Modeling Framework for Designing Strategic Scenarios: Report for 2013 Research Period

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Agenda for the Day

- Summary of the achievements in 2013
- Highlights of the supply side modeling
- Highlights of the demand side modeling
- Discussion of scenario assumptions and interactive session

Achievements in 2013
Institutional

- Technical group has been formed
  - Composed of top experts in E3 modeling with proven track record
  - Can operatively generate traceable answers to policy-relevant questions in the context of the scenario field
- New format of discussion suggested and demonstrated: from debating about singular resulting trajectories or even figures to constructive alternative ways to achieve a certain state
- Regular participation of the group in the key meetings and start of methodological cooperation with the EC teams involved in modeling
  - Pre-GAC and GAC meetings in 2013
  - Technical workshop on 21 October in Vienna

Achievements in 2013
Methodological

- Concept of ‘strategic scenarios’ clarified
  - Practical positions supported by holistic experiments
  - Adaptation of modern achievements in science
- Demand Side Modeling model ECHO introduced
  - Currently a balancing/accounting tool
  - Roadmap includes partial integration into MESSAGE
- Supply mode MESSAGE used for the study in 2012 significantly extended
  - The process coverage deepened to *resources* on the supply side and to *useful energy* on the demand side
  - The inter-regional links were significantly improved in the basic 4-regional model of the EU-28

Achievements in 2013
Case Studies

- A real booster to the research was the case studies recommended by GAC co-chairs
- Although yet without definite target audience, they allowed to demonstrate the strength of the concept in number of areas
- Typical ‘messages’ and areas of concern were generated as a part of conclusions

Technical Group: Goals

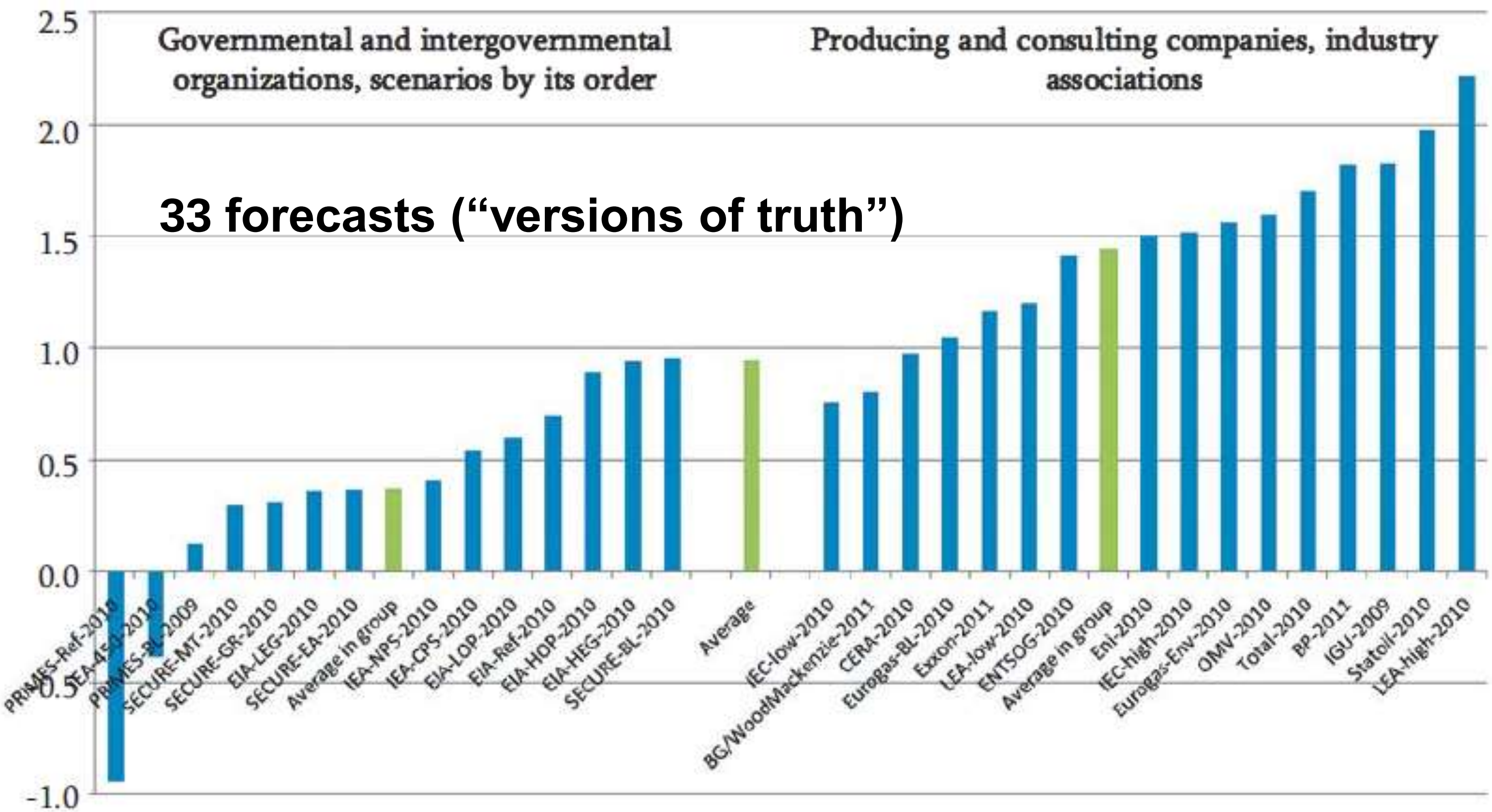
- Motto
  - To design, maintain and promote the Modeling Framework for Generating Strategic Scenarios
- Goal
  - To broaden the vision of experts and policymakers in analyzing scenarios of achieving certain targets
  - To reveal invisible or non-trivial outcomes
- Purpose
  - Analysis of the consequences of certain energy policy targets
    - e.g. “what is the cost of compliance of ‘20-20-20’ from the perspective of energy industry and end users?
  - Generation of messages as decision support aid
    - e.g. “Russia shall support any EU initiatives targeted at CO_2 reduction or RES promotion for they remove the competition from coal and position gas as transitional fuel”
  - Form a basis for Early Warning System

Technical Group: Approach

- Means
  - Tools: MESSAGE model for modeling supply, ECHO model for modeling demand side
  - Connection point to real world: Baseline (Reference) scenario, which is based on the common exogenous assumptions sources (Eurostat, IEA/OECD, Enerdata, DG Energy scenarios)
  - Exercise: Calibration of Reference scenario, simulation REF alternatives on the basis of Case Studies
- Method
  - Empirical sensing of the states and trajectories in the scenario field

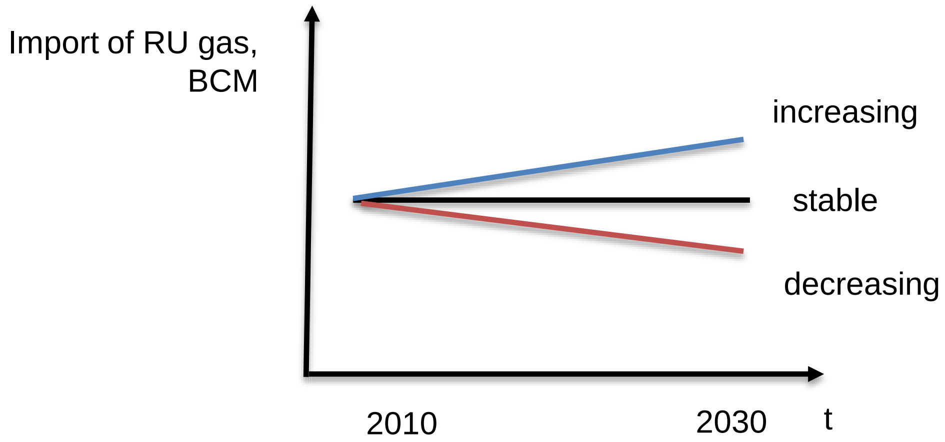
Strategic Scenarios

- Strategic Scenario – is not a forecast and not another “version of truth”. The field of strategic scenarios is intended to support the decision making.



Case Studies

- Reveal what combination of driving factors will lead to the following dynamics of Russian gas imports in the EU



Driving Factors

- The initial list of potential driving factors morphed into a list of 4 categories of most influencing events and dynamic indicators through trial and error simulations and from considerations of reasonability
    - Structure and growth of the EU economy;
    - Demographics, age structure and immigration;
    - Technology change and innovation;
    - Availability of shale gas and other unconventional gases;
    - Emergence of new LNG exporters;
    - New conventional gas discoveries (e.g., Mediterranean Sea between Cyprus and Israel, off-shore Red Sea);
    - Energy prices and subsidies (feed-in tariffs)
    - EU energy efficiency policy at the level of end-use (building stock refurbishment, new building codes, new efficiency standards);
    - EU renewables and nuclear energy policies;
    - Potential impacts of policy driven mega-projects a la DESERTEC;
    - EU environmental regulation and new internationally binding environmental agreements (under the United Nations Convention on Climate Change - UNFCCC) resulting in stringent greenhouse gas emission limitations;
    - Carbon trading schemes and carbon pricing;
    - EU energy security policy;
    - National energy legislation - e.g., banning fossil fuels for thermal energy purposes in buildings in Denmark, new building codes, subsidies for renewables and electric vehicles all of which have implications for final energy demand;
    - Natural gas as the peaking fuel in an electricity supply system dominated by intermittent renewables - a logistic challenge to fill the pipeline;
    - Social preferences, behavioural changes and perception of risks and benefits.

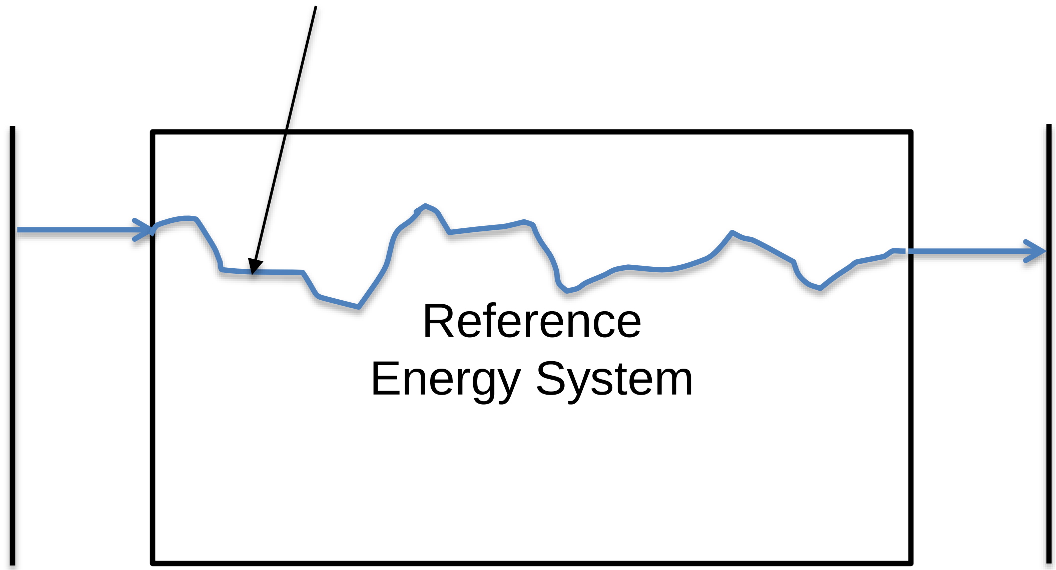
- Import energy prices
- Socio-economical: GDP, economic activity, lifestyle
- Resource availability and geopolitics
- EU regulation: CO_2, RES and Security

Reference Scenario

2012

Calibration/screening: How can this link be achieved?

Input:
Primary
Supply



Output:
Final Demand

Transformation technologies
Energy Sources
CO_2 and other constraints
Levels of transformation

Common sources:
Eurostat, Enerdata,
IEA/OECD,Platts,
assumptions from PRIMES

Reference Scenario

2013

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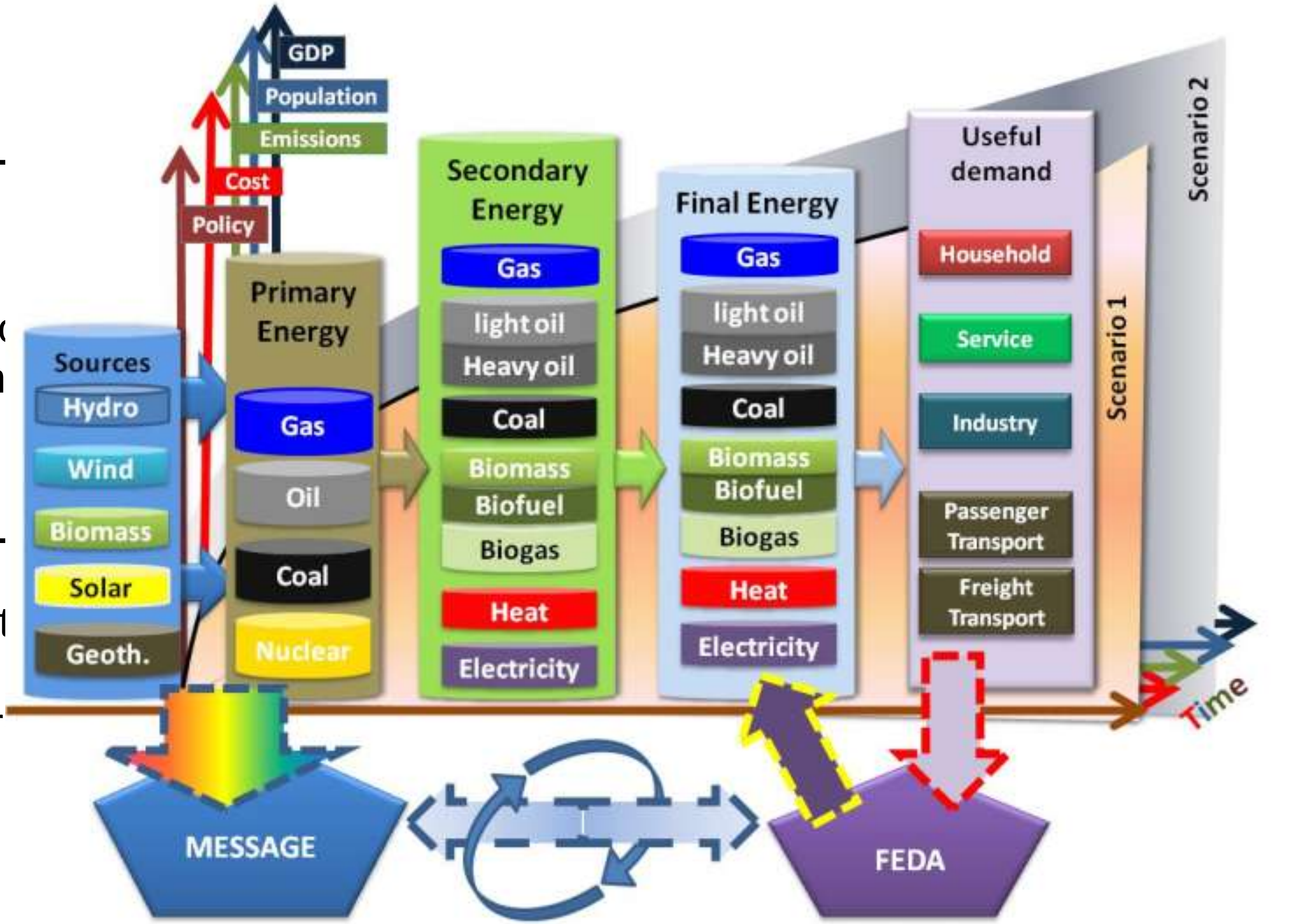
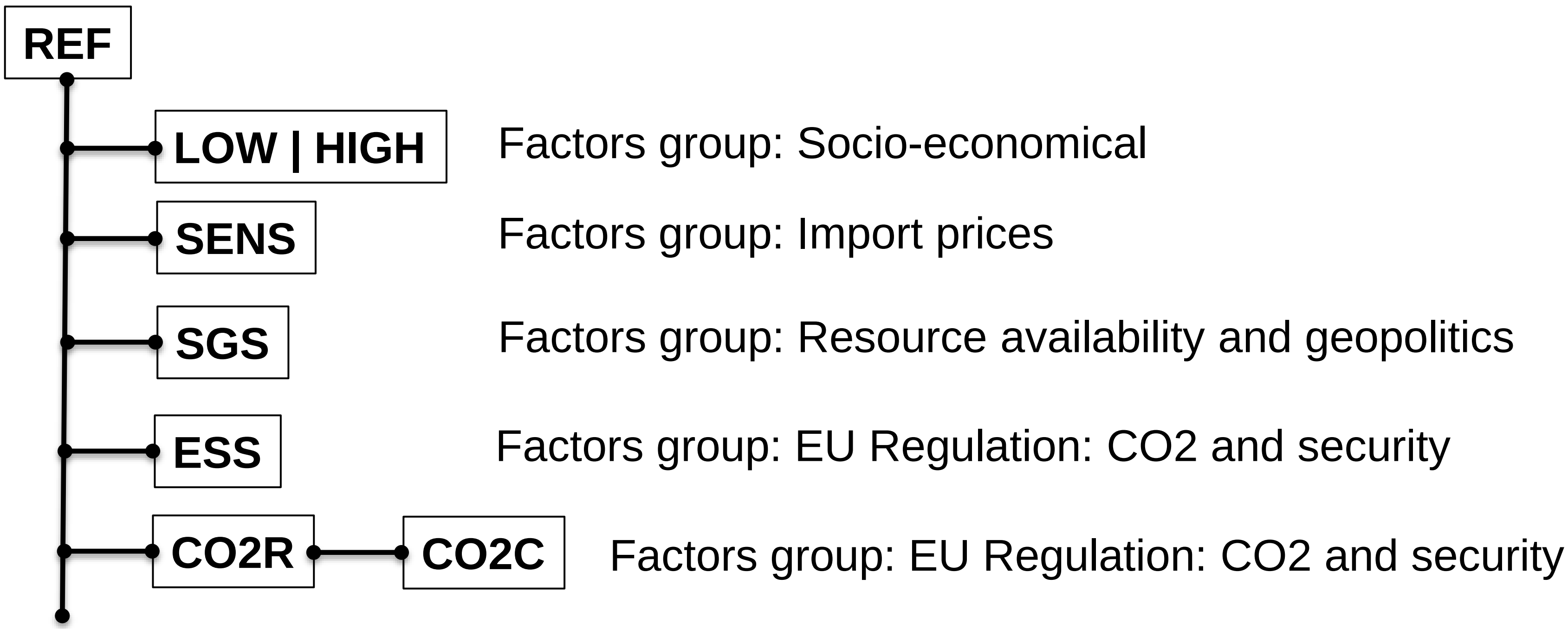


Scenarios

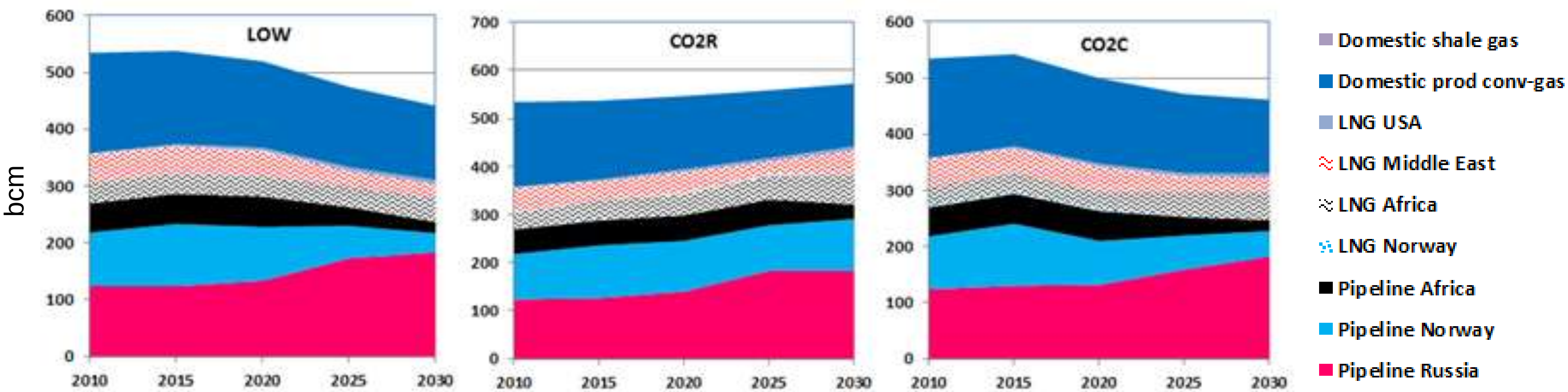
- Over 30 scenarios have been produced in a holistic manner to "touch" the scenario field and identify the basic resulting trajectories, which could be achieved by varying the driving factors
- The following was selected as tree-like alterations of the Reference Scenario



Case Studies: Stable Russian Gas Supply to the EU

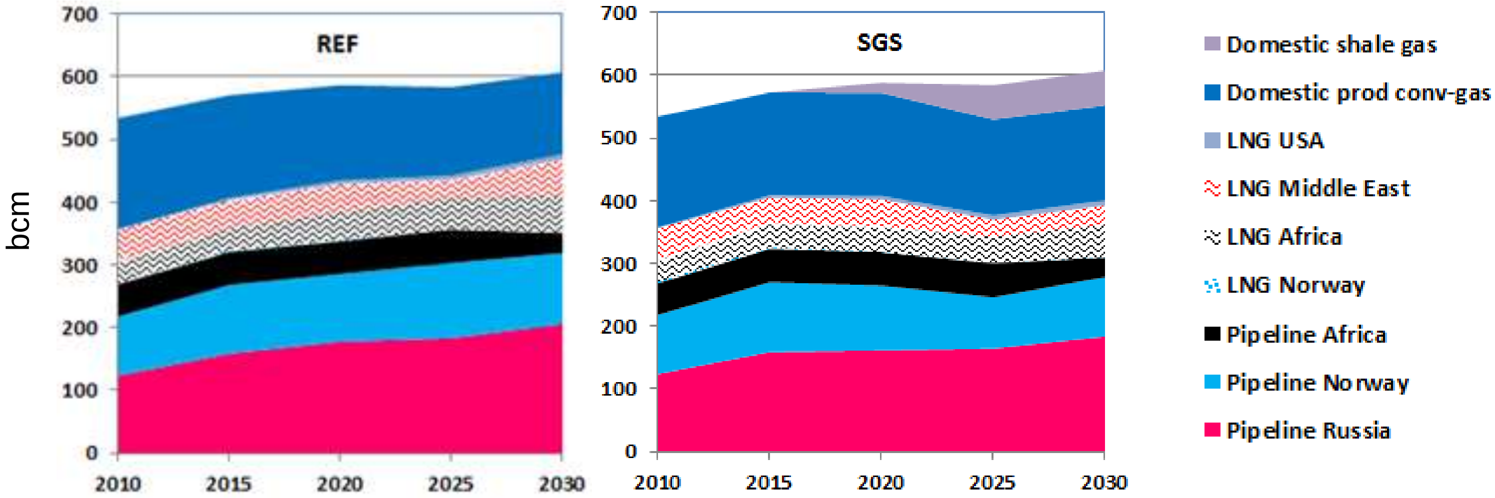
- **LOW**: moderate GDP growth (0.75% pa). Gas share in power generation remains at 25% in the first decade, but then replaced by coal and RES declines to 18%. Gas overall consumption declines but the Russian gas is affected at minimum degree. Most reductions are for Norway and LNG
- **CO2R**: the target of 20% CO2 reduction is delayed to 2030. Coal gets priority due to relaxed CO2 constraint, but not enough to reduce overall gas consumption. In the end use, again coal and partially gas replace electricity. Due to stalled gas demand in the first decade, Russian gas is also at its stable level. Closer to 20% CO2 target reach, gas begins to conquer its position.

- **CO2C**:alternation of CO2R – not only the target date for CO2 reduction is postponed, but also the level of emission is fixed on the current 3.3 GtCO2.
  The extreme CO2 scenario. Since there is no incentive to reduce emissions, gas position is only declining. Russian gas is winning due to favorable price and availability assumption.



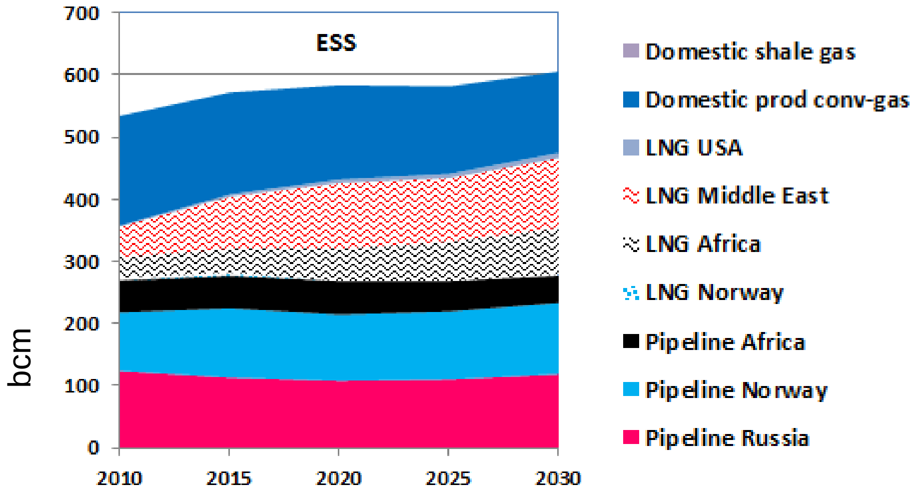
Case Studies: Growing Russian Gas Supply to the EU

- **REF**: Baseline scenario. Two first "20" out of '20-20-20' are in place, the latter "20" due to its infeasibility is replaced by efficiency improvement by 20%. After 2020, the CO2 emission reduction extends to the level of 70% by 2030.
- **SGS**: Starting from 2015 there are 6 TCM of shale gas available for commercial extraction at production cost of 25 EUR/MWh. The reaction in transformation sector and in TPES structure is negligible – compared to REF Scenario. Gas imports change slightly due to appearance of new player. Russian gas imports reduces by 20 bcm/y at any time period compared to REF.



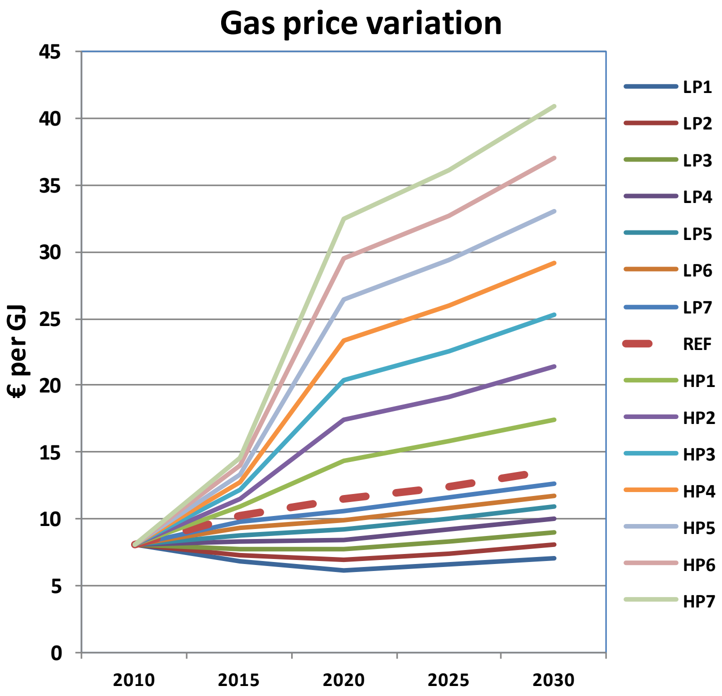
Case Studies: Declining Russian Gas Supply to the EU

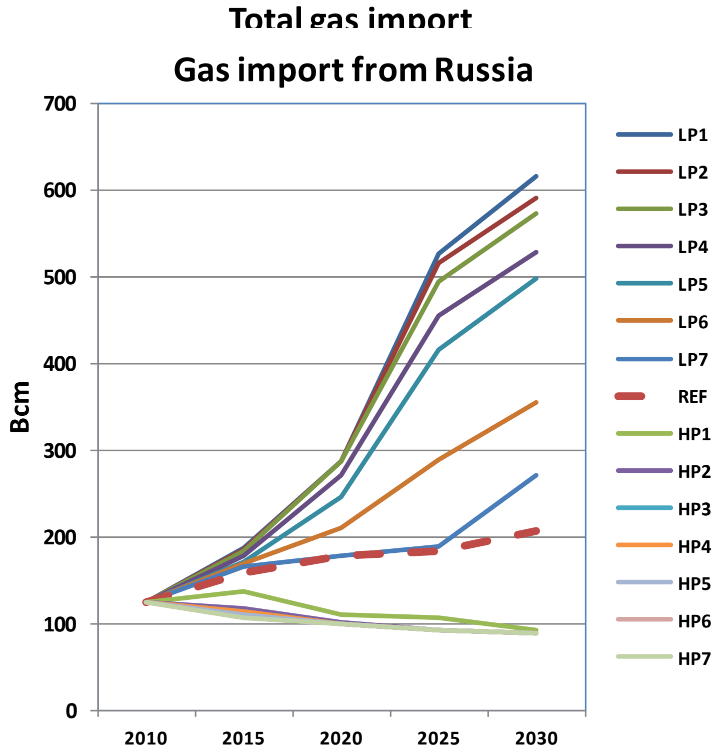
- **ESS**: The security of supply policy is assumed in a form of 25% limit for any gas importer. Here the price parity does not play big role: oligopolistic model. The remaining 25% (left after 3 major suppliers) are taken by LNG suppliers. Some quality changes in transformation sector and TPES are also to follow.



Case Studies: Sensitivity Analysis

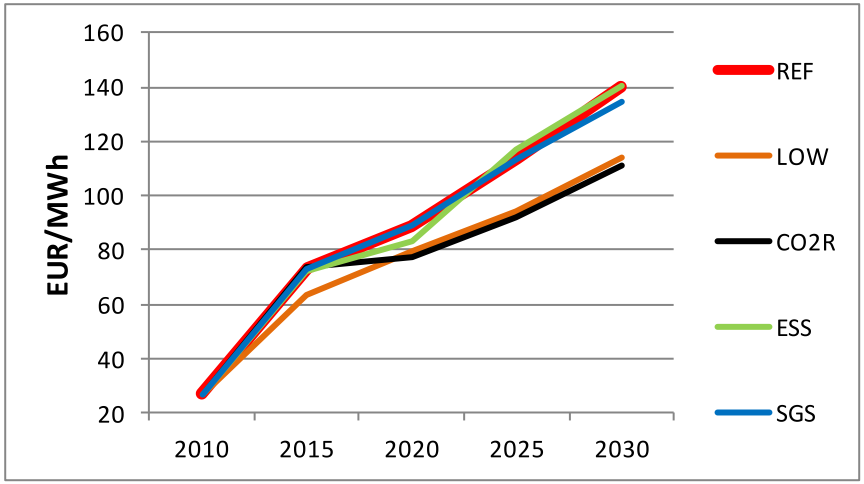
- Basis: REF scenario. Only Russian import gas prices were shocked in line with below-left graphs. Gas demand is rather insensitive to high and highest prices while is very sensitive to lower prices. Chiefly responsible for this skewed behaviour is “20-20-20” policy, especially the hard-wired CO_2 emission reductions.



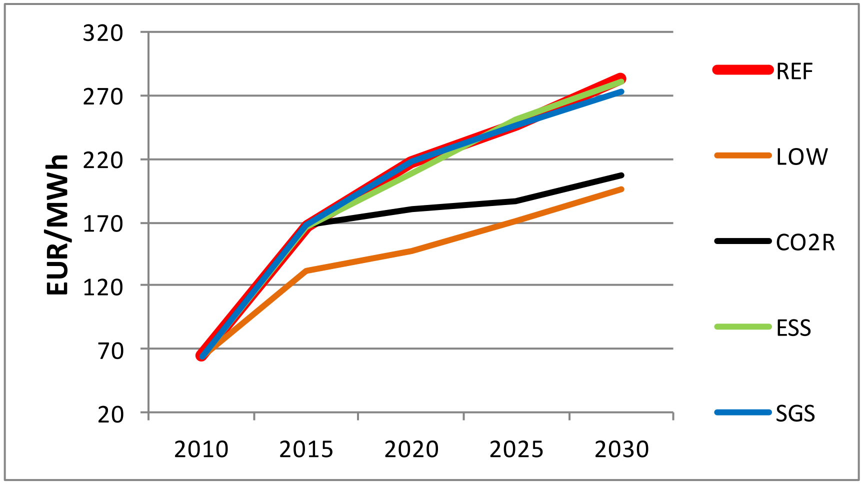


Case Studies: Social Dimension

Shadow price (opportunity cost) of end use gas



Shadow price (opportunity cost) of end use electricity



Case Studies: Social Dimension

Investments into the demand leveling will be transferred to end users

Investment in Demand Side					
Million EUR	**2010**	**2015**	**2020**	**2025**	**2030**
Renovation in Buildings		175,209	638,396	992,392	1,642,115
Electric cars		15,946	57,024	135,281	233,440
Total		**191,155**	**695,420**	**1,127,673**	**1,875,555**

	2010	**2015**	**2020**	**2025**	**2030**
Dewillings [million]	207	210	213	215	216
HH area [million m2]	27473	27909	28284	28583	28799
SS area [million m2]	4740	4935	5128	5312	5487
Population [million]	513	521	527	532	536
Average dewlling area m2	133	133	133	133	133
person per dwelling	2.480	2.479	2.478	2.476	2.475
renovated area HH [million m2]		1854	4190	6279	9284
renovated area SS [million m2]		151	359	526	861
Average renovation cost EUR/m2		87	140	146	162
Percentage of renovated area HH [%]		7%	15%	22%	32%
Percentage ofrenovated area SS [%]		3%	7%	10%	16%

Practical Example: not Enough Attention to the Consequences

- Notorious article in “the Economist”
  - Generators and utilities got into a trap:
    - From the one hand, RES policy resulted in subsidies
    - From the other hand, liquid interconnected markets

European utilities: How to lose half a trillion euros | The Economist

The Economist

European utilities

How to lose half a trillion euros

Europe's electricity providers face an existential threat

Oct 12th 2013 | From the print edition

ON JUNE 16th something very peculiar happened in Germany's electricity market. The wholesale price of electricity fell to minus €100 per megawatt hour (MWh). That is, generating companies were having to pay the managers of the grid to take their electricity. It was a bright, breezy Sunday. Demand was low. Between 2pm and 3pm, solar and wind generators produced 28.9 gigawatts (GW) of power, more than half the total. The grid at that time could not cope with more than 45GW without becoming unstable. At the peak, total generation was over 51GW; so prices went negative to encourage cutbacks and protect the grid from overloading.

The trouble is that power plants using nuclear fuel or brown coal are designed to run full blast and cannot easily reduce production, whereas the extra energy from solar and wind power is free. So the burden of adjustment fell on gas-fired and hard-coal power plants, whose output plummeted to only about 10% of capacity.

- Success of ‘20-20-20’ heavily depends on demand leveling
  - Enormous investments required for buildings renovation – who will pay?
  - Tough requirements on lifestyle change – is the society ready to accept?

Example: Typical Messages/Recommendations

- Russian gas supplies in the EU mix do not decline by 2030 in any of the scenarios except stress tests (assuming reasonable price policy)
- Russia shall support any CO_2 and RES related initiatives of the EU: they remove coal from competition in power sector, favor gas in end use

- Russia shall watch out for prices: both, from geopolitical perspective and in form of closeness to liquid markets

- Shale gas does not affect the Russian gas supplies: it frees up the indigenous production in the EU
- Demand side modeling is very important for successful achievement of ‘20-20-20’ and beyond