

# Wastewater treatment plants as system service provider for renewable energy storage and control energy in virtual power plants



Abwasserreinigungsanlagen als Regelbaustein in intelligenten Verteilnetzen mit erneuerbarer Energieerzeugung

### Background: Integration of renewable energy sources in the frame of energy system transition

- increasing need for an compensation of severely fluctuating power generation is as a result of ongoing extension of wind and solar power plants
- the decreasing amount of fossil fuel and nuclear leaded power generation as the dominating part of basic load is not only causing a gap in power generation but also in new challenges in flexibility and grid stability

### The core objective of arrivee

- integration of widely available wastewater treatment plants (WWTP) with anaerobic sludge digestion into an optimized control reserve and storage concept to counterbalance those new challenges (Figure 1)
- by using a mathematical model of an existing pilot WWTP (Figure 2) the effects of external interventions for the supply of ancillary services under different conditions are tested.
- processes inside the plant and effects for the local net will be analyzed in detail
- these processes are complemented by new innovative plant elements to optimize a participation in the control reserve market (Figure 3)

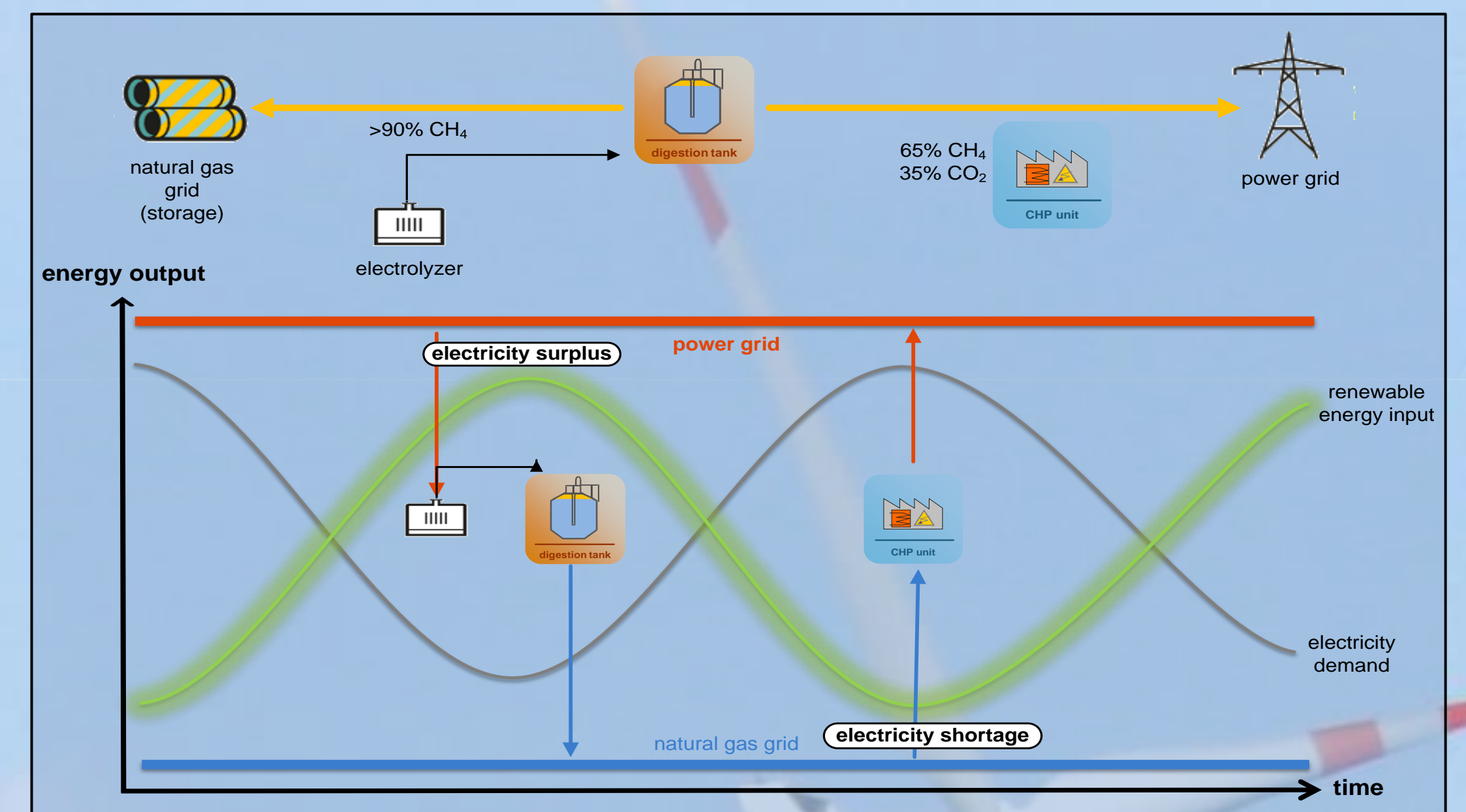


Figure 1: Counterbalance of fluctuating energy (adapted from Reuter, 2013)

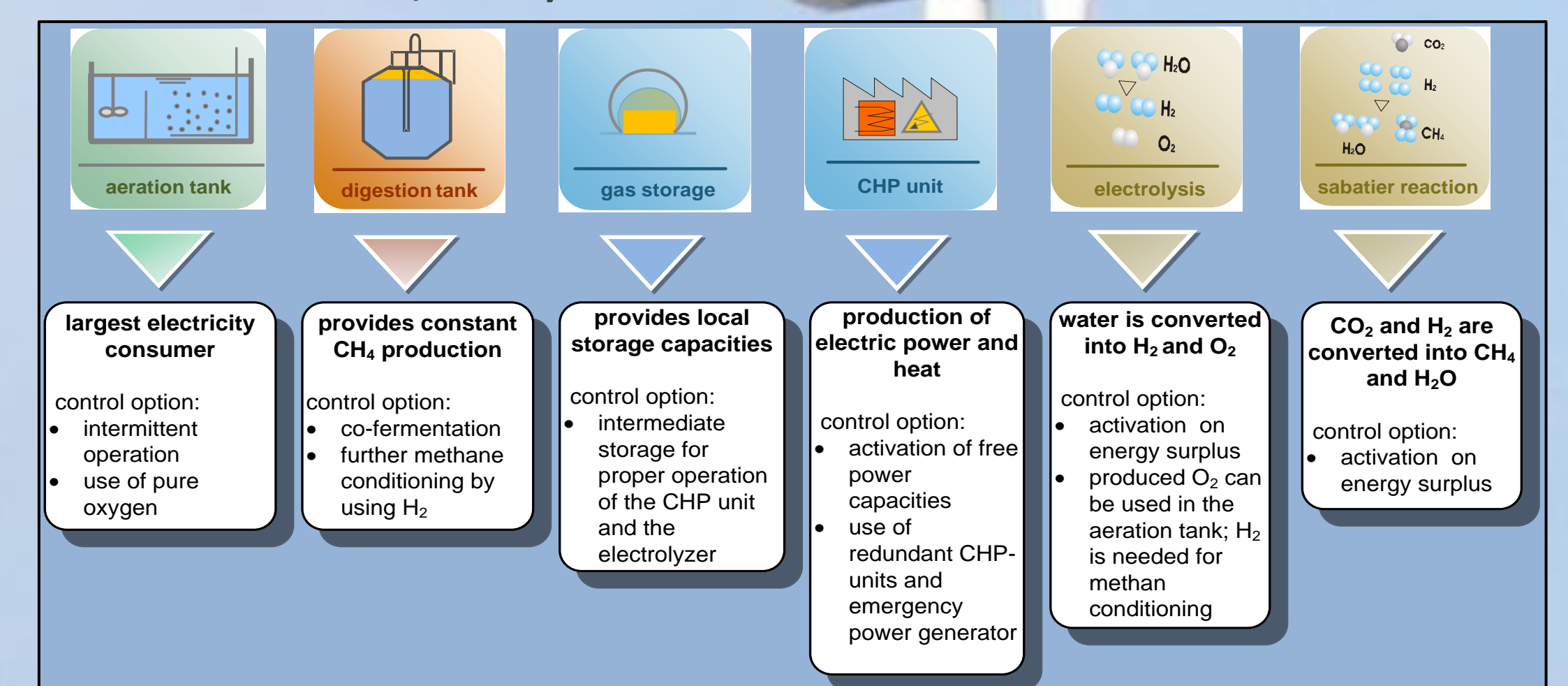


Figure 3: Modules of WWTPs to provide control reserve

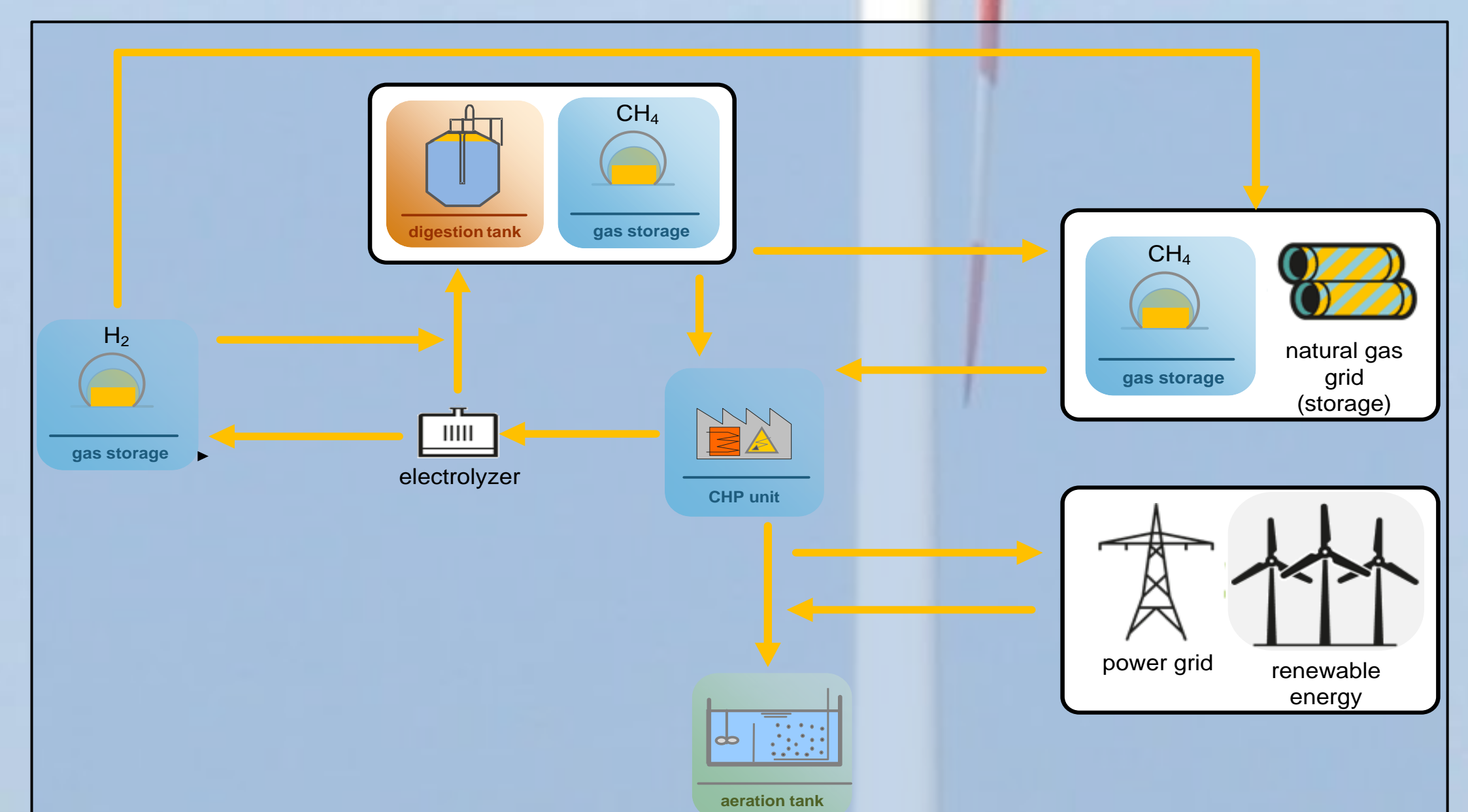


Figure 4: Possible use of power-to-gas technology on WWTPs (incl. methane conditioning)

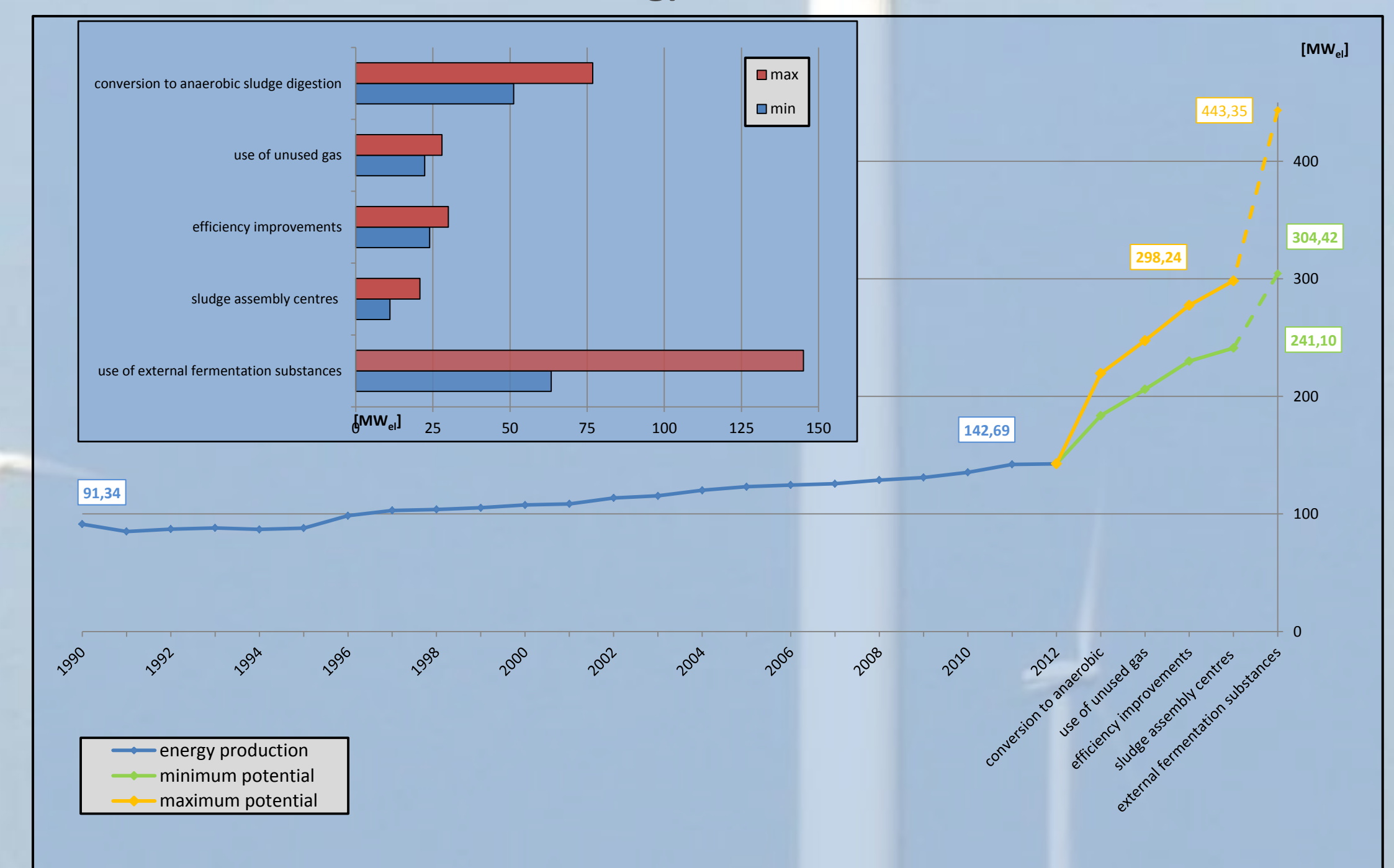


Figure 5: Development of gas usage on WWTP in Germany and calculated potentials for optimized electricity production



Figure 2: Pilot-WWTP Radevormwald

### According to demand - absorb or dispense

#### Power surplus in the grid:

- that energy is used in a first step to produce oxygen and hydrogen with an electrolyzer.
- hydrogen is used for processing high quality methane by Sabatier process (chemically) or inside the existing digestion tank (biological)
- purity of the raw gas is increased from about 65 % to more than 90% methane
- this SNG (synthetic natural gas) is compatible with the existing regular natural gas grid and the grid can be used as a nearly infinite gas storage (Figure 4)

#### Power shortage in the grid:

- non-vital plant components are shut down and the CHP-unit(s) are powered up
- emergency power systems on the plant can be powered up as well

### Master new challenges with existing infrastructure

- initial project results present a high potential of negative control reserve from WWTPs in Germany
- methods take account to: consideration of unused gas, efficiency improvements, conversion of WWTPs from aerobic into anaerobic sludge digestion and use of spare capacities of the digestion tanks
- from 1990 the energy production increased by the factor of 1,5 from 0,8 to 1,25 TWhel/a. By utilizing this potentials electricity production could rise to 2,61 TWhel/a (Figure 5)
- under this boundary conditions calculations show that WWTP could provide negative control reserve of a magnitude of nearly 300 MW

Initial results show a substantial potential of WWTPs to provide ancillary services, by reshaping the existing infrastructure in a sustainable, ecological and economic way. This may contribute significantly to a stable operation of energy grids and a further integration of renewable energy sources in the frame of energy system transition.

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