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**HYDRO POWER AND ENERGY  
PLANNING PROJECT (HPEP)**

# **TRANSITION TO HOURLY MARKET** *(Stage 1)*

*Month and Day Ahead Planning*  
*Bi-lateral contracts*  
*Balancing mechanism*

**February, 2014**



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## *Implementing Competitive Markets*

- Task 1 - Day ahead scheduling
- Task 2 - Day ahead planning
- Task 3 - Balancing Market (with restricted prices) and clearing mechanism
- Task 4 - Price zone on EPIAS' DAM
- Task 5 - Balancing market (with unrestricted prices)
- Task 6 - Georgia DAM
- Task 7 – Other Market Services Added (Forwards, futures, options, OTC trading, and so on)



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## *Key issues of the proposed approach*

1. All tasks related to the transition to the new market (from planning to settlement) are solved on an hourly basis.
2. Scheduled regimes in the market are determined on the basis of off-takers' offers.
3. Combined approach to hourly planning based on historical metering data (Excel model is developed) for major part of MPs and the use of GTMax for regulated power plants is proposed.
4. Hourly bi-lateral contracts (3 types – partial pool and free negotiations on a monthly basis and daily agreements) that act without adjustments (“take or pay” principle) are proposed.
5. Balancing market for Stage 1 is the deviations market (without bids); capacity deviations for each hour are determined as value of actual regime minus sum of capacities of bi-lateral contracts . Pricing must consider the value and the sign of deviation and the responsibilities.
6. Automated system for Stage 1 is proposed (MAP/DAP and partial pool software is developed).



## *Phases for Stage 1 implementation*

### Phase 1

- Development of “Monthly Ahead Planning” system for all market participants
- Development of “Day Ahead Planning” systems for all market participants

### Phase 2

- Implementation of MAP and DAP for bi-lateral contracting on hourly basis
- Development of "take or pay" contracting

### Phase 3

- Development and introduction of hourly balancing market and settlement system



## MAP/DAP methodology

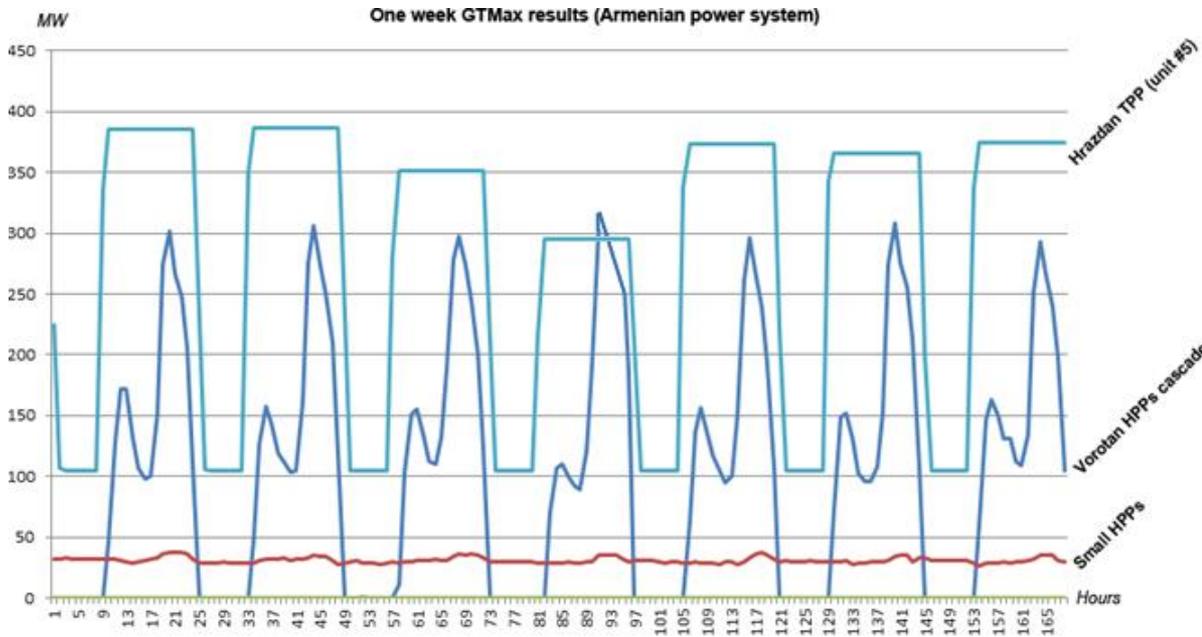
**Proposed methodology is based on combined approach** of developed model (within HPEP) for hourly planning for the main part of market participants and use of GTMax for regulated power plants (USEA has performed works to implement it in Georgia).

**Developed Excel model** can be used for all off-takers, medium and small HPPs and TPPs with limited regulation.

**GTMax** is used for regulated power plants only.

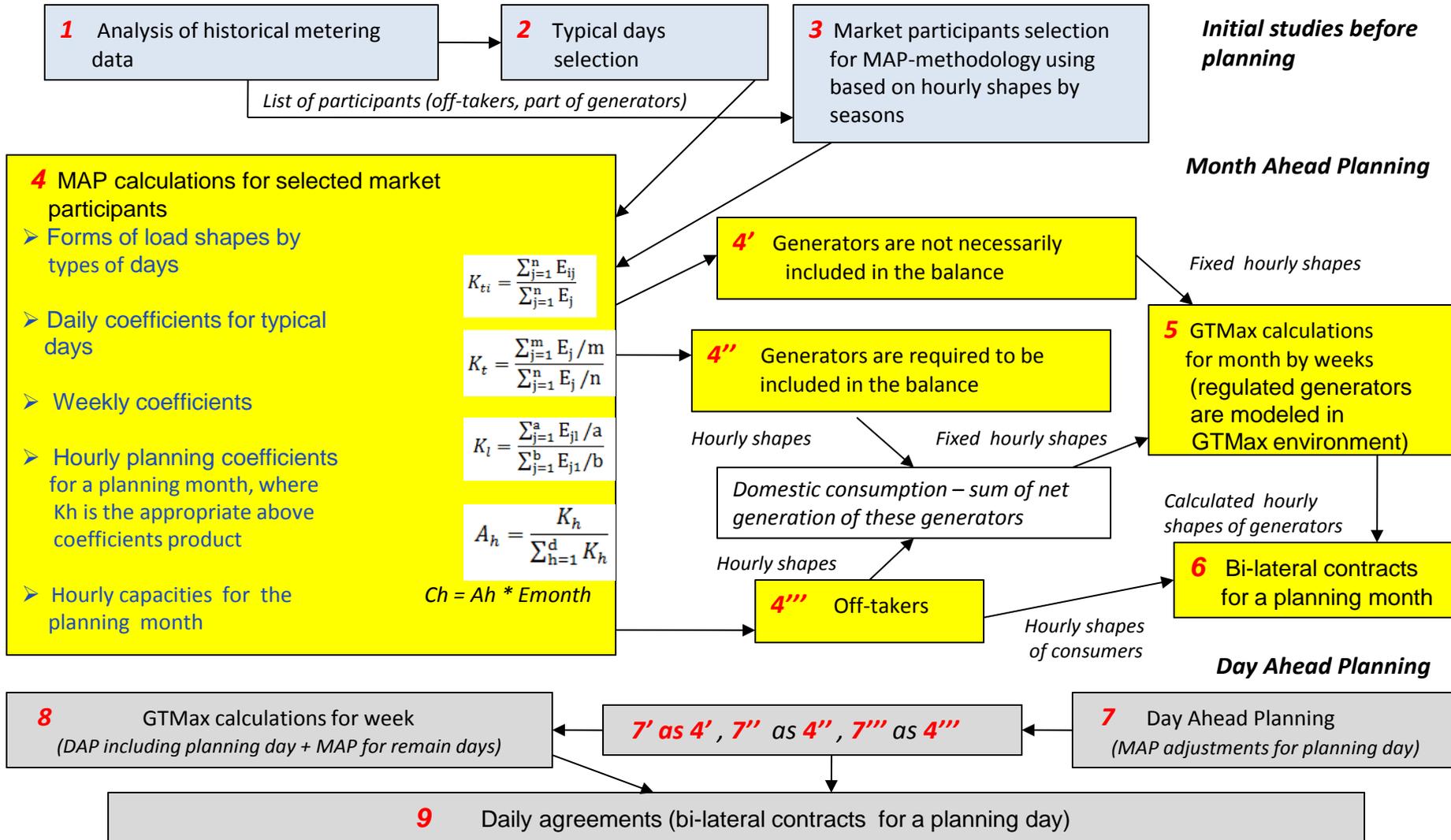
*Note, that in GTMax an hourly consumption is an input data and is determined by the Excel Model above.*

**GTMax** with simplifications (main part of generators is modeled as fixed load shapes) can be used effectively for hourly planning.





# MAP/DAP proposed methodology





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# MAP/DAP model (Historical data)

As a historical hourly data only metering data can be used, despite the fact that this system in Georgia can not be considered as fully perfect.

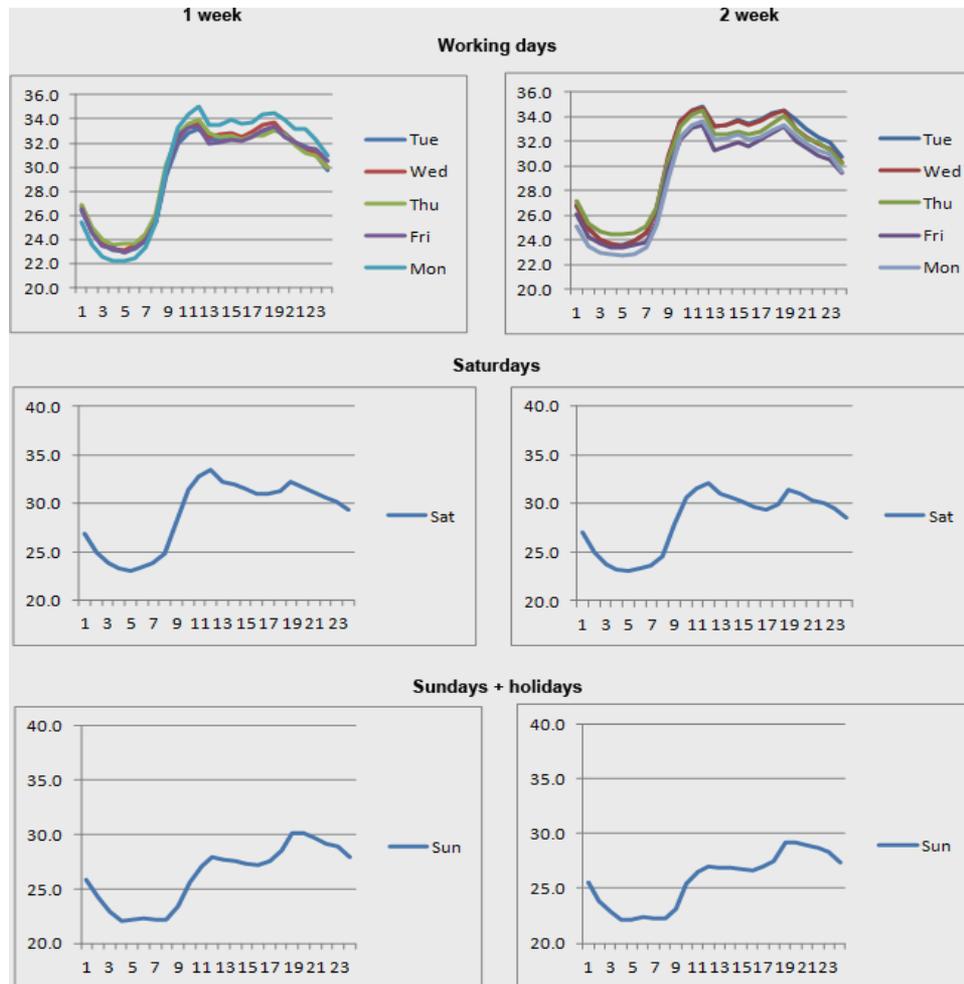
Day	1	2	3	4	5	6	7	8	9	10
Weeks	1	1	1	1	1	1	1	2	2	2
Typical Days	1	1	1	1	2	3	1	1	1	1
00:00-01:00	26.5	26.7	26.9	26.5	26.9	25.9	25.4	26.8	26.8	27.2
01:00-02:00	24.6	24.7	25.0	24.6	25.0	24.2	23.6	24.9	24.9	25.3
02:00-03:00	23.5	23.7	23.9	23.4	23.8	22.9	22.6	23.9	24.0	24.6
03:00-04:00	23.1	23.3	23.5	23.3	23.3	22.1	22.2	23.6	23.7	24.4
04:00-05:00	23.0	23.1	23.7	22.9	23.1	22.1	22.2	23.6	23.5	24.5
05:00-06:00	23.2	23.5	23.7	23.3	23.5	22.3	22.4	23.9	24.0	24.6
06:00-07:00	23.9	24.2	24.4	23.9	23.8	22.2	23.3	24.5	24.5	25.1
07:00-08:00	25.4	25.6	26.1	25.5	24.7	22.2	25.4	26.4	26.5	26.6
08:00-09:00	29.3	29.7	30.1	29.6	28.1	23.4	29.9	30.6	30.9	30.5
09:00-10:00	31.9	32.4	32.7	32.6	31.5	25.6	33.2	33.7	33.6	33.3
10:00-11:00	32.8	33.3	33.6	33.3	32.8	27.0	34.4	34.5	34.5	34.2
11:00-12:00	33.2	33.7	34.0	33.4	33.4	27.9	35.0	34.8	34.8	34.5
12:00-13:00	32.2	32.5	32.8	32.0	32.2	27.7	33.5	33.2	33.2	32.5
13:00-14:00	32.3	32.7	32.4	32.1	32.0	27.5	33.4	33.3	33.3	32.6
14:00-15:00	32.6	32.9	32.6	32.3	31.5	27.3	33.9	33.7	33.7	32.8
15:00-16:00	32.4	32.6	32.2	32.2	31.0	27.2	33.6	33.5	33.4	32.6
16:00-17:00	32.6	32.9	32.6	32.5	31.0	27.5	33.7	33.8	33.7	32.8
17:00-18:00	33.0	33.5	32.6	33.0	31.2	28.5	34.3	34.3	34.1	33.4
18:00-19:00	33.2	33.7	33.1	33.4	32.2	30.1	34.5	34.5	34.5	34.1
19:00-20:00	32.9	32.8	32.7	32.5	31.7	30.1	33.9	33.8	33.0	33.0
20:00-21:00	32.1	32.1	31.8	32.1	31.1	29.6	33.2	33.0	32.4	32.3
21:00-22:00	31.7	31.5	31.2	31.6	30.6	29.2	33.2	32.3	31.8	31.9
22:00-23:00	31.0	31.1	30.9	31.5	30.2	28.9	32.3	31.9	31.3	31.3
23:00-24:00	29.7	30.0	30.0	30.5	29.3	27.9	31.0	30.7	30.3	30.2
<b>Daily volume in MWh</b>	<b>706.1</b>	<b>712.1</b>	<b>712.5</b>	<b>708.0</b>	<b>694.0</b>	<b>629.3</b>	<b>720.2</b>	<b>729.3</b>	<b>726.2</b>	<b>724.2</b>



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## MAP/DAP model. Historical data differentiation by typical days (Turkish data, good results of metering)

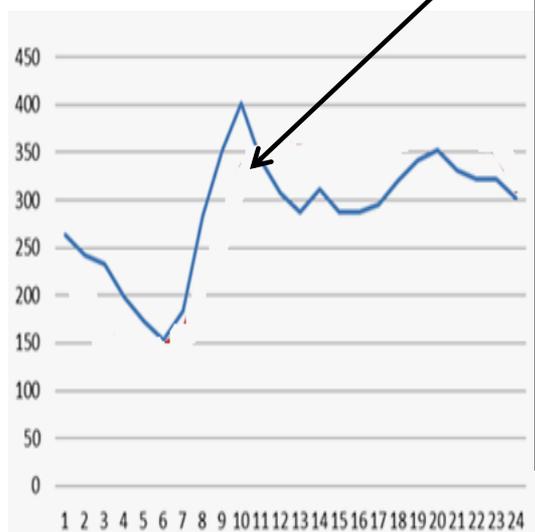
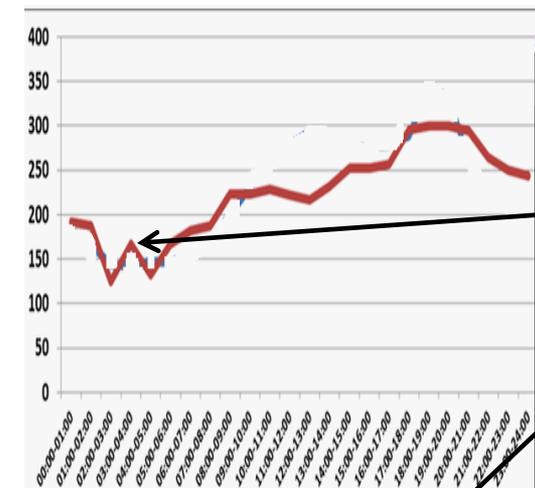




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## MAP/DAP model (Historical data filtering)



### Make Adjustments

Choose Correction Mode

Hourly Correction

Day Removal

**For Hourly Correction**

Choose Hour:

Choose Day:

**For Day Removal**

Choose Day:

Ok

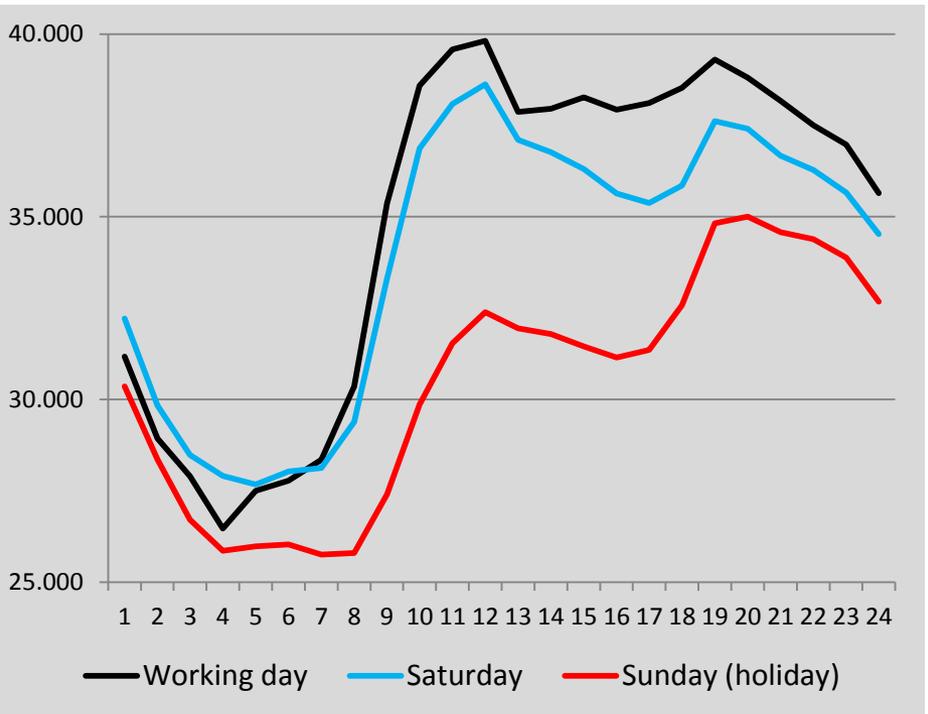
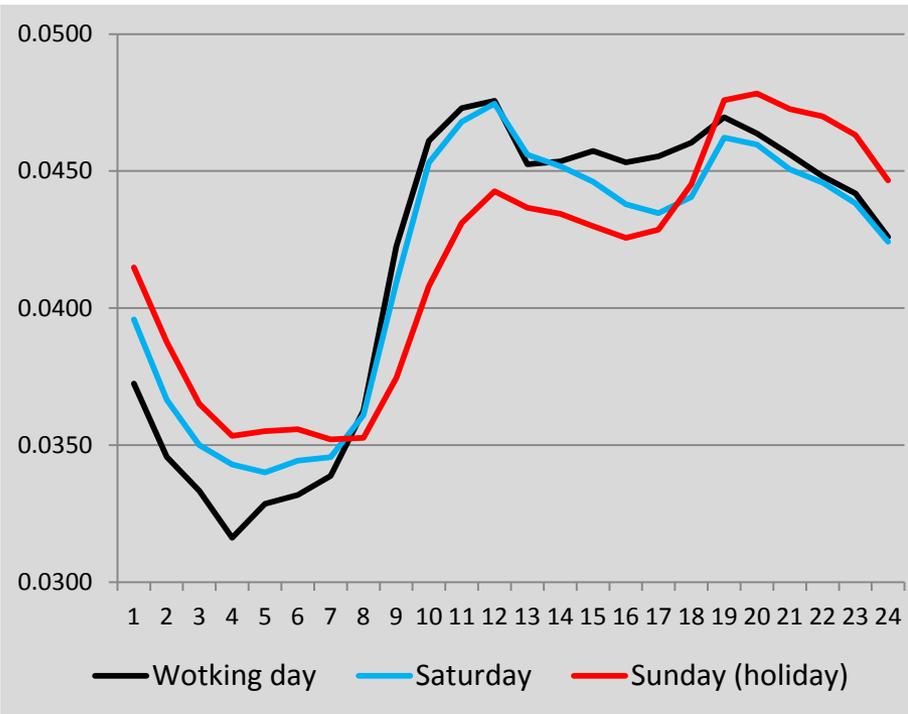
Close



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## MAP/DAP model (Average load shapes by typical days) form in p.u in MW



*Hourly coefficients for average typical day*

$$\sum K_{w\ h} = \sum K_{sat\ h} = \sum K_{sun\ h} = 1$$

*Daily coefficients for average typical day*

$$K_w = 1 \quad K_{sat} = 0.9724 \quad K_{sun} = 0.8743$$

*Weekly coefficients for a month*

$$K_1 \neq K_2 \neq K_3 \neq K_4 \neq K_5$$



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## Month Ahead Planning results

TIME/DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
00:00-01:00	30.007	30.007	31.010	29.216	30.007	30.007	30.007	32.084	32.084	33.156	31.238	32.084	32.084	32.084	31.281
01:00-02:00	27.849	27.849	28.717	27.300	27.849	27.849	27.849	29.776	29.776	30.705	29.190	29.776	29.776	29.776	29.031
02:00-03:00	26.907	26.907	27.416	25.713	26.907	26.907	26.907	28.769	28.769	29.313	27.493	28.769	28.769	28.769	28.049
03:00-04:00	25.476	25.476	26.866	24.890	25.476	25.476	25.476	27.239	27.239	28.726	26.612	27.239	27.239	27.239	26.557
04:00-05:00	26.471	26.471	26.636	25.010	26.471	26.471	26.471	28.303	28.303	28.480	26.741	28.303	28.303	28.303	27.595
05:00-06:00	26.737	26.737	26.976	25.056	26.737	26.737	26.737	28.587	28.587	28.843	26.790	28.587	28.587	28.587	27.872
06:00-07:00	27.270	27.270	27.071	24.795	27.270	27.270	27.270	29.157	29.157	28.945	26.511	29.157	29.157	29.157	28.427
07:00-08:00	29.217	29.217	28.282	24.835	29.217	29.217	29.217	31.238	31.238	30.239	26.554	31.238	31.238	31.238	30.457
08:00-09:00	32.580	32.580	32.064	26.378	32.580	32.580	32.580	34.835	34.835	34.283	28.203	34.835	34.835	34.835	33.963
09:00-10:00	35.544	35.544	35.486	28.740	35.544	35.544	35.544	38.004	38.004	37.941	30.729	38.004	38.004	38.004	37.053
10:00-11:00	36.455	36.455	36.654	30.357	36.455	36.455	36.455	38.977	38.977	39.191	32.458	38.977	38.977	38.977	38.002
11:00-12:00	36.656	36.656	37.174	31.173	36.656	36.656	36.656	39.192	39.192	39.746	33.330	39.192	39.192	39.192	38.211
12:00-13:00	34.834	34.834	35.714	30.745	34.834	34.834	34.834	37.245	37.245	38.186	32.873	37.245	37.245	37.245	36.313
13:00-14:00	34.917	34.917	35.383	30.597	34.917	34.917	34.917	37.333	37.333	37.832	32.714	37.333	37.333	37.333	36.399
14:00-15:00	35.205	35.205	34.944	30.276	35.205	35.205	35.205	37.642	37.642	37.362	32.371	37.642	37.642	37.642	36.700
15:00-16:00	34.884	34.884	34.302	29.979	34.884	34.884	34.884	37.298	37.298	36.676	32.053	37.298	37.298	37.298	36.365
16:00-17:00	35.048	35.048	34.047	30.185	35.048	35.048	35.048	37.474	37.474	36.403	32.274	37.474	37.474	37.474	36.536
17:00-18:00	35.437	35.437	34.510	31.355	35.437	35.437	35.437	37.889	37.889	36.898	33.525	37.889	37.889	37.889	36.941
18:00-19:00	37.827	37.827	36.206	33.516	37.827	37.827	37.827	40.445	40.445	38.711	35.835	40.445	40.445	40.445	39.433
19:00-20:00	37.353	37.353	36.002	33.687	37.353	37.353	37.353	39.938	39.938	38.494	36.018	39.938	39.938	39.938	38.939
20:00-21:00	36.736	36.736	35.297	33.282	36.736	36.736	36.736	39.278	39.278	37.740	35.585	39.278	39.278	39.278	38.295
21:00-22:00	36.095	36.095	34.918	33.094	36.095	36.095	36.095	38.593	38.593	37.334	35.384	38.593	38.593	38.593	37.627
22:00-23:00	35.591	35.591	34.329	32.612	35.591	35.591	35.591	38.054	38.054	36.704	34.869	38.054	38.054	38.054	37.101
23:00-24:00	34.310	34.310	33.230	31.451	34.310	34.310	34.310	36.685	36.685	35.529	33.628	36.685	36.685	36.685	35.767
<b>Daily volume in MWh</b>	<b>789.405</b>	<b>789.405</b>	<b>783.236</b>	<b>704.243</b>	<b>789.405</b>	<b>789.405</b>	<b>789.405</b>	<b>844.035</b>	<b>844.035</b>	<b>837.438</b>	<b>752.979</b>	<b>844.035</b>	<b>844.035</b>	<b>844.035</b>	<b>822.915</b>



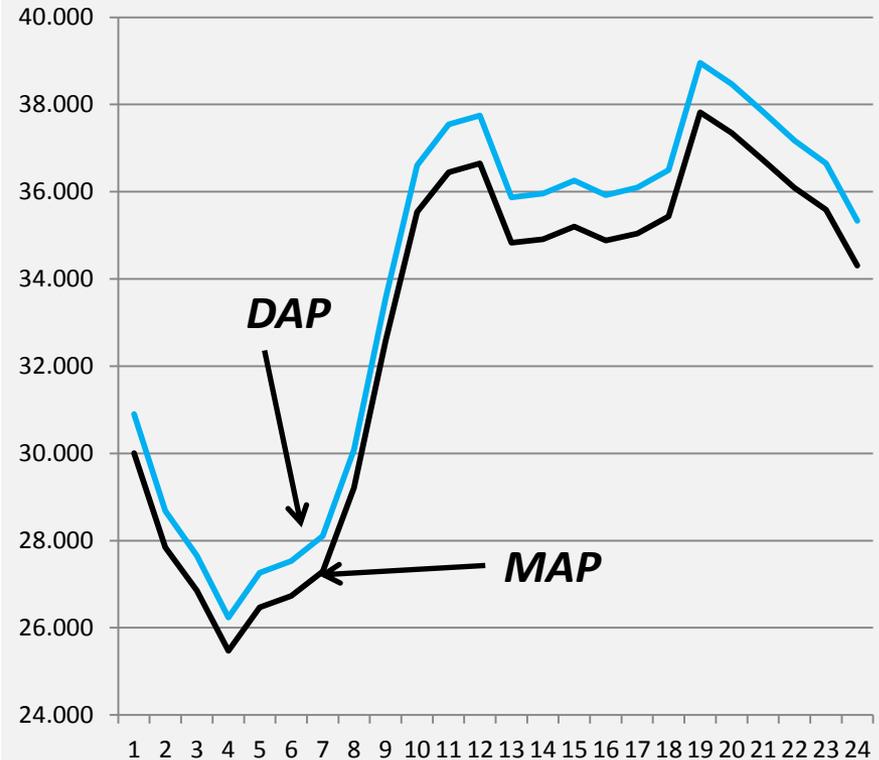
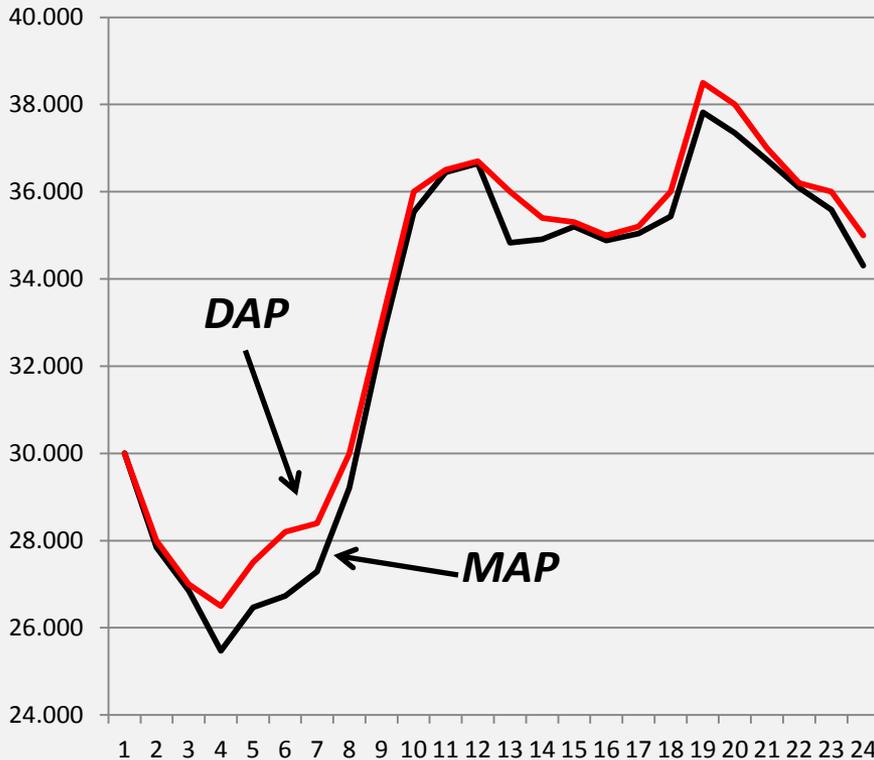
## Day Ahead Planning results

DAP is practically an adjustment of MAP for appropriate day.

There are **two options** of adjustments in the model:

*by hours (form of load shape is changed)*

*by daily volumes (form of load shape is the same)*

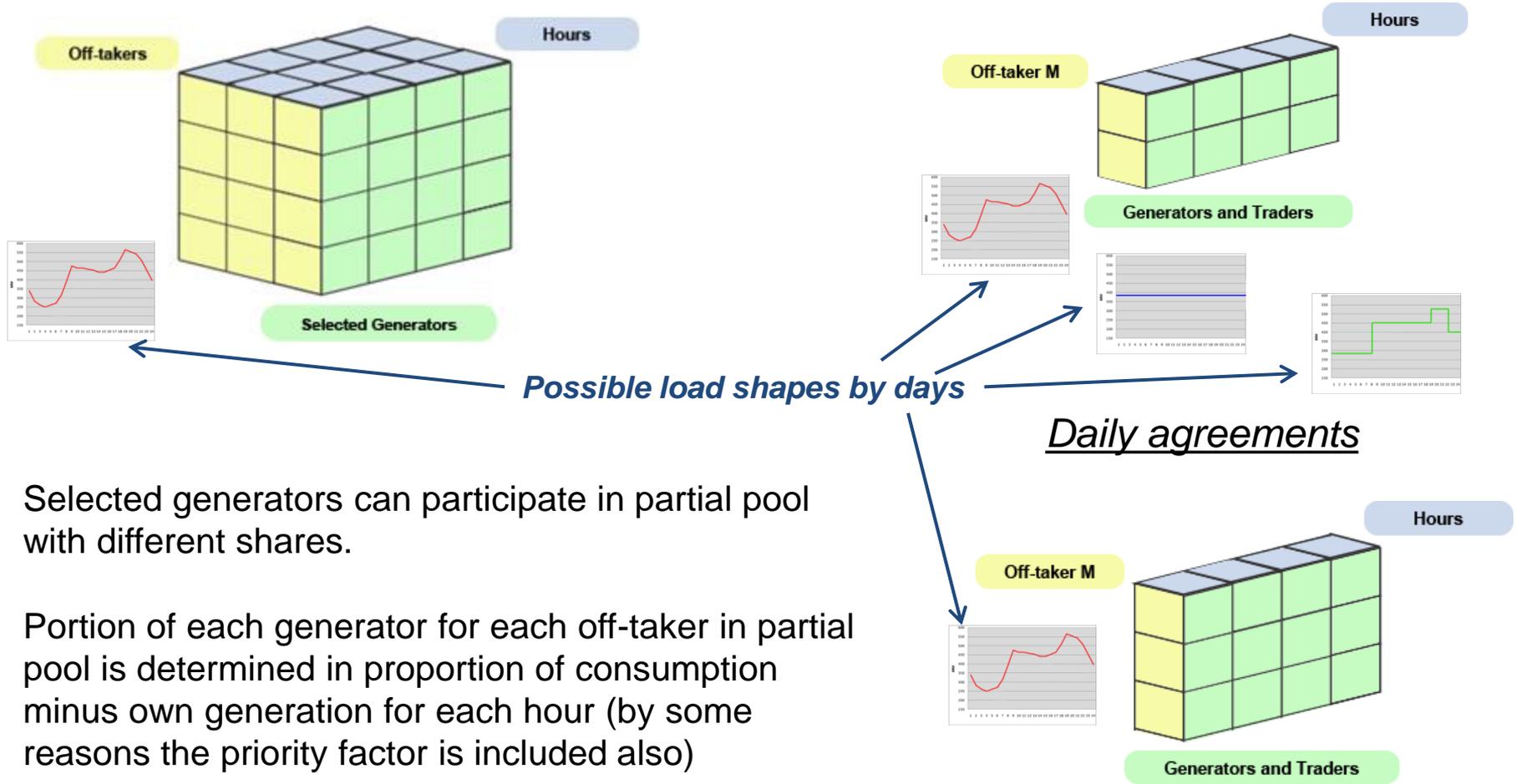


## Types of bilateral contracts

3 types of hourly contracts acting on the “take or pay” principle are proposed

Partial pool for a month ahead

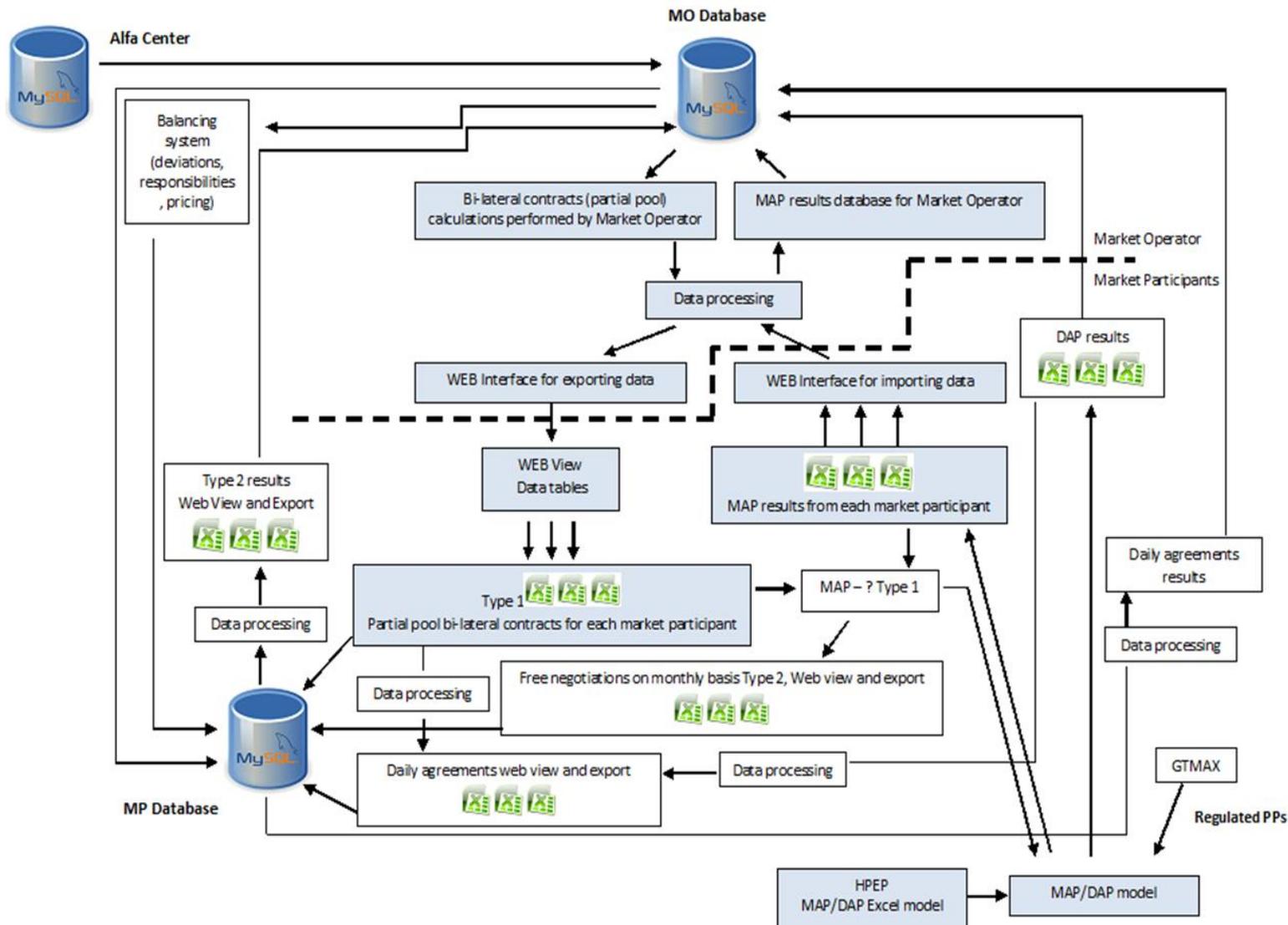
Free negotiations for a month ahead



Selected generators can participate in partial pool with different shares.

Portion of each generator for each off-taker in partial pool is determined in proportion of consumption minus own generation for each hour (by some reasons the priority factor is included also)

# Proposed structure of software (part “Bilateral contracts”)



# Software for partial pool calculations

## Participants list

ID	NAME	TYPE	ACTIONS
5	Generator 2	Generator	<a href="#">Edit</a>
6	Generator 3	Generator	<a href="#">Edit</a>
1	Off-taker 1	Off-taker	<a href="#">Edit</a>
4	Generator 1	Generator	<a href="#">Edit</a>
2	Off-taker 2	Off-taker	<a href="#">Edit</a>
3	Off-taker 3	Off-taker	<a href="#">Edit</a>

## Generators prices

Year:  Month:

GENERATOR	PRICE (TETRI/KWH)
Generator 1	<input type="text" value="3"/>
Generator 2	<input type="text" value="2"/>
Generator 3	<input type="text" value="4"/>

## Average market loss percentage

Year:

MONTH	LOSS(%)
January	<input type="text" value="2"/>
February	<input type="text" value="2"/>
March	<input type="text" value="2"/>

*The purpose of partial pool is the protection of domestic consumers and fair allocation of expensive generation*

### Step 1: select the year and month

Year:  Month:

### Step 2: select generators and participation share

	GENERATOR NAME	PARTICIPATION SHARE	MAP RESULTS
<input checked="" type="checkbox"/>	Generator 1	<input type="text" value="0.5"/>	<b>+</b>
<input checked="" type="checkbox"/>	Generator 2	<input type="text" value="1"/>	<b>+</b>
<input checked="" type="checkbox"/>	Generator 3	<input type="text" value="1"/>	<b>+</b>

*Generators participation shares are needed due to some reasons (availability of own generation, Abkhazia's factor, export opportunities for generators, possible presence of contracts between market participants)*

## Software for partial pool calculations (continued)

### Step 3: select off-takers and participation priority

GENERATORS/OFF-TAKERS	MAP RESULTS FOR OFF-TAKERS		
	+	+	+
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	OFF-TAKER 1 PRIORITY	OFF-TAKER 2 PRIORITY	OFF-TAKER 3 PRIORITY
GENERATOR 1	<input type="text" value="1"/>	<input type="text" value="1"/>	<input type="text" value="1"/>
GENERATOR 2	<input type="text" value="1"/>	<input type="text" value="1"/>	<input type="text" value="1"/>
GENERATOR 3	<input type="text" value="1"/>	<input type="text" value="1"/>	<input type="text" value="1"/>

### Monthly volumes of partial pool

January/2014

Show monthly volume in MWh  Show monthly volume in thousand GEL

 [Download excel file](#)

GENERATOR/OFF-TAKER	OFF-TAKER 1	OFF-TAKER 2	OFF-TAKER 3	
GENERATOR 1	1874.034	1900.255	1225.714	5000.003
GENERATOR 2	2507.355	2550.548	1641.58	6699.483
GENERATOR 3	1437.909	1481.565	949.325	3868.8
	5819.298	5932.368	3816.619	15568.286

Monthly average generation price in partial pool: 2.818 tetri/kWh

Monthly average generation price (with losses) for off-takers:

OFF-TAKER 1	OFF-TAKER 2	OFF-TAKER 3
2.816	2.82	2.819

Point of contract conclusion is a generation node.

Market losses for each off-taker are determined through average system losses percentage by months.

### Example 1. Participation priorities=1 for all off-takers

- *Prices in partial pool are the same for each hour for each off-taker*
- *Difference of average monthly (daily) prices for off-takers is determined by hourly consumption structure only*

## Software for partial pool calculations (continued)

Step 3: select off-takers and participation priority

	MAP RESULTS FOR OFF-TAKERS		
	+	+	+
	☑	☑	☑
GENERATORS/OFF-TAKERS	OFF-TAKER 1 PRIORITY	OFF-TAKER 2 PRIORITY	OFF-TAKER 3 PRIORITY
GENERATOR 1	1	1.2	1.1
GENERATOR 2	1.2	0.7	0.5
GENERATOR 3	0.7	1.1	1.4

### Example 2 Participation priorities are different for off-takers

- Prices for off-takers are different for each hour too.
- The difference between average prices for off-takers can be significant

### Monthly volumes of partial pool

January/2014

Show monthly volume in MWh  Show monthly volume in thousand GEL

 [Download excel file](#)

GENERATOR/OFF-TAKER	OFF-TAKER 1	OFF-TAKER 2	OFF-TAKER 3	
GENERATOR 1	1703.551	2071.403	1225.048	5000.003
GENERATOR 2	3755.022	2017.634	926.827	6699.483
GENERATOR 3	764.775	1709.254	1394.771	3868.8
	6223.348	5798.292	3546.646	15568.286

Monthly average generation price in partial pool: **2.818 tetri/kWh**

Monthly average generation price (with losses) for off-takers:

OFF-TAKER 1	OFF-TAKER 2	OFF-TAKER 3
2.52	2.947	3.132

## Software for partial pool calculations (continued)

Daily and hourly volumes of partial pool for selected market participant

Year:  Month:  Participant:

Show daily volume in MWh  Show daily volume in thousand GEL [Download excel file](#)

PARTICIPANT/DAY	1	2	3	4	5	6	7	8	9	10
GENERATOR 1	69.299	69.299	67.417	60.735	69.299	69.299	69.299	69.222	69.222	67.
GENERATOR 2	67.317	67.317	65.609	59.604	67.317	67.317	67.317	67.245	67.245	65.
GENERATOR 3	55.117	55.117	55.074	55.167	55.117	55.117	55.117	55.119	55.119	55.
	191.733	191.733	188.1	175.506	191.733	191.733	191.733	191.587	191.587	18;

For viewing of some contract click on the participant's name.

Contract "Off-taker 2" with "Generator 2"

Show hourly volume in MWh  Show hourly volume in thousand GEL [Download excel file](#)

HOURE/DAY	1	2	3	4	5	6	7	8	9	10	11
00:00-01:00	2.929	2.929	3.004	2.87	2.929	2.929	2.929	2.926	2.926	3.002	2.867
01:00-02:00	2.768	2.768	2.832	2.727	2.768	2.768	2.768	2.765	2.765	2.83	2.724
02:00-03:00	2.694	2.694	2.735	2.609	2.694	2.694	2.694	2.691	2.691	2.733	2.606
03:00-04:00	2.591	2.591	2.695	2.548	2.591	2.591	2.591	2.589	2.589	2.692	2.546
04:00-05:00	2.665	2.665	2.677	2.556	2.665	2.665	2.665	2.663	2.663	2.675	2.554
05:00-06:00	2.685	2.685	2.703	2.56	2.685	2.685	2.685	2.682	2.682	2.7	2.558
06:00-07:00	2.726	2.726	2.71	2.541	2.726	2.726	2.726	2.724	2.724	2.707	2.539
07:00-08:00	2.87	2.87	2.8	2.544	2.87	2.87	2.87	2.867	2.867	2.798	2.542
08:00-09:00	2.623	2.623	2.472	2.037	2.623	2.623	2.623	2.62	2.62	2.469	2.035
09:00-10:00	2.984	2.984	2.858	2.343	2.984	2.984	2.984	2.981	2.981	2.855	2.34

Example 2 Participation priorities are different for off-takers

← Daily volumes for selected off-taker by generators

← Monthly hourly volumes for selected couple of market participants



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## ***Balancing market***

Hourly capacities on balancing market are determined as capacity of actual regime minus sum of all types of bilateral contracts by hours.

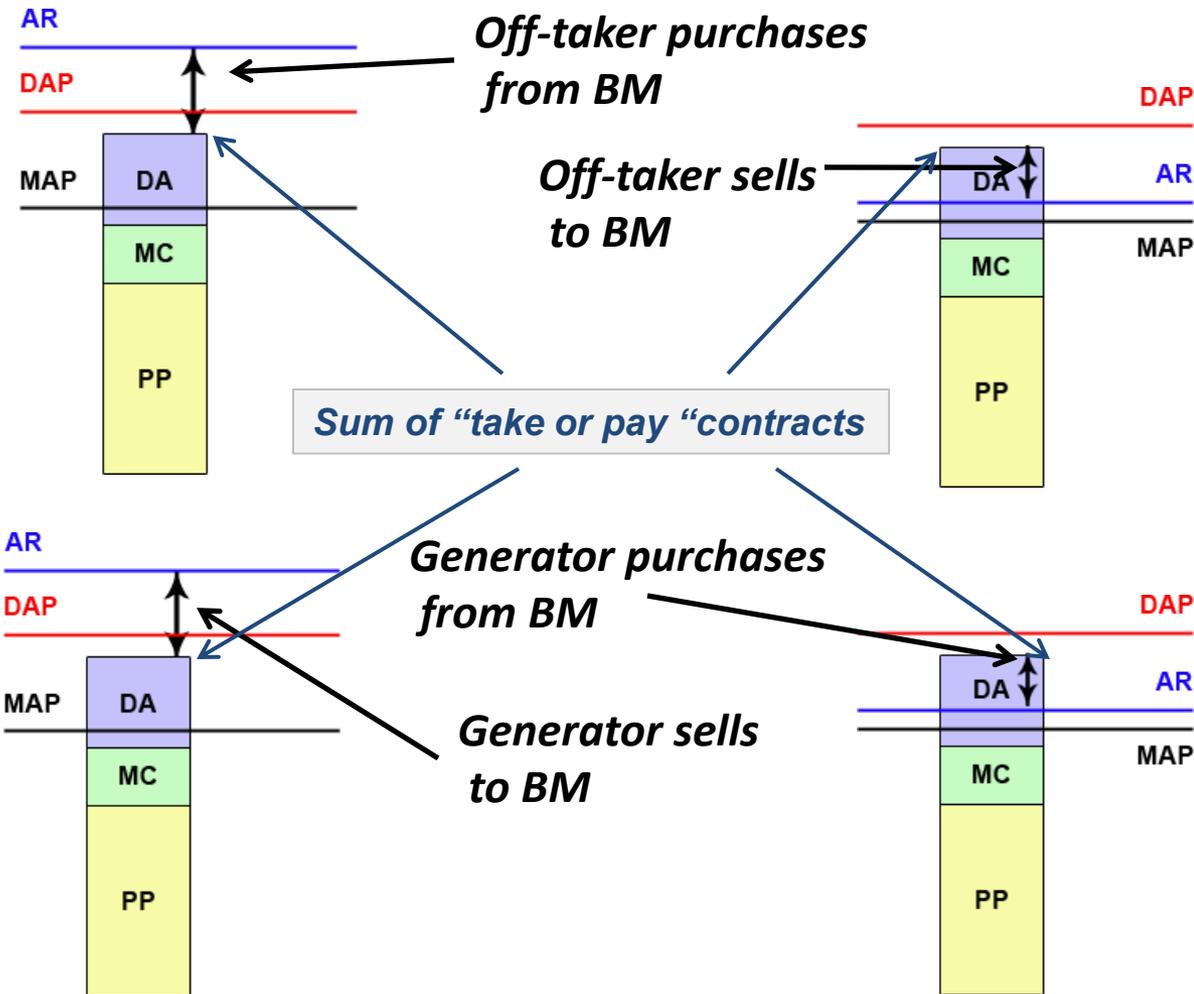
Therefore, depending on the sign of deviation Purchaser can be Seller and vice versa (see next slide).

At this stage, bids don't include prices for the inadmissibility of sharp rise in prices.

Special pricing system should be developed after the approval of the concept taking into account the value and the sign of deviation as well as market participant's responsibility for deviation by hours.



# Balancing market for one hour



**MAP** – Month Ahead Planning

**DAP** – Day Ahead Planning

**AR** – actual regime

**PP** – partial pool contracts

**MC** – monthly contracts based on free negotiations

**DA** – daily agreements



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## *Next steps*

1. Perform workshops and training with market participants regarding MAP/DAP model;
2. Support to market participants in MAP/DAP and partial pool software implementation;
3. Support to GSE for the use of GTMax for Month and Day Ahead planning;
4. Workshops with MO regarding partial pool calculations software;
5. Combined work with MO to analyze possible options of partial pool and define the optimal by seasons taking into account Abkhazia's factor, export possibilities for power plants, protection of domestic market, etc;



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## ***Next steps(continued)***

6. Update partial pool software by other types of contracts, expand database for MO and create for market participants;
7. Develop the concept of balancing market (volumes and responsibilities determination);
8. Develop pricing system for all sectors of trade;
9. Perform workshops and discussions with MoE, GSE and ESCO to implement developed approaches to final approval and realization of time-table;
10. Develop procedures for hourly market functioning;
11. Support to all stakeholders at the simulation stage.



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**Thank you**