Conference on Energy Security: Outlook & Perspectives in the Baltic Sea region

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MODELING OF ENERGY STRATEGY IN LATVIA:

Introduction of energy and climate mitigation policy issues in energy planning model

Energy system analyses tools in Latvia

- EFOM (Energy Flow Optimization Model) – multi-period linear programming optimization model describing the total energy system of a country
  - Used from 1994 – 2000
  - Research projects with focus to electricity and district heat (energy system is partly represented)
- Not continuity in Latvia (just in one case study)
  - MESSAGE – a systems engineering optimization model used for medium to long-term energy system planning, energy policy analysis
  - BALMOREL – optimization model for analyzing the power&DH sector in an international perspective
  - MESAP (Modular Energy System Analysis and Planning Environment) -PlaNet – Linear network module (Simulation model)
  - ENPEP-BALANCE – market-based simulation nonlinear equilibrium model
- Since 1995 MARKAL is used for energy and environment system analyses in Latvia
- Latvia represented as region in multi regional models
  - TIMES
    - Pan European TIMES model for projects: the New Energy Externalities Developments for Sustainability (NEEDS) (28 states pan-European model; examine externalities and life cycle assessment issues); Monitoring and Evaluation of the RES directives implementation in EU27 and policy recommendations for 2020 (RES2020); energy security (EACCESS)
    - The model TIMES_EE/EG optimizes the Electricity, Heat and Natural Gas Markets of the EU-25. The models have been used, together with several others, in the EUSUSTEL and CASCADE-MINTS projects.
  - PRIMES
  - and other

by no means exhaustive

MARKAL
IEA-ETSAP, www.iea-etsap.org

- MARKAL (TIMES) is developed by Energy Technology Systems Analysis Programme (ETSAP) (an Implementing Agreement of the International Energy Agency, the first established in 1976)
- Model generator written in the General Algebraic Model System (GAMS)
- User interfaces for managing input data, running model generator, examining results
- Used in a non-research environment since 1980 and now in use at more than 200 institutions in nearly 70 countries
- Widely used, proven and continually evolving model for assessing a wide range of energy and environmental planning and policy issues
- Has a well-developed support network around the world through ETSAP
- Analytic framework is ideally suited for assessing the role of technology in achieving environmental and policy goals

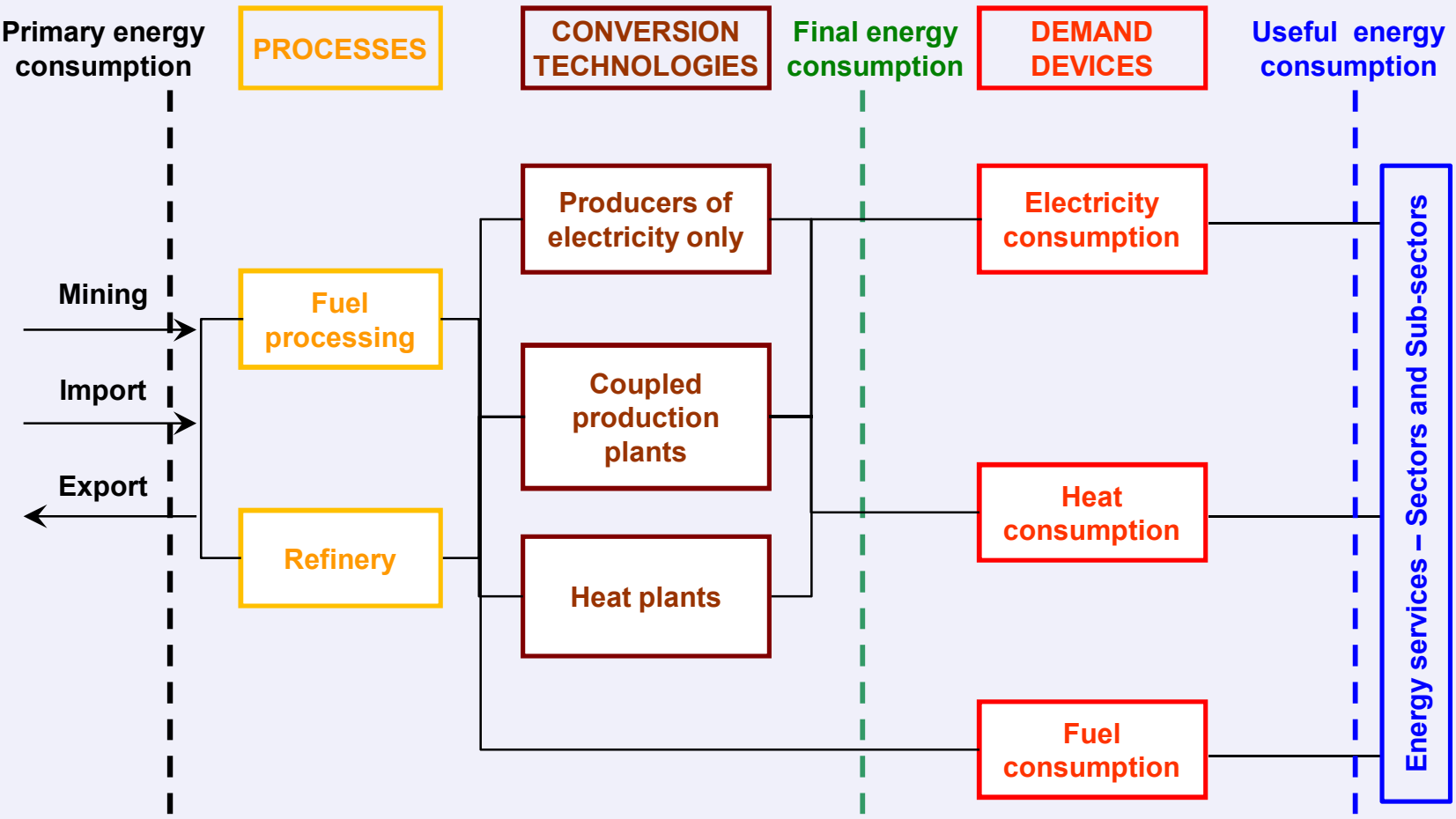
Insight into MARKAL use in Latvia

- Implemented by IFE (Norway) support in 1995
- Emission projections for energy sector
  - Projections of GHG emissions for
    - National use
    - UNFCCC National Communications (from 2nd NC)
    - Monitoring EU GHG emissions (Commission Decisions 280/2004/EC and 2005/166/EC)
  - Projections for other gases SO_2, VOC, NO_x, PM2.5, NH_3 for
    - National use
    - Convention on Long-Range Transboundary Air Pollution
- Projections of energy use
  - Mainly use for research projects
    - Identifying least-cost solutions for energy system planning
    - Evaluation of impact of introduction of energy&emissions taxes
  - Seldom direct use for national strategies
    - Evaluation of impact of introduction of different RES and energy efficiency targets

Modeling approach

- Bottom-up technology rich optimization model
- Covers all energy system from resource extraction through to end-use as represented by a Reference Energy System (RES) network
- Spread of action between supply and demand
- Emissions taxes and constraints
- Identifies most cost-effective pattern and mix of resource use and technology deployment over time under varying constraints and alternate futures by optimizing system costs. Also provides estimates of eq.:
  - energy prices
  - demand activity
  - GHG and other emission levels
  - mitigation costs
- Scenario approach: establishes baselines and the implications of alternative futures
- Sensitivity analyses
- Possibility to deal with uncertainty with stochastic analyzes

MARKAL Building Blocks

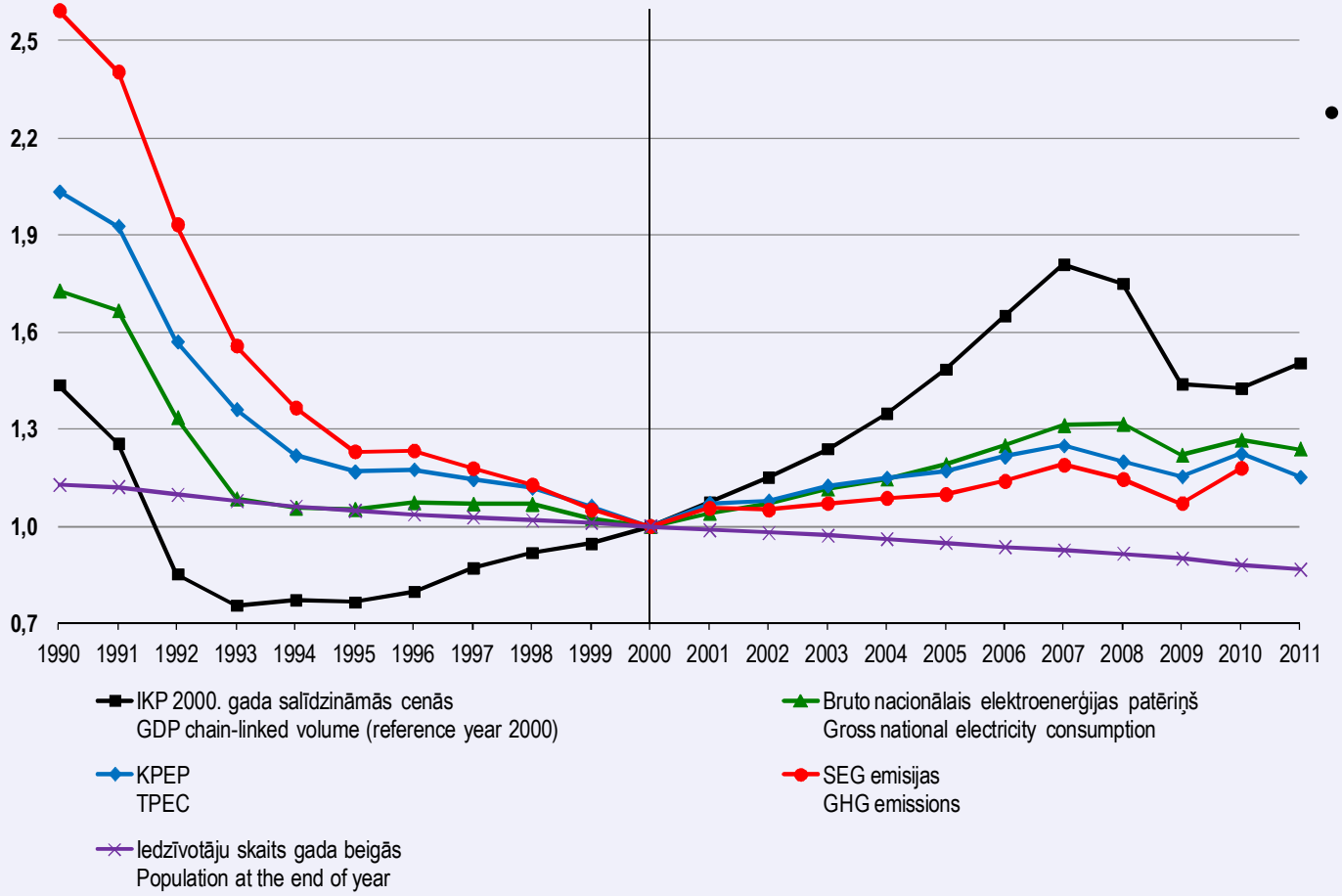


An energy technology is any device that produces, transforms, transmit, distribute or uses energy

Useful demands / Energy services – Sectors and Sub-sectors

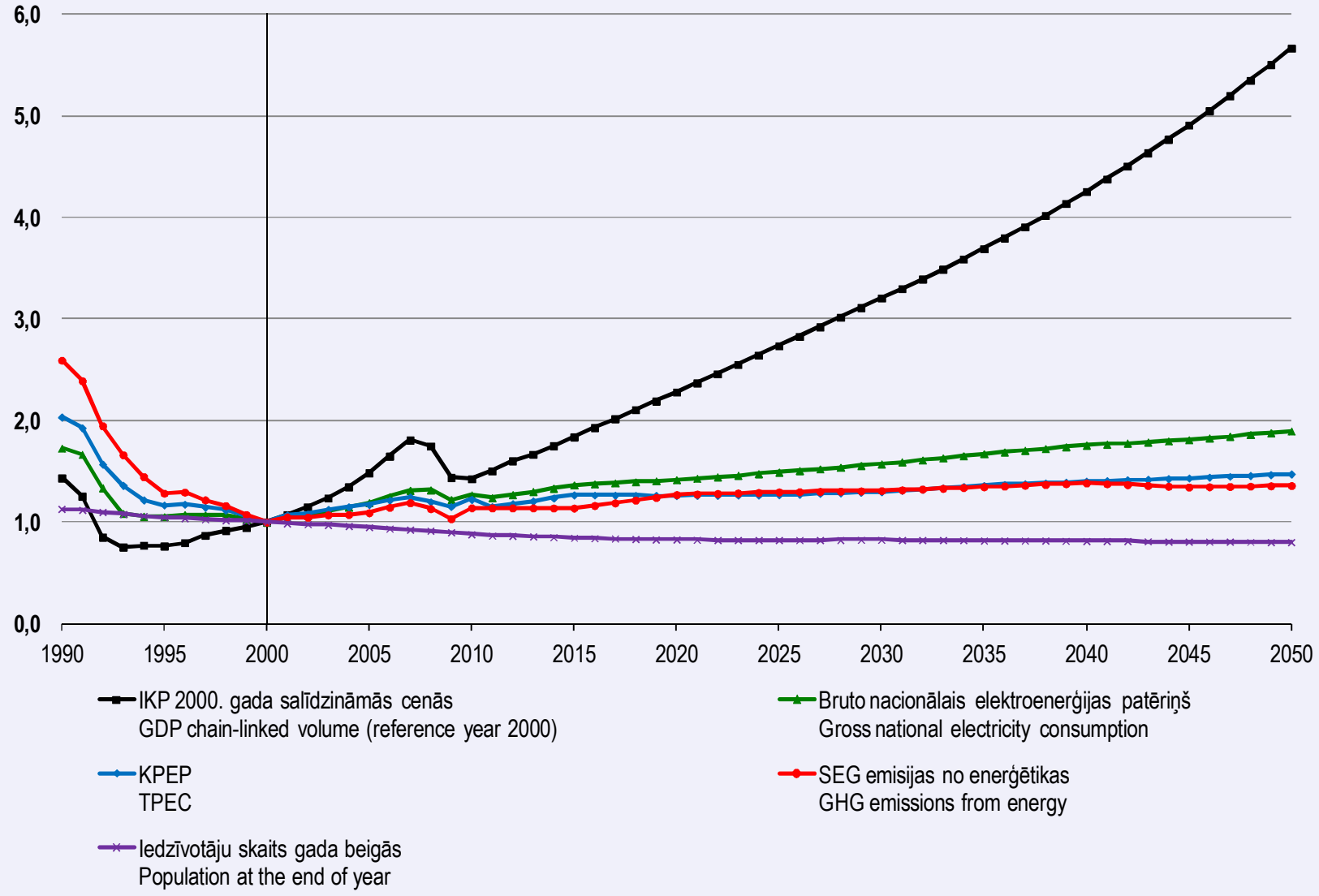
- **Agriculture, forestry, fishery**
  - AGR Electricity
  - AGR Energy Carriers (excl. ELC)
- **Services**
  - COM Air Conditioning
  - COM Cooking
  - COM Space Heating & Hot Water
  - COM Lighting
  - COM Electric Equipments
  - COM Refrigerators and freezers
- **Industry and construction**
  - ICH Chemical
  - ICO Construction
  - IES Energy Sector
  - IFB Food; Beverage and Tobacco
  - IIS Iron & Steel&Non-ferrous Metals
  - ILP Pulp&Paper and Printing
  - INM Non-metallic Minerals
  - IWP Wood and Wood Products
  - IOI Other
- **Residential**
  - RES Air Conditioning
  - RES Clothes Drying
  - RES Cooking
  - RES Clothes Washing
  - RES Dishwashing
  - RES Electric Equipments
  - RES Space Heating & Hot Water MF
  - RES Space Heating & Hot Water SF
  - RES Lighting
  - RES Refrigerators and freezers
- **Transport**
  - TRA Domestic Aviation
  - TRA International Aviation
  - TRA Pipeline Transport
  - TRA Road – Buses
  - TRA Road - Trucks (Heavy Duty Trucks, Light Duty Vehicles)
  - TRA Road - Car (Cars, Mopeds, Motorcycles)
  - TRA Railway
  - TRA Domestic Navigation
  - TRA International Navigation (Bunkers)

Development indexes (2000=1) – GDP, TPEC, GEC, GHG, POP

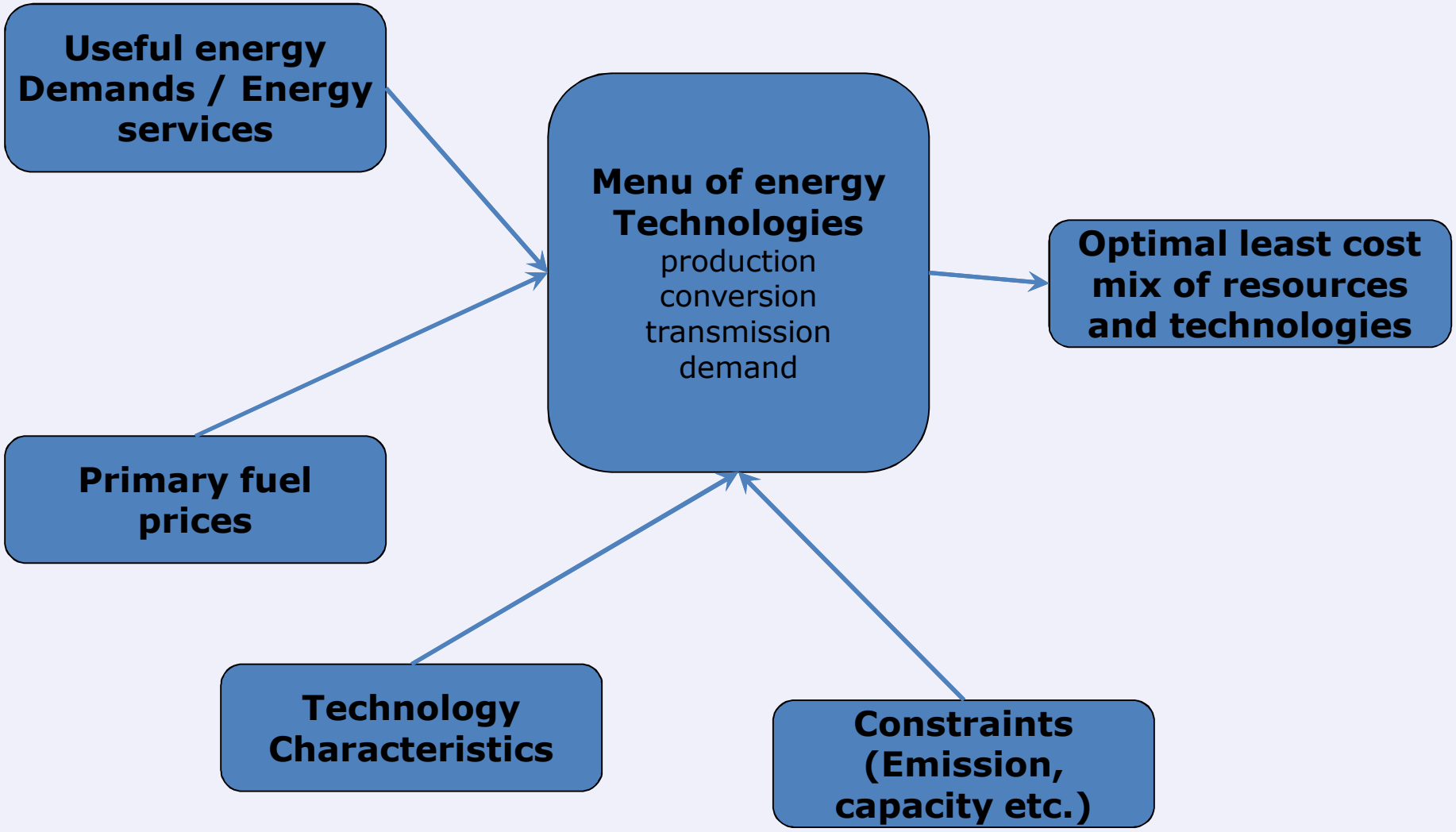


- Largest source of GHG emissions is 1.ENERGY with 69,6% share of total GHG emissions
- 32.7% of 1.ENERGY is covered by ETS
  - 1.AA.1. Energy Industries - 87.4%
  - 1.AA.2. Manufacturing Industries and Construction – 64,4%
  - 1.AA.4. Other Sectors – 4,2%
  - Remaining – 0%

Projections (2000=1) BASE scenario – GDP, TPEC, GEC, GHG, POP



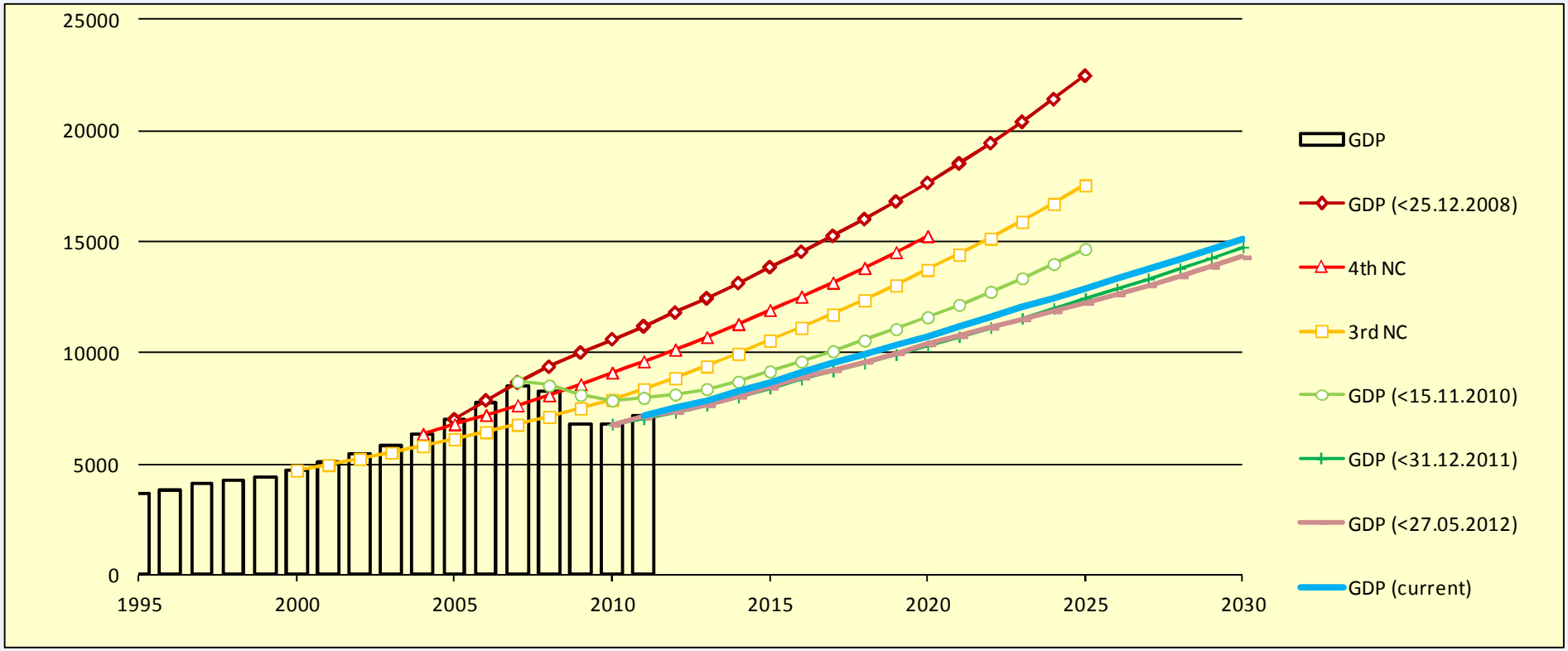
Overview of model



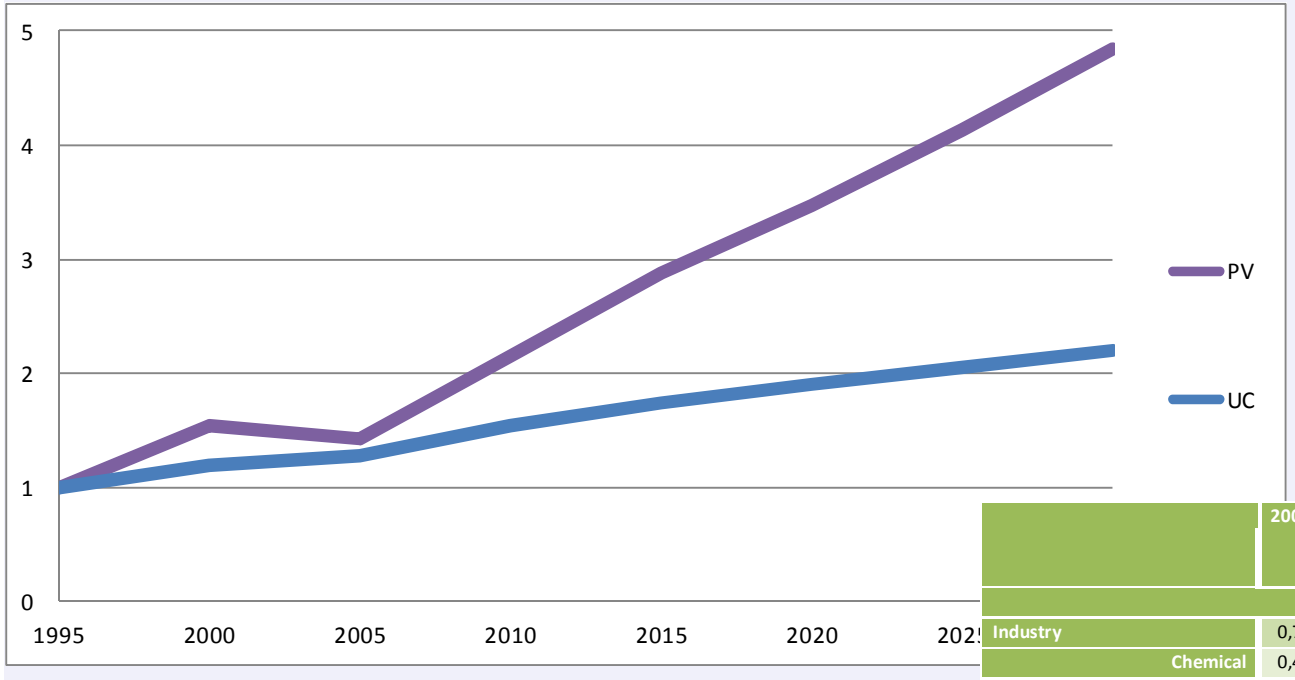
Challenges for Input Data

- GDP projections – how to project future development of our economy?
- Useful Energy Demand projections – how to project behavior of our customers? What is demand elasticities? How to link with macroeconomic forecast?
- Primary Energy prices projections – how to project future prices in global fuel market?
- Changes in governmental policy to provide national energy supply security may significantly influence the scenario definition and description

Projecting of GDP is a continuous process

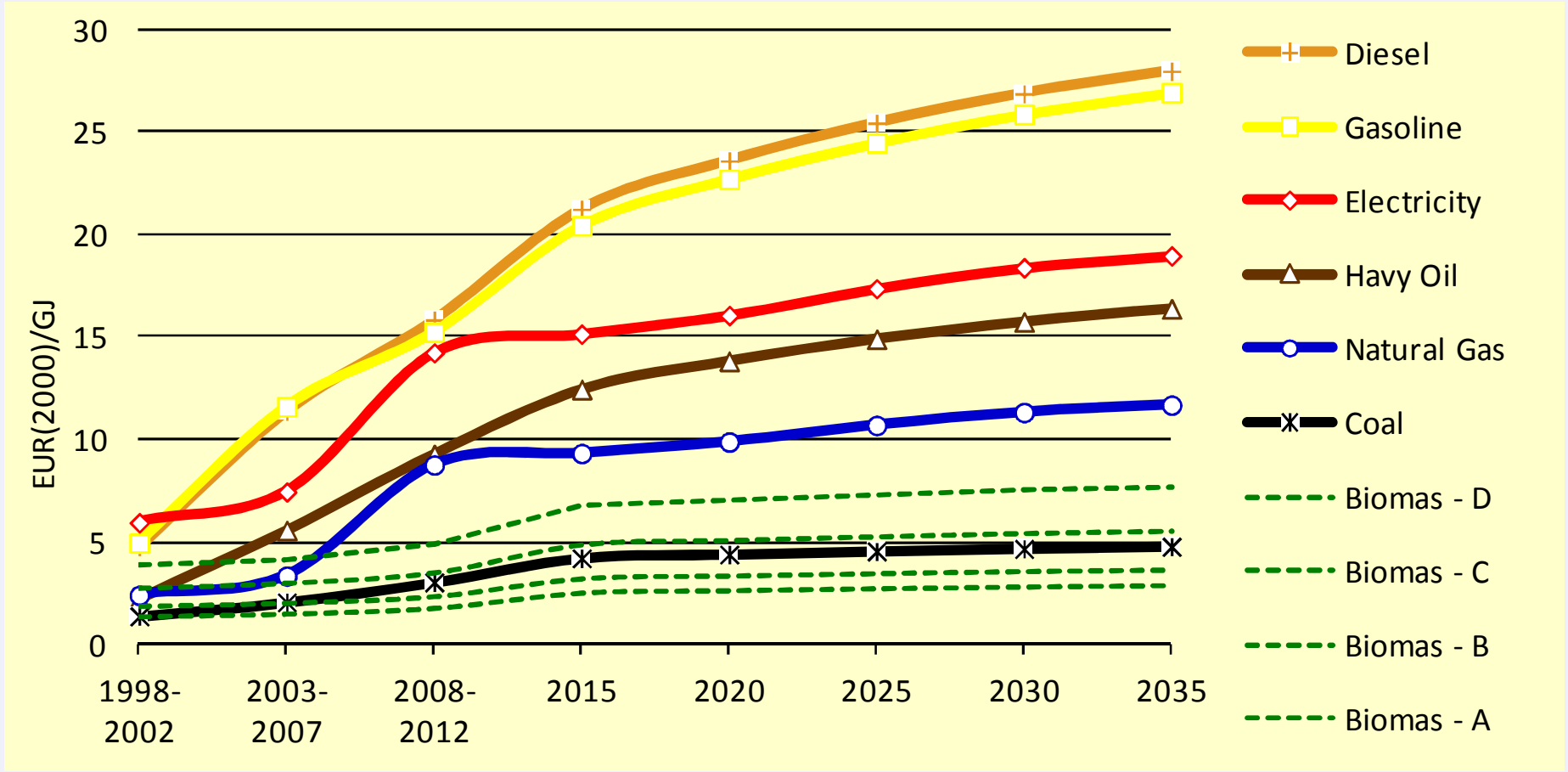


Aggregate of projected VA and Useful energy in Industry



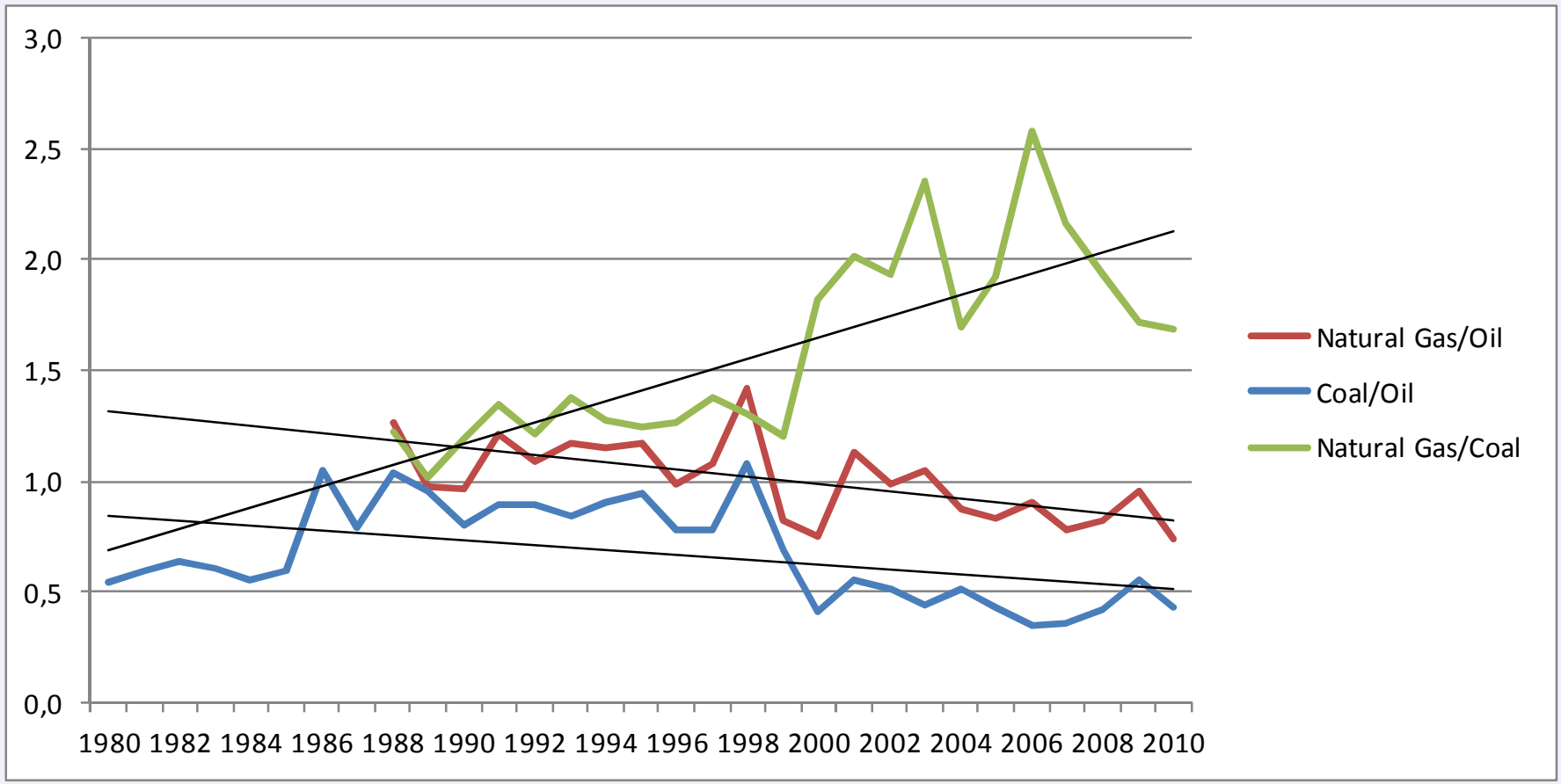
	2000	2005	2010	2015	2020	2025	2030	Elasticity	
								2000-2010	2010-2030
VA									
Industry	0,70	1,08	1	1,50	2,01	2,42	2,89		
Chemical	0,45	0,77	1	1,50	1,97	2,37	2,85		
Food	1,04	1,43	1	1,11	1,32	1,47	1,64		
Metals	1,15	1,56	1	1,38	1,94	2,55	3,21		
Non-metallic Minerals	0,37	0,73	1	1,69	2,23	2,69	3,23		
Pulp&Paper	1,18	1,46	1	1,21	1,53	1,75	2,00		
Wood	0,56	0,82	1	1,53	2,00	2,41	2,90		
Other	0,61	0,93	1	1,58	2,09	2,60	3,16		
Useful energy									
Industry	0,78	0,94	1	1,20	1,37	1,49	1,61	**0,68**	**0,44**
Chemical	0,55	0,66	1	1,17	1,30	1,39	1,48	**0,75**	**0,37**
Food	1,49	1,49	1	1,03	1,07	1,10	1,13	**11,34**	**0,24**
Metals	1,06	1,02	1	1,14	1,30	1,45	1,58	**0,41**	**0,38**
Non-metallic Minerals	0,55	0,96	1	1,31	1,50	1,64	1,78	**0,59**	**0,49**
Pulp&Paper	0,78	1,20	1	1,06	1,13	1,18	1,22	**-1,54**	**0,29**
Wood	0,31	0,50	1	1,23	1,39	1,51	1,63	**2,11**	**0,45**
Other	1,95	2,05	1	1,18	1,30	1,40	1,49	**-1,29**	**0,34**

Projections of energy prices

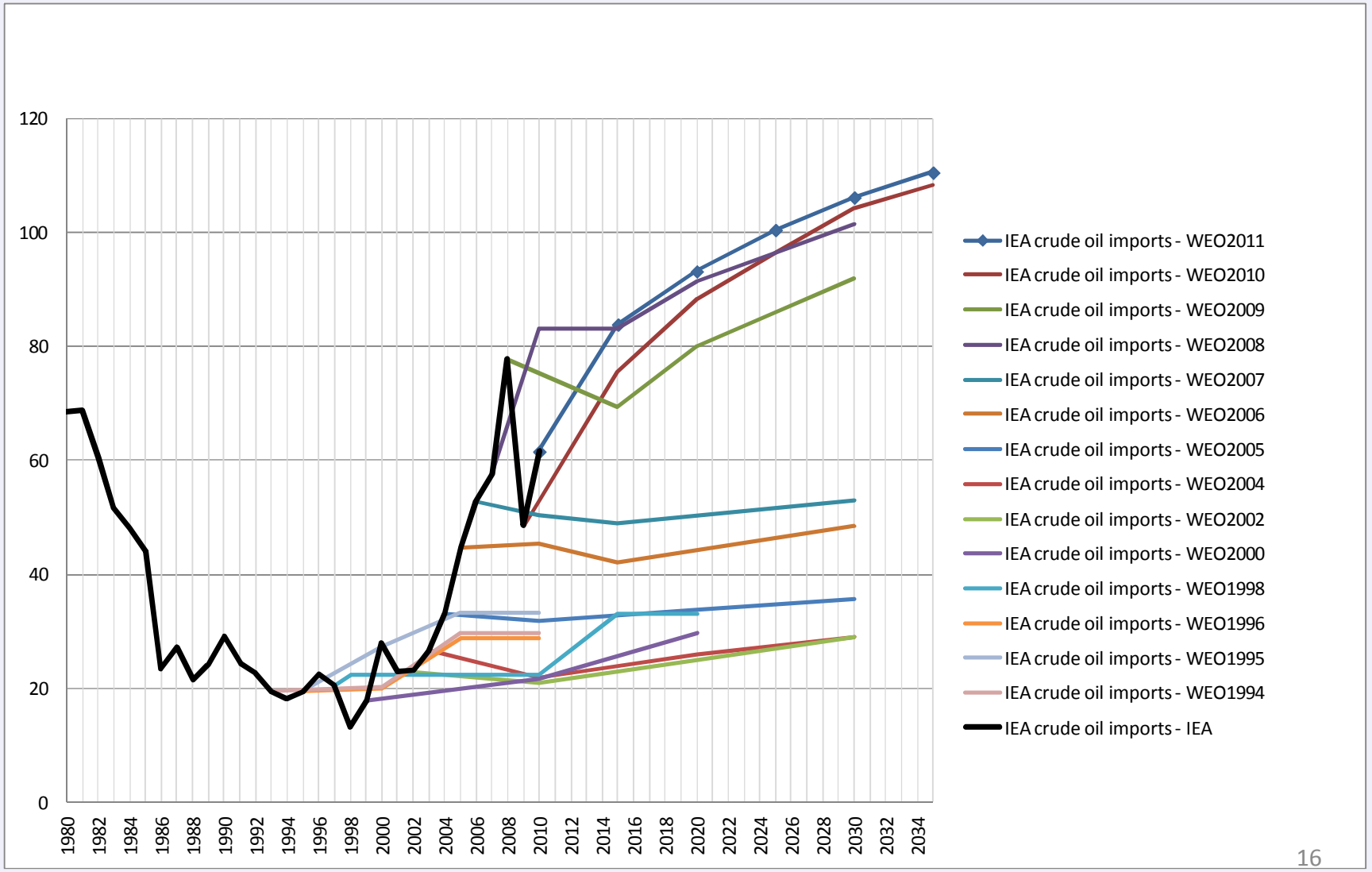


Separately are tacked into account energy&emission taxes and fuel delivery costs

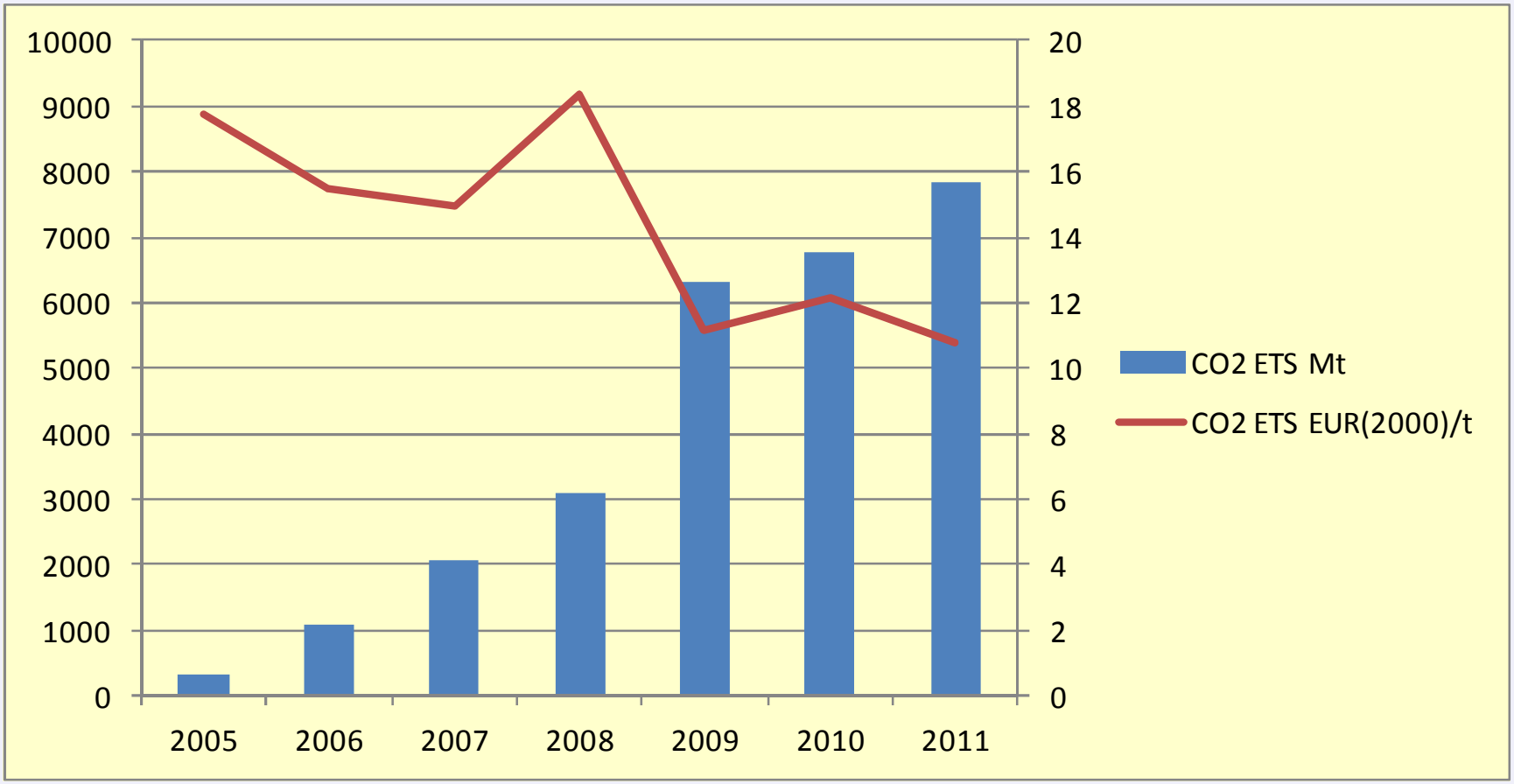
Price ratios are important



OIL import price of IEA countries and IEA WEO projections, US$2000/barrel



Uncertain is price of CO_2



Source: Series of publication State and trends of the Carbon Market, World Bank

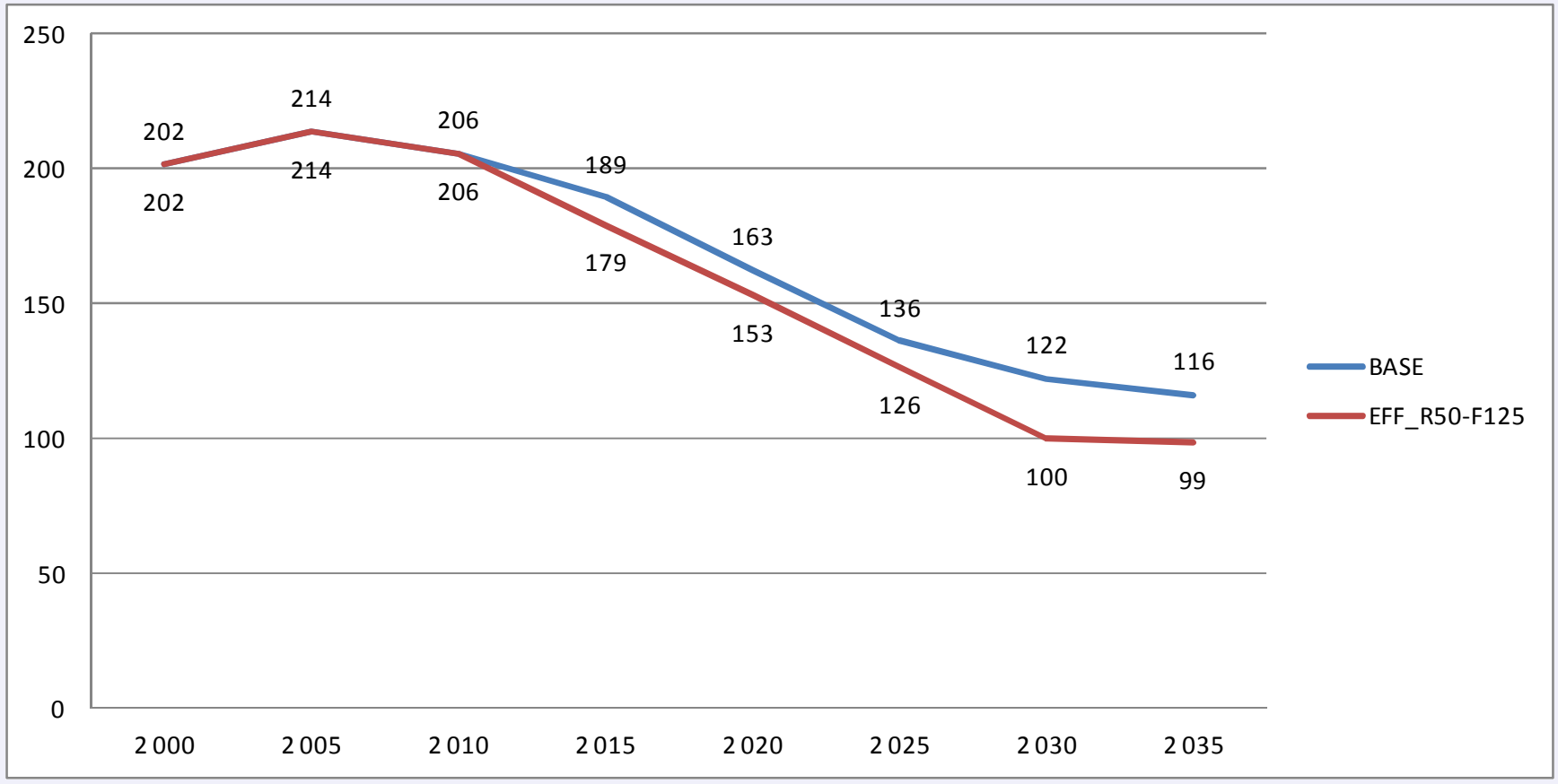
Modeling Energy Strategy - Recent results

- Projects funded by
  - State energy research programme
  - Soros Foundation – Latvia
  - Public Utilities Commission
  - Ministry of Economics of the Republic of Latvia

Definitions of scenarios

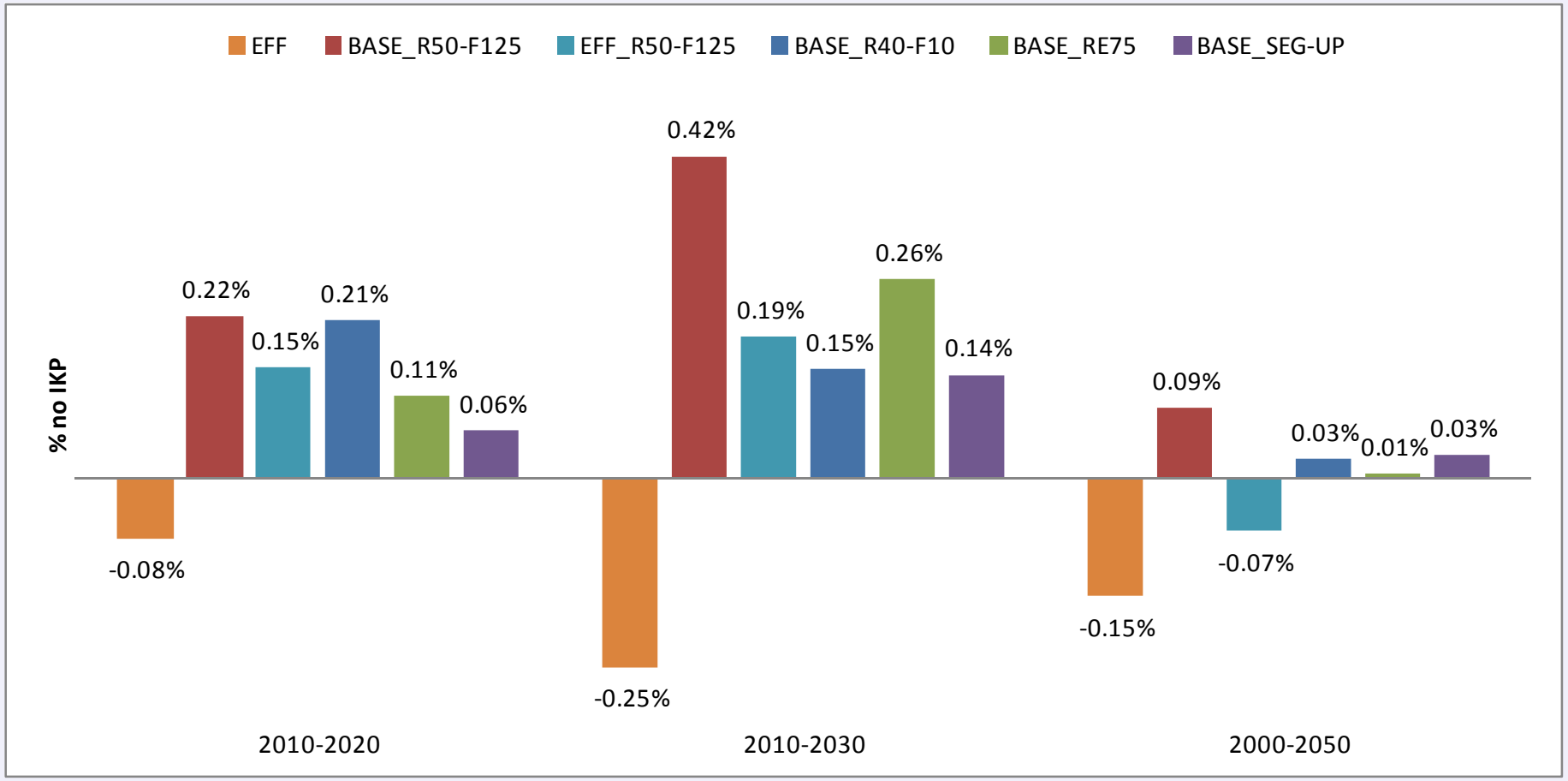
- **BASE** with Existing P&M
- **EFF (efficiency SC)** - BASE + Heat consumption for heating in residential houses – 153 (2020) and 100 (2030) kWh/m^2
- **BASE_R40-F10 (RES 40% SC)** - BASE + RES 40% from 2020 (RES-F – 10%)
- **EFF_R40-F10** - EFF+ BASE_R40-F10
- **BASE_R50-F125 (RES 50% SC)** - BASE_R40-F10 + RES 50% in 2030 (RES-F – 12.5%)
- **EFF_R50-F125 (Energy strategy SC)** – EFF + BASE_R50-F125
- **BASE_RE75 (RES-E 75% SC)** - BASE + RES-E 75% from 2030
- **BASE_SEG-UP (GHG emission cup SC)** - BASE + GHG emission cup 8550 Gg from 2020
- **EFF_SEG-UP** - EFF+ BASE_SEG-UP

Energy consumption for heating in Residential sector, kWh/m²

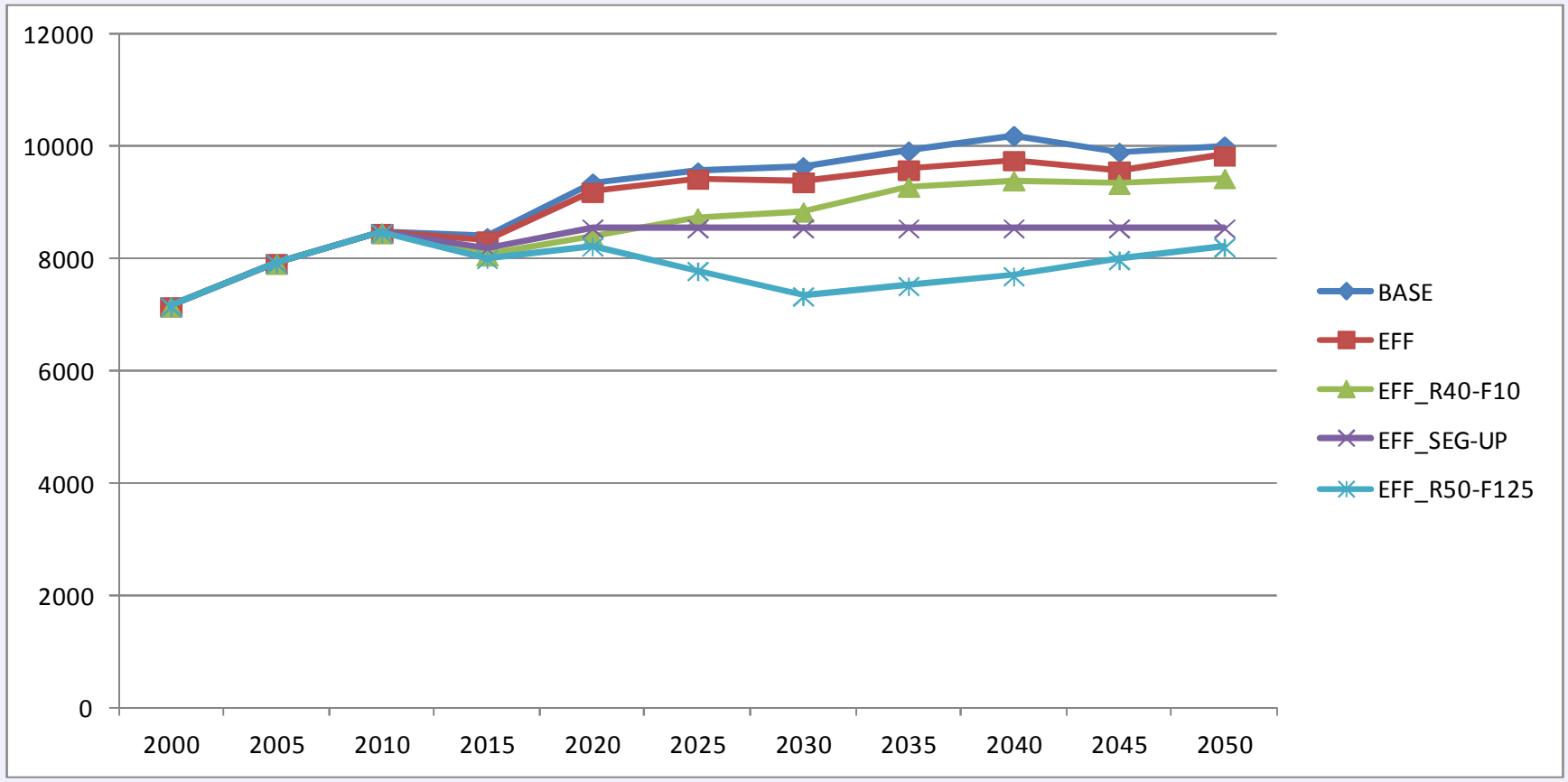


Changes of Total system cost of GDP

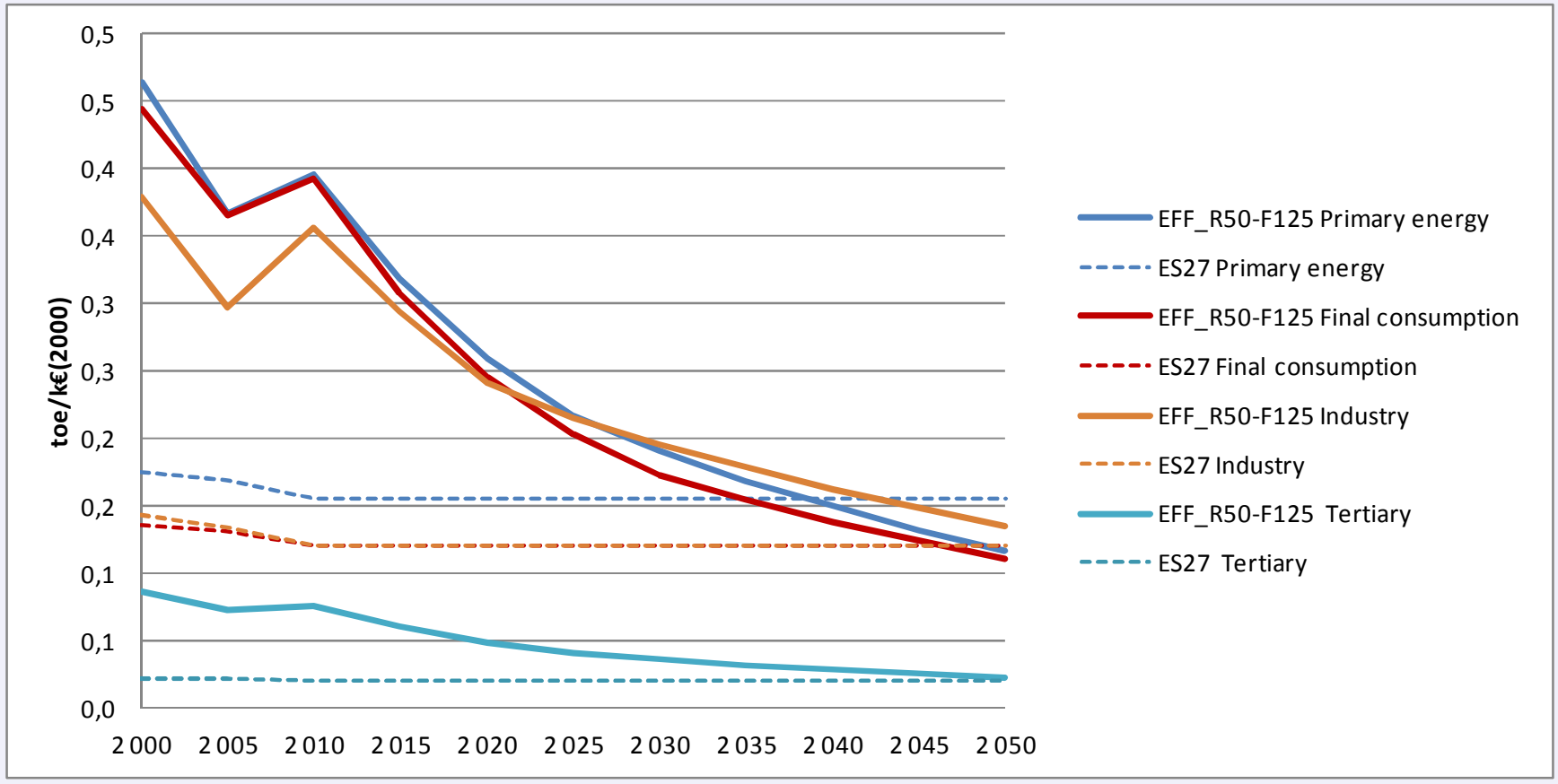
%=(BASEsc-Xsc)/GDP



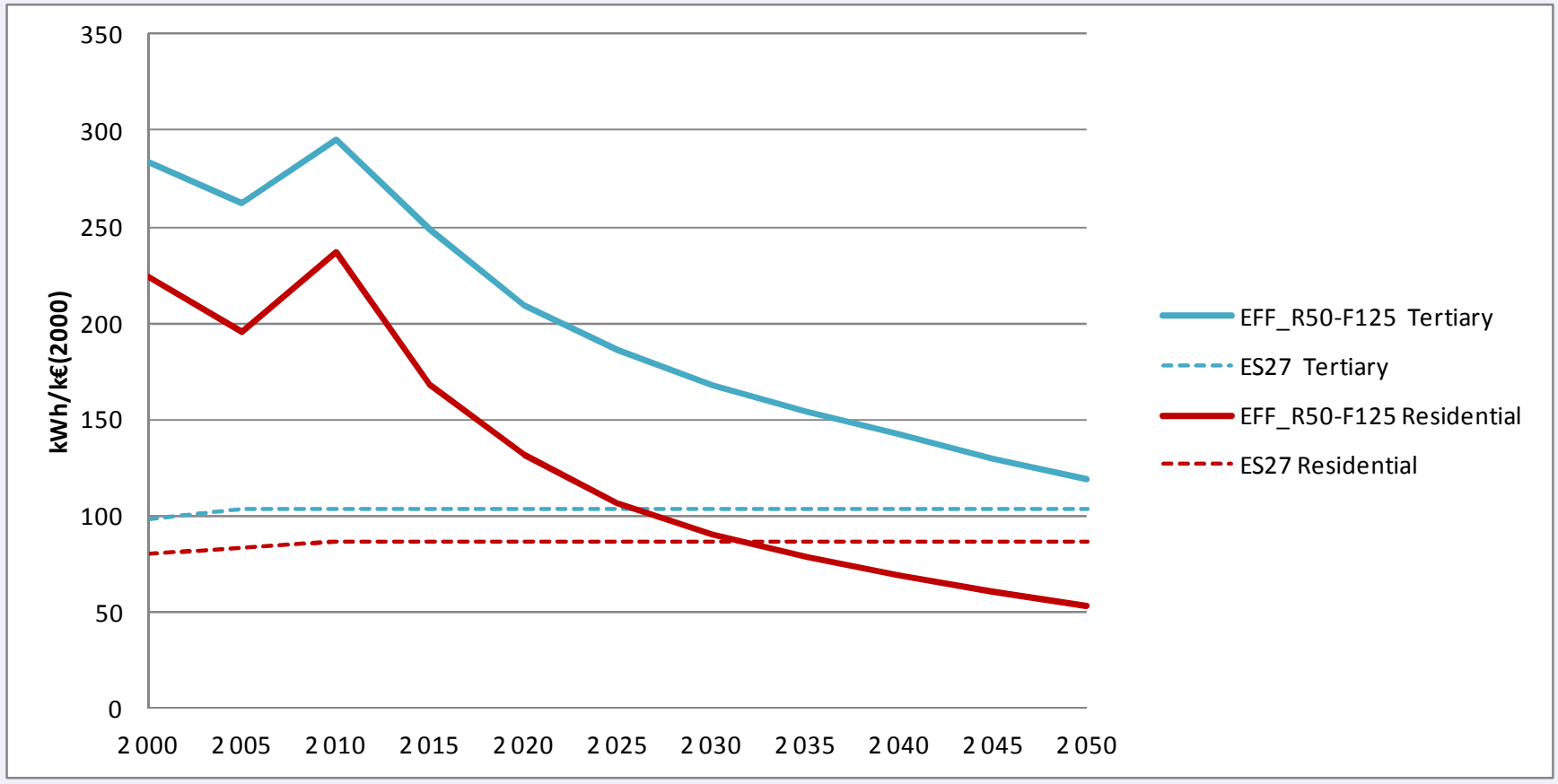
GHG emissions, Gg



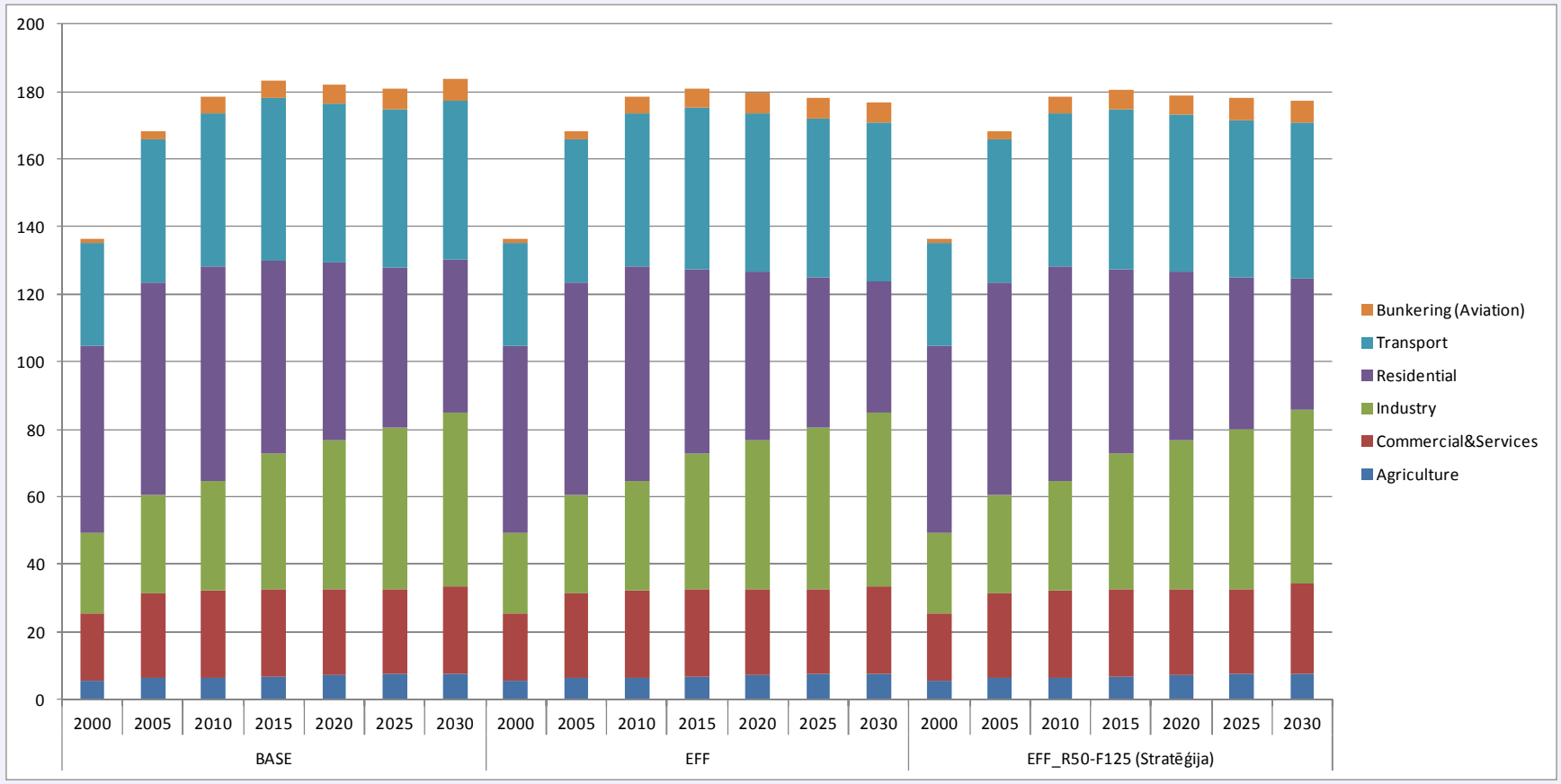
Energy intensity



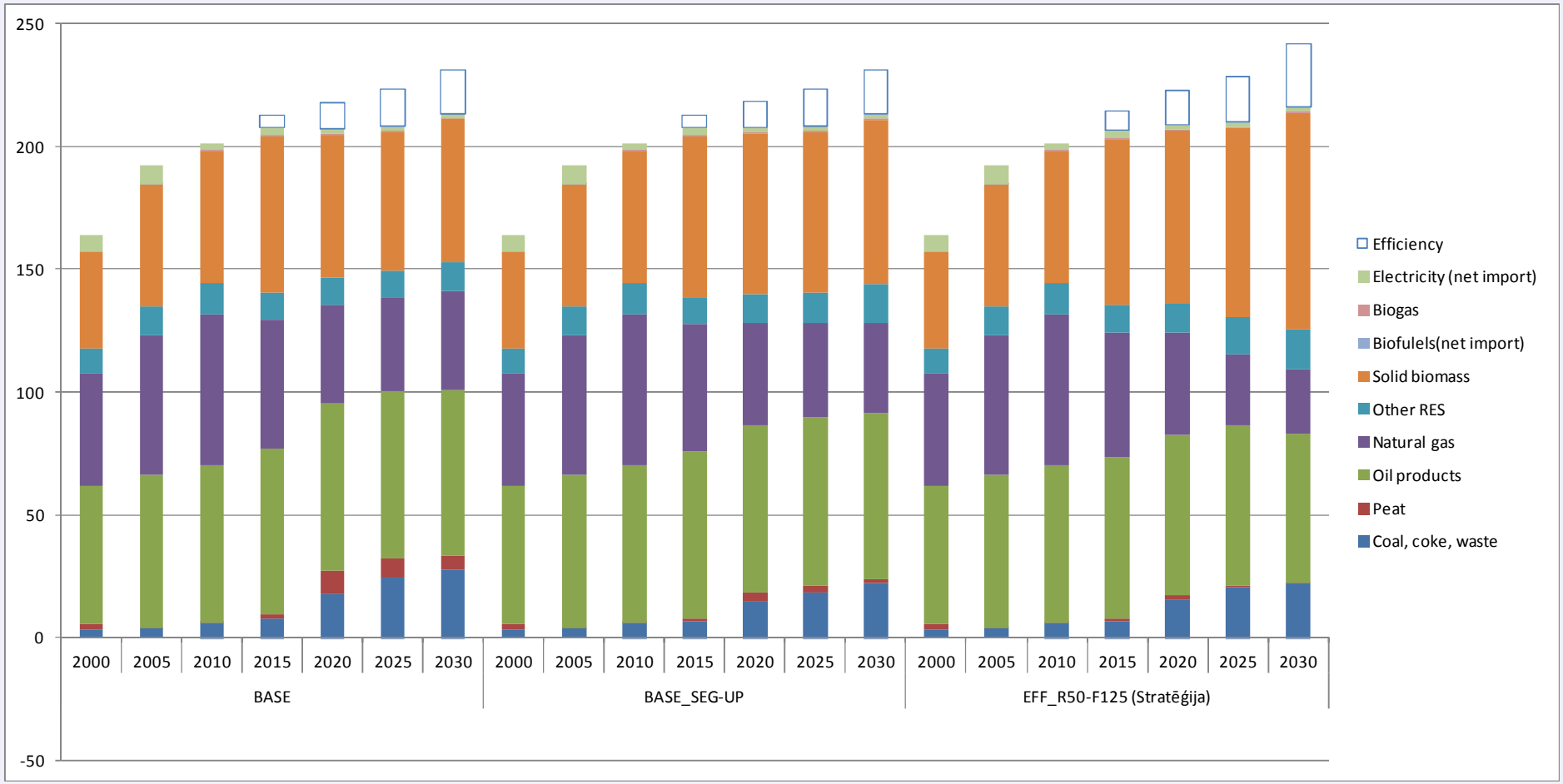
Electricity intensity



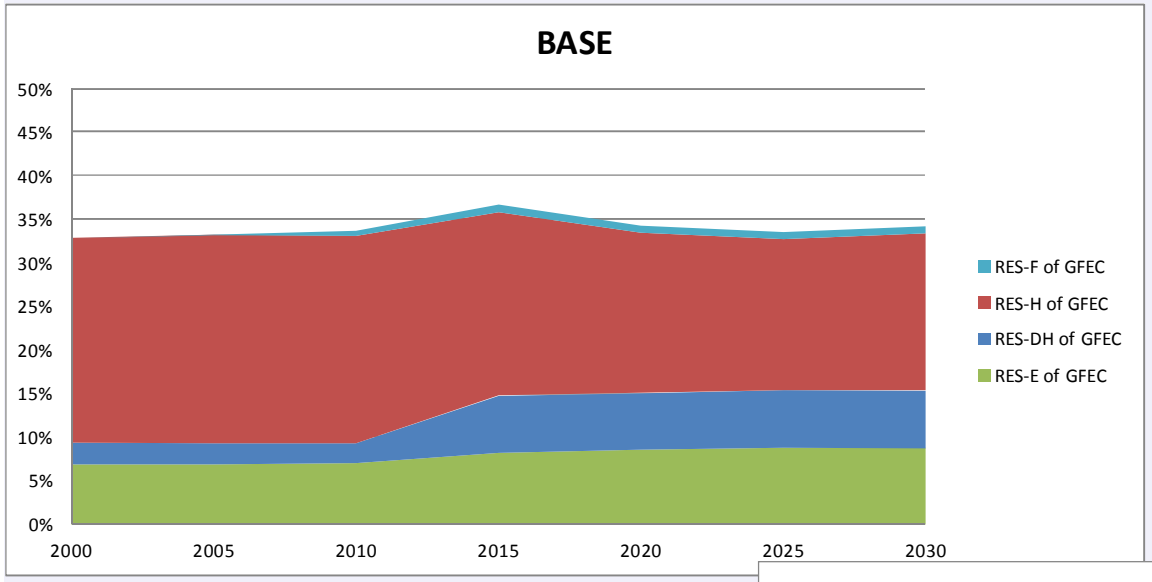
Final energy consumption, PJ

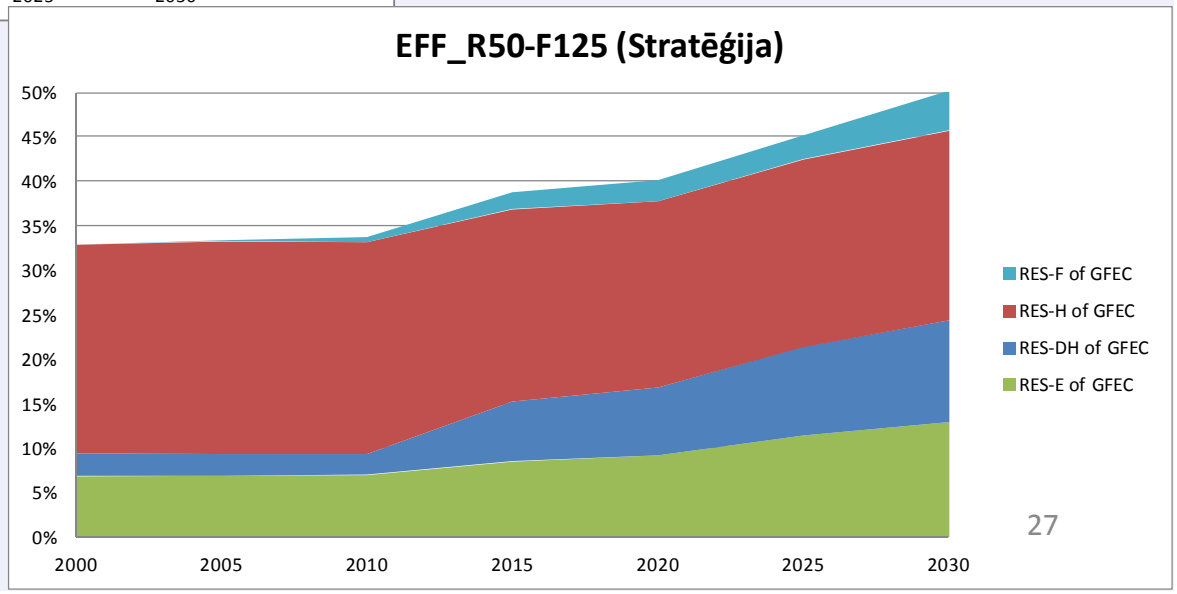


Primary energy consumption, PJ

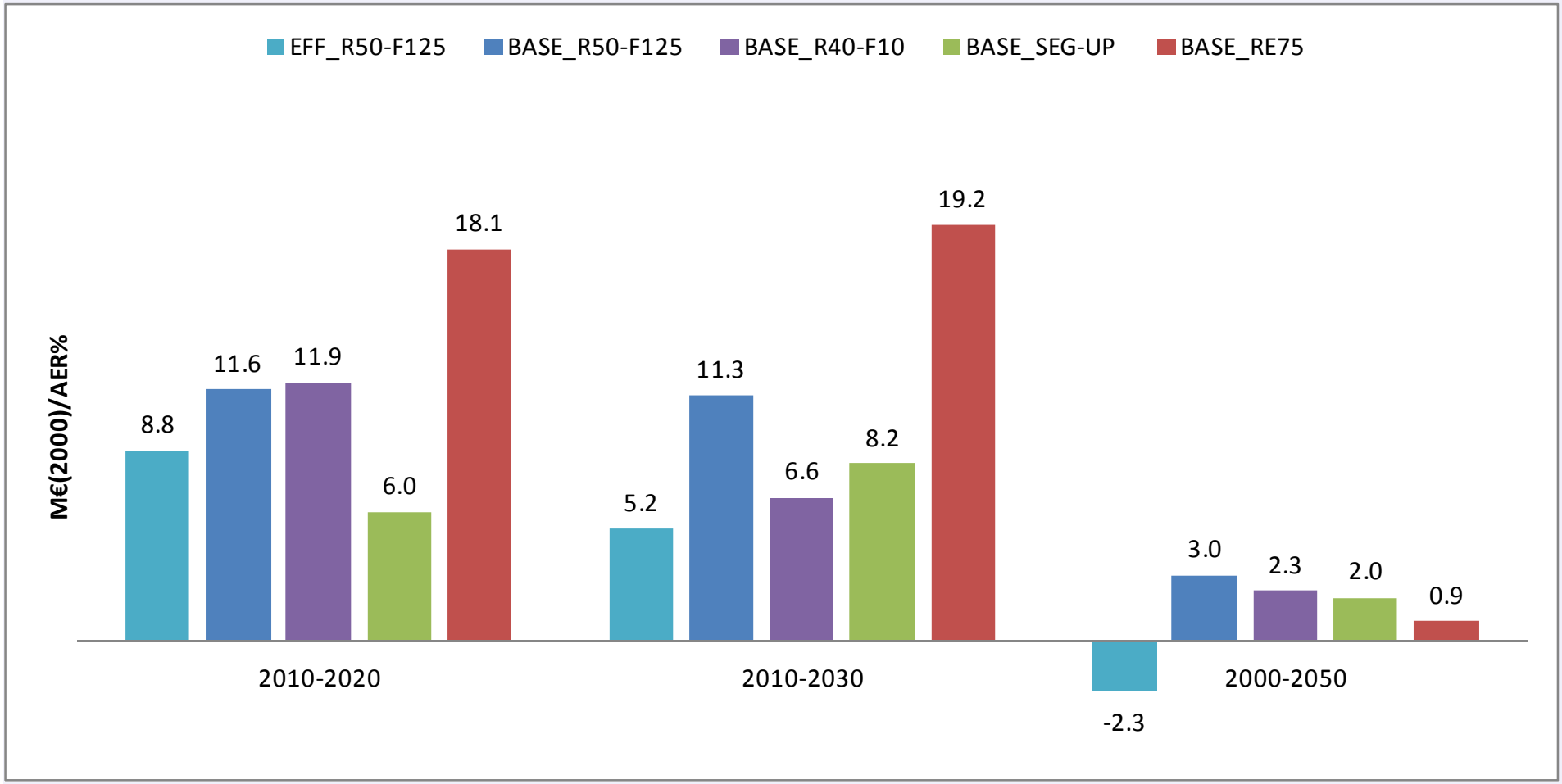


RES share in gross final consumption of energy





How much costs one percentage point of additional RES



Issues

- Initial costs for software
- Model development is a long-term and continuous process
  - Change in staff
- Data intensive characterization of technologies and reference energy system used to be labor intensive
- Results sometimes sensitive to small changes in data assumptions
- Limited ability to model consumer behavior
- Emission factors for new fuels&technologies
- Discrepancy between structure of energy balance and emission inventory (e.g. off-road, auto producers)
- ETS and noETS sectors

THANK YOU FOR ATTENTION!!!