PBL Netherlands Environmental Assessment Agency

National measures complementary to EU ETS

Assessment of unilateral and multilateral options

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EU ETS post-2020 revision

- Revision EU ETS Directive end of 2017:
  - faster annual decrease in overall number of allowances
    - › linear reduction factor of the cap from 1.74% to 2.2%
  - strengthening of the MSR
    - › doubling of intake rate MSR until 2023
    - › from 2023, allowances in the reserve above the total number of allowances auctioned during the previous year no longer valid

- Nevertheless EU ETS not in alignment with Paris agreement
- and impact on prices not sufficiently contributing to national targets and long-term ambitions of several member states …
- … so continuation of debate on additional measures at national level

National measures complementary to EU ETS

- Inefficient and ineffective drawbacks at EU-scale
  - relocation of emissions through trade (e.g. power production)
  - 'waterbed effect': as long as total number of permits within EU ETS is unchanged, emissions may still occur at any place/time

- Generic competitiveness concerns (intra-EU and internationally)

Can these drawbacks be mitigated when taking complementary measures within a coalition of countries?

Analysis of complementary measures

- analysis of macro-economic impacts for Netherlands with PBL's general equilibrium model Worldscan
  - carbon floor price power sector and industry within EU ETS
  - account for banking + new MSR rules
  - alternative options to prevent increasing emissions elsewhere
  - unilateral policy vs. coalition

Simple intertemporal submodel of EU ETS market

- Model characteristics:
  - Include supply of allowances over time and their distribution over countries
  - Possibility to bank allowances (no borrowing)
  - Impacts of Market Stability Reserve
  - No uncertainty; fully forward looking

Simple intertemporal submodel of EU ETS market

- Intertemporal abatement cost minimization (Hotelling):

$$\min_{e} \sum_{t=1}^{T} \frac{C_t(e_t)}{(1+r)^t}$$

with e_t actual emission level in year t

- Characteristics of the emission allowance market:

$$B_t = B_{t-1} + \overline{EUA}_t - e_t$$ banking equation

$$\overline{EUA}_t = \overline{EUA}_t^{auct} + \overline{EUA}_t^{free}$$ supply of allowances (cap) in year t

$$B_T = 0;\ B_t \geq 0, \quad \forall t$$

$$e_t \geq 0, \quad \forall t$$

- Time horizon T: $B_t = 0$
- As long as $B_t \geq 0$ the price path follows Hotelling rule:

$$p_t = (1+r)p_{t-1}$$ (r = 8.5%)

Simple intertemporal model of EU ETS market

- Market stability reserve ($\forall\, t \geq 2019$):

$$\bar{e}_t^{auct} = \begin{cases} \overline{EUA}_t^{auct} - 0.12 \cdot B_{t-1} & if \quad B_{t-1} > 833 \\ \overline{EUA}_t^{auct} & if \quad 400 < B_{t-1} \leq 833 \\ \overline{EUA}_t^{auct} + min(100, MSR_{t-1}) & if \quad B_{t-1} \geq 400 \end{cases}$$

$$MSR_{2018} = 900 + \sim 300$$

$$MSR_t = \begin{cases} MSR_{t-1} + 0.12 \cdot B_{t-1} & if \quad B_{t-1} > 833 \\ MSR_{t-1} & if \quad 400 < B_{t-1} \leq 833 \\ MSR_{t-1} - min(100, MSR_{t-1}) & if \quad B_{t-1} \geq 400 \end{cases}$$

Complementary national measures

- Carbon price floor increasing to €50/tCO_2 in 2030
  - by carbon tax in addition to EU ETS price
    - for power sector only – **CO2TAX-POW**
    - for all ETS sectors – **CO2TAX-ETS**
  - by additional permits to be surrendered
    - by power sector only – **ADDEUA-POW**
    - by all ETS sectors – **ADDEUA-ETS**
- Buy and cancel allowances – **CANCEL**
  - Total annual budget 50% auction revenues (reduction ≈ **CO2TAX-POW**)
- Lump sum revenue recycling (households)
- Unilateral (NL) vs. coalition (B,D,F,NL)

Methodology

- Introduce simple intertemporal model ETS into computable general equilibrium (CGE) model WorldScan to consider:
  - Domestic and international emissions (incl. 'emissions leakage')
  - Indirect effects in the economy
  - Impact on international trade

- WorldScan:
  - Recursive dynamic model
  - GHG emissions - energy-related and process
  - includes abatement by add-on technologies

- Iteration until B = 0 (cut-off 2040 as investors' planning horizon)

Top-down analysis of climate change policies

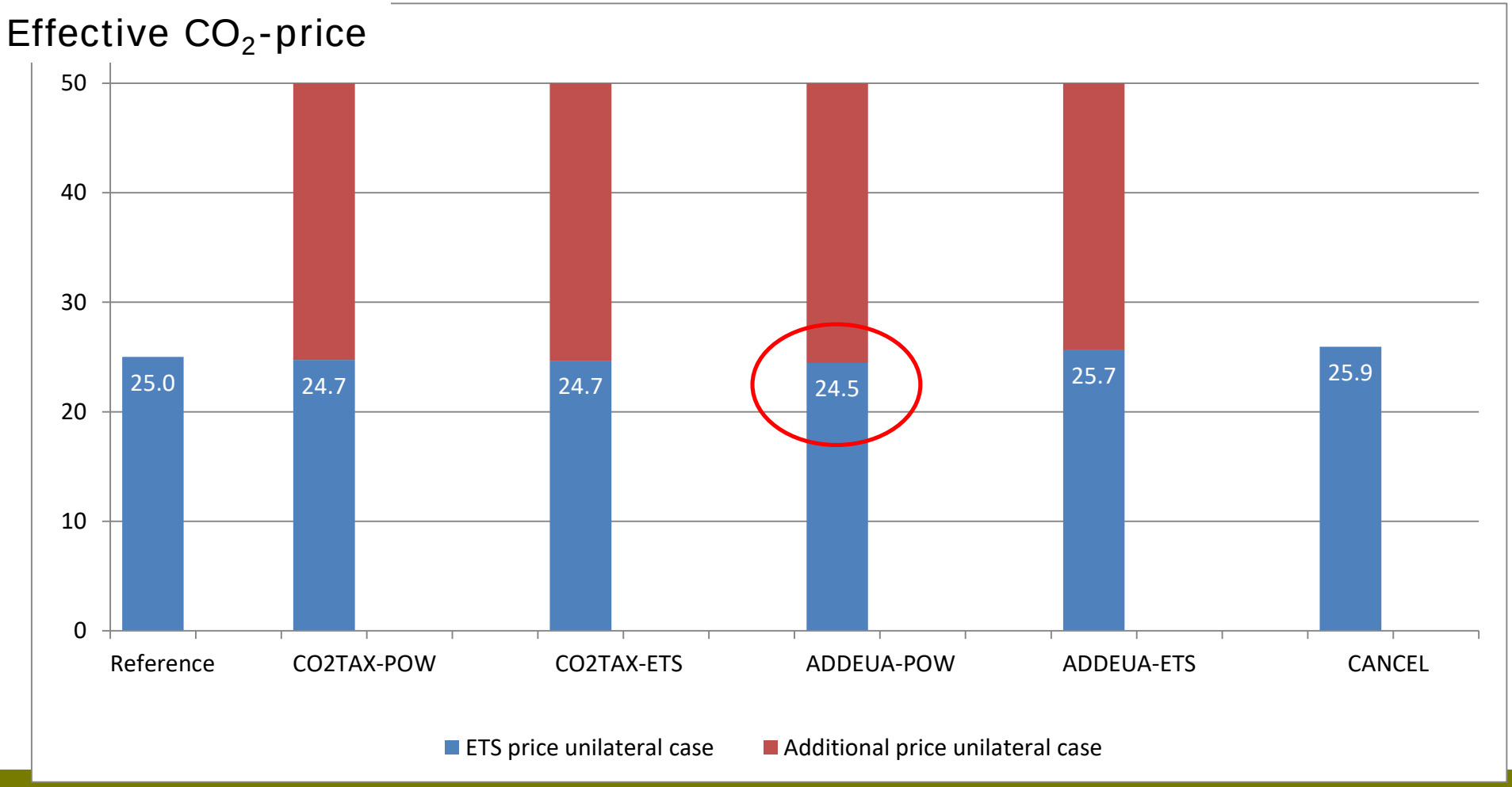
- energy use most important source of emissions
- simplified representation of energy system with CO_2-emissions calculated based on fossil fuel input
  - constant and uniform emission factors per fuel type
  - different for non-CO_2, but less relevant
  - process emissions also included
- mitigation CO_2 mainly through:
  - output substitution, e.g. CO_2 extensive products
  - input substitution, e.g. fuel switch, energy efficiency improvements
  - abatement technology
  - change in size and composition of the economy
- long-term and global impact => ‘carbon leakage’

Calibration

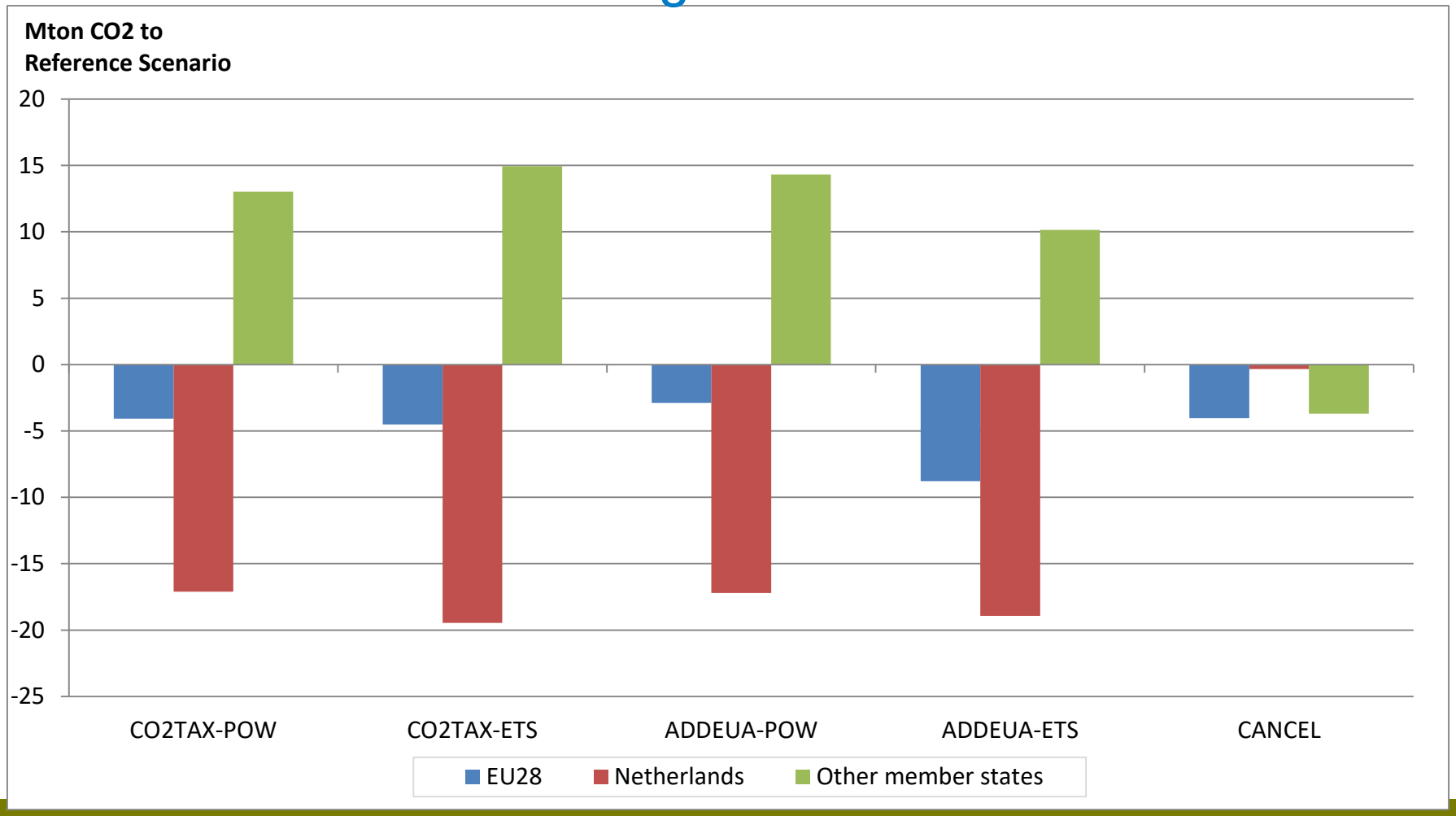
- Reference scenario includes:
  - Revised EU ETS Directive (LRF 2.2% and changes to MSR)…
  - … plus effect of 2030 energy targets
    - renewables (27%)
    - Energy efficiency (30%)
  - Distributional characteristics member states according to EU

- Parameterization :
  - Exogenous GDP, energy use and energy prices (WEO)
  - Substitution and Armington elasticities literature
  - Uniform efficient subsidy to accommodate renewables target

Results: unilateral case – CO_2 prices 2030



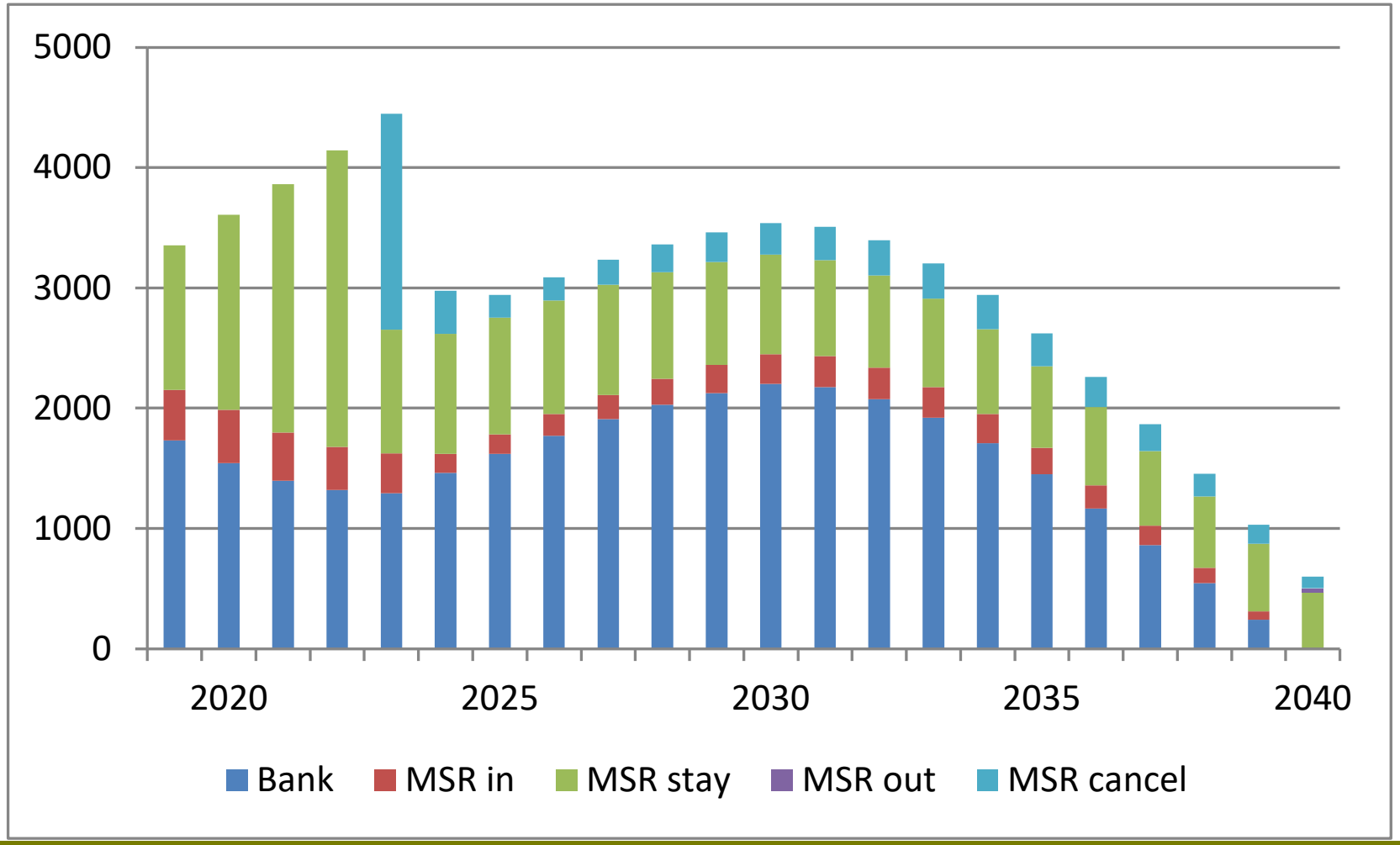
Unilateral case – change in GHG emissions 2030



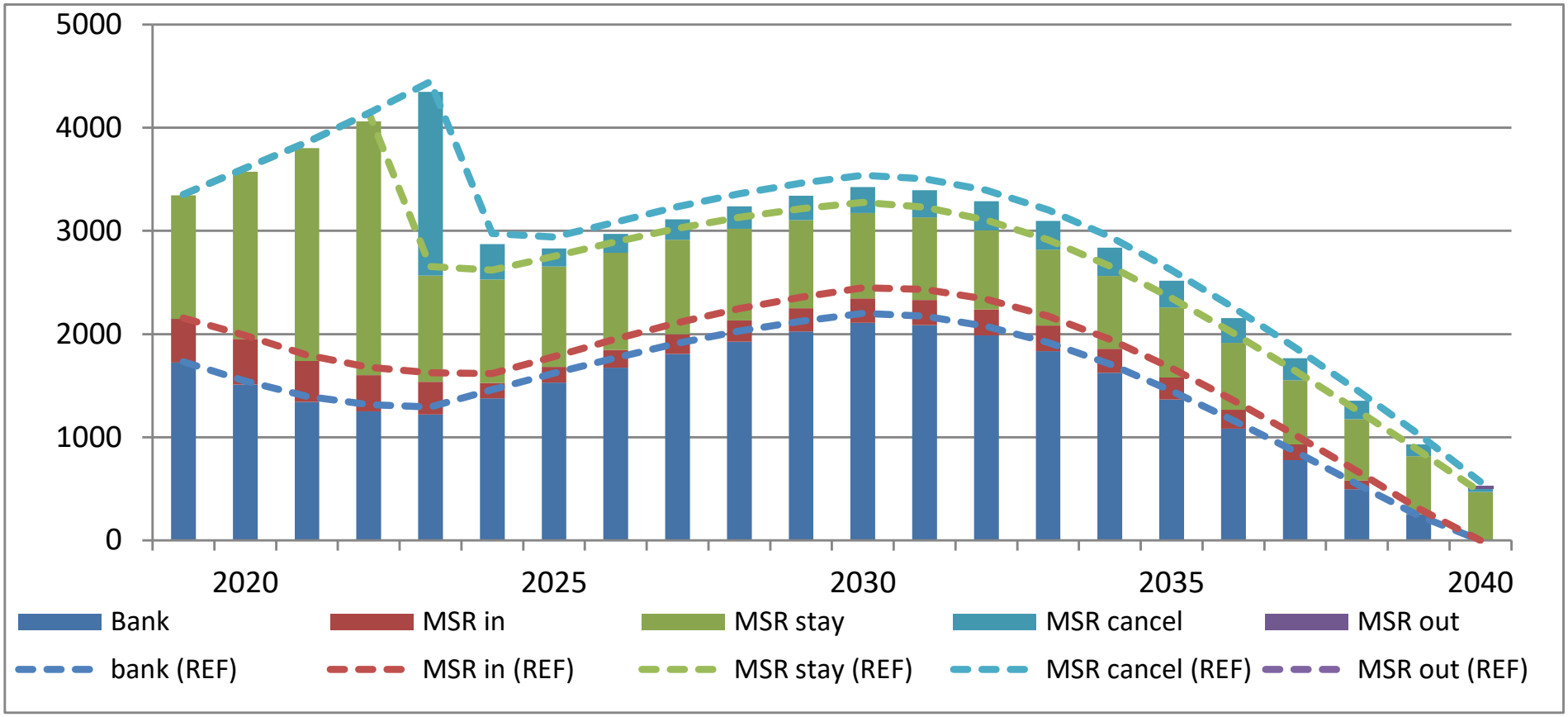
Unilateral case – change in GHGs 2019-2040

Cumulative change to Reference 2019-2040 (Mton CO2)					
	CO2TAX-POW	CO2TAX-ETS	ADDEUA-POW	ADDEUA-ETS	CANCEL
Emissions 2019-2040	-28	-35	+21	-213	-170
EUAs additionally surrendered			+265	+743	
EUAs canceled by policy					+242
EUAs canceled from MSR	+28	+35	-286	-530	-72

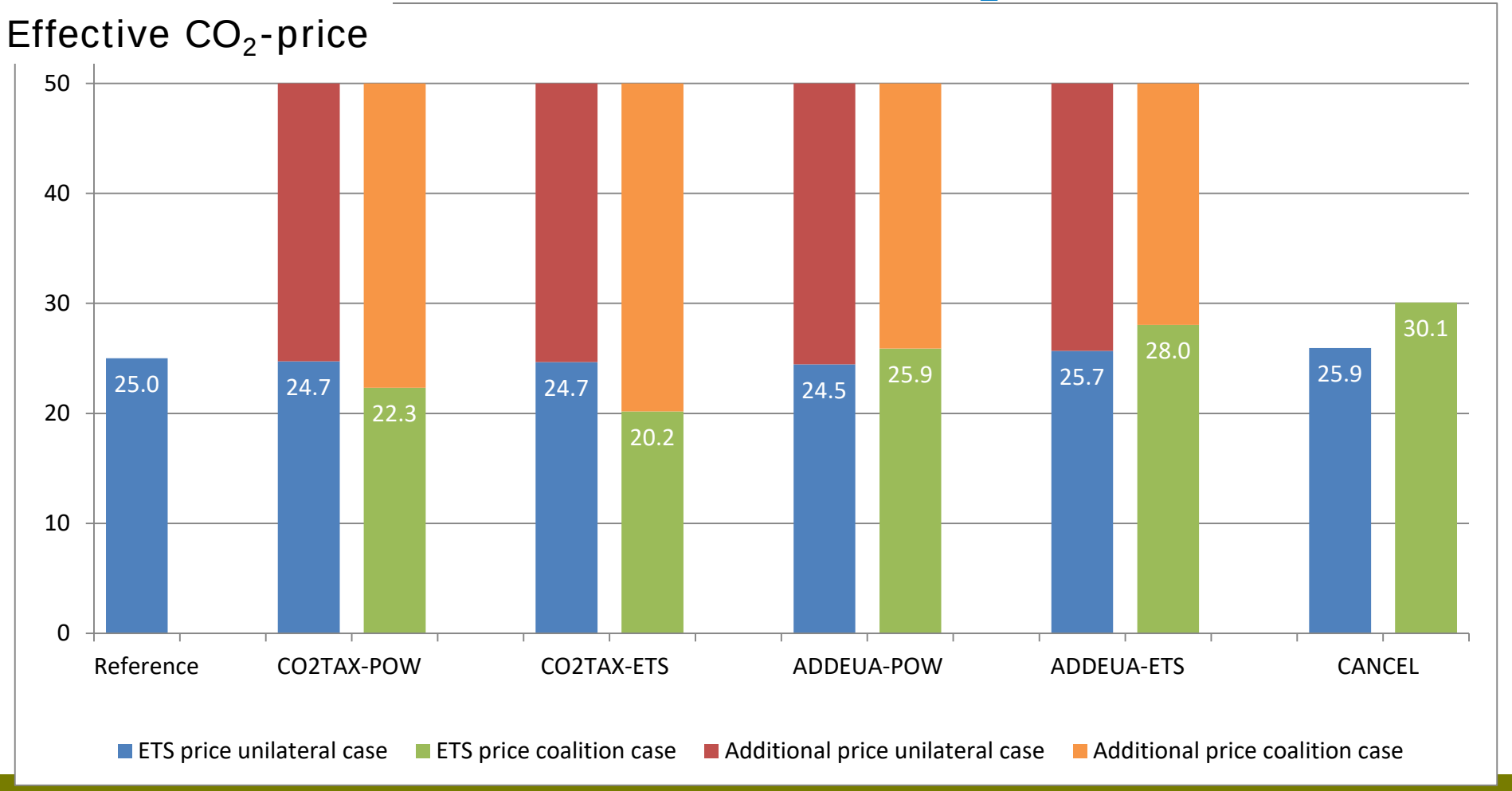
Role of Market Stability Reserve



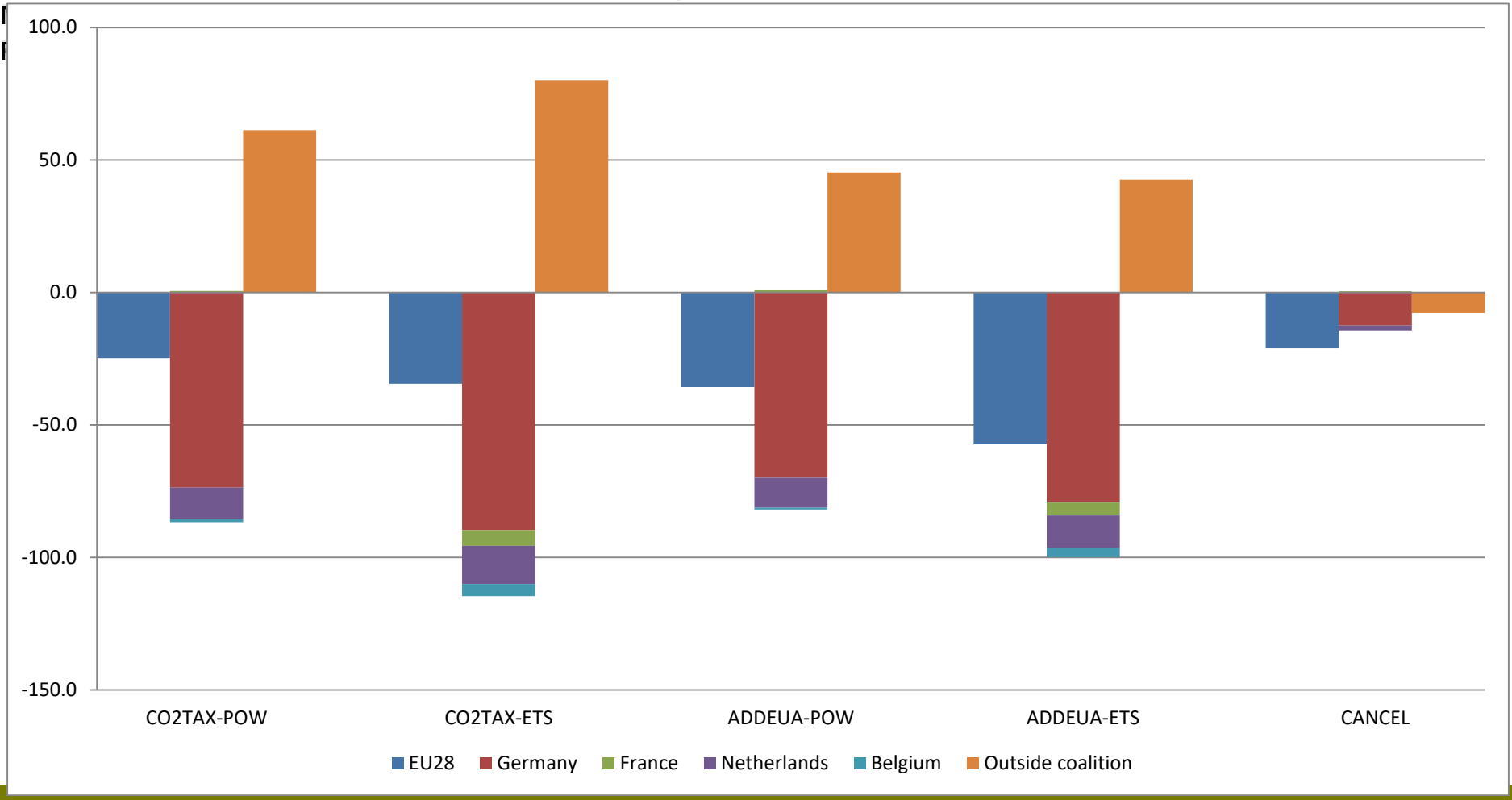
Role of Market Stability Reserve



Unilateral vs Coalition case – CO_2 prices 2030



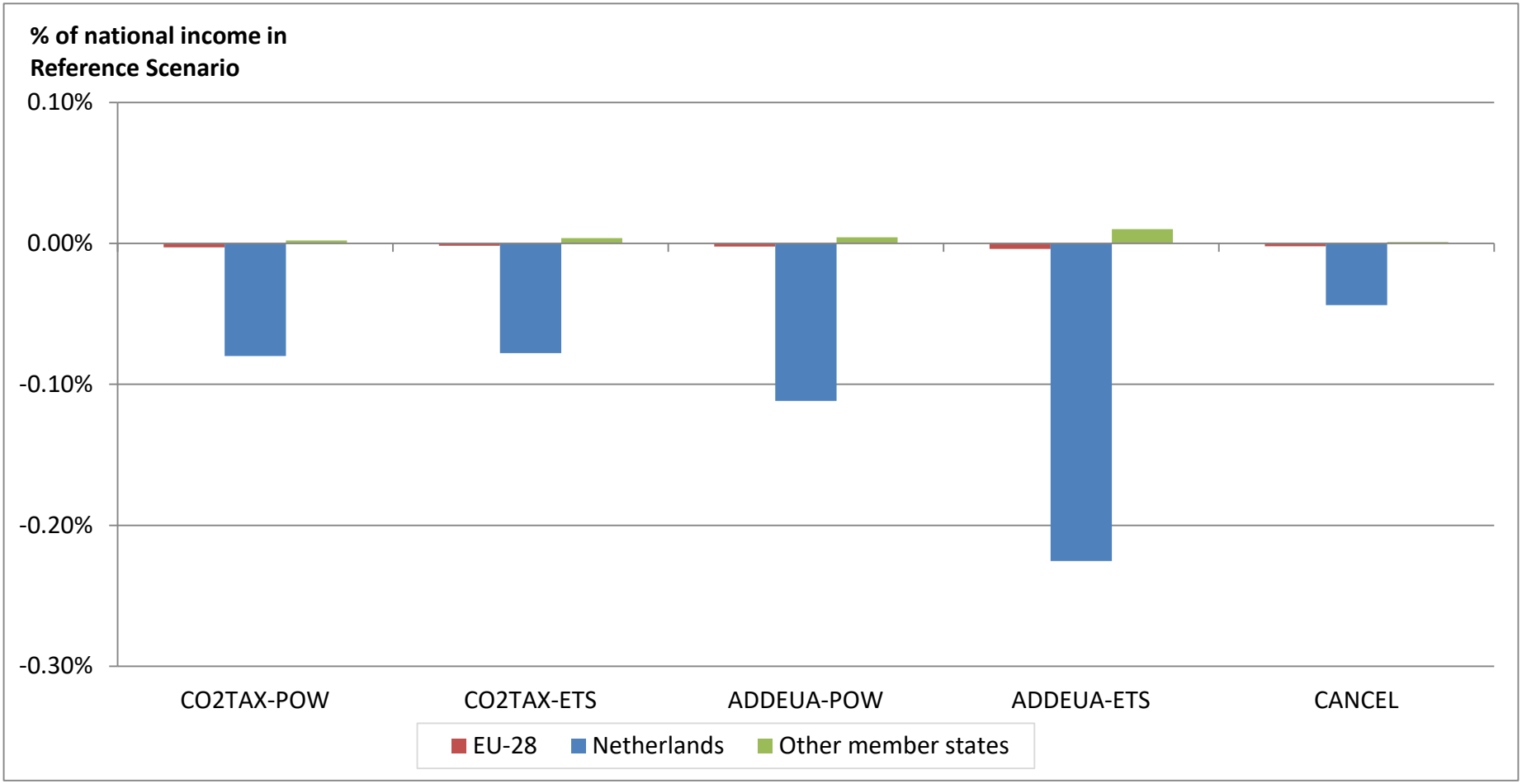
Coalition case – change in GHG emissions 2030



Coalition case – change in GHGs 2019-2040

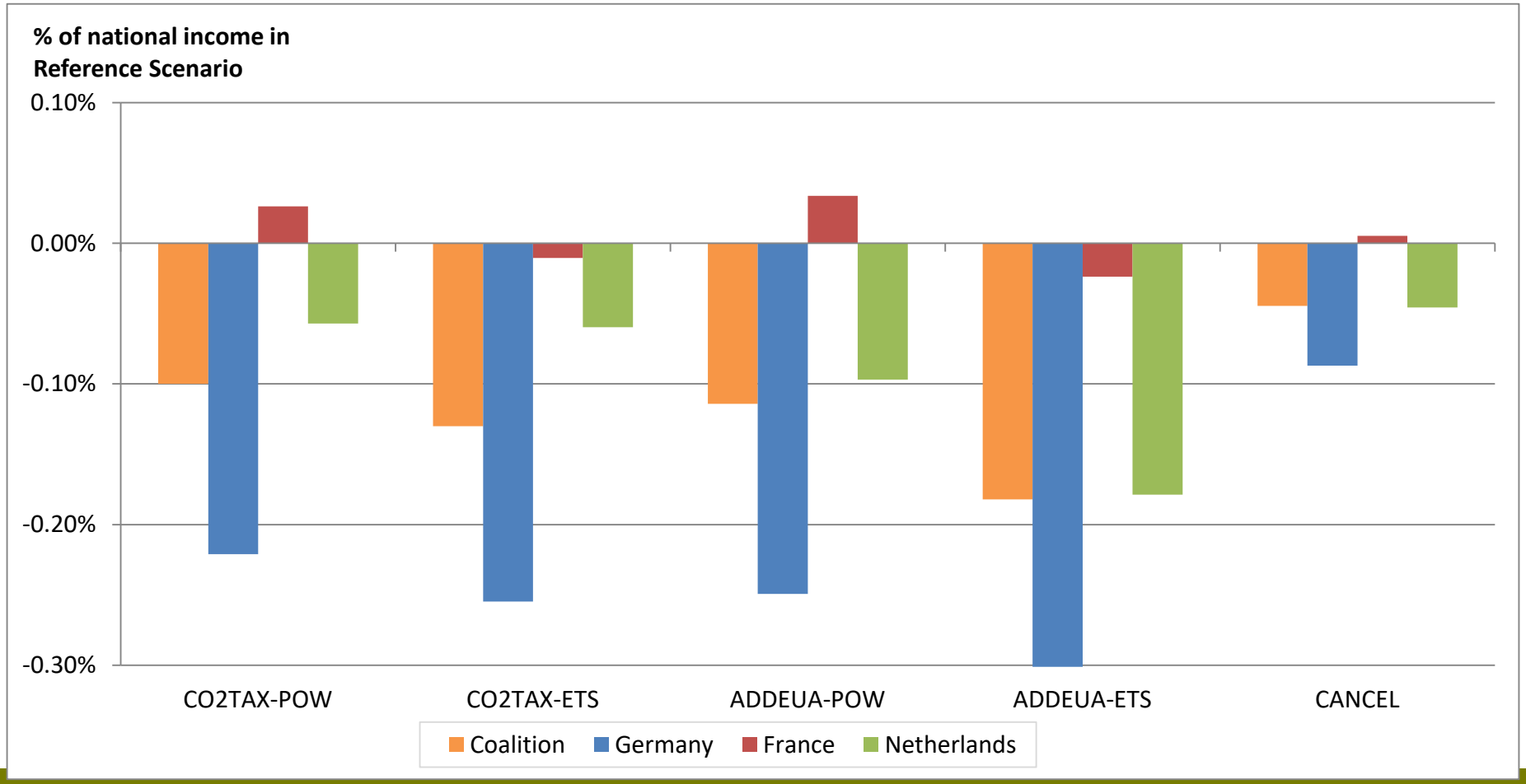
Cumulative change to Reference 2019-2040 (Mton CO2)					
	CO2TAX-POW	CO2TAX-ETS	ADDEUA-POW	ADDEUA-ETS	CANCEL
Emissions 2019-2040	-242	-261	-710	-1194	-954
EUAs additionally surrendered			+1710	+4135	
EUAs canceled by policy					+1912
EUAs canceled from MSR	+242	+261	-1000	-2940	-959

Unilateral case – compliance costs 2030*



* Hicksian equivalent variation measured as a percentage income change relative to the Reference Scenario (see Brink et al., 2016, Energy Policy 97)

Coalition case – compliance costs 2030



Unilateral case – average cost per ton CO_2

Compliance cost to domestic emission reduction (euro per ton CO2)					
	CO2TAX-POW	CO2TAX-ETS	ADDEUA-POW	ADDEUA-ETS	CANCEL
Netherlands	17	15	24	45	486

Coalition case – average cost per ton CO_2

Compliance cost to domestic emission reduction (euro per ton CO2)					
	CO2TAX-POW	CO2TAX-ETS	ADDEUA-POW	ADDEUA-ETS	CANCEL
Coalition	40	39	49	63	115
Germany	48	46	57	65	112
France	410	16	363	505	460
Netherlands	18	16	32	54	92

Average cost per ton CO_2 – domestic vs EU-wide reduction

Compliance cost to domestic emission reduction (euro per ton CO2)					
	CO2TAX-POW	CO2TAX-ETS	ADDEUA-POW	ADDEUA-ETS	CANCEL
Netherlands - unilateral	17	15	24	45	486
Netherlands - coalition	18	16	32	54	92

Compliance cost related to EU28 emission reduction (euro per ton CO2)					
	CO2TAX-POW	CO2TAX-ETS	ADDEUA-POW	ADDEUA-ETS	CANCEL
Netherlands - unilateral	73	64	145	96	41
Coalition overall	140	131	111	110	73

Findings

- MSR makes projecting outcomes more complex…
- not one unambiguous ‘most cost effective’ option but trade-offs:
  - emission reduction vs costs
  - domestic reduction vs reduction EU wide
- including industry:
  larger emission reductions, larger economic impact
- unilateral vs coalition:
  - less domestic emission reduction…
  - …but smaller leakage rates and lower cost
- relatively high costs in Germany
  - CO2-intensive power sector compared to France
  - lower existing energy taxes compared to the Netherlands (?)

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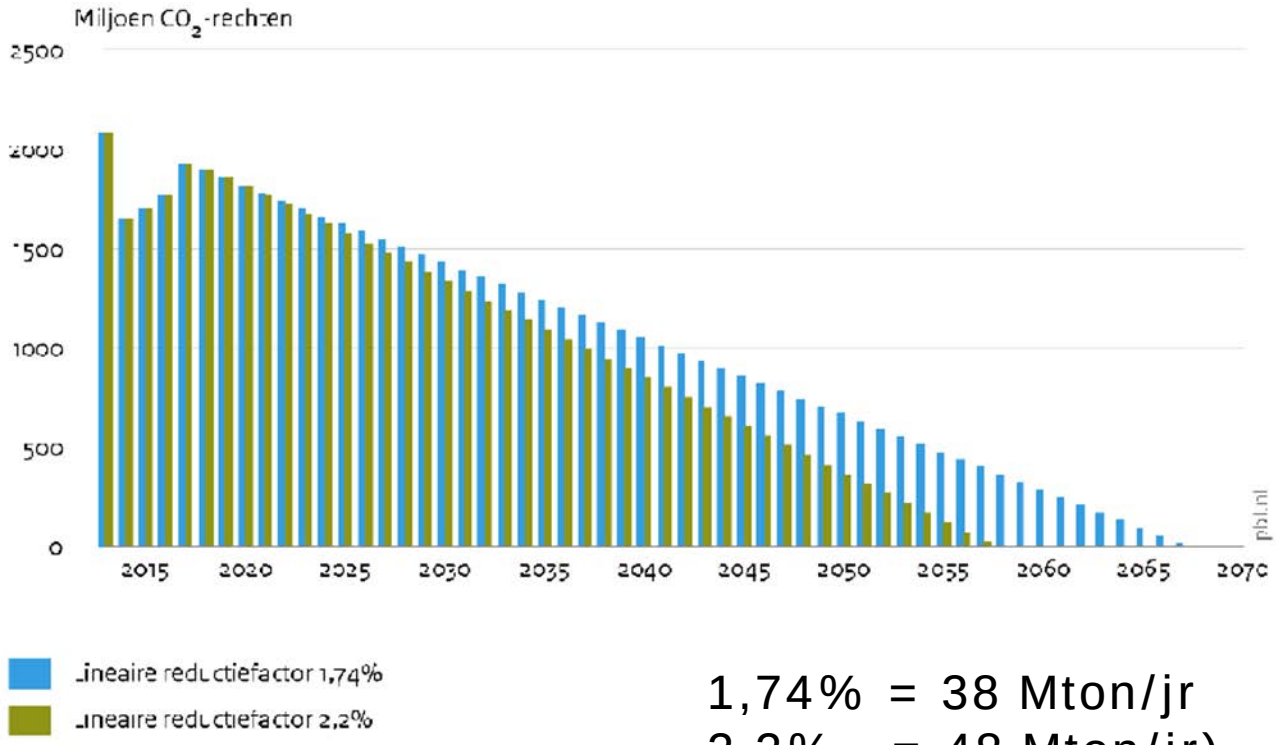
Emission cap $\bar{e}_t$ from -1,74 to -2,2% each year

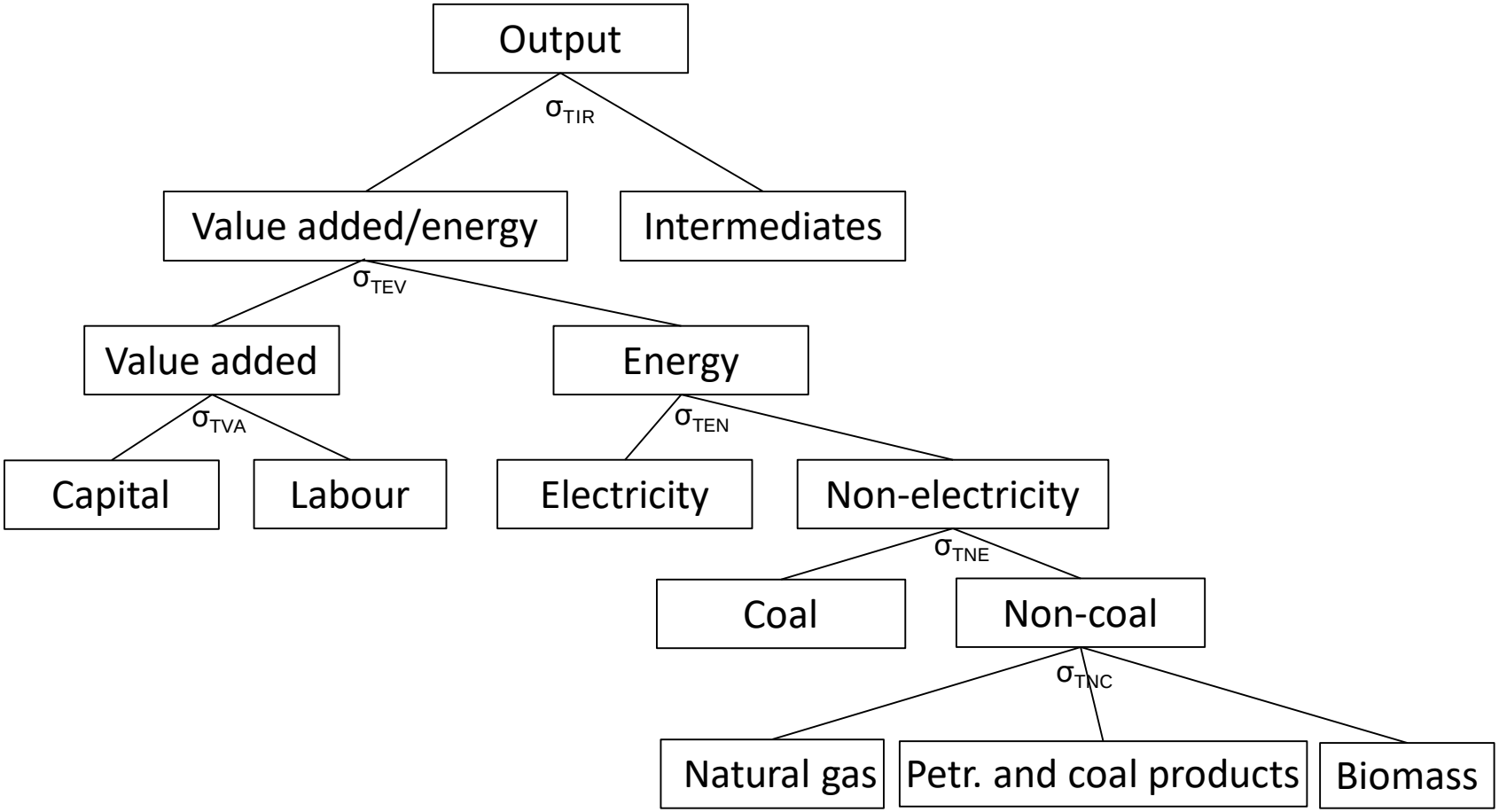
Figuur 1

Jaarlijks aanbod van emissierechten in het EU ETS vanaf 2013



1,74% = 38 Mton/jr
2,2% = 48 Mton/jr)

Production structure WorldScan



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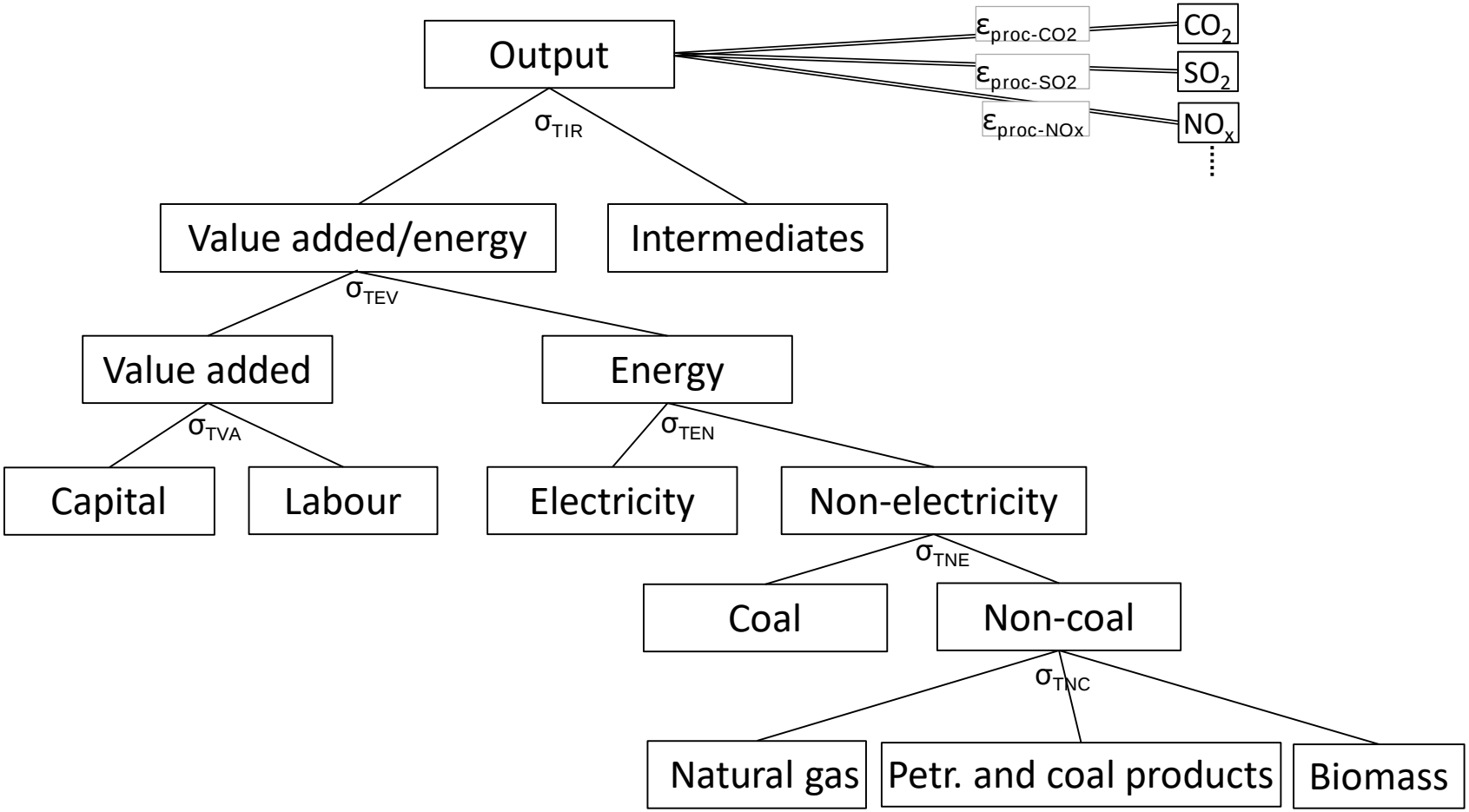
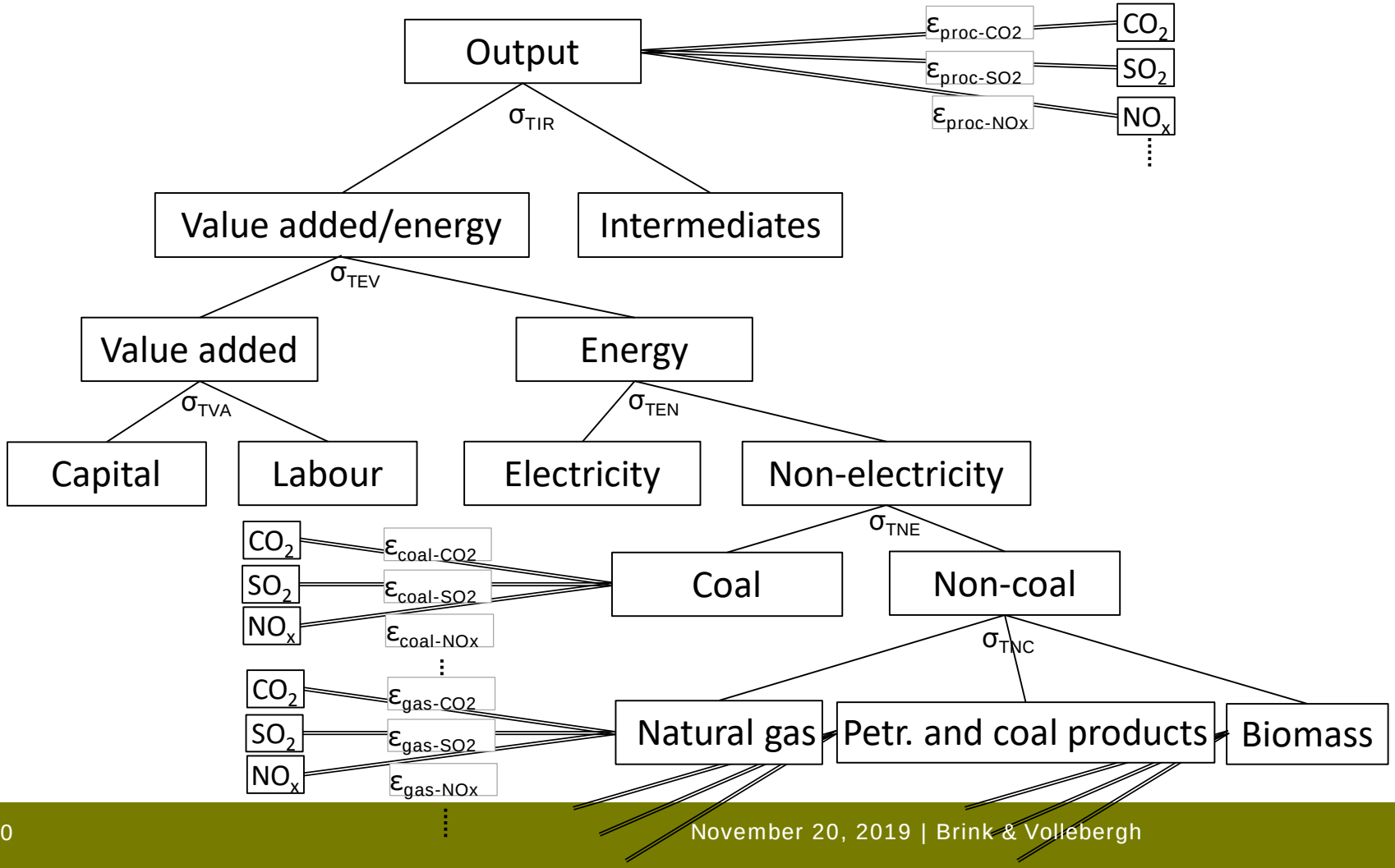


Production structure WorldScan



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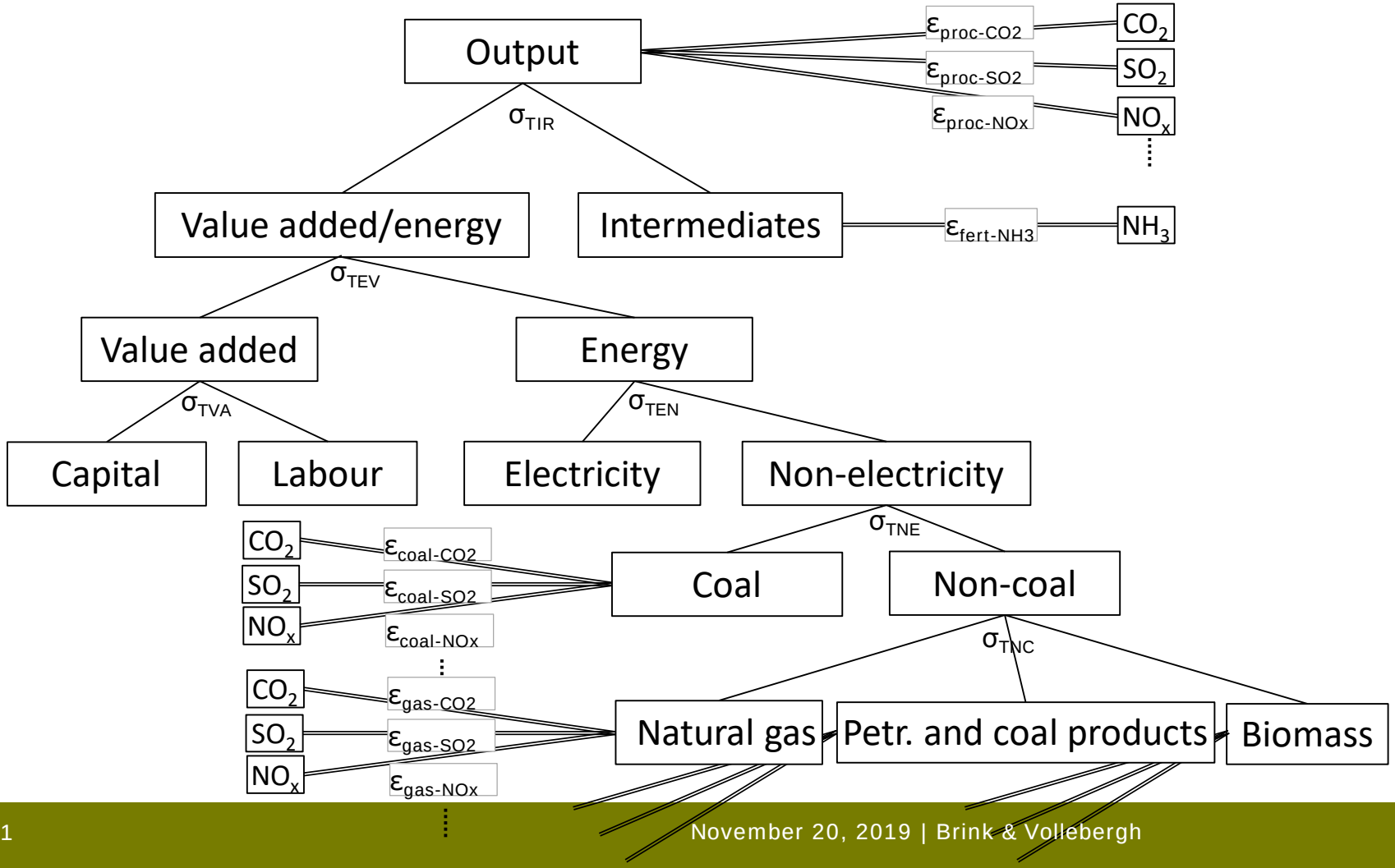

Production structure WorldScan