Workshop: 'Synergies and Trade-offs between Climate and Air Pollution Policies'

'Air polluting emissions bioenergy chains'

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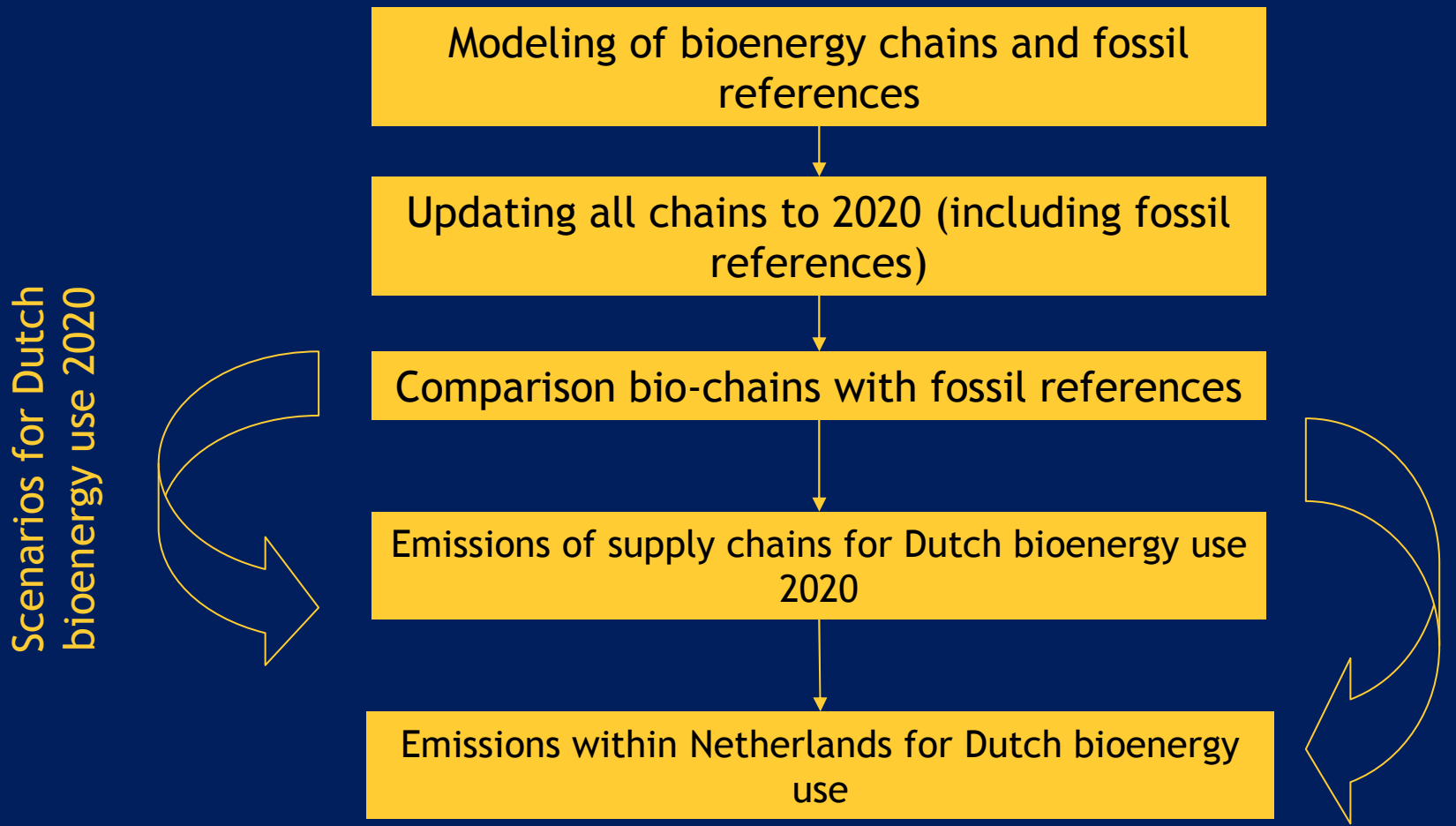
Background and aim

- The effects of new climate policies on emissions of classical air pollutants in the Netherlands in 2020 are not well known. Synergies and trade-offs are unknown.

- Aim: To analyse the emissions of classical air pollutants that will occur in the Netherlands and abroad in 2020 caused by the supply chains of biofuels, biogas and biomass.

Approach of the study

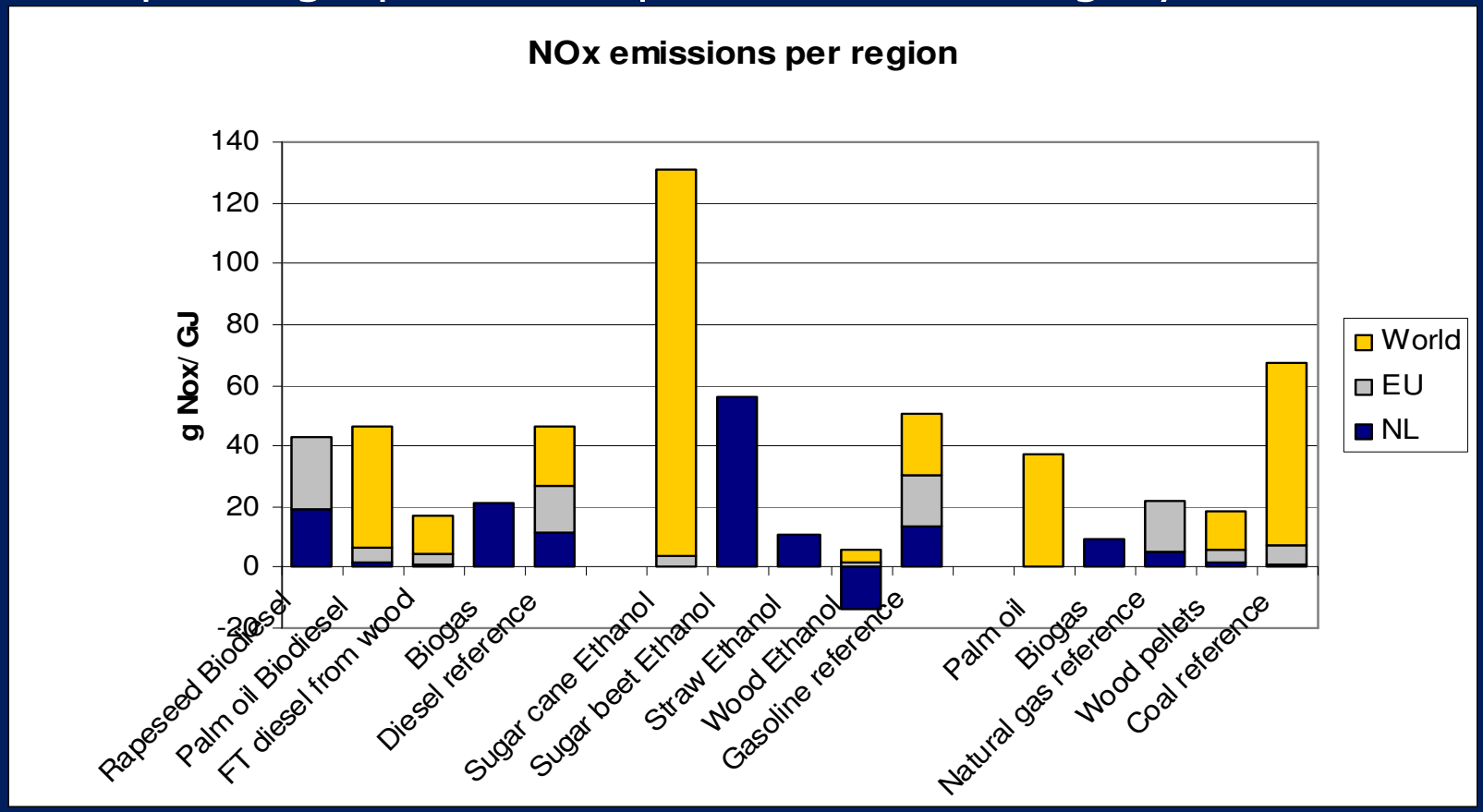


Selection chains

- Biofuel for transport:
  - Biodiesel from palm oil and rapeseed
  - Bioethanol from sugar cane and sugar beet
  - Bioethanol from straw and wood
  - FT diesel from wood
- Electricity/heat from biomass:
  - Electricity/heat from palm oil (replacing natural gas)
  - Electricity/heat from wood pellets (replacing coal)
- Co-digestion:
  - Biogas as transport fuel
  - Biogas for electricity production

Results 2020 compared to fossil reference

- Example of graphs made per emission category



Results biodiesel 2020 versus fossil

Emission	Unit	Biodiesel from rapeseed	Biodiesel from palm oil	FT diesel from wood	Biogas as transport fuel	Diesel reference
NOx	g/GJ	42.88	46.08	17.18	21.14	42.80
SOx	g/GJ	21.60	30.86	10.16	13.26	96.29
NH3	g/GJ	51.10	23.14	0.07	0.23	0.14
PM10	g/GJ	14.81	5.82	0.95	1.14	2.24
PM2.5	g/GJ	3.89	2.18	1.38	0.46	4.36
NMVOC	g/GJ	13.74	7.45	13.32	9.71	27.09

- FT diesel & biogas better then reference and almost all other chains
- Current biofuels lower on SO_x and NMVOC than fossil. On NO_x & $PM_{2.5}$ similar and NH_3 & PM_{10} higher than fossil.
- Use of biofuels can lead to large differences

Results ethanol 2020 versus fossil

Emission	Unit	Ethanol from sugar cane	Ethanol from sugar beet	Ethanol from straw	Ethanol from wood	Gasoline reference
Nox	g/GJ	130.60	56.11	10.61	-8.15	50.53
SOx	g/GJ	40.79	49.63	66.00	53.82	133.07
NH3	g/GJ	3.77	6.79	25.17	-0.58	0.16
PM10	g/GJ	9.08	8.97	6.24	0.45	2.67
PM2.5	g/GJ	1.62	2.88	1.56	0.98	5.29
NMVOC	g/GJ	39.95	41.94	13.57	13.83	27.75

- Advanced chains:
  - Ethanol from wood with negative emissions (excess electricity)
  - Ethanol from straw similar to current fuels only NO_x and NMVOC better, NH_3 & SO_x considerably worse)
- Current fuels perform better on SO_x and $PM_{2.5}$ on the other emissions they perform worse then fossil

Results stationary 2020 versus fossil

Emission	Unit	Palm oil (CPO)	Biogas	Natural gas reference	Wood pellets	Coal reference
Nox	g/GJ	37.22	9.51	21.72	18.23	67.50
SOx	g/GJ	24.80	4.41	24.40	16.28	15.84
NH3	g/GJ	20.75	0.00	0.02	0.17	5.91
PM10	g/GJ	4.93	0.42	0.93	1.14	3.80
PM2.5	g/GJ	1.76	0.00	0.97	2.17	3.58
NMVOC	g/GJ	5.05	7.79	17.80	7.57	9.82

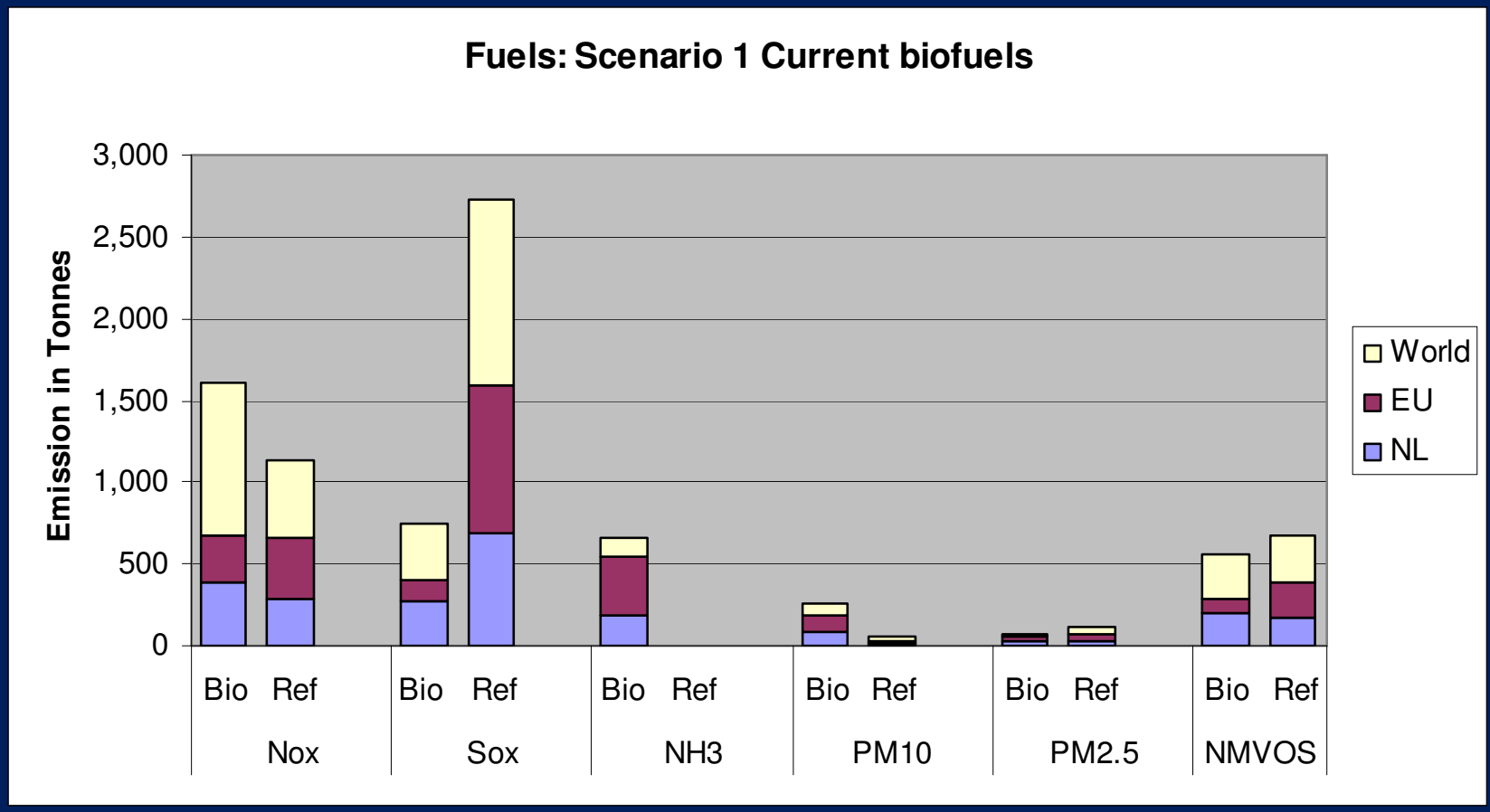
- Biogas and wood pellets chains perform better than all other chains on almost all emissions
- High NMVOC and SO_x emissions natural gas chain caused by 'sweetening' step in production. On all other emissions natural gas performs better than palm oil & coal chains

Application of scenarios

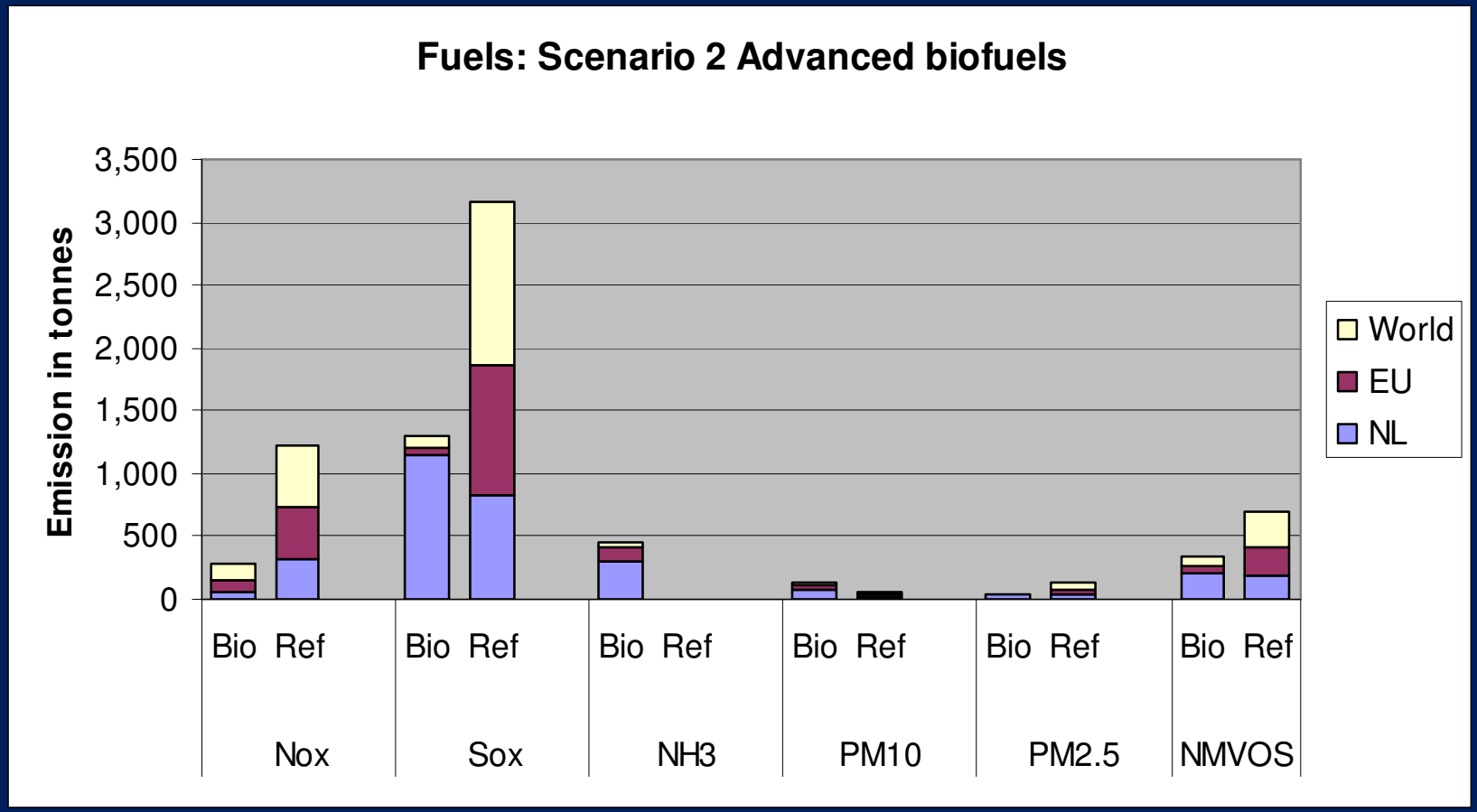
Scenarios for the application of bioenergy in 2020 were used to estimate total effects on air polluting emissions (in total and in Netherlands):

- Scenarios Biofuels:
  - From CE/TNO
  - Current biofuels (1), advanced biofuels (2), biogas (3)
- Scenarios Stationary applications:
  - From ECN/TNO
  - Low (1) and High (2) Bioenergy use

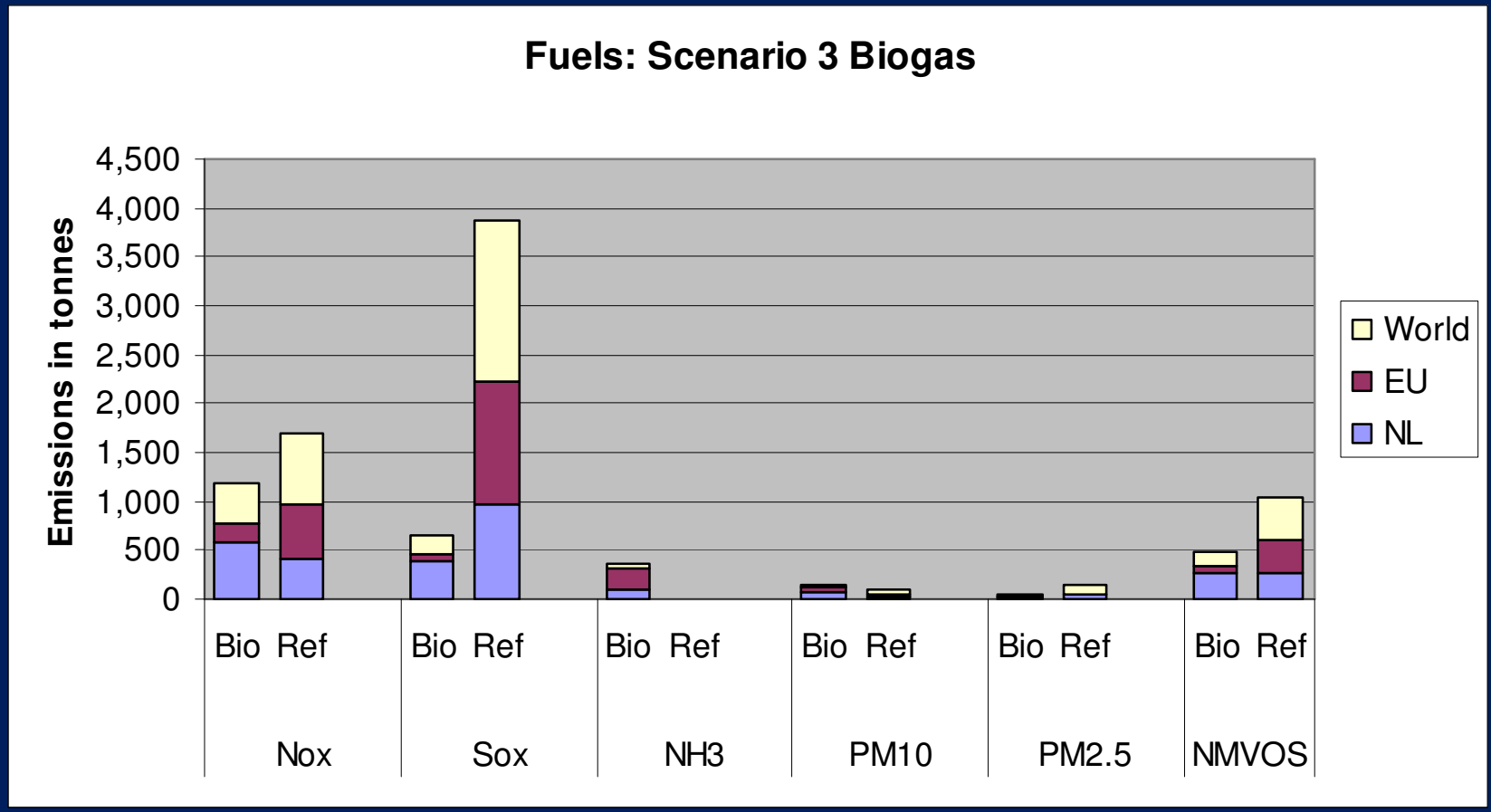
Results scenarios: Fuels



Results scenarios: Fuels



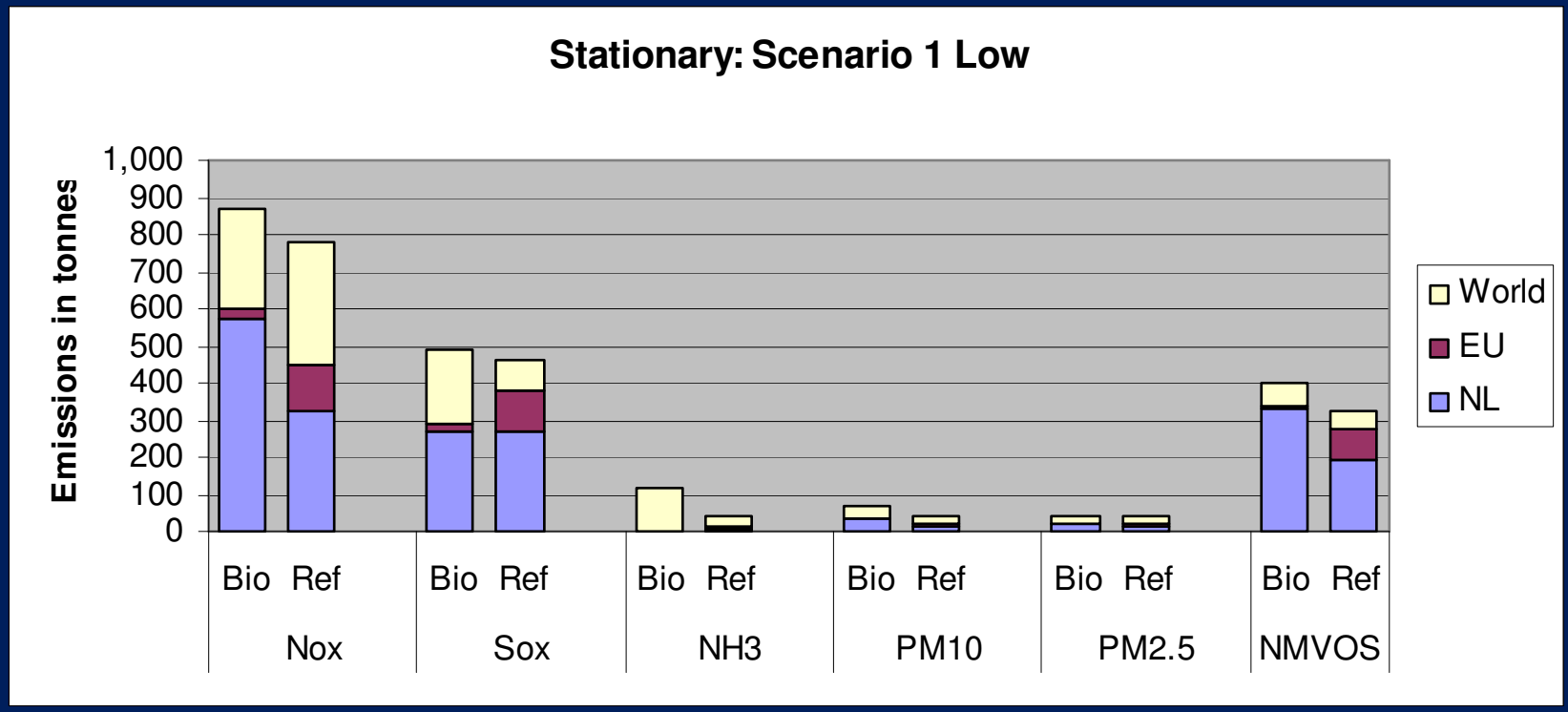
Results scenarios: Fuels



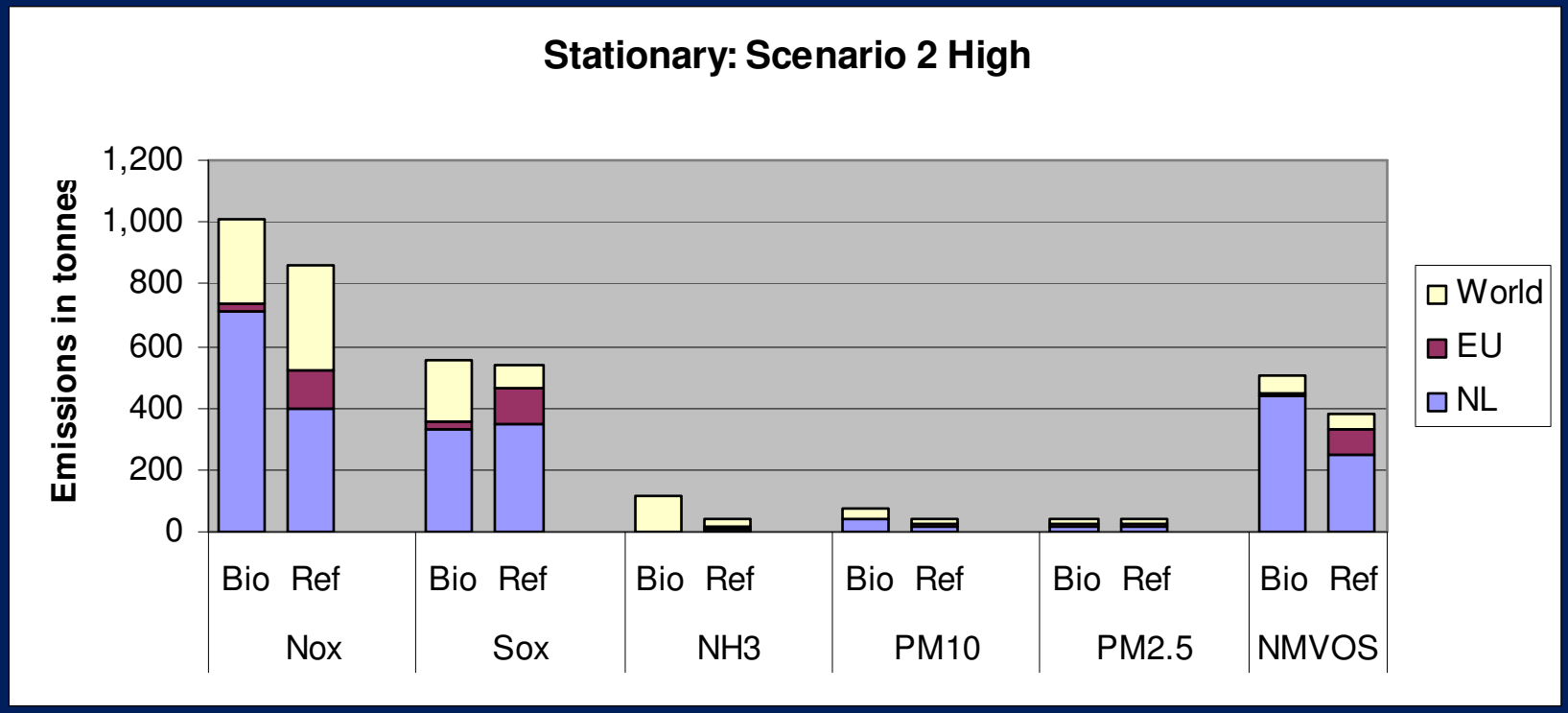
Changes compared to total emissions

	Estimated chain emissions inside NL from fossil fuel use for road transport 2020	Changes inside NL			Changes inside and outside NL		
		Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
NOx	6600	100	-268	166	483	-948	-502
SOx	15800	-419	324	-583	-1,980	-1,863	-3,235
NH3	0	180	291	102	652	443	367
PM10	350	64	61	39	201	63	68
PM2.5	680	-5	-3	-22	-49	-87	-122
NMVOC	3980	30	20	12	-115	-350	-559

Results scenarios: Stationary



Results scenarios: Stationary



Changes compared to total emissions

	Estimated chain emissions inside NL from coal and natural gas use for electricity production	Changes inside NL		Changes inside and outside NL	
		Scenario 1	Scenario 2	Scenario 1	Scenario 2
NOx	3790	251	316	89	153
SOx	3910	-2	-15	31	18
NH3	30	-8	-9	75	74
PM10	170	19	22	27	30
PM2.5	170	2	0	0	-3
NMVOC	2840	137	185	76	125

Results for emissions from biofuel chains in the Netherlands

(tonnes)	Scenario 1 Current Biofuels		Scenario 2 Advanced Biofuels		Scenario 3 Biogas	
	Bioenergy	***Reference***	***Bioenergy***	***Reference***	***Bioenergy***	***Reference***
NOx	388	288	55	324	586	420
SOx	277	696	1,153	829	377	960
NH3	181	1	292	1	104	1
PM10	80	15	78	17	61	22
PM2.5	25	30	30	34	21	43
NMVOC	202	172	203	183	275	263

- More NH_3, PM_{10} and NMVOC emissions in the Netherlands for all scenarios (but difference for NVMOC are small).
- NO_x emissions are higher and SO_x emissions are lower compared to the fossil for all but the advanced biofuel scenario.
- $PM_{2.5}$ emissions in the Netherlands seem lower for all biofuel scenarios.

Results emissions 'stationary' chains in the Netherlands

Emission	Scenario 1		Scenario 2	
(tonne)	Biofuel	Reference	Biofuel	Reference
NOx	575	324	715	399
SOx	269	271	334	349
NH3	1	9	1	10
PM10	34	15	41	19
PM2.5	17	15	19	19
NMVOC	332	195	437	252

- NO_x, PM_{10} and NMVOC emissions in Netherlands are higher for bioenergy use
- SO_x and $PM_{2.5}$ emissions do not differ much
- NH_3 emissions in the Netherlands of bioenergy chains are lower than fossil chains

Conclusions

- Overall results per chain:
  - Innovative chains in general perform better than fossil reference or current biofuels on air polluting emissions (because they are mostly based on residues)
  - For electricity wood pellets and biogas are the best performing chains
- Overall impact Dutch scenarios
  - Bioenergy use in general higher emissions on NH_3 and PM_{10}
  - NO_X and NMVOC emissions higher than fossil for stationary bioenergy use and scenarios with large share of current ethanol
  - SO_X and $PM_{2.5}$ emissions are lower for the biofuel scenarios, but hardly difference for stationary bioenergy scenarios

Conclusions

- Impact in the Netherlands of Dutch scenarios:
  - Compared to total emissions from transport and electricity production, effects due to bioenergy use are relative small
  - Larger part of the bioenergy chains takes place in the Netherlands than for the fossil chains;
  - This in general leads to a negative effect on air polluting emissions caused by the introduction of bioenergy in the Netherlands;
  - To reduce impact in the Netherlands, chains with larger part of the supply chain outside of Netherlands could be selected, but total emissions still occur. Furthermore this could have negative effects on employment, economy and control of emissions;
  - Stimulating cleaner chains (those based on residues e.g.) is a solution to reduce the impact on air polluting emissions in total.

Questions and suggestions?