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PROJECT 101059411

A case study in North Macedonia: cost-benefit analysis for coal thermal plant decommissioning – work in progress

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Content

- Decarbonization policy context/Status of implementation - RNM
- Introduction to I-O and regional coefficients
- How to use the I-O results for CBA
  - Regional economic output costs and benefits – direct and indirect
  - Regional labor implications – direct and indirect
- Baseline scenario for TPP Oslomej decommissioning
  - Social costs and benefits with assumptions
  - Health costs and benefits with assumptions
  - Environmental costs and benefits with assumption

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Context: Decarbonization in Energy Sector

- European Union
- The national energy and climate plans (NECPs) were introduced by the Regulation on the governance of the energy union and climate action (EU)2018/1999, part of the Clean energy for all Europeans package which was adopted in 2019.
- The national plans outline how the EU countries intend to address the 5 dimensions of the energy union:
  - decarbonisation
  - energy efficiency
  - energy security
  - internal energy market
  - research, innovation and competitiveness
- The governance mechanism is based on integrated national energy and climate plans (NECPs) covering ten-year periods starting from 2021 to 2030, EU and national long-term strategies, as well as integrated reporting, monitoring and data publication.
- The transparency of the governance mechanism is ensured by consulting wide public on the NECPs.

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Policy – Strategic context vs. Implementation

- North Macedonia
- North Macedonia was on first among n the Energy Community members**, which developed a NECP, including the 5 dimensions as per the EC regulation, one of which is decarbonization
  - Decarbonization is one of the main pillars of the National Strategy for Energy Development until 2040.
- The country's dependence on natural gas imports, as well as on fuels, makes the decarbonization scenario significantly vulnerable to turmoil in the markets for coal, oil, natural gas and electricity.
- As North Macedonia has undertaken decarbonization, it is expected in the next period to close the thermal power plants and thus to stop the production of electricity from coal, to increase the participation of renewable sources in the energy sector, a process that has already started with investments in photovoltaic power stations, as well as reducing dependence on imported electricity.
- According to the Energy Development Strategy, the share of RES in the gross final consumption of energy is expected to reach range of 35-45% in 2040
- ** The Energy Community has nine Contracting Parties - Albania, Bosnia and Herzegovina, Kosovo*, North Macedonia, Georgia, Moldova, Montenegro, Serbia and Ukraine. The European Union is a Party to the Energy Community Treaty. (https://www.energy-community.org/aboutus/whoweare.html)

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Policy – Strategic context vs. Implementation

- North Macedonia
- National Energy and Climate Plan (NECP), covers the period from 2021 to 2030

- Energy Law (Official Gazette 96/2018 and 96/2019) transposes the Third Energy Package in the electricity and natural gas sector, as well as the Renewable Energy Directive 2009/28/EC - created the momentum for integrated energy and climate planning.

- Energy Law amended for the development of NECPs, as well as harmonized national reporting against various energy and climate targets.

- Energy Efficiency Law (Official Gazette 32/2020), warrants transposition of the Energy Efficiency Directive 2012/27/EU, Energy Performance of Buildings Directive 2010/31/EC and stipulates preparation of Energy Efficiency Action Plans (the Fourth Energy Efficiency Action Plan until 2021 is under preparation).

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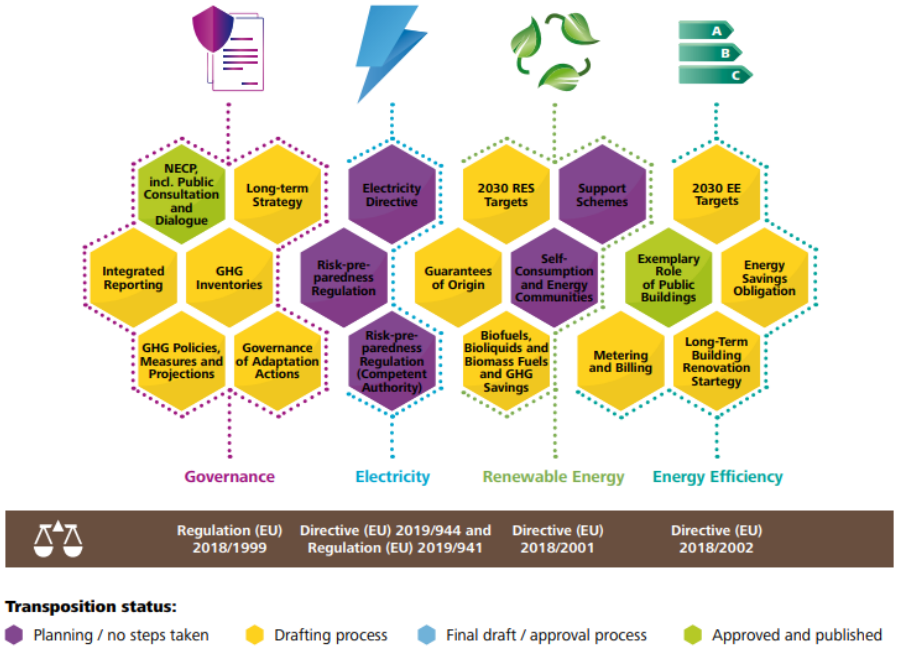
Strategic context- Status

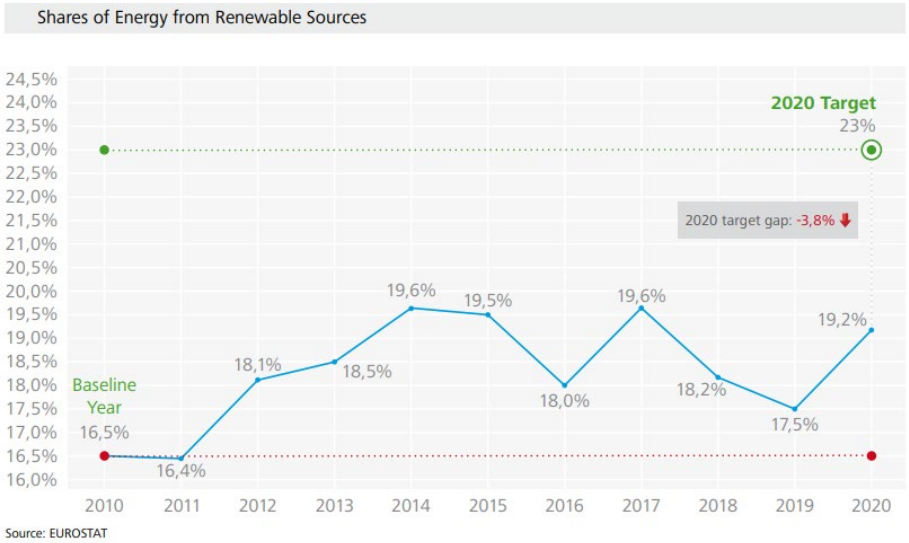
2020 Primary fuel mix in North Macedonia [ktoe]

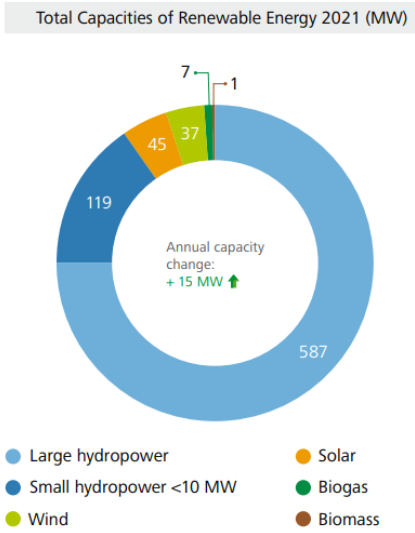
- Solid fossil fuels
- Hydro
- Other renewables

Source: EUROSTAT

Decarbonisation readiness - 2021 Clean Energy Package transposition







Source: North Macedonia Annual Implementation Report, Energy Community 2022, https://www.energy-community.org/dam/jcr:f0c98e19-9500-4b08-981e-c41a1d7827fe/IR2022_North_Macedonia.pdf

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Long term energy strategy: Just Transition Program

PM_D16: Program for just transition		
Main objective: Developing programs for socially responsible and just transition **Description:** Depending on selected level of transition from conventional energy, it is important to develop programs for socially responsible and just transition to mitigate negative effects of associated job losses. Such programs should provide an answer how to redeploy employees to other jobs and stimulate new job opportunities by investing in low carbon technologies and services.		
Timeframe		2020– 2030
Type		Regulatory
Sector		Energy
Relevant planning documents, legal and regulatory acts		• Strategy for Energy Development of the Republic of Macedonia up to 2040 • Law on Energy • Documents from project which are working in this area
Assumptions		Oslomej is decommissioned in 2021 Bitola is decommissioned in the period 2025-2027
Status of implementation		• EBRD project of just transition in Oslomej region • NGO project of just transition in Oslomej region • 100 MW PV power plant in Oslomej • 20 MW PV power plant in Oslomej • 20 MW PV power plant in Bitola
Finance	Budget	n/a
	Source of finance	n/a
Implementing entity		• Government of the Republic of North Macedonia • Ministry of Economy • JSC Macedonian Power Plants (ESM AD) • Ministry of labor and social policy
Monitoring entity		• Ministry of Economy
Progress indicators		Program adopted and project realized
Relation with other dimensions		Research, innovation and competitiveness (research)

- NECP:
- Energy sector – 66% (6,321 Gg CO2-eq) GHG emission reduction (mainly through decommissioning of coal fired TPP Oslomej in 2021 and TPP Bitola up to 2027)

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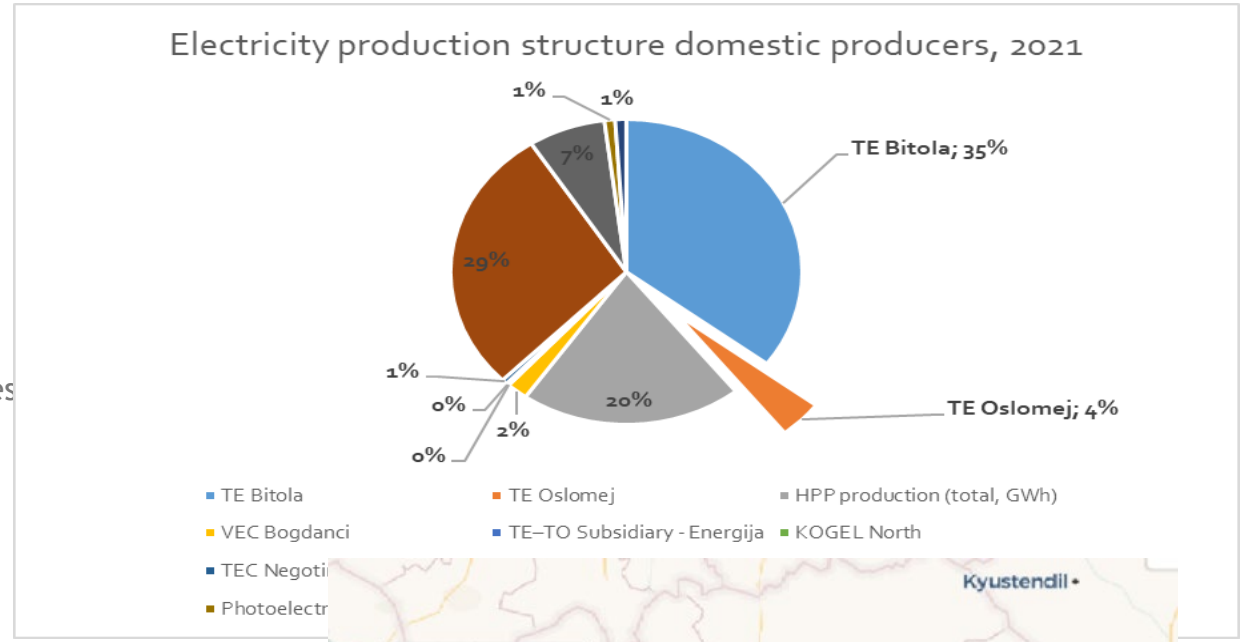
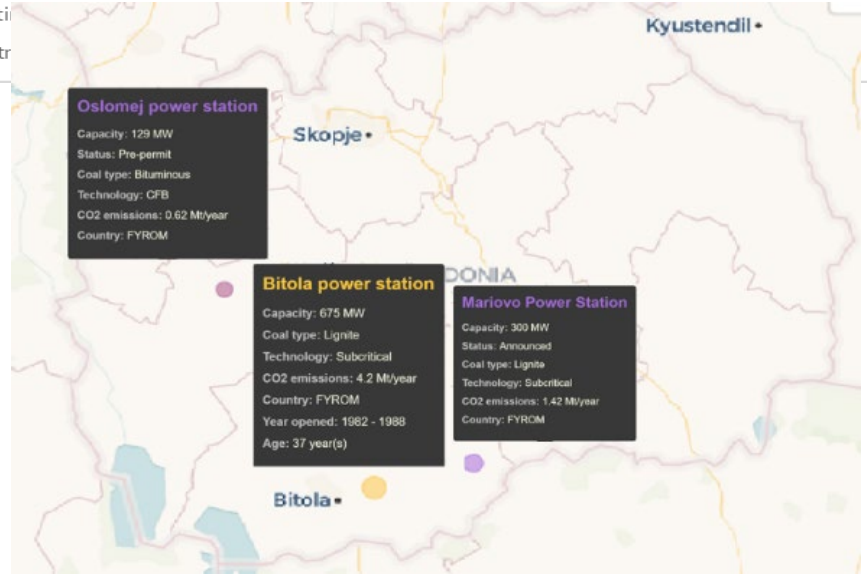
Case of Decarbonization – decommissioning?

- TPP Oslomej is 2nd in installed power in RNM
  - In the past participated with roughly 10% in the total domes generation of electricity
  - currently contributes with 4%.
- 2022 trial production of the PVPS Oslomej 1, with announcement for another identical plot and capacity/ projects were announced as an initiation of the energy transition in the region.
- pollution data Oslomej's contribution is 3,378 tonnes of SO2, which is 80 % plant's individual ceiling. This is almost twice as much as in previous years and is a result of the extended operating hours of the plant during the energy crisis/the polluter is exceed the limits for dust emission.
- Opposite of the taken policy obligations, towards plant closures (as per the Energy Strategy 2020-2040), actions for **extension of the lifetime of the coal plants** with the opening of new open-cast lignite mines
- These new developments were explained as a need arising from the energy crisis;





North Macedonia (2021)

SO_2 ceiling	SO_2 emissions	Dust ceiling	Dust emissions	NO_x ceiling	NO_x emissions
15,855	82,884	1,738	2,976	11,255	3,789

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What is the ‘best’ just scenario?

Table 7 Financial NPV – Scenario 0

MKD	*Scenario 0: Closure of TPP*						
				2023	*2024*	*2025*	*2026*	*2027*
I.	Financial Analysis			0	1	2	3	4
REVENUES	Total Revenues (7,06% of ESM Operating Revenues)			2,404,279,894	2,404,279,894	2,404,279,894	2,404,279,894	2,404,279,894
	Reported Price (unit price for surplus in 2022 for kWh)	*MKD/ kWh*		2.9116	2.9116	2.9116	2.9116	2.9116
	Reported Electricity production (average 2 consecutive years)	*GWh*		233	233	233	233	233
EXPENSES								
	New investments			-	-	-	-	-
	Total Expenses			1,665,216,502	1,665,216,502	1,665,216,502	1,665,216,502	1,665,216,502
DIFFERENCE								
	Net Profit (Cash Flow)			158,877,463	158,877,463	158,877,463	158,877,463	158,877,463
NPV			707,294,239					

- Electricity generation companies that operate coal-fired power plants must carefully make and execute the decommissioning decision to ensure **more** than just financial prudence. Typically, the financial decisions are the easy part. The people side of the process require a more thoughtful approach

- The human element of retiring an older coal plant requires careful consideration and execution to ensure that:
  - employees are treated fairly;
  - stakeholder concerns are considered;
  - regulators are provided adequate notice;
  - etc.

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CBA as a valuation method

- CBA compares net social benefits of investing resources in a particular project with net benefits of a hypothetical project which would be displaced if the project under evaluation is to proceed. Usually the counterfactual is the status quo – no change in government policy (sometimes the status quo is not a viable alternative)
- Cost benefit analysis (CBA) is widely used for quantifying the effect of proposed policies to initiate a meaningful debate in respect of designing crucial public policies (Dietz and Hepburn, 2013; Arrow et al., 1996….).

- ***CBA essentially entails summing up the costs and benefits of each of the policy alternatives over a lifespan and converting these into present value (PV) estimates using Discounting cash flow (DCF) techniques*** (Noel and McCormack, 2014).
- By identifying net benefits (Gross benefits-costs) in present value (PV) terms, CBA supports the introduction of ***one policy alternative over the other.***

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Steps is CBA

1. Specify set of alternative projects
2. Decide whose benefits and costs count (whose perspective? e.g.. local, regional?)
3. Catalogue the impacts and select measurement indicators (units)
4. Predict the impacts quantitatively over the life of the project

   (predictive accuracy?; prediction is especially difficult when projects are unique, over long time horizons, among complex variables… under and overestimation a reality)
5. Monetize (attach $ values to) all impacts
6. Discount benefits and costs to obtain present values (PV)
7. Compute the net present values (NPV) of each alternative
8. Perform sensitivity analysis (uncertainty)
9. Make recommendation (not decisions) based on the NPV and sensitivity analysis

CBA does not always succeed!

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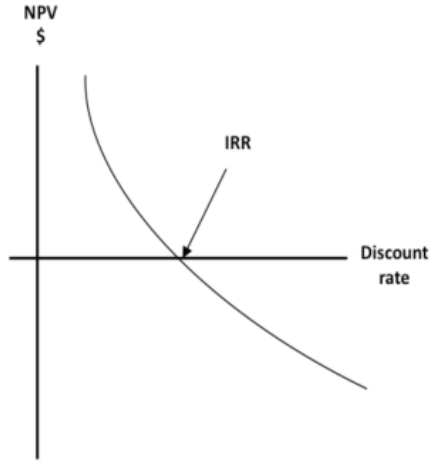
CBA

$$NPV = \sum_{t=0}^{n} \frac{Rt}{(1+i)^t}$$

Rt=Net cash inflow-outflows during a single period, t
i=Discount rate or return that could be earned in alternative investments
t=Number of timer periods

- What are the costs and benefits for the decarbonization on a regional/territorial aspects?

- The **financial aspects** are primary private sector indicators: profitability. In capital budgeting, there are a number of different approaches that can be used to evaluate a project. Two very common methodologies of evaluating a project are the internal rate of return and net present value. Each approach has its own distinct advantages and disadvantages.



(1) NPV – net present value calculated by estimating future cash flows for a given project, discounted to present value using a discount rate

(2) IRR - internal rate of return estimates profitability of potential investments using a % value rather than a dollar amount

(3) Other (Benefit/Cost indicator…)

$$IRR = r_a + \frac{NPV_a}{NPV_a - NPV_b}(r_b - r_a)$$

r_a = lower discount rate chosen
r_b = higher discount rate chosen
N_a = NPV at r_a
N_b = NPV at r_b

- **What about the social profitability?**
  - **Socio economic costs and benefits come to play**

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Decommissioning & being just?

COSTS

- ***Financial costs***: pre-decommissioning, shut down, dismantling, waste, site security, restoration… (closure costs)
- ***Carbon pricing?***
- ***Energy independency*** – cost of electricity
- ***Social costs - job loss***
  - Direct & Indirect
- ***Health costs***
- ***Environmental costs***
  - GHG, SO_2
- ***Cultural degradation***

BENEFITS

- ***Financial benefits - Revenues*** – electricity, and salvage and srap
- ***Energy diversification*** – green sources – repurposing
  - ***JUST transition…***
- ***Social benefits - job substitution***
  - Direct & Indirect
  - Renewable energy employment may replace coal employment Health savings
- ***Health and Environmental Justice***
- ***Health Impact***
- ***Environmental Impact***
  - GHG reduction, SO_2 reduction
- ***Cultural savings***

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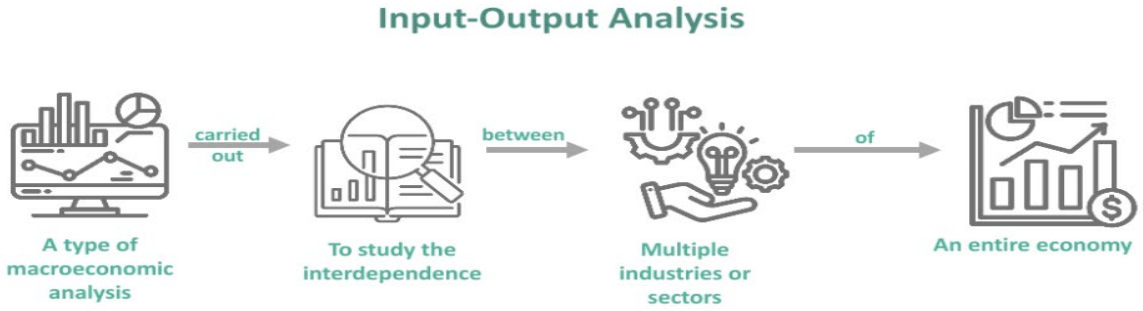
Assess economic impact through economic interlinkages

- Input-output analysis (I-O) is a form of macroeconomic analysis based on the interdependencies between different economic sectors or industries.
- Foundations are the Input-output tables: rows and columns of data that **quantify the supply chain** for all of the sectors of an economy.
- Three types of impacts in the I-O analysis:
  - direct impact,
  - indirect impact, and
  - induced impact.



- These impacts on the economy are determined by input levels changes.

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Understanding Input-Output Analysis

- The foundation of I-O analysis involves input-output tables IOTs
  - Industries headers of each row and each column.
  - The data in each column corresponds to the level of inputs used in that industry's production function.

- **Input-Output Tables (IOTs)** describe the sale and purchase relationships between producers and consumers within an economy
- *Input-output tables depict the link between producers and consumers in an economy regarding sales and purchases - data from different industries throws insight into the inter-industry relationship.*

- The OECD *harmonized* national Input-Output Tables
  - integration with collections of statistics compiled according to industrial activity such as R&D expenditure, employment, foreign direct investment and **energy consumption.**

Figure 1. Format of OECD harmonised national Input-Output Tables

Figure 1.1. Total table

	Symmetric *industry-by-industry* I-O table	Intermediate demand			Final expenditure					Output (bp)
		Industry 1	...	Industry 45	Domestic demand	Exports (cross border)	Direct purchases by non-residents	Imports (cross border)	Direct purchases abroad	
1	Industry 1 (total, bp)									
..	...									
45	Industry 45 (total, bp)									
91	Taxes *less* subsidies in intermediate and final imported products									
92	Taxes *less* subsidies on intermediate and final products paid in the domestic territory									
93	Total intermediate / final expenditure (pu)	Sum of (1:92)	..	..						
94	Value-added (bp)									
95	Output (bp)									

GDP (expenditure approach)
GDP (output approach)
pu: purchasers' prices
bp: basic prices

https://www.oecd.org/sti/ind/input-outputtables.htm

https://stats.oecd.org/Index.aspx?DataSetCode=IOTS_2021

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What abut the regional/localized impact?

- Input - Output modelling is an analytical framework in applied regional research when there are potential changes in a regional economy.

- The primary reason for usage of Input–Output models (I-O) over alternative approaches is in cases when there are **no time-series datasets available.**
  - I-O models are characterized by consistency and can give a blueprint of the regional economy and its potential changes.
  - I-O models are used to estimate changes in a regional economy following an exogenous "disruption" and estimate effects of the exogenous change on the local economy, through regional multipliers, which in turn will be used to calculate the regional effects.
  - The following steps were taken to calculate regional multipliers then used in the scenario assessments.

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Technical Regional Coefficients and Multipliers

- The Regional Technical Coefficients estimated is the matrix A for SWPR, for both Value Added, and Employment. Then the Regional Multipliers L were estimated and both used in the design of the different scenarios.
- Regional Multipliers

Gross Value added		B, C, D, E			
A Agriculture, forestry, fishing	1.099	0.054	0.025	0.021	
B, C, D, E Mining and quarrying; processing industry; Supply with electricity, gas, steam and climatization	0.378	2.043	0.944	0.470	
F Construction	0.050	0.024	1.083	0.026	
G, H, I Wholesale and retail trade; Transport and storage; Facilities for accommodation and food related services	0.025	0.082	0.060	1.235	
J Information and communications	0.001	0.004	0.003	0.007	
K Financial service and insurance	0.006	0.018	0.019	0.044	

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Scenarios for comparison

- **Scenario 0 – Closure of TPP Oslomej by 2027 "As Is - business as usual" - baseline scenario** – this is about not doing any preparatory or any activities whatsoever Oslomej functions up until 2027, non-compensation for the jobs lost and the value added expected to be lost with the closure;
-
- **Scenario 1 – Decommissioning according to standards and technical activities -** Closure in accordance with standards and relevant technical activities – decommissioning with remediation, environmental abatement, demolition, and closure of TPP Oslomej, without just transition measures for mitigation of economic, social and environmental impact in the SWPR.
-
- **Scenario 2 - Decommissioning with just transition via substitution of energy production with RES / PV** and labour transitioning - alternative economic activities in primary, secondary and tertiary sector in the region as a substitute for the added value and direct employments in the electricity supply sector for the persons already working in Oslomej.

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Focus of Scenario 0 – Baseline

- **Scenario 0 - Closure of TPP Oslomej by 2025 "As Is - business as usual" - baseline scenario -** this is about not doing any preparatory or any activities whatsoever Oslomej functions up until 2025, or 2027 non-compensation for the jobs lost and the value added expected to be lost with the closure;

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- **Scenario 0 - Closure of TPP Oslomej by 2025 "As Is - busine as usual",** assumes that the TPP Oslome will be closed down without any preparatory or activities that compensate for job substitution or other transition activities t reduce the effects o both the regional economy as well as for labour market.

Scenario o: "As is -Business as usual"

No. Employees in TPP Oslomej - 2020	#
Permanent Employment	965
Total FTE	**965**

Total FTE in the sector 2021 SWPR	#
B - Mining and quarrying	2,850
C - Manufacturing	10,442
D - Electricity, gas, steam and air conditioning supply	785
E - Water supply; sewerage, waste management and remediation activities	3,072
Participation of TPP Oslomej in B & D	**27%**
Participation of TPP Oslomej in B, C, D, E	**6%**

GDP SWPR - 2021	*mill MKD*
B,C,D,E Mining and quarrying; processing industry; Supply with electricity, gas, steam and acclimatization	8,367.00
GVA per FTE (mill MKD)	0.49
Assessed Contribution of TPP Oslomej in GVA of SWPR (annually)	***470.82***

Table 4 Total Jobs and Regional Value Added in Scenario o

Sectors	FTE		GVA Region	
	Direct effect	Indirect effect (multipliers)	Direct effect	Indirect effect (multipliers)
A Agriculture, forestry and fishing		-52.6		-25.6
B, E Mining, manufacturing, electricity, gas and water supply, sewerage, waste management, remediation activities*	-965.0	-1,006.2	-470.8	-490.9
F Construction		-23.1		-11.3
G, I Wholesale and retail trade, repair of motor vehicles and motorcycles, transportation and storage; accommodation and food service activities		-79.1		-38.6
J Information and communication		-3.5		-1.7
K Financial and insurance activities		-17.3		-8.5
L Real estate activities		-7.3		-3.6
M, N Professional, scientific and technical activities; administrative and support service activities		-18.2		-8.9
O, Q Public administration and defence; compulsory social security; education; human health and social work activities		-18.5		-9.0
RSTU Arts, entertainment and recreation, repair of household good and other services		-7.5		-3.7
Total	***-965.0***	***-1233.2***	***-470.8***	***-601.7***

Scenario o:	*"As is -Business as usual"*
Input Output - Regional GVA Direct effect (mill MKD)	-470.82
Input Output - Regional GVA Direct + Indirect effect (mill MKD)	-1,072.51
Input Output – Regional FTE direct effect (# of jobs)	-965.00
Input Output – Regional FTE Direct + Indirect effect (# of jobs)	-2,198.22

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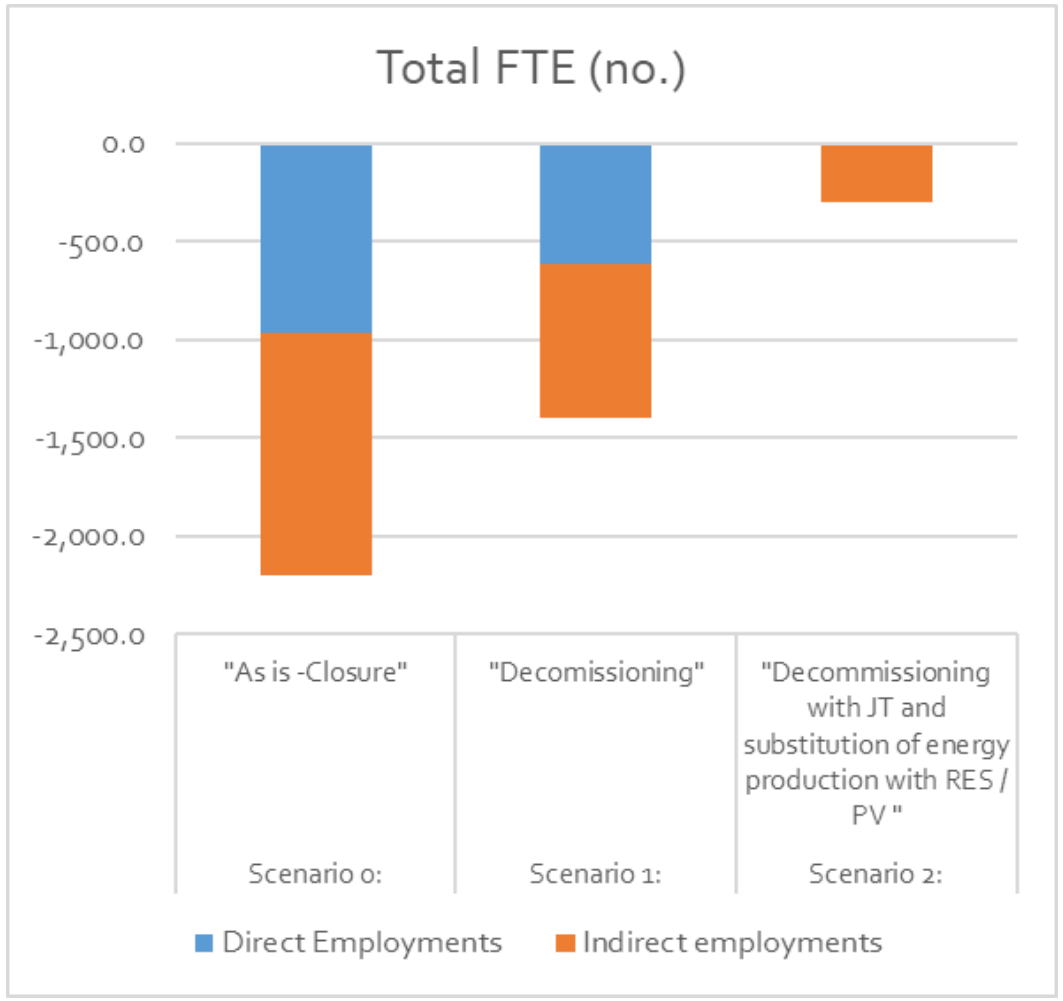

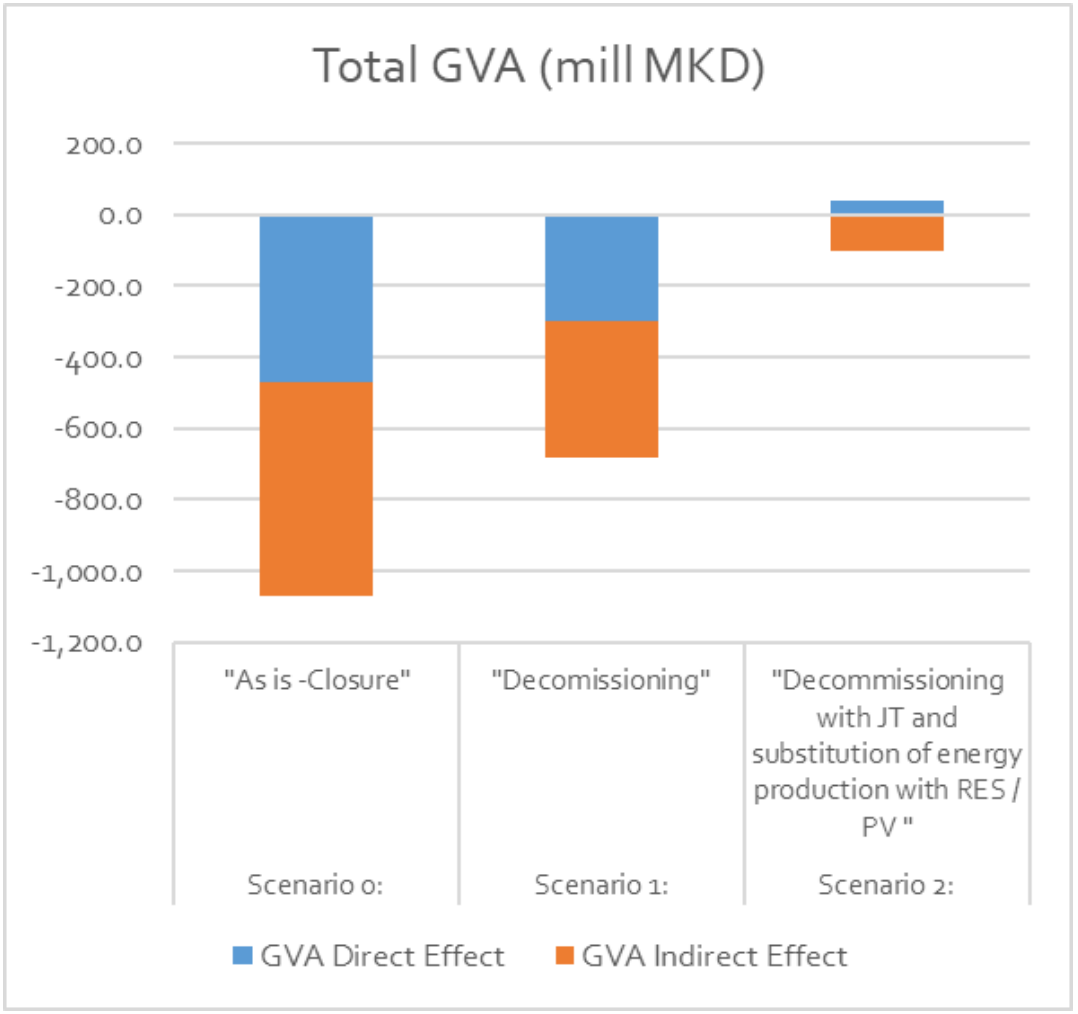

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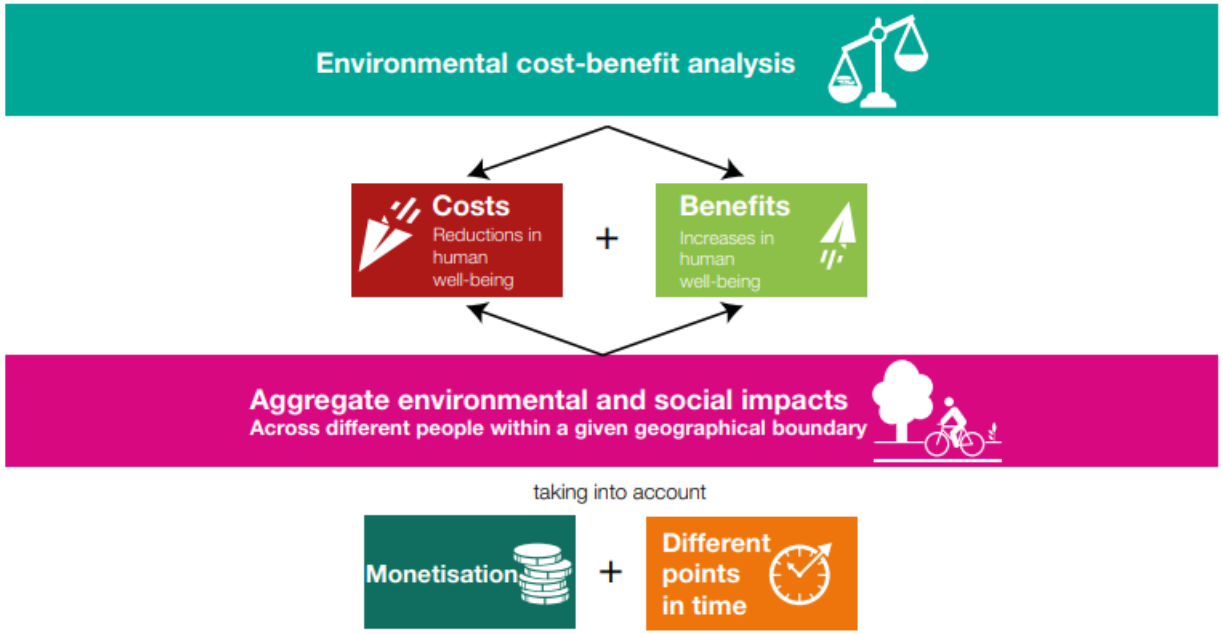
CBA – extension of the valuation technique in ecosystems

- Costs
- Benefits



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Decommissioning & being just?

COSTS

- ***Financial costs***: pre-decommissioning, shut down, dismantling, waste, site security, restoration… (closure costs)
- ***Carbon pricing***
- ***Energy independency*** – cost of electricity
- ***Social costs – job loss***
  - Direct & Indirect
- ***Health costs***
- ***Environmental costs***
  - GHG, SO_2
- ***Cultural degradation***

BENEFITS

- ***Financial benefits – Revenues*** – electricity, and salvage and srap
- ***Energy diversification*** – green sources – repurposing
- ***JUST transition***
- ***Social benefits – job substitution***
  - Direct & Indirect
  - Renewable energy employment may replace coal employment Health savings
- ***Health and Environmental Justice***
- ***Health Impact***
- ***Environmental Impact***
  - GHG reduction, SO_2 reduction
- ***Cultural savings***

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Social Costs and Benefits (savings): Jobs loss vs Substitution of professions

- Contribution to the ***economy*** (GVA : regional, local, national…) - LOSS
  - Measured through economic output
  - How? Made estimates with the I/O
    - Direct (~1,000 from the TPP)
    - Indirect (~1,200 from inter-industry linkages)

- **Social transfers** due to unemployment
  - National/Regional/Local programs and support aid, unemployment benefits (state social system due to additional unemployed in the case of ceasing of the operations of the TPP and consider them as costs) – unemployment allowance

- On the contrary as there is a substitution of the labor and reentering on the labor market the benefits as the costs will reduce and the ***savings will generate benefits*** which are monetized under the same assumptions
  - The benefits form of savings will start generating from Y5 i.e. immediately after the closure of the plant. As in the cost section also the benefit section considers both direct and indirect FTE effects.

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Health Costs/Pollution Costs

- **Pollution Costs affecting Human Life**
- The quantified economic effects of pollution on human life terms is difficult to be measured however for the purposes of estimating this cost a study for North Macedonia's thermal plants which are coal fueled consider several methods that have been widely accepted.
- For instance, Health risks of air pollution in Europe - HRAPIE where it is calculated that all thermal power plants cost us 17 human lives per year, with a monetary value between 20 and 22.35 million EUR.
- For simplification of the costs we base the estimated costs of human life on the HRAPIE method, as calculation of the costs per annum per GWh produced and the contribution of TPP Oslomej is estimated.
  - As long as the plant operates these will be costs
  - Once the plant is decommissioned these are benefits in the form of savings

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- Others have calculated higher costs….
- The Unpaid Health Bill – How coal power plants in Western Balkans make us sick (Mike Holland) estimated based on the emissions of the coal plants in the WB, these are amounting between 2.9-8.6 bill EUR annually
  - health costs that include lost productivity, burden on health care system, lost utility of individuals suffering ill health or dying early
  - for RNM is estimated from 265-720 mil eur which from TPP Oslomej given the contribution to production at the time of the estimates can be estimated to a larger scale ranging between 3.2 to 8.6 mil EUR per annum*

*our estimate 1.5 mil EUR per annum

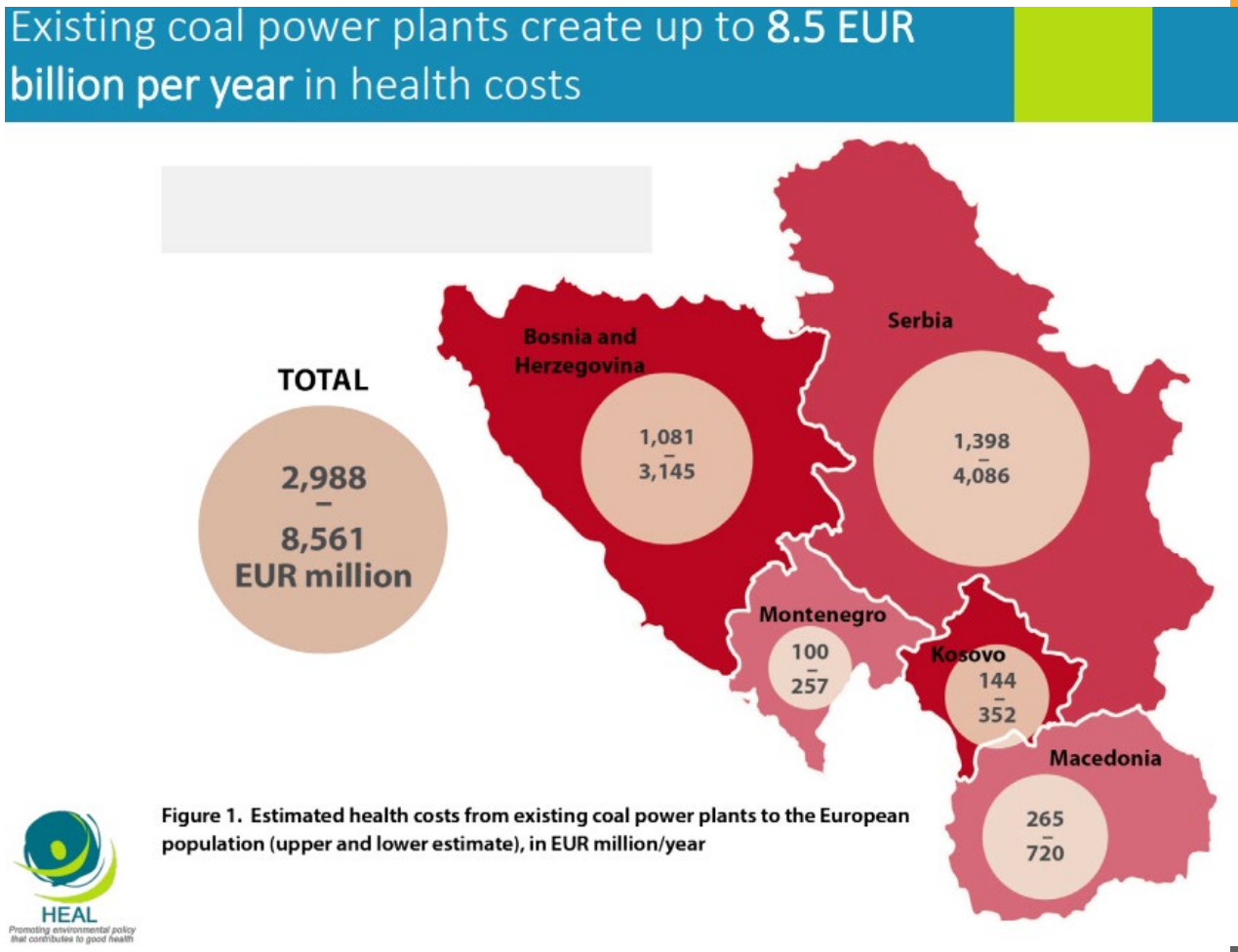

Figure 1. Estimated health costs from existing coal power plants to the European population (upper and lower estimate), in EUR million/year

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Policy recommendations are clear and evident?

- Support the rapid phase out of coal: Close all old coal-fired plants and do not build new ones
- Take into account health protection and opt for renewables and energy savings
- Fulfil the obligations and fully implement standards agreed in international treaties (such as Energy Community, Kyoto protocol, Paris Treaty 2015…)

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Thank you

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