# Matra Power Plant
# Possible pathways for low-carbon energy generation

**Zoltán Orosz**
**06.11.2018.**

# Matra Power Plant - Company profile

MÁTRAI ERŐMŰ ZRT.

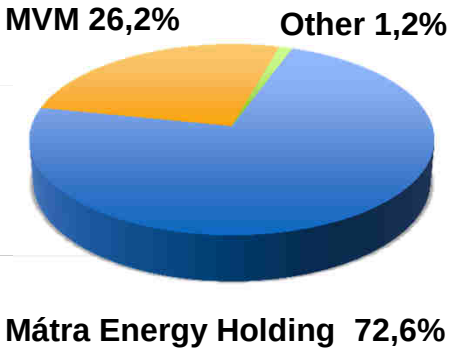
### Location of the site

### Key figures

| | |
|---|---|
| Installed capacity | **966 MW** |
| Sold electricity | **5 495 GWh** |
| Net income | **234 m EUR** |
| Result after tax | **2,4 m EUR** |
| Employees | **2 083** |

(prognosis for: **2018**)

### Shareholder structure




- **Main activities: Electricity generation based on lignite (2×100 MW; 1×220 MW; 2×232 MW) and gas (2×33 MW) (84% coal; 14% biomass; 2% RDF) 16MW photovoltaic unit from 2015 on**
- **Approx. 17% share in Hungarian electricity generation**
- **Coal extraction in two company-owned mines (Hungary's largest lignite deposit)**
- **The mine's and power plant's capacity maintained by retrofit projects till 2030**
- **Future of the power plant to be secured beyond 2030**
- **New regulations of EU ETS set extraordinary challenges**

# Electricity consumption in Hungary - 2017

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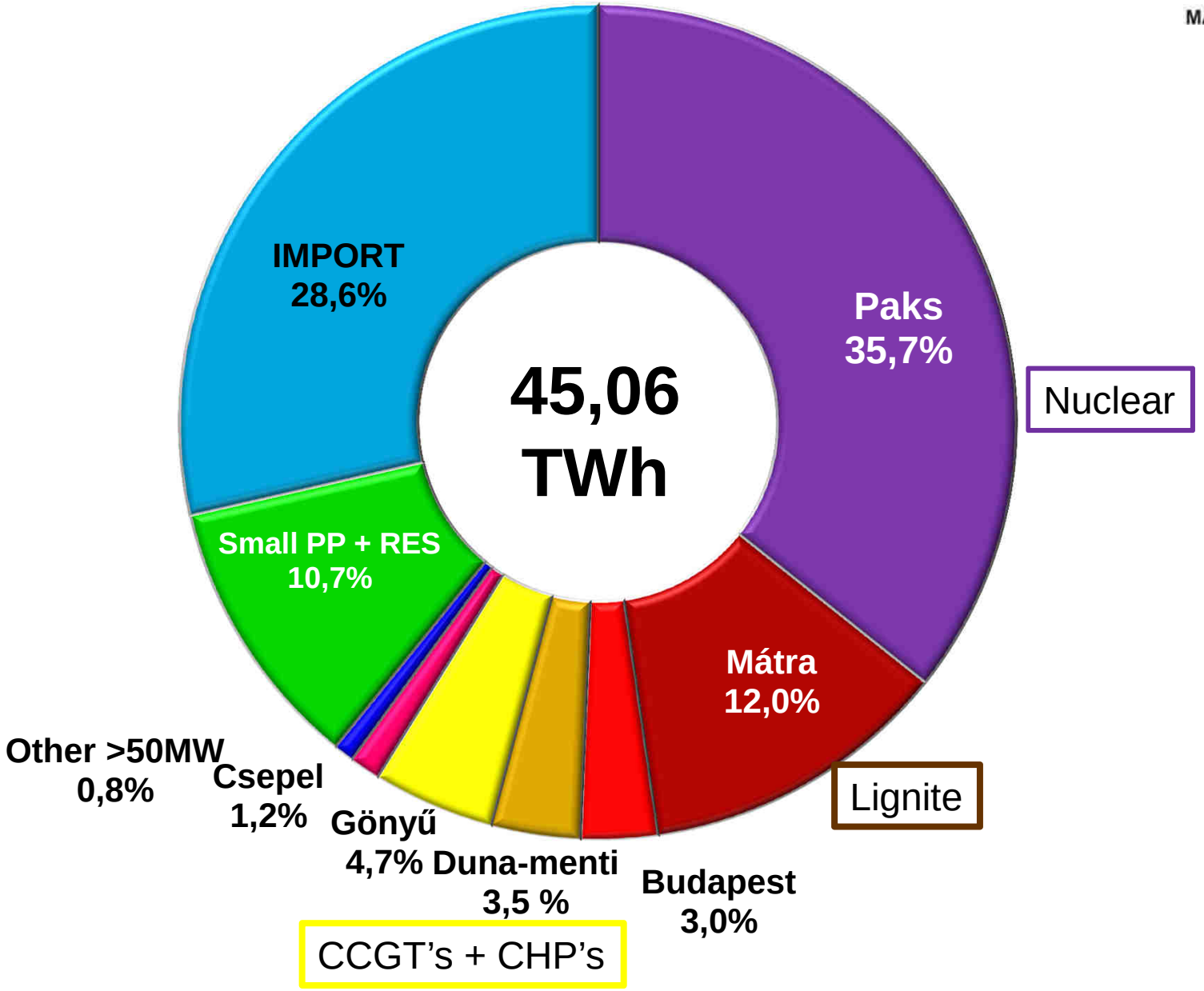




**Source**: Dr. Stróbl, http://mavir.hu/web/mavir/adatpublikacio

# Export – import 2012 - 2016

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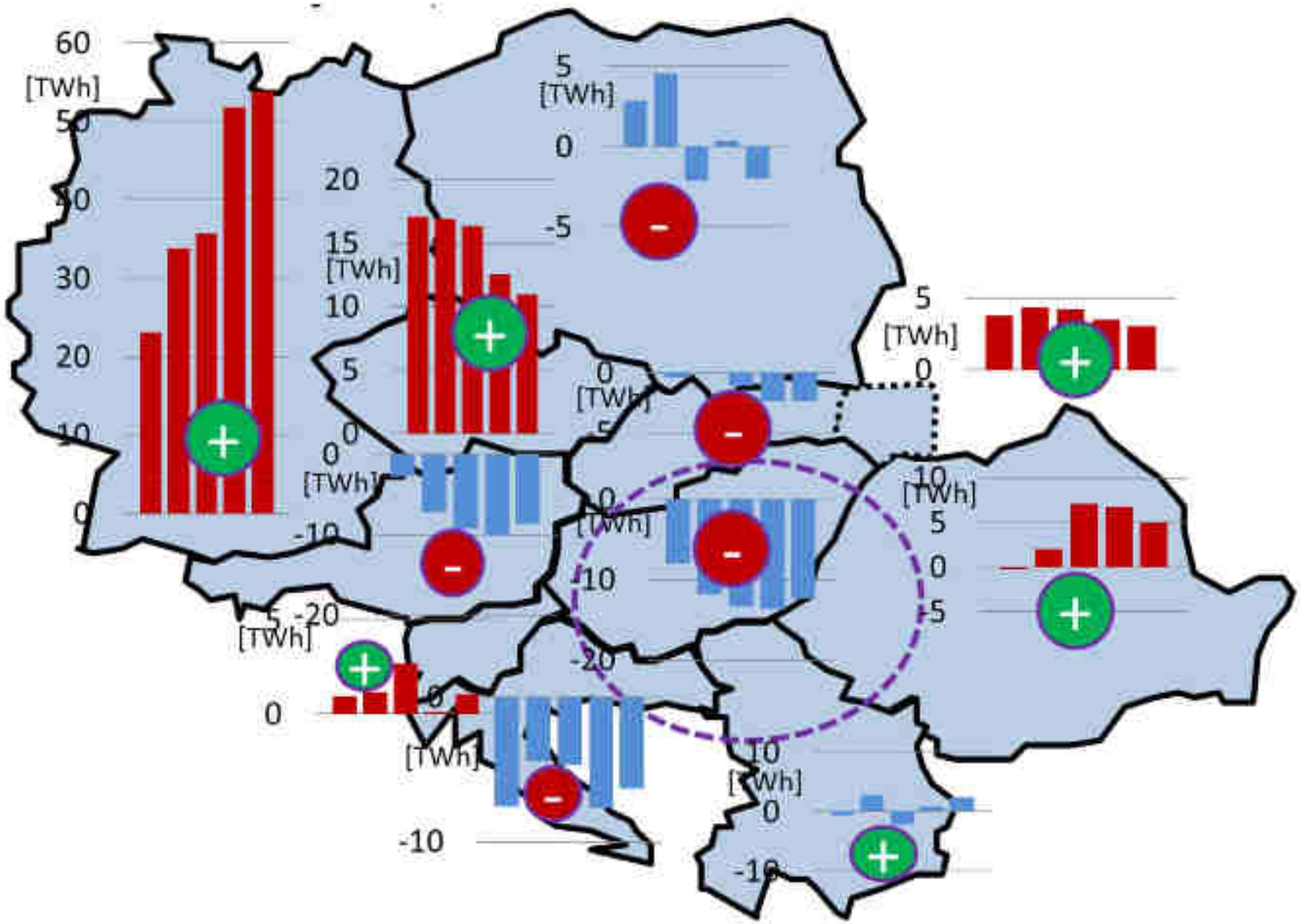


**Source**: www.mavir.hu MAVIR-RTO-DOK-0016-00-2017-10-02

# Electricity generation in Hungary - 2017

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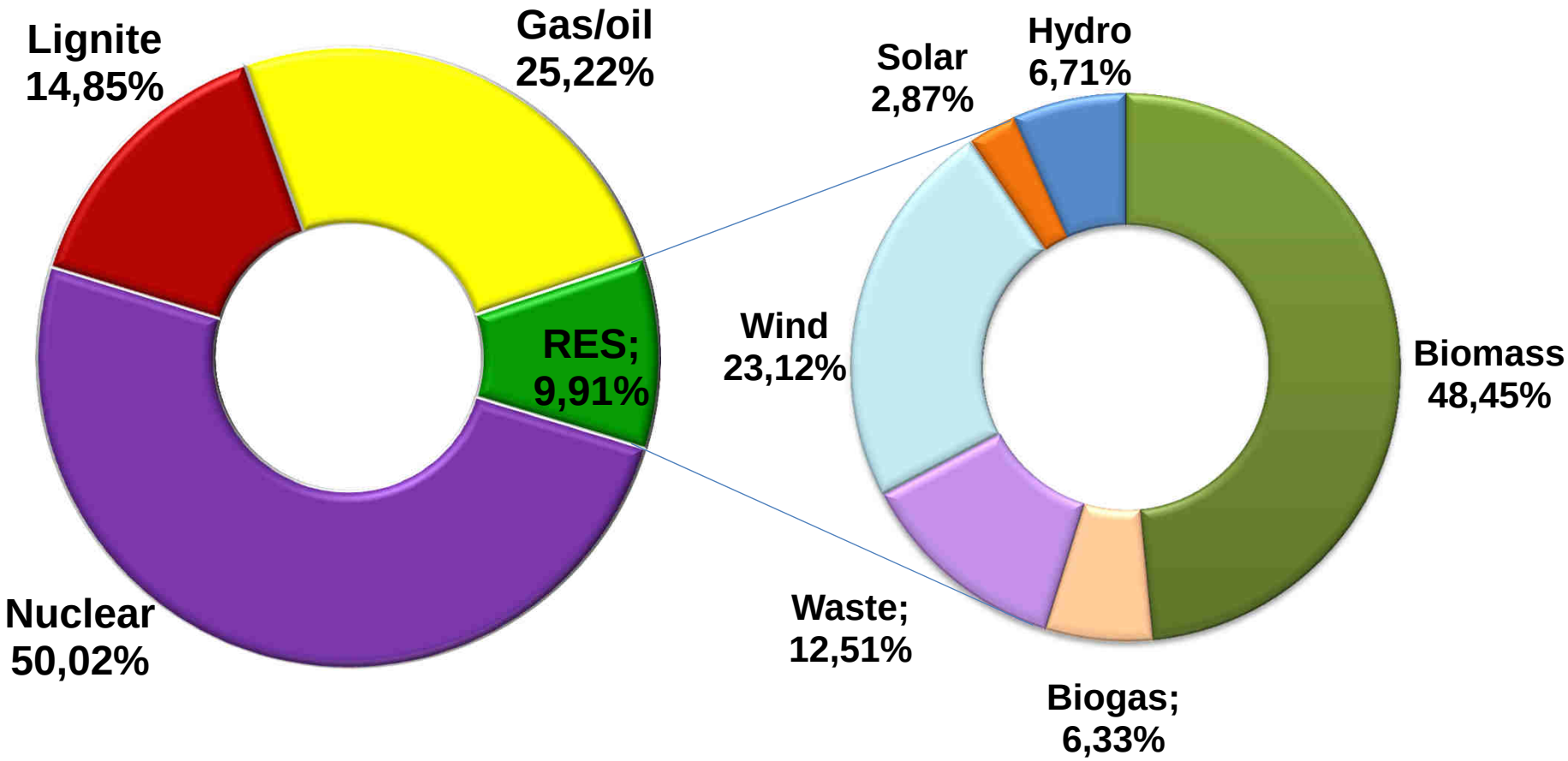




**Source:** Dr. Stróbl, http://mavir.hu/web/mavir/adatpublikacio

# Coal-fired (hard coal + lignite) production rate in EU

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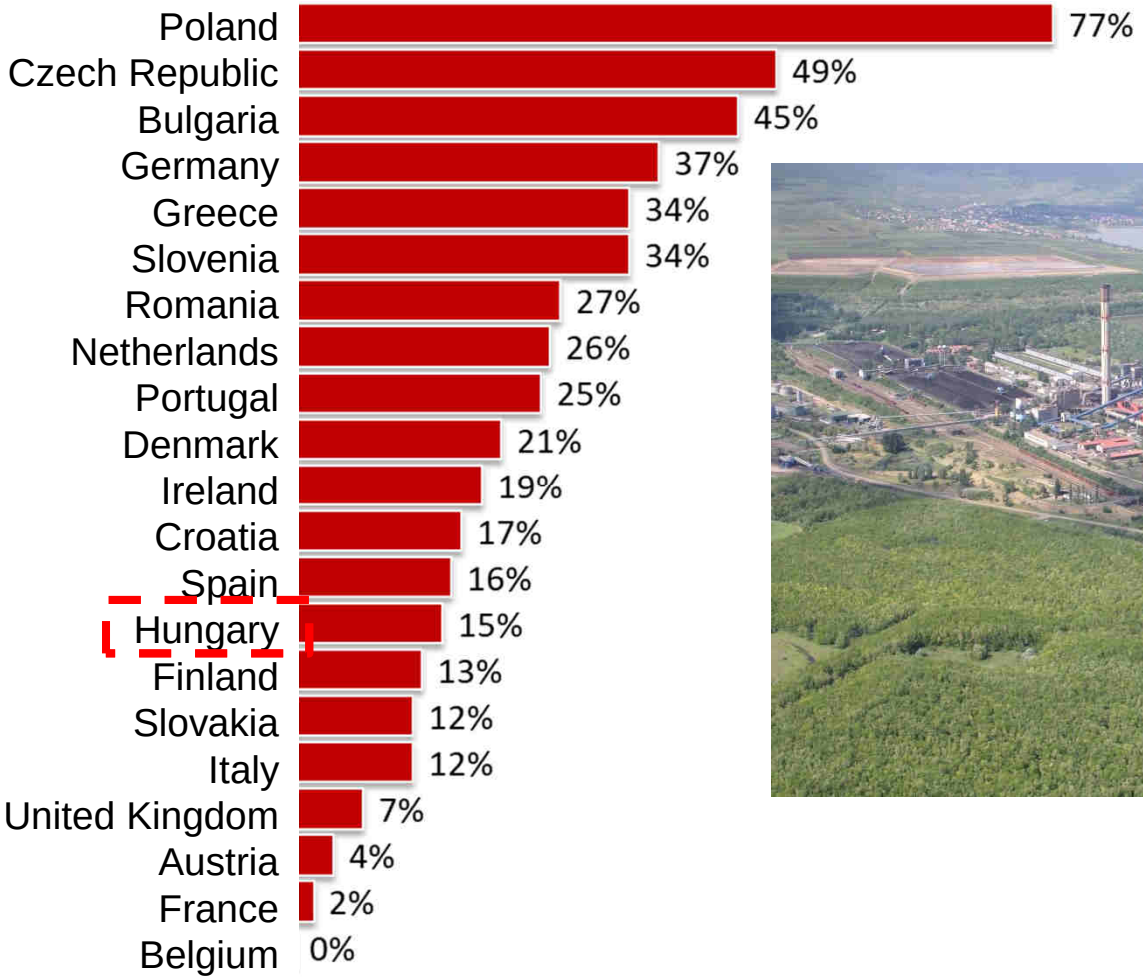
## 106,000 MW coal/lignite-fired capacity is installed, which gives most of the production and regulation




**Matra Power Plant**

**Source**: www.agora-energiewende.de (The European Power Sector in 2017; January 2018)

# Electricity production of Matra by energy sources

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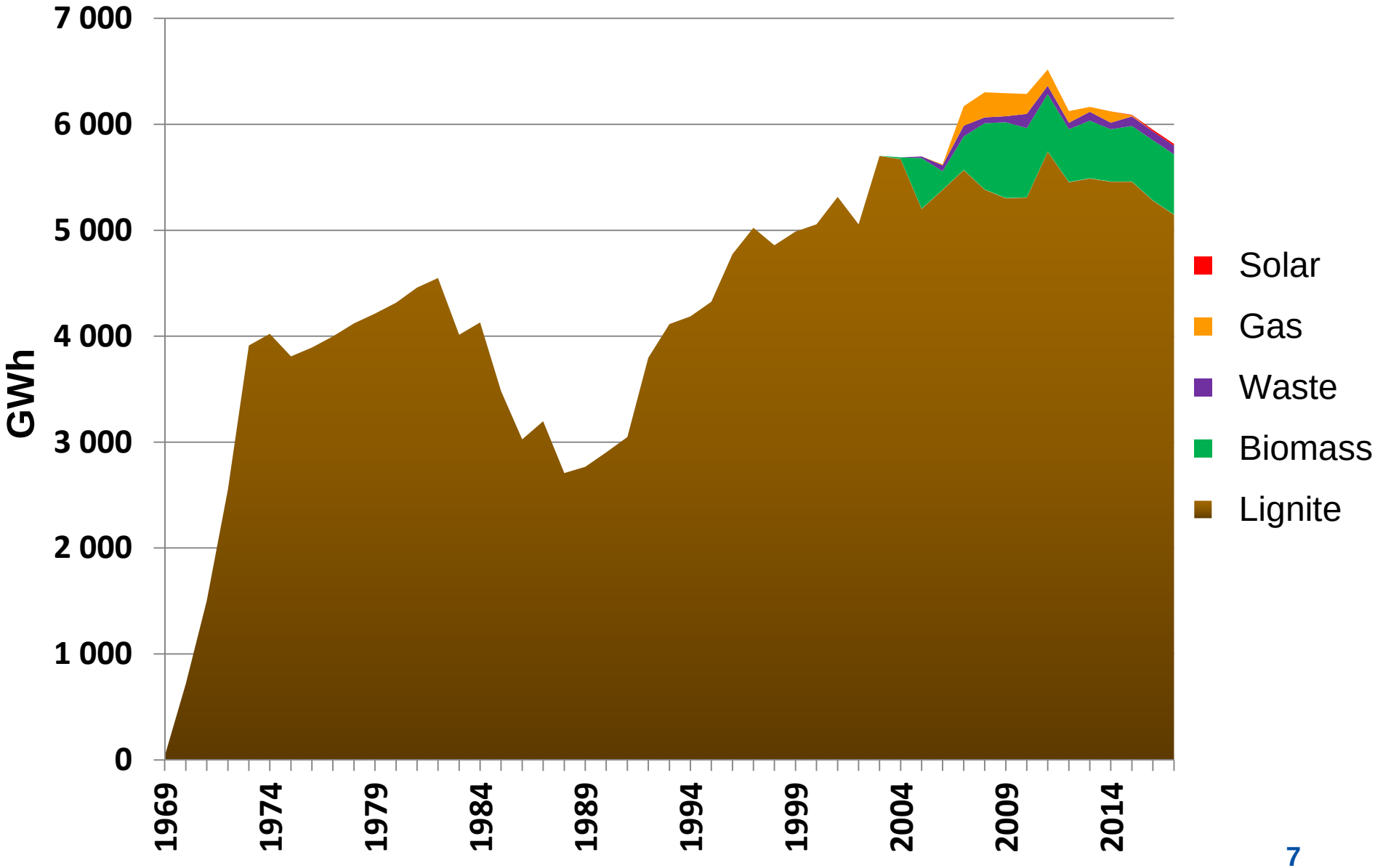

# The company-owned strip mines in Visonta and Bükkábrány

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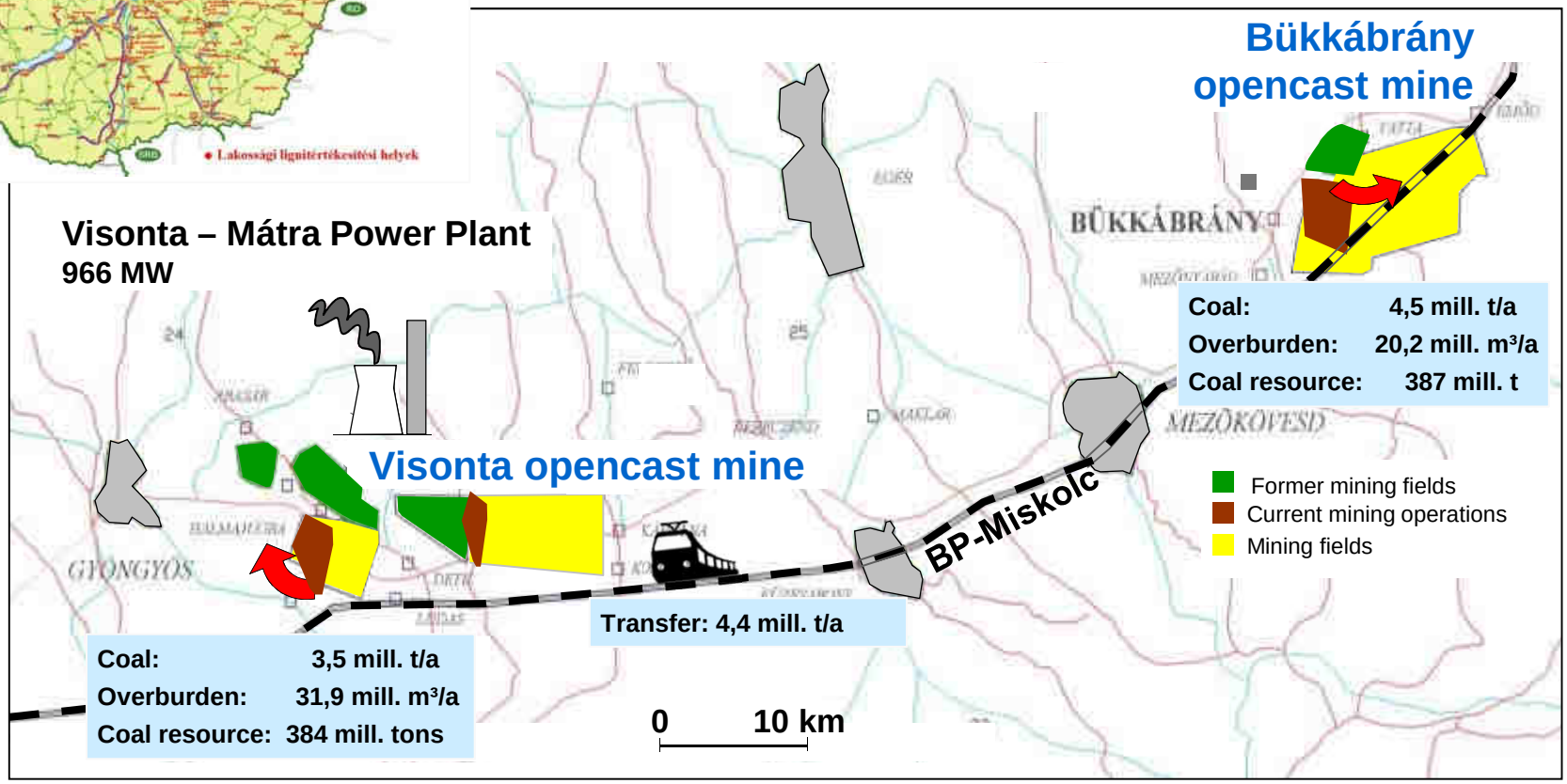


# Production capacities of own mines, 2018

MÁTRAI ERŐMŰ ZRT.

| | Visonta | Bükkábrány | ∑/Average |
|---|---|---|---|
| Sites |  |  | |
| Lignite | 3.5 Mt | 4.5 Mt | 8.0 Mt |
| Overburden | 31.9 Mm³ | 20.2 Mm³ | 52.1 Mm³ |
| Strip ratio | 9.0 : 1 | 4.4 : 1 | 6.4 : 1 |
| Calorific value | 6,545 kJ/ kg | 6,920 kJ/ kg | 6,742 kJ/kg |
| Features | Southern mine will be closed down by the end of the decade. Instead of this, opening Eastern-III. mine was started at the end of 2015 | Amount of the excavated coal reaches 4.5 m tons per year, that is why the mine is extended towards north | |

MÁTRAI ERŐMŰ IPARI PARK

# Mátra Power Plant
# Main partners of the Industrial Park

MÁTRAI ERŐMŰ ZRT.

## Geosol Kft

- Preparation of biomass 500Tt/y
- electricity

## Zöldolaj BB ZRt.

- 40 Tt/y plant oil
- Biodiesel fuel
- steam, electricity
- By-product: rape-cake (biomass fuel for PP)

## Rigips Kft

- 20 M $m^2$/y plasterboard
- electricity
- FGD gypsum

## Baumit Kft

- 100 Tt/y alpha hemihydrates
- steam, electricity
- FGD gypsum

**Further companies are going to settle in the IP**

# Development of the Industrial Park at Mátra

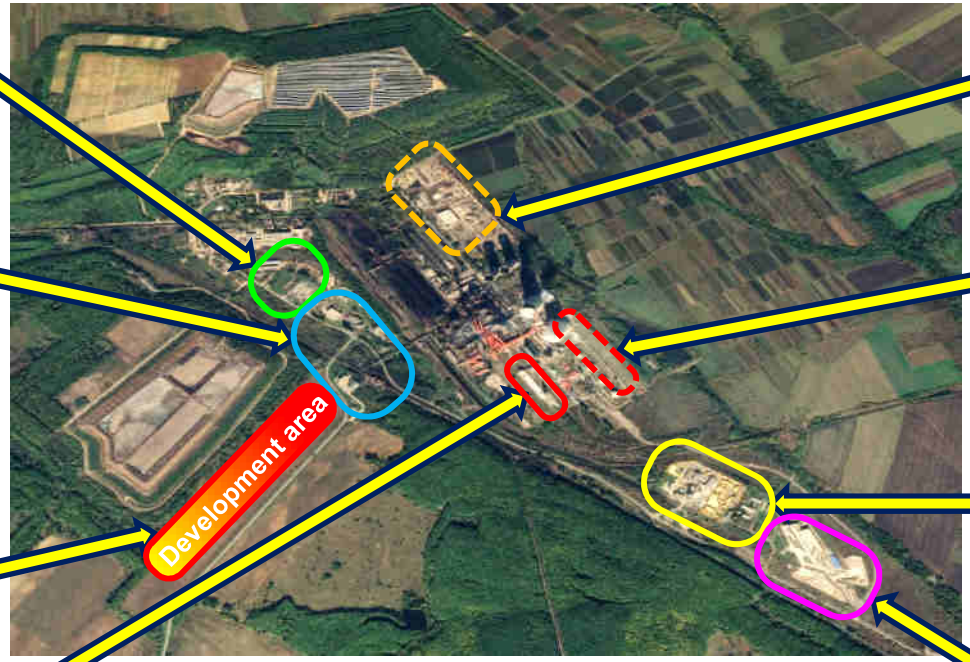
MÁTRAI ERŐMŰ ZRT.

**Zöldolaj BB Plc.** 1
- > 40 Tt/year vegetable oil
- > Biomass fuel
- > Steam, electricity

**Geosol Ltd.** 2
- > 500 Tt/year biomass preparation
- > Electricity
- > Sewage drying + Biomass-processing
- > 9 GWh/y power demand

**Development area** 2
- > Owned by Matra

**Baumit Co.** 4
- > 100Tt/year Alfa-Semi-hydrate
- > Steam, power
- > FGD gypsum




**VIRESOL Ltd.** 5
- > Starch production
- > 800 TJ steam, 64 GWh/a power demand

**Duna Develop. Ltd.** 6
- > 60 M Liter/year bioethanol
- > Biomass Fuel
- > 600 TJ steam, 12 GWh/a steam demand

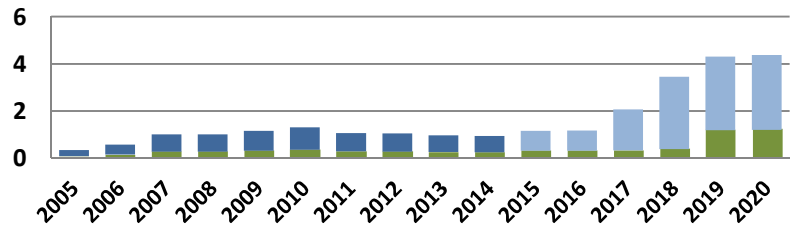
**Xella Ytong Ltd.** 7
- > 120.000 $m^3$ /a brick block
- > 2,2 GWh/a power demand
- > Steam, FGD gypsum

**Rigips Ltd.** 8
- > 20 M $m^2$/a Plasterboard
- > Power
- > FGD gypsum

## Key indicators of the Mátra Industrial Park

- > **300 ha plot**
- > **23 settled firms**
- > **26 subsidiaries**
- > **1674 workplaces**
- >**total revenue 23 bln HUF**
- >**more than 20 bln HUF investments**
- >**100.000 t/a fly ash sales**
- >**300.000 tons/a gypsum sales**

**blnHUF** **Revenue from industrial park**




**Basic commodity supplies**

>**Fly ash** - cement industry Hungary / Slovakia

>**Gypsum** – mortar production (BAUMIT)

- Foam concrete block production (YTONG)
- Plasterboard production (Saint Gobain RIGIPS)
- other (land reclamation, aluminum industry)

# Sustainable biomass program

MÁTRAI ERŐMŰ ZRT.

| | |
|---|---|
|  | **Traditional biomasses:** In the surrounding of Mátra PP there is a growing potential of vine cane, fruit-tree cuttings, other tree cuttings, mushroom compost, straw etc. |
|  | **Grains, rape-cake from the Mátra Industrial Park**<br>By products from the biodiesel factory and from the future starch and bio-ethanol factories 200.000 tons/a |
|  | Using the **biomasses** of **local** agricultural, forestry, cutting areas, and RDF with high biomass content |
|  | **Energy forests**. Mátra PP started a 20 ha pilot project and after success extended to 120ha.<br>Depending on future energy forest developments in the 30km surrounding Matra is ready to close long term contracts |

**By biomass utilization the avoided $CO_2$ cost is capitalized in the agriculture**

# Investments related to energy efficiency

MÁTRAI ERŐMŰ ZRT.

## 1 Dense slurry system by GEA-EGI

> The existing energy intensive thick slurry system for the fly ash transportation was replaced. 80% less circulating water
> Smaller environmental load was achieved



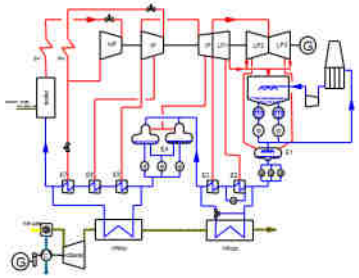
## 2 Flue gas desulphurization by Babcock

> Wet limestone-based FGD to reduce $SO_2$ from 10.000 to 200 mg/Nm$^3$
> The by-product gypsum is utilized in the local industrial park. Steam and electricity by Mátra



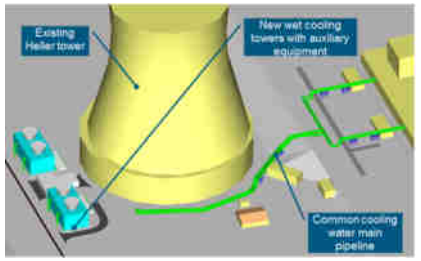
## 3 Topping gasturbines by Hitachi Power Europe

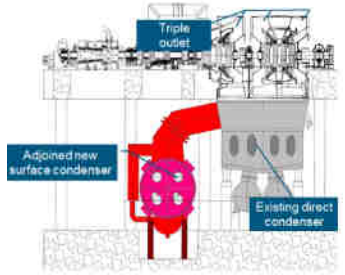
> Peaking gas turbines connected to existing units IV and V
> Feed water preheating in the HR boiler
> Surplus 11MW due to external feed water preheating realized at the lignite units


## 4 Hybrid cooling system by ALSTOM Hungary

> Wet cooling cells combined with existing dry cooling tower and mixing condenser system
> Bottleneck of cooling capacity eliminated
> Surplus 9MW capacity due to efficiency increment at the unit IV and V





# Implemented measures related to biomass

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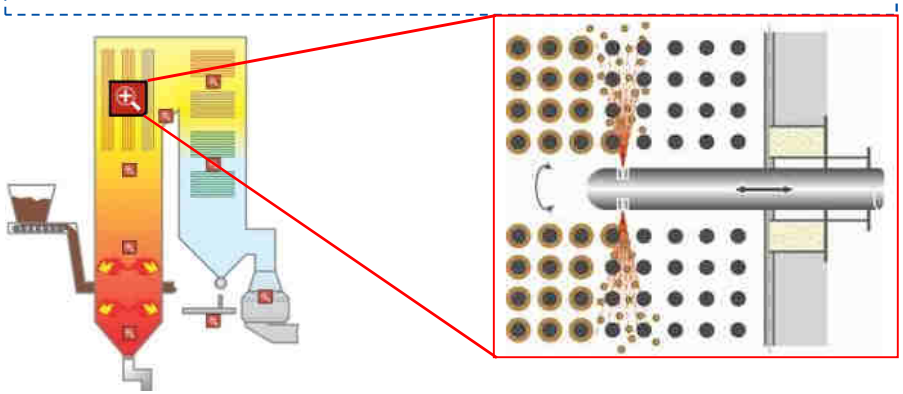
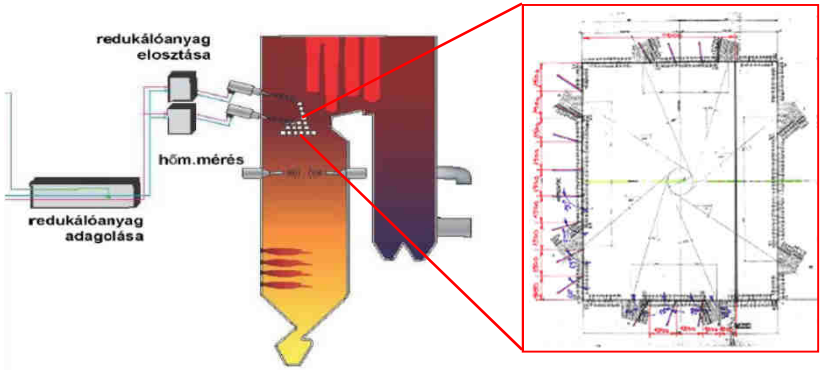
## 1 Soot blowers for the super heaters

> Soot blowers for SH3 and SH4 on units III-IV-V (it was not necessary before)



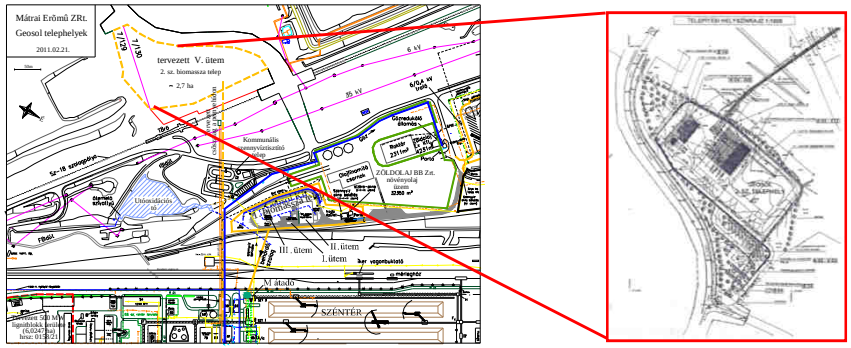
## 2 $NO_x$-reduction by SNCR

> Back-up secondary measure beside the primary measures



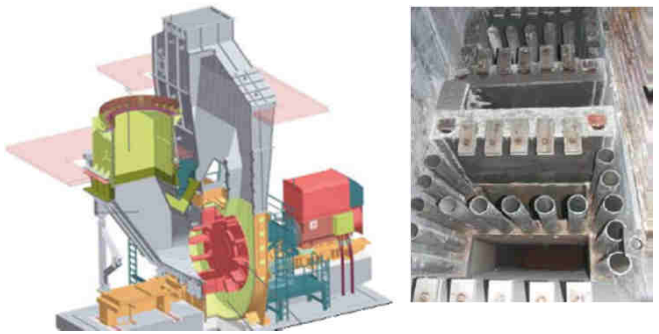

## 3 Extension of the biomass-site

> The capacity was 420 ktons, which was extended to 900 ktons/a
> Sewage drying and disinfection facility




## 4 $NO_x$ reduction by primary measures

> Unit V. was the first complete unit. Unit IV. and III. were gradually converted
> Guaranteed $NO_x$ limit <200 mg/Nm$^3$



# 16MW PV unit in Visonta

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## Project description

**Implementation of a 16MW PV plant as recultivation measure**

- Investment start 16. 04. 2015.
- Commissioning 15. 09. 2015.
- Capacity $18{,}5MW_p$ ($16MW_{net}$)
- CAPEX 6,5 bln HUF
- **Rationale** Feed-in tariff for 11 years after commissioning
  Avoided recultivation costs of slurry deposit
  Usage of existing grid connection

**Implementation progress**

- In order to avoid turnkey premium the project was cut into four public procurement parts. The first contained the turnkey implementation of the power plant on the slurry deposit. The second was the procurement of 2×24MW transformers necessary for grid connections. The third and fourth package covered the procurement of the grid cables and the cabling and grid connection works.
- Wire-Vill, IBC Solar GmbH, Energobit SA consortium and CG Electric

## Technical details

- Installed net capacity: 16,0 MW
- Inverter type: SMA Sunny Central 800CP XT, 20 pcs
- Transformer type: Robust Solar 2MVA, 10 pcs
- Module type: 255W KIOTO polycrystalline, 72.480 pcs
- Support structure: rammed, special hot dip galvanized, with 6 row arrangement
- DCS: Sunny String Monitoring, fully integrated into the existing MAB system of the Mátra PP
- Spares and reserve main equipment in a value of 300.000 EUR
- Guarantees: 10 years overall, (but 25 years on modules, 15 years on inverters, 25 years on transformers and 30 years on support structure)
- Final acceptance (after fulfilling operational guarantees): after two years
- **The biggest PV unit in Hungary till 10.2018.**

# 20 MW PV unit in Bükkábrány mine

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***An additional 60 MW could be built as an extension of the actual site on the overburden deposit of the mine***



**Technical data**

| | |
|---|---|
| > Construction start | 13.09.2018. |
| > Commissioning | 15.02. 2018. |
| > Contractor: | SPIE Hungary & bejulo |
| > PV panels: | 63.840 × 355W CanadianSolar |
| > Inverters: | 20 × 1000 kW SMA CompactSt |
| > CAPEX | 5,4 bln HUF |
| > Feed-in tariff for 19 years | |
| > Utilization of existing grid connection | |
| > Avoided recultivation costs overburden deposit | |


Sunny investments… but sunset for the site?

# Existing installed capacity in Hungary

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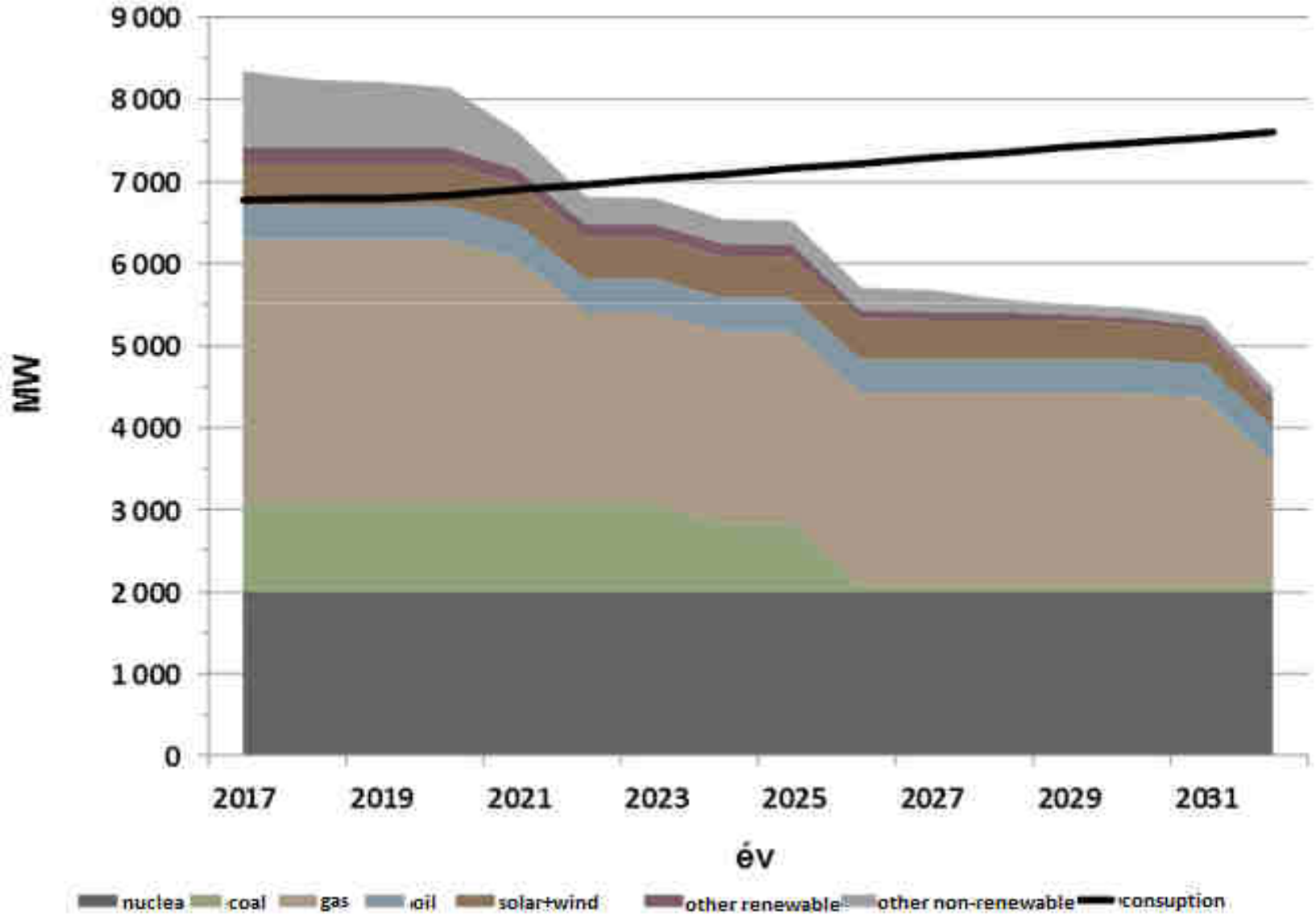




**Source**: www.mavir.hu MAVIR-RTO-DOK-0016-00-2017-10-02

# Production distribution plans in Hungary 2022-32

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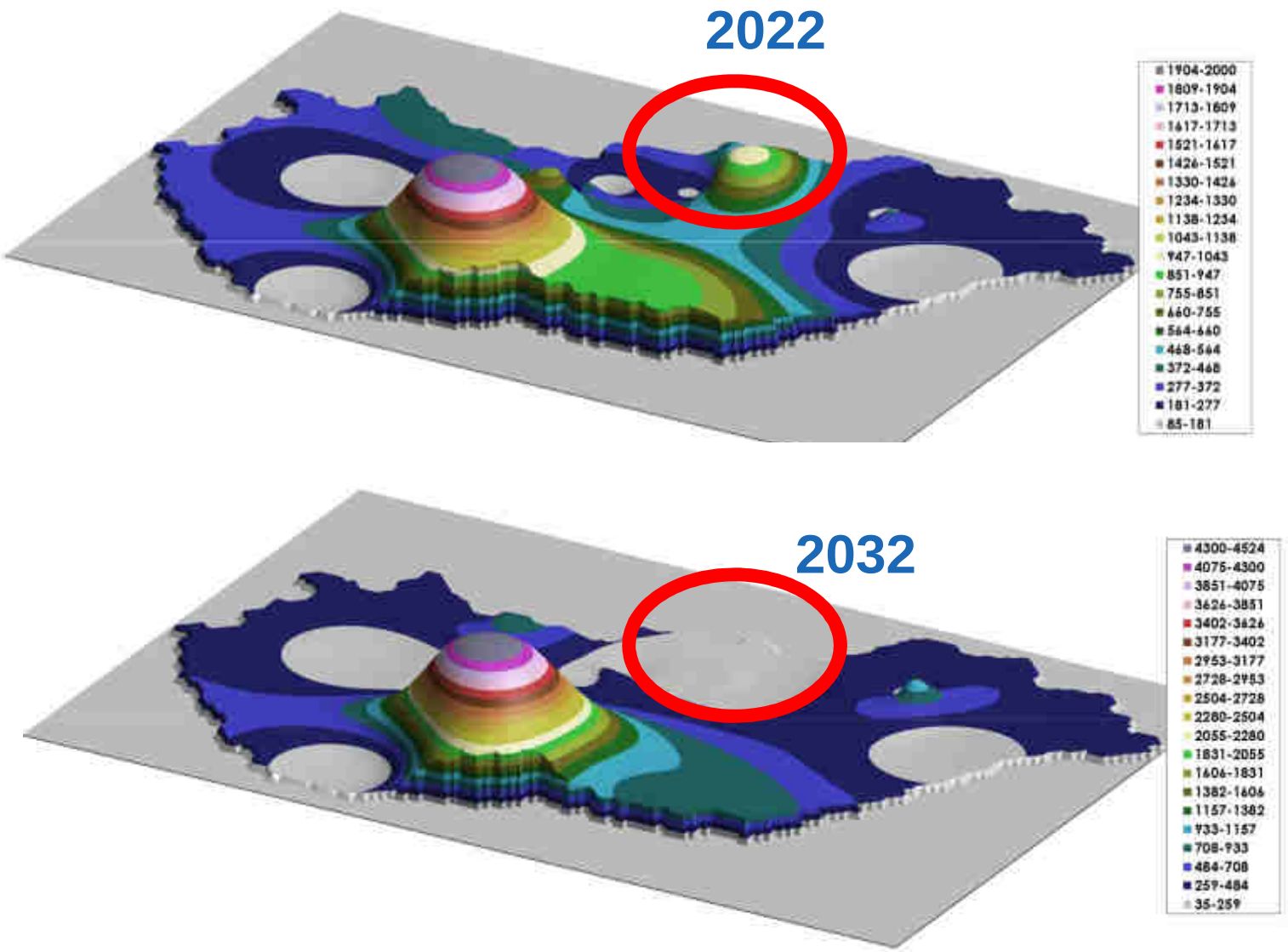




**Source**: www.mavir.hu MAVIR-RTO-DOK-0016-00-2017-10-02

# Development concepts

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## 31,5 MW RDF unit

Capacity: 31,5 MW

Average building time: 32 months

**Rationale:** brown field, existing RDF value chain

## 450 MW gas

Capacity: 450 MW
Average building time: 30 months
**Rationale:** brown field, existing gas connection and capacity

## 100 MW biomass

Capacity: 100 MW

Average buliding time: 36 months

**Rationale:** brown field, existing biomass chain

## 50 MW battery storage

Capacity: 50 MWh

**Rationale:** connected to existing PVs, substituting system services

## 200 MW PV

Capacity: 200MW

Average building time: 15 months

**Rationale:** O&M knowhow

Free areas in mine and PP

## Solar panel factory

Capacity: 2bd

**Rationale:** given medium-long term demand

Re-skilled workplace



**Source**: pictures from various existing examples

# 20 MW PV unit in Visonta / Halmajugra

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## *Copy-Paste*

***An additional 100 MW can be built as an extension of the actual site on the overburden deposit of the mine***

# 31,5 MW RDF-fired unit

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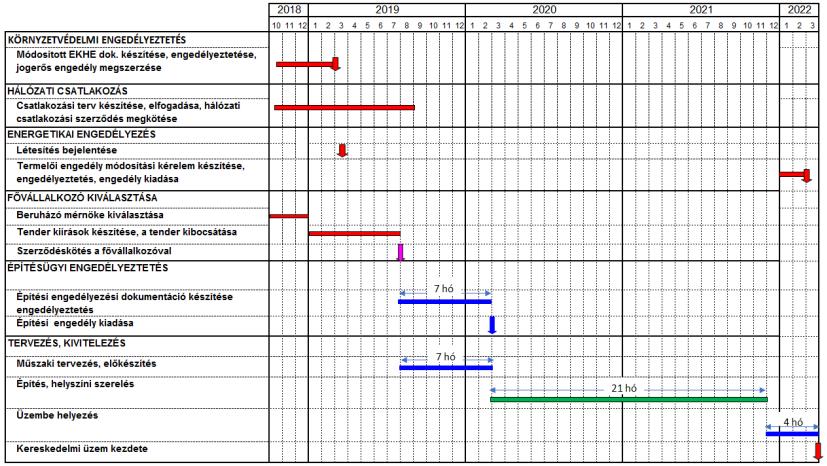
## Technical concept

- 2 RDF/biomass **grate-fired** boiler
- Renewable electricity generation
- To supply demands from the industrial park (Viresol, other buyers from the industrial park)
- Exploiting the existing RDF biomass logistics
- Biomass as a probable secondary fuel
- Brownfield investment
- In case of the reorganization of the site, it can supply alone the remaining industrial park establishments




## Next steps

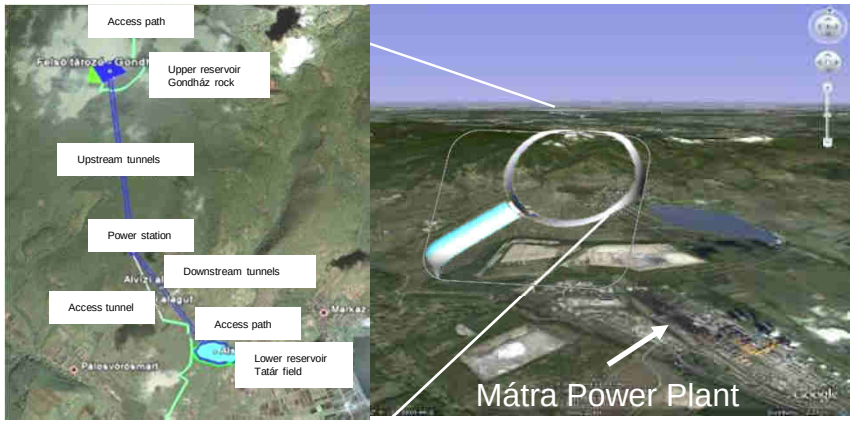
- Obtaining IPPC permission (modifying the necessary, already completed documentation) **– new emission and spread calculation**
- Secure RDF fuel supply
- Providing financial conditions
- Investment decision
- Availing investment engineering service
- Conducting authorization processes
- Implementation

# Pumped storage plant(s)[1]: global change of the production side draws attention to energy storage

MÁTRAI ERŐMŰ ZRT.

## Technical data

> **Capacity**: 600 (4 x 150 MW)
> **Storage**: at least 6 hours full load turbine operating time; ±600 MW operating range
> Raw water volume of the reservoir ~ 4,24 Mio. m³
> Amount of electricity which can be stored: 3,6 GWh
> **Minimum height difference:** 502 m
> **Sites**: Gondház rock as the upper reservoir, Tatár field as lower reservoir




## Project description

> 600 MW pumped storage plant can be established in Mátra mountains. The site was chosen from numerous possible fields in Mátra mountains. **It provides almost the longest falling height** in Hungary.

> **Grid connection** is possible at Mátra site.

> Comparing with other sites, this has one of the least environmental effects. Administrative consultation is finished. **There are not any exclusive items**.

> Market demand for flexible capacities. Prerequisite of the extension of Paks II. and the renewable energy capacity(wind, decentralized energy.)

## Advancements

> Preliminary feasibility study is completed
> 2011 – Introducing the advancement of the project to MVM
> 2011/12 – Obtaining approvals and permissions (obtaining territory) to investigate detailed feasibility and for the researches
> 2012 - Natura2000, biota, ornithological analyses
> 2013 – Detailed 3D geodesic surveys are completed

> Geologic examinations can be started in 2019

[1] **Decentralized establishment of plants with less capacity, which can be faster built, must be investigated.**

# Battery storage solution

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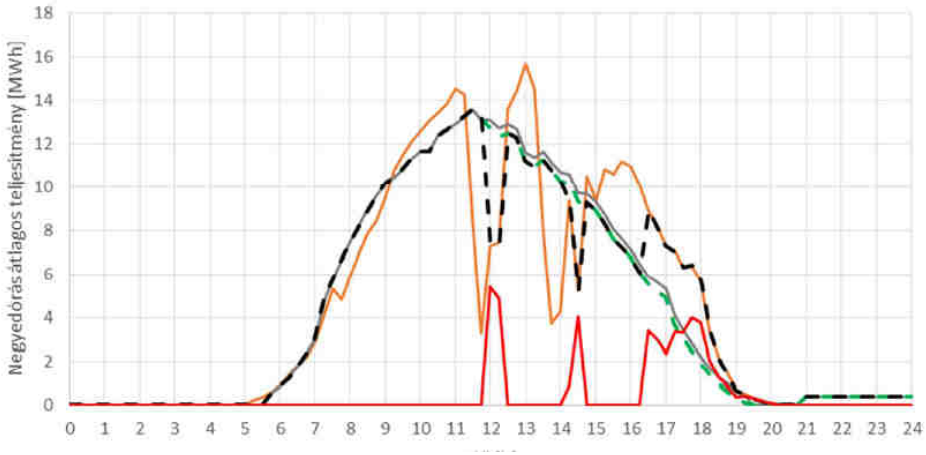
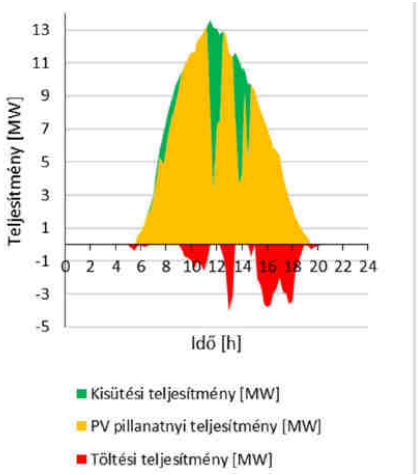
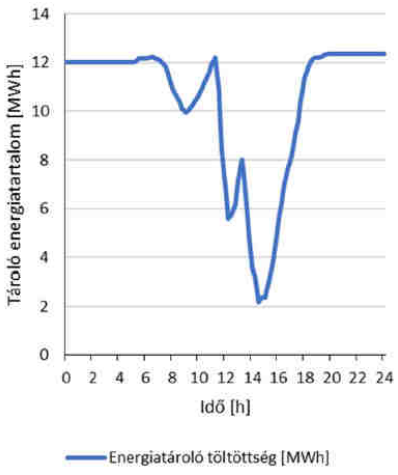
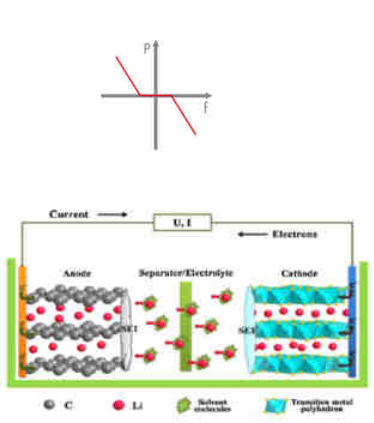
***If establishing a pumped storage plant shows political and local concerns, we have to move towards battery storages***



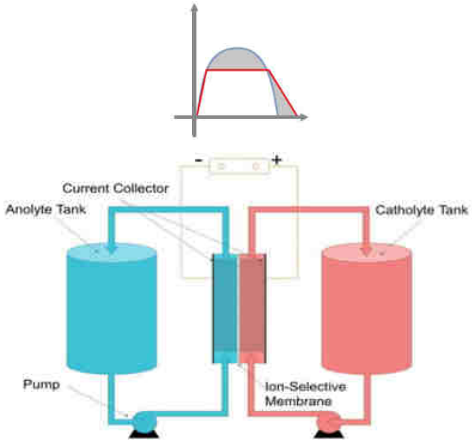



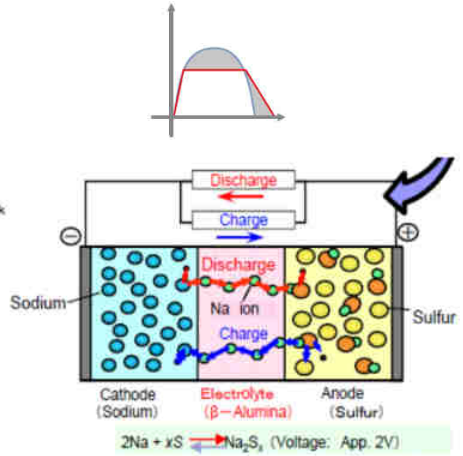

**Lithium-ion battery**




**Redox-flow battery**




**Sodium-Sulfur battery**



# 500 MW combined cycle gas turbine unit

MÁTRAI ERŐMŰ ZRT.

## Advantages

> Providing Hungarian market with regulated schedule electricity

> Low-$CO_2$ alternative of the 500 MW unit

> Reduce loading of the environment and emission

> Maintaining industrial park's heat consumers

> 1x1 CCGT design (specifically cheaper) or

> 2x1 CCGT (more flexible)

Source: SIEMENS

## Rationale

> Brown field unit

> Existing gas connection to Brotherhood pipeline

> Existing electric grid connections

> Other existing infrastructure

## Next steps

> **Preparations and decision in 2019**

> Authorization in 2019

> The construction starts in 2019 – 2020

> Building time is 18 months

> **Start of operation in 2023**

# Possible scenarios for Mátra site

MÁTRAI ERŐMŰ ZRT.

| | | I. | II. | III. | IV.+VI. | V.+VII. | VIII. |
|---|---|---|---|---|---|---|---|
| Mátra Old+RETROFIT | 555 MW | 100 MW(1) (2019) | 100 MW(1) (2020) | 220 MW (2029) | 232 MW(2) (2033) | 232 MW(2) (2033) | 31,5 MW RDF (2050) |
| | | | | | 29,6 MW | 29,6 MW | |

(1) Unit I and II will stopped for cold reserve. Only limited operation.

(2) RETROFIT is necessary in 2022-23

| | | I. | II. | III. | IV.+VI. | V.+VII. | VIII. | IX. | X. | XI. | XII. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mátra Low carbon | 1382 MW | 100 MW (2019) | 100 MW (2020) | 220 MW (2029) | 232 MW (2029) | 232 MW (2029) | 31,5 MW(3) RDF (2050) | 100 MW bio-mass (2050) | 450 MW(4) CCGT (2050) | 600 MW(5) pump-st.(2070) | 200 MW(6) PV (2050) |
| | | | | | 29,6 MW | 29,6 MW | | | | | |

(3) RDF unit to utilize Hungarian RDF

(4) Gas unit with high efficiency to generate energy and to regulate

(5) Pump-storage plant with high efficiency to regulate the system (Paks too)

(6) Additional photovoltaic parks with or without battery storage

| | | I. | II. | III. | IV.+VI. | V.+VII. | VIII. | IX. | X. | XI. |
|---|---|---|---|---|---|---|---|---|---|---|
| Mátra High carbon | 1332 MW | 100 MW (2019) | 100 MW (2020) | 220 MW (2029) | 232 MW (2029) | 232 MW (2029) | 31,5 MW RDF (2050) | 500 MW(7) Lignite new (2050) | 600 MW pump-st.(2070) | 200 MW PV (2050) |
| | | | | | 29,6 MW | 29,6 MW | | | | |

(7) New 500 MW lignite unit with 42% efficiency

* Mátra's owners invest only into renewable energy till the establishment of the long-term European energy generation trends

## There is a political determination to phase-out the coal, but acceptable action plans have not been worked out yet to handle consequences. Professional workshops were just established.

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**If Mátra is shut down, 20% of the Hungarian generation capacity disappears**

| Industry | Population | Energy | Grid |
|---|---|---|---|
| ▪ Railway (-5 Mio t)<br>▪ Cement production<br>▪ Plasterboard production<br>▪ Building raw material<br>▪ Limestone production<br>▪ Alumina production | • Workplaces<br>• Local authorities<br>• Heating fuel-supply | • Biomass utilization<br>• RDF firing<br>• Industrial consumers' heat supply | • Voltage control of high voltage grids in Eastern Hungary |

- 2100 direct, 4700 indirect workplaces, SME in the value chain

- Just Transition: workforce is aging; lignite sector is embedded in the region's economy ; high potential for energy generation would remain after lignite;

- Low-carbon trajectory requires the involvement of key stakeholders: central government, local governments, TSO, Energy Authority, Trade Unions etc.


… or transform the site for the future?

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# Thank you for your attention

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