P r o i e c t

GUVERNUL REPUBLICII MOLDOVA

H O T Ă R Î R E nr. _____
din _____________________ 2021

Chişinău

cu privire la aprobarea limitelor de capacitate, cotelor maxime și categoriilor de capacitate în domeniul energiei electrice din surse regenerabile pînă în anul 2025

În temeiul art.10 lit. e) al Legii Nr.10/2016 privind promovarea utilizării energiei din surse regenerabile *(Monitorul Oficial al Republicii Molova, 2016, nr. 69-77, art. 117)*, cu modificările ulterioare, Guvernul HOTĂRĂŞTE:

1. Se aprobă, conform anexei, limitele de capacitate, cotele maxime și categoriile de capacitate în domeniul energiei electrice din surse regenerabile valabile pînă la data de 31 decembrie 2025 în vederea aplicării schemelor de sprijin prevăzute la art. 34 din Legea nr.10/2016 privind promovarea utilizării energiei din surse regenerabile.
2. Monitorizarea prezentei hotărîri se pune în sarcina Ministerului Economiei și Infrastructurii.
3. Prezenta hotărîre intră în vigoare la data publicării în Monitorul Oficial al Republicii Moldova.

Prim-ministru interimar **Aureliu CIOCOI**

Coordonat:

Secretar de stat al Ministerului Economiei şi Infrastructurii **Mihail LUPAȘCU**

Anexă
la Hotărîrea Guvernului nr.___
din ________________2021

<table>
<tr><th rowspan="2">Nr.</th><th rowspan="2">Tehnologia
de producere
a energiei electrice</th><th>Categorii de capacitate</th><th colspan="3">Cotele maxime de capacitate pentru tipurile de instalații de generare considerate, MW</th><th rowspan="2">Limita de capacitate, [MW]*</th></tr>
<tr><th>[MW]</th><th>TOTAL [MW]</th><th>Surse la Tarif fix</th><th>Surse la Preț fix</th></tr>
<tr><td colspan="7">Categoria I. Surse intermitente</td></tr>
<tr><td>1.</td><td>Instalații EOLIENE</td><td>< 4</td><td>105</td><td>25</td><td>80</td><td>4,0</td></tr>
<tr><td>2.</td><td>Instalații SOLARE PV (fotovoltaice), total:
dintre care:</td><td>---</td><td>145</td><td>75</td><td>70</td><td>---</td></tr>
<tr><td rowspan="3">2.1.</td><td rowspan="3">- instalații PV montate pe acoperișurile obiectivelor industriale și agricole, inclusiv ale sectorului terțiar (servicii)</td><td>< 0,05</td><td rowspan="7"></td><td rowspan="3">20</td><td rowspan="7">---</td><td rowspan="7">1,0</td></tr>
<tr><td>0,051 – 0,2</td></tr>
<tr><td>0,201-1,0</td></tr>
<tr><td rowspan="3">2.2.</td><td rowspan="3">- instalații PV montate pe acoperișurile construcțiilor aferente sectorului rezidențial și public</td><td>< 0,05</td><td rowspan="3">10</td></tr>
<tr><td>0,051 – 0,2</td></tr>
<tr><td>0,201-1,0</td></tr>
<tr><td>2.3.</td><td>- instalații PV, altele decât cele de la pct. 2.1. și 2.2.</td><td>< 1,0</td><td>45</td></tr>
<tr><td colspan="2">sub-TOTAL</td><td></td><td>250</td><td>100</td><td>150</td><td>---</td></tr>
<tr><td colspan="7">Categoria II. Surse non-intermitente</td></tr>
<tr><td>3.</td><td>Instalații de COGENERARE pe bază de biogaz, total:
dintre care:</td><td>---</td><td>150</td><td>150</td><td>---</td><td>---</td></tr>
<tr><td>3.1.</td><td>- unități în cogenerare pe bază de biogaz (produs prin valorificarea potențialului energetic al dejecțiilor animaliere, deșeurilor zootehnice, deșeuri agricole, culturi agricole, plante energetice, deșeuri ale industriei alimentare, etc., inclusiv amestecul dintre acestea)</td><td>---</td><td rowspan="2"></td><td>50</td><td rowspan="2">-</td><td>---</td></tr>
<tr><td>3.2.</td><td>- unități în cogenerare pe bază de biogaz produs prin valorificarea deșeurilor municipale solide</td><td>---</td><td>50</td><td>---</td></tr>
</table>

3.3.	- unități în cogenerare pe bază de biogaz produs prin valorificarea deșeurilor municipale lichide /ape reziduale/	---		*50*		---
4.	Instalații de COGENERARE pe bază de singaz (pe biocombustibil solid, deșeuri agricole, inclusiv culturi/plante energetice)	---	15	15	-	---
5.	Instalații de COGENERARE utilizând arderea directă (pe biocombustibil solid, deșeuri agricole, inclusiv culturi/ plante energetice, deșeuri menajere solide)	---	30	30	-	---
6.	Instalații HIDRO	---	5	5	-	1,0
sub-TOTAL		---	200	200	-	---
TOTAL		---	**450**	**300**	**150**	---

Notă:

1. *Limită de capacitate* – noțiune definită în art.3 al Legii nr.10/2016 privind promovarea utilizării energiei din surse regenerabile
2. *Biocombustibil solid* – noțiune definită în conformitate cu prevederile Hotărârii Guvernului Nr. 1070/ 2013 pentru aprobarea Regulamentului cu privire la biocombustibilul solid.

Jan. 11, 2021

ANTARES model for year 2025 and scenarios results

1. Model input data and assumptions

1.1. Prices

Except for gas where a value of 9.32 €/GJ (from TIMES results) is used, all necessary prices used correspond to the 2025, BE (Best Estimate) scenario of ENTSO-E TYNDP2020, shown in the following Table:

Table 1: Fuel prices in ENTSO-E TYNDP 2020 scenarios[1]

		2020	2021	2023	2025		2030			2040		
					BE	G2C	NT	DE	GA	NT	DE	GA
	Nuclear	0.47	0.47	0.47	0.47		0.47			0.47		
	Lignite	1.1	1.1	1.1	1.1		1.1			1.1		
	Oil shale	2.3	2.3	2.3	2.3		2.3			2.3		
€/GJ	Hard Coal	3.0	3.12	3.4	3.79		4.3			6.91		
	Natural Gas	5.6	5.8	6.1	6.46		6.91			7.31		
	Light Oil	12.9	14.1	16.4	18.8		20.5			22.2		
	Heavy Oil	10.6	11.1	12.2	13.3		14.6			17.2		
€/tCO_2	CO_2 price	19.7	20.4	21.7	23	56	27	53	35	75	100	80

1.2. Load

Annual electricity demand for year 2025 is as follows:

- Right Bank: 4.53 TWh
- Left Bank: 1.89 TWh

Therefore, the total electricity demand of Moldova is 6.42 TWh.

The timeseries of year 2019 have been used in the ANTARES model, scaled for the corresponding annual demand.

[1] ENTSO-E // ENTSOG TYNDP 2020 Scenario Report, June 2020.

1.3. Generation in Right Bank

All generation in the Right Bank is non-dispatchable. Non-dispatchable generation is supplied as input (predefined timeseries) in ANTARES with zero cost. For CHP, this means that fuel cost (and emissions) is assigned to heat generation, while its electricity generation is considered with zero variable cost.

1.3.1. Non-dispatchable thermal generation

- CHP 2: generation timeseries provided (Max = 218 MW, Min = 0 MW)
- CHP North: generation timeseries provided (Max = 30 MW, Min = 0 MW)
- CHP of sugar factories (autoproducers): generation timeseries provided (MAX = 23 MW, Min = 0 MW)
- New gas CHP of 13.4 MW installed capacity:
  - C.F. = 70% in winter
  - C.F. = 50% in summer
- New gas CHP of 55 MW installed capacity:
  - C.F. = 90% in winter
  - C.F. = 80% in summer

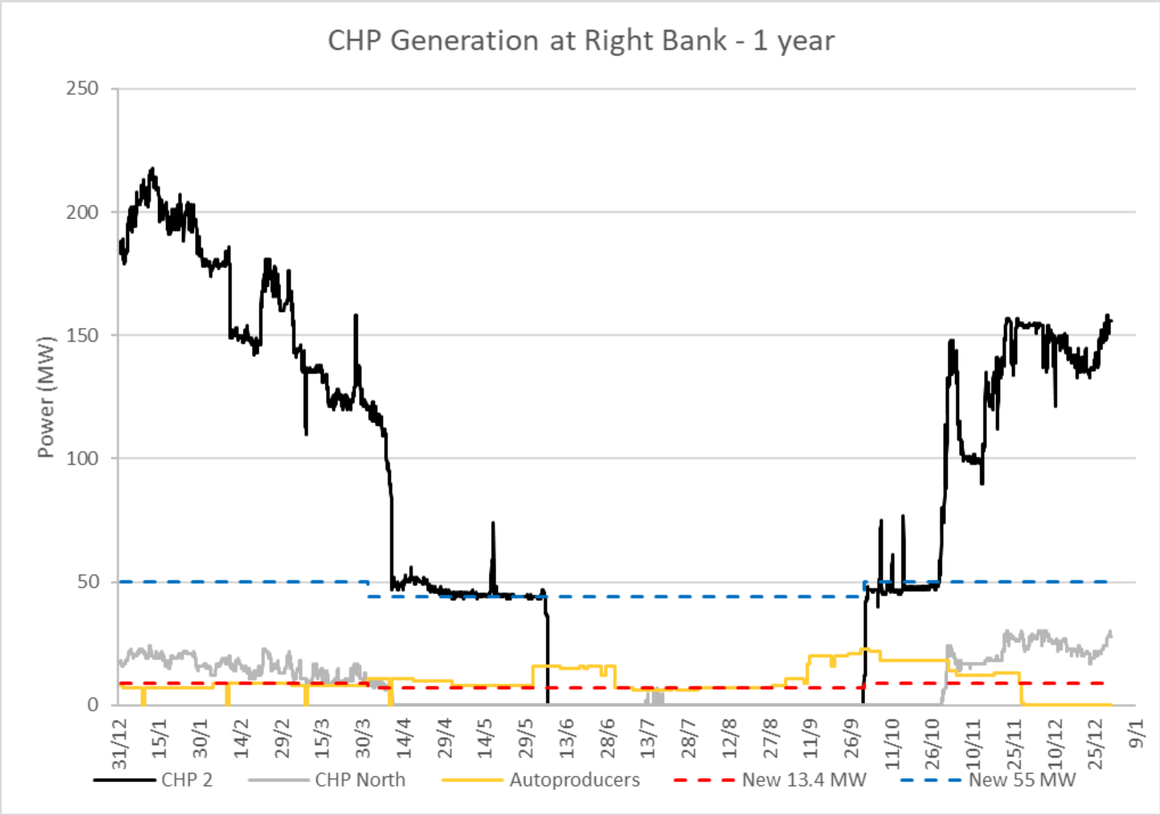

Fig. 1. Hourly thermal generation timeseries in Right Bank

1.3.2. Non-dispatchable RES generation

- Biogas new generation (200.64 MW capacity):
  - Annual Capacity factor = 45%
  - 50% constant generation
  - 50% same timeseries with sugar factories
- Variable RES in Right Bank:
  - Solar-PV: 203 MW capacity with provided hourly C.F. timeseries, adjusted for annual C.F.=13%
  - Wind: 161 MW capacity, with provided hourly C.F. (annual C.F. = 24%)
- Hydro: 21.6 MW capacity with fixed timeseries of annual C.F.=32.3% ("Run-of-River" hydro)

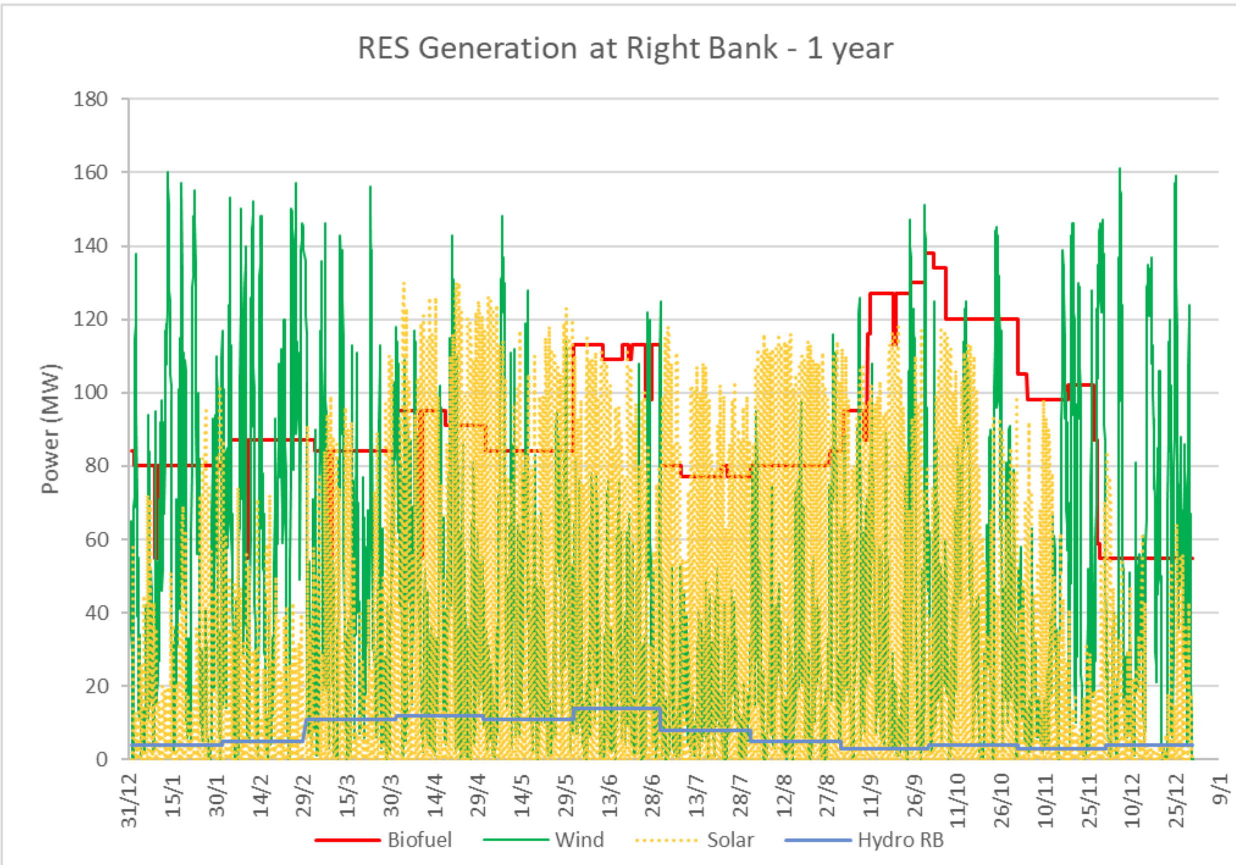

Fig. 2. Hourly RES generation timeseries in Right Bank

1.4. Generation in Left Bank

The only RES generation is hydro (non-dispatchable): 48 MW capacity with predefined timeseries of annual C.F. = 54.2% ("Run-of-River" hydro).

The MGRES power plant is modeled with the following dispatchable gas-fired units:

Table 2: Parameters of MGRES unis

Name	N. of units	Fuel	Type	Standard efficiency	Min Time on	Min Time off	Start-up fuel consumption	Start-up fix cost	CO_2 emissions	Unit Capacity	Min. Generation
				%	hours	hours	Net GJ /MW. start	€ /MW. start	Tons/MWh	MW	MW
MGRES G4, G5	2	Gas	conventional old 1	36%	5	5	7.6	68	0.570	110	110
MGRES G7, G8	2	Gas	conventional old 1	36%	5	5	7.6	68	0.570	200	80
MGRES G9, G10	2	Gas	conventional old 1	36%	5	5	7.6	68	0.570	210	80
MGRES G11, G12	2	Gas	CCGT old 1	40%	3	3	7.6	73	0.513	250	80

1.5. Neighbor Systems

Neighbor systems are modeled on technology level, i.e. not on a generator-by-generator basis.

1.5.1. Ukraine

The ANTARES model of Ukraine is based on publicly available data of ENTSO-E 2019 Mid-Term Adequacy Forecast and EBRD Report 3 (Modeling Report) of "Support to the Government of Ukraine on updating its Nationally Determined Contribution (NDC)". The most ambitious scenario of the latter has been considered (Fig. 3), according to which the total electricity production is 176 TWh. It is assumed that this equals Ukraine's electricity annual demand.

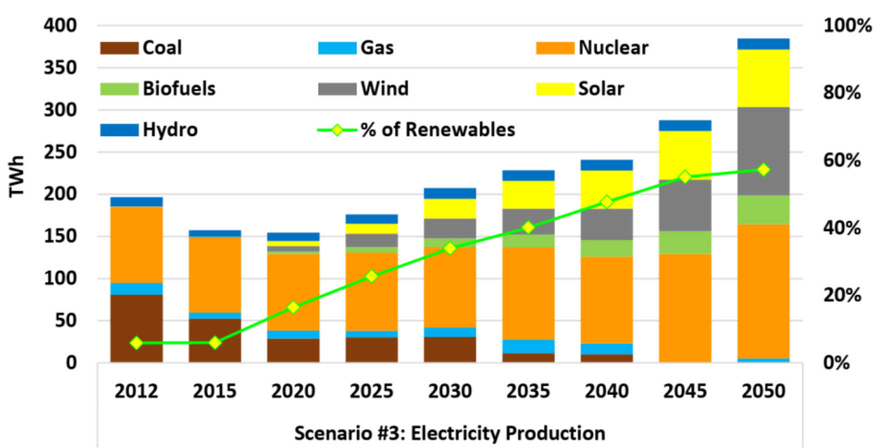

Fig. 3. Electricity Generation shares in Ukraine from NDC Modeling Report[2].

Assuming Ukraine in isolated operation, the annual shares of the ANTARES model are the following:

[2] EBRD, *Support to the government of Ukraine on updating its Nationally Determined Contribution (NDC), Report 3/Modeling Report*.

Table 3: Shares of 2025 Ukraine model (operating as electric island)

Technology	Nuclear	Coal	Wind	Solar	Hydro	Gas	Other RES & Waste
%	55,7%	14,1%	8,1%	7,6%	7,1%	3,4%	4%

1.5.2. Romania

The ANTARES model of Romania for the year 2025 is based on the following:

- Projected installed capacities from Romania NECP as shown in Fig. 4.

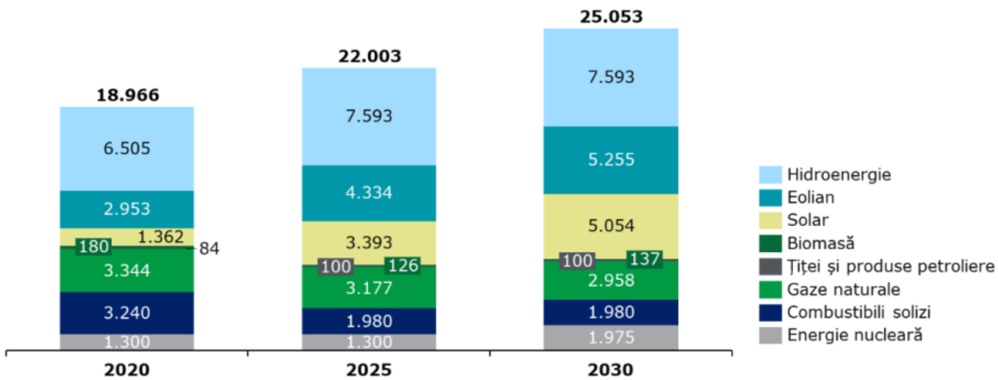

Fig. 4. Projected installed capacities in Romania NECP.

- Publicly available results of ENTSO-E TYNDP2020 for 2025, National Trends Scenario, and mainly:
    - Total annual electricity demand: 61 TWh
    - Total annual net exports to Bulgaria, Serbia and Hungary, which results to 14 TWh approximately.
- Generation data from ENTSO-E Transparency Platform for the year 2019
- Publicly available data of ENTSO-E 2019 Mid-Term Adequacy Forecast
- The Rest of South-East Europe (i.e. Bulgaria, Serbia, Hungary, etc.) is considered as a spot market, in which market price is insensitive to price fluctuations in Romania and are constrained with transmission capacity in energy exchange with Romania. The hourly annual time series of the Day-Ahead Market of the Hungarian Power Exchange is used as the market price (€/MWh) profile.

2. Scenarios and results

2.1. Base case

2.1.1. Assumptions

In the base case for year 2025, the power system model of Moldova in ANTARES is an electric island, i.e. **the available Net Transfer Capacity of 400 MW from/to Ukraine is set to zero**, and no interconnection with Romania is assumed.

We assume no NTC limit between the Right and the Left Bank. However, we have added a constraint that does not allow exports from the Right Bank to the Left Bank on an hourly basis, i.e. **every hour the generation of the Left Bank is equal to or higher than the Left Bank load**. Therefore, the Left Bank always exports to the Right Bank.

In order to account for spinning reserves, two MGRES units are forced to operate every hour. It is assumed that these are one of G9-G10 and one of G11-G12. In addition, the minimum generation of these two must-run thermal units is set higher than their technical minimum generation, in order to leave room also for downward reserves (also some RES power plants could provide downward reserves).

2.1.2. Results

First, indicative results of the one-year simulation results are shown in Fig. 5 and Fig. 6 for a sample day with average daily load (12.4 GWh in Right Bank).

Fig. 6 shows the generation in the Left Bank from MGRES and from hydro. As a result of the optimization algorithm (e.g. have enough capacity during peak-load hours), there are three MGRES units in-service in all 24 hours. Fig. 6 shows also the spinning reserves, which are calculated from the ANTARES results (post-processing) for every hour as follows:

Spinning Reserves = [Capacity of MGRES units in-service] – [generation of MGRES units]

Fig. 5 shows:

- The total generation and the load of the Left Bank. The Left Bank exports power to the Right Bank.
- The total generation of Moldova which is the sum of the total generation in the Left Bank plus the generation in the Right Bank (which is all non-dispatschable).
- The total load of Moldova.
- The overgeneration (“spilled energy”) which occurs when the total system generation is higher than the total system load

In the first hours of the day some overgeneration occurs as the total generation of the Moldovan system is higher than the system load. During these hours, the MGRES units produce their minimum generation which is 260 MW. The technical minimum of all three generators in service (G9, G11 and G12) is 3 x 80 = 240 MW. Another 20 MW come from the downward reserves constraints.

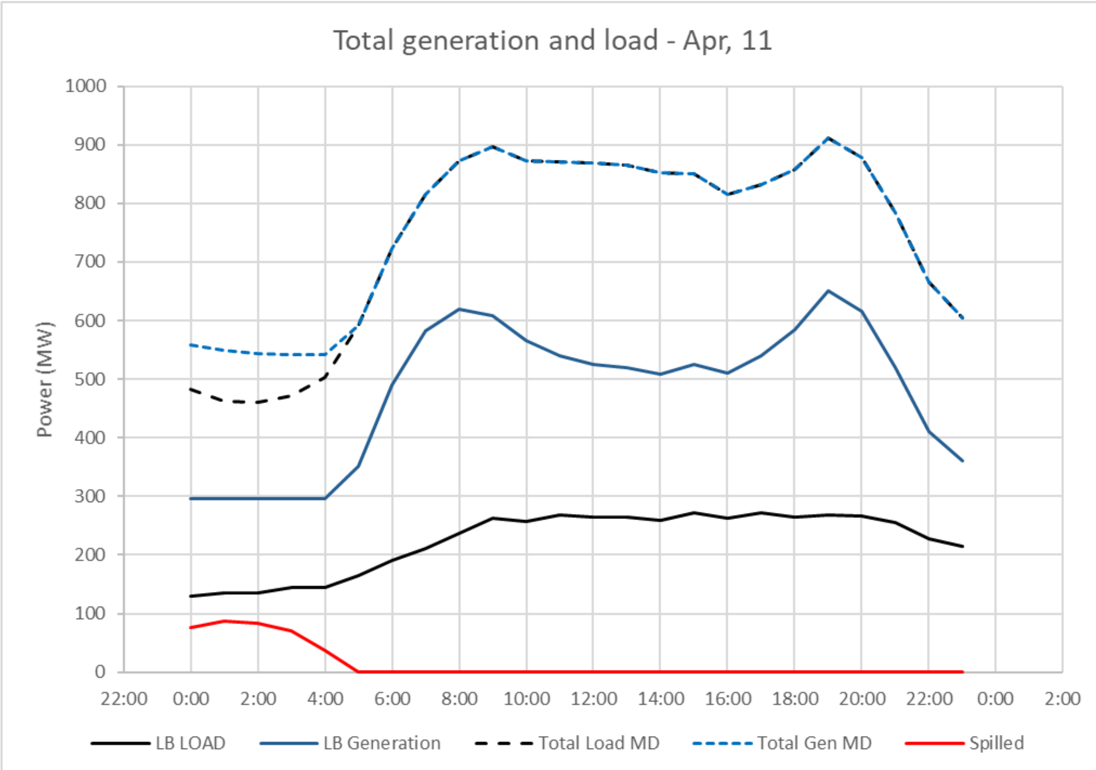

Fig. 5. Hourly results for one day with average daily load: Left Bank and total MD

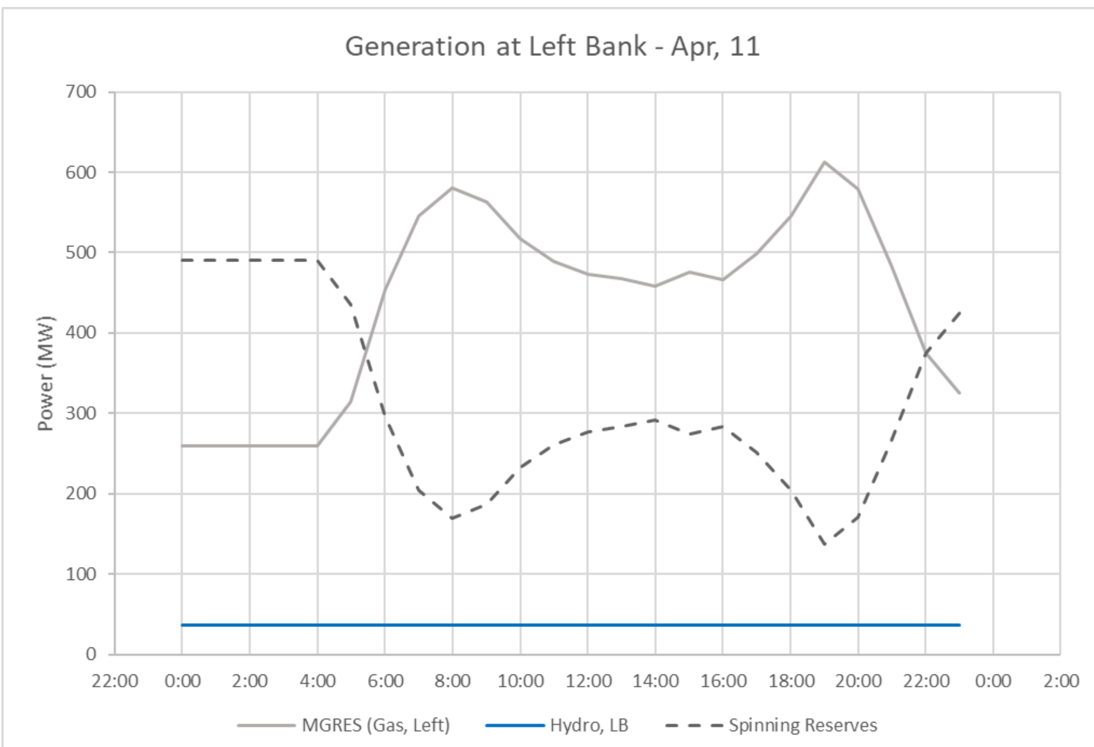

Fig. 6. Hourly results for one day with average daily load: Generation in Left Bank.

Fig. 7 shows the components of the generation in the Right Bank. As an example, the generation at 01:00 is:

- Biofuel: 95 MW
- Hydro: 12 MW
- Wind: 38 MW
- Gas (CHP): 109,

while there is no solar generation. At the same time, generation in the Left Bank is 36 MW of hydro and 260 MW from MGRES. Since the total load is 463 MW, the generation surplus is 87 MW.

Taking into account that wind generation is 38 MW and there are another 20 MW of downward reserves, there is another 29 MW of surplus that is not associated either directly or indirectly with the variable RES capacities (wind and solar). This illustrates that the overgeneration reported by the model at some hours is a result of the total system inflexibility. In practice, this relatively small energy surplus can be exported to Ukraine.

Fig. 7. Hourly results for one day with average daily load: Generation in Left Bank.

In order to evaluate if there are enough reserves, an indicative reserves index is calculated every hour from the ANTARES results, consisting of two components:

- Regulation reserves = 5% Load + 10% Wind + 5% Solar
- Contingency reserves = 50% of largest generator = 125 MW

It is assumed that the regulation component is divided equally to upward and downward reserves, while the contingency reserves are only relevant to upward reserves. The duration curve of the resulting reserves margin as calculated from the ANTARES results is shown in Fig. 8. It can be seen that the reserves are not higher only for a small fraction of the 1-year simulation duration (8760 hours).

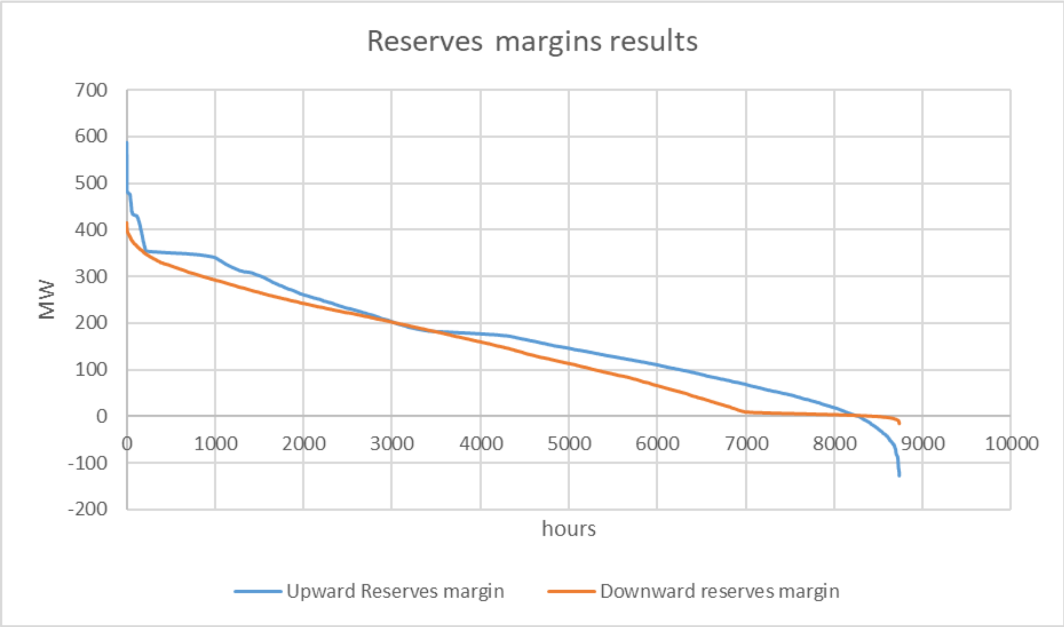

Fig. 8. Reserves margin duration curve.

Finally, Table 4 shows the annual results for this base case, where the Moldovan electricity system is assumed to operate as an electric island, i.e. there is no interconnection with Romania and the interconnection to Ukraine is not used. All the gas-based generation reported comes from the MGRES power plant and provides 54% of the total. Another 20% comes from CHP plants and 25% approximately comes from RES.

It can be concluded that the modeled generation mix is feasible, as the total spilled energy reported is relatively low (1.4% of the total generation or 3.3% of the total non-dispatschable generation in the Right Bank), even in this case of island operation.

Table 4: Annual results of base case (MD as electric island)

		Right	Left	MD, Total	MD, % Gen.
Gas	[GWh]		3502	3502	54.0%
CHP	[GWh]	1316		1316	20.3%
Biofuel	[GWh]	788	0	788	12.1%
Hydro	[GWh]	61	228	289	4.5%
Wind	[GWh]	363	0	363	5.6%
Solar	[GWh]	231	0	231	3.6%
Total Gen	[GWh]	2760	3730	6490	100.0%
Imports from RO	[GWh]			0	
Impors from UA	[GWh]			0	
Total Imports	[GWh]			0	
Spilled	[GWh]			92	1.41%
Demand	[GWh]	4514	1884	6398	
Total Imports [% of Demand]	[%]			0%	
CO2	[Mton]	0.00	1.86	1.86	
Op. Cost	[M€]	0	357	357	

2.2. Case 2: With interconnection to Romania

2.2.1. Assumptions

In this scenario for year 2025, **the available Net Transfer Capacity of 400 MW from/to Ukraine is set to zero** and **a Net Transfer Capacity of 600 MW from/to Romania is modeled**.

We assume no NTC limit between the Right and the Left Bank. However, we have added a constraint that does not allow exports from the Right Bank to the Left Bank on an hourly basis, i.e. **every hour the generation of the Left Bank is equal to or higher than the Left Bank load**. Therefore, the Left Bank always exports power.

As in the base case, two MGRES units are forced to operate every hour. These are one of G9-G10 and one of G11-G12. In addition, the minimum generation of these two must-run thermal units is set higher than their technical minimum generation, in order to leave room also for downward reserves (even though, RES power plants could provide downward reserve themselves).

2.2.2. Results

First, indicative results of the one-year simulation results are shown in Fig. 9 and Fig. 10 for a sample day with average daily load (12.4 GWh in Right Bank).

Fig. 10 shows the generation in the Left Bank from MGRES and from hydro, as well as the spinning reserves. As a result of the optimization algorithm, there are three MGRES units in-service in all 24 hours.

Fig. 9 shows:

- The total generation and the load of the Left Bank. The Left Bank only exports power.
- The total generation of Moldova which is the sum of the total generation in the Left Bank plus the non-dispatschable generation in the Right Bank.

- The total load of Moldova.
- The net imports of Moldova from Romania. In all 24 hours, the net imports are equal to the load of the Moldovan power system after subtracting the local generation.

No spilled energy occurs. The Moldovan system mostly imports energy during this day, but it also exports some energy to Romania. Looking also to Fig. 11, exports from Moldova to Romania occur during hours with high load in Romania and low non-dispatchable generation (in which solar power generation is very important).

The components of the generation in the Right Bank are shown in Fig. 7, as they are the same with the base case.

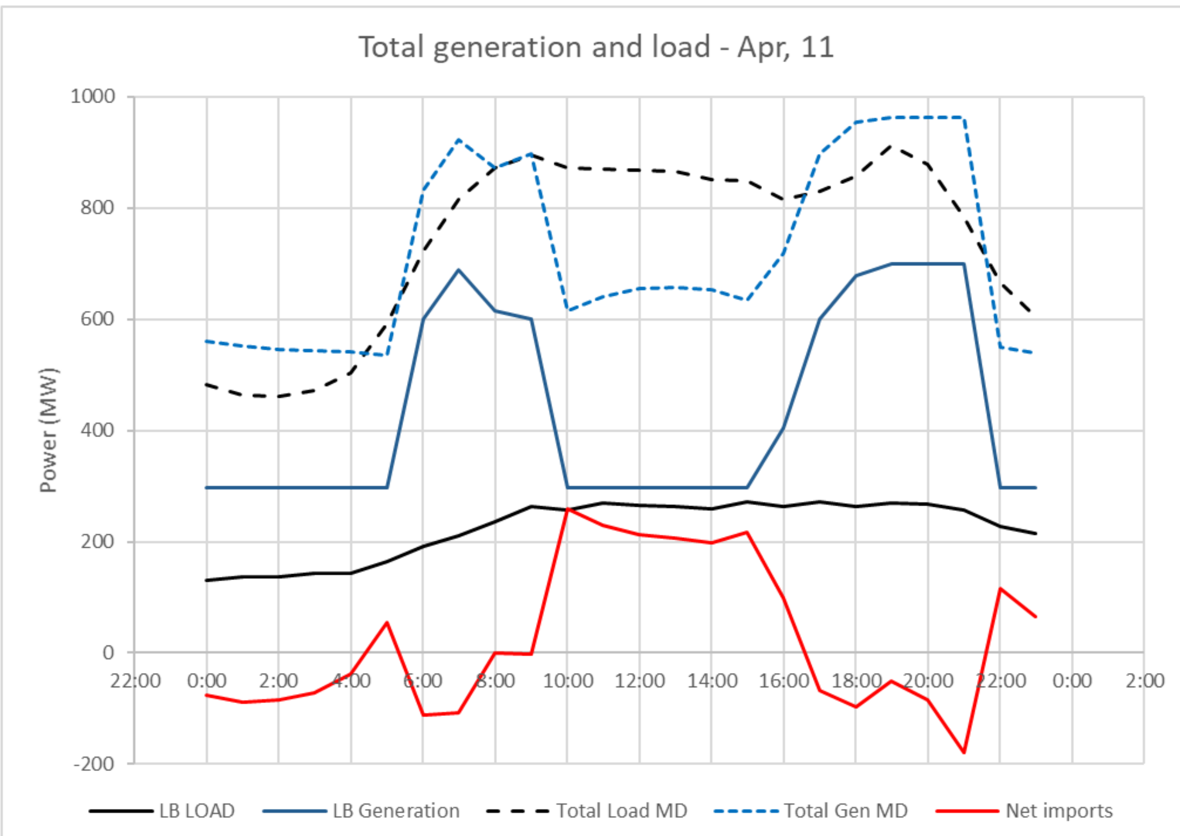

Fig. 9. Hourly results for one day with average daily load: Right Bank and total MD load

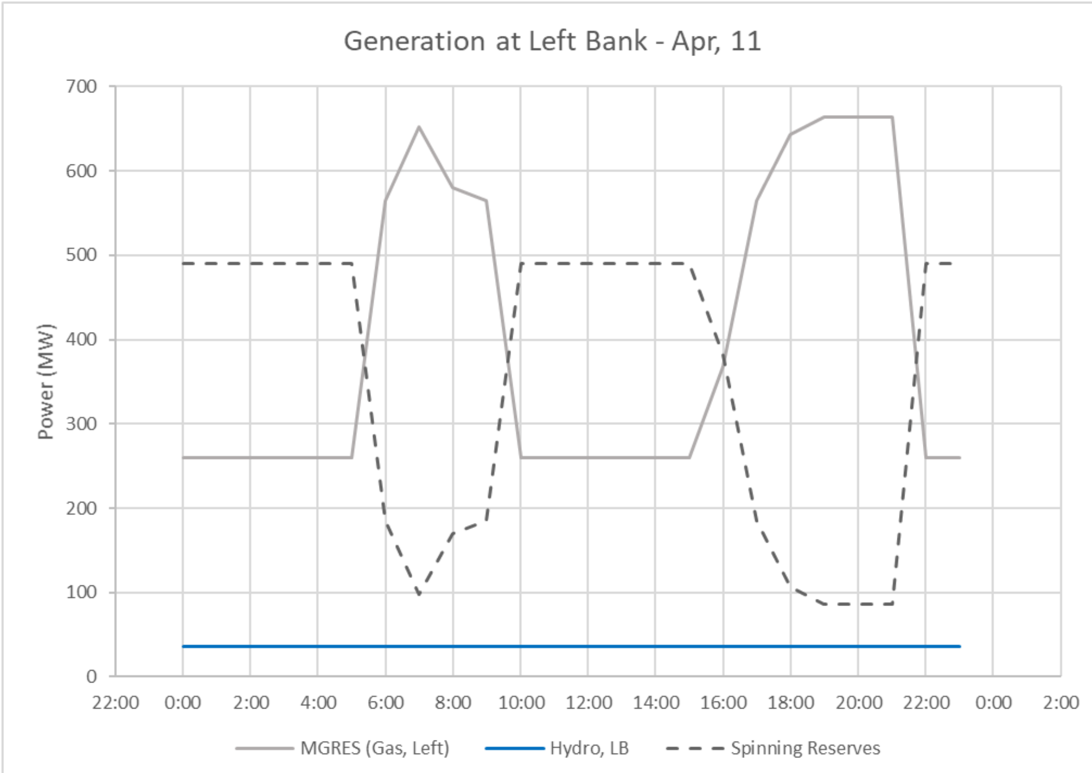

Fig. 10. Hourly results for one day with average daily load: Generation in Left Bank.

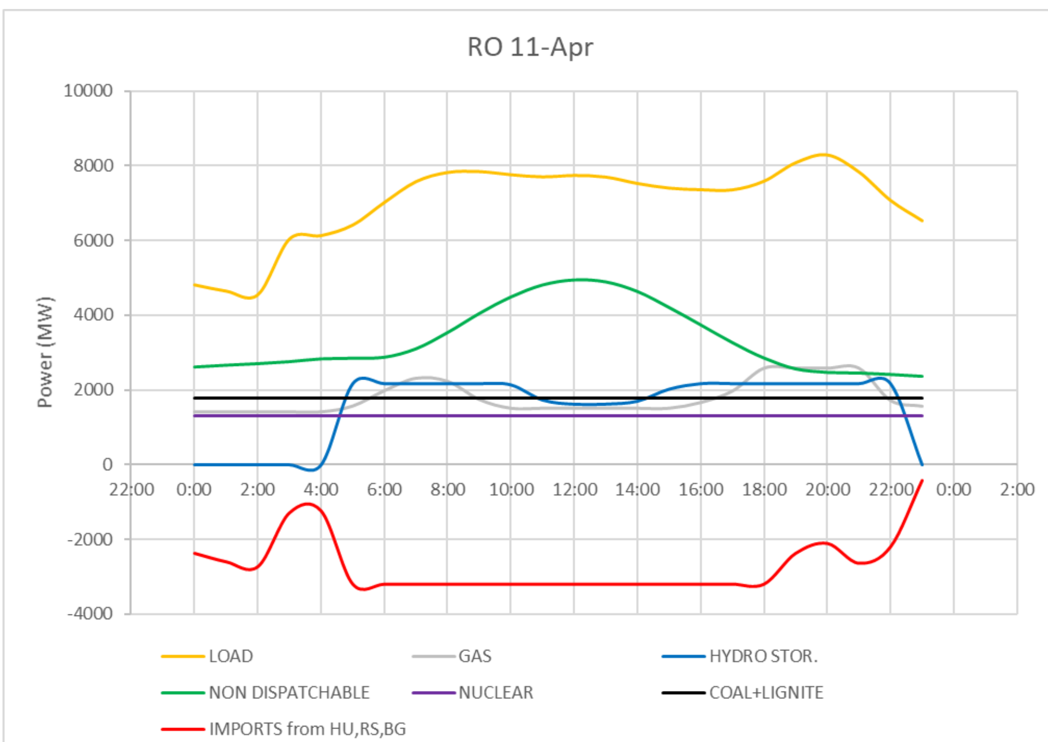

Fig. 11. Hourly results for one day with average daily load: System of Romania.

Fig. 12 shows the reserves margins duration curve for this case.

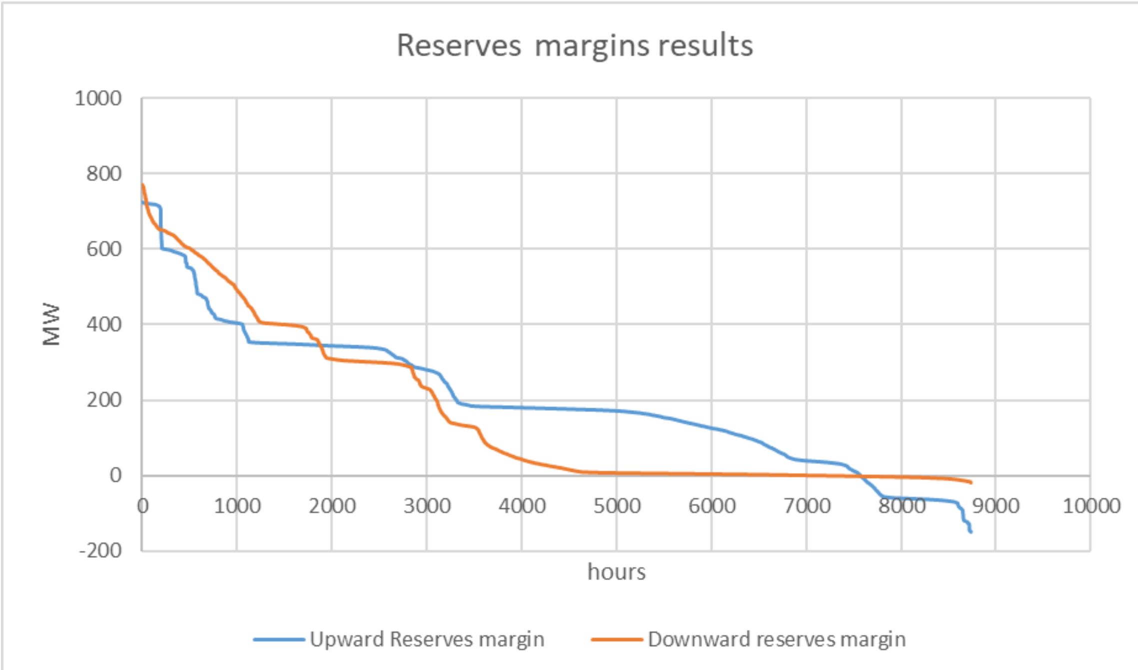

Fig. 12. Reserves margin duration curve.

Finally, Table 5 shows the annual results for this case. No spilled energy occurs in this case.

Due to the relatively high prices modeled for the European system (in order to obtain high exports from RO to the rest of Europe as per ENTSO-E TYNDP results, i.e. 14 TWh approximately or 23% of Romania's annual electricity demand), the gas-based generation of MGRES has increased, as it is cost-efficient to export to Romania. Annual net imports to Romania are negative in this case, i.e. Moldova exports to Romania.

Table 5: Annual results of Case 2: With interconnection to RO

		Right	Left	MD, Total	MD, % Gen.
Gas	[GWh]	0	4059	4059	57.6%
CHP	[GWh]	1317		1317	18.7%
Biofuel	[GWh]	788	0	788	11.2%
Hydro	[GWh]	61	228	289	4.1%
Wind	[GWh]	363	0	363	5.2%
Solar	[GWh]	231	0	231	3.3%
Total Gen	[GWh]	2761	4287	7048	100.0%
Imports from RO	[GWh]			-650	
Impors from UA	[GWh]			0	
Net Imports	[GWh]			-650	
Spilled	[GWh]			0	0.00%
Demand	[GWh]	4514	1884	6398	
Total Imports [% of Demand]	[%]		0%	-10%	
CO2	[Mton]	0.00	2.19	2.19	
Op. Cost	[M€]	0	418	418	