Impact Assessment of the Energy and Climate Plan of Cyprus

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Disclaimers

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- The contents of the impact assessment report do not necessarily reflect the official views of the government of Cyprus.

Work Plan of the Project

Actions/Deliverables	Initial timetable (months after contract signature)	Realised work plan (months after contract signature)
Project start: 6 December 2018		
Kick-off meeting: 18 January 2019		
Deliverable 1: Inception Report	1	1
Deliverable 2 and sub-deliverables 2.1 – 2.12: Minutes of teleconferences with SRSS on project progress	2 – 13 (on a monthly basis)	2 – 13 (on a monthly basis)
Deliverable 3: policies and measures (PaMs) that will be considered in the impact assessment and data collection	2	7 (PaMs were finalised July 2019)
Deliverable 4: Methodology for performing the impact assessment	3 (draft version); 4 (final version)	6 (draft version); workshop 9/7/2019; 7 (final version)
Deliverable 5: Impact assessment results	7 (draft version); 8 (final version)	11 (draft version); 12 (final version)
Deliverable 6: Comparison of policies and measures	11	11 (draft version); 12 (final version)
Deliverable 7: Final version of policy comparison of policies and measures	13	13

Requirements of Regulation 2018/1999 on the Governance of the Energy Union and Climate Action

Chapter 5 of Section B of National Energy and Climate Plan – Impact Assessment of Planned Policies and Measures:

- Impacts on energy system and GHG emissions
- Macroeconomic and, to the extent feasible, health, environmental, employment and education, skills and social impacts, including just transition aspects
- Existing investment flows and forward investment assumptions
- Impacts on the energy system in neighbouring and other Member States in the region to the extent possible, and impacts on energy prices and energy market integration

Impacts on Energy System and Greenhouse Gas Emissions

Policies and Measures affect the national energy mix, mainly in:

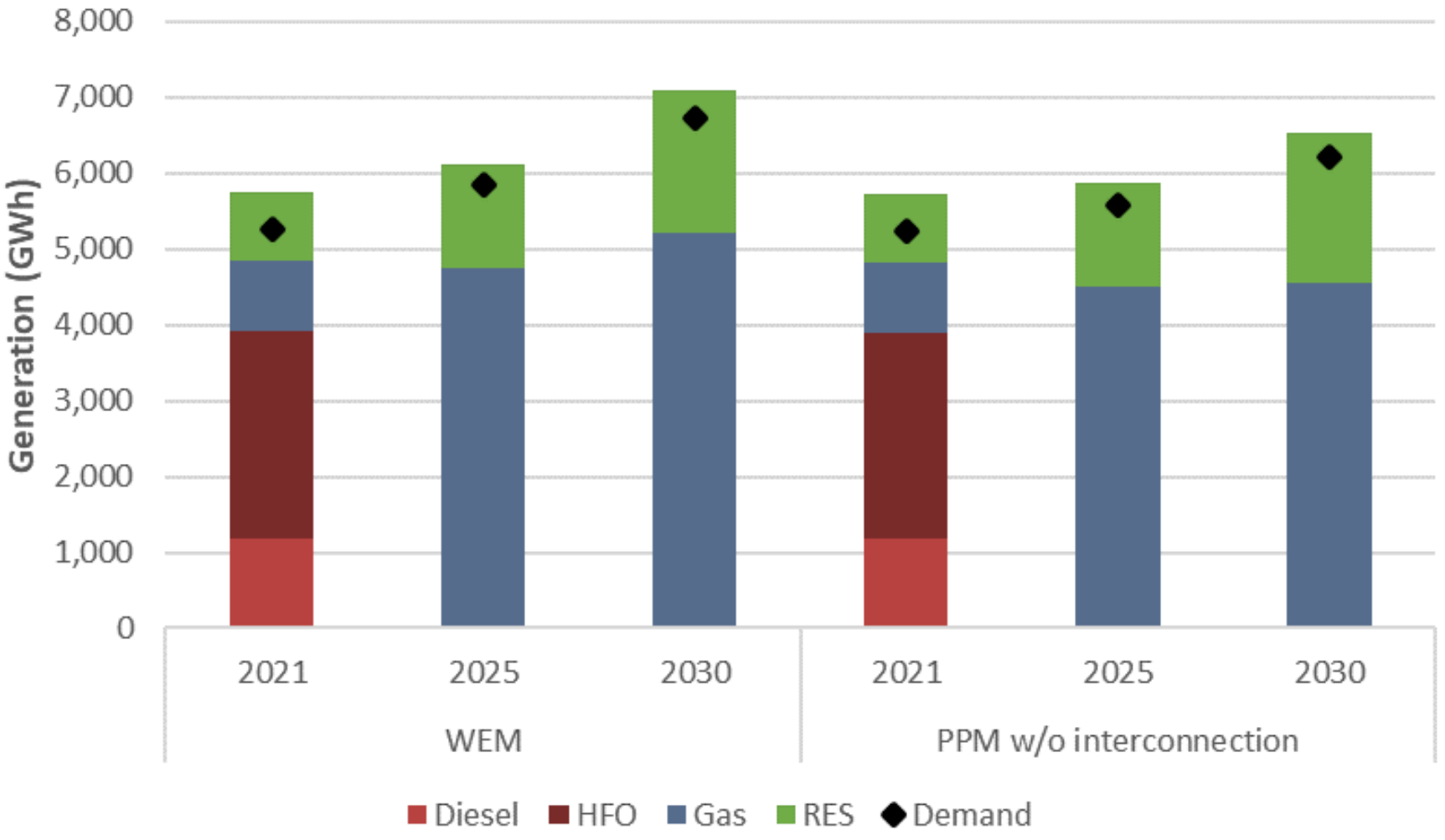
- Power generation
- Transport
- Buildings
- Industry

Adoption of new technologies affects in turn greenhouse gas emissions.

Power Generation – Installed Capacity

	WEM			PPM without Interconnection		
	2021	2025	2030	2021	2025	2030
Vasilikos	868	868	868	868	868	868
Dhekelia	460	102	102	460	102	102
Moni	150	150	150	150	150	150
New CCGT	216	432	432	216	432	432
RES	560	759	1,048	560	750	1,110
Pumped Hydro	0	0	130	0	0	0
Li-Ion Batteries	0	22	41	0	0	0

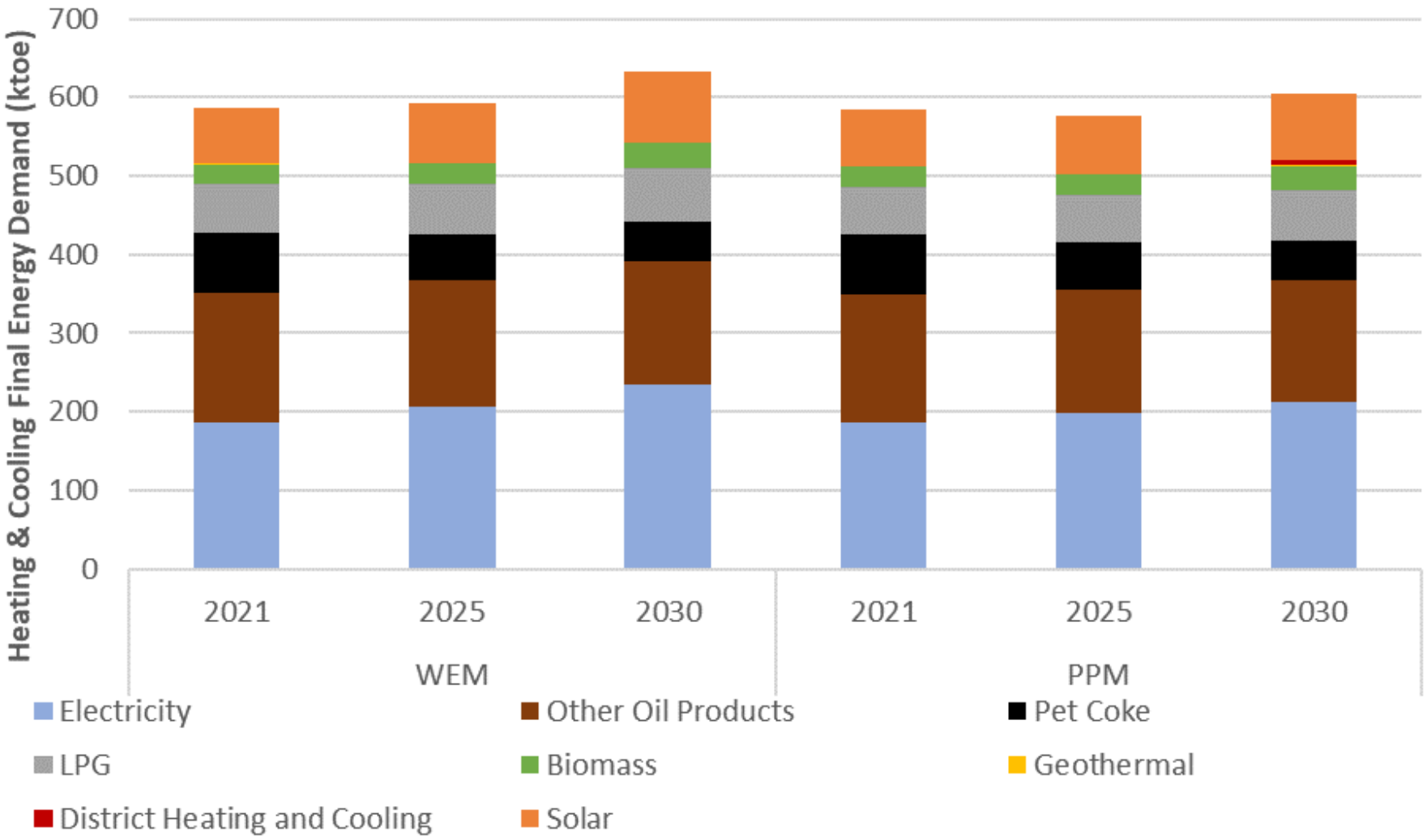
Power Generation – Electricity Production in 2021-2030



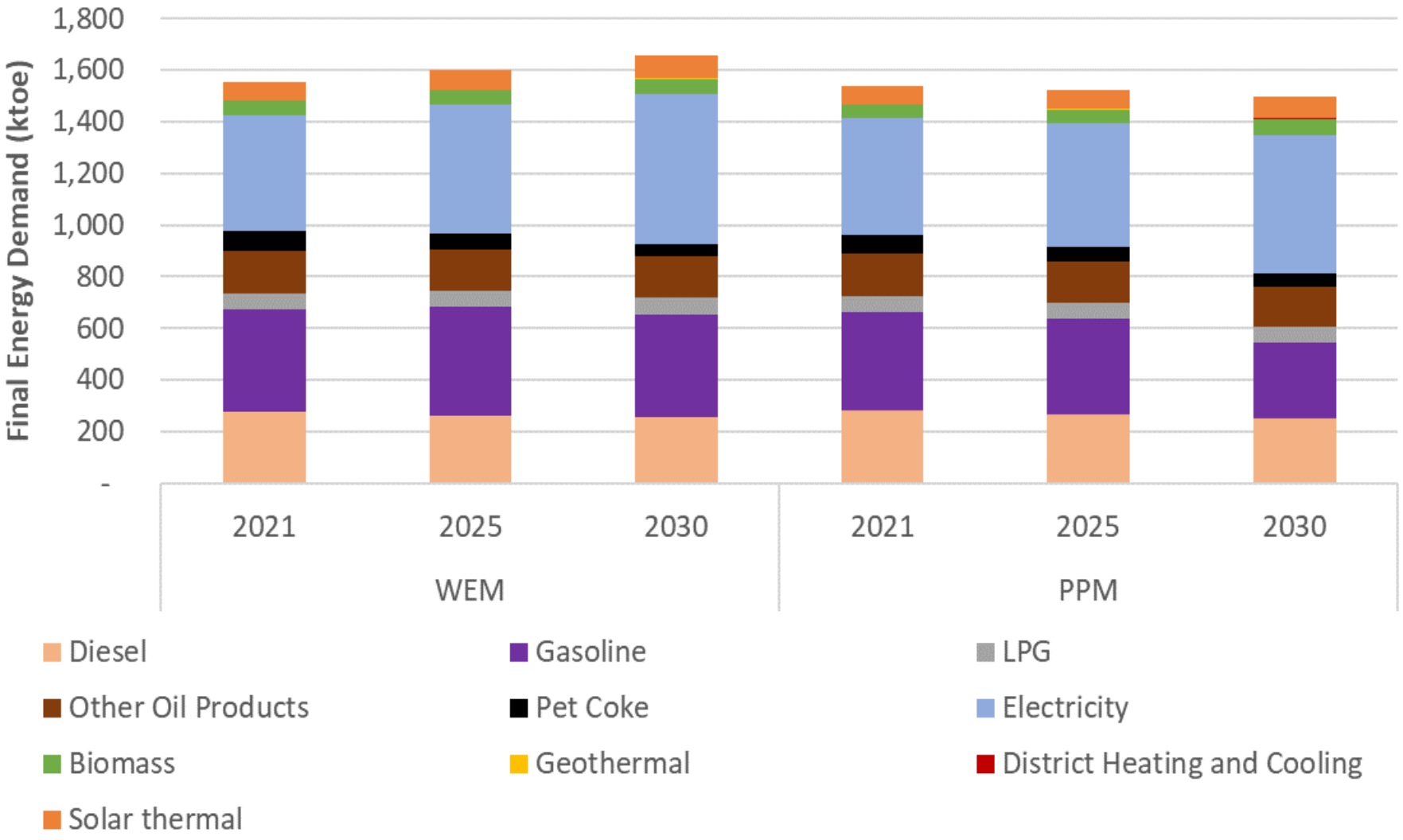
Land Transport – Evolution of Motor Vehicle Fleet in 2021-2030

		WEM			PPM		
		2021	2025	2030	2021	2025	2030
Light duty vehicles (passenger cars)	Diesel	63,430	40,372	37,055	63,430	40,372	28,964
	Diesel PHV	-	-	-	-	252	799
	Gasoline	485,181	538,687	485,950	471,561	472,909	347,579
	Gasoline Hybrid	5,170	5,170	59,927	5,170	5,170	59,927
	BEV	241	467	41,770	241	467	55,281
	LPG	320	739	1,174	320	739	1,174
Buses	Diesel	3,058	3,230	3,450	3,314	4,372	5,574
	BEV	-	-	-	-	138	436
MCs	Gasoline	51,685	54,667	58,383	50,442	48,476	46,000
Trucks	Diesel	13,166	13,923	13,907	13,209	14,146	13,738
	BEV	-	-	961	-	-	1,573
Light Trucks	Diesel	121,355	128,323	137,032	121,024	126,670	133,726
	Total	**743,606**	**785,578**	**839,609**	**728,711**	**713,710**	**694,771**

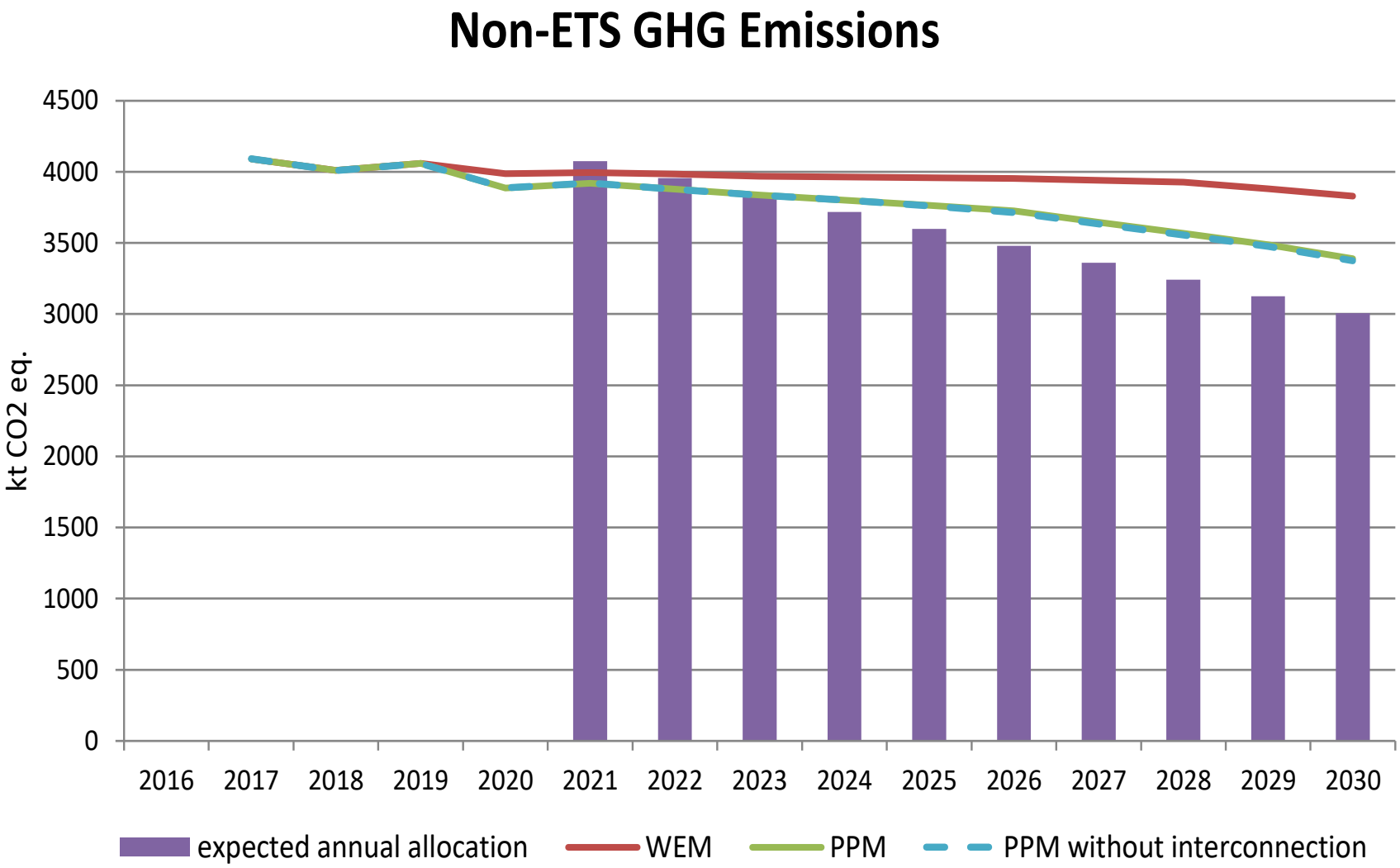
Energy Consumption for Heating & Cooling



Total Final Energy Consumption



Greenhouse Gas Emissions of Sectors Subject to the Effort Sharing Regulation



Progress Towards Achievement of Energy and Climate Targets of Cyprus

		Progress Towards Target in Scenario:		
Energy Union Objective	**Target for 2030 Relevant for Cyprus**	***Existing Measures***	***Planned Policies & Measures***	***Planned Policies & Measures no interconnection***
Reduction of GHG emissions	Non-ETS Sectors: -24% compared to 2005	-3%	-14%	-15%
Promotion of Renewable Energy	Energy-Wide Share of Renewables: 23%	20%	30%	23%
	Renewable Energy in Transport: 14%	8%	15%	14%
Improvement of Energy Efficiency	Cumulative savings of 243 ktoe in final energy consumption	To be met	To be met	To be met

Macroeconomic Impacts – 1

Methodology: Input-Output (IO) Analysis

- IO is a quantitative technique for studying the interdependence of production sectors in an economy and is extensively used for policy impact evaluation.
- The PPM scenario will involve additional and/or different types of investments during the period 2020-2030 in comparison to the WEM scenario.
- We developed and applied a dynamic IO model to estimate the economy-wide effects of the two scenarios on the economy of Cyprus.

Macroeconomic Impacts – 2

- Investments are classified in seven categories: industry, power generation technologies, electricity storage technologies, gas infrastructure, electricity interconnector, public transport, private transport, and buildings (energy efficiency measures)
- A critical parameter is to what extent production for implementing the investments occurs inside the economy of Cyprus or abroad. Estimation of macro-economic impacts is based on investment expenditures inside the national economy and not directly imported from abroad

Effect on GDP and Employment – 2

	2025	2026	2027	2028	2029	2030
With Existing Measures	64,916	66,380	67,944	69,464	71,037	72,514
With Planned Policies and Measures without electricity interconnection	65,047	66,510	68,060	69,646	71,257	72,725
Difference between Scenarios	0.20%	0.19%	0.17%	0.26%	0.31%	0.29%
With Existing Measures	524,825	536,458	548,936	560,590	572,776	584,814
With Planned Policies and Measures without electricity interconnection	525,884	537,489	549,866	562,166	574,636	586,502
Difference between Scenarios	0.20%	0.19%	0.17%	0.28%	0.32%	0.29%

- In 2030, economic output and employment of the country under the PPM scenario without interconnection will be higher by 0.29% compared to the WEM Scenario.
- Negative effects in the economic output of the energy sector due to reduced energy demand thanks to energy efficiency measures.
- In the rest of the economy, increase in construction and metal products due to energy efficiency measures adopted in the PPM scenario.

Change in economic output by main economic sector in the PPM scenario, in comparison to WEM scenario

Sectors of economic activity	*2030*
Agriculture	-0.08%
Forestry	0.00%
Mining	0.23%
Food Manufacturing	-0.07%
Textile	0.03%
Wood and Paper	0.55%
Chemical and Plastic Products	0.32%
Metal Products	1.24%
Machinery and Equipment	0.09%
Energy	-1.32%
Construction	2.04%
Trade	-0.25%
Accommodation and Food Services	0.06%
Transportation	0.64%
Banking-Financing	0.23%
Real Estate	0.24%
Public Administration	0.03%
Education	0.01%
Health	0.00%

Impacts on Social Equity

- Impact of PPM scenario on income distribution of households is the composite effect of a) changes in energy prices compared to WEM scenario and b) response of consumers to these price changes.
- Electricity costs are expected to be 5.2% lower in the PPM scenario with interconnector in 2030, leading to a drop in consumer prices of electricity of about 4% by 2030.
- Electricity costs are expected to be 2.7% higher in the PPM scenario without interconnector in 2030, leading to a rise in consumer prices of electricity of about 1.5% by 2030.
- Blending of automotive gasoline and diesel with (more costly) advanced biofuels to increase retail prices of gasoline and diesel by 2.0% and 0.9% respectively in 2030, or 1.5% as a weighted average

Effect on Household Expenditures

- Weighted average of price change in all energy goods is about 1.3% ➔ very small increase in the cost of living of Cypriot households up to 2030
- Negligible distributional effect: poor and rich households may experience increase in their costs of 10-20 Euros'2015 and 30-50 Euros'2015 per year respectively – in all cases a ~0.1% effect on their incomes
- Conclusion: PPM scenario (with & without interconnection) will not cause substantial costs or benefits to households nor affect the distribution of income or poverty levels in the Cypriot society

Health Impacts – 1

- PPM Scenario with interconnector projects a decline in emissions of air pollutants PM, NOx and SO_2 by 2030 in comparison to WEM Scenario
- Improved air quality thanks to less fossil fuel powered motor vehicles, elimination of oil-fired power generation and less biomass use in households
- PPM Scenario without interconnector projects a decline in emissions of air pollutants PM, NOx and an increase of SO_2 by 2030 in comparison to WEM Scenario
- According to European Environment Agency, exposure of Cypriot population to high levels of ambient PM, NO_2 and ozone caused about 580, 240 and 30 premature deaths respectively in 2016.
- Premature deaths may decrease by about 20-25 per year in the PPM scenario.

Health Impacts – 3

- PPM Scenario without interconnector leads to lower emission reductions compared to the PPM scenario, and to higher SO_2 emissions due to very small remaining fossil fuelled power generation in 2030
- Economic benefits due to reduced air pollution of PPM scenario exceed 11 MEuros'2016 in 2030; over the whole decade 2020-30 benefits exceed 70 MEuros

Pollutant	Change in emissions in 2030	Avoided damage costs in 2030 (mio Euros'2016)
NO_x	-3.9%	2.8
PM	-4.8%	9.8
SO_2	9.1%	-1.0
Total benefit		11.6

Cumulative additional investment needs of the period 2020-2030 to implement the PPM scenario without interconnection, in comparison to the WEM scenario

Sector	mio Euros'2016	% of total GDP of 2021-2030
Power generation (new CCGT plants, PVs etc.)	-46	-0.02%
Electricity storage technologies (pumped hydro & batteries)	-72	-0.03%
Electricity Interconnector	0	0.00%
Sustainable Mobility (buses & tram, bus lanes, cycle lanes etc.)	1378	0.48%
Private transport (shift to sustainable transport modes, more efficient cars, electric cars, biofuels etc.)	-2098	-0.73%
Residential & commercial buildings (energy efficiency renovations)	715	0.25%
Industry	77	0.03%
Total Additional Investments	**-46**	**-0.02%**

Change in energy system costs of PPM scenario without interconnection compared to WEM scenario – 1

Sector	Costs (mio Euros'2016)	2021-25	2026-27	2028-30
Power Generation (new thermal and renewable power plants)	Investment	317	52	42
	Operation & Maintenance	-43	-10	-79
	Total	**274**	**42**	**-38**
Electricity storage technologies (pumped hydro & batteries)	Investment	-3	-19	-51
	Operation & Maintenance	0	-3	-7
	Total	**-3**	**-22**	**-58**
Electricity interconnector	Investment	0	0	0
	Operation & Maintenance	0	0	0
	Total	**0**	**0**	**0**
Sustainable mobility (buses & tram, cycle lanes, bus lanes etc)	Investment	355	291	723
	Operation & Maintenance	30	26	53
	Total	**385**	**317**	**776**

Change in energy system costs of PPM scenario without interconnection compared to WEM scenario – 2

Sector	Costs (mio Euros'2016)	2021-25	2026-27	2028-30
Private transport (shift to sustainable transport modes, more efficient cars, electric cars, biofuels etc.)	Investment	-619	-477	-1001
	Operation & Maintenance	-507	-493	-1029
	Total	**-1125**	**-970**	**-2030**
Energy efficiency improvements (buildings & industry)	Investment	360	144	216
	Operation & Maintenance	-43	-46	-96
	Total	**317**	**98**	**120**
Difference in Total System Costs	Investment	411	-9	-71
	Operation & Maintenance	-562	-525	-1158
	Total	**-151**	**-534**	**-1229**
Difference in Environmental Costs		**-23**	**-17**	**-32**
Difference in Total System Costs incl. Environmental Costs		**-174**	**-551**	**-1261**

Conclusions – 1

- Existing policies and measures are insufficient to lead Cyprus to compliance with obligations of the Energy Union Governance Regulation
- Planned Policies and Measures can make Cyprus meet its goals regarding energy efficiency and penetration of renewable energy sources
- If fully implemented, PPM will lead to net economic benefits to society of ~500 million Euros'2016 by 2030, with small positive effects on economic indicators (0.3-0.4% increase in national GDP and a 0.3-0.4% rise in total employment in 2030)
- No adverse impact on the welfare of households and social equity from PPM scenario

Conclusions – 2

- Road transport holds the key to emissions abatement for 2030 and for the longer term. Investments in sustainable mobility may exceed 1.3 billion Euros in 2020-2030 but will fully pay off.
- Multiple benefits from reduction of car use can yield economic benefits to society of ~2 billion Euros'2016. Coupled with fast electrification, the only way to achieve the 2030 non-ETS target and shift the Cypriot economy to a low-carbon path towards 2050.

Conclusions – 3

- If electricity interconnection of Cyprus with Greece and Israel is not realised, penetration of renewable energy will be considerably lower. This may still allow compliance of Cyprus with its renewable energy commitments in 2030, but will slow down investments for decarbonising the electricity system
- Research and innovation can accelerate deployment of novel technologies and development of expertise for innovative services for low-carbon technologies.
- Even if implemented effectively, PPM (with or without interconnection) are not sufficient to reach non-ETS GHG emission reduction target of 24% by 2030; only 14-15% is reached.

Recommendations on Compliance of Cyprus with Energy Governance Regulation

- Successful implementation of the PPM package is not guaranteed; requires significant investments for energy renovations in buildings and industry and a substantial commitment to promote sustainable transport and electric vehicles. **Public funding necessary; EU funds can play a very important role.**
- Purchasing allowances to fill the 2030 emissions gap does not lead to strong decarbonisation towards 2050; it will cost >50 mio Euros in 2021-2030 (or much more) and **will lock the economy to an unsustainable path**.
- Gradual adoption of a **green tax reform** from 2021 (carbon tax on non-ETS sectors) is a necessary additional policy, both for 2030 target and enabling the transition to a net-zero-carbon economy by 2050.

Reflections on Impact Assessment Study

Challenges during the study:

- Strong collaboration among various governmental authorities required for NECP preparation; this caused delays in preparation of final list of Policies and Measures ⇨ delayed input received by the modelling team from authorities
- Dynamic policy environment ⇨ changing requirements from the study (RES target, electricity interconnection project, national afforestation policies etc.)
- Consultants had a double role: Provide independent assessment ⇔ Prepare a text that would be used by national authorities in the NECP

Lessons Learned?

To be discussed!

Modelling for Long-Term Decarbonisation

→ **DEVELOPMENT OF A MARGINAL ABATEMENT COST (MAC) CURVE**

- Bottom-up ‘measure-explicit’ MAC curve for Cyprus through SESS funding, public policy perspective
- Identification of a country-specific cost-effective policy mix for 2030

→ **DEVELOPMENT OF OPTIMISATION MODEL**

- Multi-constraint optimisation model
- Examination of least-cost greenhouse gas emission abatement pathways with medium- and long-term targets
- Relationship between 2030 abatement targets of varying ambition and the possibility of achieving deep decarbonisation in 2050

Simulation

We perform four different scenarios:

►Scenario I:

No additional measures
+ purchase of permits to cover 2030 emissions gap

►Scenario II:

Measures up to €30/tonne
+ purchase of permits to cover 2030 emissions gap

Unambitious Scenario

►Scenario III:

Measures up to €120/tonne
+ Carbon tax up to €120/tonne
+ purchase of permits to cover 2030 emissions gap

Ambitious Scenario

►Scenario IV:

All available measures
+ Carbon tax up to level to meet 2030 target

Results for all Scenarios up to 2030

Scenario	Investment costs (1000 €)	2030 emissions gap (ktCO2e)	Purchase of permits to cover 2030 emissions gap (1000 €)	Total Costs (1000 €)	Total Costs including the savings over the lifetime of measures (1000 €)	Total Costs including the savings over the lifetime of measures and externalities (1000 €)	2050 emissions gap (ktCO2e)
No additional measures + purchase of permits to cover 2030 emissions gap	€ -	1016.96	€ 128,113.31	€ 128,113.31	€ 128,113.31	€ 128,113.31	2978.60
Measures up to €30/tonne + purchase of permits to cover 2030 emissions gap	€ 105,214.41	955.1		21	-€ 216,444.45	-€ 257,363.25	1884.14
Measures up to €120/tonne + Carbon tax up to €120/tonne + purchase of permits to cover 2030 emissions gap	€ 1,573,837.37	431.3		.19	-€ 446,770.41	-€ 926,483.19	238.60
All available measures + Carbon tax up to level to meet 2030 target	€ 1,752,838.43	0.00	€ -	€ 1,752,838.43	-€ 924,161.20	-€ 1,407,308.45	0.00

Unambitious Scenario

Ambitious Scenario

Cumulative Emissions Abatement (% of the total abatement in 2050)

Unambitious Scenario: Measures up to €30/tonne
+ purchase of permits to cover 2030 emissions gap

Ambitious Scenario: Measures up to €120/tonne
+ Carbon tax up to €120/tonne
+ purchase of permits to cover 2030 emissions gap

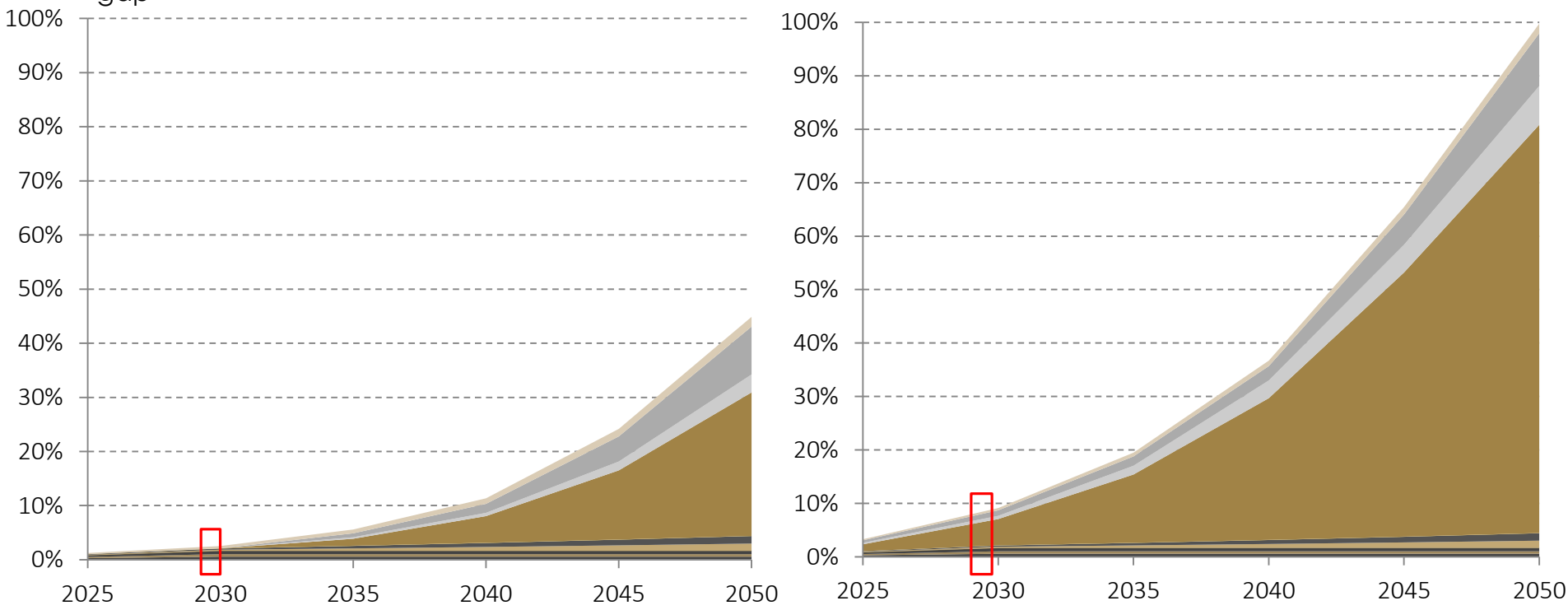


Figure 1: Emission abatement in non-ETS sectors up to 2050 by type of measure

Cumulative Emissions Abatement up to 2030 (% of the total abatement in 2050)

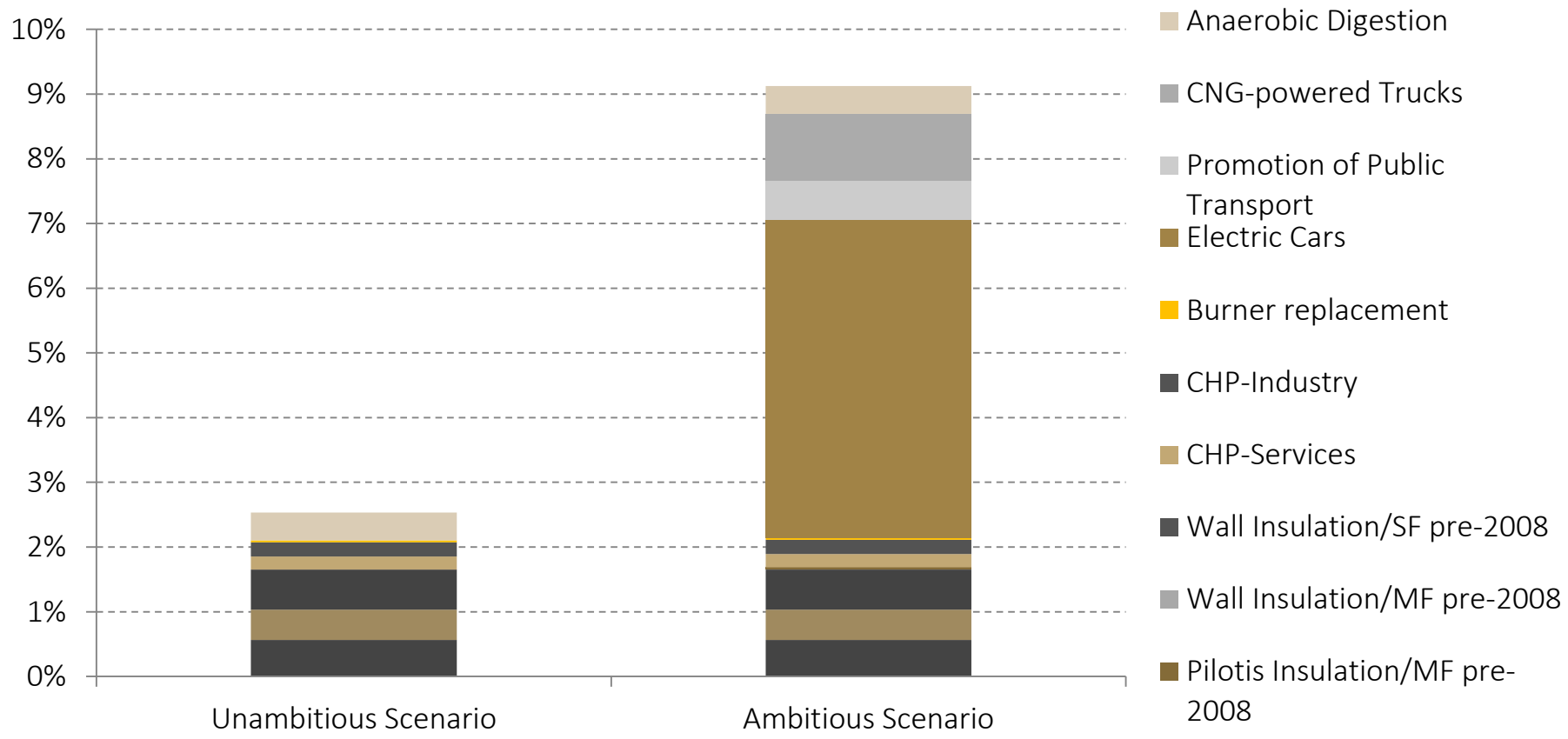


Figure 2: : Emission abatement in non-ETS sectors for the year 2030 by type of measure

Results for Scenarios III & IV up to 2050

Scenario	Investment costs (1000 €)	2030 emissions gap (ktCO2e)	Purchase of permits to cover 2030 emissions gap (1000 €)	Total Costs (1000 €)	Total Costs including the savings over the lifetime of measures (1000 €)	Total Costs including the savings over the lifetime of measures and externalities (1000 €)	2050 emissions gap (ktCO2e)
Measures up to €120/tonne + Carbon tax up to €120/tonne + purchase of permits to cover 2030 emissions gap	€ 8,134,178.80	431.37	€ 54,342.82	€ 8,188,521.62	-€ 841,931.25	-€ 2,980,964.46	238.60
All available measures + Carbon tax up to level to meet 2030 target	€ 7,458,832.42	0.00	€ -	€ 7,458,832.42	-€ 2,981,642.03	-€ 5,023,943.92	0.00

Wrap up

- Deep decarbonization in the country's non-ETS sectors is very demanding;
- The implementation of all mitigation measures identified in non-ETS sectors is not sufficient to fulfil the country's medium- and long-term climate targets;
- Adoption of cost-effective greenhouse gas reduction measures coupled with the implementation of a gradually increasing carbon tax in these sectors is necessary;
- Unambitious medium-term scenarios could miss key and essential economic sectors for achieving deep decarbonization (quality of abatement);
- 'lock-in' effect - prioritizing abatement options which are cheaper and faster to implement but do not have sufficient potential to meet ambitious abatement targets must be avoided;
- Early deployment: Implementation of seemingly expensive measures is necessary in order to achieve serious decarbonization in 2050;