



## Country Experiences with Long-term Capacity Expansion Planning with a High Share of Renewables

### Georgia

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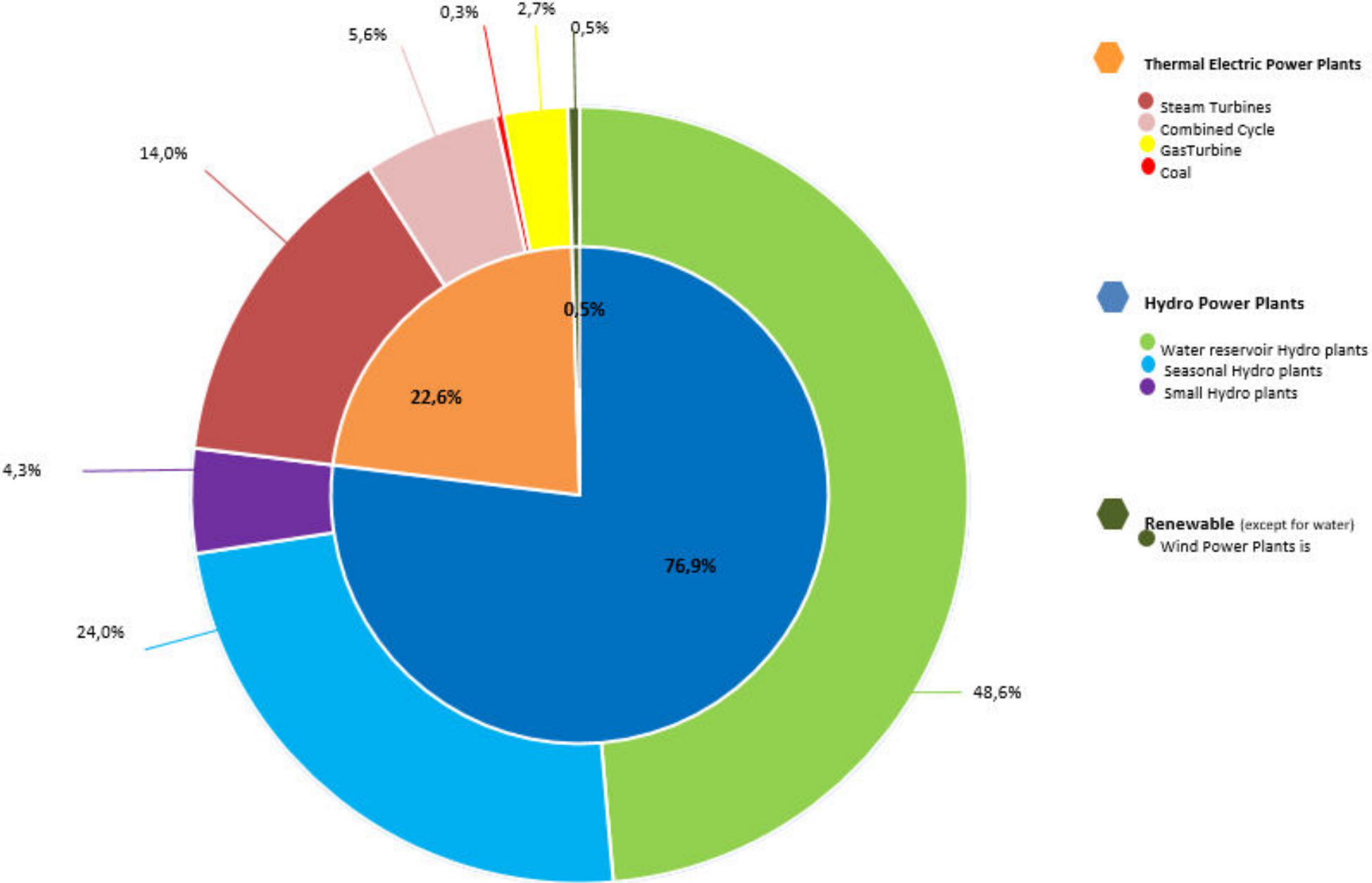
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# Georgian Power System Structure



# Generation Capacities' location








Wind PP



Thermal PP





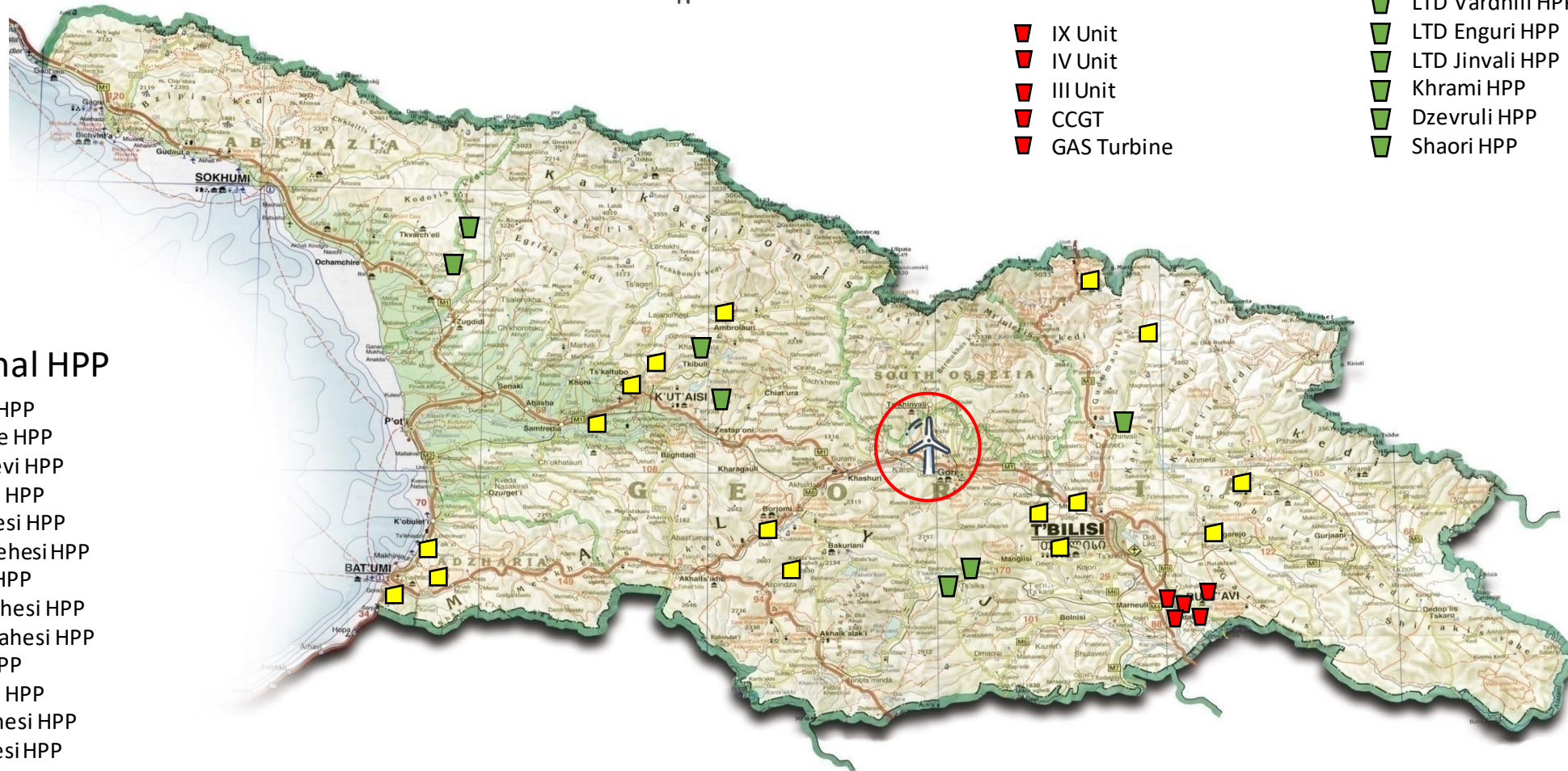
Regulating HPP

-  IX Unit
-  IV Unit
-  III Unit
-  CCGT
-  GAS Turbine

-  LTD Vardnili HPP
-  LTD Enguri HPP
-  LTD Jinvali HPP
-  Khrami HPP
-  Dzevruli HPP
-  Shaori HPP

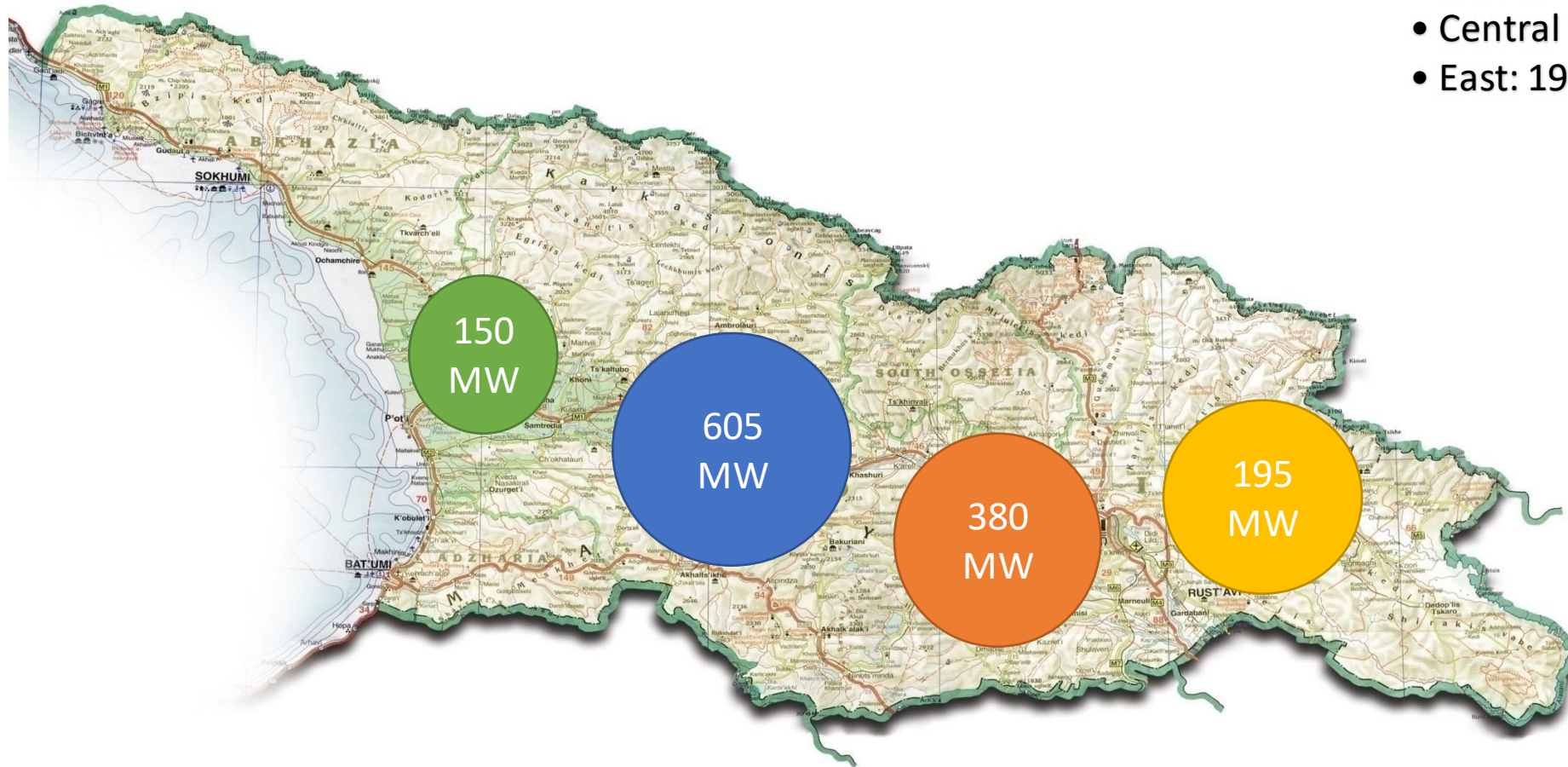
## Seasonal HPP

-  Khadori HPP
-  Vartsikhe HPP
-  Chitakhevi HPP
-  Rionhesi HPP
-  Gumathesi HPP
-  Satkhenehesi HPP
-  Atshesi HPP
-  Ladjanurhesi HPP
-  Ortachalahesi HPP
-  Zahesi HPP
-  Larsihesi HPP
-  Faravanhesi HPP
-  Darialihesi HPP
-  Khelvachauri HPP
-  Shuakhevihesi HPP
-  Kirnatihesi HPP



# Different Zones of wind generation

- West: 150 MW
- Central West: 605 MW
- Central East: 380 MW
- East: 195 MW



# Wind and Solar in Georgia

In recent years, the interest in construction of wind and solar power plants in Georgia has increased because:

✓ Wind turbines and solar panel cost is reducing

✓ Minimal Operating Costs

✓ Construction of power plants requires less time than HPPs

✓ Intensive Growth of Power Consumption



# Factors required for the integration of large capacity of wind and solar in Georgia

Inertia

Powerful  
lines



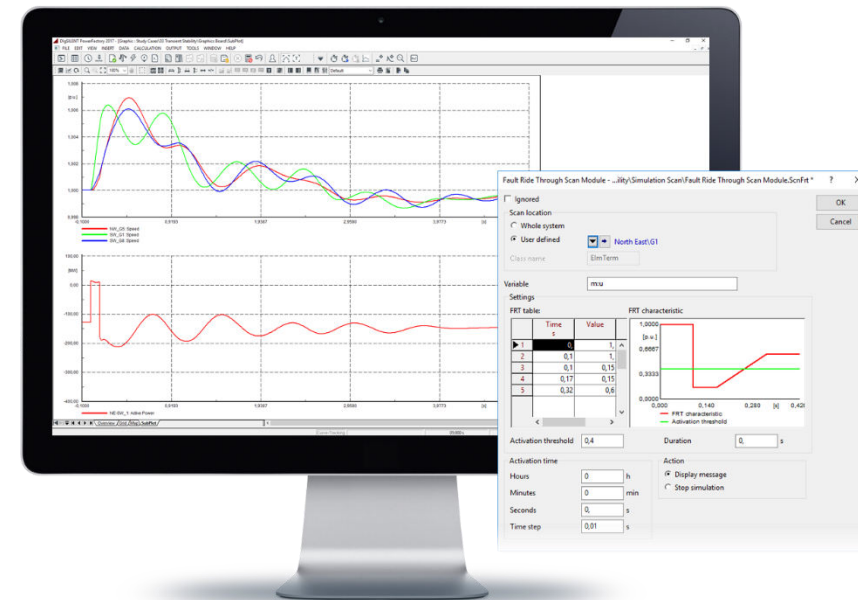
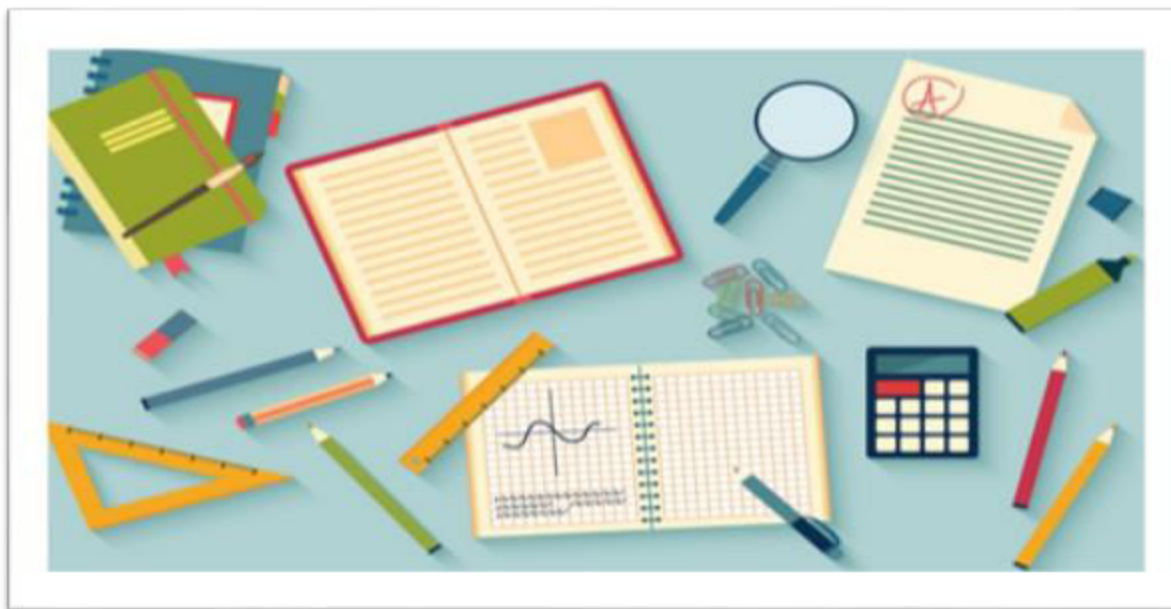
Primary,  
Secondary  
And  
Tertiary  
Reserves

Wind forecast



Balancing  
Market

# Tools we use



**The Georgian State Electrosystem (Transmission System Operator of Georgia) created study using the world-wide DigSILENT PowerFactory Engineering Modeling Program with the support of European Consultants DigSILENT, DMCC, R2B Consortium, to explore the possibilities of integrating variable renewable energy sources into Georgian power system.**

# Base information and assumptions

- ✓ 520 MW solar
- ✓ 1330 MW wind
- ✓ Annual growth of consumption 5-6%

From 2020:

- ✓ Existence of balancing market
- ✓ Keeping current generators voltage and speed governors, , which should be done according to the plan by 2020;

From 2025 Year

- ✓ All planned HPPs are in operation except Khudoni and Tskhenistskali HPP.
- ✓ Maintaining existing generators voltage and speed governors, which should be made according to the plan by 2025;

2030 Year:

- ✓ All planned planned HPPs are in operation



# Results

Maximum Allowable VRE Integration	VRE Integration			
	25% Wind – 333MW; Solar -130 MW;	50% Wind – 665 MW; Solar - 260 MW;	75% Wind – 1000 MW; Solar - 390 MW;	100% Wind – 1330 MW; Solar - 520 MW;
Year 2020		#2a #2c #3		
Year 2025	#2a #2c		#1 #3 #4	
Year 2030	#2a #2c			#2b #4

Acceptable
Acceptable considering some issues
Not Acceptable

The survey was based on international recommendations, which considers geographical scattering of wind farms as much as possible by equal capacity.

## Surplus should be exported or curtailed

- ✓ Capacity of Interconnection is enough
- ✓ Is it possible to export ?

## 1. Effect of saturation: Wind and Solar generation can not effectively replace thermal generation

### 2. Deficit of operating reserves:

- a. An additional 260 MW operating reserve is required
- b. An additional 380 MW operating reserve
- c. An additional reserve ( for down-regulation ) is required, which is 30% of the capacity of the Hydro Run Of River , Wind and Solar power plants

### 3. Improve frequency stability (installation of 65 MW batteries with estimated value 142 m €)

### 4. Transmission network and infrastructure reinforcement

# The Recommended capacity of Wind and Solar

Solar recommended The maximum total installed capacity			
Scenario	2020	2025	2030
<b>Total Capacity</b>	<b>130</b>	<b>260</b>	<b>520</b>

Recommended maximum total capacity (Wind)	2020	2025	2030
Central West	83,15	171	605
West	83,15	150	150
Central East	83,15	171	380
East	83,15	171	195
<b>Total</b>	<b>333</b>	<b>663</b>	<b>1330</b>



Wind integration can not be concentrated in any specific zone, because in this case power system needs significant reserves and the network reliability is reducing. The survey does not consider such case.

**Thank you for your Attention**