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'Creating regional opportunities through landfill rehabilitation'

An inoperative landfill goes gas station: Biogas as a vehicle fuel

(REGIO-MOB)

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Niepołomice

Key points

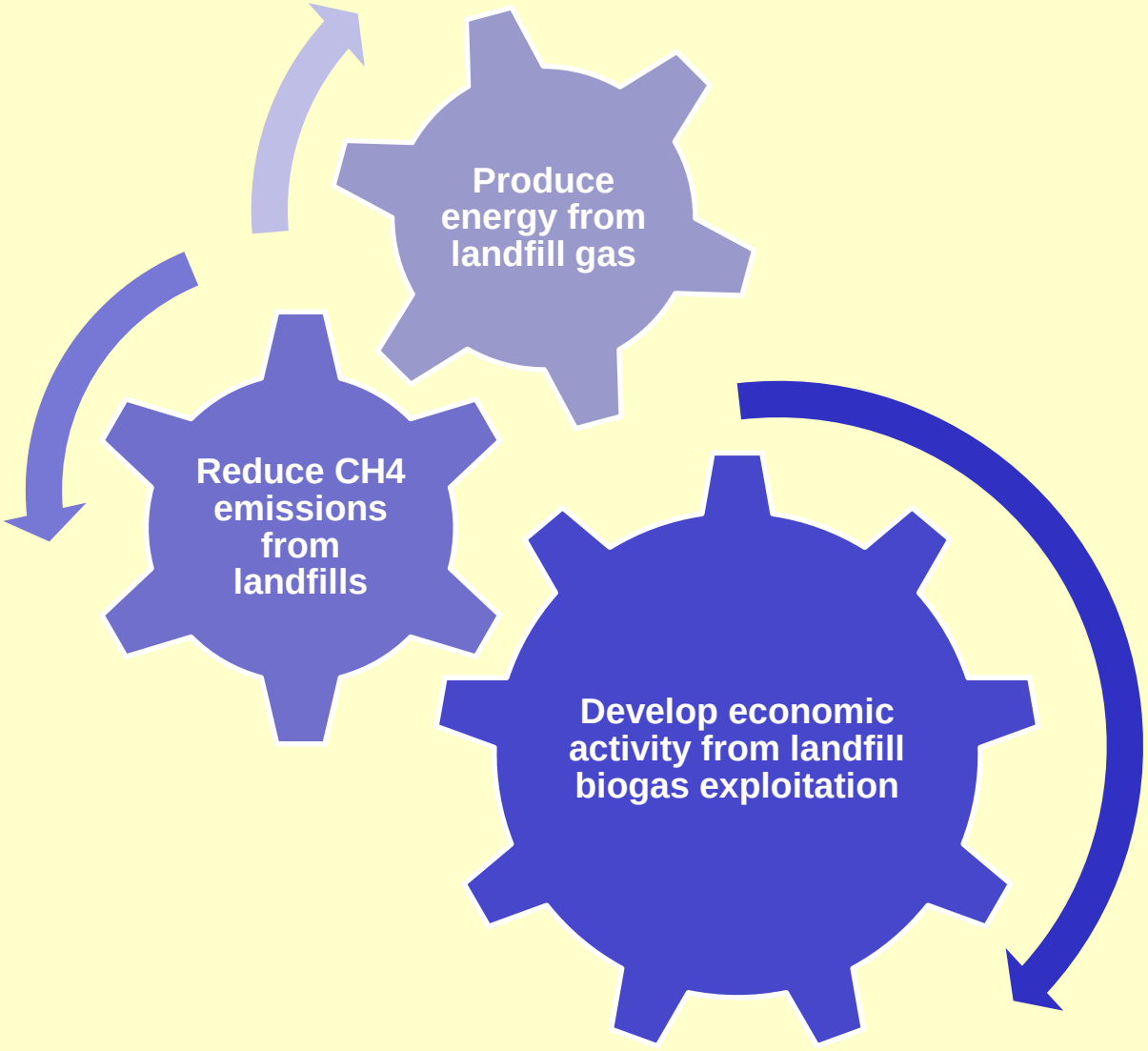
1. Our good practice shows how closed landfills can be exploited for landfill gas collection, and how this gas can be used as a fuel for trucks or buses.
2. It is a technical good practice, but it requires the decisions of public policy makers to enable it.
3. The good practice shows a local circular economy business model that links waste management and mobility policy
4. It is relevant for all local and regional authorities with closed landfills of a certain size and age in their territory

Introduction

- The legal municipal landfills in Poland cover an area of approx. 1,700 hectares
- Number of landfills: 286
- The thickness of deposited material varies from 4 - 20 meters
- During 20 years of disposal 1 ton of waste generates 100 - 400 m^3 of biogas which contains about 50% methane of calorific value from 17,000 - 19,000 kJ/m^3 (i.e., about 6 kWh/m^3)

=> There is a high energy potential in closed landfills

A triple opportunity at local level



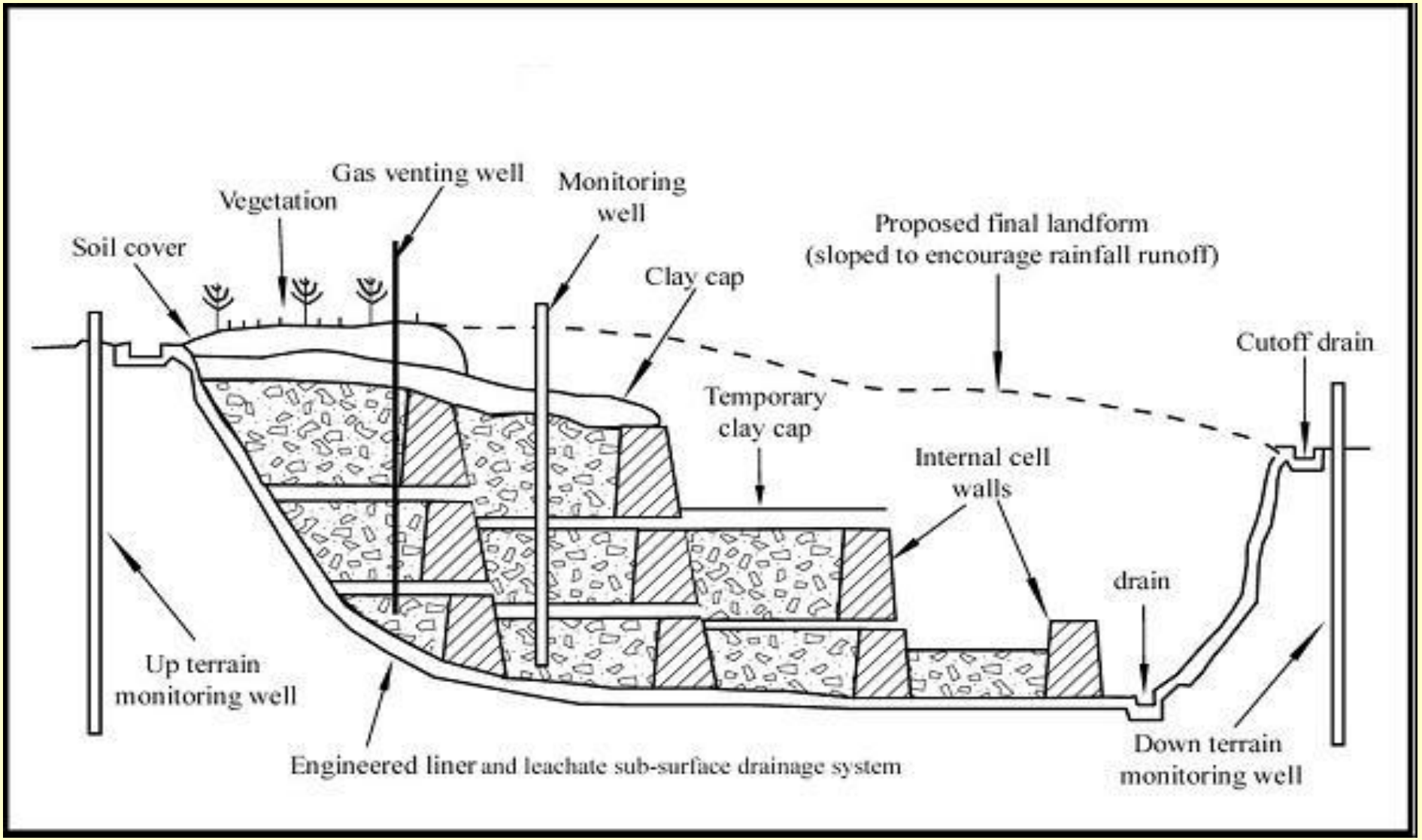
Potential analysis

- Landfills can be considered as anthropogenic biogas deposits
- Not all landfills have sufficient biogas potential to make their exploitation worthwhile

=> First step is a potential analysis

- In order to estimate the volume of biogas generated in a landfill, two criteria are used:
  - population density
  - average composition of wastes

Typical landfill design



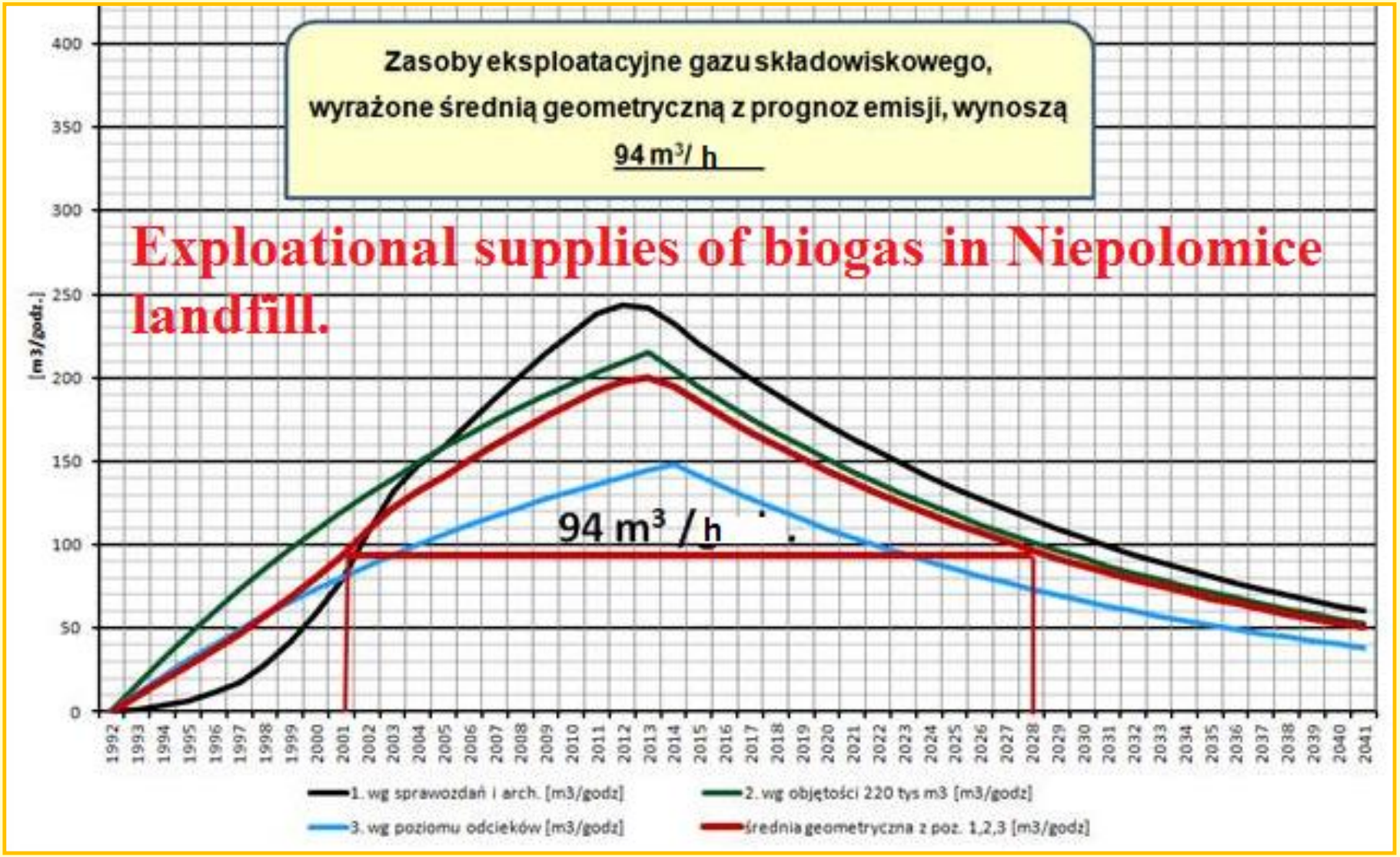
Gas analysis

Composition of biogas produced by anaerobic decomposition

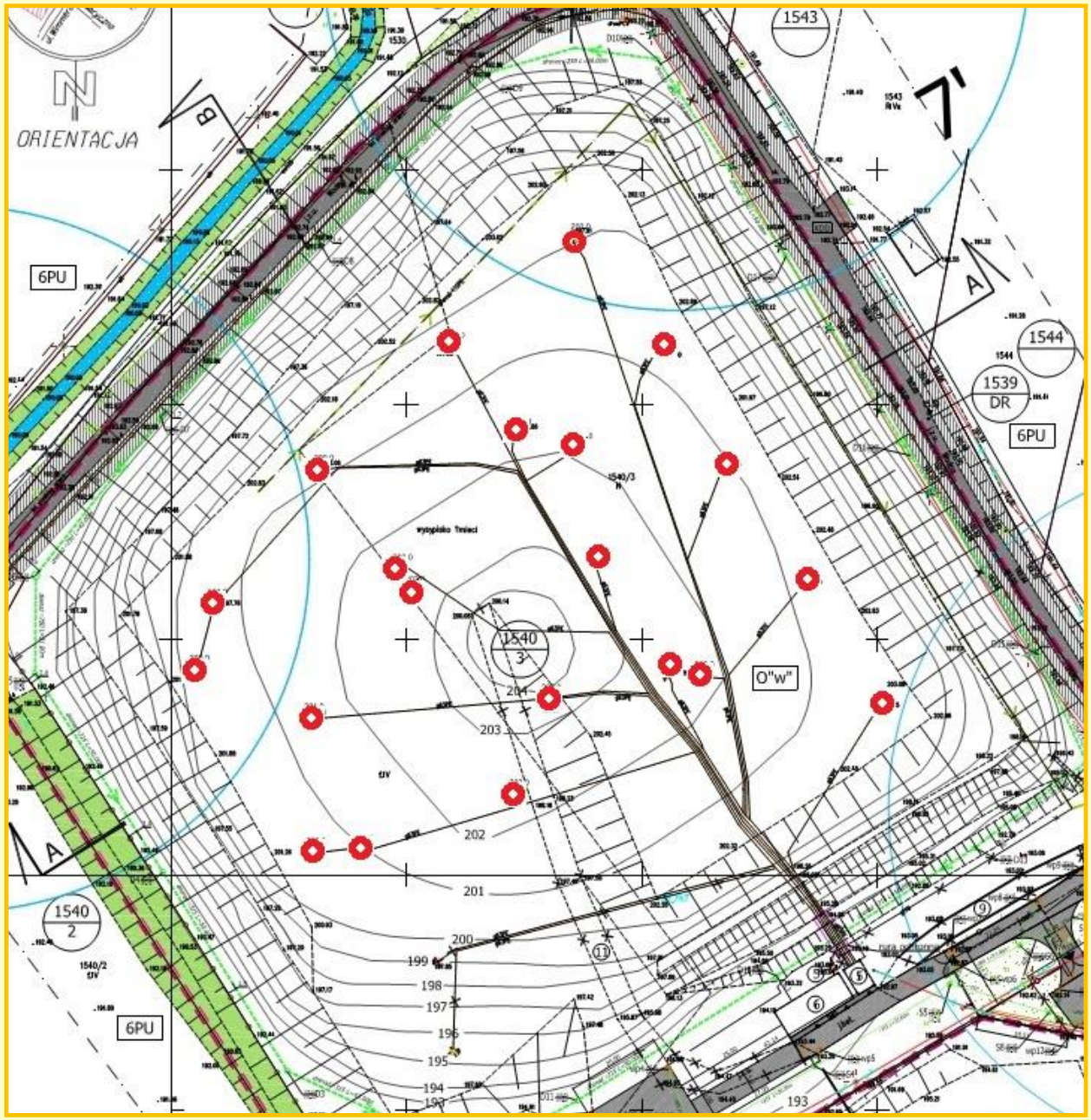
Component	Landfill gas [% by volume]
Methane	50 – 75
Carbon dioxide	25 – 50
Non-methane volatile organic compounds	0,01 - 0,6
Water vapour	6 – 6,5
Nitrogen	3,9 – 4,1
Oxygen	0,9 – 1,1
Amonia	< 0,1 - 1

- Biogas samples are taken at the landfill.
- The gas composition is analysed
- This gives the basis for:
  - estimation of biogas reserves, which will be generated in the nearest 15-20 years,
  - designing the biogas drainage system, including the number and parameters of producing wells,
  - designing the biogas intake station, including the gas utilization system.

Biogas reserves in the Niepołomice landfill



Degassing system in the Niepołomice landfill



Degassing system in the Niepołomice landfill

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Rys. 42 Wiercenie studni pionowych – z lewej: świdrem spiralnym (szenkiem); z prawej świdrem rurowym (szapą)

Rys. 43 Typowe filtry studni gazowych – perforacja otworowa (z lewej) i szczelinowa (z prawej)

Rys. 44 Zabudowa studni gazowej – instalacja filtra (z lewej), żwirowanie i uszczelnienie otworu (z prawej)

drilling the production wells and assembling the filters

Our data and our experience supported by the literature reveal that:

- old landfills of an area over 3 ha *can* be an economic source of biogas,
- important factor is the energy recovery at the efficiency level η= 0.8 (or lower if landfill localization is favourable),
- biogas reserves calculated by various authors with various methods are consistent only for landfills of an area over 6 ha and age between 20 and 30 years,
- biogas reserves calculations for landfills of lifetime <15 years are completely discordant.

=> There is much insecurity in potential estimations for landfills smaller than 6 ha and less than 20 years.

Installation for upgrading biogas

Biogas is not as pure as natural gas. It must be “upgraded” to natural gas quality before it can be used in motors and generators.

Our aim was to power vehicles with compressed biogas gas (CBG) with the purity of biomethane.

A prototype installations was built for upgrading of bioagas with a nominal capacity of 60 - 100 m^3/h of biogas.

The main objective of design was to develop a container-solution for the installation that can be easily transported.

Biogas upgrading in the Niepołomice landfill – container system

INSTALLATION OF UPGRADING FOR BIOGAS

is composed of two functional blocks (modules) installed in separate containers sets:

1. The compression module, storage and distribution of compressed biogas consisting of

- Biomethane compressor max. pressure of 250 bar,
- Treaty storage of compressed biomethane (set of cylinders) with a water capacity of 1500 dm^3
- Distribution treaty covering the refueling system using the connector NGV1 (the typical method used when refueling vehicles powered by CNG) and measuring the amount of natural gas oil (Nm^3).

2. Upgrading module appropriate consisting of:

- Adsorptive system removal hydrogen sulphide;
- System removals of CO_2;
- Adsorptive system removal of siloxanes;
- Adsorptive system drying biomethane.

Technical details for gas upgrading – for later reading

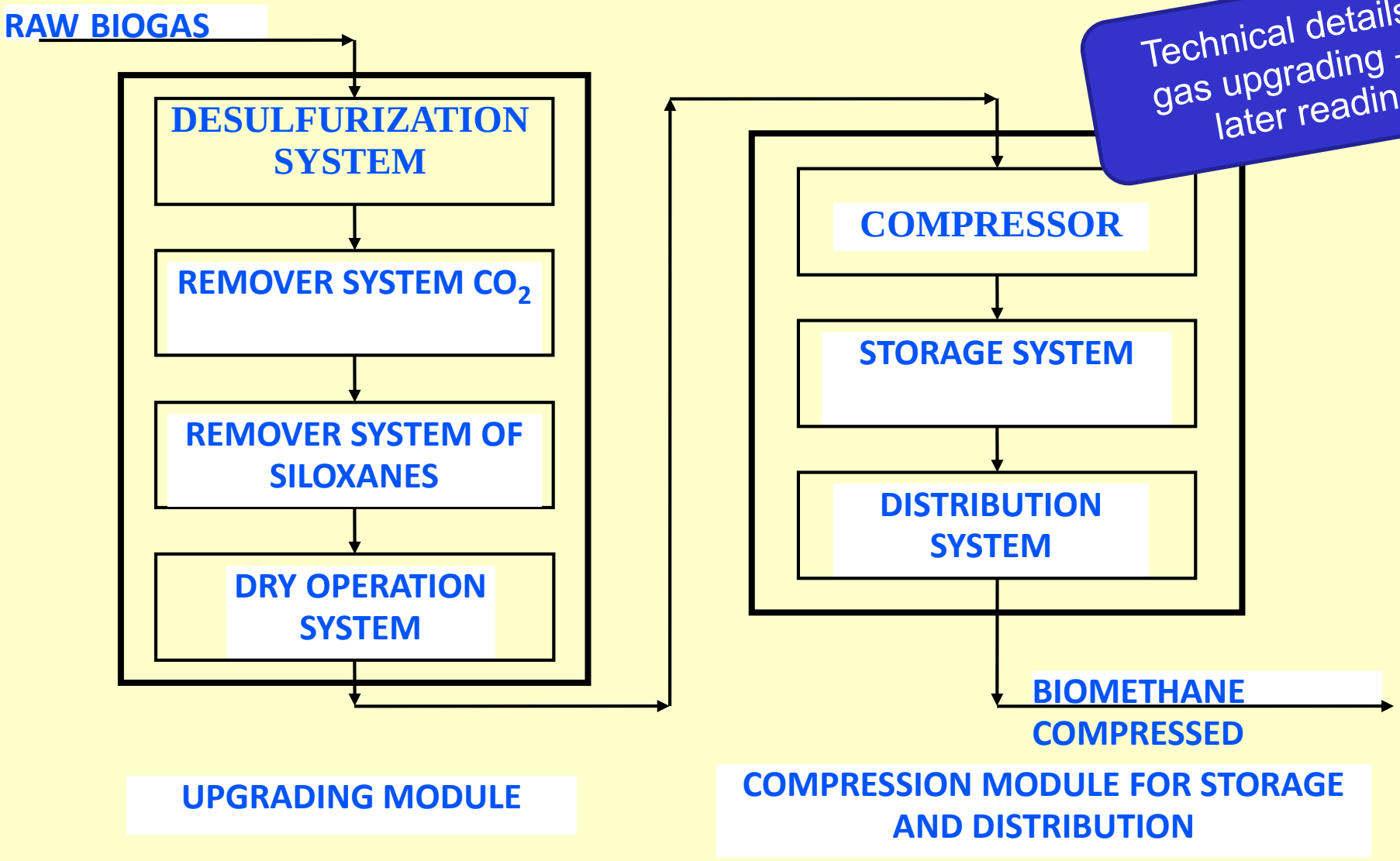
3. The adsorption system removing siloxanes

- To remove the siloxanes used adsorption on activated carbon.
- The vertical adsorber filled with granular activated carbon with a grain size of 4 x 8 mesh (2.36 - 4.75 mm) type Sorbotech® GGCO 105.
- The adsorption drying system biomethane
- Used for drying system of biomethane adsorption on 3A molecular sieve test.
- The vertical adsorber filled with zeolite 3A in balls having a diameter of 2 - 3 mm.

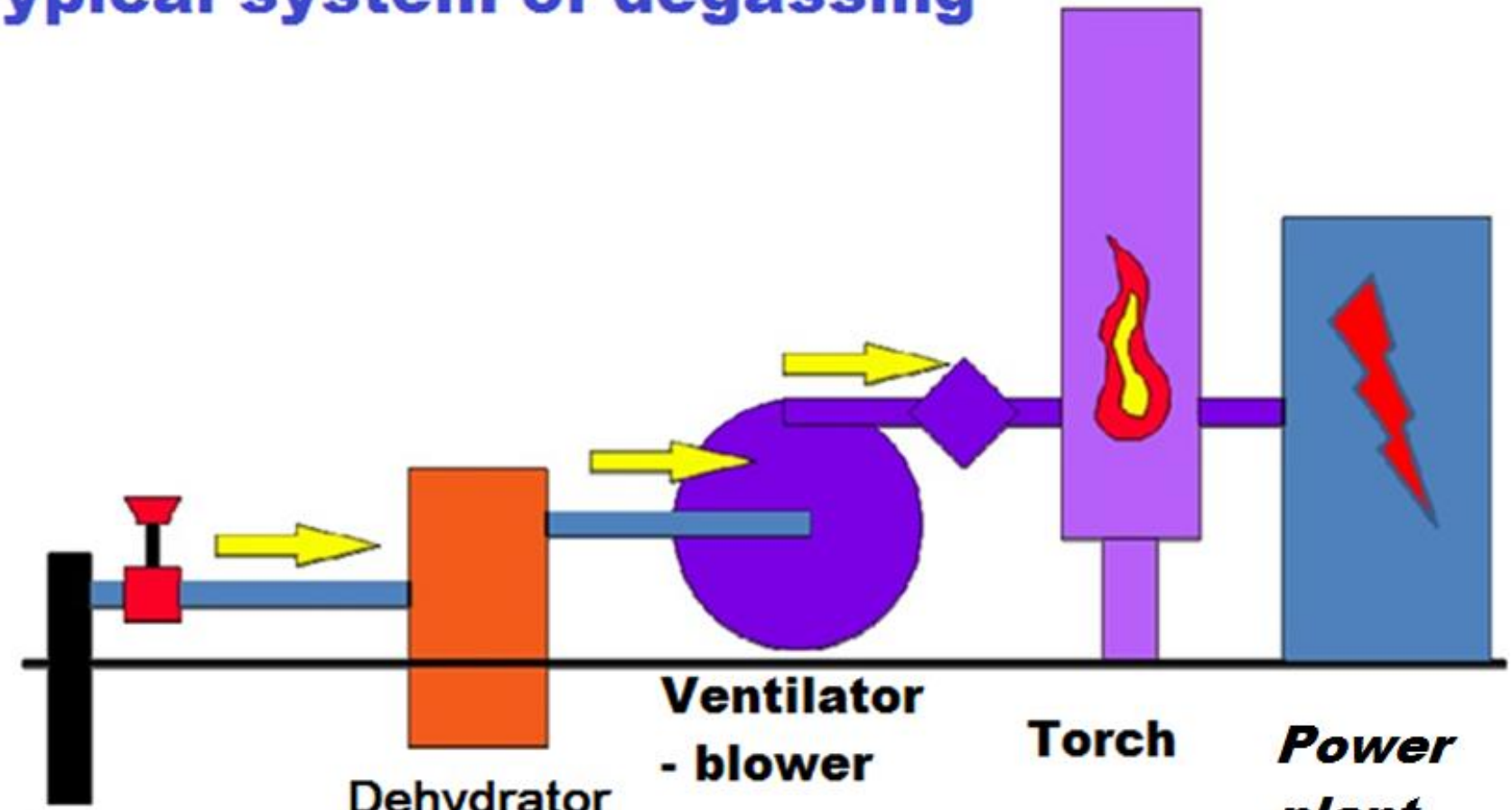
The installation system to compress and biogas purify by application P – 401129

Co-autors of patent registration no. 401129, Polish Patent Office
Marek Rudkowski, PhD. Eng., director of NGV AUTOGAS COMPANY, Poland
Zdzisław Borowiec, PhD. Eng., expert of NGV AUTOGAS COMPANY, Poland

Technical details for gas upgrading – for later reading

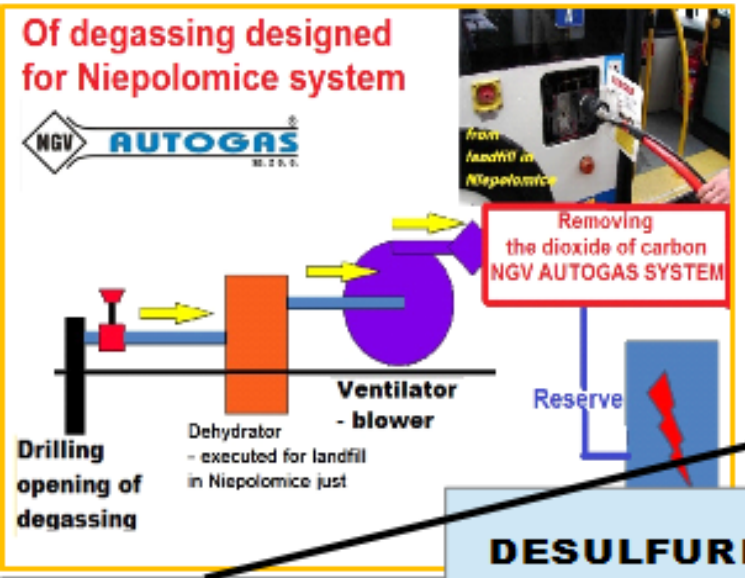


Typical system of degassing



From biogas to fuel

- example from Niepolomice landfill



DRYING THE BIOGAS

DESULFURIZATION THE BIOGAS

DEHYDRATING THE BIOGAS

REDUCTION OF DIOXIDE OF CARBON

DRYING THE BIOGAS

COMPRESSION THE BIOGAS

STORING THE BIOGAS

FUELLING TO BUS BIOGAS

Lessons

1. Closed landfills contain a lot of energy
2. A potential analysis should be done at regional level to determine in which landfills there is enough economic potential for biogas exploitation
3. The sites with best potential can be exploited for biogas collection and upgrading for use in motors and generators
4. Biogas can be transformed into electricity, or into a clean renewable transport fuel as compressed biogas (CBG)
5. Waste trucks or local buses can be powered by CBG to close the loop

Thank for your attention

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