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CREATING THE AMBIENT FOR SUSTAINABLE ECONOMIC DEVELOPMENT OF MONTENEGRO THROUGH THE PROJECTS OF RENEWABLE ENERGY SOURCES[***]

Abstract: Nowadays, the energy sector in Montenegro is in tremendous transition period. The overview of the new legislation framework in this sector, especially in the field of renewable energy sources, is presented. The European legalisation regarding renewable energy sources is commented. An approach of how Montenegro is creating an ambient for faster economic growth through the implementing the European legalisation is demonstrated. The pipeline projects and the most reasonable exploitation of the renewable energy potentials for satisfaction of the national renewable energy target in Montenegro are given. The ambient for sustainable economic development though the projects of renewable energy is presented.

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[***] Full paper is given in terms of PowerPoint presentation.

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OUTLINE OF THE PRESENTATION

1. Introduction
2. Potentials of RES
3. RES projects
4. Support Schemes
5. Conclusions

Abbreviation:

RES - Renewable Energy Sources

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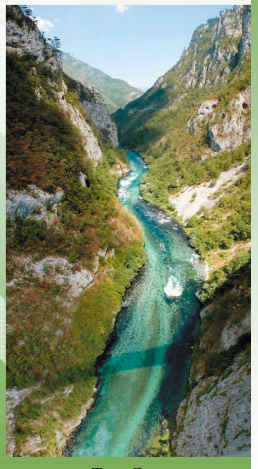
1.1. Major Strategic Commitments

- **Reasonable valorization of available potentials**
- Achieving a **balance between energy development** and **environmental protection**
- Regulatory, legislative and operational integration in the **process of approaching the EU in the fields of energy and environment**
- Implementation of obligations under the**Treaty establishing the Energy Community**
- Continuation of **energy reform**, while **respecting sustainable development and market operation principles**
- Ensuring **social protection** in the process of reform changes in energy sector



Tara Canyon

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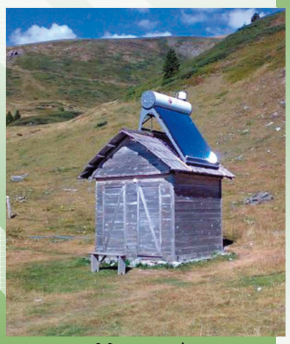
1.2. Energy Sector

- **Energy sector** is recognized in Montenegro (MNE) as **an important driving force of the economic growth**
- **Energy Development Strategy of Montenegro until 2025** (2007) (EDS) and **Action Plan 2008-2012**
- The Strategy sets guidelines for energy progress and sustainable development:
  - improving energy efficiency
  - better use of RESe (hydro, wind, biomass)
  - revitalization of existing and construction of new electricity infrastructure (TSO, DSO) and
  - **Montenegro as RESe investment challenge**



Montenegrian
"Katun"

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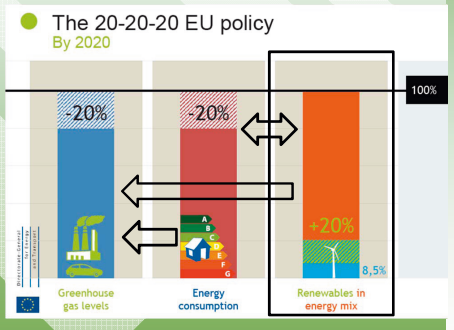
1.3. Legislative RES Framework

- **Directive 2009/28/EC** of the European parliament of the Council on the **promotion of the use of energy from RES**

Energy Law adopted in May 2010:

- **Incentives** for energy produced from RES and cogeneration
- **National target** for energy produced from RES
- **Guarantees of origin** of electricity, heating and cooling produced from RES
- **Preferential producers**
- **Joint Projects and Joint support schemes**



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1.3. Legislative RES Framework (cont.)

- National RES target [%] is calculated by

$$\%\,\text{RES} = \frac{\text{Total energy produced form RES}}{\text{GFEC}} = \frac{\mathbf{RES_e + RES_{th} + RES_{tra}}}{\mathbf{GFEC}}$$

GFEC – gross final energy consumption

- Mandatory national target for RES to 2020 for EU countries:

$$\text{National target \% RES} = S_{2005} + 5.5\,\% + \text{GDP factor}$$

- Contracting parties of the Energy Community Treaty are also under obligation to calculate a mandatory RES target

Renewable Energy Target Calculation - Montenegro

29.5 % (S_{2005} = 23.0 % and GDP factor = 1.0 %)

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1.4. Incentives for Electrical Energy Generation from RES

Methodology for calculation of the price of electrical energy generated from RES

- Guaranteed price for **12 years**
- **Inflation** rate is included
- Calculation is made for sHPP, wind farms and biomass
- The price for sHPP is depend from the annual production of electrical energy

Type of generation	P [€/MWh]
Small hydro power plants	
do 0.5 GWh	114.41
od 0.5 – 3 GWh	104.02
od 3 – 15 GWh	74.37
iznad 15 GWh	38.42
Wind farms	95.99
Biomass	
Wood-processing industry	123.10
Forestry and agriculture	137.06

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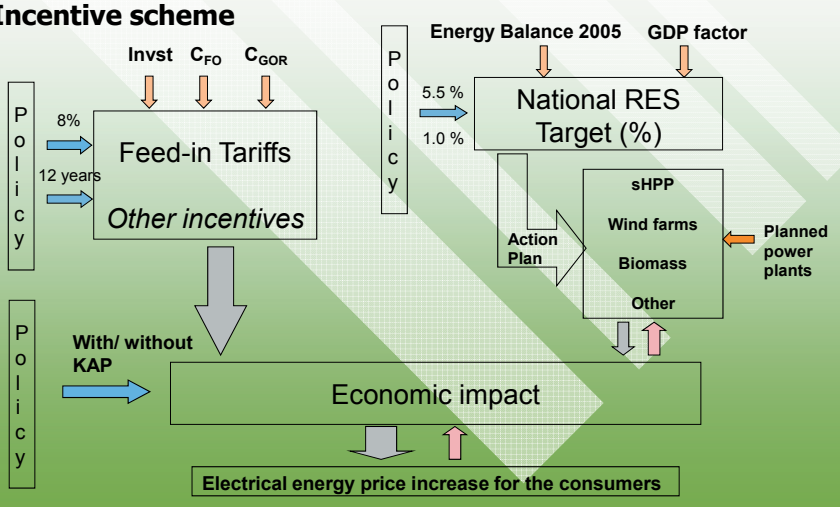
1.4. Incentives for Electrical Energy Generation from RES (co

Incentive scheme



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OUTLINE

1. Introduction
2. **Potentials of RES**
3. RES projects
4. Support Schemes
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2.1. Hydro Potentials

Theoretical researches

- **Total theoretical** hydro-potential of Montenegro, as given in the *Water Management Plan of Montenegro,* is **~10 TWha**
- **Theoretical (gross)** hydro-energy potential for building sHPP in Montenegro (excluding Tara, Ćehotina and Ibar rivers) is estimated to be **800-1000 GWha**
- **Technical (net) usable** potential for building sHPP is estimated to be around **400 GWha**

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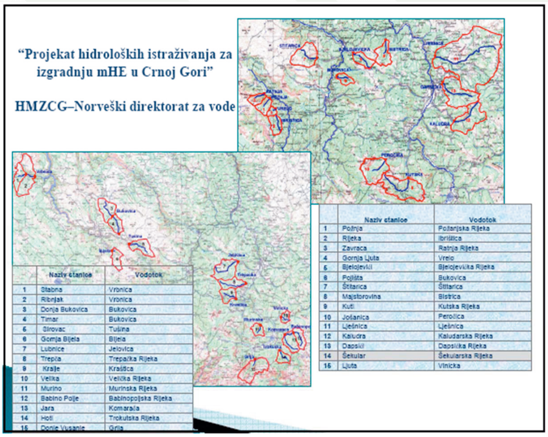
2.1. Hydro Potentials (cont.)

Field measurements

- HMZCG, hydrology sector, produced two *HYDROLOGY ASSESSMENTS for sHPP profiles in Montenegro* based on one year measurements on **27 watercourses, at 30 locations**.
- HMZCG is currently doing measurements on additional **12 watercourses** and will create report after one year of measurements.



	Naziv stanice	Vodotok
1	Stabna	Vrbnica
2	Ribnjak	Vrbnica
3	Donja Bukovica	Bukovica
4	Timar	Bukovica
5	Sirovac	Tušina
6	Gornja Bijela	Bijela
7	Lubnice	Jelovica
8	Trepča	Trepačka Rijeka
9	Kralje	Kraštica
10	Velika	Velička Rijeka
11	Murino	Murinska Rijeka
12	Babino Polje	Babinopoljska Rijeka
13	Jara	Komarača
14	Hoti	Trokutska Rijeka
15	Donje Vusanje	Grlja

	Naziv stanice	Vodotok
1	Požnja	Požanjska Rijeka
2	Rijeka	Ibrištica
3	Zavraca	Ratnja Rijeka
4	Gornja Ljuta	Vrelo
5	Bjelojevići	Bjelojevićka Rijeka
6	Pojišta	Bukovica
7	Štitarica	Štitarica
8	Majstorovina	Bistrica
9	Kuti	Kutska Rijeka
10	Jošanica	Peročica
11	Lješnica	Lješnica
12	Kaludra	Kaludarska Rijeka
13	Dapsiil	Dapsička Rijeka
14	Šekular	Šekularska Rijeka
15	Ljuta	Vinicka

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2.2. Wind Potential

Theoretical researches

- Based on numerical calculation and model the wind maps for Montenegro show significant potential in certain areas
- Yearly average wind speed (m/s) at 80 m above ground estimated by Vestas
- Map of 1 km resolution

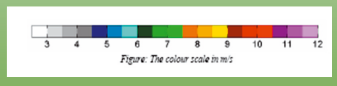
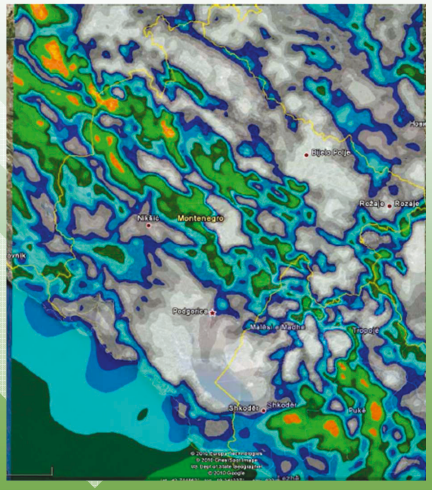


Figure: The colour scale in m/s



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2.2. Wind Potential (cont.)

Field measurements

- Mozura site

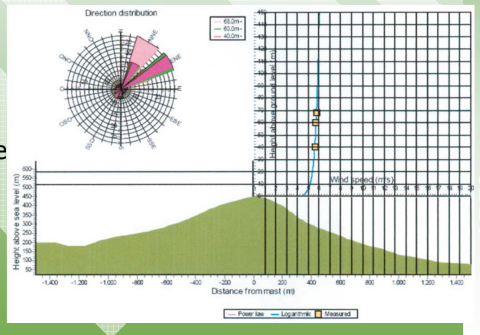
Municipality Ulcinj and Bar

- Measurements for 1 year, 10 min mean, 40-60-68 m pole
- Average wind speed 5.6-5.8 m/s

- Krnovo site

Municipality Niksic and Savnik

- Measurements for 1 year, 60 m pole
- Average wind speed 6.2 m/s



Mean wind profile and terrain profile, Mozura site

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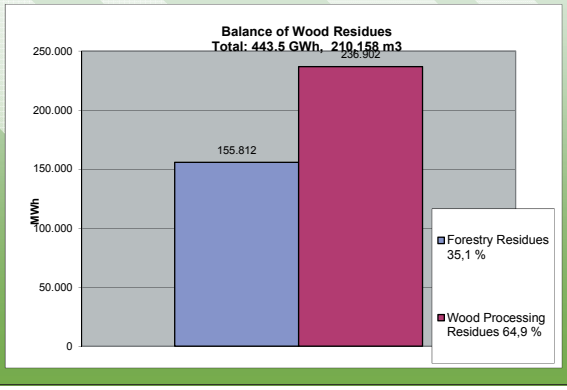
2.2. Biomass Potential

Studies of potential

- Montenegro has potential for energy production by using biomass from forestry, wood-processing industry, viticulture and other agriculture

- FODEMO project study done by Prof. Glavonjic estimates the energy **potential from wood residue** to be around **400 GWh**



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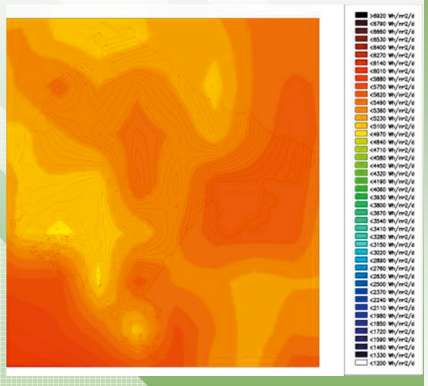
2.4. Solar Potential

Studies of potential

- High potential for using solar radiation in Montenegro
- Number of sunny hours for most part of Montenegro is above 2000 h/year, and more than 2500 h/year on the coast
- Podgorica has annual sun radiation 1602 kWh/m^2
- Specific heat from **solar-thermal collectors:**
  - Households ~700 kWh/m^2
  - Tourism ~900 kWh/m^2



Global sun radiation – mean daily values at monthly level (May)

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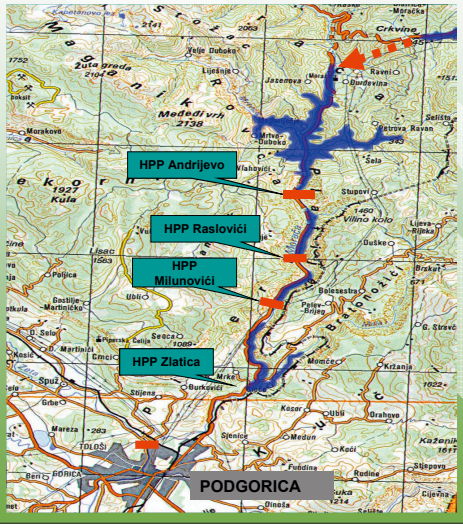
3.1 Hydro Power Plants on Morača



HPP Andrijevo; HPP Raslovići
HPP Milunovići; HPP Zlatica

- Total installed capacity
  ~ **238.4 MW**
- Annual production
  ~ **721 GWh**
- Time frame for construction of all power plants **6 years**
- Construction costs
  540 million €

Hydro Power Plants (HPP)

www.minekon.gov.me

Tender process is underway!

Renewable Energy Projects

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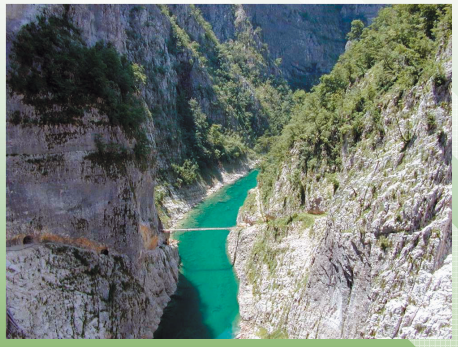
3.2. HPP Komarnica



- Total installed capacity **168 (2 x 84) MW**
- Annual production **232 GWh**
- Time frame for construction **7 years**
- Construction costs **160 million €**

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3.3. Small HPPs

List of water streams for which concessions are awarded

tender	Water stream	Municipality	Number of sHPP	Installed capacity [MW]	Production [GWh]
I	Bistrica	Berane	**8**	**10.00**	**37.00**
	Šekularska	Berane	**5**	**5.00**	**21.00**
	Bistrica	Bijelo Polje	**2**	**17.00**	**50.00**
	Bjelojevićka	Mojkovac	**2**	**15.00**	**48.00**
	Crnja	Kolašin	**1**	**3.00**	**10.00**
	Zaslapnica	Nikšić	**3**	**1.00**	**3.60**
	Grlja	Plav	**1**	**1.70**	**5.70**
	Babinopoljska	Plav	**2**	**9.45**	**24.20**
II	Vrbnica	Plužine	**2**	**12.00**	**27.00**
	Tušina	Šavnik	**4**	**6.00**	**16.45**
	Trepačka rijeka	Andrijevica	**1**	**8.30**	**33.10**
	Murinska rijeka	Plav	**2**	**2.36**	**9.45**
	Komarača	Plav	**1**	**4.00**	**10.60**
	Total		**34**	**~95**	**~300**

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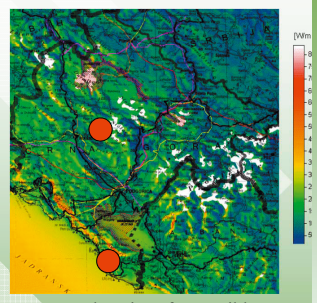
3.4. Wind Farms

- Projects for two wind farms are developing
- The one year on-site measurements are finished on six locations
- Study of absorption of the transmission system (TSO) in Montenegro is ongoing



Two locations for possible construction of wind farms

Wind farm	Municipality	Number of wind generator	Installed capacity [MW]	Generation [GWh]
Možura	Ulcinj	23	**46**	**~97**
	Bar			
Krnovo	Nikšić	21	**50**	**~110**
	Šavnik			

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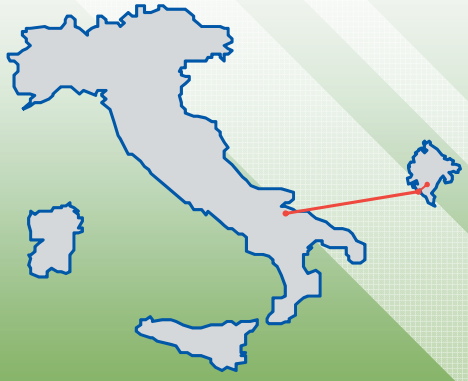
3.5. 400 kV HVDC Cable Italy – Montenegro



- 375 km of undersea cable
- **1000 MW** capacity
- HVDC bipolar cable, 2x500 MW
- 700 million € investment
- Project is developed in cooperation with **TERNA (Italy) and CES (Prenos Montenegro)**
- Start of operation - 2015

Renewable Energy Projects

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3.5. 400 kV HVDC Cable Italy – Montenegro (cont.)

- Line **400 kV Pljevlja-Tivat**
- 90 M€ investment
- Transformation station in Tivat

Transmission and distribution network

	Capacity [MVA]	Long [km]
400 kV	1 400	254
220 kV	700	400
110 kV	774	657
35 kV	584	1 150
10 kV	1 000	4 230
0.4 kV	-	14 000

Renewable Energy Projects

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4.1. Introduction of Support Schemes

Support schemes (mechanisms) are:

1. **Feed-in tariffs** (Guarantied prices)
2. **Guaranty of Origin** (GO)
   - Creation of national market in Montenegro (not realistic)
   - International market, Renewable Energy Certificates (REC)
   - Bilateral Green Certificate agreement, Italian Gestore Servizi Energetici – Montenegrian Regulatory Energy Agency
3. **CO_2 certificate**, **C**lean **D**evelopment **M**echanism (CDM)

Two combinations: 1+3 or 2+3

Producers of electrical energy from **RES** have **priority** in connection to transmission or distribution system operator and dispatching of electricity generated

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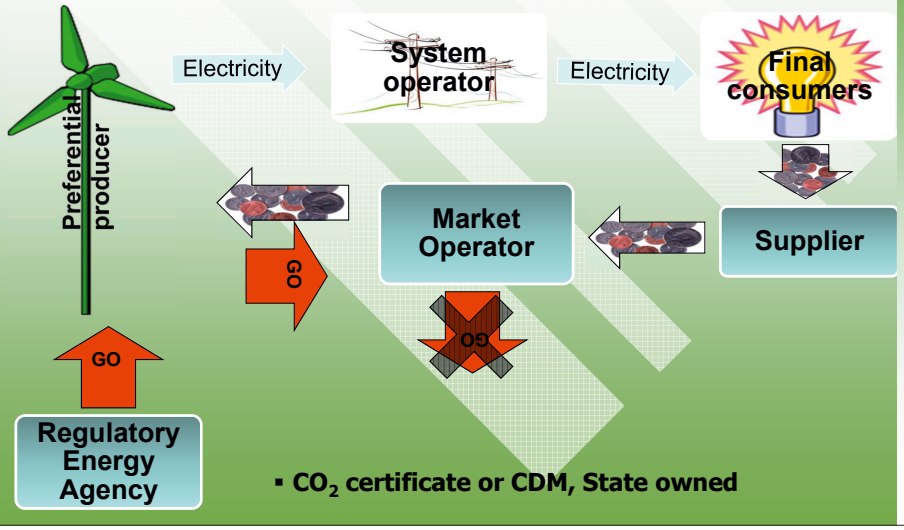
4.2. Feed-in Tariffs



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4.2. Feed-in Tariffs (cont.)

Investment cost

- Investment ~1.5 M€/MW (per installed power), capacity factor is 3000 h/a
  - Min. 30 % civil works , **~0.50 M€/MW** (NPV-Net present value)

Electricity price

- Electricity price is ~80 €/MWh, for example installed power sHPP 5 MW
- Average import price is ~60 €/MWh in the next 12 years
- NPV for price difference is **-0.45 M€/MW**

CO_2 certificate

- CO_2 certificate, 0.58 tCO_2/MWh on electricity system, assum. 20 €/tCO_2 => 11,6 €/MWh or NPV is **~0.26 M€/MW** (12 years)

Economic Analysis

- Reducing import 0.18 M€/MW; Exporting CO_2 certificate, 0.035 M€/MW
- Income of electricity production 0.24 M€/MW
- Sustainable economic growth with 0.275 M€/MW or 0.009 % GDP/MW (GDP=3000 €), investment is not included

Support Schemes

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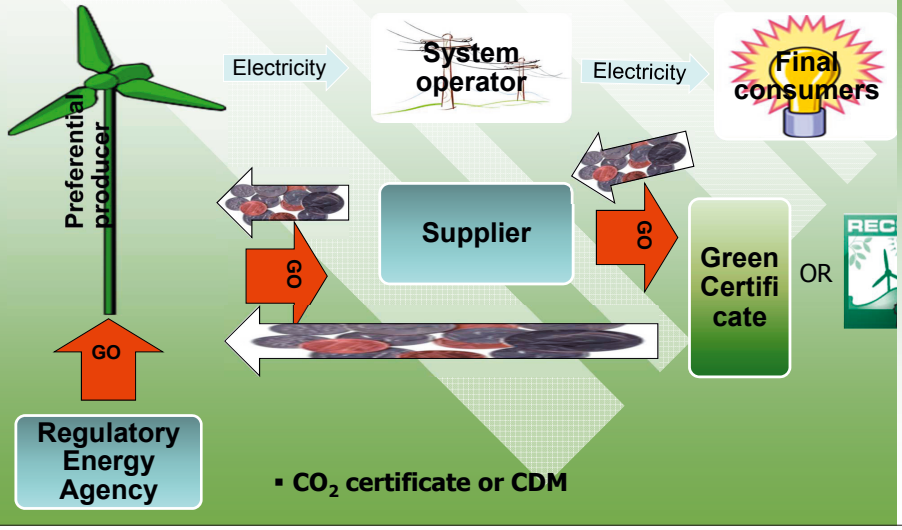
4.3. Guaranty of Origin



Support Schemes

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4.3. Guaranty of Origin (cont.)

Investment cost

- Investment ~1.5 M€/MW, capacity factor is 3000 h/a
  - Min.30 % civil works , **~0.50 M€/MW** (NPV-Net present value)

  (**THE SAME like in feed-in**)

Electricity price

- Market electricity price (60 €/MWh), NPV for the price difference is **0.00 M€/MW**
- **Green certificate** (assum. 70 €/MWh), NPV is **1.575 M€/MW** (12 years)

CO_2 certificate

- CO_2 certificate, 11.6 €/MWh or NPV **~0.26 M€/MW** (12 years) **(THE SAME)**

Economic Analysis

- Reducing import 0.18 M€/MW **(THE SAME),** Income 0.18 M€/MW
- Exporting **Green Certificate** and CO_2 certificate, total 0.245 M€/MW
- Sustainable economic growth 0.425 M€/MWh or 0.014 % GDP/MW

Support Schemes

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4.4. Conclusions about Support Schemes

Reasoning behind it

- Increase **energy security**
- **Decrease import** of electric energy
- **Energy independence** and **using national potentials**

After 12 years

- lifetime 20 or 30 years
- **market price** for electrical energy generated from RES

Support Schemes

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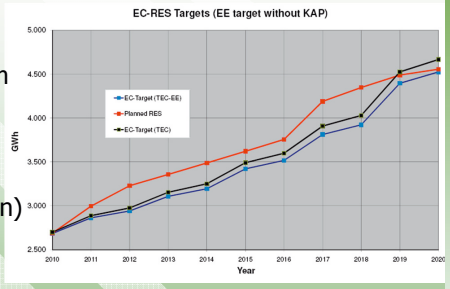
4.5. Share of National Potentials

- Based on the **planned projects**, Montenegro should not have a problem **meeting the RES National target**
- **Programme for development and use of RES** in Montenegro (Action plan) to meet National target



1. Projects planned under the Action plan will have an option to receive FIT
2. Projects not needed to fulfill the National target – GO

- Since Montenegro has higher RES potential than needed for National target, Montenegro will exploit possibilities and share national potential of RES through:
  - **Joint projects**
  - **Joint support schemes**

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5. CONCLUSIONS

- Montenegro is creating the ambient for sustainable economic development throw the renewable energy projects
  - new legalislative RES framework, including primary and secondary regulations under Directive 2009/28/EC
- The RES national target of ~30 % from GFEC can be achieved in Montenegro
- Two support schemes for RES projects are presented:
  - Feed-in tariffs
  - Green certificate

Both of them are in the line major strategic commitments and the sustainable economic growth on Montenegro

- High RES potential in Montenegro can be used for Joint RES projects Montenegro has a high potential for utilization of RES