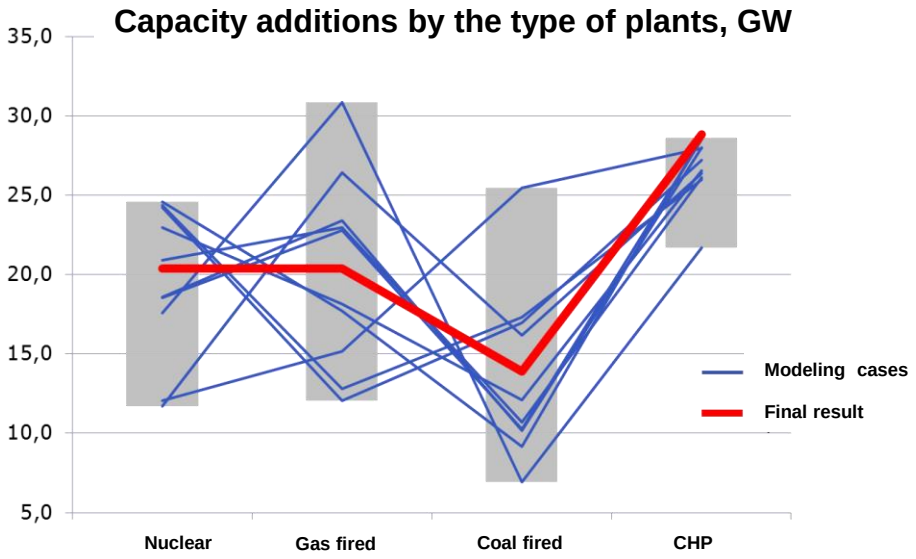
How to estimate price impacts:

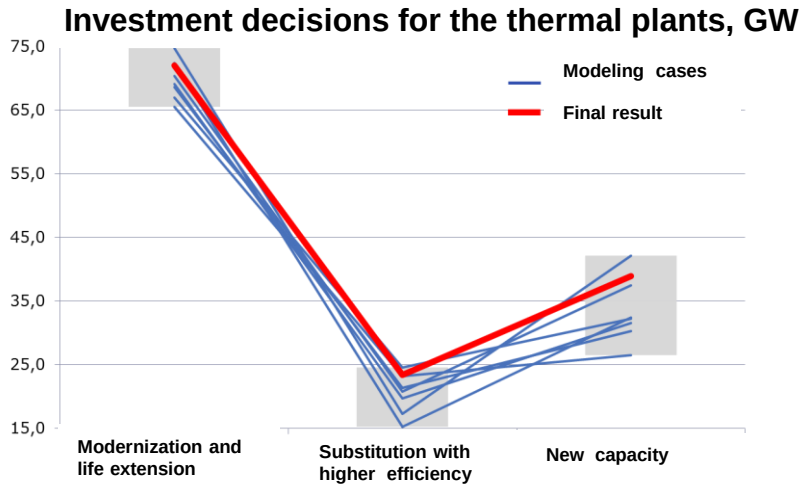
- **Spot electricity prices – reduced costs of electricity supply constraints (marginal cost of electricity supply)**
- **Capacity payments – fixed O&M costs and capital charge rates from the model cost function**

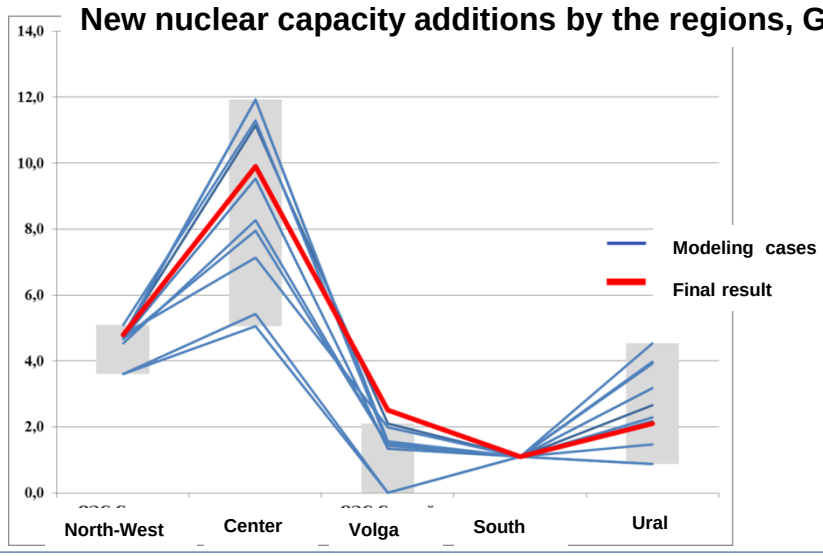


Multy-case optimization of the generating capacity structure

	Upgrade of existing thermal capacities	Development of co-generation	Development of new thermal and nuclear plants
Variable factors	❑ Fuel prices ❑ Capital costs of upgrade projects ❑ Electricity demand ❑ Investment stimulation for upgrade	❑ Fuel prices ❑ Capital costs of new CHP and boilers ❑ Heat demand ❑ Stimulation of distributed generation for substitution of existing boilers	❑ Fuel prices ❑ Capital costs of new nuclear, gas and coal plants ❑ Electricity demand ❑ Alternative regional location of greenfield plants
Number of modeling cases	10	8	11

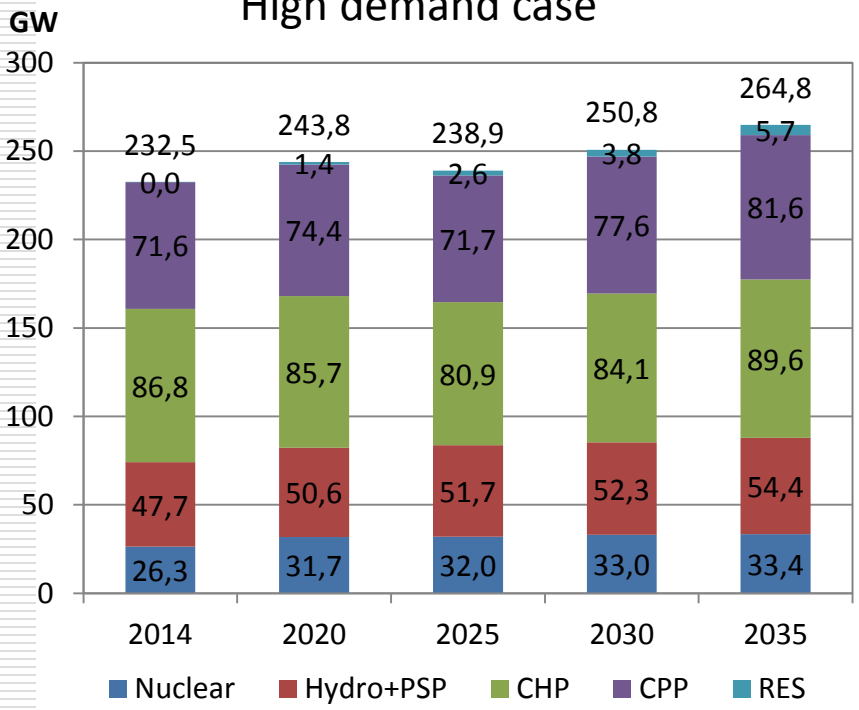






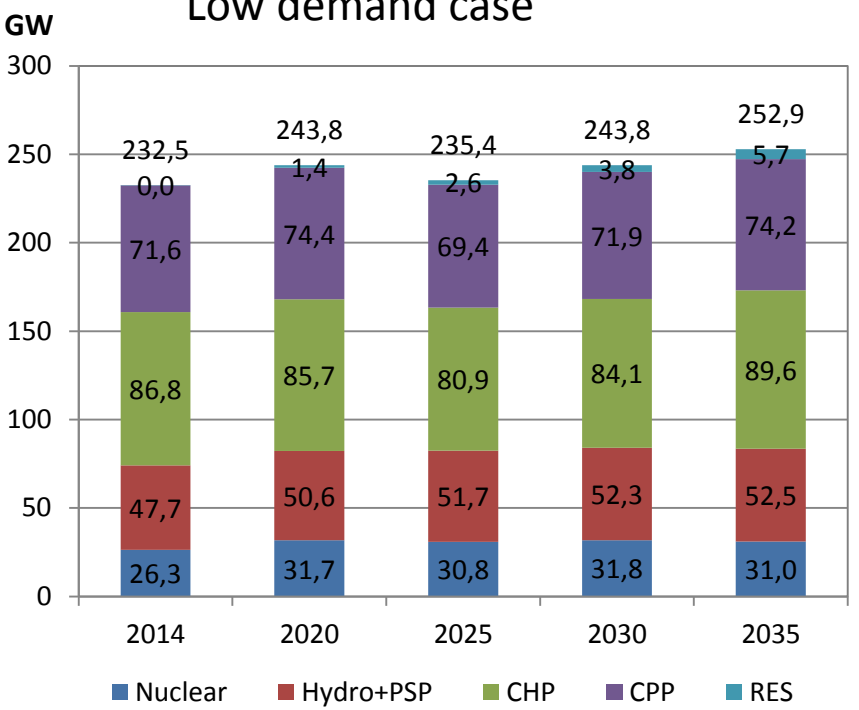
Installed capacity structure (Unified power system)

High demand case



	2014	2020	2025	2030	2035
Nuclear	11,3%	13,0%	13,4%	13,2%	12,6%
Hydro+PSP	20,5%	20,7%	21,6%	20,9%	20,6%
CHP	37,3%	35,2%	33,9%	33,5%	33,8%
CPP	30,8%	30,5%	30,0%	30,9%	30,8%
RES	0,0%	0,6%	1,1%	1,5%	2,2%

Low demand case



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Hydro+PSP	20,5%	20,7%	22,0%	21,5%	20,8%
CHP	37,3%	35,2%	34,4%	34,5%	35,4%
CPP	30,8%	30,5%	29,5%	29,5%	29,3%
RES	0,0%	0,6%	1,1%	1,6%	2,2%

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Step-by step self-training

Recent experience in:	Irina	Tatiana	Andrey
			
- Power sector economics	Good (master degree)	Good (master degree)	Good (master degree)
- Power sector balances	Good skills, key expert	None	Good skills, key expert
- LP-modeling experience	None	None	Good, creating similar models

Step-by step self-training

Educational resources:

- Initial e-learning course (5 days)
- MESSAGE manual (2008 version)
- Some presentations from IAEA and Internet

Single region case

- Plant data input
- Electricity and heat demand constraint
- Modeling plant operating modes (also CHP)
- Modeling capacity decrease/addition
- Modeling installed capacity requirements

Extension to the multi-region case

- Integration of data from single cases
- Modeling the transmission lines and electricity exchange

Add load region options

- Presenting the hourly load data in the best way (aggregation into load regions)
- Modeling the seasonal/daily variations of supply/demand options

Extension to the whole energy sector

- Developing the full-scale multi-regional energy model
- Modeling the inter-fuel and technological competition

Step-by step self-training

Direct purpose – to enhance the experience of young scientists and obtain (or improve) their modeling skills

Indirect purpose – to estimate how easily specialists can learn the MESSAGE and use it in their practice – starting from zero and without regular external assistance

General estimation – it is possible, but the way is not very straight and clear:

- ✓ E-learning (english version) is rather comprehensive and useful as a first step

But after…

- ✓ Manual is detailed but not finished: in some very important parts there are ??? Instead of explanations/examples.
- ✓ Parameters are often not explained clear and in formulas – sometimes it is necessary to
  - ✓ make several iterations to change the value or combination and later understand how the model understand the user choice
  - ✓ read the matrix directly to see on row and columns and find the sense of parameters from that side
- ✓ More tested examples are required: it is easier to see and repeat instead of “invent a new bicycle” again.

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Thank you for attention!