

GHG Abatement potential in Poland 2050

May 2013



This document is a summary of the analysis „Potencjał Redukcji Emisji Gazów Ciepłarnianych do 2050” commissioned by: Polskie Sieci Elektroenergetyczne Operator S.A., ENERGA S.A., Jastrzębska Spółka Węglowa S.A., Kompania Węglowa S.A., Węglokoks S.A., Katowicki Holding Węglowy S.A., Polskie Górnictwo Naftowe i Gazownictwo S.A., GAZ-SYSTEM S.A., PKN Orlen S.A., Grupa LOTOS S.A., POLENERGIA S.A., ENEA Wytwarzanie S.A., Polska Grupa Energetyczna S.A., TAURON Polska Energia S.A., EDF Polska, European Climate Foundation, Instytut Badań Strukturalnych, Instytut na Rzecz Ekorozwoju.

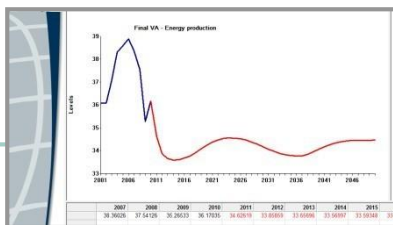
Our analytical approach links the OE macromodel with the cost curve

Basic modeling logic

- GDP & production levels by sector
- Energy consumption
- Interest rates
- ...

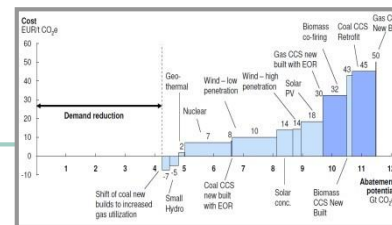
Oxford Economics Model

- General Equilibrium model
- Macro-economic indicators for 30 distinct sectors



Cost curve (CC) Model

- Bottom-up lever model
- Baseline emissions by sectors
- Abatement potential and cost by levers and sectors



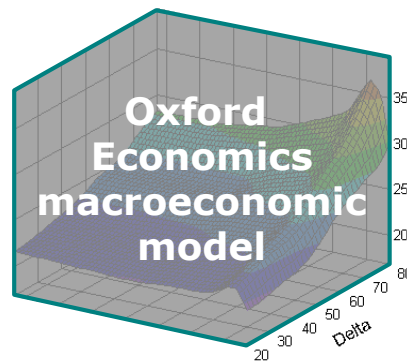
- Energy savings
- CAPEX savings
- OPEX savings
- Electricity cost and mix
- Transport mix

The Oxford Economics macroeconomic model can be used to assess the impact of the abatement scenarios on the economy

NOT EXHAUSTIVE

Key inputs to the model

- Energy and power demand and efficiency
- CAPEX and OPEX of abatement measures across all sectors
- Reductions in fuel use resulting from abatement
- Power generation supply pathways over time
- Costs for power over time
- Fuel price assumptions
- Cost of capital assumptions
- Transport sales and mix over time

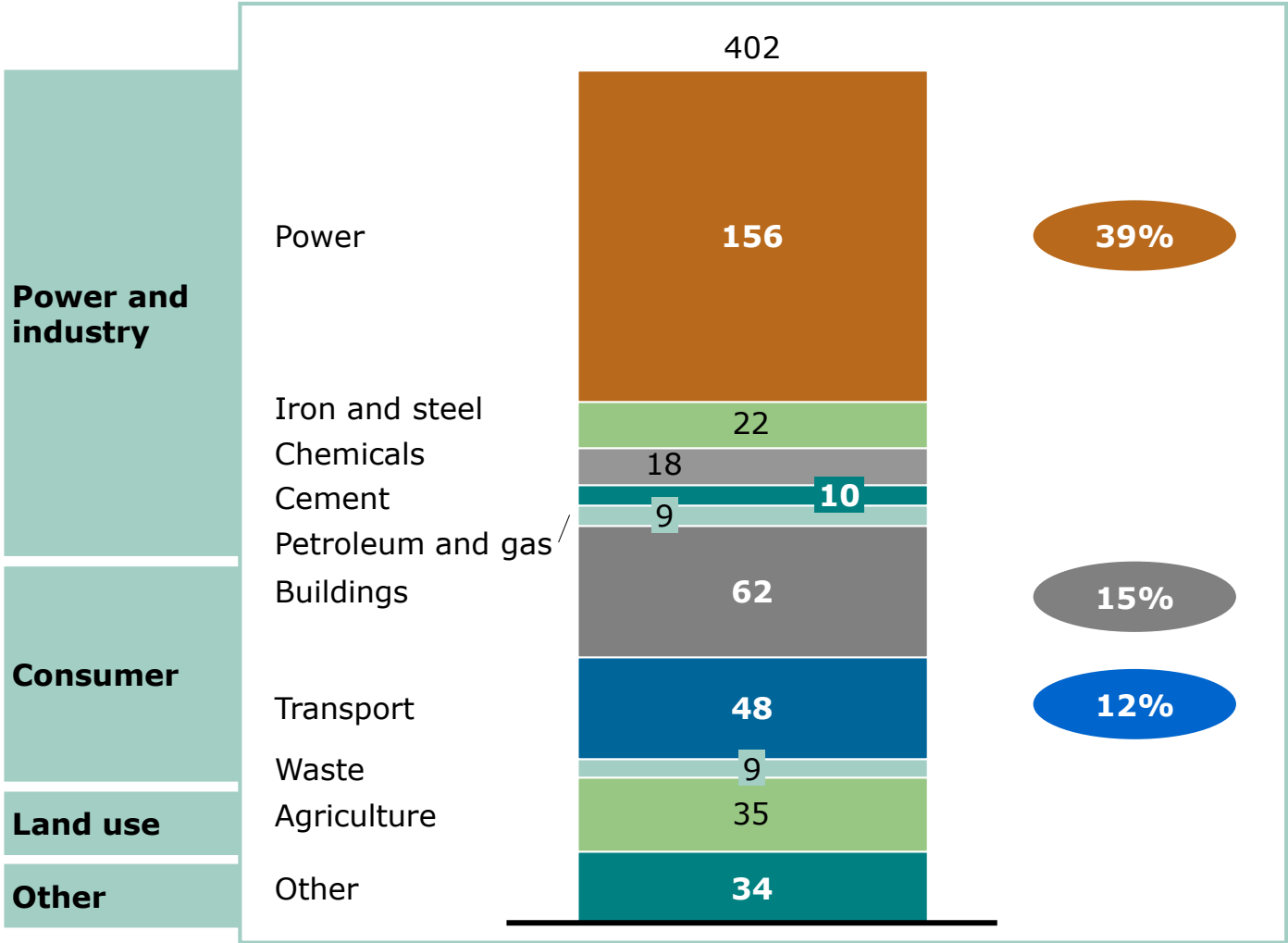


Outputs from the model

- GDP by scenario
- Decomposition of value added changes, e.g., increasing sectors, higher prices, etc.
- Inflation and employment
- Interest rates
- Investment impacts

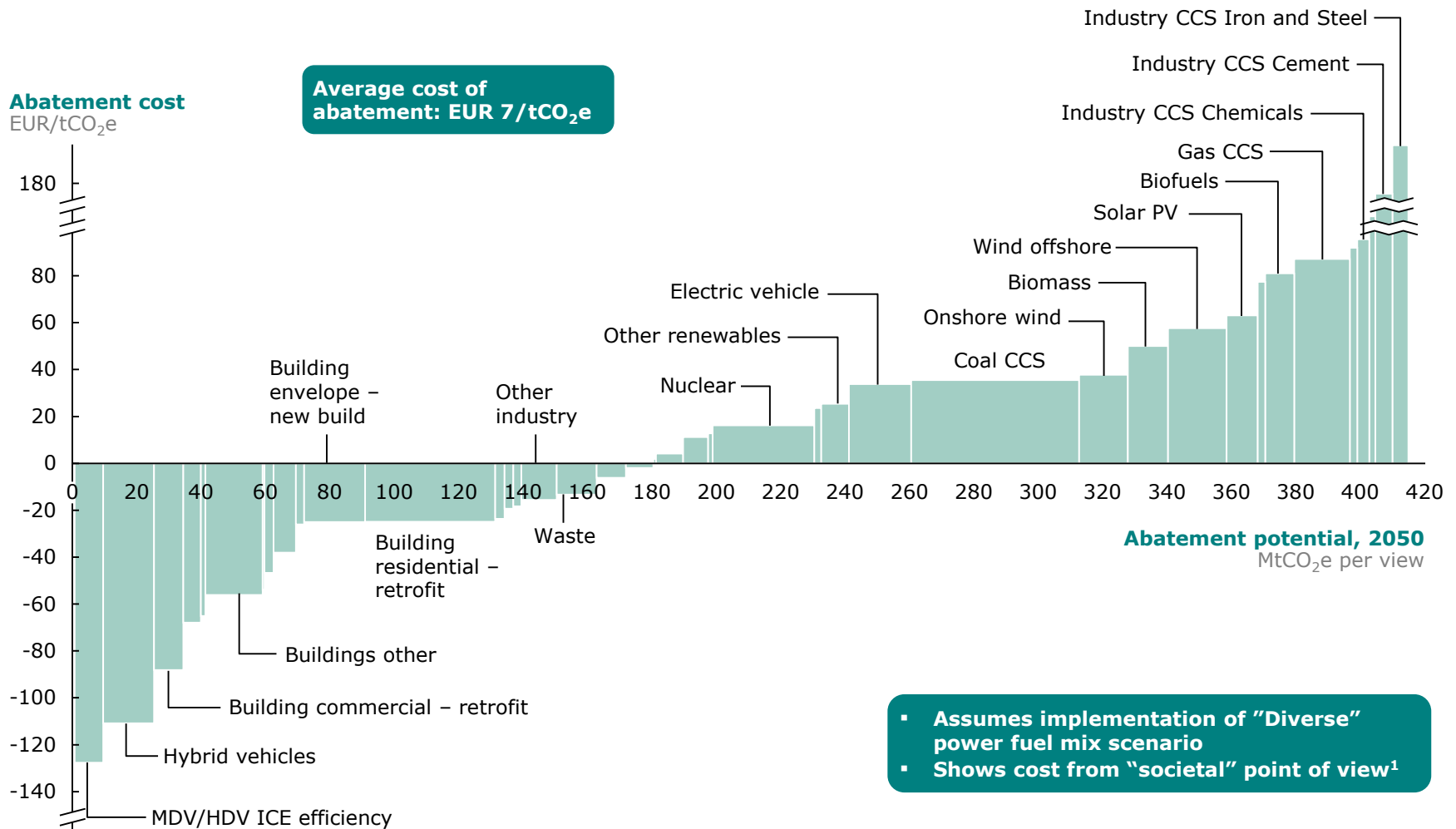
Current emissions in Poland by sectors

2010, MtCO₂e/year



2050 Cost curve for greenhouse gas abatement

IN THE "DIVERSE" POWER FUEL MIX SCENARIO



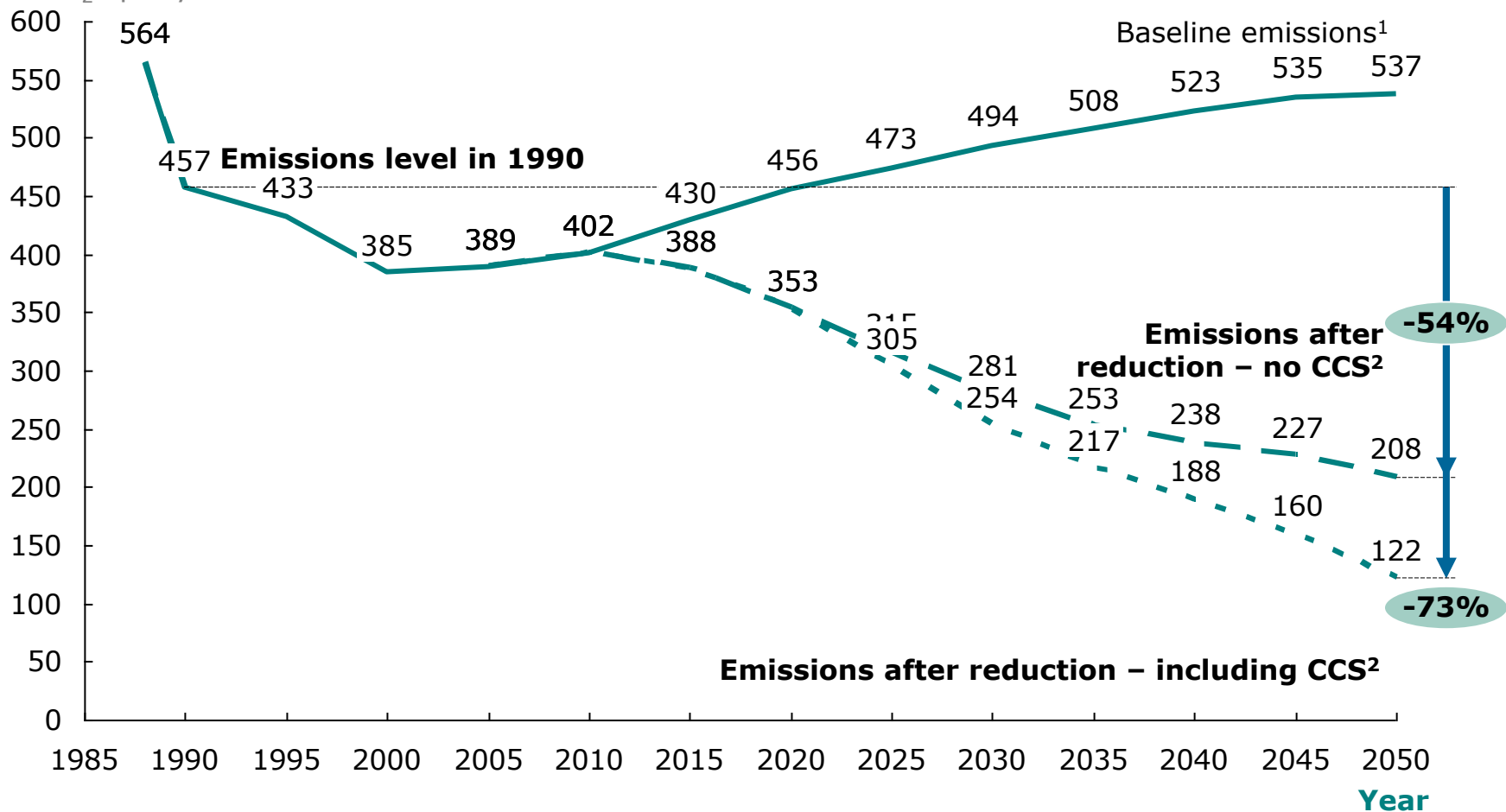
¹ Cost estimates used a 4% discount rate and do not account for subsidies, taxes, or transaction costs

Emissions reduction potential relative to the baseline case

Annual emissions

MtCO₂e per year

IN THE "DIVERSE" POWER FUEL MIX SCENARIO



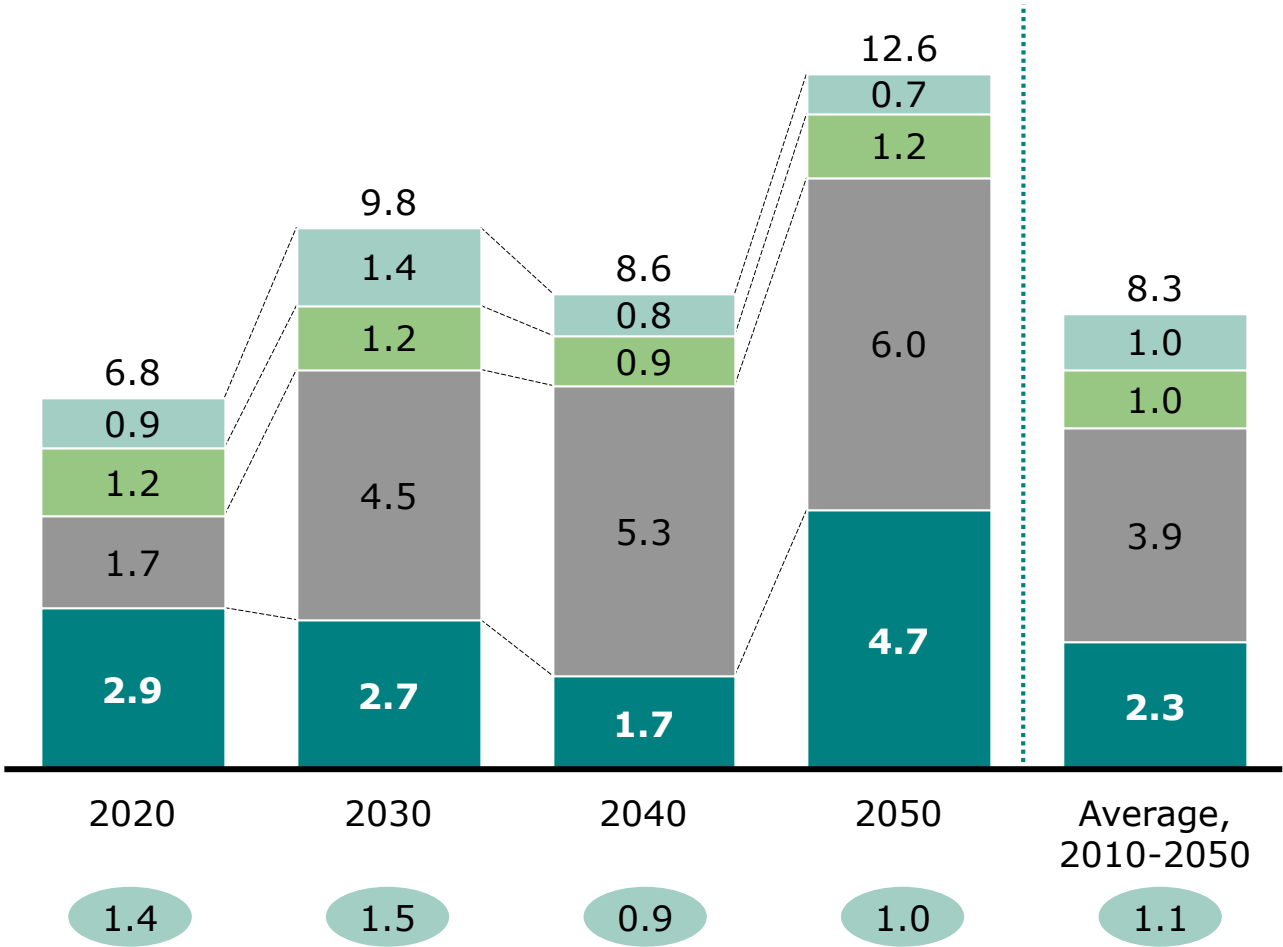
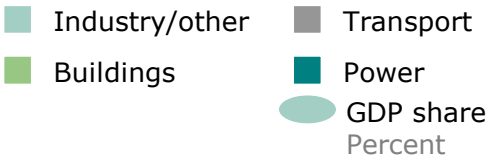
1 The baseline case illustrates a theoretical development of emissions levels which would be reached if current trends were preserved and no significant emission reduction policies were implemented. The estimate was created based on estimates of economic activity (industrial production, traffic, energy consumption,...) assuming increases in technical efficiency on the currently observed level (without implementation of further significant measures). The baseline case does not take into consideration currently discussed climate policies or target levels of emissions reductions.

2 Full implementation of Carbon Capture and Storage in power generation and industry

The 73% abatement scenario requires CAPEX equaling 1.1% of GDP by 2050

Average annual incremental CAPEX , billions EUR/year

BASED ON THE "DIVERSE" POWER FUEL MIX SCENARIO



Key conclusions

- Required CAPEX will equal 1.1% GDP on average by 2050
- Investments will be higher in the period until 2030, equaling 1.5% GDP in 2025-2030
- The most CAPEX-heavy sectors would be transport (50% of total CAPEX) and power (~30% of total CAPEX)
- Total CAPEX required to implement the abatement policy will equal ~4% of all investments in Poland across 2010-2050

The abatement scenario will yield 1.4% GDP of savings by 2050

Average annual savings (OPEX),
EUR billion/year

BASED ON THE "DIVERSE" POWER FUEL MIX SCENARIO

Industry/other

Buildings

Transport

Power

GDP share
Percent



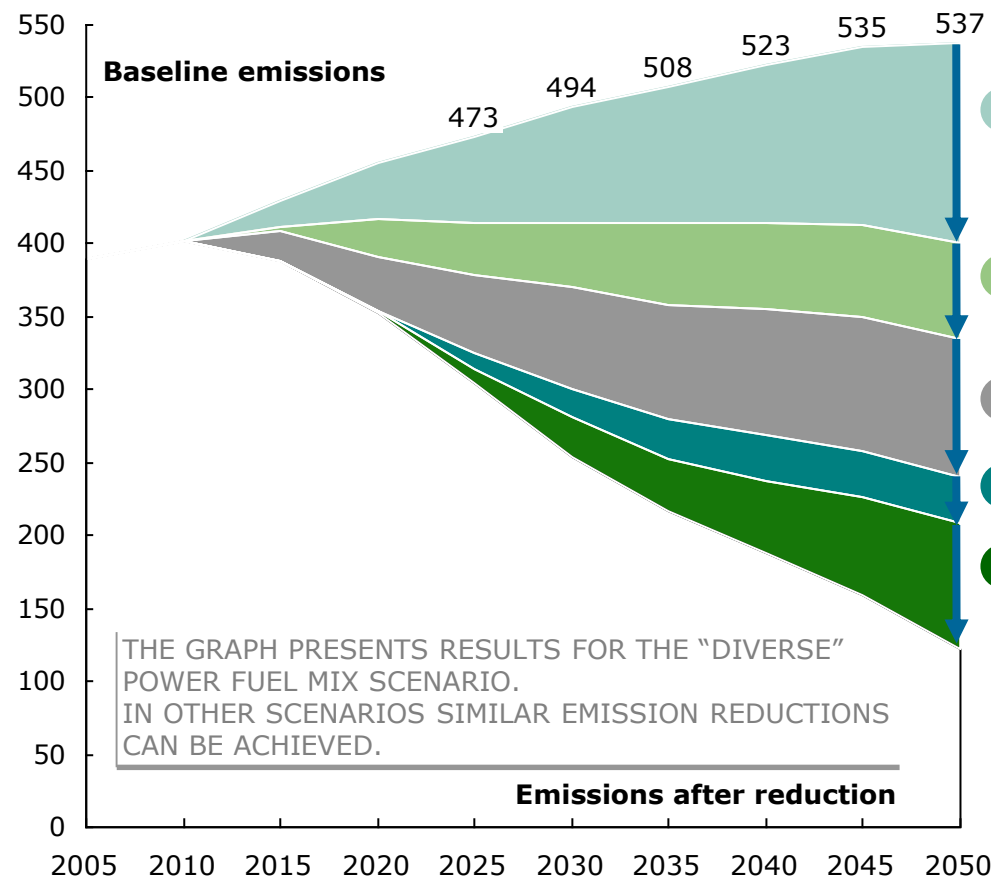
Key conclusions

- Fuel savings will grow over time due to increasing abatement and growing fuel prices
- Transport and buildings will be the key sources of savings (mainly due to lower fuel consumption)

Reduction potential by category

IN THE "DIVERSE" POWER FUEL MIX SCENARIO

GHG emissions
MtCO₂e per year



- 1 Energy efficiency
- 2 Renewables
- 3 Other levers¹ (e.g., in the industry)
- 4 Nuclear
- 5 CCS³

	Share of total abatement Percent	Average cost EUR/tCO ₂ e
1 Energy efficiency	33	-41
2 Renewables	16	50
3 Other levers ¹ (e.g., in the industry)	22	-11
4 Nuclear	8	16
5 CCS ³	21	68
Total/average	330-415 MtCO ₂ e	-9-7 ² EUR/tCO ₂ e ²

1 Non-CO₂ gases, industrial processes, other industries and levers in transport which were not classified as "Energy efficiency"

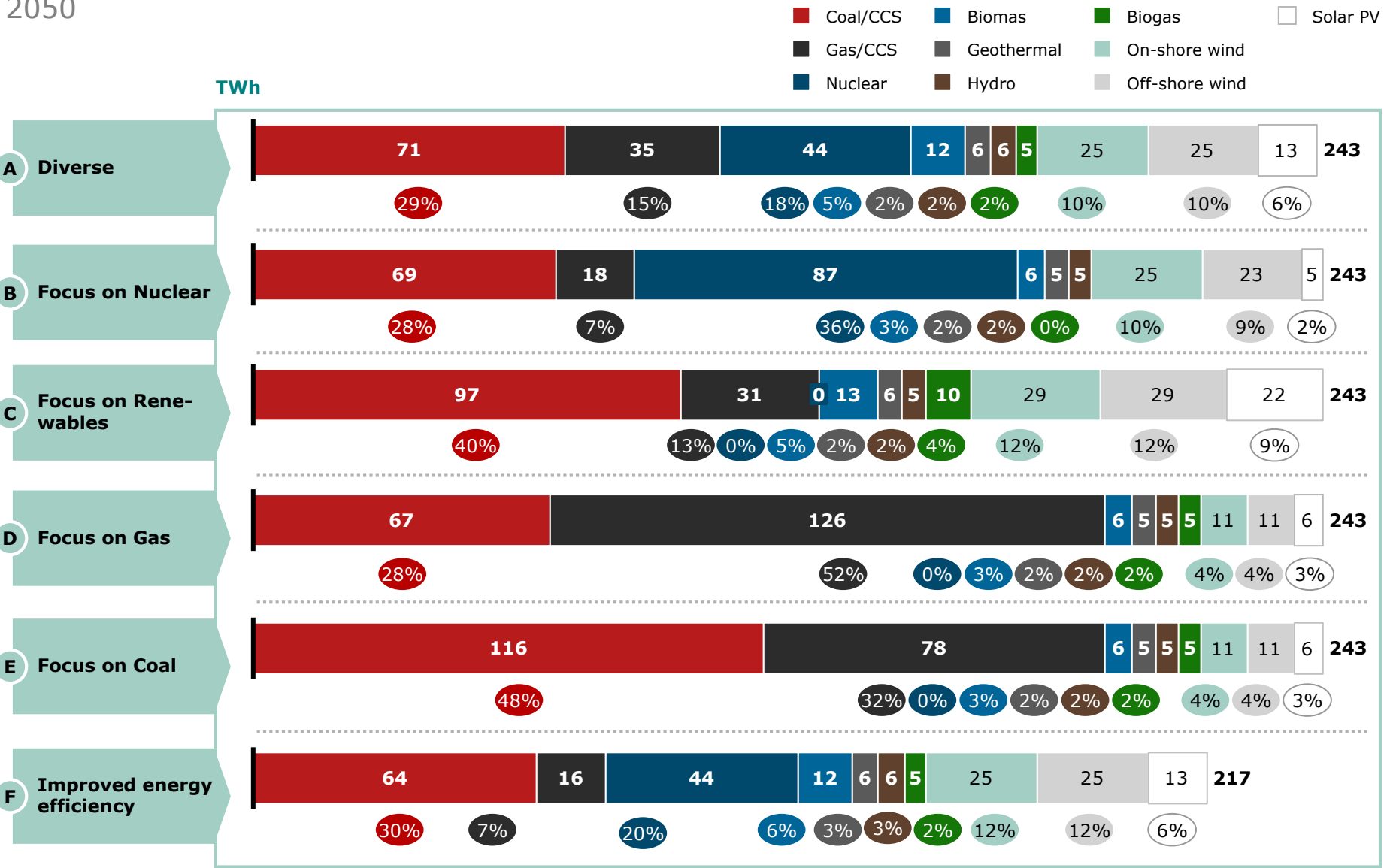
2 -9 EUR/tCO₂e assumes implementation of four groups of levers (energy efficiency, renewables, other levers, nuclear), and 7 EUR/tCO₂e assumes implementation of all five groups of levers (inclusive CCS)

3 Assuming CCS becomes commercialized in 2030

POWER

Power generation in different energy scenarios

2050



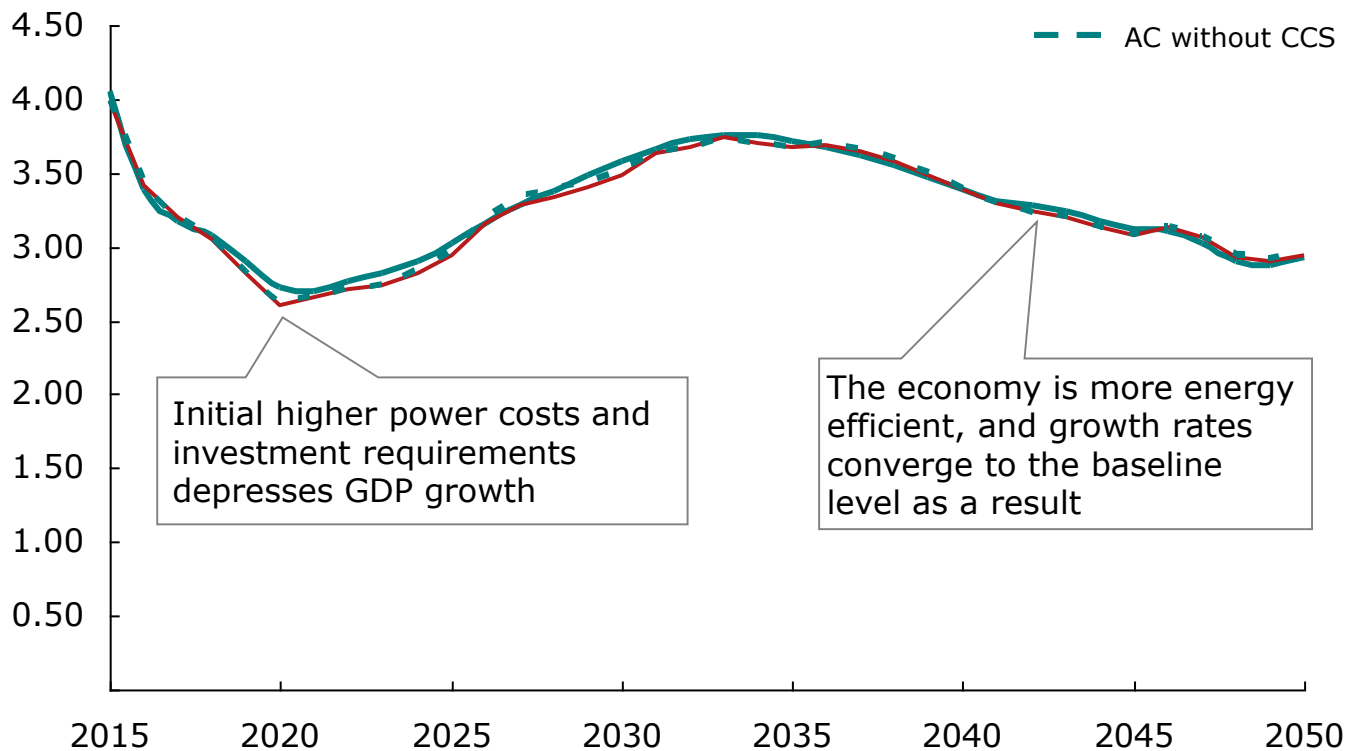
The emission reduction program moves GDP growth only slightly away from the baseline

RESULTS FOR THE "DIVERSE" POWER FUEL MIX SCENARIO

GDP growth¹

Annual growth

Percent



Deviation from baseline GDP growth

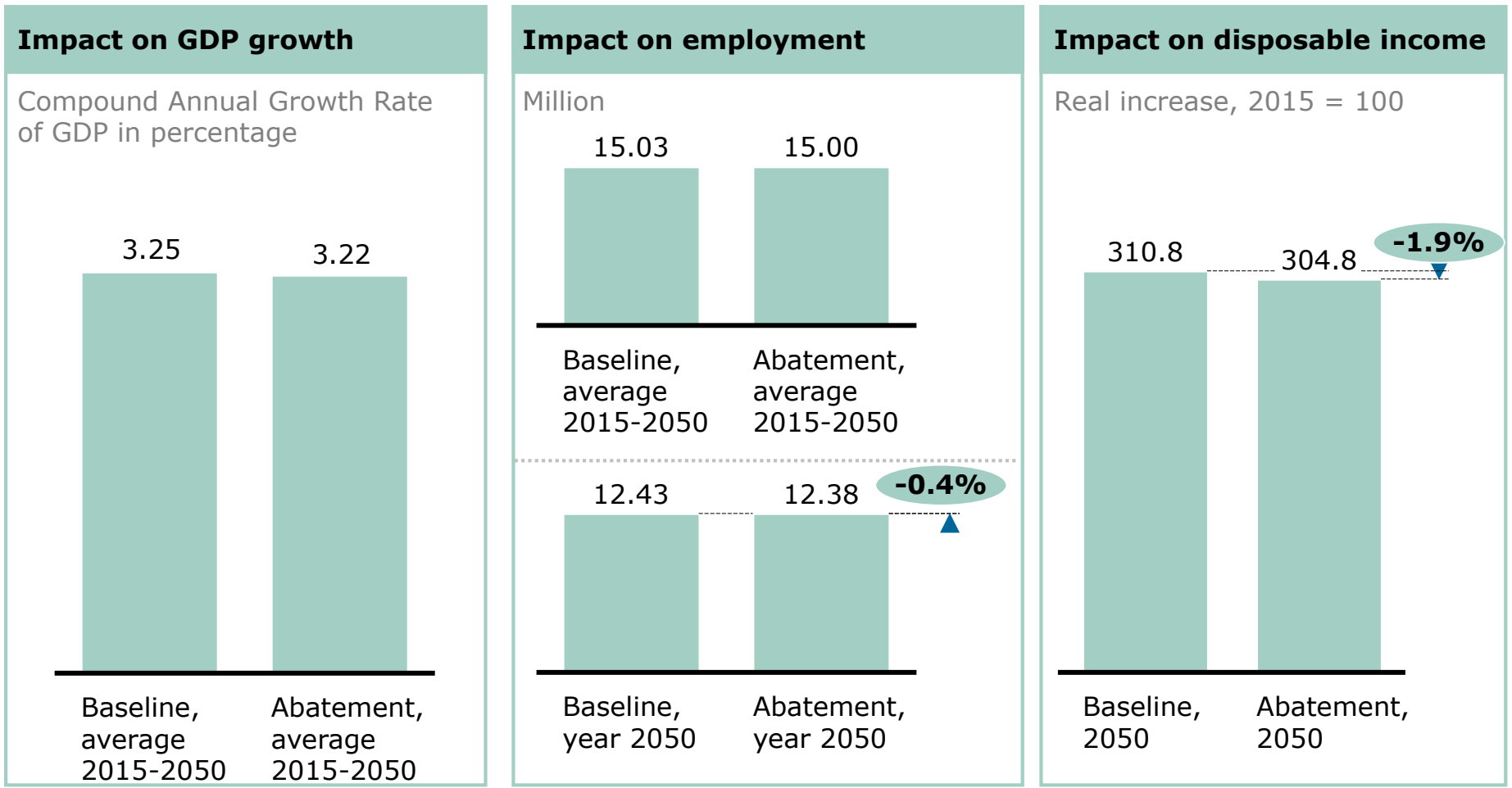
- The deviation from baseline GDP growth rate for both CCS and NOCCS scenarios remain in the range -12 to +3 b.p. throughout the period

¹ In base prices scenario

SOURCE: Oxford Economics' Global Energy Industry Model

The effect of the abatement is visible only in case of the disposable income level¹

RESULTS FOR THE "DIVERSE" POWER FUEL MIX SCENARIO



¹ In base prices scenario, with CCS

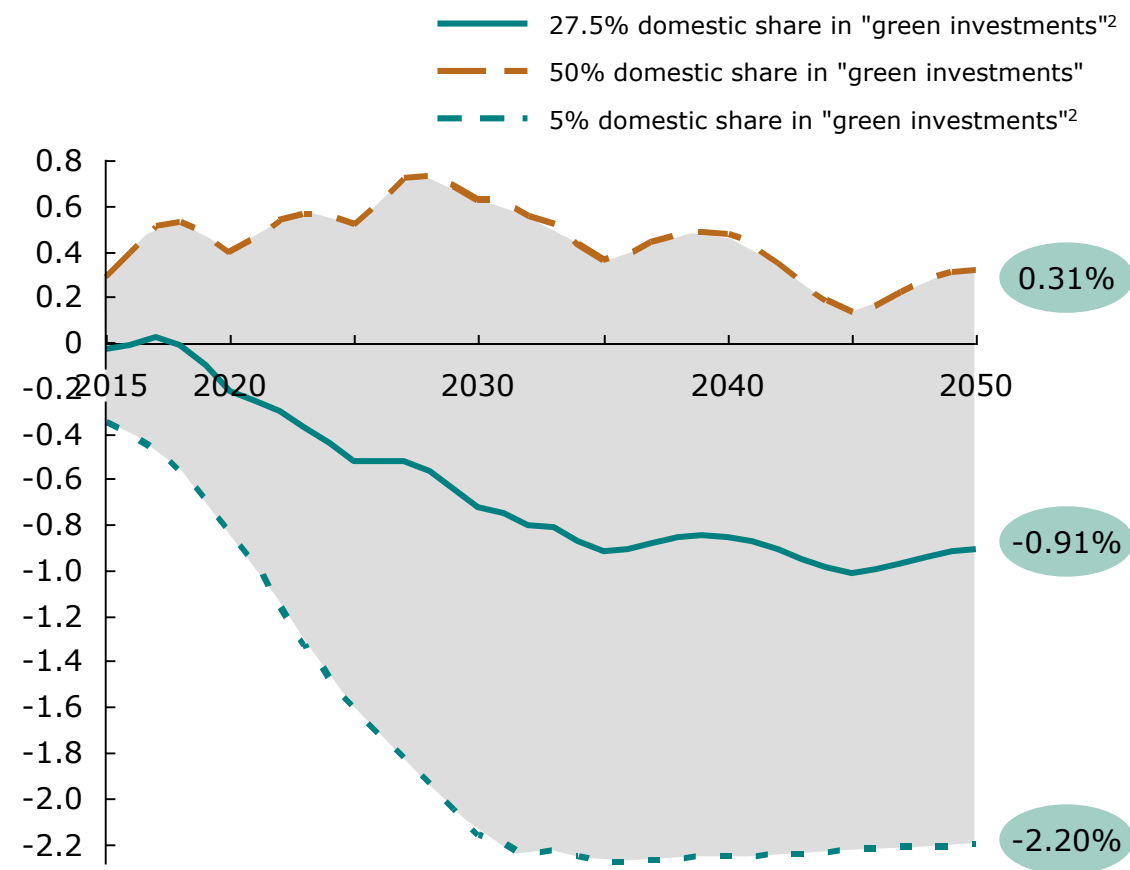
SOURCE: Oxford Economics' Global Energy Industry Model

Spending on electricity and heat will have a 5.6% share in households' disposable income

The range of GDP deviation from baseline largely depends on the share of CAPEX that remains in Poland¹

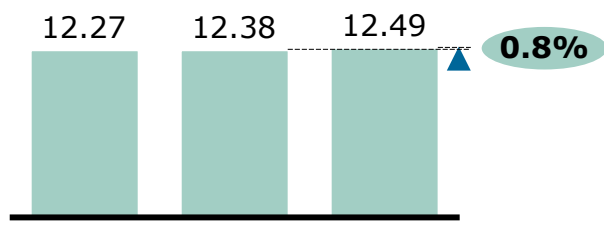
Abatement pathway

Absolute cumulative real GDP difference from the baseline, percent



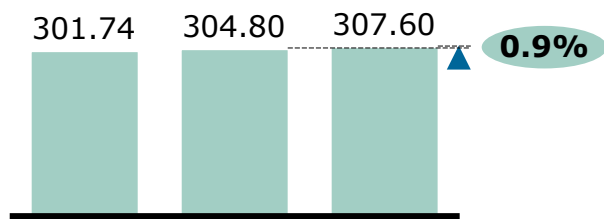
Employment under different CAPEX scenarios

Employment in 2050, million



Disposable income under different CAPEX scenarios

Real increase, 2015 = 100



¹ In base fossil fuels scenario

² Base case scenario assumes ~27.5% domestic companies share in the additional investments assumed in scenario