Summary of scenario analysis of GHG emissions reduction up to 2050

Matjaž Česen, Energy efficiency centre

„Jožef Stefan“ Institute, 17.5.2021

LIFE CLIMATE PATH 2050

Projekt LIFE ClimatePath2050 (LIFE16 GIC/SI/000043) je financiran iz finančnega mehanizma LIFE, ki ga upravlja Evropska komisija, in iz Sklada za podnebne spremembe Ministrstva za okolje in prostor RS.

Content

- Scenarios
- Sectoral projections – final energy consumption sectors
- Transformation sector
- Total emissions
- Other impacts

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Scenarios

Without measures (WOM)

	With existing measures (OU)	**With additional measures – moderate (DU)** DU JE in DU SNP	**With additional measures - ambitious (DUA)** DUA JE in DUA SNP
GHG target 2050:		**- 80 %**	**From -90% to -95%** **Net zero emissions** (with LULUCF)
			NECP, Long term climate strategy

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Scenarios

Without measures (WOM)

With existing measures (OU) - WEM

All measures **before 1.1.2019**
Extrapolation of technological progress

With additional measures – moderate (DU) – WAM M
DU JE in DU SNP

Fast technological progress
Moderate rate of additional measures
Some **behavioural** measures.

With additional measures - ambitious (DUA) – WAM A
DUA JE in DUA SNP

Faster technological progress
Intensive rate of **additional measures**
More behavioural measures

Two scenarios in electricity production (after 2030):
SNP – synthetic gas (carbon neutral)
JE – nuclear energy

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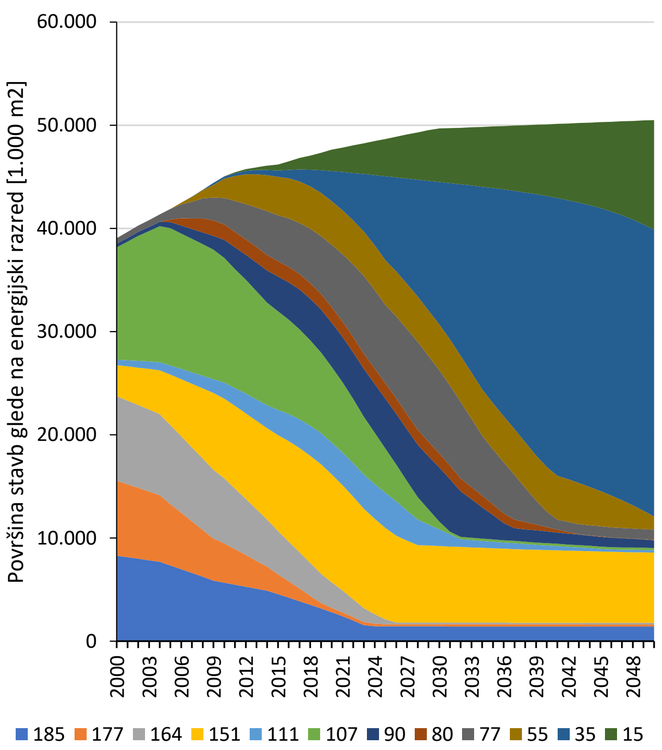
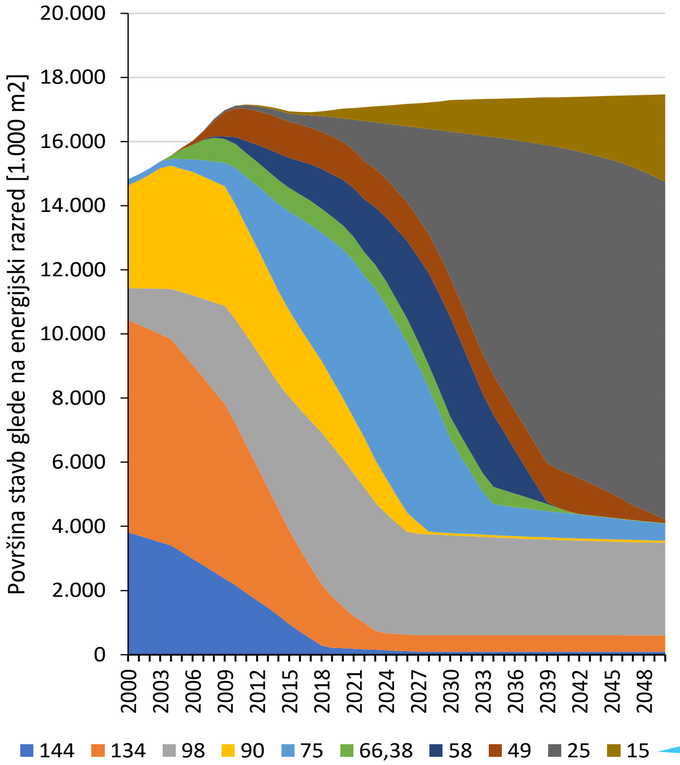
Residential buildings – renovation assumptions

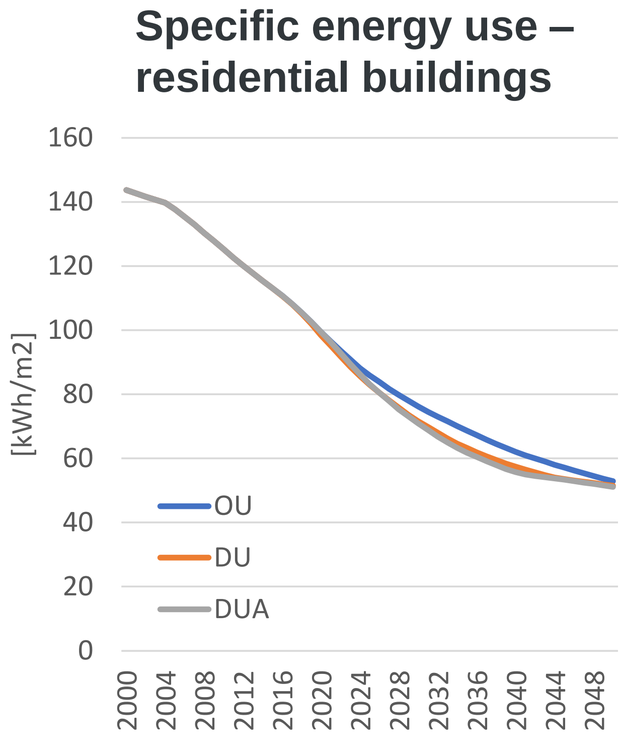
Surface area 1000 m²



Singlefamily houses



Multifamily houses



Specific enegy use in kWh/m2/year

Energy for heating

By 2030 95 % of buildings renovated / 60 % deep renovation
By 2050 73 % of buildings deeply rennovated / technical limitation

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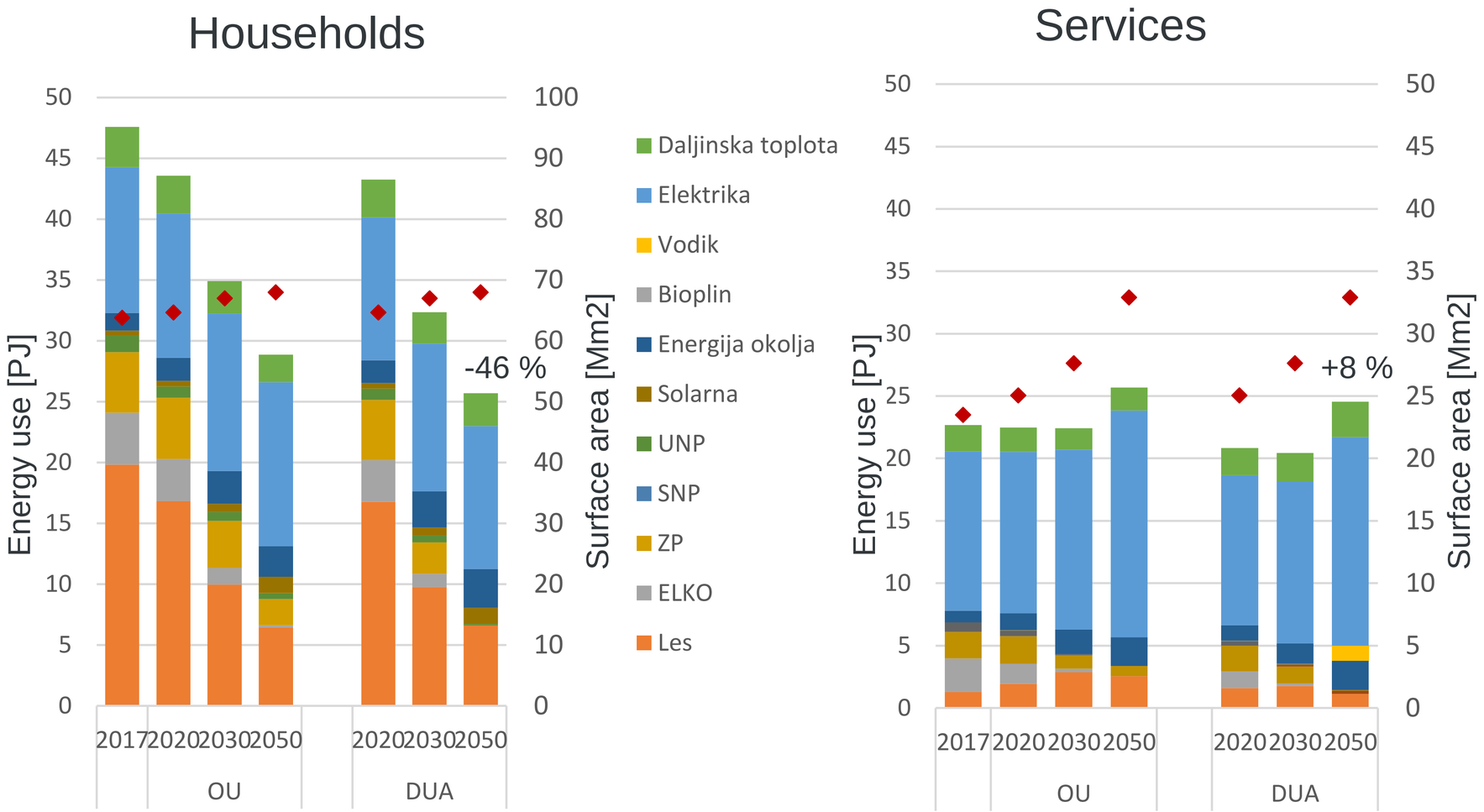
Energy consumption - buildings



- **Strong energy efficiency improvement** (buildings renovation, heating system replacements, appliances, behaviour changes); *Specific total energy - 38 %*

- **Strong push toward renewable energy, district heating** (share of fossil fuels 23 % ⟶ 0 %), Synthetic gas 1 % (+) RES and DH 43 % (o) 1%t Electricity 57 % (+) 22%t

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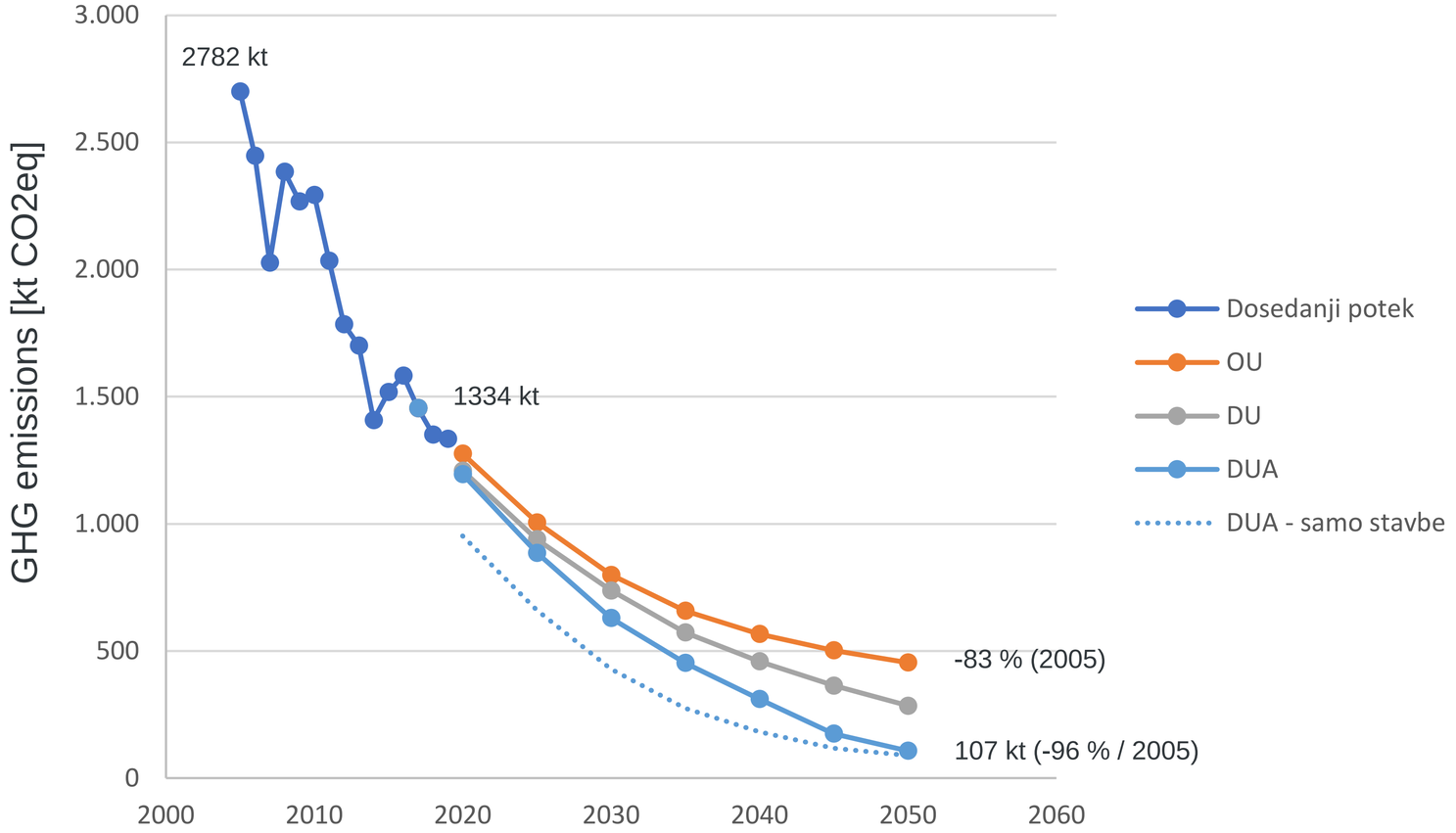
GHG emissions – Other sectors



- **Other sectors:** Buildings + Energy use in agriculture
- **Strong decrease of GHG** emissions (WAM) (-96 % compared to 2005)
- Emissions in 2050 mainly from **CH4** (wood) and **N2O**
- Emission reduction in agriculture: penetration of new technologies (tractors): biofuels, sinthetic fuels,electricity, biogas

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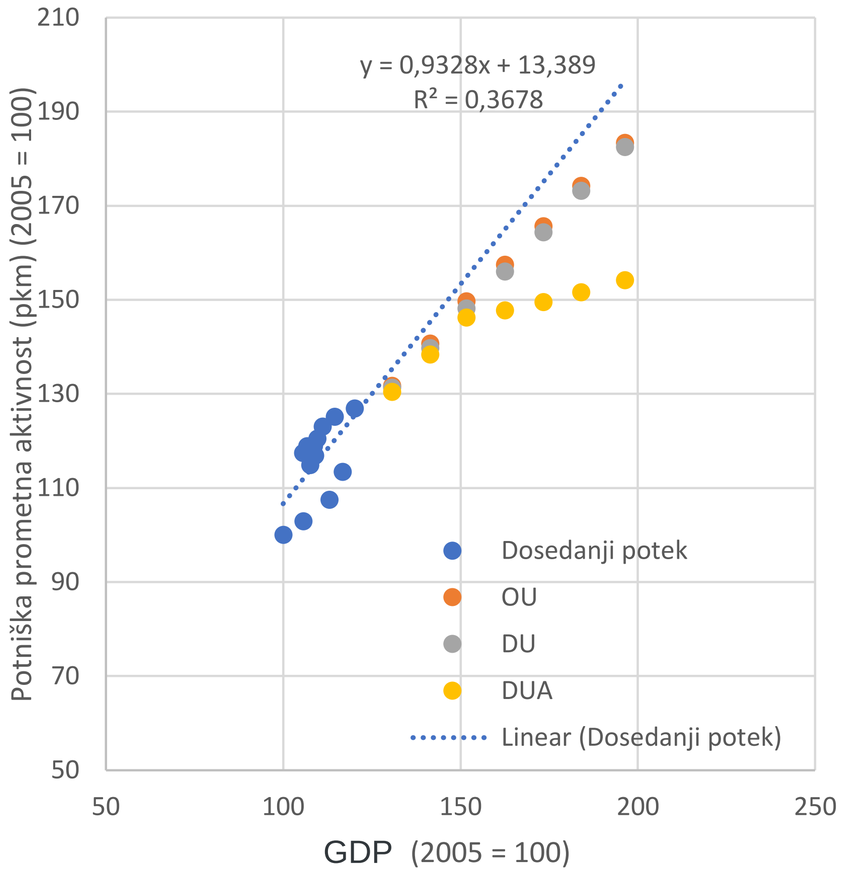
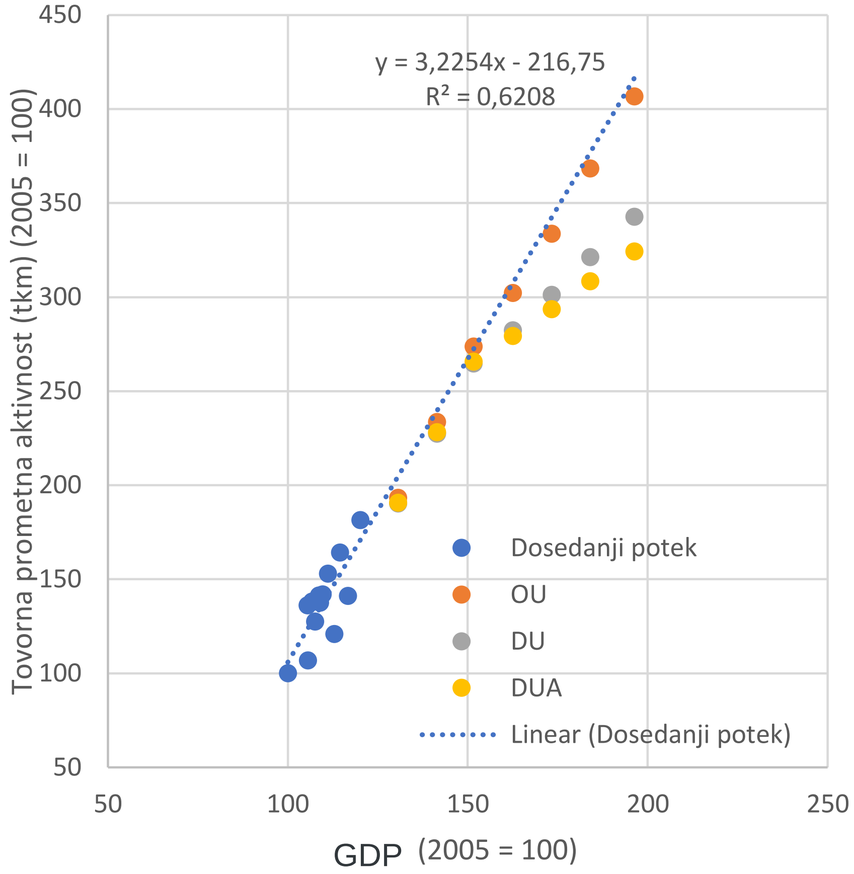
Transport motor activity

Passenger activity and GDP



Freight activity and GDP



Ambitious WAM foresees strong decoupling of motor activity from GDP

- Spatial planning
- Work at home
- Promotion of walking and cycling
- Circular economy
- Increasing cost of transport (external cost)

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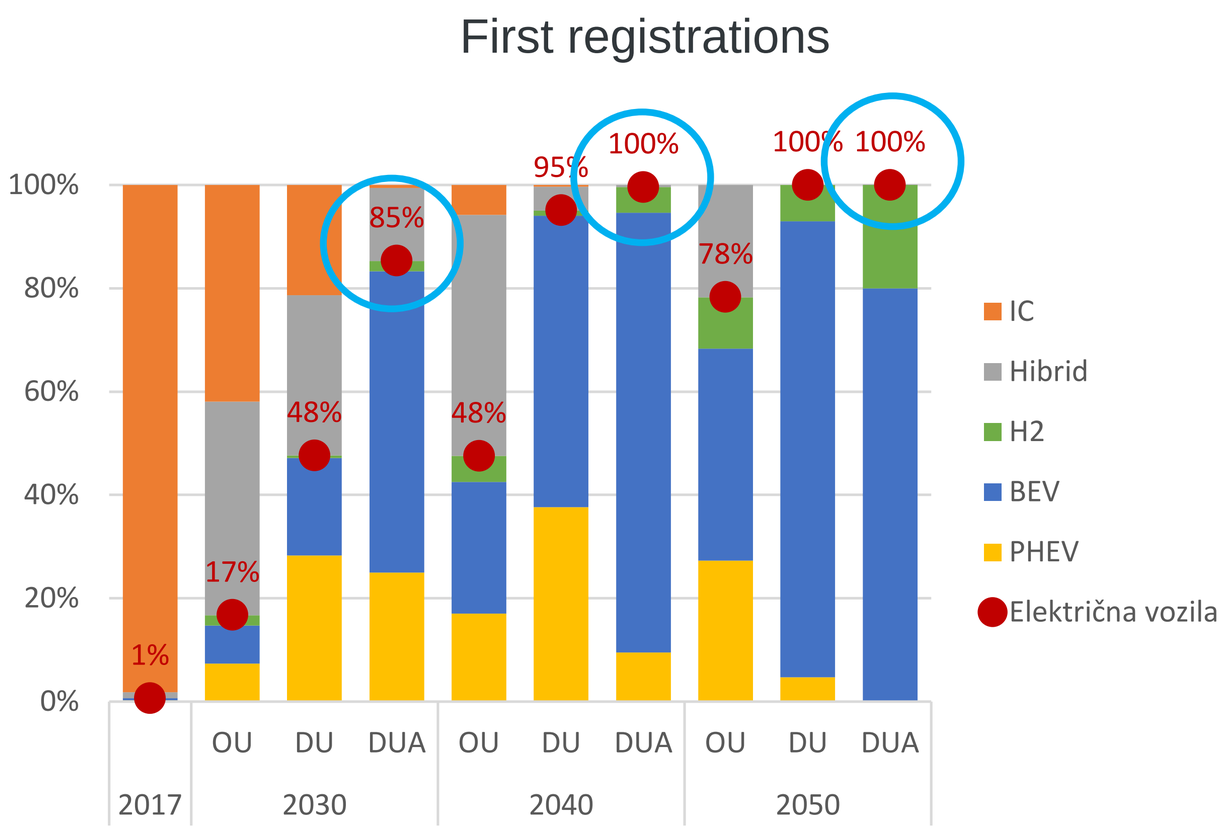
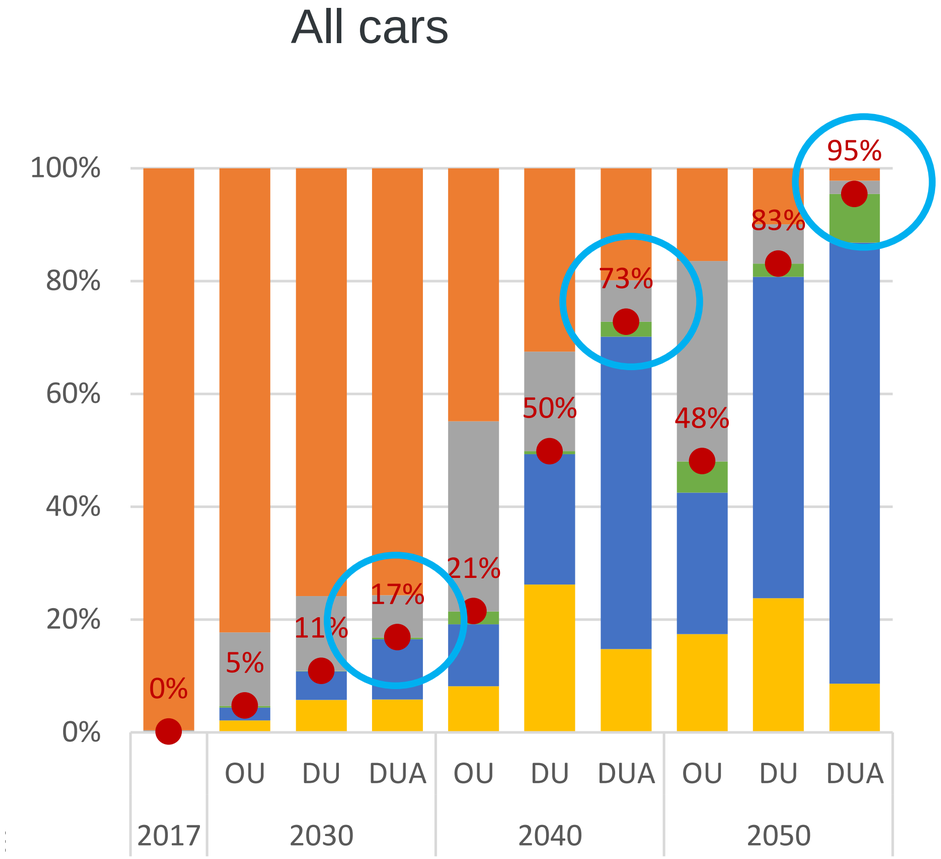
Structure of first and all registrations – cars





Cars have long lifetime – slow increase of share of new technologies in vehicle stock

Important technological progress, charging infrastructure

LIFE CLIMATE PATH 2050

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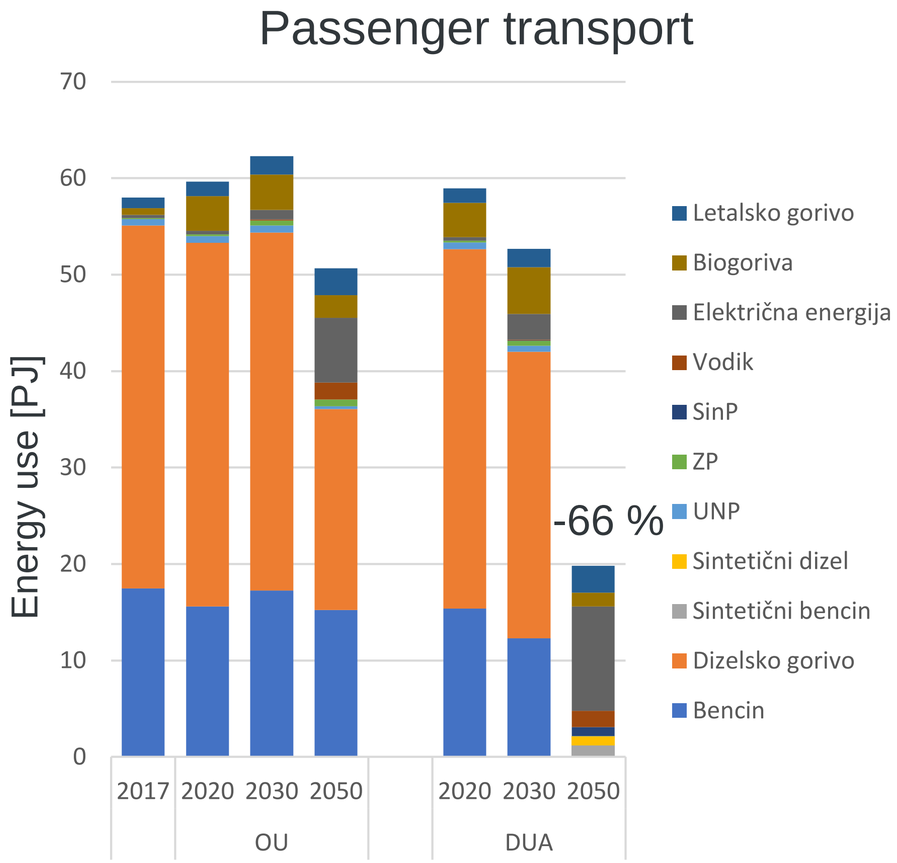
Energy consumption - transport



Total consumption in transport compared to 2017

2030: - 1 %

2050: - 48 %

1. High efficiency improvements

Passenger [TJ/pkm]:

2030 - 23 %, 2050 - 75 %

Freight [TJ/tkm]:

2030 - 20 %, 2050 - 47 %

2. Increase in use of alternative fuels

2 % ➡ 12 % ➡ 100%

Electricity	1 %	⟶ 38 %
SyntF & H2	0 %	⟶ 59 %
Biofuels	1 %	⟶ 3 %

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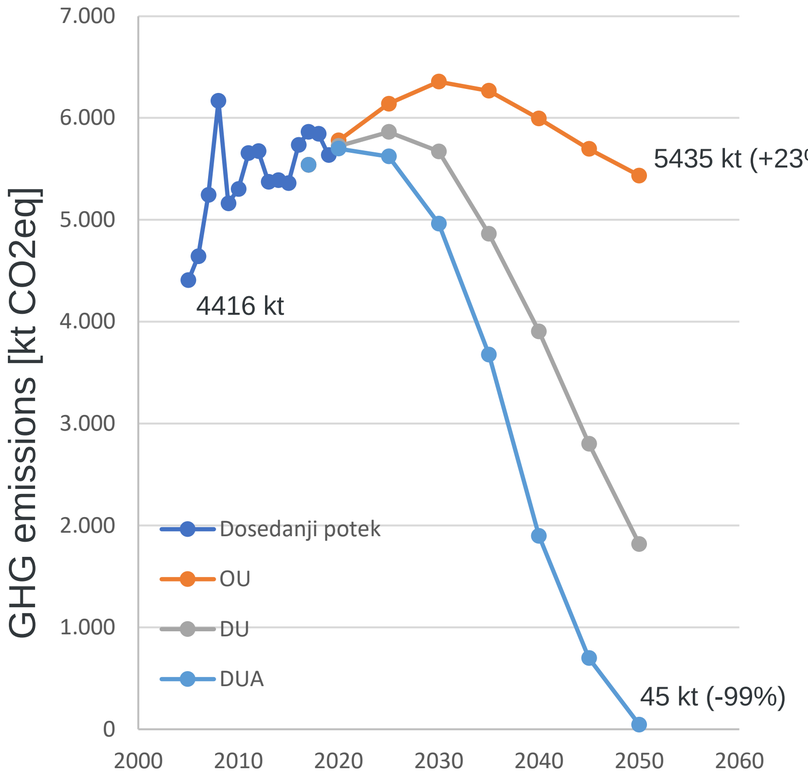
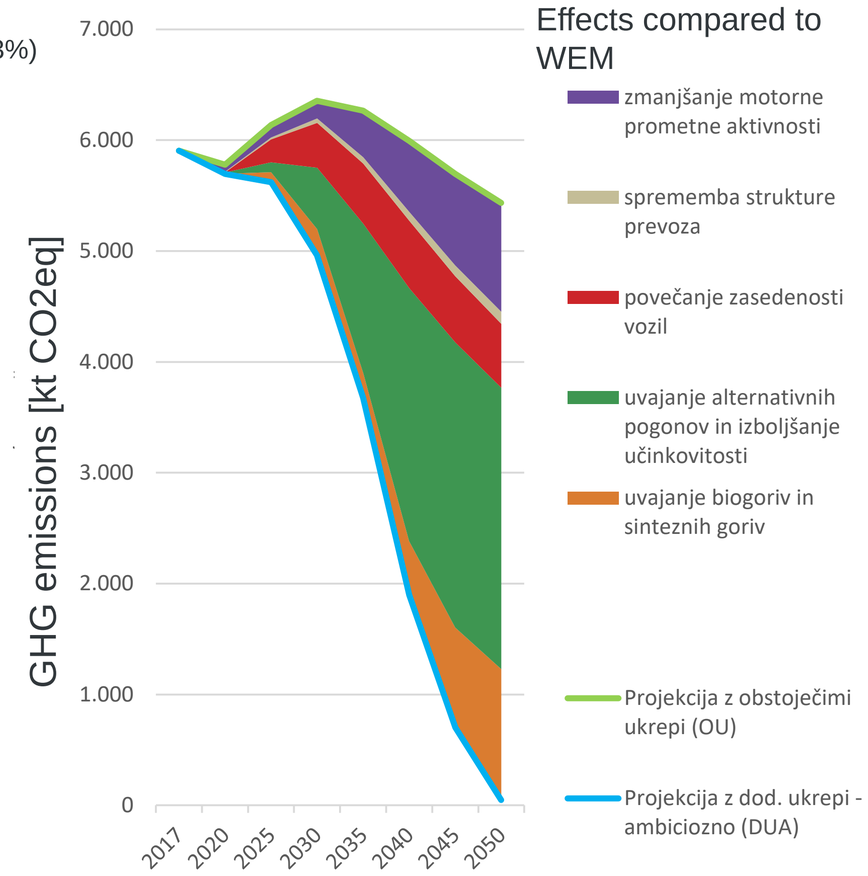
GHG emissions - transport



GHG emissions decrease by

99 %



Main measures

- Reduction of **motor transport activity** (2030: **11 %**; 2050: **18 %**) compared to WEM
- **Public transport** and freight on **railways** (2030: **3 %**; 2050: **2 %**)
- Increasing **occupancy of vehicles** (2030: **29 %**; 2050: **11 %**)
- **Increasing efficiency** of vehicles (also through electricification) (2030: **40 %**; 2050: **47 %**)
- Use of **synthetic and biofuels** (2030: **17 %**; 2050: **22 %**)

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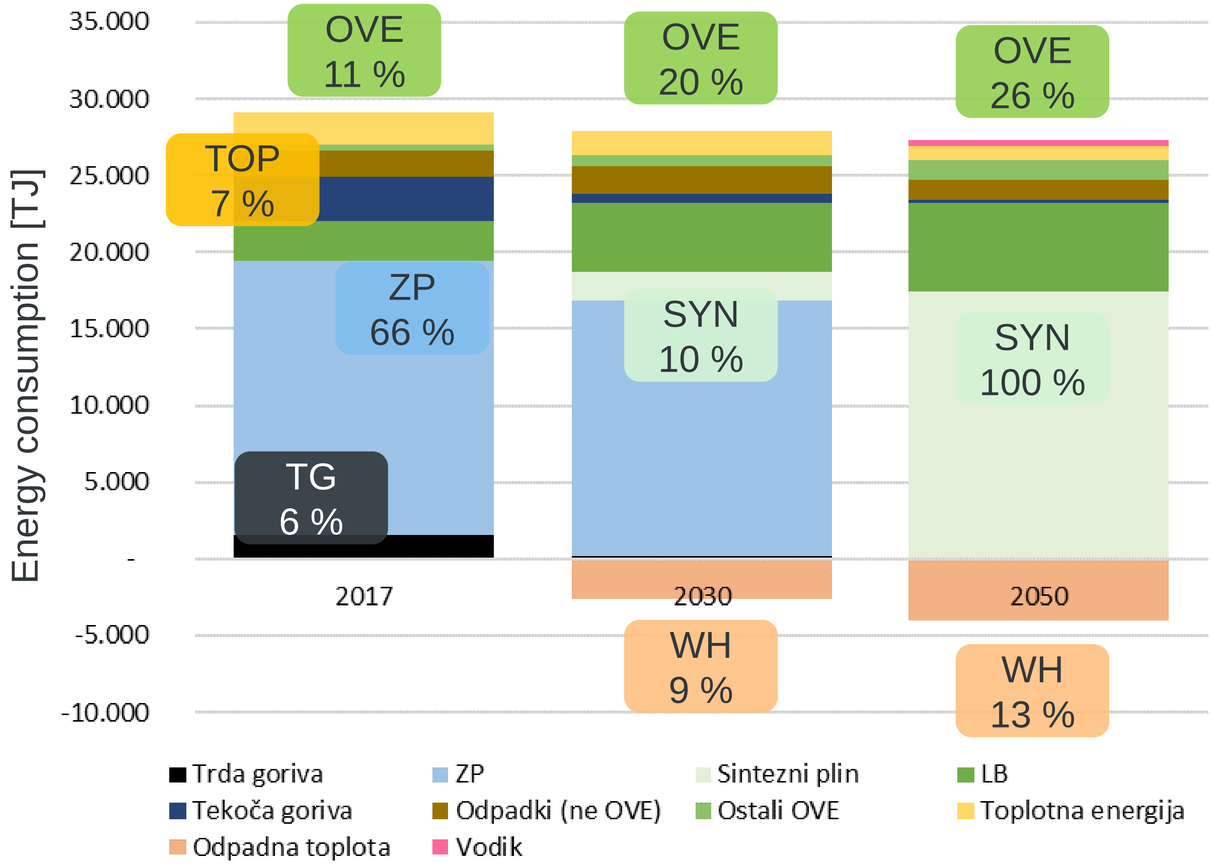
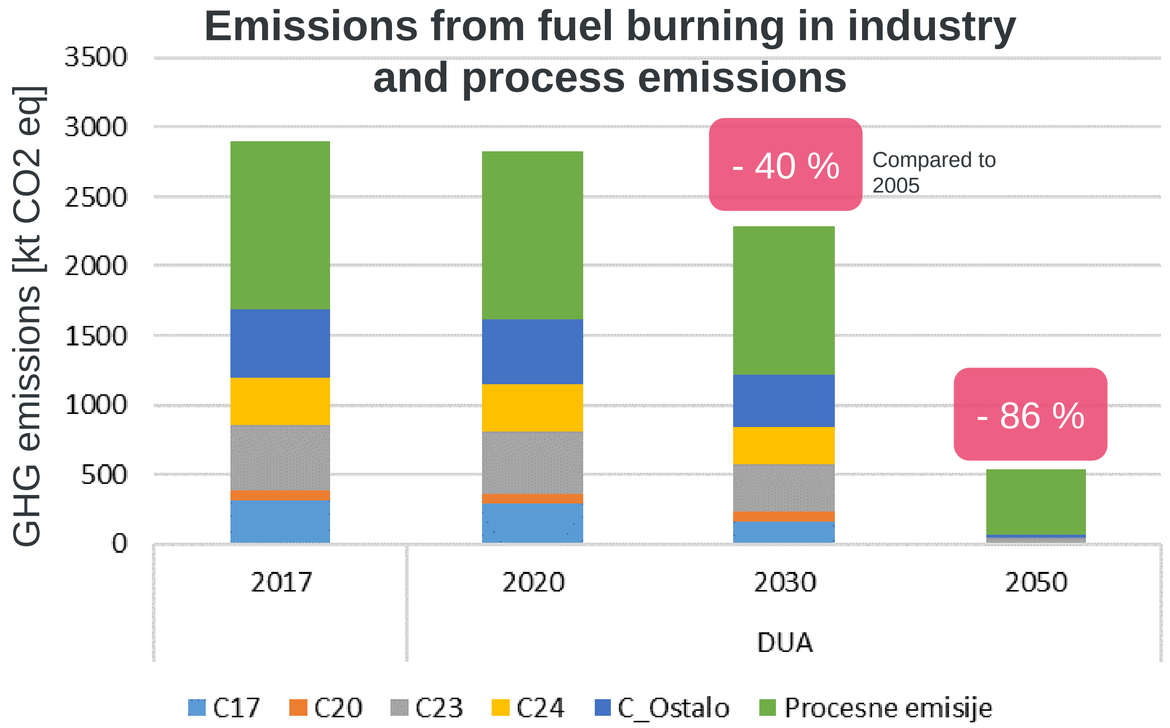
Industry

→No significant change in industry structure

→Strong efficiency improvement: Energy use slightly decreasing despite production growth (-1 %; -3%) (use of waste heat)

→Increasing share of RES, Synt. gas; no fossil fuels in 2050; CCS on cement production unit





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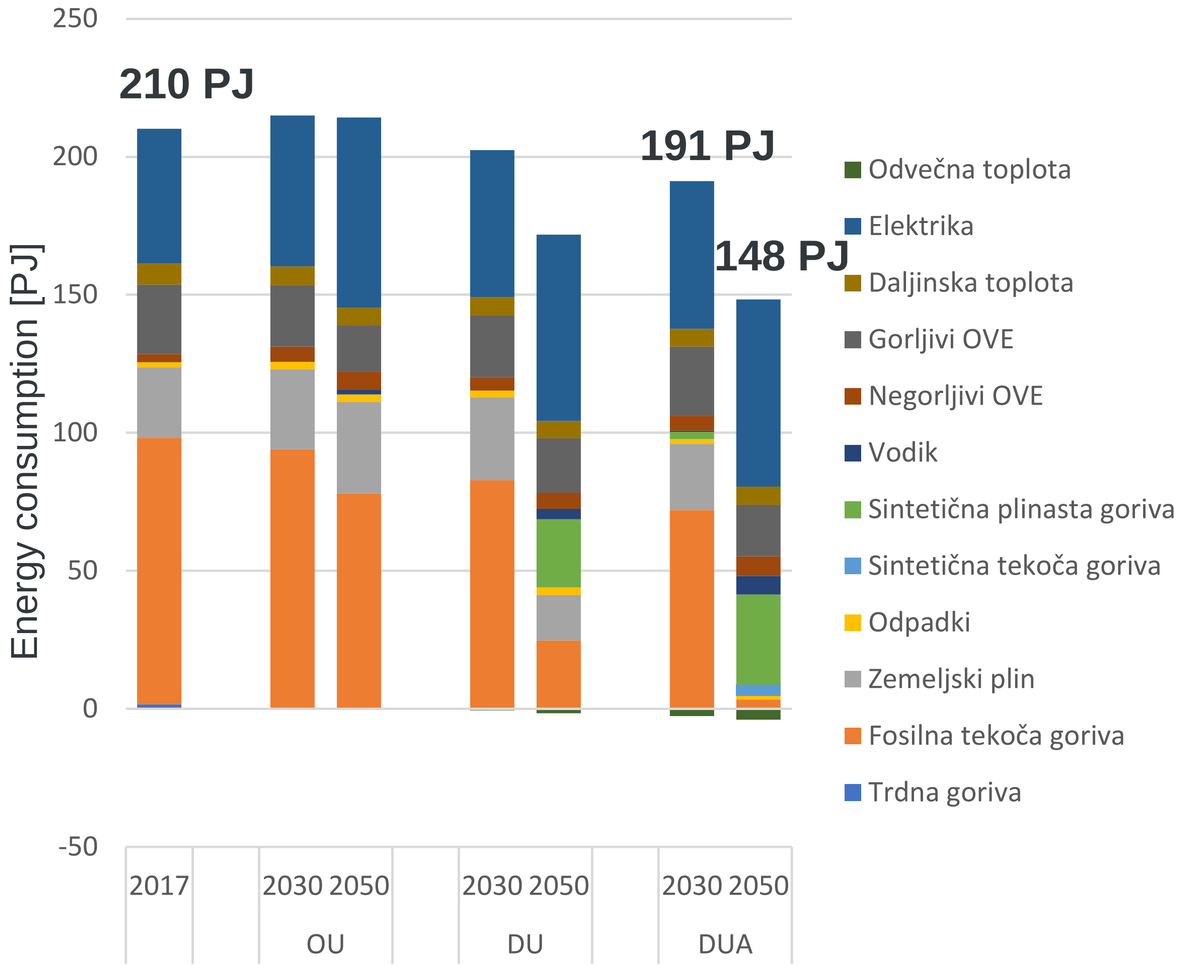
Final energy consumption



- Decrease in **energy consumption** (2030/2017: - 9 %; 2050: - 29 %)
- Estimated energy savings: 145 PJ (2050)

- Increase in use of **RES** **(13 %** 2017**; 16 %** 2030**; 17 %** 2050**)**
- Important role of **synthetic fuel and hydrogen** **(2 %** 2030**; 29 %** 2050**)**

- Increasing use of **electricity**
  2017: **14 TWh 23 %**
  2030: **15 TWh 28 %**
  2050: **19 TWh 46 %**

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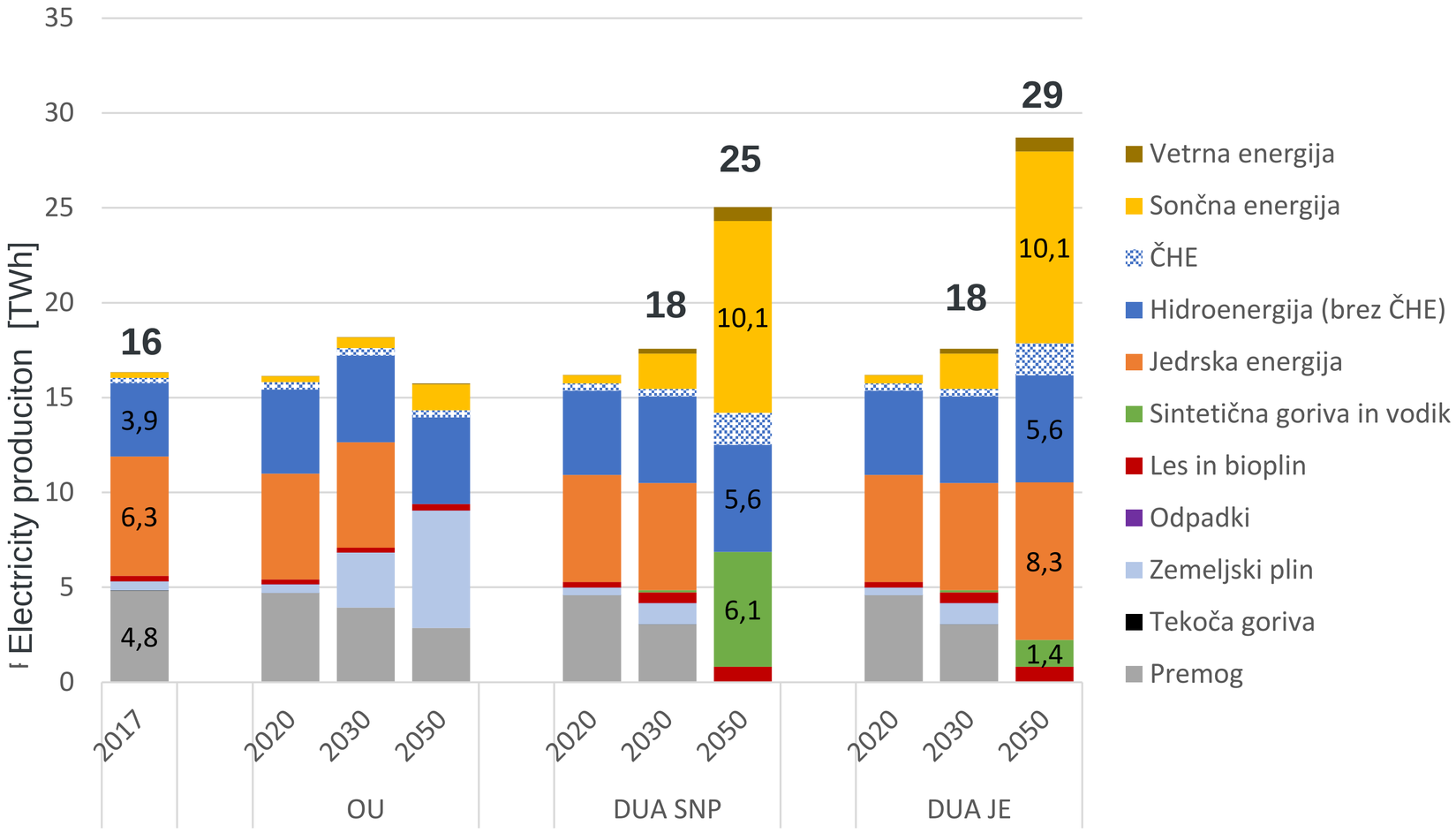
Electricity production



Increase in production
2030 8 %
2050 53 % - 76 %

Structural change
2017; 2030; 2050
FF: 33 %; 24 %; 0 %
RES: 29 %; 44 %; 76 % (66 %)

Nuclear / Synt. gas & H2

Security of supply;

Yearly production / hourly / minute - Power availability

Electricity network

Criteria on coverage of consumption

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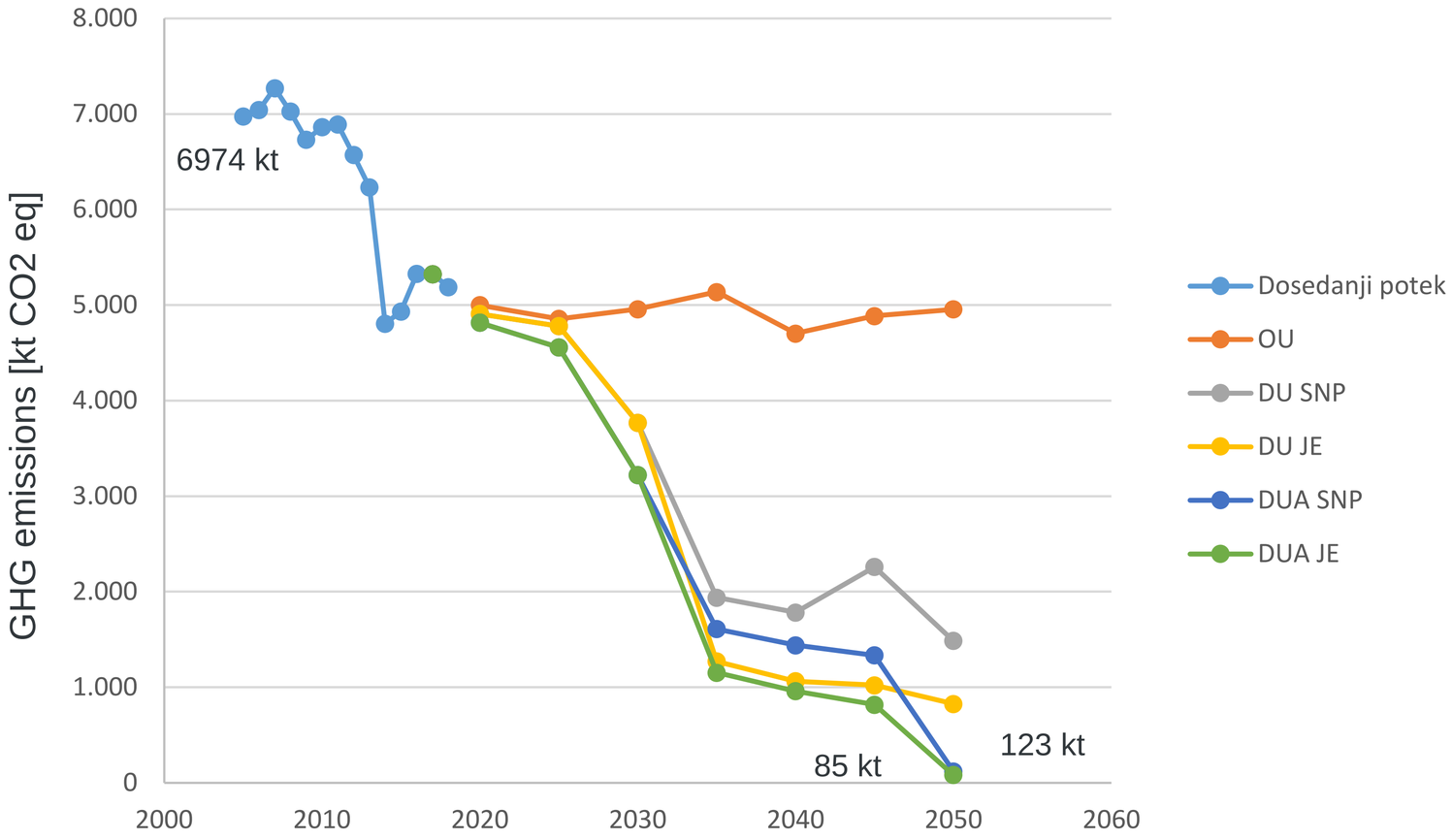
GHG emissions - Transformation



- **Strong GHG emission reduction**
  2030 - 54 %
  2050 - 98 % (SNP); - 99 % (JE)

- CCS on coal power plant in 2035 (both WAM scenarios) – shutdown before 2050
- Synthetic gas substituting NG (gradually from 2030, DUA 100% in 2050)
- Emissions include fugitive emissions (coal mining, distribution of gas, liquid fuels) and emisisons from district heating

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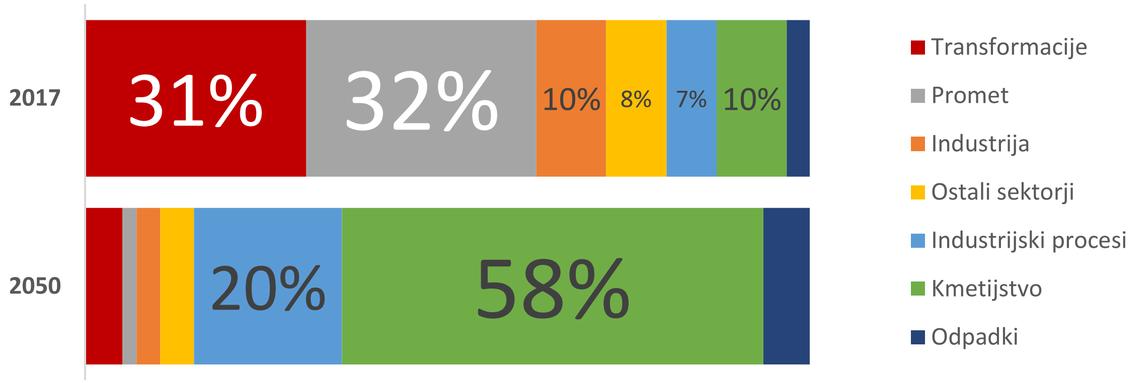
GHG emission per sectors

DUA SNP	2005	2017	2020	2025	2030	2035	2040	2045	2050	2050/ 2005	2050/ 2017	Share 2017	Share 2050
Transformation	6.974	5.324	4.820	4.561	3.225	1.614	1.444	1.337	123	-98%	-98%	31%	5%
Industry	2.485	1.679	1.627	1.519	1.276	1.166	927	537	75	-97%	-96%	10%	3%
Transport	4.416	5.541	5.700	5.623	4.964	3.678	1.899	699	45	-99%	-99%	32%	2%
Other sectors	2.661	1.456	1.195	886	629	453	311	175	107	-96%	-93%	8%	5%
Ind. processes	1.426	1.208	1.207	1.146	1.066	1.010	629	522	471	-67%	-61%	7%	20%
Agriculture	1.709	1.688	1.734	1.716	1.700	1.618	1.572	1.457	1.343	-21%	-20%	10%	58%
Waste	848	557	465	355	262	220	189	166	148	-83%	-73%	3%	6%
TOTAL	**20.519**	**17.453**	**16.748**	**15.807**	**13.122**	**9.760**	**6.970**	**4.892**	**2.313**	**-89%**	**-87%**		

DUA JE

Transformation	6.974	5.324	4.820	4.561	3.225	1.155	962	821	85	-99%	-98%	31%	4%
TOTAL	**20.519**	**17.453**	**16.748**	**15.807**	**13.122**	**9.301**	**6.488**	**4.376**	**2.275**	**-89%**	**-87%**		



Main emission sources:

2017 Transport, Transformation (63 %)
2050 Agriculture, Ind. processes (79 %)

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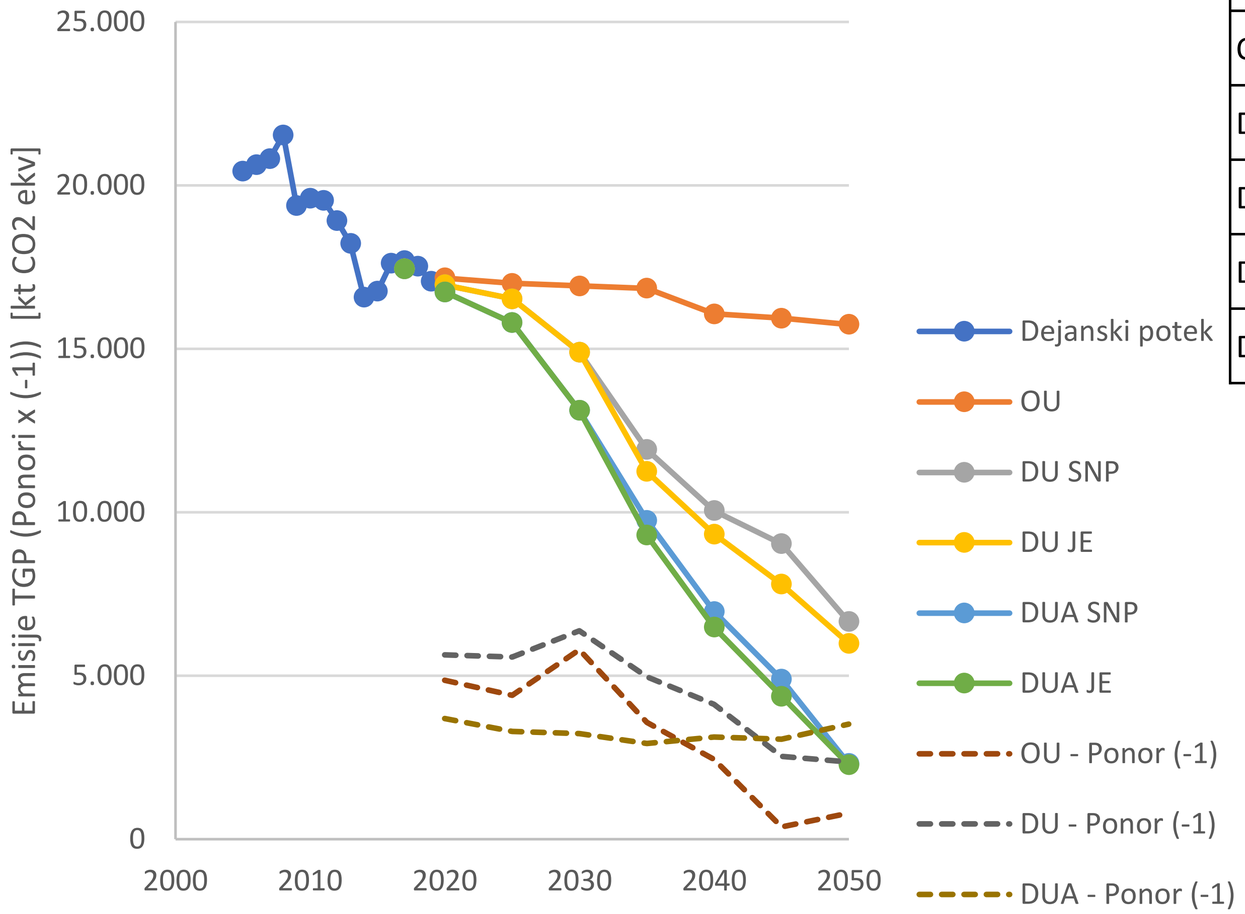
GHG emissions - TOTAL



[kt CO2 eq]	**2005**	**2017**	**2020**	**2030**	**2040**	**2050**		2030/ 2005	2050/ 2005	2050/ 2017
OU	20519	17453	17174	16928	16074	15750		-18%	-23%	-10%
DU SNP		17453	17015	14968	10083	6676		-27%	-67%	-62%
DU JE		17453	17015	14968	9365	6015		-27%	-71%	-66%
DUA SNP		17453	16748	13122	6970	2313		-36%	-89%	-87%
DUA JE		17453	16748	13122	6488	2275		-36%	-89%	-87%

Slovenia **by 2050** reaches **net zero emisions** based on projections with **ambitious implementation of additional measures** taking into account **optimistic projections for sinks**.

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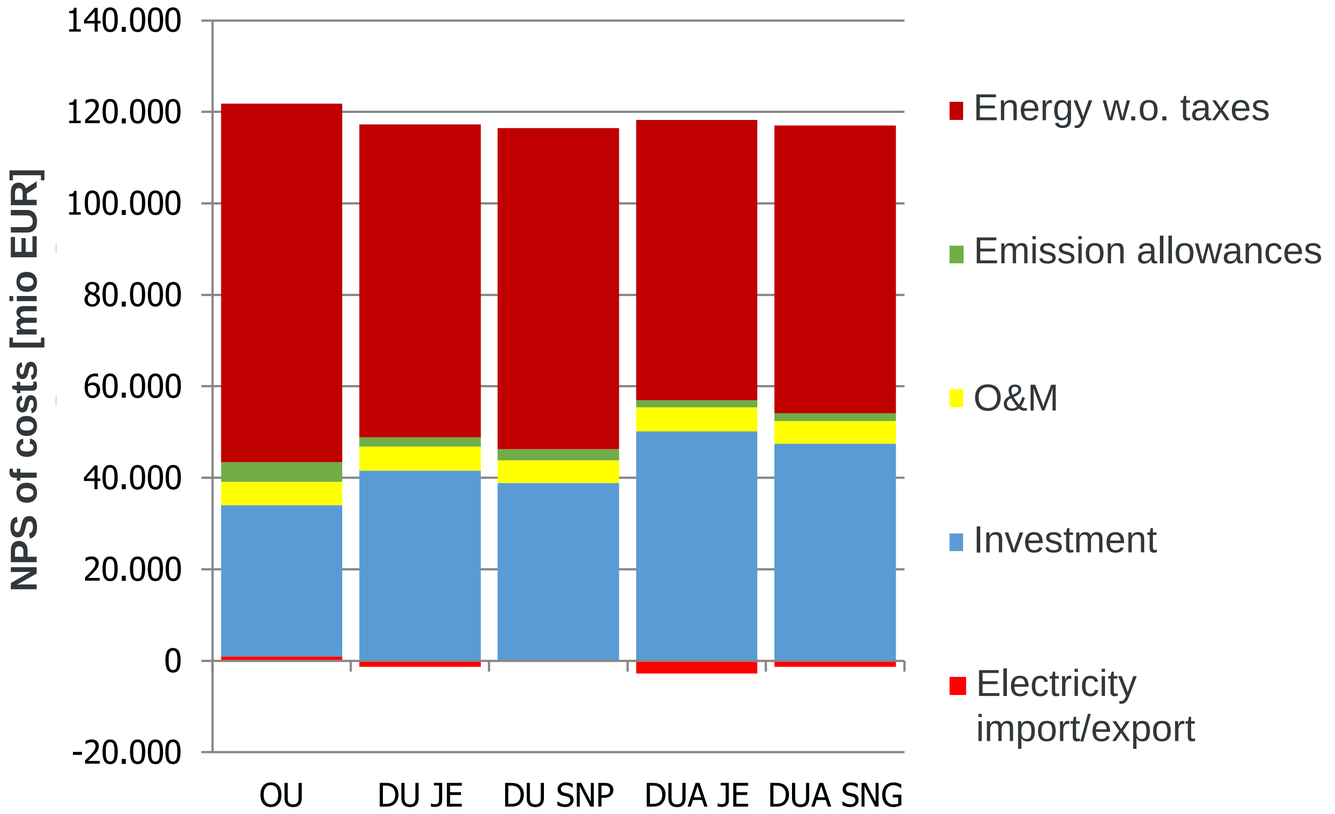
Costs of transition

Total costs of energy supply and demand **are comparable in all DU an DUA scenarios**

Cost structure: in DUA scenario (ambitious) share of **investment costs is higher** and costs **of energy and emission** allowances is **lower.**

Costs for imported energy (fuels) are much lower in more ambitious scenarios



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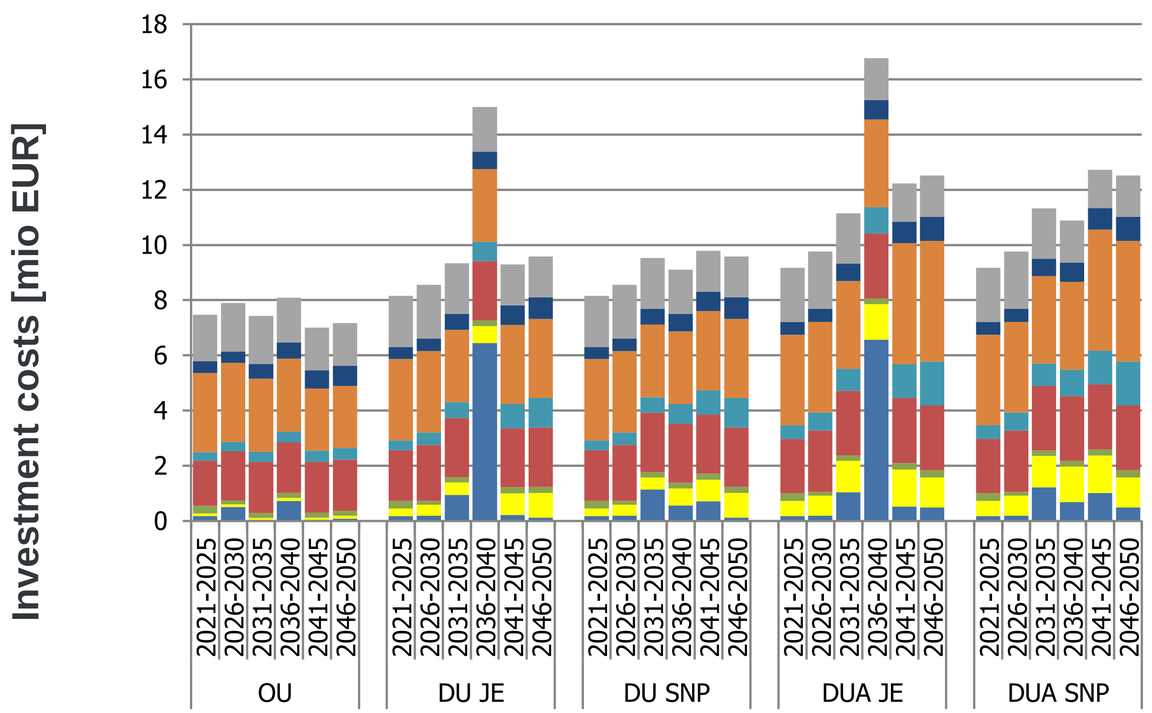
Investment costs



Investment costs by scenario:

- **OU** 45 mlrd EUR,
- **DU JE** 60 mlrd EUR,
- **DU SNP** 55 mlrd EUR,
- **DUA JE** 72 mlrd EUR in
- **DUA SNP** 66 mlrd EUR.

Share of sectors in investment costs:

- **28–34** % transport,
- **19–24** % el. distribution
- **14–22** % households
- **3-13 %** el. generation (>10 MW)
- **5–9 %** industry
- **1–9 %** local energy supply
- …

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Assessment of the macroeconomic impacts until 2030

- Investments contribute to energy efficiency. Lower prices of inputs results in increase in demand on labor market, decrease in unemployment and increase in production. Positive effects are on costs of consumable goods and available households incomes.
- Comparison of scenarios DU in DUA in 2030 (improvement relative to scenario OU in %) :

	DU	DUA
GDP *	+1,1%	+2,1%
Private consumption*	+1,5%	+2,2
Employment	+0,9%	1,4%

GDP and private consumptions evaluated in monetary terms. Increases do not represents the increase in material consumption/production.

- There are positive effect also on other indicators (export, investment, etc.)

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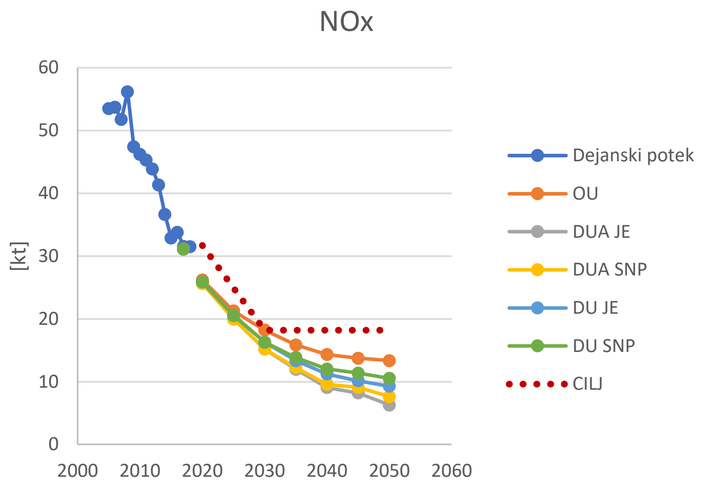
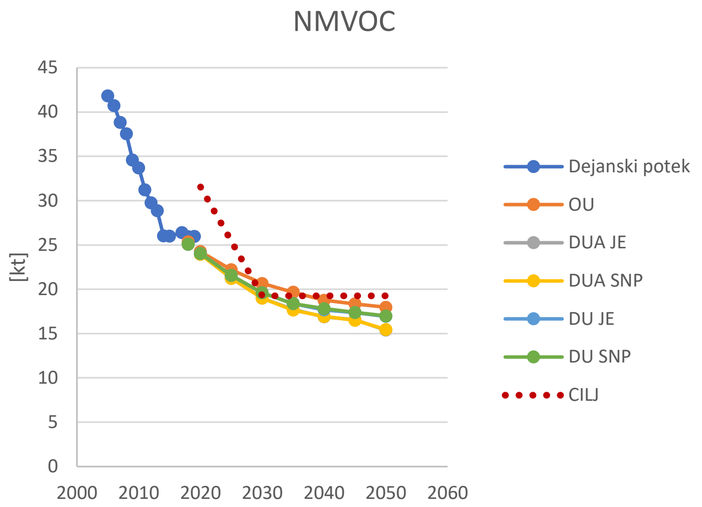
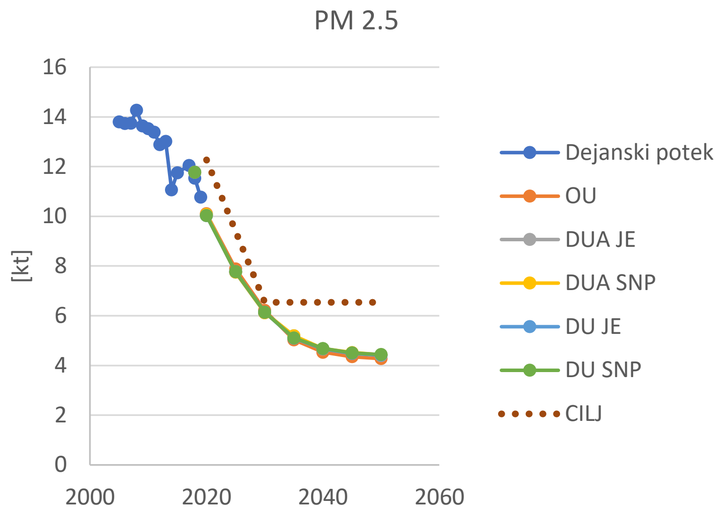
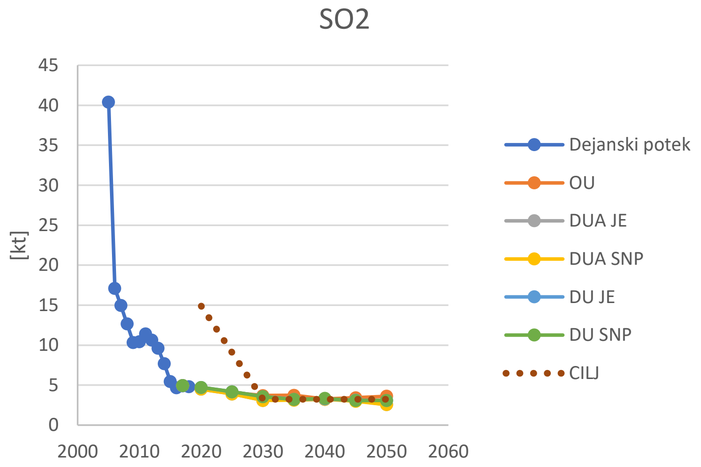
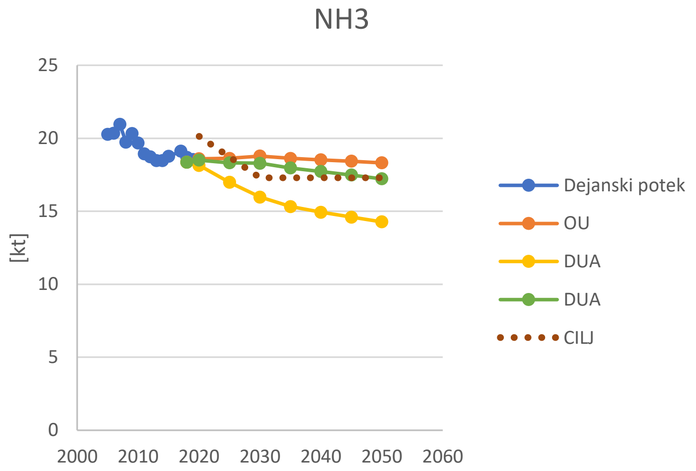
Air pollutant emissions











Implementation of measures mitigating GHG has very positive impact on reduction of AP emissions and achievement of targets

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Conclusions (1)

- Net zero emissions by 2050 are achievable
- Energy efficiency must come first – technological and behavioral changes
- Technology substitution needs to be backed by education / training / awareness raising
- Complete overhaul of the fuels we use – no fossil fuels in 2050 substituted by RES, electricity, synthetic fuel & hydrogen
- GHG emission mitigation has positive impact also on other areas – economy / air quality / social
- All sectors must contribute

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Conclusions (2)

- Projections allow in depth analysis of the target achievement and on the ways to reach targets –
  shedding light on connection between exogenous factors / measures implementation / GHG reductions
- Models are a complex tools covering large specter of activities
- Modelling is becoming more and more complex – sector coupling / new technologies / more detailed time resolution
- Projections are uncertain – have to be done in regular intervals
- Involvement of different experts needed

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Thank you for attention

matjaz.cesen@ijs.si

Projekt LIFE ClimatePath2050 (LIFE16 GIC/SI/000043) je financiran iz finančnega mehanizma LIFE, ki ga upravlja Evropska komisija, in iz Sklada za podnebne spremembe Ministrstva za okolje in prostor RS.

LIFE CLIMATE PATH 2050

Vodilni partner projekta LIFE Climate Path 2050:

Institut “Jožef Stefan”
Center za energetsko učinkovitost

Vodilni partner projekta LIFE Climate Path 2050:

ELEK

ELEK, načrtovanje, projektiranje in inženiring, d.o.o.

ZRMK

Gradbeni Inštitut ZRMK, d.o.o.

IER

Inštitut za ekonomska raziskovanja

Kmetijski inštitut Slovenije

pnz

PNZ svetovanje projektiranje, d.o.o.

Gozdarski inštitut Slovenije

www.PodnebnaPot2050.si

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