ICELAND LIECHTENSTEIN NORWAY eea grants

MINISTRY OF ENVIRONMENTAL PROTECTION AND REGIONAL DEVELOPMENT

Development and implementation of policies, measures, and national systems – projections

Oslo, November 10, 2015

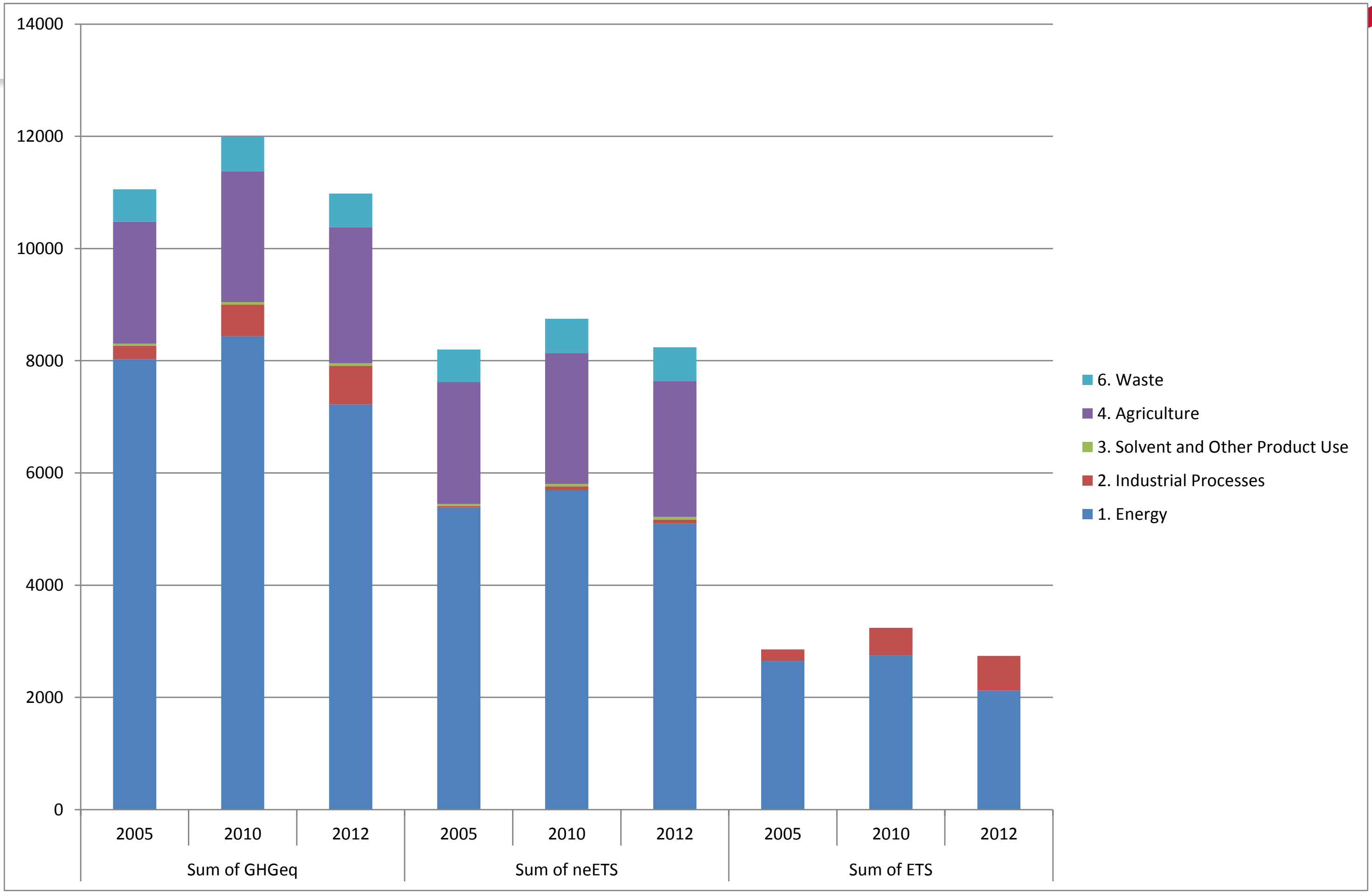
Norwegian Environment Agency (Grensesvingen 7, Oslo, Norway)

Projections for Energy sector

Dr. J.Rekis

Institute for Physical Energetics, Latvia

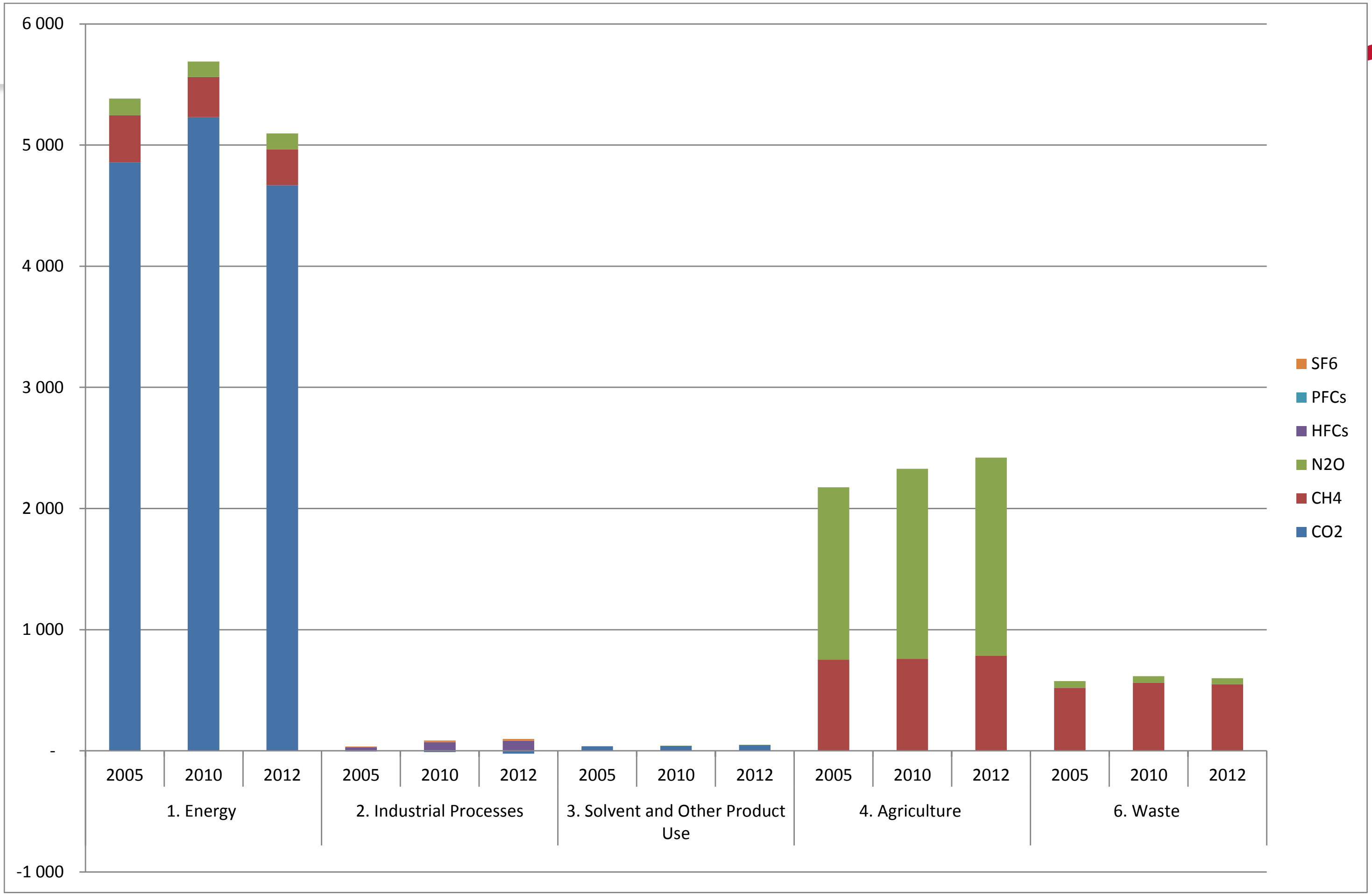
FEI



Total, non-ETS and ETS GHG emissions, Gg

Largest GHG emission source is Energy (66% in 2012), followed by agriculture with 22%

ETS covers approx. ¼ of total GHG emissions



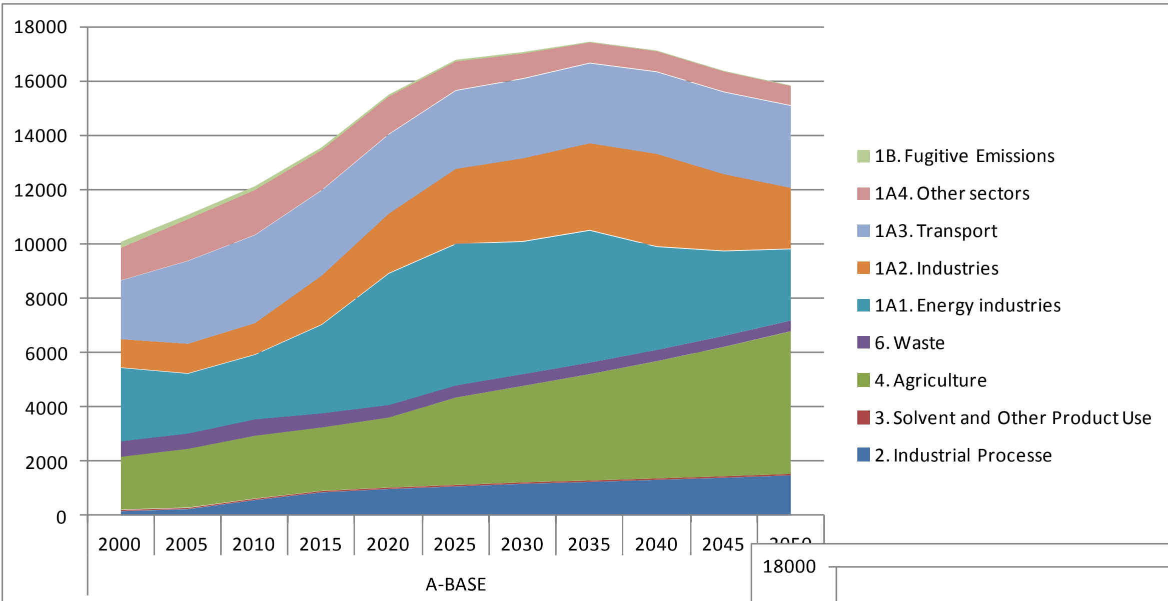
GHG emissions in non-ETS by gas, Gg

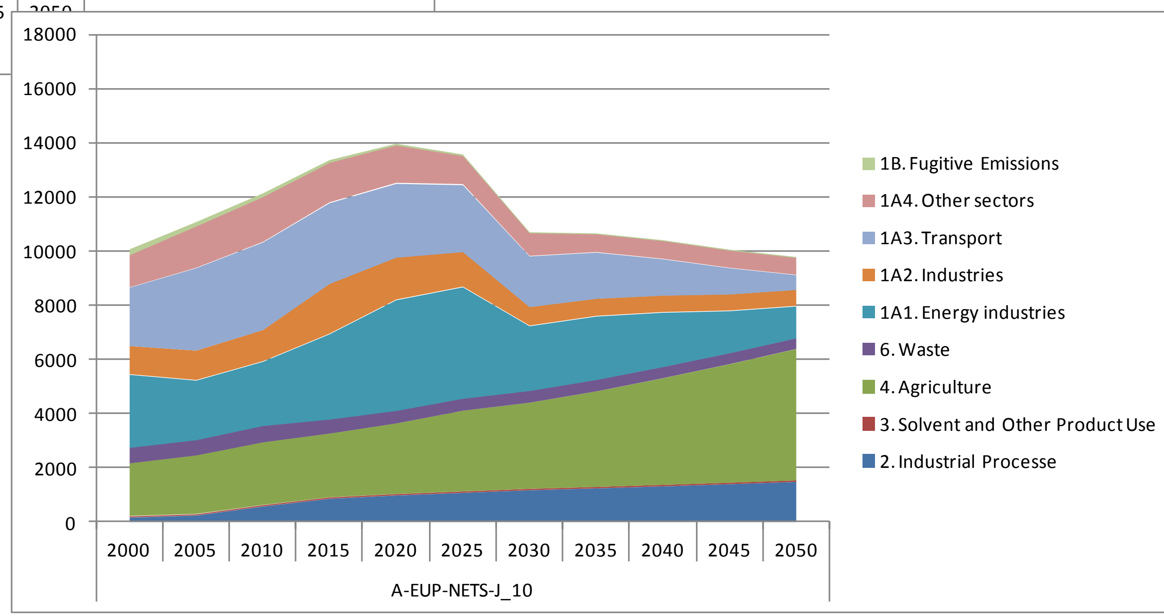
In 2012 57% of the total non-ETS sector GHG emissions is CO_2, followed by 22% N_2O and CH_4 20%

The biggest emitter of GHG in non-ETS sector, with 62% are energy, followed by agriculture with 29%

GHG EMISSION PROJECTION EXAMPLE

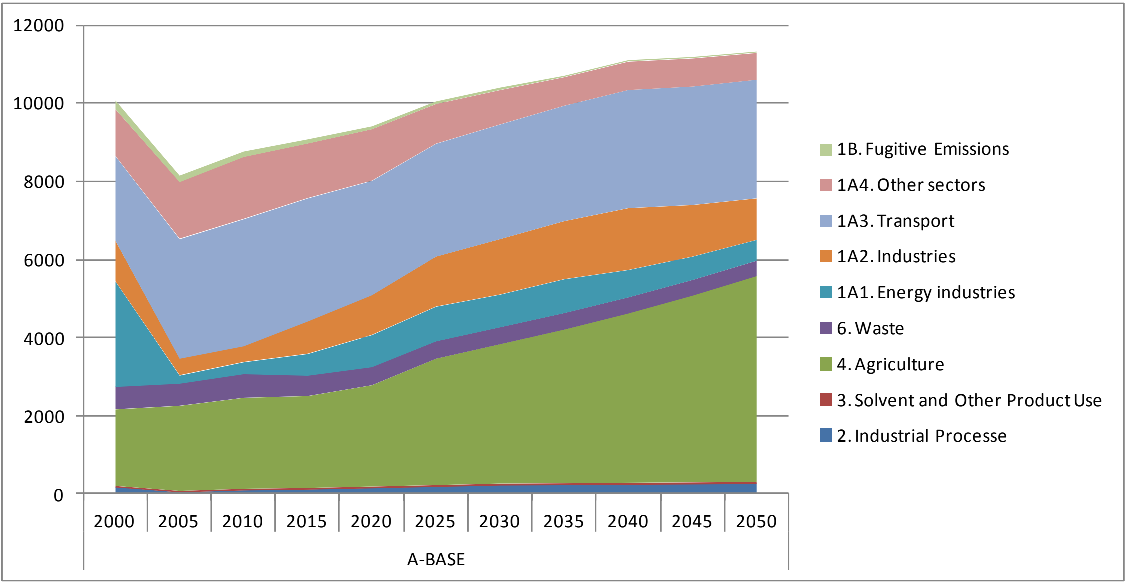
GHG emissions in WEM and 10% reduction (A-EUP-NETS_10) sc., GG CO_2^{eq}

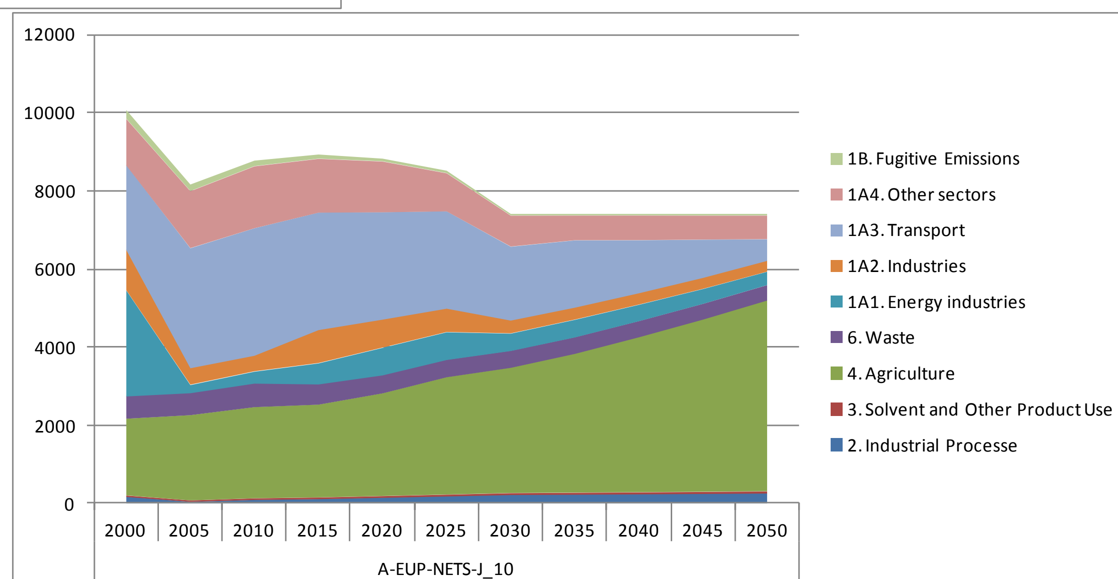




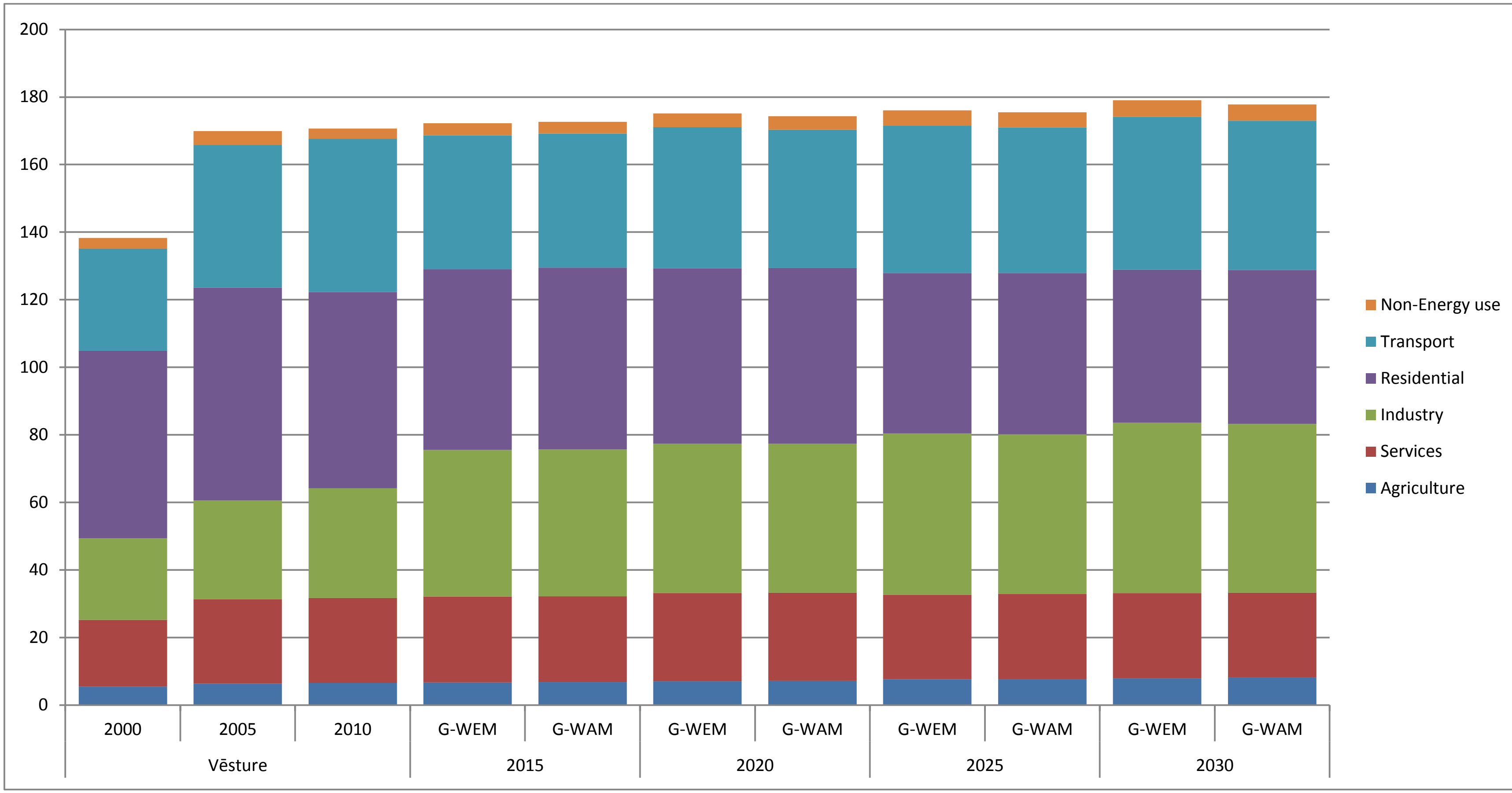
Cap putted on non ETS sector emissions
Tax imposed for ETS sector

GHG emissions in non-ETS sector in WEM and 10% reduction (A-EUP-NETS_10) sc., GG CO_2^{eq}

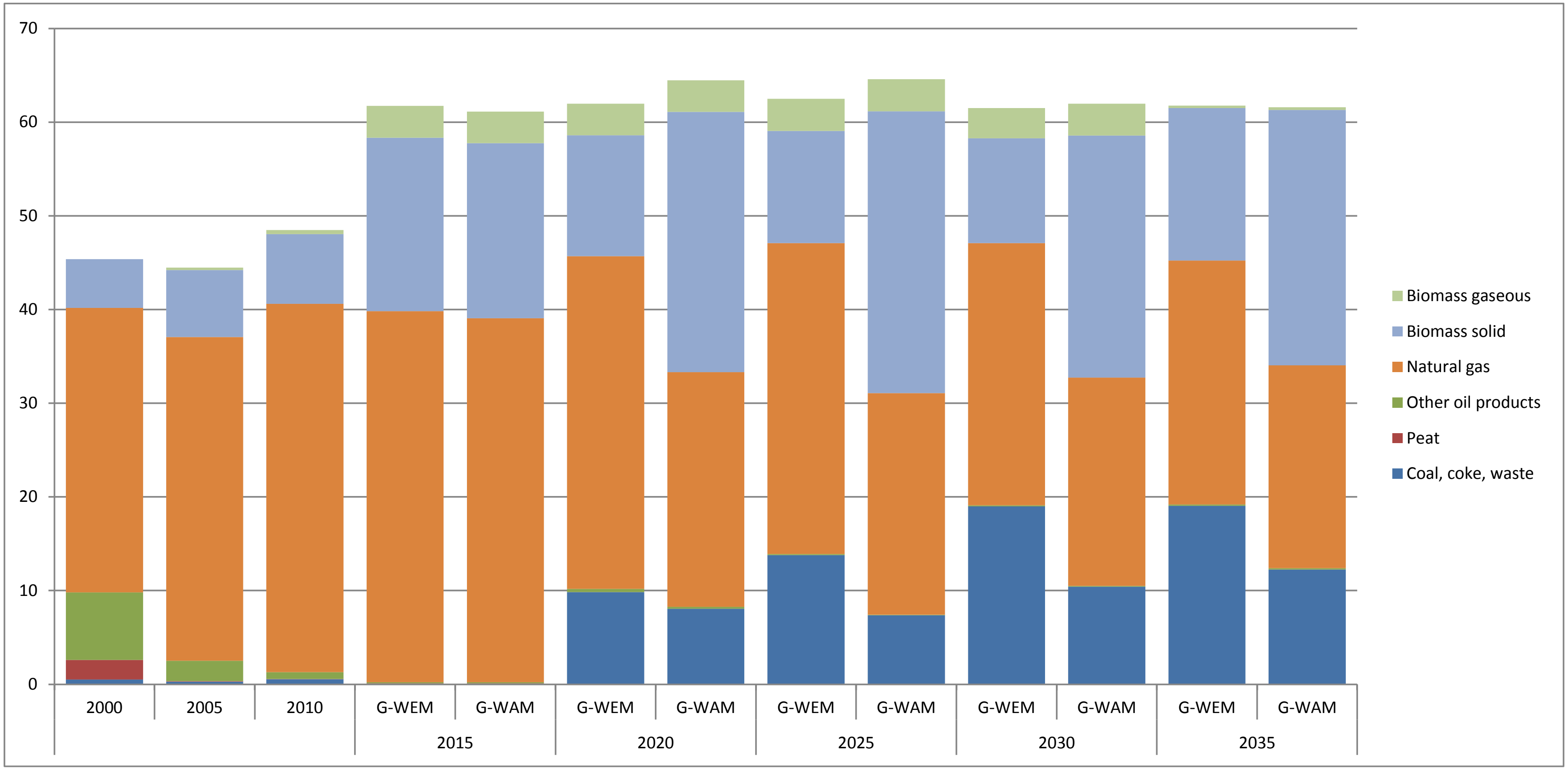




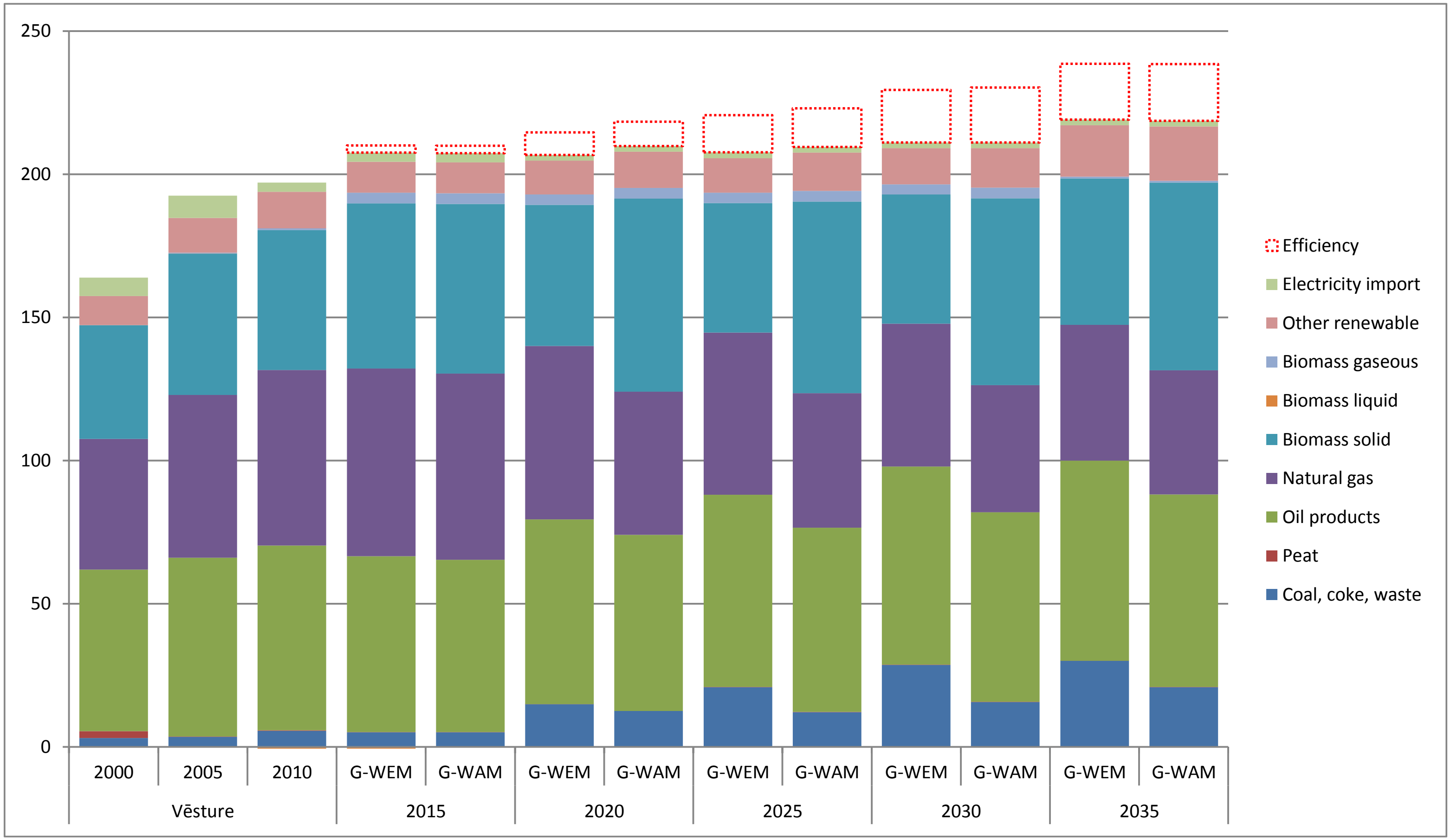
Final energy consumption, PJ



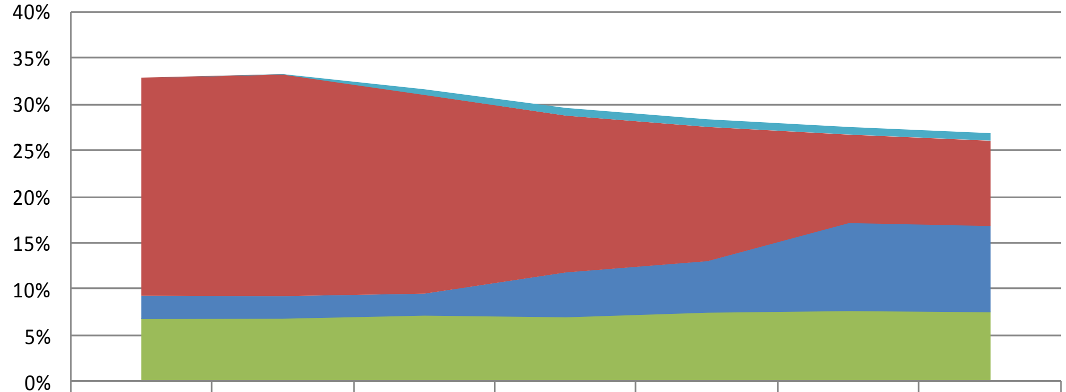
Energy consumption in transformation, PJ



Primary energy consumption, PJ

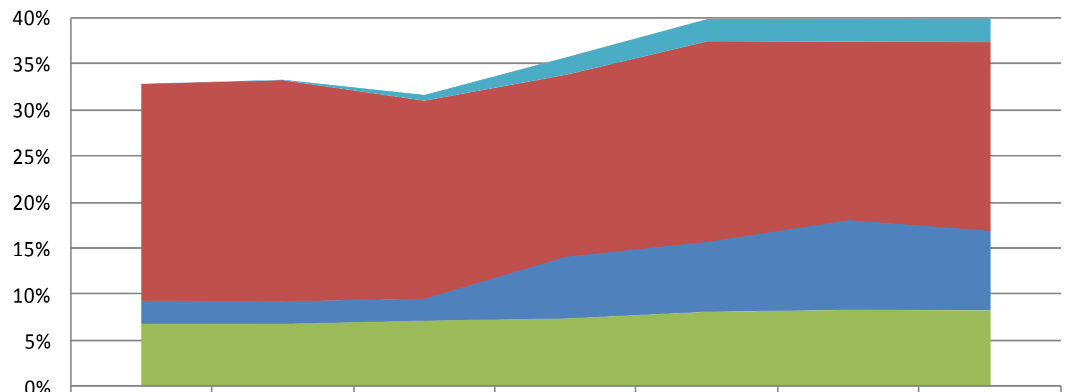


D-BASE



	2000	2005	2010	2015	2020	2025	2030
RES-F of GFEC	0.0%	0.1%	0.6%	0.8%	0.8%	0.8%	0.8%
RES-H of GFEC	23.5%	23.9%	21.5%	16.9%	14.5%	9.5%	9.2%
RES-DH of GFEC	2.5%	2.4%	2.4%	4.8%	5.6%	9.5%	9.3%
RES-E of GFEC	6.9%	6.9%	7.2%	7.0%	7.5%	7.7%	7.6%

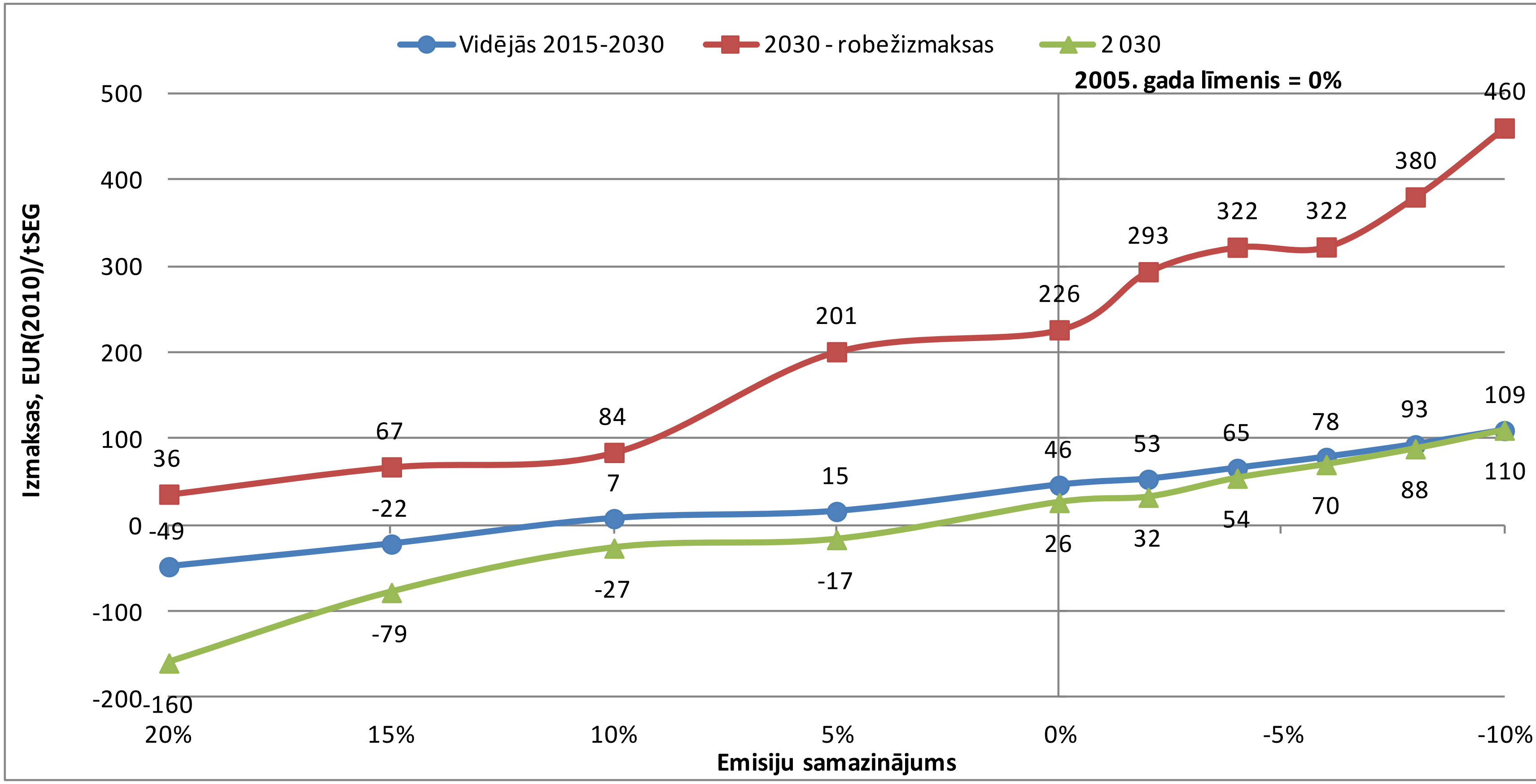
D-WAM



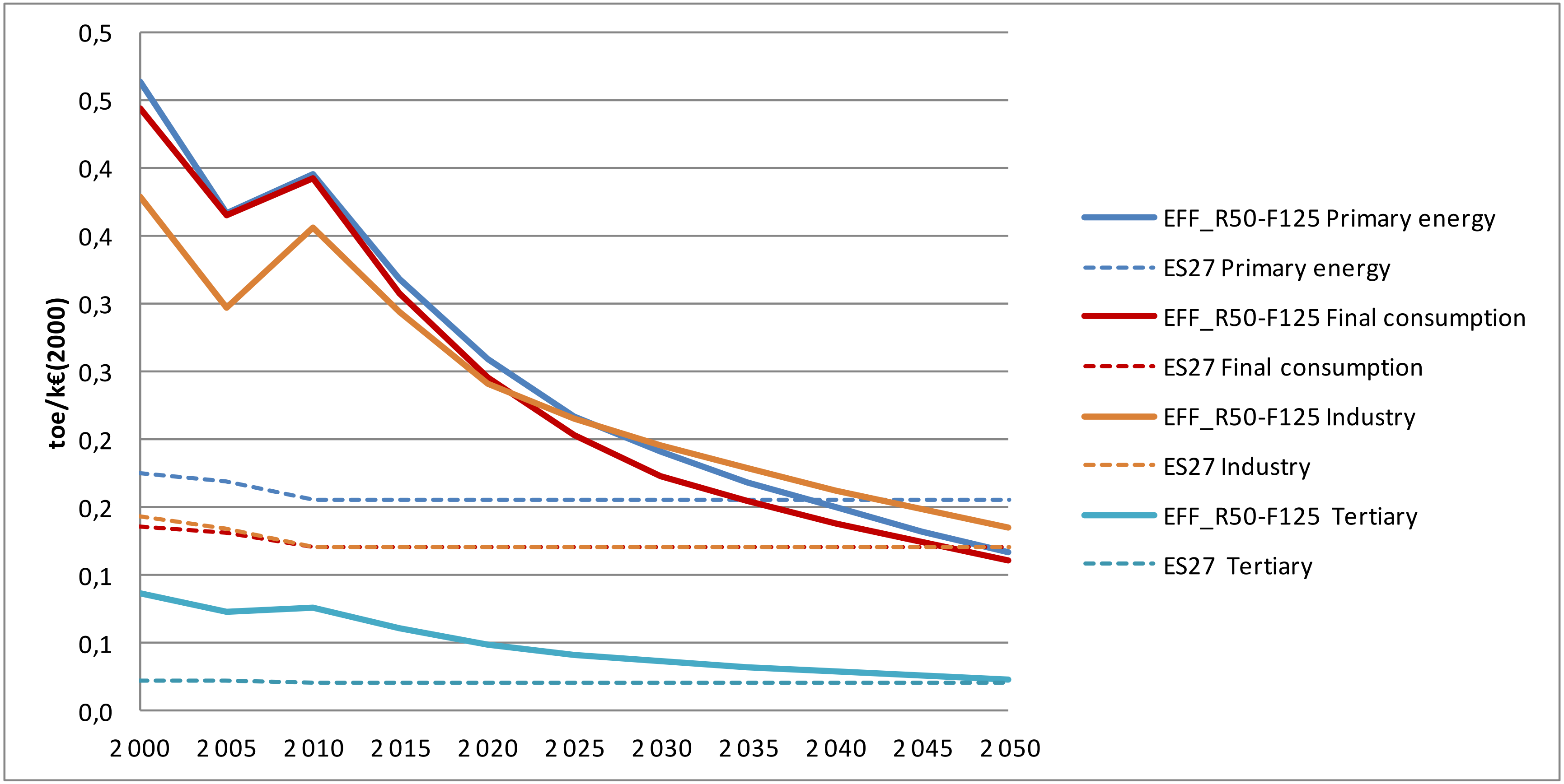
	2000	2005	2010	2015	2020	2025	2030
RES-F of GFEC	0.0%	0.1%	0.6%	1.9%	2.4%	2.5%	2.5%
RES-H of GFEC	23.5%	23.9%	21.5%	19.7%	21.7%	19.3%	20.5%
RES-DH of GFEC	2.5%	2.4%	2.4%	6.7%	7.6%	9.7%	8.6%
RES-E of GFEC	6.9%	6.9%	7.2%	7.4%	8.2%	8.4%	8.3%

RES SHARES IN GROSS FINAL ENERGY CONSUMPTION, %

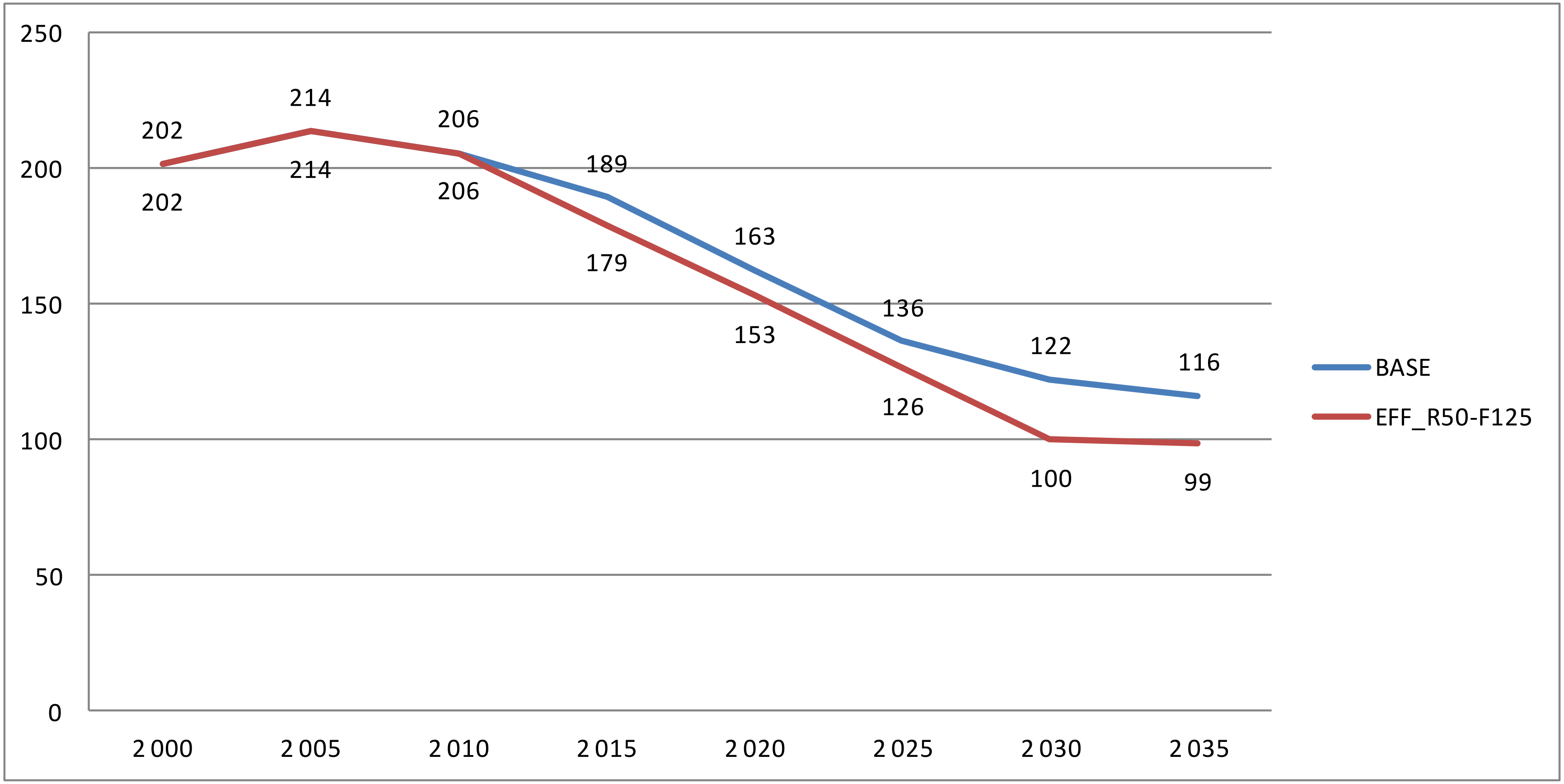
GHG emission reduction in nonETS (against 2005) marginal and average costs, EUR(2010)/tCO_2^{eq}



Energy intensity



Energy consumption for heating in Residential sector, kWh/m²

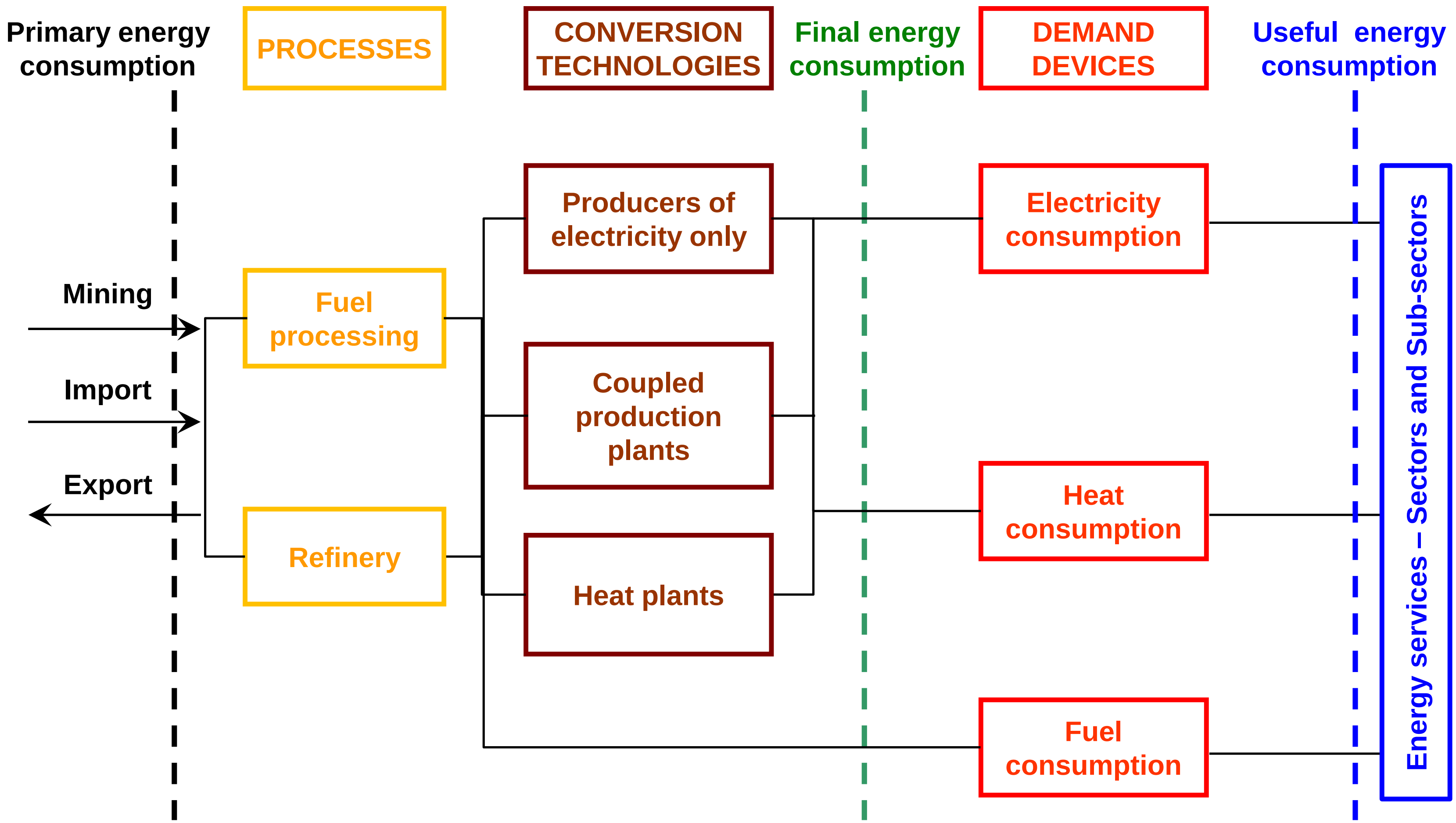


HOW WE CALCULATE?

Modeling approach

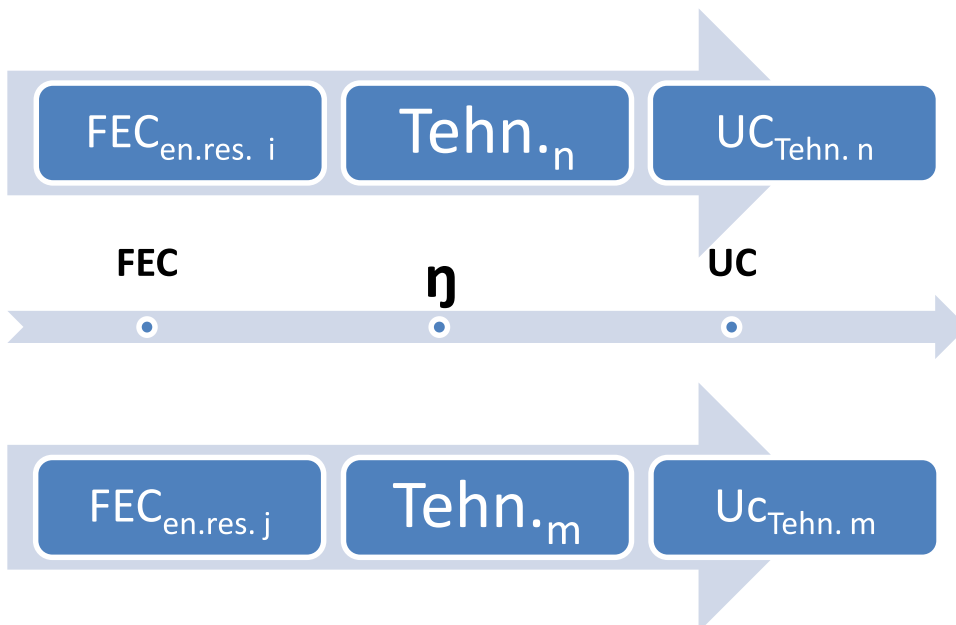
- Bottom-up technology rich optimization model
- Covers all energy system from resource extraction through to end-use as represented by a Reference Energy System (RES) network
- Spread of action between supply and demand
- Emissions taxes and constraints
- Identifies most cost-effective pattern and mix of resource use and technology deployment over time under varying constraints and alternate futures by optimizing system costs. 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

Model building blocks



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

Energy services or useful energy consumption (UC) are input paramiter
Final demand (FEC) are model result

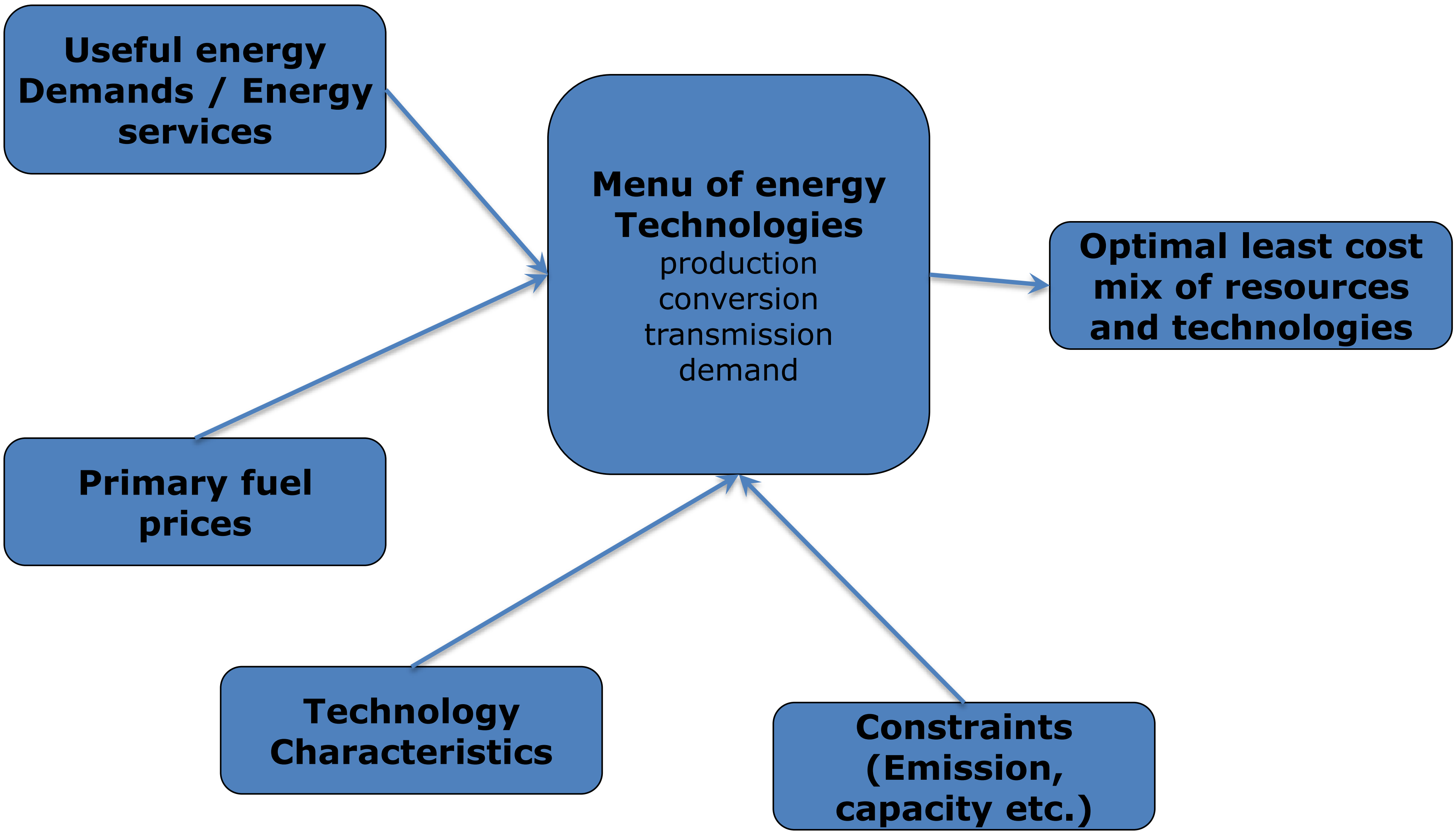


Insight into MARKAL use in Latvia

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

NECESSARY DATA

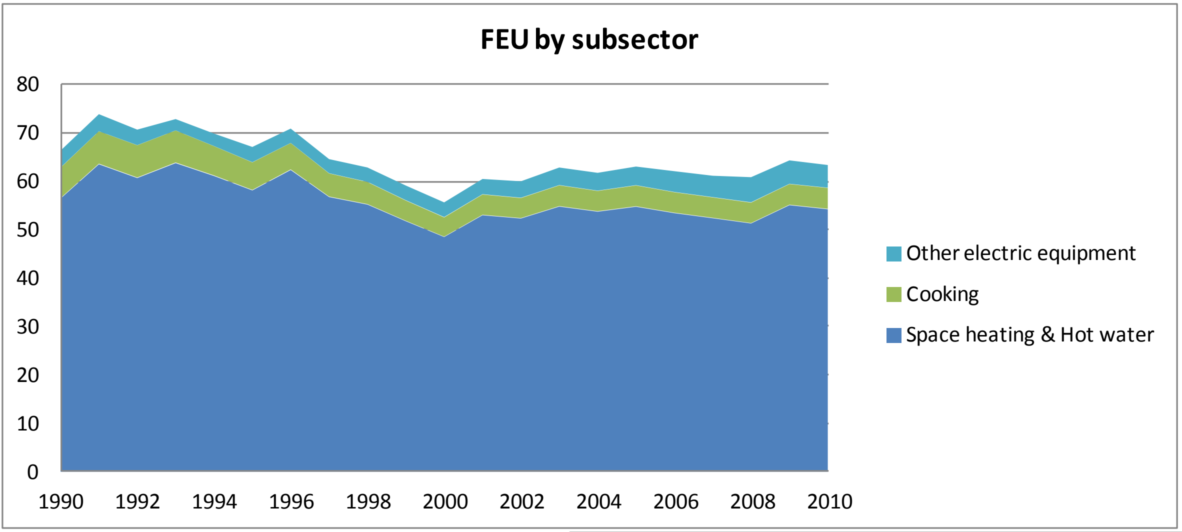
Overview of model (MARKAL)

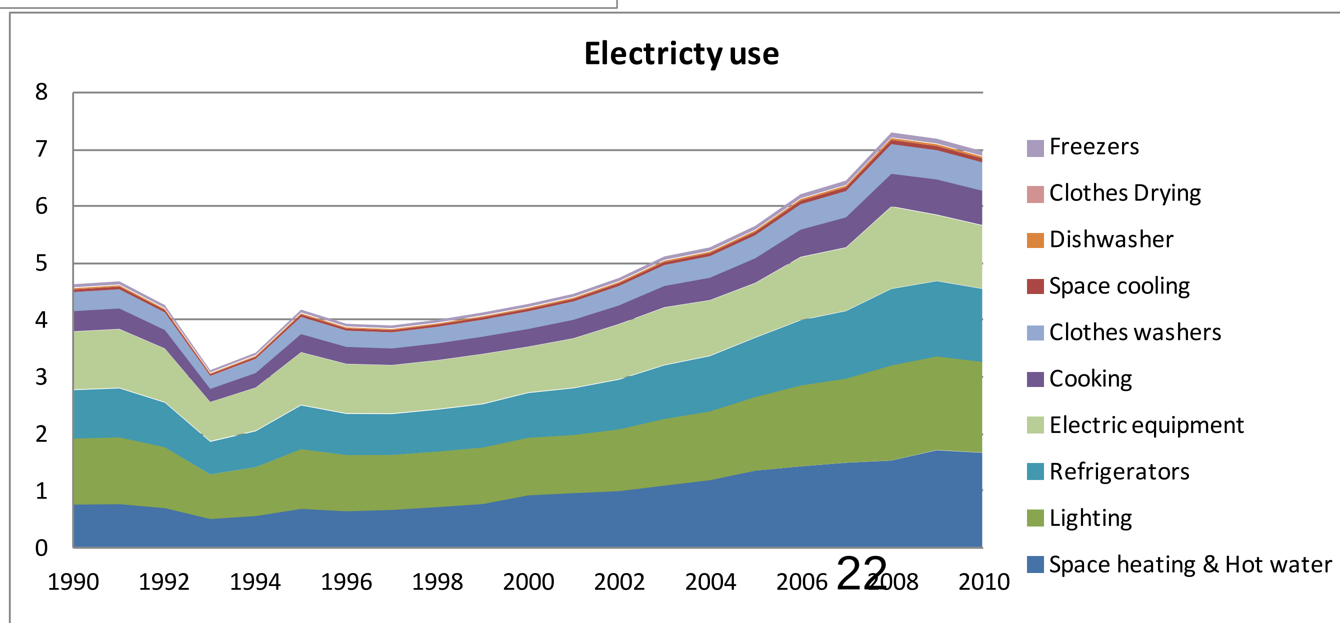


Useful demands / Energy services – Sectors and Sub-sectors

- **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)

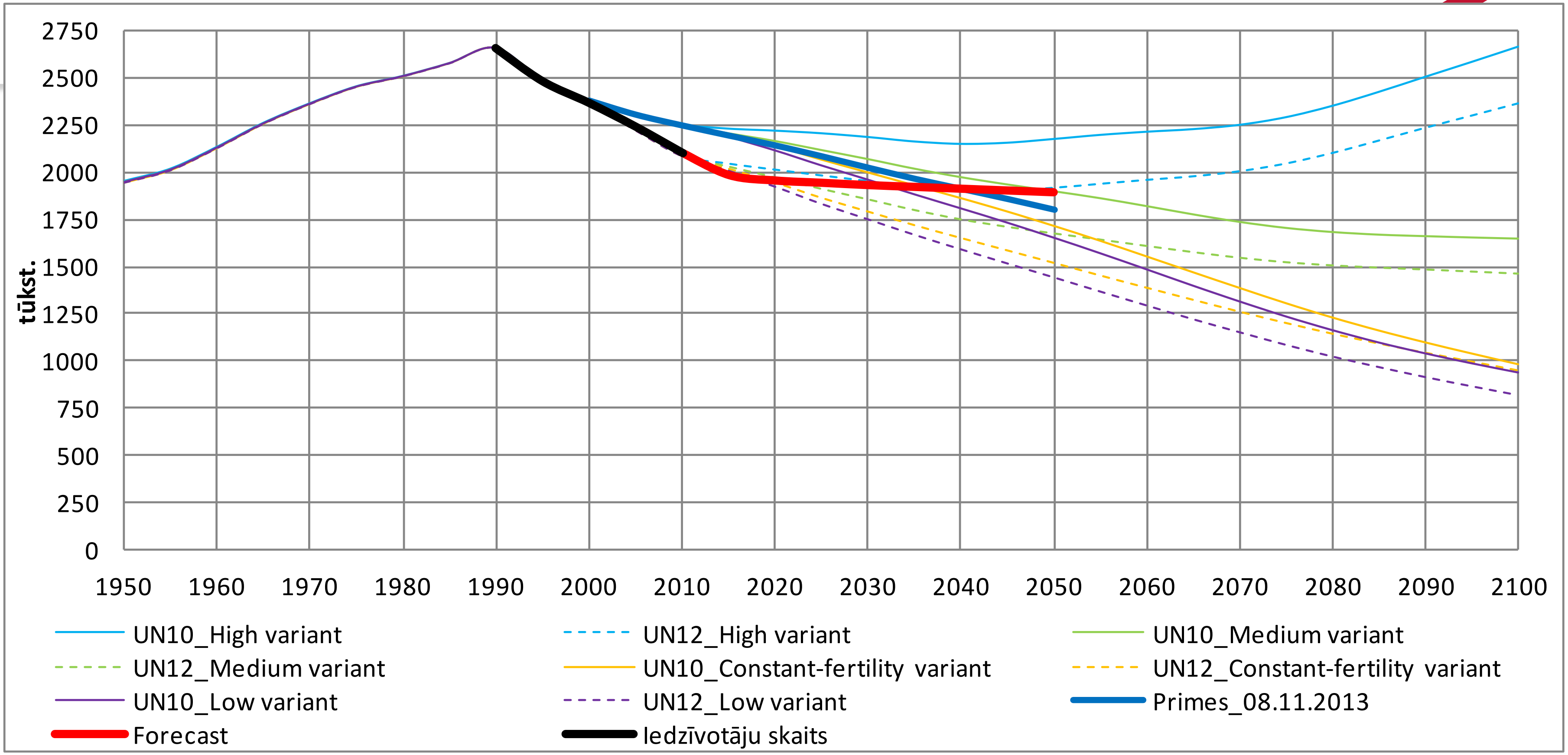
Residential FEC breakdown in sub-sectors





Challenges for Data

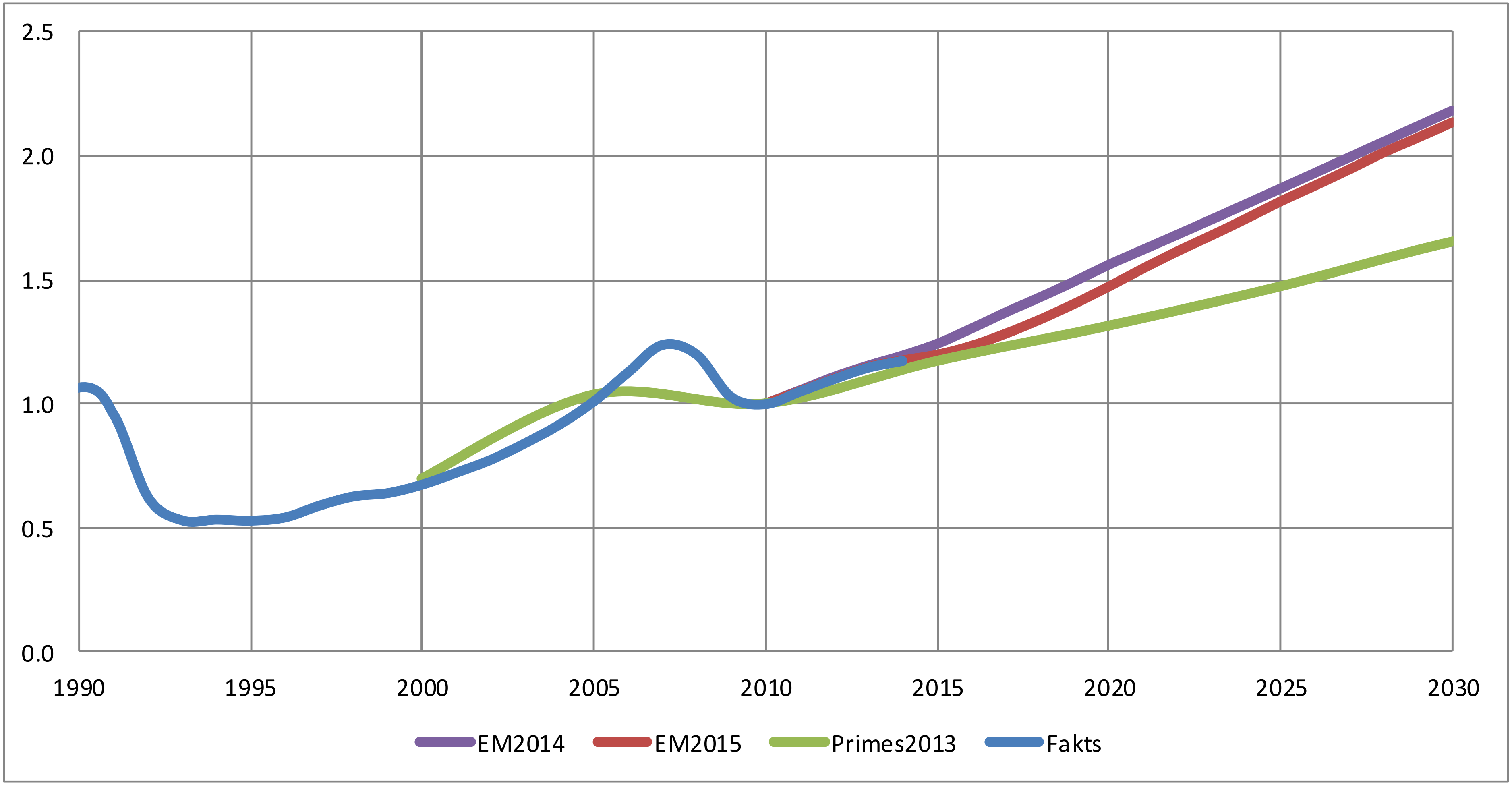
- GDP projections – how to project future development of our economy?
- Useful Energy Demand projections – how to project behavior of our customers? How to link with macroeconomic forecast? What is demand elasticities?
- Primary energy prices projections – how to project future prices in global fuel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



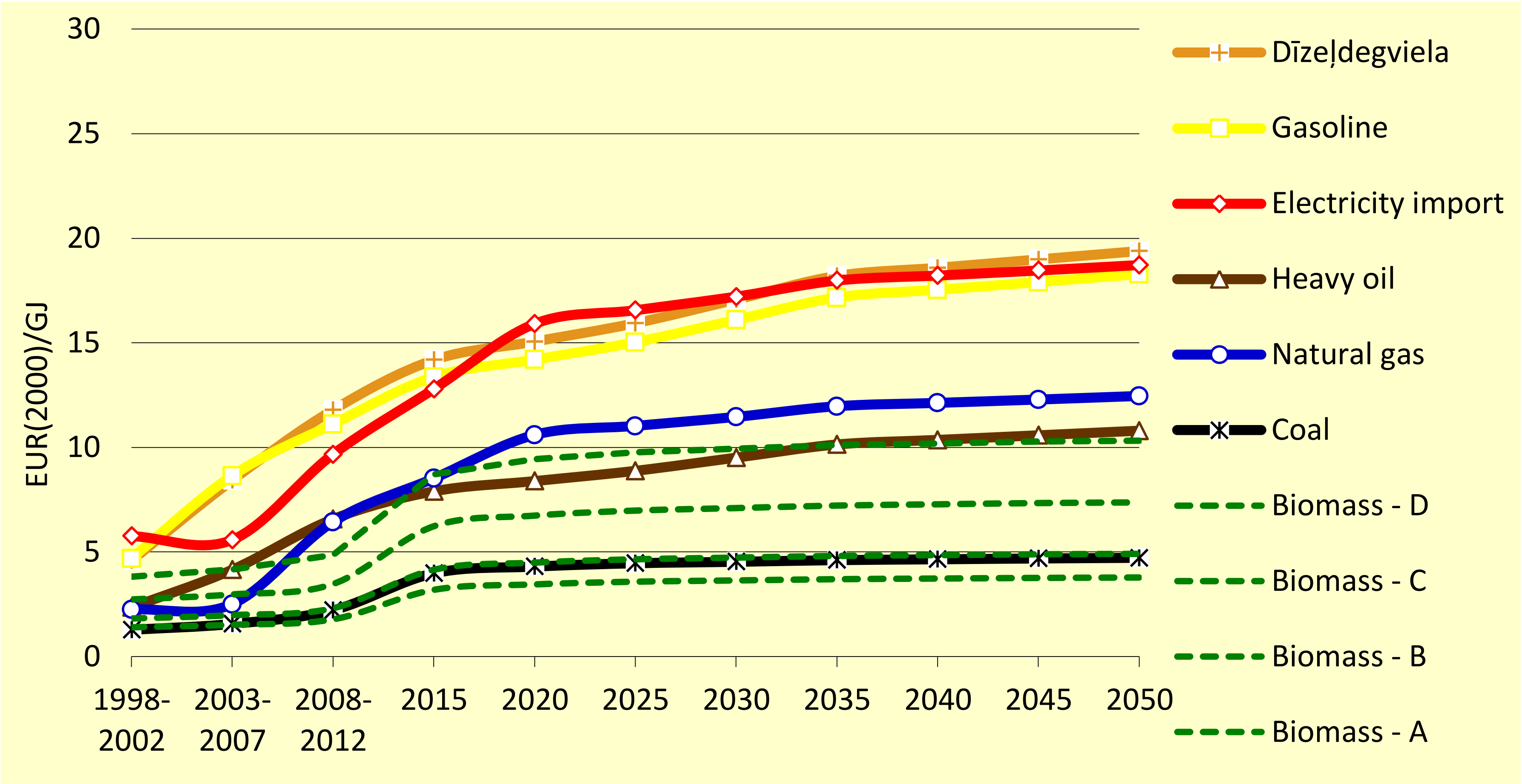
Population

Source: Primes 2013; UN World Population Prospects

GDP projection

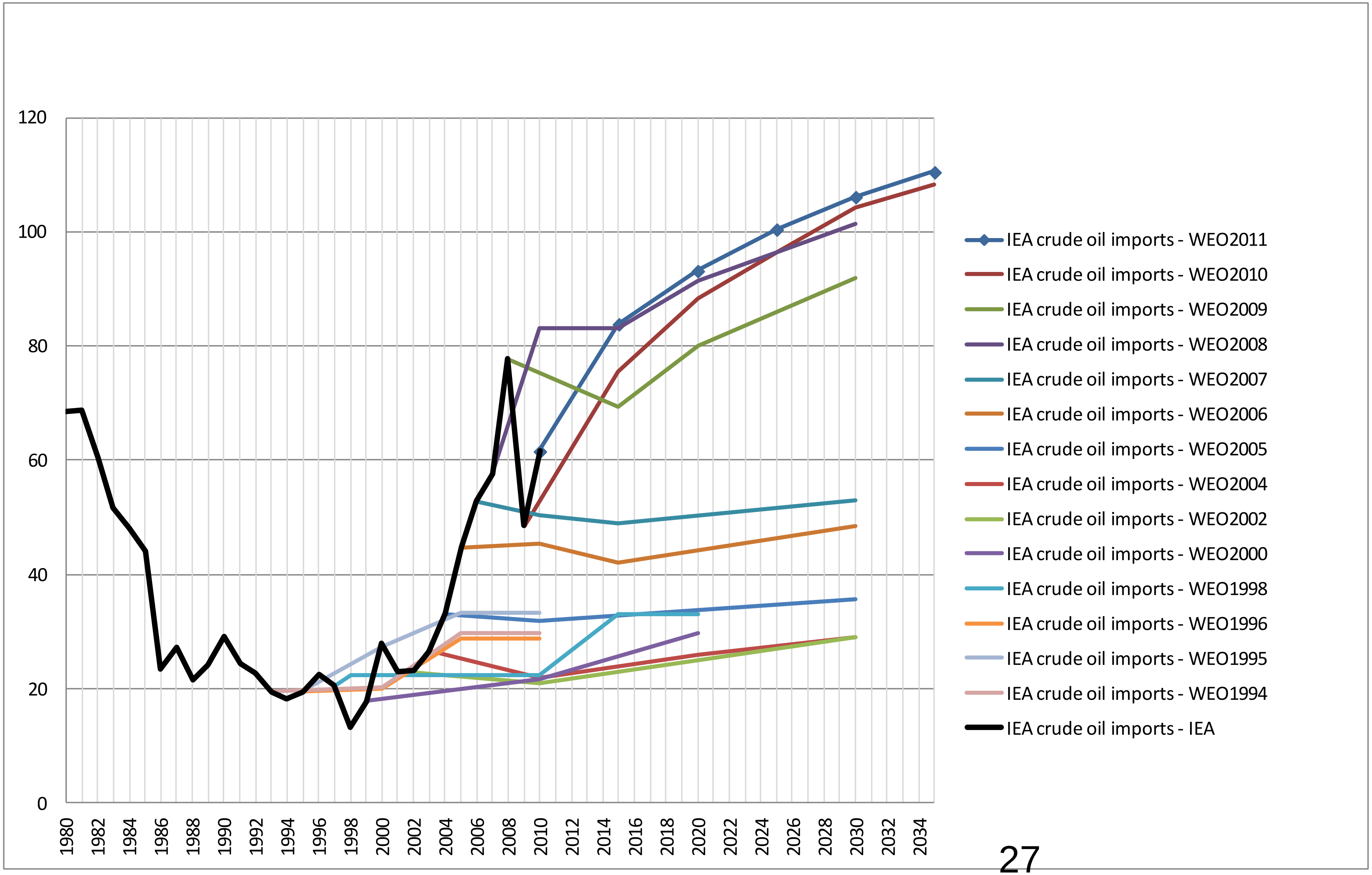


Projections of energy prices

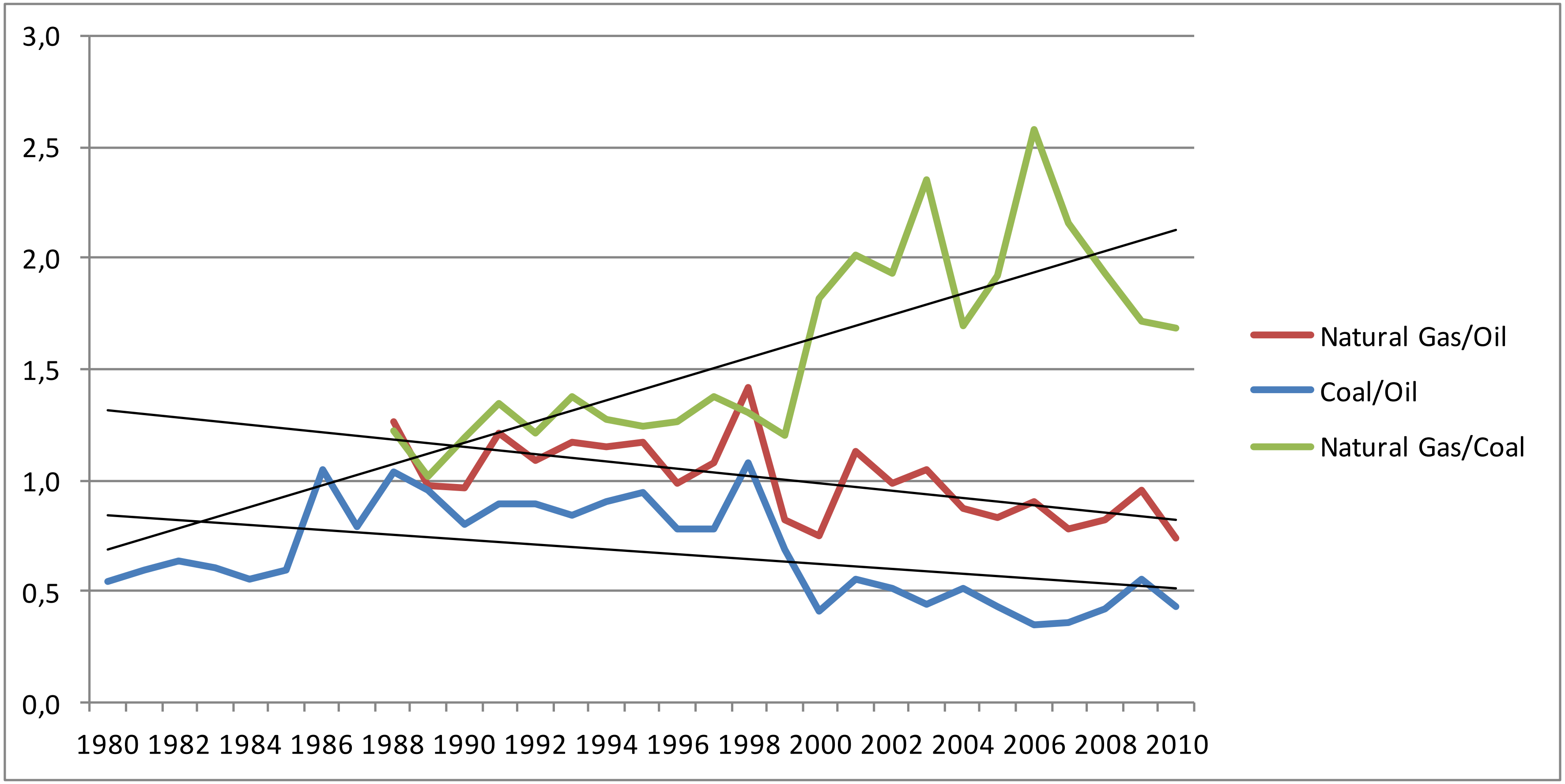


Separately are tacked into account energy&emission taxes and fuel delivery co

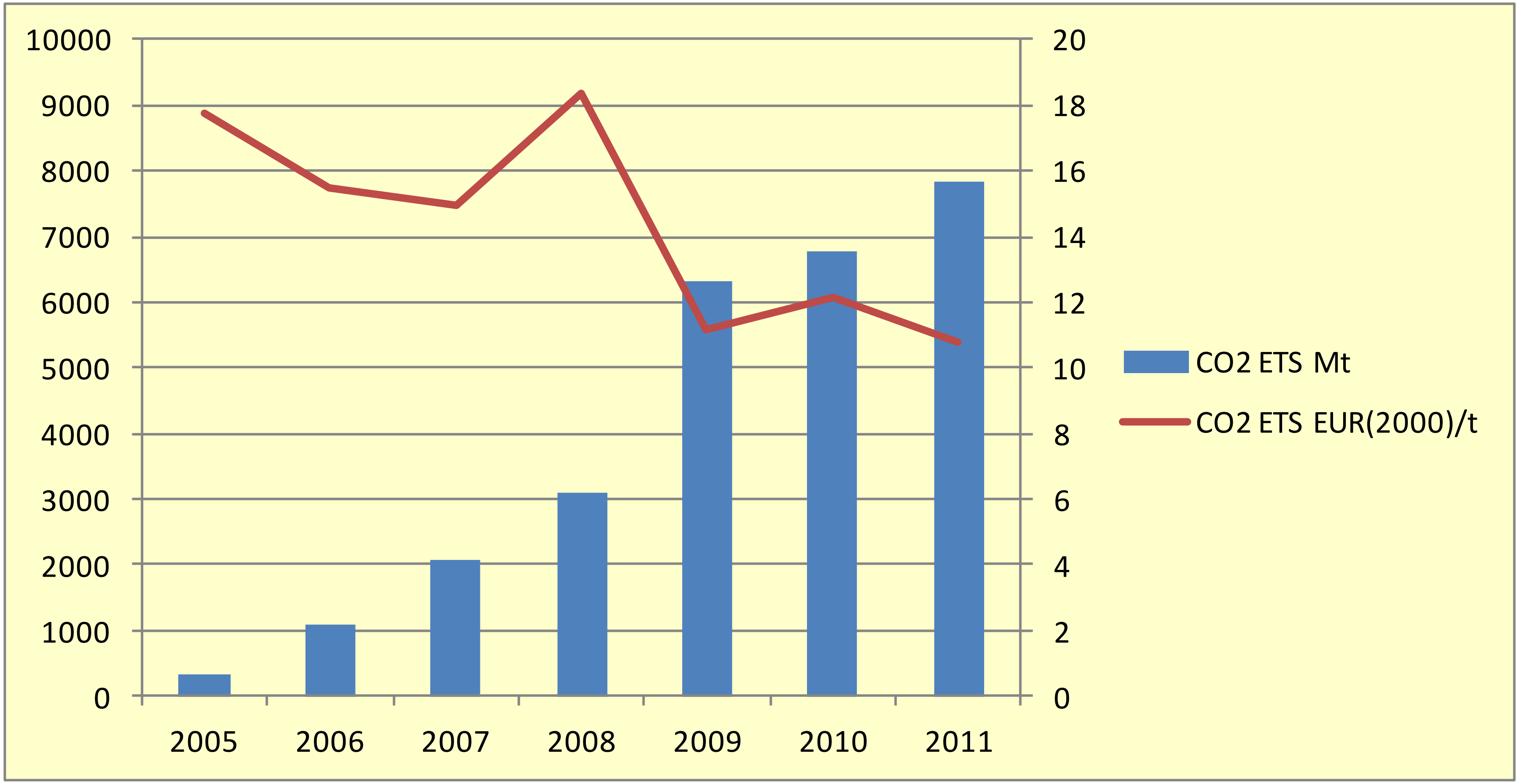
OIL import price of IEA countries and IEA WEO projections, US$2000/barrel



Price ratios are important



Uncertain is price of CO_2



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

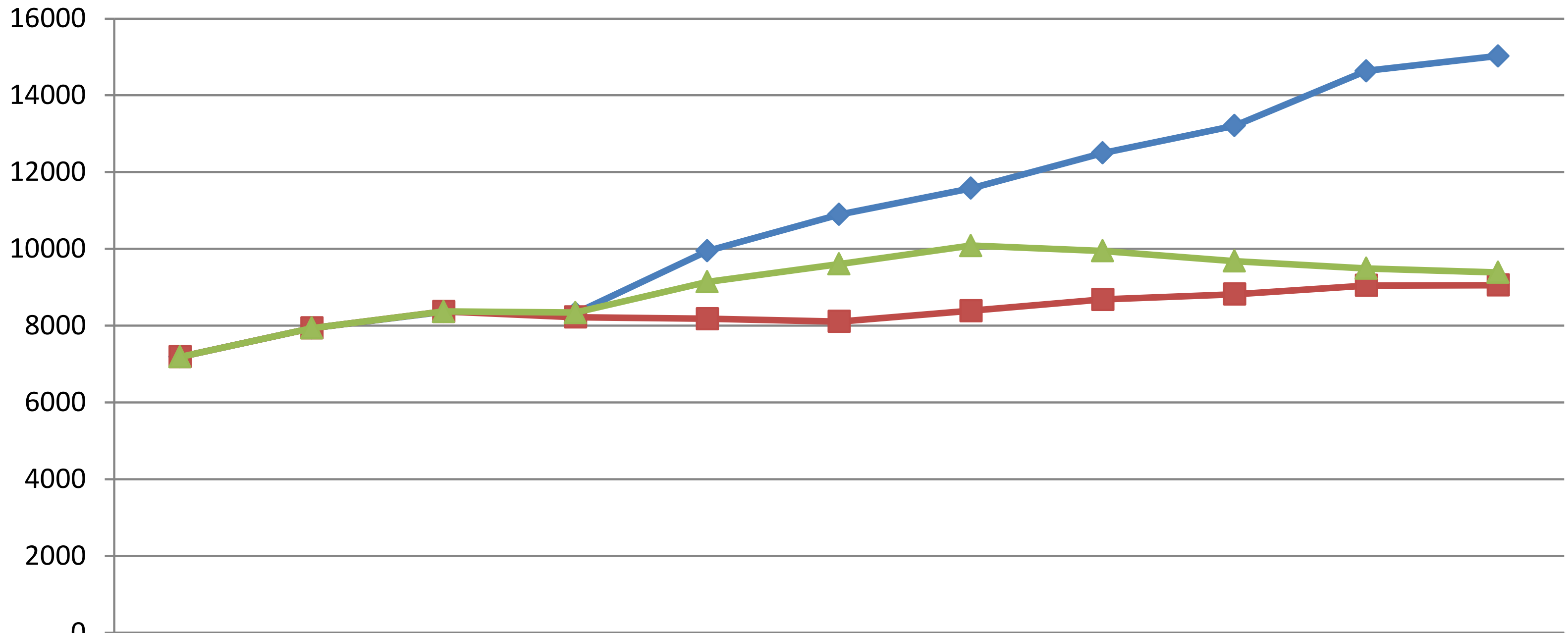
Energy taxes, EUR(2000)/GJ

	2000	2005	2010	2015	2020	2025	2030
Transports							
Benzīns	7.78	7.22	9.09	9.36	9.36	9.36	9.36
Dīzeļdegviela	5.15	5.47	7.29	7.19	7.18	7.18	7.18
LPG	1.42	2.14	2.26	2.52	2.71	2.71	2.71
Dabas gāze	0	0	1.18	2.27	2.27	2.27	2.27
Kurināmais							
Dīzeļdegviela	0.50	0.51	0.88	1.23	1.23	1.23	1.23
Degvieleļļa	0	0	0.18	0.30	0.30	0.30	0.30
Ogles	0	0.03	0.23	0.24	0.24	0.24	0.24
Dabas gāze	0	0	0.23	0.39	0.39	0.39	0.39
Kūdras ieguve	0.02	0.02	0.02	0.04	0.04	0.04	0.04
Rūpniecība							
LPG	1.42	2.14	2.26	2.52	2.71	2.71	2.71
Dīzeļdegviela	0.50	0.51	0.88	1.23	1.23	1.23	1.23
Dabas gāze	0	0	0.23	0.39	0.39	0.39	0.39
Elektroenerģija							
Elektroenerģija	0	0.02	0.20	0.22	0.22	0.22	0.22

Emisson average taxes, EUR (2000)/ton

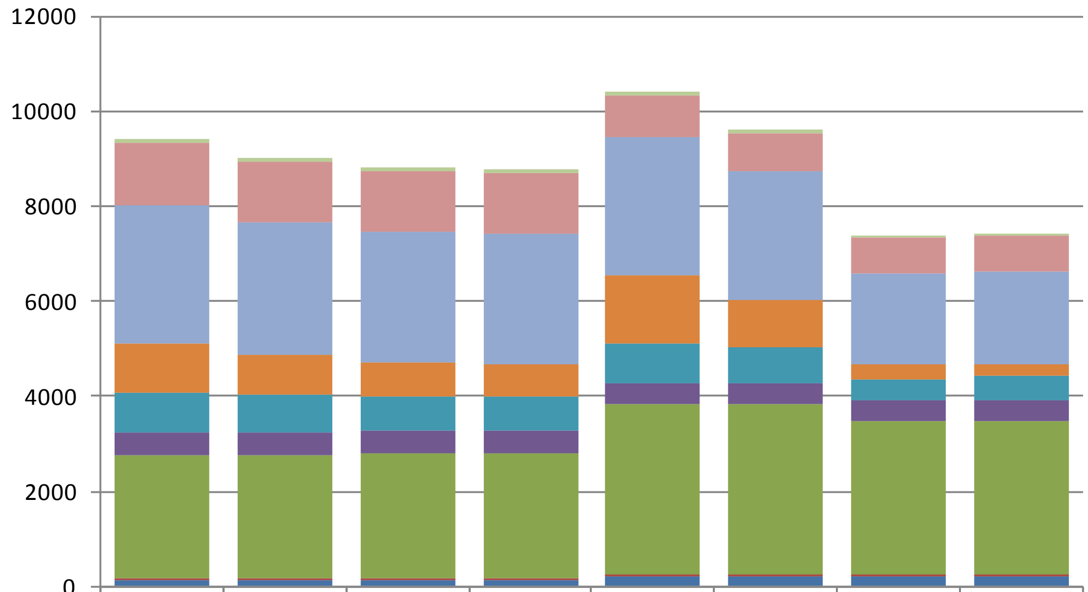
		2000	2005	2010	2015	2020	2025	2030
CH4, Nox, Sox, GOS	Lauksaimniecības, Pakalpojumu, Rūpniecības un Pārveidošanas sektors	17.7	30.0	65.4	65.4	65.3	65.3	65.3
PM	Lauksaimniecības, Pakalpojumu, Rūpniecības un Pārveidošanas sektors	5.4	4.4	8.2	40.9	57.4	57.4	57.4
NH3	Rūpniecības un Pārveidošanas sektors	19.0	17.0	15.0	14.0	14.2	14.2	14.2
CO2	ETS	0	16.1	12.3	5.8	8.2	11.4	28.6
	ne-ETS	0	0.1	0.7	2.3	2.7	2.7	2.7

GHG emissions in Energy, GG



	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
G-REF	7186	7936	8366	8328	9948	10898	11577	12501	13211	14637	15024
G-WAM	7186	7936	8366	8224	8178	8109	8386	8683	8821	9047	9054
G-WEM	7186	7936	8366	8338	9141	9607	10084	9950	9684	9493	9386

Non-ETS GHG emissions in WEM (BASE) and 10% reduction sc. with high (A-) and lower (B-) GDP projection, GG $CO_2^{ekv.}$



	2020				2030			
	A-BASE	B-BASE	A-EUP-NETS-J_10	B-EUP-NETS-J_10	A-BASE	B-BASE	A-EUP-NETS-J_10	B-EUP-NETS-J_10
1B. Fugitive Emissions	74	72	68	67	59	56	39	36
1A4. Other sectors	1318	1298	1304	1282	878	822	793	736
1A3. Transport	2922	2790	2737	2743	2930	2689	1881	1937
1A2. Industries	1024	839	729	663	1422	990	342	274
1A1. Energy industries	822	769	700	730	837	774	443	516
6. Waste	471	471	471	471	439	439	439	439
4. Agriculture	2592	2590	2623	2615	3571	3567	3200	3198
3. Solvent and Other Product Use	46	46	46	46	49	49	49	49
2. Industrial Processe	139	139	139	139	212	212	212	212

Issues

- Initial costs for software
- Model development is a long-term and continuous process
- 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

!!!

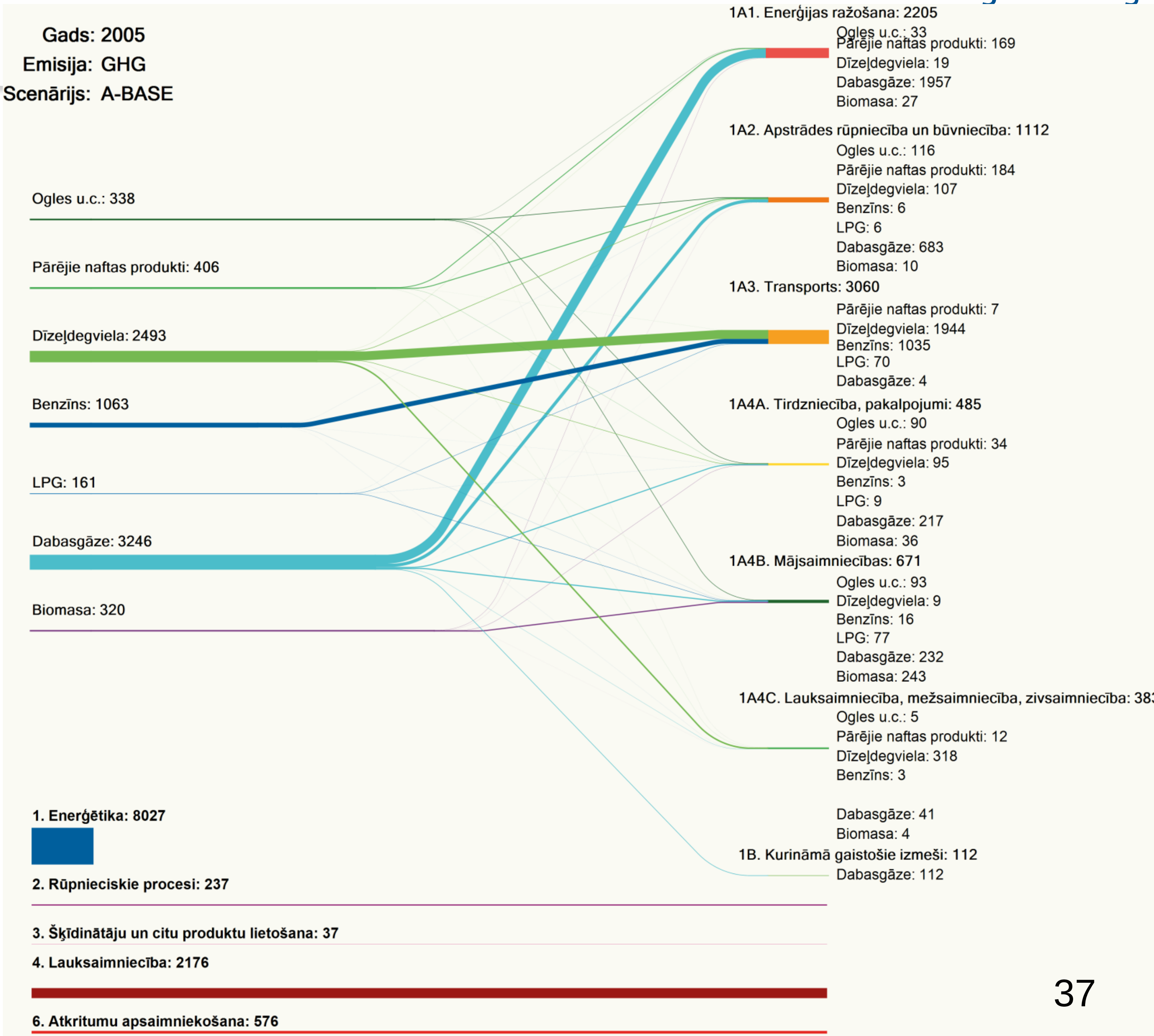
- The emission reduction potential for PAMs in non-energy sectors, is significantly lower than energy sector, eg., fuel switching or energy efficiency
- Emissions in non-energy sectors very much depends on sector development trends
- Note that the cheapest PAMs is not always the best in terms of investment
- By increasing energy prices, PAMs are getting cheaper
- The most effective policy instruments for reducing GHG emissions
  - Policy - taxes followed by investment support for measures - efficiency, energy substitution

Implementation of research results

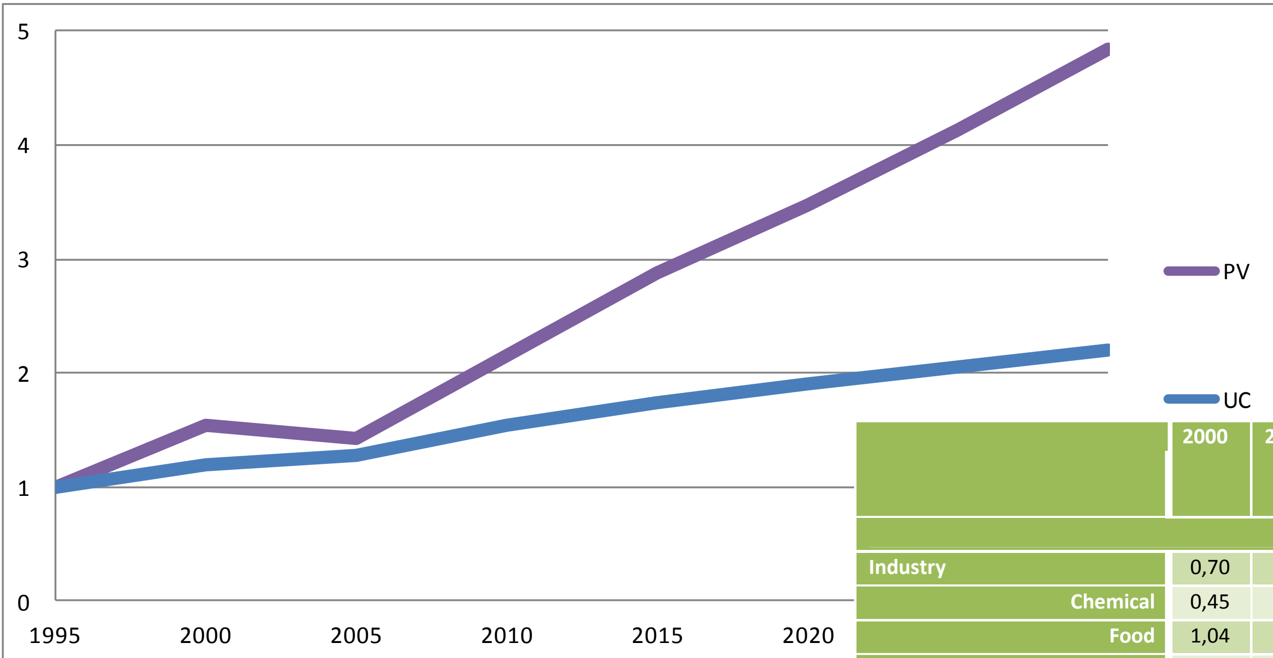
examples 2012-2015

- Integrated Latvian energy supply system and demand development planning taking into account the environmental and economic conditions in the framework of National Energy Research Program
- Modeling of Latvia energy development scenarios (PUC)
- Modeling of Latvia energy development scenarios 2012-2030 taking into account economic, environment policy factors (MOE)
- GHG emission projections in Latvia 2013-2030 for reporting under Directive 280/2004/EC (MOEPRD)
- GHG emission projections 2020-2030 in Latvia and emission reduction policy cost assessment (MOEPRD)
- Impact assessment of the main policies and measures covered in Energy Development Guidelines for 2014- 2020 (MOE)

GHG emissions in Latvia, 2005

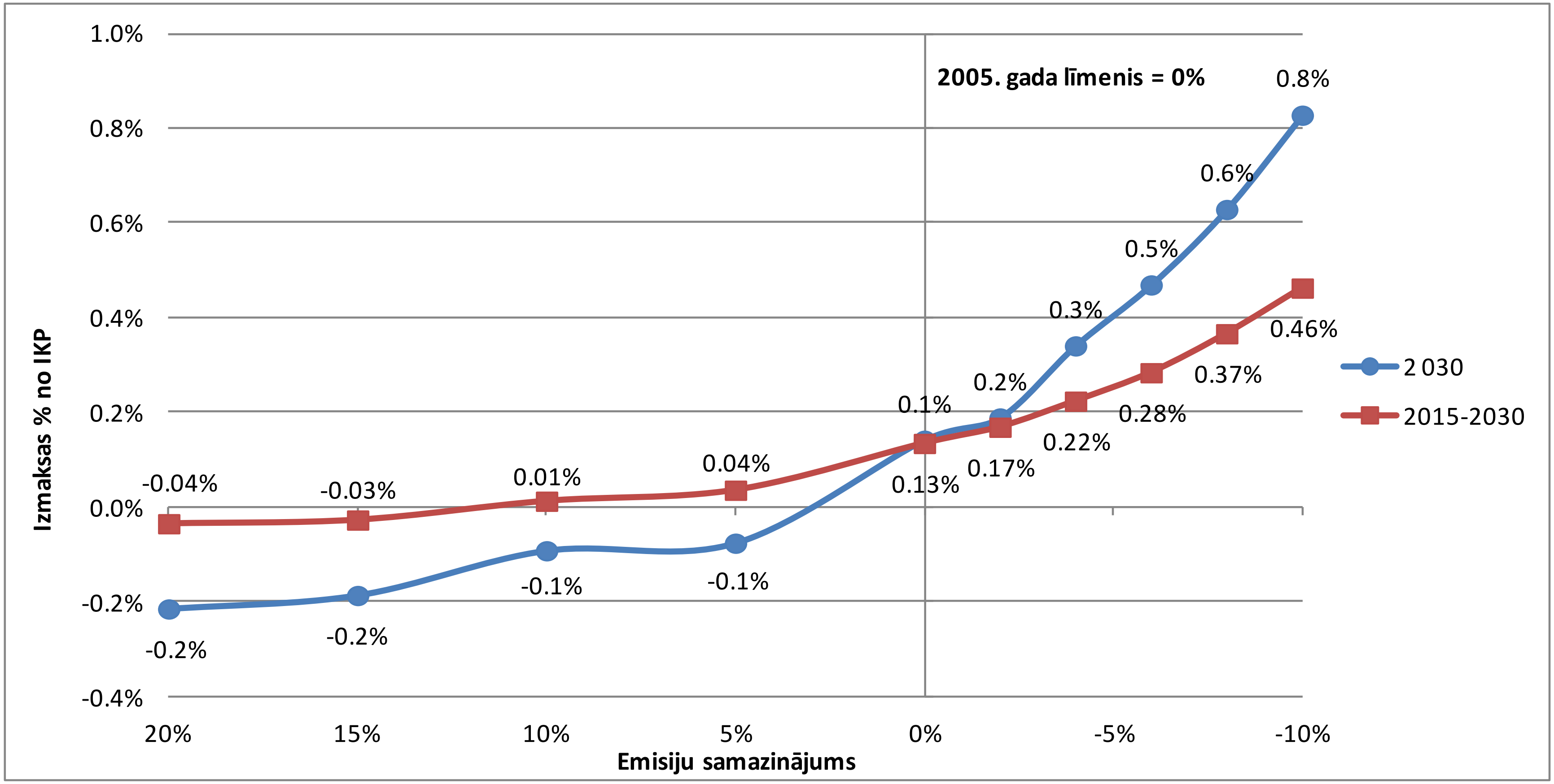


Aggregate of projected VA and Useful energy in Industry



	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**

GHG emission reduction costs, % of GDP

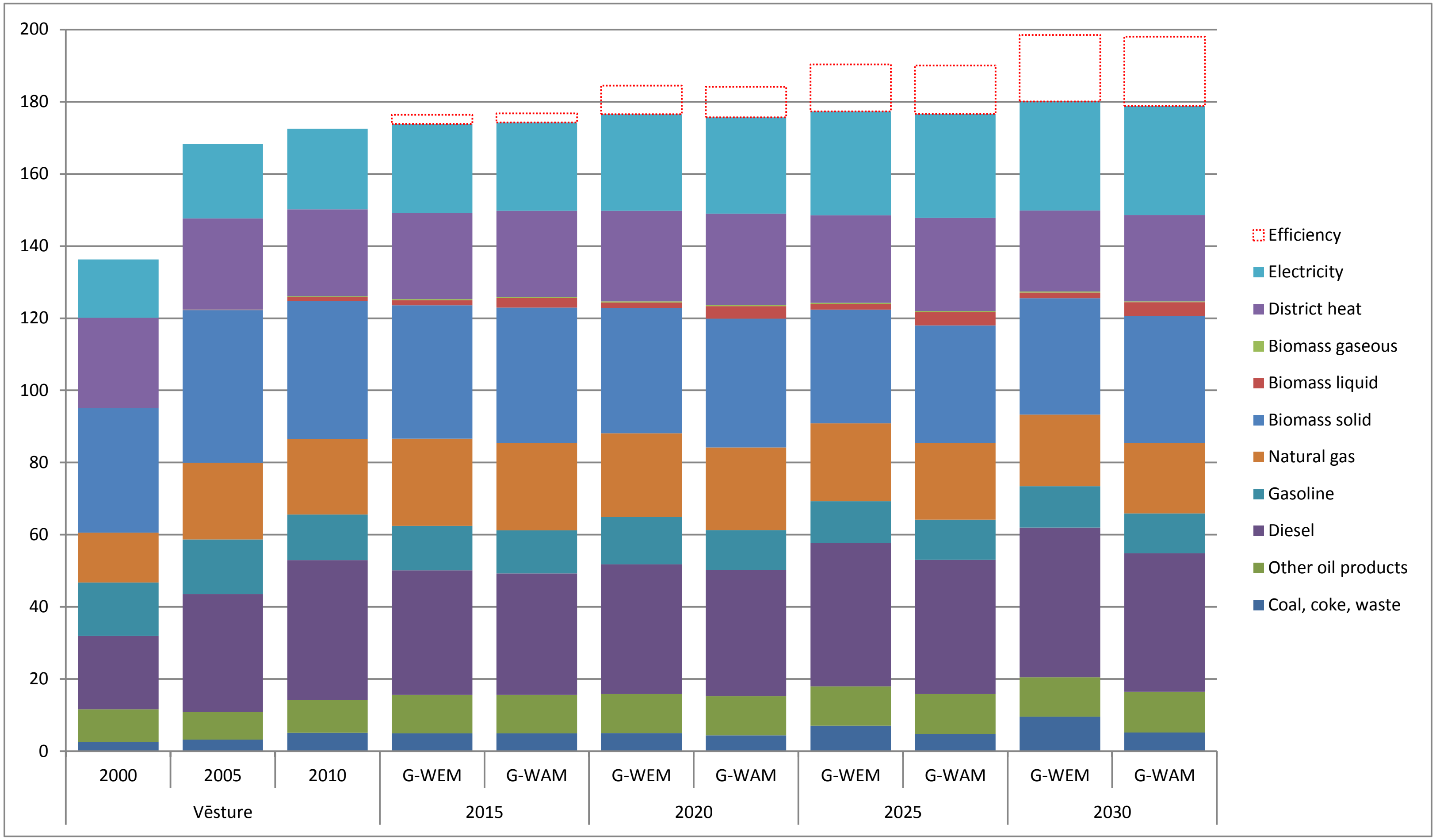


Model MARKAL

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

Final energy consumption, PJ



Energy system analyses tools in Latvia

- EFOM (Energy Flow Optimization Model) – multi-period linear programming optimization model describing the all energy system of a country
  - Used from 1994 – 2000 in research projects with focus to electricity and district heat (energy system is partly represented)
- Since 1995 MARKAL is used for energy and environment system analyses in Latvia
- Latvia represented as region in multi regional models
  - TIMES
    - The Joint Research Centre-EU-TIMES model
    - 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 others
  - 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

by no means exhaustive

THANK YOU!