Benefits and costs of the Smart Power System development in Russia. The role prosumers in the improvements of the Smart Power System efficiency

Energy Research Institute of the Russian Academy of Sciences

Open seminar «Russian and international prospects for the development of smart grid solutions focusing on the involvement of the non-residential consumers»

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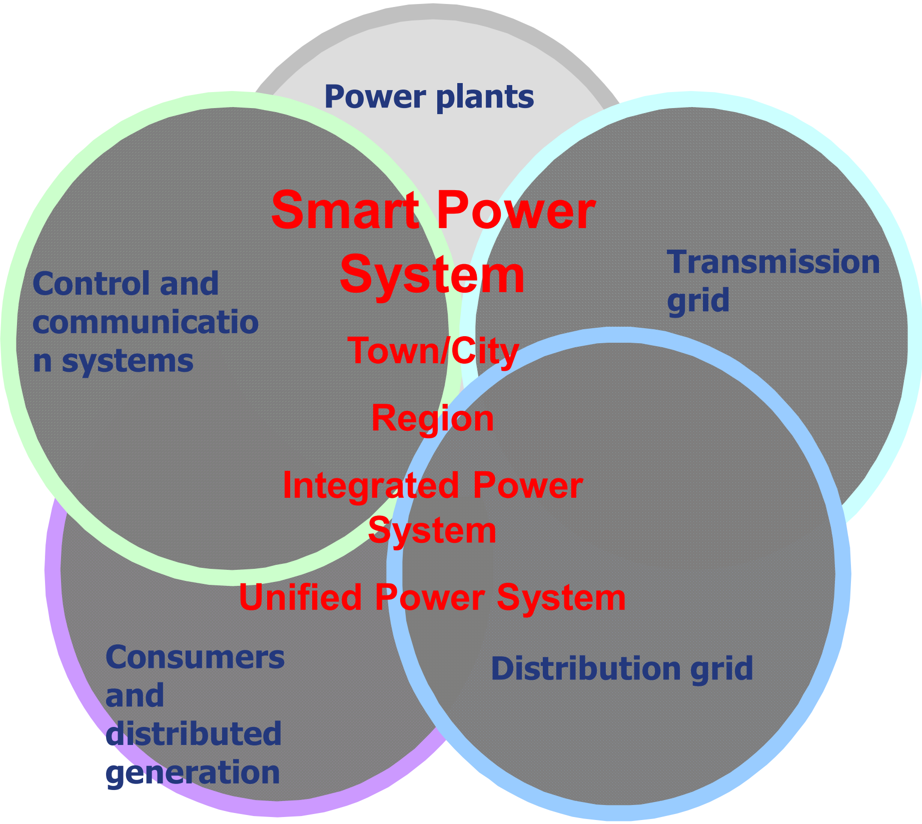
ИНЭИ РАН

From Smart Grid to the Smart System. Innovative opportunities for Russia



- *Design and development of the Smart Unified Power System – national energy system of the 21st century*
  - The unique experience and skills of the system design and dispatching of the Russian Unified Power System must be applied to new types of the state-of-the-art generation/transmission/distribution/consumption technologies and smart control systems
- *Design and development of the integrated smart electricity and heat supply system for consumers in towns and cities*
  - Largest volumes of the CHP development (CHP form near 50% of the installed capacity of total thermal power plants), wide-scale development of different centralized heating systems based on CHP and boilers create the unique opportunities for the energy saving and energy efficiency improvements and for the decrease of GHG emissions.

Technological and economic effects from Smart Power System (SPS) development

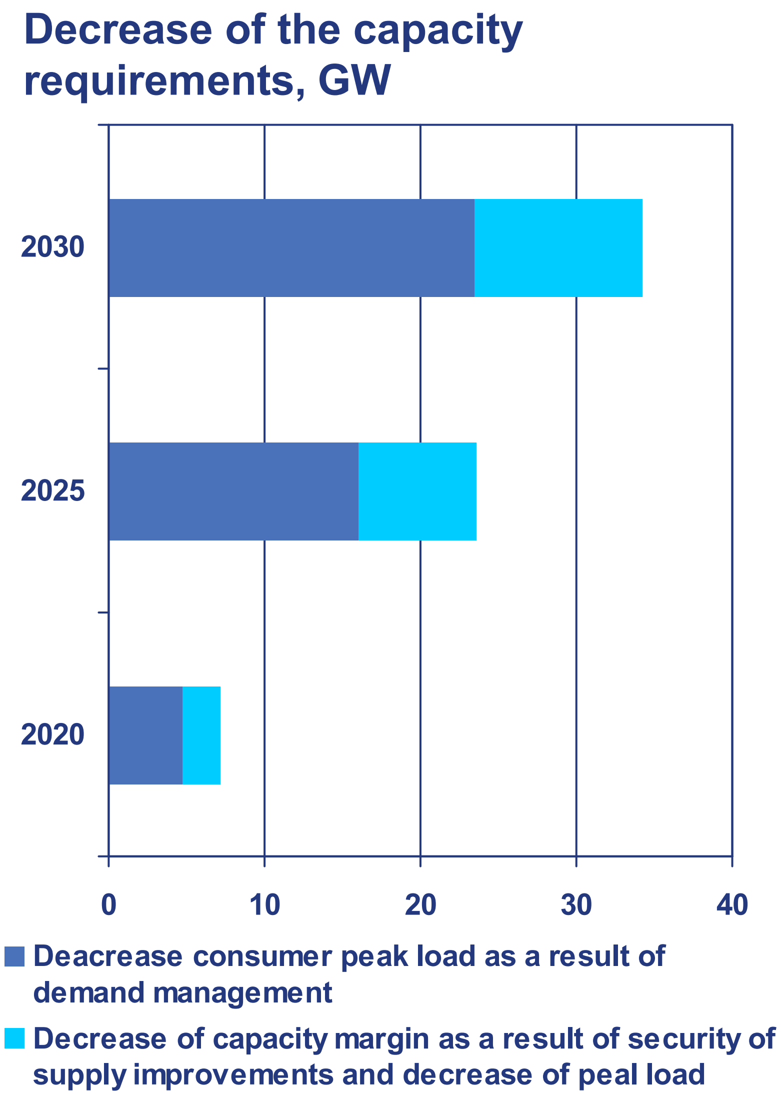
- **Functionality changes** – changes of the existing or appearance of new technical features in separate sector technological sub-systems (generation, transmission, distribution, consumption of electricity)
- **Technological effects** – changes of the technical performance parameters of the power sector/sub-sectors
  - ***Local*** – *impact on the separate technological sub-system*
  - ***System-wide*** – *impact on performance parameters of different sub-systems and on the supply/demand balance situation as a whole*
- **Economical effects** – cost estimation of technological effects
  - ***Local*** – *changes of economic characteristics of the separate technological sub-system*
  - ***System-wide*** – *economic result of system-wide technological effects superposition*

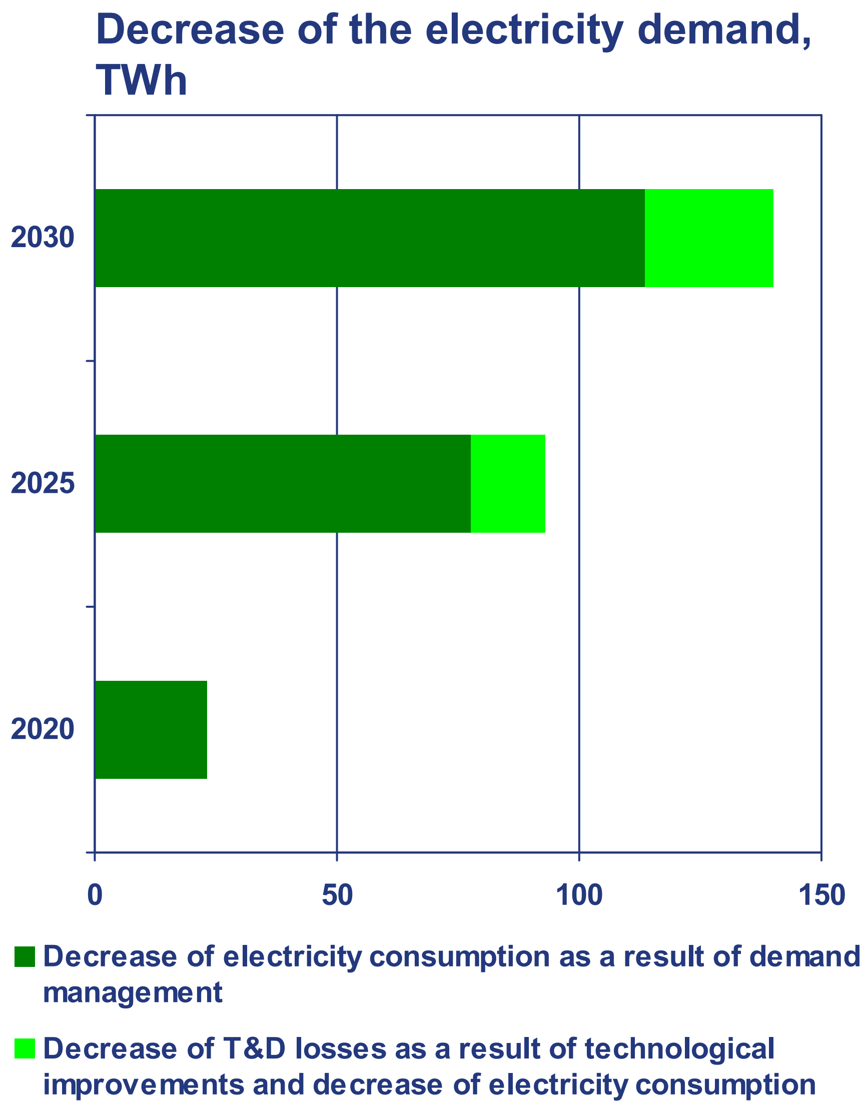
Key system effects in transition to the Smart Power System

- effect from electricity demand/load management (LF effects)
- effects from T&D losses management
- effects from T&D lines capacity management
- effects from generation load management (CF effects)
- effects from security and quality of power supply management

	Pilot Smart Grid projects worldwide	Target indicators for Russian Smart Power System to 2030
Decrease of peak demand	**10-20%**	**10%**
Decrease of the final electricity consumption	**5-15%**	**8%**
Decrease of grid losses (% to actual)	**20-50%**	**30%**
Decrease of the capacity margin (% to actual)	**20-30%**	**20%**
Decrease of the intersystem transmission capacities	**5-10%**	**10%**

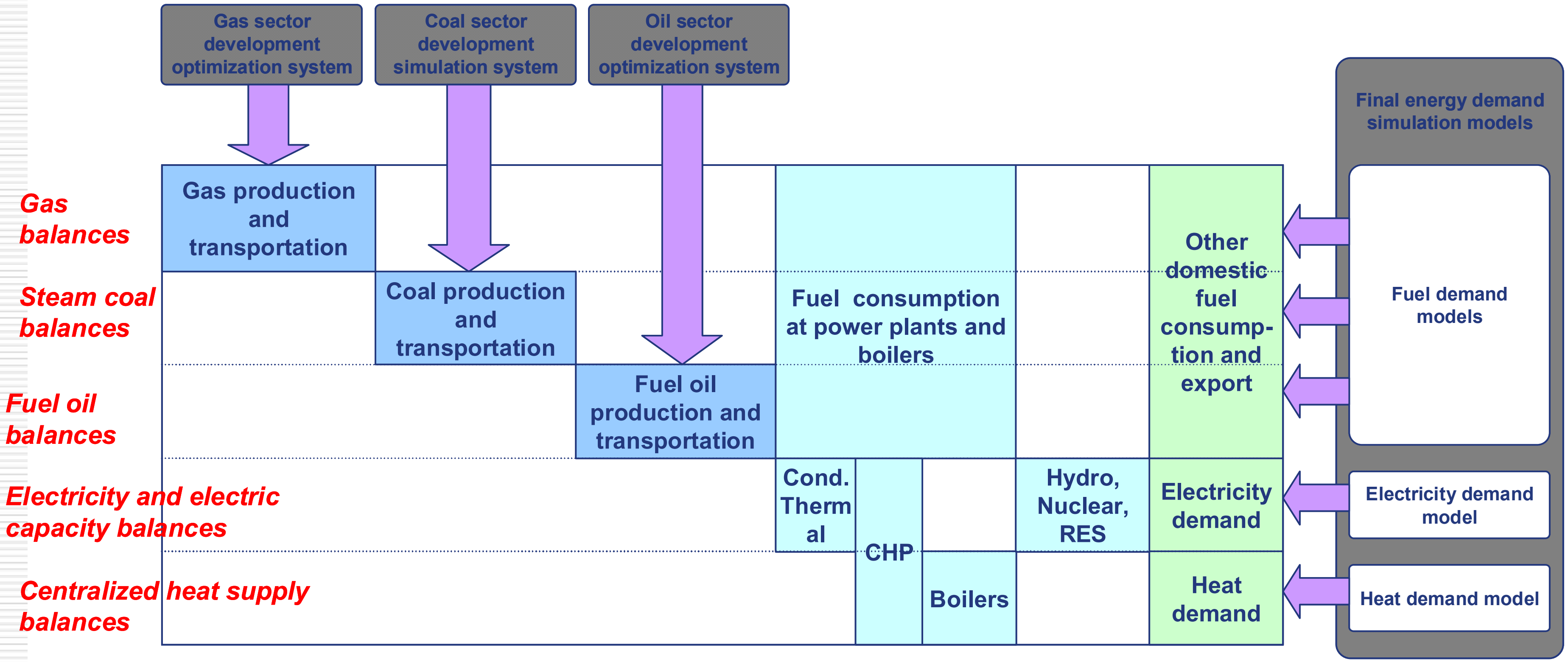
Impact on the balance situation in the SPS





Modeling tools for the system effects and SPS benefits estimation

EPOS – the optimization model of power sector development as an integrated part of the whole energy sector was used to estimate economic consequences from changes in capacity and electricity balances due to SPS development



Экономические эффекты при создании интеллектуальной энергосистемы (ИЭС ААС) до 2030 г.

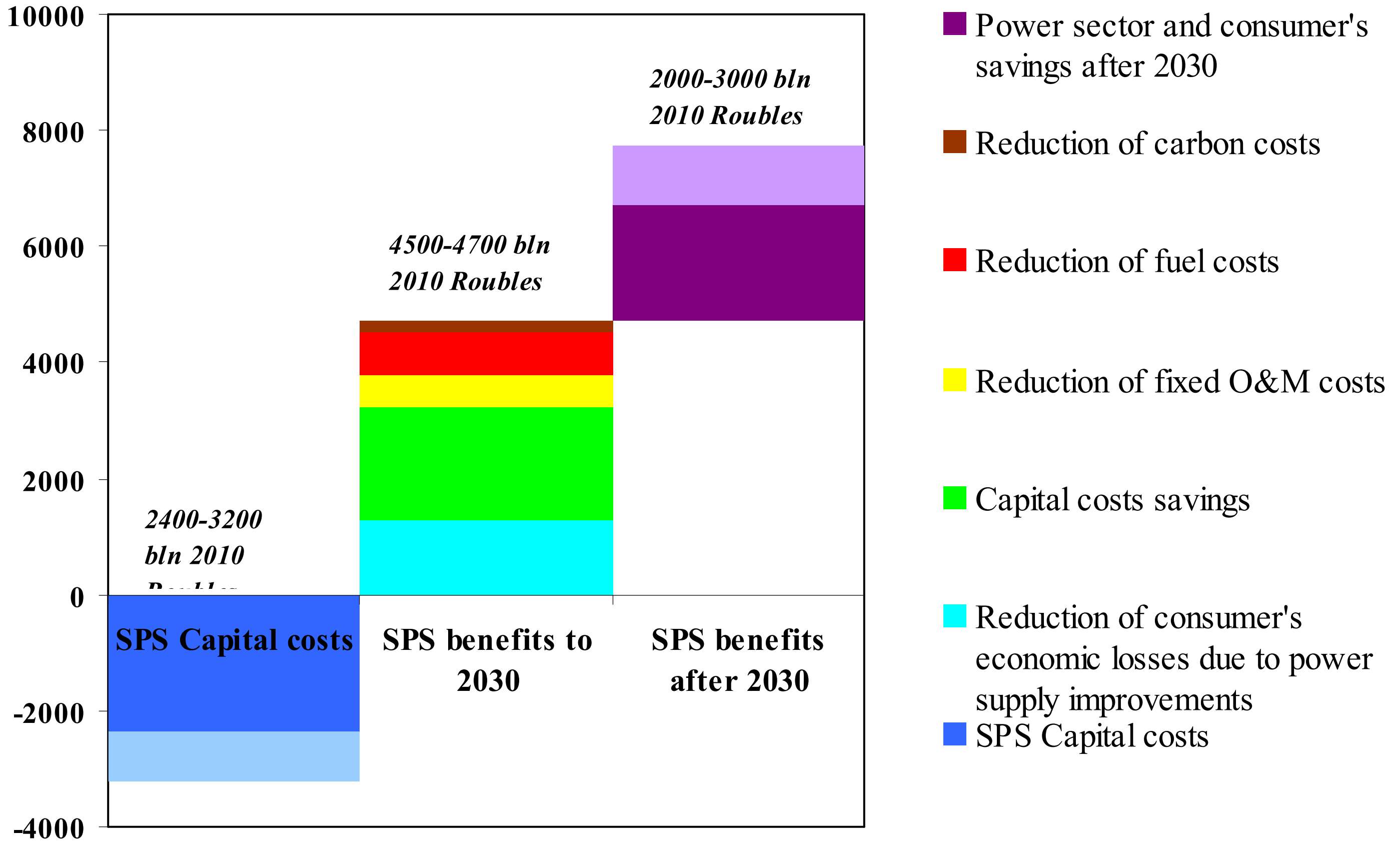
Bln 2010 Roubles

	Until 2020	2025	2030	Total 2015-2030
Decrease of capacity additions, GW	*7.8*	*15.3*	*11.0*	*34.1*
Decrease of fuel consumption, Mtce	*4.7*	*13.5*	*27.6*	*173.6*
Decrease of CO2 emissions, Mt	*8*	*23*	*46*	*298*
Avoided capital costs	**682**	**744**	**526**	**1953**
Avoided fixed O&M costs	**17**	**52**	**73**	**560**
Avoided fuel costs	**12**	**56**	**139**	**756**
Total avoided capital and O&M costs	**711**	**852**	**738**	**3269**
Avoided carbon costs	**5**	**14**	**28**	**183**

Preliminary capital cost requirements for Russian SPS development (made analogous to EPRI approach for US power industry) were estimated at 2400-3200 bln 2010 Roubles

Preliminary SPS cost and benefit estimation. Results

Billion 2010 Roubles

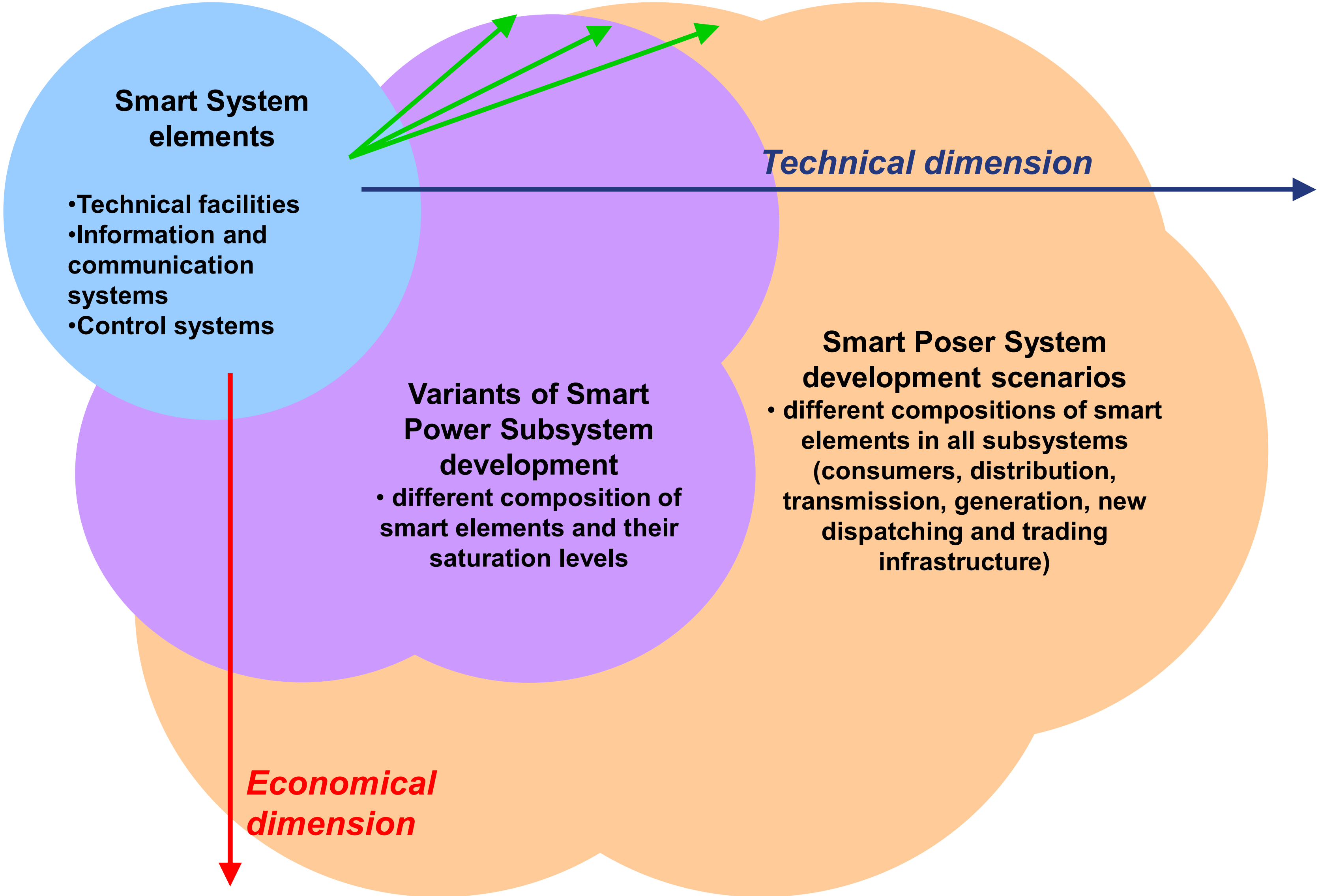


Direct economic effects in electric power industry and consumer supply reliability will exceed costs of SPS implementation in 2,5-3,5 times. But it does not take into account external effects!

External effects from Smart Power System development

- **Decrease of the ecological impact**
  - *Degrease of GHG emission, other pollutants, electromagnetic radiation, land use for energy facilities*
- **Innovative impulse for the national economy**
  - *Wide-scale demand for the innovative production in power engineering, electrotechnical industry, IT and communication technologies*
- **Increase of energy security**
  - *Increase of the security of supply for final consumers, incl. the enhanced security requirements of the “digital” economy sectors, and improvements of the local energy independency*
- **Improvements of the conditions for economic market integration and competition**
  - *Decrease of the infrastructural and informational barriers for the electricity market integration and creation of the mass active consumer at the wholesale and retail levels*
- **Increase of the labor productivity and safety**
  - *Decrease of personnel, remote control and management of the facilities, decrease of the human involvement in their operation and maintenance*

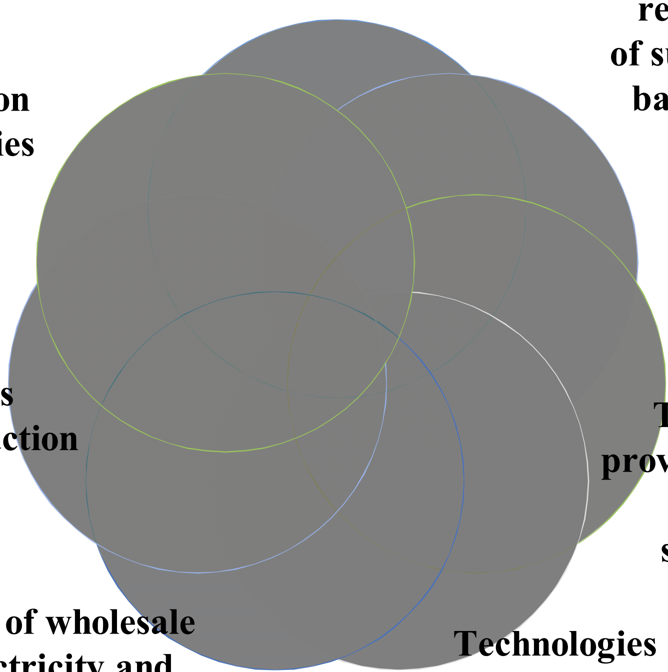
Optimizing the future shape and structure of Smart Power Syatem



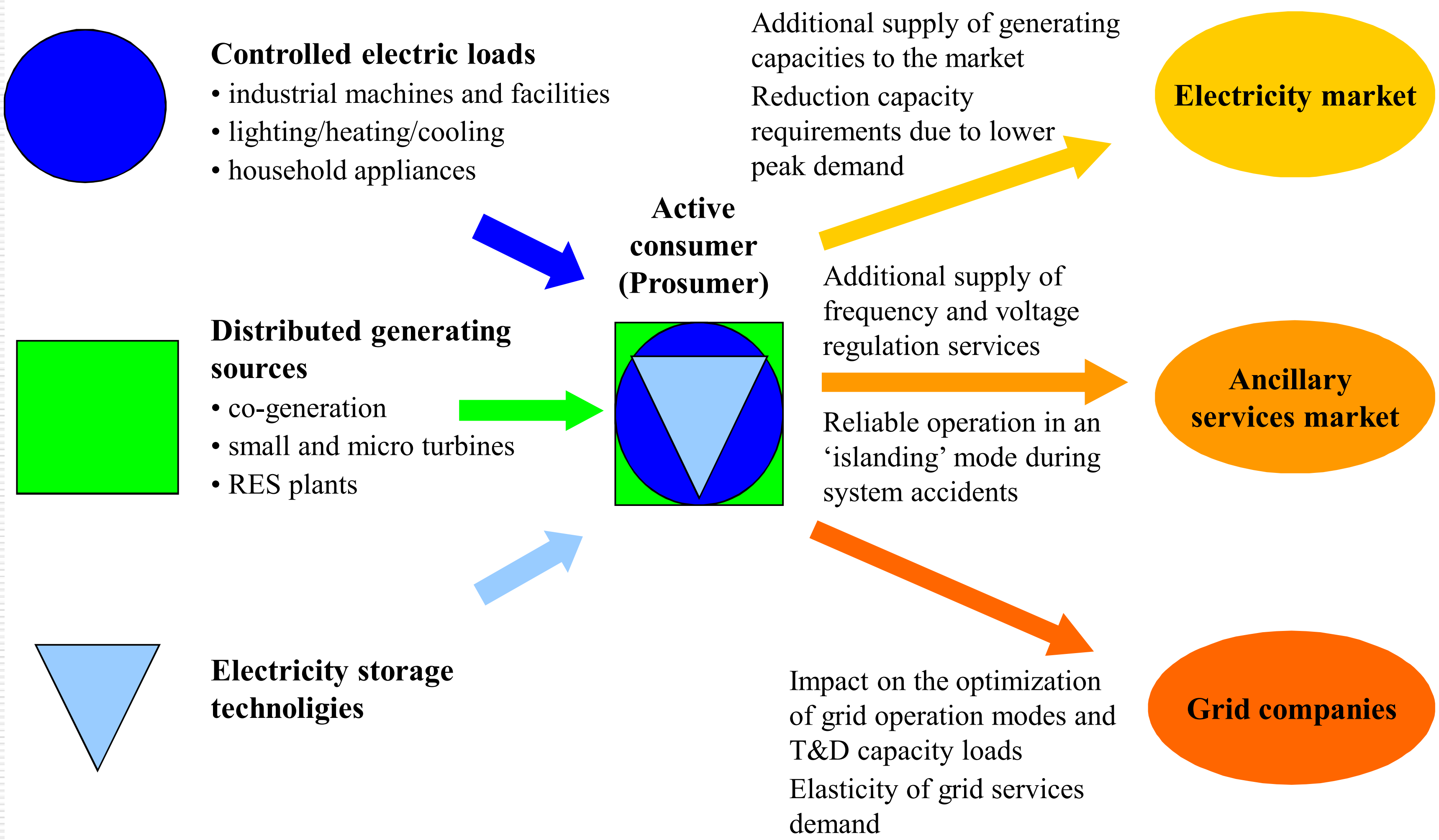
Cost and performance parameters must be revised at the each stage of Smart Power System design and feasibility analysis

Variety of smart elements (technical and control) and variants of SPS subsystem development with different smart elements composition and saturation level	Engineering models of technical and operation control processes in electricity generation, transmission, distribution, consumption and system dispatching	Cost and performance parameters of smart elements, terms of their development and effective levels of introduction (saturation levels)
Technically allowable whole SPS implementation scenarios based on integration of engineering decisions in separate SPS subsystems	Engineering models of technical and operation control processes in the whole power system (modeling of subsystem interaction)	Required capital costs by variants of SPS implementation. Assessment of cumulative impact of technological effects on the future balance structure
Economically preferable SPS implementation scenarios, considering overall impact of the system effects on conditions of electricity and capacity balances and the economy as a whole	Balance-type economic model of energy system development, financial models of power sector as a whole and its subsectors	Cost/benefit estimation of changes in scale and structure of generation and grid development as well as pricing effects for consumers

Active consumers/prosumers – required technical and control solutions in the Smart Power System

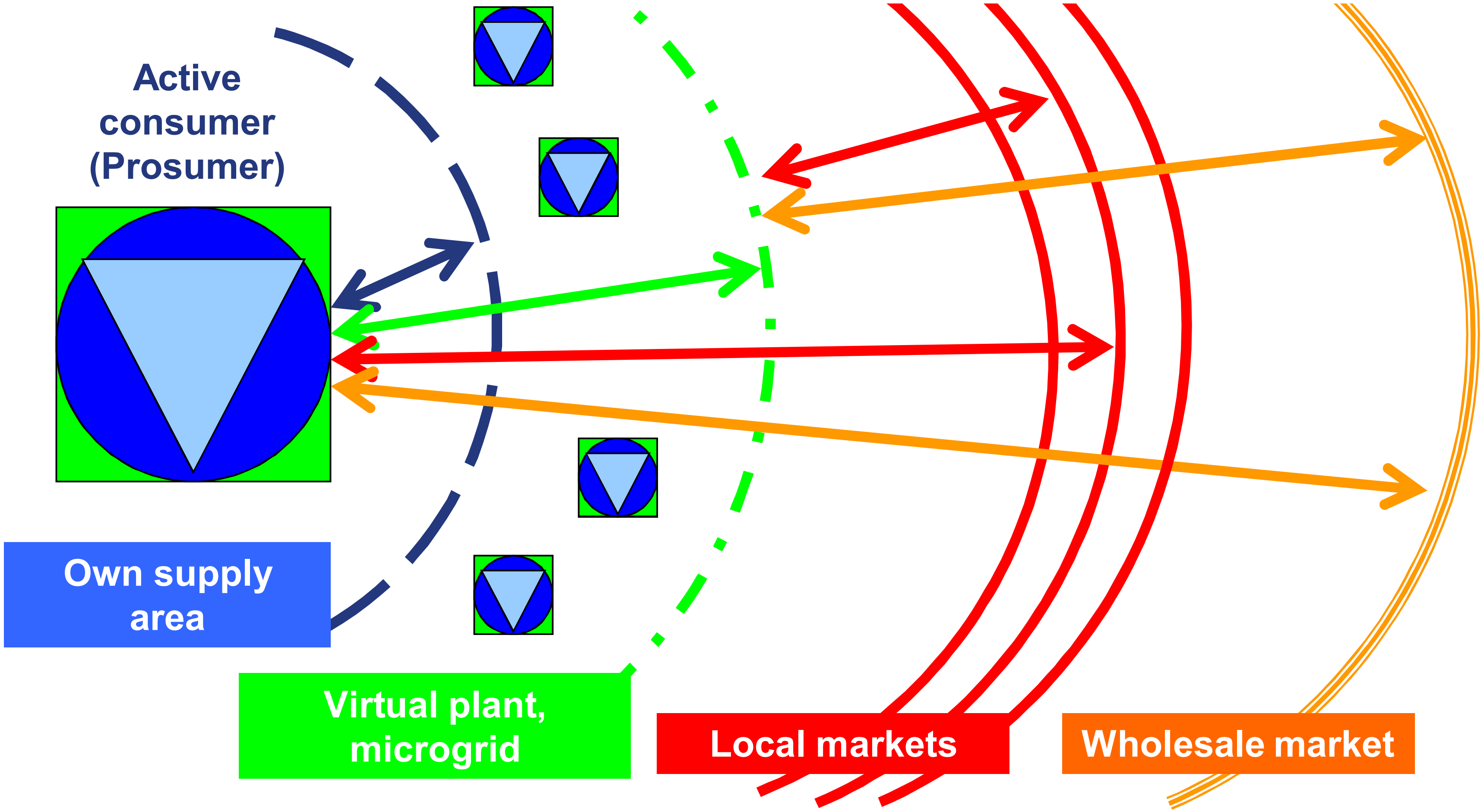


Active consumers/Prosumers will form new competitive conditions for the traditional generation and grid suppliers



Active consumers/Prosumers form a new competitive challenges to the traditional wholesale/regional centralized markets

Active consumers/Prosumers create new quality of the retail competition and provide effective competition to the centralized high-level markets and traditional power suppliers



Development of active consumers/prosumers is an unconditional factor ensuring the Smart Power System development effectiveness

Most of direct economic effects are estimated at the consumer side, partially as a result of their active behavior in the Smart Power System

- Smart systems of demand, distributed generation and storage control make the main contribution to the reduction of generation and grid capacity requirements in the power system and provide the capital and operation cost savings in power industry

- Active behavior of consumers in the power system increases the competitiveness at the electricity and auxiliary services' markets and provide the pricing effect as a power supply costs savings

- New technical opportunities and economic choice of consumers between distributed and centralized alternatives securing the reliability and quality of supply provide the saving of consumer's economic losses and costs for their compensation.

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Thank you for attention