MAIN ASSUMPTIONS FOR A BASELINE ENERGY SCENARIO FOR THE ENERGY COMMUNITY COUNTRIES

By Professor Pantelis Capros, E3Modelling – E3MLab

Project

Energy Community Study on Carbon Pricing

Workshop March 26, 2020

Content of the outlook

- Projection into the future of
  - Energy demand by sector
  - Energy supply
  - Investment
  - Prices, costs
  - Emissions
- Purpose
  - Use it as a Baseline
  - Impact assessment draws on comparison of policy scenarios to a Baseline
- Features
  - Comprehensive – entire energy system, all sectors
  - Consistent – balanced energy markets and system
  - Coherent with behaviours of agents by sector and market outcome
  - Dynamic – projecting investment and technology vintages

Methodology

- Exogenous assumptions reflect the design of the Baseline
- Key issue: policies to include in the Baseline (subject to consultation)
- Projections using a PRIMES model version
- Coverage
  - Per CP and for 3 EU MS
  - Imports-Exports also projected
  - Horizon: 2020-2030, 2035 and 2040
  - Sectors
    - Buildings, Industry by sector, Transport
    - Power sector, District heating, Steam, Fossils supply
  - Energy Balances, Prices and Costs, Investment, Emissions and Indicators
- Deliverable within Task C

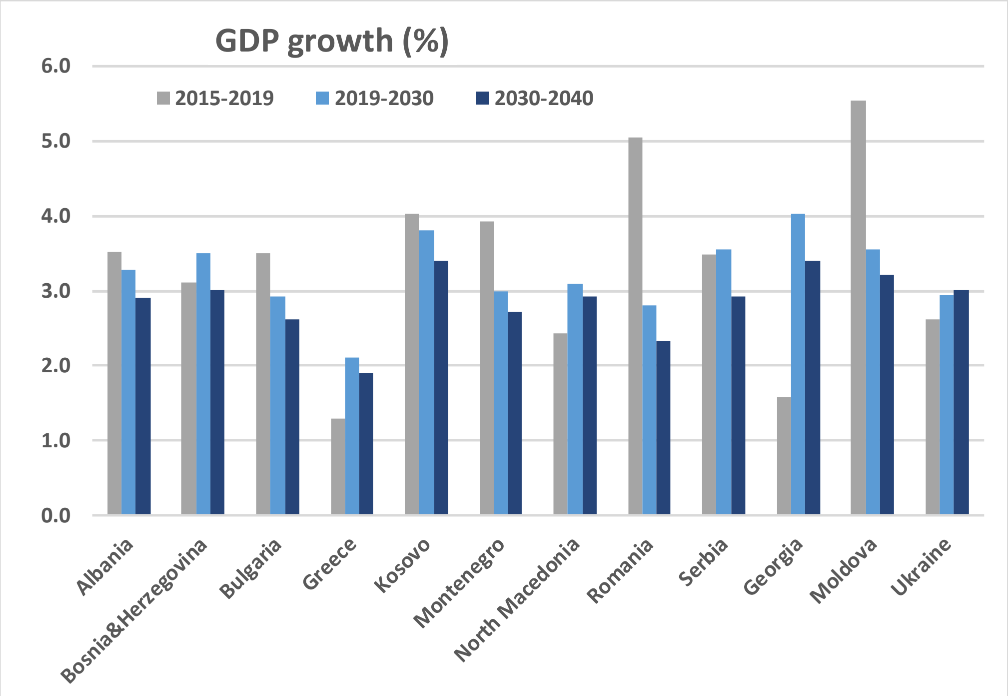
Assumptions

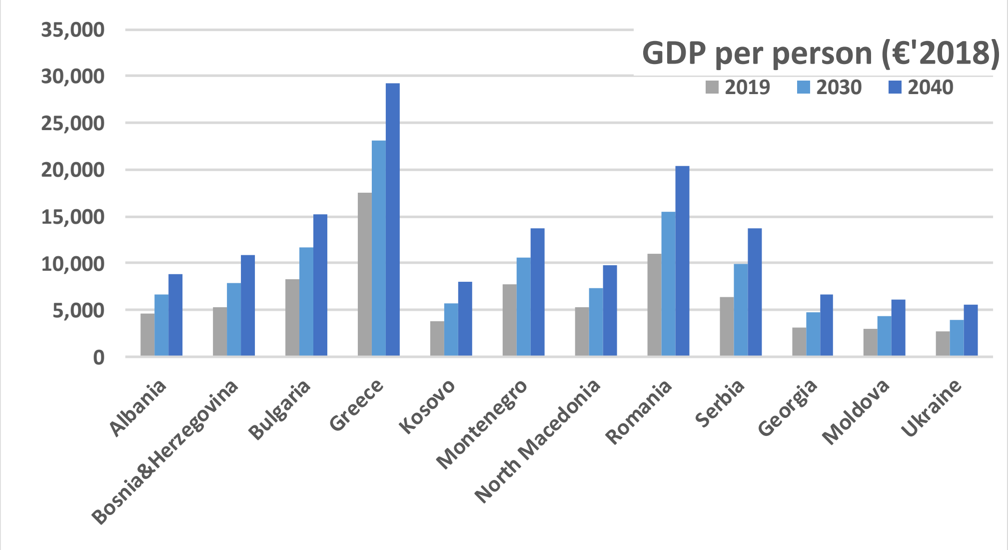
- Macroeconomy and demographics
  - GDP growth
  - Population
  - Physical activity per industrial sector
  - Transport-mobility activity
  - Housing stock
- Fuel prices
  - Unit costs of domestically produced fossils (e.g. lignite)
  - Prices of imported fossils, mainly for oil and gas
- Taxation and subsidies
  - Excise and VAT taxes per sector
  - Subsidies, direct and indirect
  - Carbon pricing, where applicable under Baseline conditions
- Main investment
  - Power plants under construction
  - Decided decommissioning
  - Power interconnectors
  - Gas infrastructure
  - District heating networks
- Renewables policies
  - Licensing and facilitation of grid connection
  - Support schemes
  - Special policies, e.g. offshore wind, biomass, roof top PV
- Market policies
  - Competition, Pricing policies etc.
- Standards and energy efficiency
  - Eco-design, Renovation of buildings, Emission standards
  - Large combustion plants – opt out

GDP AND POPULATION GROWTH

	GDP (mill.€'2018)	annual rate of growth in volume		
	2019	2015-2019	2019-2030	2030-2040
Albania	13,115	3.52	3.28	2.91
Bosnia&Herzegovina	17,279	3.12	3.50	3.01
Bulgaria	58,106	3.50	2.93	2.62
Greece	188,334	1.30	2.11	1.90
Kosovo	6,995	4.03	3.80	3.41
Montenegro	4,803	3.93	2.99	2.73
North Macedonia	11,030	2.43	3.09	2.92
Romania	212,622	5.06	2.81	2.34
Serbia	44,650	3.49	3.56	2.92
Georgia	11,360	1.58	4.03	3.41
Moldova	10,469	5.53	3.56	3.22
Ukraine	113,520	2.62	2.94	3.02

	Population (mill.)	annual rate of change	GDP per person (€'2018)		
	2019	2019-2040	2019	2030	2040
Albania	2.86	(0.10)	4,582	6,604	8,887
Bosnia&Herzegovina	3.30	(0.29)	5,234	7,900	10,920
Bulgaria	7.00	(0.14)	8,301	11,616	15,208
Greece	10.72	(0.43)	17,561	23,143	29,189
Kosovo	1.86	(0.09)	3,754	5,714	8,067
Montenegro	0.62	0.10	7,720	10,570	13,694
North Macedonia	2.08	0.07	5,310	7,362	9,744
Romania	19.41	(0.40)	10,952	15,542	20,363
Serbia	6.96	(0.41)	6,412	9,861	13,690
Georgia	3.72	(0.08)	3,051	4,724	6,699
Moldova	3.54	(0.10)	2,955	4,390	6,089
Ukraine	41.98	(0.51)	2,704	3,938	5,579





Final demand projections

- The economic growth is mainly based on services and to a lesser degree on construction
  - Office and utility buildings modernize, improve insulation
  - Electrification increase at a fast pace, while use of fossil fuels reduce
- Industry
  - Energy intensive industries continue in the future but they grow very modestly compared to GDP
  - High value added manufacturing drive industrial growth, notably for equipment goods, food, other industries and low-energy intensive chemicals
  - Specific energy consumption reduces, driven by technological progress embedded in new investment, as well as by energy efficiency investment, mainly heat recovery and control systems
  - Electricity shares in industry increase significantly, while heat and steam uses tend to use more gas rather than fuel oil or solids (where gas supply exist)
- Agriculture: modest pace of growth, improvement of energy efficiency
- Residential
  - Useful energy demand for heating and cooling increases as the countries have not yet reached saturation of comfort levels
  - Renovation of old buildings stay slightly above historical rates, which are modest and involve shallow refurbishment
  - Building codes impose high efficiency standards for new constructions, but their rate of growth is small
  - Electrification is a dominant trend in heat uses, driven by heat pumps; higher use of gas replacing other fossils is also seen (where gas supply exist)
  - Increase of income per capita allows expansion of the appliances stock. So, electricity consumption for appliances and lighting continue to increase despite improvement of efficiency driven by technological progress and eco-design regulation.
- Transport sector trends
  - Mobility is also not saturated and tend to increase faster than GDP both for passengers and for freight
  - Aviation, cars and trucks see transport activity increasing faster than in other modes
  - Rail support policies succeed to slowdown the declining trend
  - Energy efficiency of vehicles improve, driven by vehicle standards, but the high share of imported second hand vehicles reduces potential improvement
  - Car mobility electrification will emerge but to a lesser extent than in large EU countries

Segmentation in the PRIMES model

Industrial sectors (vol.)

- Integrated steelworks, Electric arc steel
- Alumina, Primary Aluminium, Copper, Zinc, Lead, Ferroalloys, Nickel, Aluminium products, Other nonferrous
- Fertilizers, Petrochemicals, Other chemicals, Cosmetics and pharmaceuticals
- Paper and Pulp
- Cement, Glass, Ceramics, Other NMM
- Food, Textiles
- Metal processing, electrical and equipment goods
- Other industries, wood processing, furniture, rubber, plastics

Services sectors: Offices, Utility buildings

Agriculture and fishery: single sector

Residential: Space heating, cooling, water heating, cooking, white appliances, black appliances, lighting

Transport:

- Modes for Passengers: Cars, Mopeds, Public Road, Tram/Metro, Rail, Navigation, Aviation
- Modes for Freight: Road (light duty, heavy duty), Rail, Navigation, Bunkers

E3Modelling Energy Economy Environment

Total gross electricity consumption														
GWh	2010	2011	2012	2013	2014	2015	2016	2017	2018	2020	2025	2030	2035	2040
Albania	6,618	7,452	7,262	9,280	7,790	7,293	7,738	7,439	7,639	*7,757*	*8,396*	*9,199*	*10,037*	*10,880*
Bosnia&Herzegovina	-	-	-	-	14,184	14,300	14,007	14,594	*14,689*	*14,934*	*16,353*	*18,081*	*19,864*	*21,673*
Bulgaria	38,200	40,128	39,013	37,597	38,024	38,644	38,899	40,125	39,023	*39,426*	*41,142*	*43,274*	*45,398*	*47,239*
Greece	63,086	62,657	62,733	59,029	59,282	61,471	63,223	61,492	59,530	*60,208*	*61,885*	*63,464*	*64,484*	*65,077*
Kosovo	5,633	6,218	6,095	6,182	5,926	6,249	5,474	6,280	6,062	*6,107*	*6,510*	*7,015*	*7,537*	*8,056*
Montenegro	4,023	4,217	4,055	3,600	3,433	3,525	3,445	3,602	3,614	*3,656*	*3,860*	*4,125*	*4,394*	*4,659*
North Macedonia	8,679	9,434	8,929	8,521	8,332	8,157	7,659	7,581	7,526	*7,670*	*8,111*	*8,699*	*9,310*	*9,917*
Romania	58,694	60,298	59,287	56,860	58,538	59,556	60,075	61,391	62,321	*63,301*	*67,221*	*71,754*	*76,280*	*80,741*
Serbia	37,799	38,315	37,181	37,333	35,617	37,373	37,413	37,864	37,535	*37,781*	*40,875*	*44,479*	*48,062*	*51,651*
Georgia	-	-	-	10,091	10,618	10,870	11,492	12,340	13,066	*13,613*	*15,380*	*17,733*	*20,327*	*22,508*
Moldova	4,096	4,161	4,210	4,236	4,305	4,252	4,230	4,307	4,453	*4,580*	*4,984*	*5,502*	*6,049*	*6,578*
Ukraine	184,740	188,624	187,372	184,454	174,353	162,302	160,790	150,832	*155,870*	*160,293*	*172,252*	*187,029*	*203,207*	*213,505*
Total	411,569	421,504	416,139	417,184	420,402	413,993	414,444	407,849	411,329	419,326	446,968	480,354	514,948	542,484

Total gross electricity consumption							
Annual rate of change (%)	2014-2015	2016-2018	2019-20	2021-25	2026-30	2031-35	2036-40
Albania	-6.4%	-0.6%	0.8%	1.6%	1.8%	1.8%	1.6%
Bosnia&Herzegovina	0.8%	2.4%	0.8%	1.8%	2.0%	1.9%	1.8%
Bulgaria	1.6%	0.2%	0.5%	0.9%	1.0%	1.0%	0.8%
Greece	3.7%	-3.0%	0.6%	0.6%	0.5%	0.3%	0.2%
Kosovo	5.4%	5.2%	0.4%	1.3%	1.5%	1.4%	1.3%
Montenegro	2.7%	2.4%	0.6%	1.1%	1.3%	1.3%	1.2%
North Macedonia	-2.1%	-0.9%	1.0%	1.1%	1.4%	1.4%	1.3%
Romania	1.7%	1.9%	0.8%	1.2%	1.3%	1.2%	1.1%
Serbia	4.9%	0.2%	0.3%	1.6%	1.7%	1.6%	1.5%
Georgia	2.4%	6.6%	2.1%	2.5%	2.9%	2.8%	2.1%
Moldova	-1.2%	2.6%	1.4%	1.7%	2.0%	1.9%	1.7%
Ukraine	-6.9%	-1.5%	1.4%	1.4%	1.7%	1.7%	1.0%
Total	-1.5%	-0.4%	1.0%	1.3%	1.5%	1.4%	1.0%

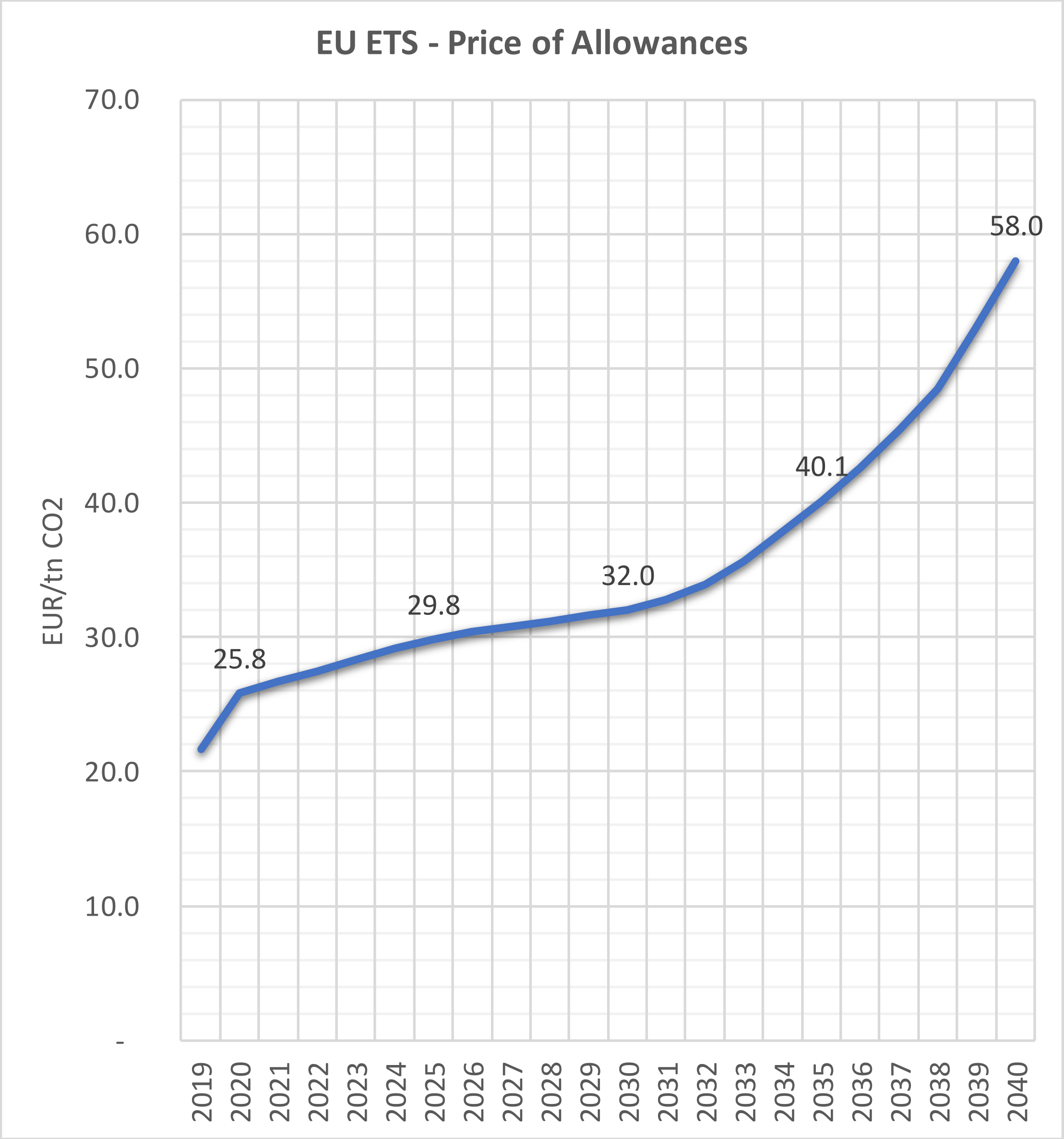
Drivers

- Electrification of heat and mobility are dominant trends but develops mainly in the last half of the current decade and in the next decade
- Higher ownership of appliances and living standards tend to increase in the region but it is offset by the significant improvement of energy efficiency enacted by technological progress and the eco-design regulation

Projection of EU ETS Carbon prices

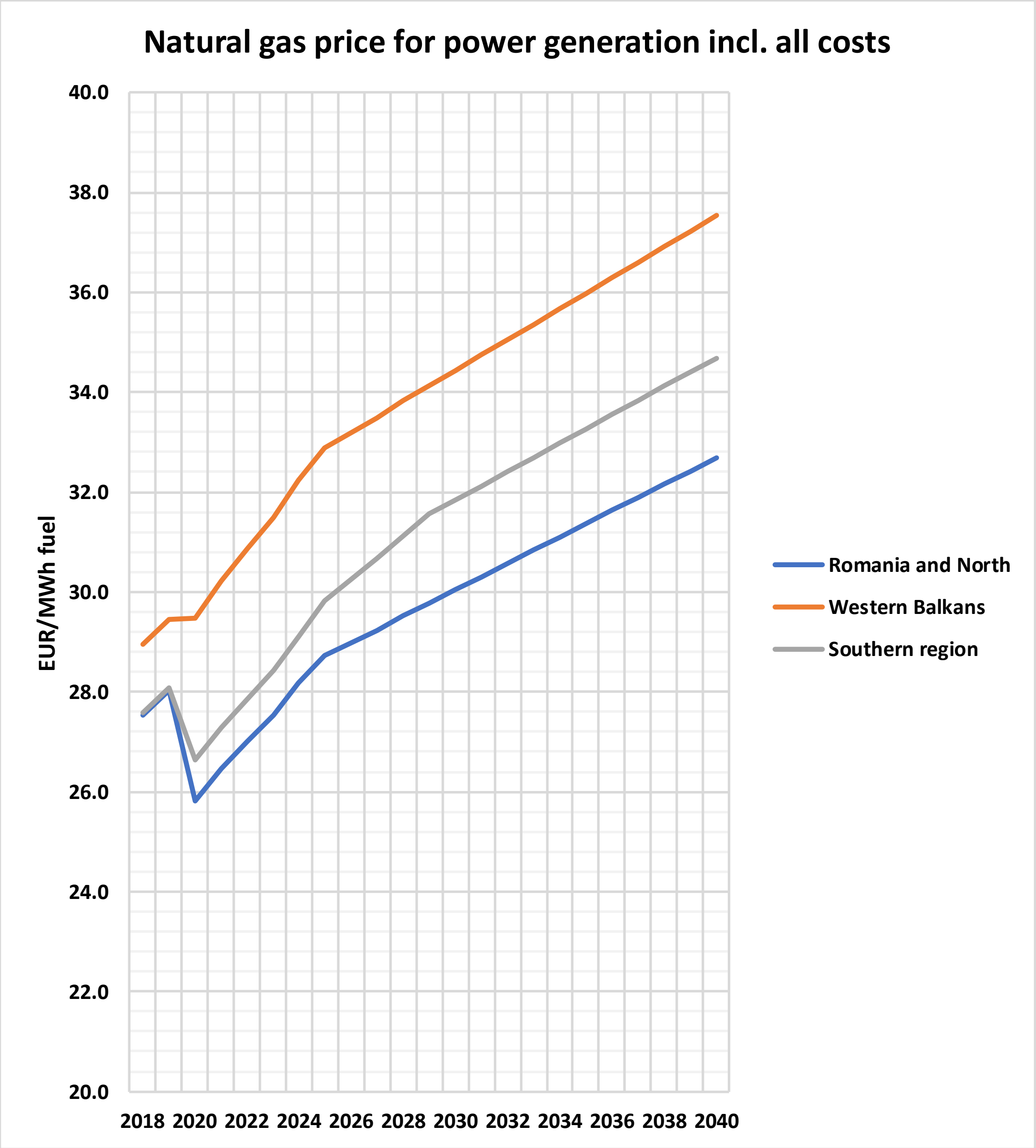
- The projection of EU ETS prices into the future foresees a rather slow pace of increase in prices until 2030, following the spectacular increase happened in 2018 after the implementation of the MSR (Market Stability Reserve).
- The projection relies on recent scenarios quantified for the European Commission using the PRIMES model.
- The projections assume an effective implementation of the NECPs of the EU MS, which plan for a significant increase in vRES and include ambitious coal phase-out plans *(in the majority of countries a phase-out before 2030)*.
- Therefore, carbon emissions in the EU ETS sectors are projected to decrease significantly until 2030, which to a large extent offsets the trend towards higher scarcity of allowances as regulated by the MSR until 2030.
- Beyond 2030, the EU ETS carbon prices will tend to increase significantly, due to the stringency of the MSR

Note: The projection does not include the Green Deal Agenda, which may further increase MSR stringency.



Drivers

- We assume that average natural gas prices in imports increase only slightly during the decade reflecting global gas market conditions.
- Rising LNG supplies originating from US shale gas compete strongly with – until now dominant – pipeline gas. The LNG global market contests pipeline gas pricing based on oil price indexation. The gas market takes its own dynamism independent of oil.
- ***Which assumption to adopt on gas development in the WB?*** Looking at the WB region, the poor gas supply infrastructure, in particular the lack of interconnections and diverse entry points in the regional gas system, makes gas pricing and supply uncertain. Gasification in WB region is uncertain under such conditions.
- *Gas subsidies in Ukraine is a practice that will continue? Also gas prices are not well known for Moldavia and Georgia.*



Lignite and coal mining costs

- Historically the costs of lignite have been low compared to other energy sources. Cheap lignite has sustained electrification in several CPs by ensuring affordable and stable prices of electricity.
- In the recent past, however, dis-economies of scale due to the increasing costs of mining exploitation and to the decrease in the rate of use of the mining capacities have pushed lignite costs significantly upwards (with few exceptions).
- In some cases, the prices have been kept stable artificially via direct or indirect subsidies granted by the state.
- At the same time, a large part of the region's old power plant fleet is aged, as exploitation has often exceeded standard power plant lifetimes. In addition, the majority of them do not comply with the Large Combustion Plant air pollution standards. The portion of the fleet requiring refurbishment is large, but there is reluctancy for investment to uncertainties surrounding return on investment and the continuation of lignite fleet operation in the future.
- Both technical and market conditions have led to a decrease in the rate of use of lignite power plants which in turn has implied low rates of use of lignite mining and have pushed lignite costs upwards, as the majority of mining costs are fixed and inelastic.
- It is highly uncertain whether direct or indirect subsidies to lignite mining can survive in the future to prevent lignite costs from rising.
- ***This issue of continuation or not of indirect or direct subsidies to mining is an important assumption for the modelling***

Range of lignite mining costs

€/MWh-fuel	Low	High
ALBANIA	0.0	0.0
BOSNIA_HERZEGOVINA	7.1	9.2
BULGARIA	4.8	6.3
KOSOVO	7.5	8.7
NORTH_MACEDONIA	12.1	12.6
MONTENEGRO	11.1	11.6
SERBIA	5.8	8.3
GREECE	7.4	13.6
ROMANIA	5.9	9.4

Cross border exchanges

- New interconnections under construction add significant cross-border capacity in the region. Total interconnection capacity is likely to increase by 50% until 2025 in the region.
- However, a small fraction of the interconnection capacity is currently available to markets and traders. The NTC values are currently small in all countries. Below 30% of interconnection capacities are on average available for commercial operations.
- Market coupling is first of all applying the rule of allocating at least 70% of interconnection capacity to the markets, rather than for system reserves. This will be a considerable change of cross-border flow possibilities. **By when this will happen in the region? And by When full market coupling including for intra-day and reserve balancing?**
- The highest NTC restriction applies on the interconnection Bulgaria-Romania, although both are in the EU. The sub-region of ex-Yugoslavian countries maintain significant interconnection capacity, plan for additional reinforcements and lines and apply less restrictive NTC values than other countries of the region. Romania has coupled the market and has opened interconnection capacities with four countries in the North, but maintains a poor interconnection opening with the countries in the SEE region. Bulgaria-Greece interconnection is likely to significantly extend and further open to trade, soon.
- **Which assumption to adopt for cross border trade opening for Ukraine, Moldova and Georgia?**

Interconnections

Country 1	Country 2	Commissioning year	Thermal Capacity of the new interconnector (MW)
ALBANIA	NORTH_MACEDONIA	2020	1330
BOSNIA_HERZEGOVINA	SERBIA	2025	1300
BOSNIA_HERZEGOVINA	MONTENEGRO	2020	1300
BOSNIA_HERZEGOVINA	CROATIA	2025	1300
BULGARIA	ROMANIA	2020	1300
BULGARIA	GREECE	2023	1500
KOSOVO	NORTH_MACEDONIA	2025	1300
MONTENEGRO	ITALY	2020	600
SERBIA	ROMANIA	2025	2*1300
SERBIA	MONTENEGRO	2030	1300
ROMANIA	UKRAINE	2025	1300

Power mix and prospects

- Most of the countries have significant capacity of hydropower but expansion is unlikely to happen except for few concrete projects under development
- Nuclear countries are Bulgaria, Romania and Ukraine. They plan to maintain nuclear capacities, and for Romania to expand after 2030. Financing is a challenge for this prospect. ***Which assumptions to maker about future nuclear?***
- Coal and lignite power plants have significant capacities in the countries, and several depend on coal and hydro exclusively. Diversification to CCGT did not take place in these countries. Their mix is thus vulnerable to carbon pricing (e.g. BA, RS, XK, ME)
- The coal plant fleet is aged and polluting, requiring refurbishment to continue operating. There is generally reluctancy to undertake such investment. ***Concrete assumptions to make case by case.***
- Large and efficient CCGT have developed and will further develop in Greece, but much less in the rest of countries. Few projects exist for new CCGTs in these countries. ***Assumptions about new CCGTs***
- The vRES have developed considerably in Greece and will further develop according to the NECP. But the vRES development has been poor in the rest of the countries, probably except in Romania where wind may develop further. The rest of countries have moderate vRES potential and slow paces of investment. ***A range of RES potential investment is assumed by technology in the scenarios. Carbon pricing will drive investment in vRES upwards.***

Power generation capacities in 2018 (MW)

COUNTRY	LIGNITE (MW)	COAL (MW)	GAS (MW)	NUCLEAR (MW)	VRES (MW)	HYDRO (MW)
ALBANIA	0	0	0	0	0	1874
BOSNIA HERZEGOVINA	1955	0	0	0	105	2236
BULGARIA	2904	845	665	1890	1829	2323
GREECE	3904	0	4901	0	5194	3590
KOSOVO	910	0	0	0	2	115
MONTENEGRO	225	0	0	0	72	682
NORTH MACEDONIA	699	0	220	0	63	693
ROMANIA	**3298**	**609**	**2742**	**1305**	**4360**	**6329**
SERBIA	4021	0	208	0	239	2314
UKRAINE	1000 (oil plants)	15800	11200	13100	1800	6200
MOLDOVA			2900			100
GEORGIA		313	640		26	3145

E3Modelling Energy Economy Environment

Opt-out and refurbishment of old coal plants

- The table to the right summarises assumptions about known decommissioning-commissioning of thermal power plants.
- To validate and complement

vRES potential until 2035

GW	Solar	Wind	other
ALBANIA	0.25 - 1	0.15 – 0.75	1 GW hydro
BOSNIA HERZEGOVINA	1 - 2	0.9 -1.5	0.25 Hydro
BULGARIA	1.5 -4.5	1 – 4.	
GREECE	4 - 10	4 – 8.5	0.45 Hydro
KOSOVO	0.15 – 0.5	0.2 -0.5	0.30 Hydro
MONTENEGRO	0.4 – 0.8	0.3 -0.6	0.6 Hydro
NORTH MACEDONIA	0.4 – 1	0.3 -0.5	0.25 Hydro
ROMANIA	2 - 5	3 - 8	0.5 Hydro
SERBIA	1.8 – 3.2	2.4 – 3.1	
UKRAINE			
MOLDOVA			
GEORGIA			

	Opt out	New coal	New CCGT
ALBANIA	No	No	No
BOSNIA HERZEGOVINA	930 MW	450 MW	
BULGARIA	775 MW		1600 MW
GREECE	Phase out by 2023	600 MW until 2028	2000 MW
KOSOVO	390 MW	450 MW	
MONTENEGRO	516 MW		
NORTH MACEDONIA	No	No	No
ROMANIA	800 MW		400 MW
SERBIA	300 MW	320 MW	200 MW
UKRAINE	Unknown		
MOLDOVA			
GEORGIA	300 MW		

POLICY DESIGN OPTIONS FOR A CARBON PRICE MECHANISM IN THE ENERGY COMMUNITY COUNTRIES

By Professor Pantelis Capros, E3Modelling – E3MLab

<u>Project</u>

Energy Community Study on Carbon Pricing

Workshop March 26, 2020

Main definitions

Carbon pricing is an instrument that captures the external costs of greenhouse gas (GHG) emissions. Carbon pricing refers to a measure that puts an explicit price on GHG emissions, i.e. a price expressed as a value per ton of carbon dioxide equivalent (€/tCO_2). Consumers and emitters are thus incited to adjust operation and investment to the price structure modified by the carbon price.

- Carbon pricing can be
  - explicit or
  - implicit
- Carbon pricing may entail
  - transfer payments to the state by the entities
  - No transfer payments
- Recycling of state revenues from carbon pricing can take various forms
- Carbon pricing certainly implies adjustment costs in addition to transfer payments
  - Costs of restructuring operation (e.g. fuel mix)
  - Costs of restructuring investment (e.g. change in capacities)
  - Costs due to non-recouping of fixed costs because of limited operation (stranded assets)
- Costs and transfer payments pass through to consumer prices, issues
  - Fully under market conditions, but also opportunity costs?
  - Partly, as average and not marginal costs, under regulatory intervention

Explicit carbon pricing can apply in two distinct ways:

Carbon tax

- At the purchasing of a GHG emitting product, e.g. a fuel, in which case the buyer of the product bears the carbon pricing.
- Does not differ from excise or energy tax except the way it is numerically calculated
- It differs from excise tax because the latter is proportional to volume or energy content of the product.
- Mixed taxation may apply carbon tax for part of taxation and excise taxation for the rest.

Environmental tax

- To an installation which emits GHG, e.g. proportionally to GHG emissions ignoring the fuel origin of the emissions,
- in which case the company running the installation bears the carbon pricing.
- It has applied to a variety of environmental issues

Explicit carbon pricing certainly entails

- Transfer payments to the state (thus a budget effect on consumer)
- Additional costs of adjustment

Excise versus carbon taxes

Excise tax

- Typically defined in proportion to volume of energy product (EUR/liter)
- As every fuel has a fixed specific heat conversion factor,
- an excise tax is thus typically an energy tax

Carbon tax

- Defined in proportion to GHG emissions
- As the oil products have similar carbon emission factors and similar specific heat factors,
- A carbon tax on oil products can thus be applied, totally or partly, instead of an excise tax without additional tax burden

Applying a uniform carbon tax to all energy products is different than today practice where excise (energy) taxes differ for certain fuels and sectors.

There is currently no example of country in the EU having truly reformed excise taxes to a uniform carbon taxation. This is under consideration in the Green Deal agenda

Implicit carbon pricing

Implicit carbon pricing applies as the price of a GHG emission allowance certificate.

A central authority issues the allowances. The allowances serve to justify GHG emissions; otherwise, a penalty applies.

The emitting installation has to own the corresponding allowances to justify emissions.

The number of allowances issued are less than actual emissions, which are capped in this manner.

The allowances may be tradable or not.

Emission credits (also an implicit carbon pricing system) or equivalently emission certificates

- Central authority sets upper bound of emissions on installations or entities, which receive emission credits or a certificate (tCO2 avoided) when fulfilling the obligation.
- Entities exceeding emission limits will have to buy emission credits, otherwise a penalty applies.
- The credits are thus tradable, two possibilities for pricing:
  - **Prices of emission credits are determined by the market of exchanging credits;**
  - **Prices are regulated and thus the central authority handles the transfer of money between the entities.**

Three approaches to get allowances:

A. The central authority grants allowances for **free**

The **allocation** per installation of an amount compared to estimated emissions is decisive

B. The installation has to pay to buy the allowances.

Two possibilities apply:

B1. Regulated prices: The installation pays for the allowances at a price set by the authority administratively, and the authority defines the maximum number of allowances available per installation.

B2. Market prices: The authority organizes auctions, of pay-as-clear nature, to allow installations to buy allowances. The number of allowances auctioned is less than expected emissions, and the prices of the allowances are thus market-based.

C. Hybrid mechanism: part of allowances given for free and part auctioned.

Tradability – definitions and pre-conditions

Tradability

- No tradability implies a central buyer and seller
- Tradability can apply
  - By sector within one country
  - Cross-border
- Tradability is independent of whether allowances are free or payable
- Tradability may be allowed to
  - Only to emitters, or
  - All entities

Banking of allowances

- Valid only within the year of issuance, or
- Valid to use a future time (usually allowed)

Borrowing allowances

- If tradable, allowances are exchangeable assets
- As certificates, they can justify emissions only once
- Must be already issued to be used (no borrowing from the future)

Financial pre-conditions – stricter when tradable cross-border

- Guarantee for financial settlements
- Currency of financial settlements
- Dispute resolution
- Accountability, transparency
- Non-manipulation of markets
- Level-playing field, no state aid etc.

Modelling the Market Stability Reserve of EU ETS

Allowances in circulation

- Issuance policy is the amount of new Allowances in circulation (e.g. 2.2% linear reduction every year)
- Removal of Allowances is to reduce planned issuance
- Surplus is the amount of Allowances in circulation in a year

Agents

- Long: hold more allowances than they need to justify emissions, may sell or bank allowances
- Short: need to buy allowances to justify emissions, may buy allowances above current needs

Indicator to anticipate scarcity of allowances

- Surplus over Current Year Emissions
- Similar to Reserve/Production ratio in depletable resource economics (Hoteling pricing rule)
- A reasonable minimum level for the Surplus/Emissions ratio is 0.25-0.4 (i.e. a quarter or a third of a year) to qualify the market as in a steady-state balance

Adjustment of EU ETS carbon price

- If Surplus/Emissions is higher than min value, carbon prices adjust downwards and vice-versa
- Future growth of demand increases emissions, reduce Surplus/Emissions and prices tend to increase
- Coal phase out decreases emissions, increase Surplus/Emissions and prices tend to decrease or stabilize

The Market Stability Reserve acts on the Surplus

- Removes Allowances as an ad hoc measure
- Decreases or increases the issuance of new allowances according to automatic and pre-determined thresholds for the surplus

On price impacts and policies

Transfer payments to the state (carbon tax or purchased allowances)	If emitters are suppliers of goods, they will pass-through to consumer prices transfer payments; this is unavoidable.
	For power and heat producers transfer payments will increase the price of energy products. For industry transfer payments will increase industrial prices, and will impact on consumers
	If emitters are final consumers, they will bear a loss of income effect: lower demand for energy services and products, energy poverty threats, crowding out effect on non-energy expenses
If transfer payment to the state does not apply (free allowances)	If allowances are tradable, emitters perceive an opportunity cost (equal to the market price of the allowance – when selling allowances not used to justify emissions)
	They may consider the opportunity cost to price carbon emissions internally. In this manner, they may reach optimality by restructuring as to the point where marginal production costs equal the implicit carbon price
	But also, they may sell their outputs (e.g. electricity, heat) at marginal costs plus the opportunity cost of allowances, even if free. Windfall profits may arise, but fierce competition will not allow doing that fully.
When free allowances apply, the state has options:	Tolerate marginal cost pricing by emitters including the pass-through to consumer prices of opportunity costs, as much as competition allows for. Tolerate windfall profits if trust they become expenditures in carbon-free investment.
	Regulate emitters to apply average cost pricing and increase consumer prices only due to true costs (i.e. adjustment costs to internal carbon pricing, excluding opportunity cost). This mitigates price increases, but may offset the carbon signal.
	It is logical to pass-through to consumer prices costs of structural adjustment needed as a response to carbon pricing. When opportunity costing applies, the impact on restructuring, hence lower emissions, may be higher than otherwise.
Recycling state revenues	Several options with different macroeconomic effects (several GEM-E3 studies)
	Important not to cancel the emission reduction incentive
	Enabling positive externalities (infrastructure, new yet immature technologies, etc.)
	Alleviating adverse effects (e.g. income effect on social classes, vulnerable industrial sectors)
	Manage the transition, return transfer payment as a bonus under conditions to offset cost impacts

Internal Carbon Pricing

- Consideration of a carbon price in all decisions for operation and investment by an entity
- The carbon price can be:
  - **Explicit** (set as a price administratively; affects all economic calculations supporting decisions), or
  - **Implicit** (an upper bound on emissions applied internally or externally, both for present time operations and future investment)
- It does not entail transfer payments to the state, but do imply adjustment costs (both in operation and investment) that otherwise the entity would not incur; therefore consumer prices may change.
- May be mandatory by regulation or enforced via emission credits – or certificates
- This is a precursor – a preparation stage for transforming into an ETS later

Public economics: to mitigate a negative externality

- Coase Theorem – Cap and Trade is a first best policy choice
  - The theorem states that if trade in an externality is possible and there are sufficiently low transaction costs, bargaining will lead to a Pareto efficient outcome regardless of the initial allocation of property (i.e. permits).
  - Transaction costs are high as bargaining with a large number of individuals is difficult and increase as a result of social costs. The assignment of the initial allocation of property is a challenging issue in reality.
  - This explains why the first best policy option, i.e. cap and trade, is applicable practically only for large-scale installations, which can be verified, and under condition of broad and non-manipulated trade of property.
  - Still the initial allocation of permits is difficult, always inefficient and causes adverse effects. This is the case of granting allowances for free.
  - Therefore, auctioning the permits is preferable, provided that the size of the market and the degree of competition are sufficiently large.
  - But, the price signal of auctioning will be fluctuating, causing uncertainty to long-term corrective investment. Restricting the possible range of fluctuation is the purpose of measures such as the Market Stability Reserve, and the carbon price floor. However, stricter such measures, closer they become to a carbon tax policy option.
- Pigou Theorem – Taxation is a second best policy choice
  - The state can mitigate divergences between marginal private costs and marginal social costs (externalities) by applying discouragements, such as taxes.
  - It is a second best choice because it allows less freedom to the market forces to modify allocation, compared to cap and trade.
  - Implementing a tax system is practically easy, but may be politically difficult due to social adverse effects. This is because a tax implies transfer payments, reduces available income and cause distributional impacts. It has all inequality impacts of an indirect taxation.
  - Deciding upon the level of the tax is difficult and arbitrary
  - Nonetheless, “the beauty of a carbon tax is its market-based simplicity”

Alleviating adverse effects

- The carbon pricing, implicit or explicit, modifies the relative costs of inputs.
  - An inflexible entity will bear a high cost, close to carbon price times emissions, which will cause a crowding out effect, such as loss of income, loss of financing or loss of a market share
  - Flexibility can be seen as
    - Short term: modify the fuel mix in operation and decrease the overall operation
    - Long term: modify investment to replace current capacity possibly also prematurely.
- Higher and shorter the flexibility of adjustment, lower the adverse effects of carbon pricing.
  - The degree of flexibility often depends on enabling conditions, for example on infrastructure, institutional factors, maturity of new technologies, market coordination and other “positive” externalities
  - Very important role of public policy to take measures accompanying the carbon pricing to enable the positive externalities
- Factors justifying a transition period – gradual increase of carbon pricing
  - Magnitude of social and industrial adverse effects when the economy and the social structure are vulnerable or under development
  - Time needed for the state to implement measures and investment enabling positive externalities so as to allow for maximum flexibility possibilities for entities subject to carbon pricing
  - Time needed to fulfill the policy implementation pre-conditions, when institutional mechanisms are not yet mature

Macro – indicators to consider

- Price-cost diffusion in the economy
- Poverty - affordability thresholds
- Industrial competitiveness thresholds
- Activity and employment multipliers

Current situation

- At present all CPs impose excise taxes on oil products (gasoline, diesel, LPG, kerosene, fuel oil, heating oil) and some on natural gas. The tax rates often differ by sector, e.g. between transport and heating.
- Carbon tax is absent or very small – insignificant. Taxation of inputs to power generation or district heating does not exist or is very small
- **Remarks**: heating oil less taxed than in the EU; diesel less taxed than gasoline; no minimum tax on natural gas and electricity; LPG less taxed than competitors; Ukraine has lower taxes than the rest of countries and maintain subsidies.
- **Transforming the excise taxation into a carbon tax**
  - **An excise tax of 0.4€/lit of an oil product is approximately equivalent to a carbon tax of 150 €/tCO2, see example of gasoline tax**
  - **But for fuel oil, the current excise tax is equivalent to only 7€/tCO2, for heating oil to 50€/tCO2 and for natural gas almost zero (but in the EU the tax is equivalent to 40€/tCO2).**

In EUR	Gasoline (per lit)	Diesel (per lit)	LPG (per lit)	Kerosene (per lit)	Fuel oil (per lit)	Heating oil (per lit)	Nat. Gas (per m3)	Coal (per kg oe)	Electricity (per MWh)	VAT
Albania	0.514	0.514	0.064	0.160	0.030	0.297	0.000	-	-	20%
North Macedonia	0.350	0.195	0.079	0.181	0.036	0.051	0.000	-	-	18%
Kosovo	0.360	0.360	0.150	0.150	0.025	0.150	0.000	-	-	18%
Montenegro	0.460	0.350	0.124	0.156	0.020	0.120	0.000	-	-	21%
Bosnia & Herzegovina	0.381	0.355	0.203	0.152	0.023	0.228	0.000	-	-	17%
Serbia	0.369	0.252	0.126	0.126	0.027	0.252	0.000	-	-	20%
Ukraine	0.214	0.140						-	-	20%
Georgia	0.315	0.197	0.158	0.158	0.020	0.158	0.079	-	-	18%
Moldova	0.340	0.143	0.214	0.143	0.026	0.143	0.340	-	-	20%
Bulgaria	0.363	0.330	0.174	0.330	0.020	0.330	0.023	0.013	1.000	20%
Romania	0.373	0.342	0.136	0.476	0.016	0.342	0.146	0.013	1.000	19%
Greece	0.700	0.410	0.430	0.410	0.038	0.410	0.079	0.013	1.000	24%

Policy options to consider for carbon tax

Option T-1: Carbon tax with minimum tax burden

- Maintain the same relative tax burden between fuel types and sectors but calculate tax rates proportional to carbon emissions
  - **No income or price impact on consumers**
  - **Weak emission reduction signal in the short term, but in the longer term positive incentive**
  - **Blending with carbon neutral fuels reduces average taxation**

Option T-2: Carbon tax with smaller gaps between fuels/sectors

- Apply option 2 and gradually reduce the gap of tax burden between fuels and sectors, mainly by rising taxation on diesel, LPG, heating oil, natural gas and fuel oil. The adjustment however would stop up to the average practice of excise taxation in the EU
  - **Small effects in transport sectors, significant price and income effects in the heating and industrial sectors**
  - **Alignment with the EU**
  - **Price signals to reduce emissions in industry and heating, favoring electricity in the latter**

Option T-3: Carbon tax in addition to current excise taxation

- Apply a uniform carbon tax (e.g. 40€/tCO2 or 0.100€/lit of oil) on all fuels and sectors, in addition to the existing excise taxes
  - **This is one of the options under consideration for carbon taxation within the Green Deal Agenda.**

Policy options for Cap and Trade

Option C-1: Internal carbon pricing – certificates

- Impose that the subject entities assign a carbon price to carbon emissions for all internal decisions for operation and investment
- The state allocates to the entities emission allowances up to a targeted level of emissions
- If the entity has excess of allowances, the state provides a credit, and otherwise pays a penalty to the state. Both are calculated using an administrated carbon price
- No trade of allowances is possible between the entities

Option C-2: Internal carbon pricing – traded at a national level

- As in option C-1, but the allowances are tradable between the entities within the same country
- Also the state can act as a buyer and a seller to balance the market and increase liquidity. Both bilateral transactions and an organized market for allowance are possible to coexist.
- The carbon price is market-based, but a carbon price floor is suggested to apply

Option C-3: Cross-border trade

- As in option C-2, but trade of allowances is also possible cross-border depending on bilateral agreements between countries.
- Reasonable pre-conditions apply for this purpose, mainly for financial transactions, market liquidity and transparency and level-playing field in the underlying energy product market (e.g. electricity).
- Allowances are still granted for free, in majority.
- To be seen if cross-border trading of allowances is allowed also between CP and EU-MS countries, depending on the conditions stated above

Option C-4: Adherence to the EU-ETS under a transitional regime

- As in option C-3, but full trade of allowances within the EU ETS system.
- However, free allowances during the transition period are possible

Option C-5: Full integration in the EU-ETS

- Free allowances abolished, all allowances auctioned

The national approach: policy options as stages

- The duration of the stages may vary per country depending on
  - the degree of flexibility to respond to carbon pricing,
  - the threat of social and industrial adverse effects,
  - the potential available to decarbonize via investment, and
  - the expected positive impacts
- Whether or not to follow all stages may also vary
- The details, e.g. level of carbon price or degree of ambition in the issuance of allowances to be defined by country

The regional approach: harmonization and coordination

- The pre-conditions are of crucial importance for applying a regional approach, namely pre-conditions for
  - Trade: liquidity security and transparency
  - Energy market coupling, level playing field in competition, avoidance of national state aids and subsidies
- Part of the CP region may fulfill the pre-conditions and opt for a regional approach, while few selected countries apply the national approach
  - A regional approach makes EU-ETS integration to be possible sooner than uncoordinated regional approaches

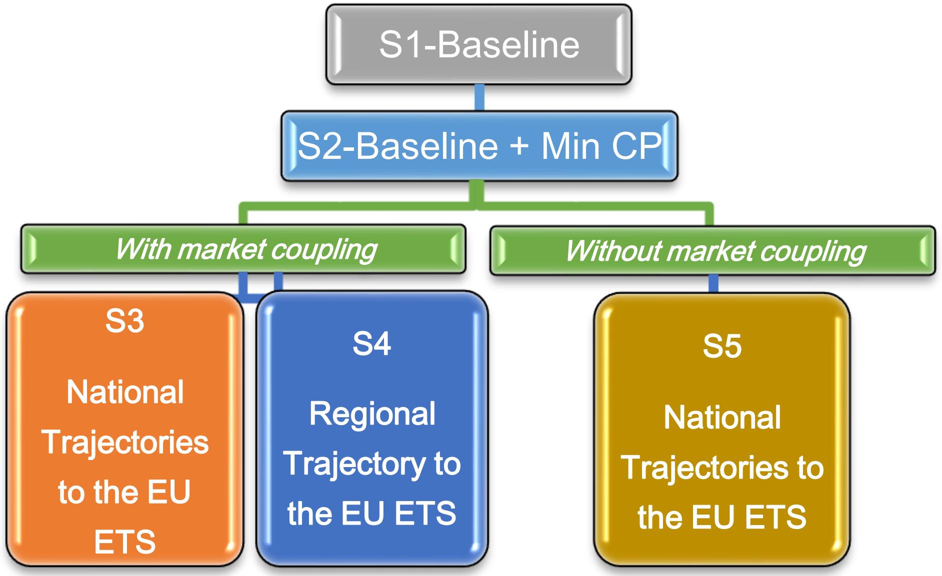
Policy scenarios for modelling

- Every scenario is defined until 2040 per country
- Detailed specification per country to be defined through a written procedure (in 2 weeks time)
- Scenarios:
    - **S1-Baseline scenario**: no carbon pricing
    - **S2-Baseline + Min CP**: minimum national carbon tax to non-ETS sector and a minimum carbon price in ETS sector; the non-ETS sector minimum carbon tax applies in all subsequent scenarios
    - **S3-National Trajectories to the EU ETS under market coupling**: pre-conditions fulfilled for large part of the region, but national specificities still important to consider so that the CP follow national pathways towards the EU ETS
    - **S4-Regional Trajectory to the EU ETS**: pre-conditions fulfilled for large part of the region, and the regional applies a harmonised and coordinated pathway towards the EU ETS
    - **S5-National Trajectory to the EU ETS**: pre-conditions not fulfilled and national considerations prevail opting for national pathways for cap and trading systems

Example of timing (years indicate the start)

	T-2	C-1	C-2	C-3	C-4	C-5
S1	**No**	**No**	**No**	**No**	**No**	**No**
S2	**Yes**	**No**	**No**	**No**	**No**	**No**
S3	**Yes**	**2022**	**2025**	**2028**	**2032**	**2035**
S4	**Yes**	**No**	**2022**	**2025**	**2028**	**2030**
S5	**Yes**	**2022**	**2025**	**2030**	**Few CP**	**Few CP**

Schematic view of scenario definition



Considerations by country - preliminary

	Flexibility	Decarb. Inv.	Threats	Market Integration	National or Regional
Albania	High	High	Few	High	Regional
N. Macedonia	Rel. High	Rel. High	Moderate	High	Regional
Kosovo	Poor	Poor	Significant	Moderate	National
Montenegro	High	High	Moderate	High	Regional
Bosnia&Herz.	Moderate	Moderate	Significant	Potentially	National then Regional
Serbia	Moderate	Moderate	Significant	Potentially	National then Regional
Ukraine	High	High	High	Not obvious	National then Regional
Moldova	High	Moderate	Moderate	Poor	National (Regional)
Georgia	Moderate	Moderate	Moderate	No	National

Stages of the Policy Design Options' Implementation

1st stage: Internal Carbon Pricing for ETS sectors

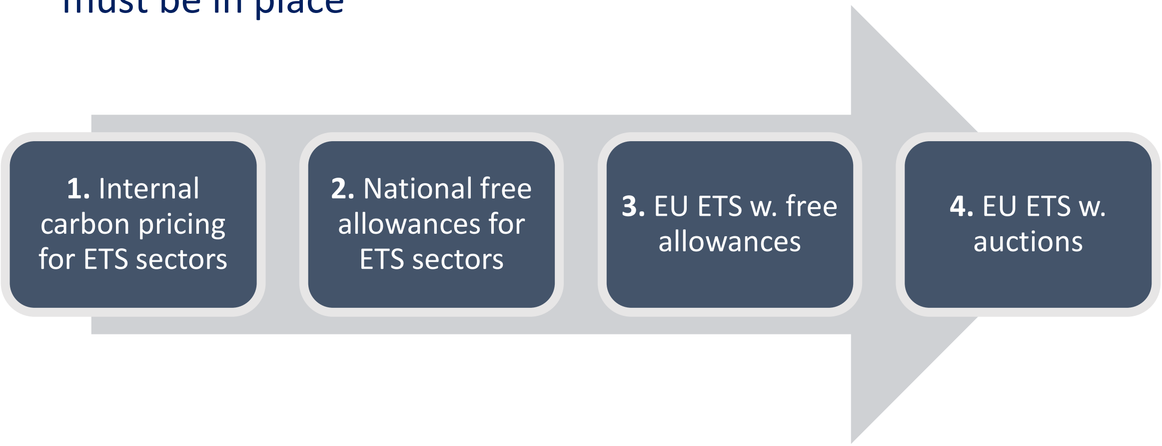
- A company adopts a price on carbon internally.
- Affects all economic calculations that support decision-making both for on-going operations and future investment of a company.
- Accompanying measures to avoid significant costs being passed on to consumers.
  - Oblige entities to sell at prices reflecting true average costs rather than marginal or opportunity costs, when receiving credits; *or*
  - Price-setting is free but the state grants compensations to the consumers (recycling of state revenues from carbon prices, or from other public finance resources).
- Proposed carbon price: Half of the value of existing EU ETS carbon price.

2nd stage: National Free Allowances for ETS sectors

- Implemented as implicit carbon pricing; applies as the price of a GHG emission allowance certificate.
- A robust MRV must be in place.
- The central authority grants the allowances for free. Important! **allocation of allowances per installation & amount to be granted compared to estimated emissions.**
- Accompanying measures to compensate consumers should be in place.
- Proposed carbon price: ½ value of existing EU ETS carbon price, which smoothly increases towards the EU ETS price.

3rd stage: Regional trade and then EU ETS with Free Allowances

- Trading occurs but with free allowances. Operating as a satellite market or a fully integrated market.
- No transfer payments. Financial and market pre-conditions must be in place



4th stage: EU ETS with Auctions

- The final stage of carbon pricing is the one currently in place within the EU ETS. In this stage, a central authority organises auctions of pay-as-clear nature in which installations buy allowances.
- Since the number of auctioned allowances is less than the expected emissions, the prices of the allowances are market-based. Financial and market pre-conditions must be in place.

E3Modelling Energy Economy Environment

1st step: Using the model PRIMES-IEM to quantify the scenarios

- Quantify assumptions about the market context and reflect carbon pricing schemes outcomes on fuel costs and other operation variable and fixed expenses.
- Run the model for each scenario, calculate economic and price impacts and determine carbon emissions.
- Check consistency between emissions and carbon prices in the case of a Cap and Trade system, and repeat from first step with adjusted carbon prices.
- Finalize model running and Excel report generation.

2nd step: Economic and social impact assessment

- With multipliers derived from the GEME3 model, assess the impacts of prices on
  - Private consumers – family budgets, affordability, poverty
  - Industry – competitiveness, indirect impacts on prices of industrial outputs and propagation into the economy
- Indirect effects on activity and employment due to lost domestic fuel production (e.g. lignite) and new investment (e.g. RES)
  - Recycling of state revenues from carbon pricing
  - Assessment of few revenue recycling options
  - Comparative assessment of impacts
  - Feedback on economic, affordability and competitiveness impacts

3rd step: Policy indicators and qualitative assessment

- Based on model results for all sectors, covering emissions, fuel mix, energy balances, investment, costs and prices
- Policy implementation difficulties – discussion
- Threats and opportunities – social and economic – discussion

4th step: Final reporting and presentations

The PRIMES-IEM model

Fully-fledged dynamic simulation and optimization of the electricity system and markets	Optimal capacity expansion
	Individual power plant economics and technical constraints
	Unit commitment – co-optimizing demand, plant operation, ancillary services and cross-border flows
	Simulation of bidding behaviors in wholesale markets
	Determination of wholesale market prices
	Flow-based allocation of interconnectors, DC-linear power-flow, NTC constraints
	Determination of retail prices of electricity by stylized consumption sectors
Outputs	Investment in new power plants, RES and storage
	Dispatching in power generation – hourly
	Cross-border flows
	Bidding behaviors
	Wholesale market prices
	Losses and profit by power plant
	Retail prices (options on passing through carbon costs to consumer prices)

E3Modelling Energy Economy Environment