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Sektion für Prävention in der chemischen Industrie

Green world – safe and sound?

INAIL/ISSA Seminar
Emerging risks in industry 4.0: innovative approaches for safety and security
Rome, November 25th 2019

Dr. Oswald Losert, BG RCI
Joint working group ‘explosion protection’
of ISSA Sections ‘Chemistry’ resp. ‘Machine and System Safety’

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International Social Security Association

The world's leading international organization for social security

Promoting excellence in social security

- **Community:** Platforms for member exchange and networking
- **Knowledge:** guidelines, analysis, good practices
- **Services:** practical support for social security administrations
- **Innovation:** strengthening administration, managing change
- **Promotion:** global advocacy to promote social security

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ISSA - Leading global social security organization

350 member organizations

157 countries

HQ ILO Geneva

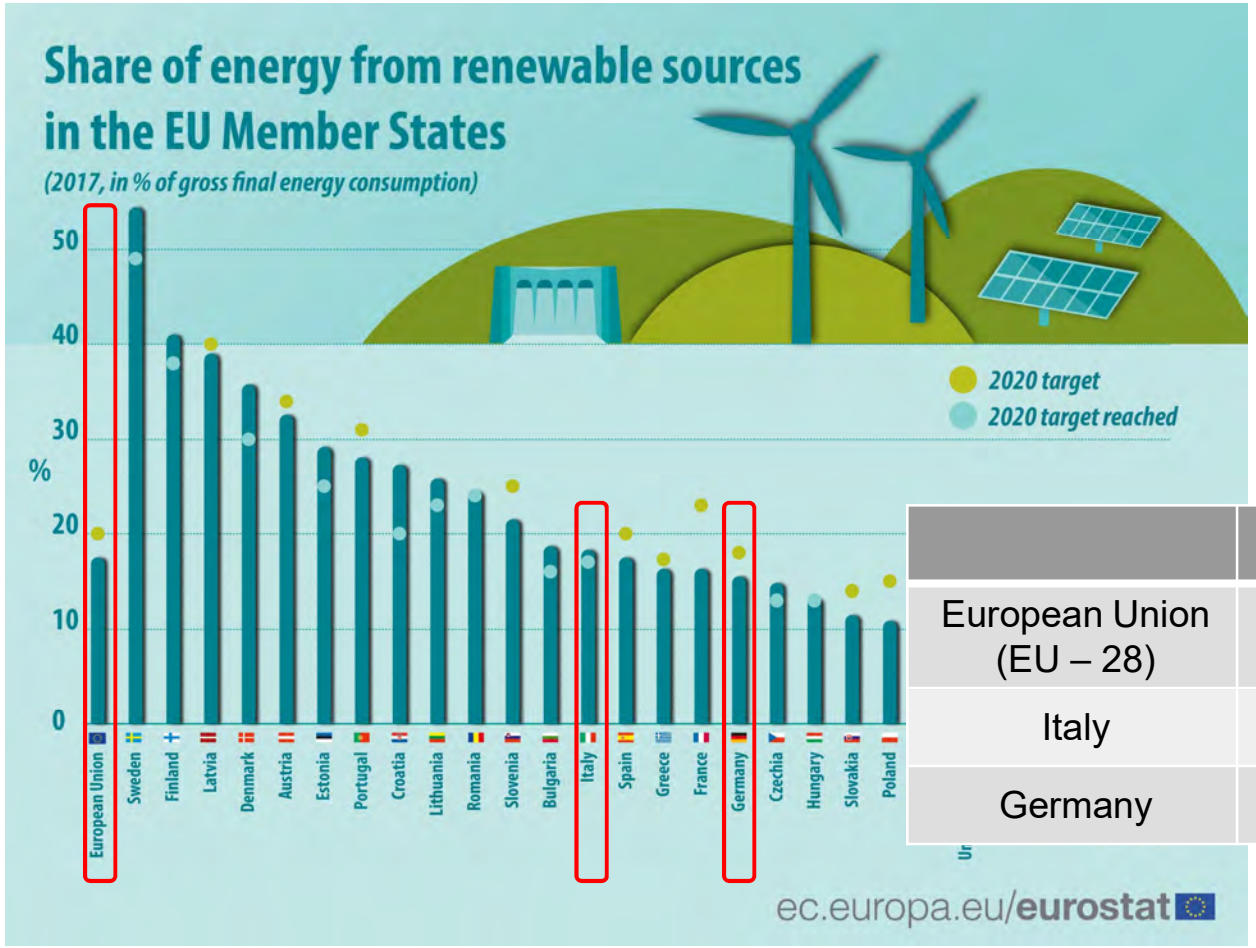
13 international **prevention sections**

joint activities in the field of prevention of occupational risks coordinated by the **Special Commission**

16 liaison offices and focal points

founded in **1927**

Share of renewable sources – EU 28 (2017)



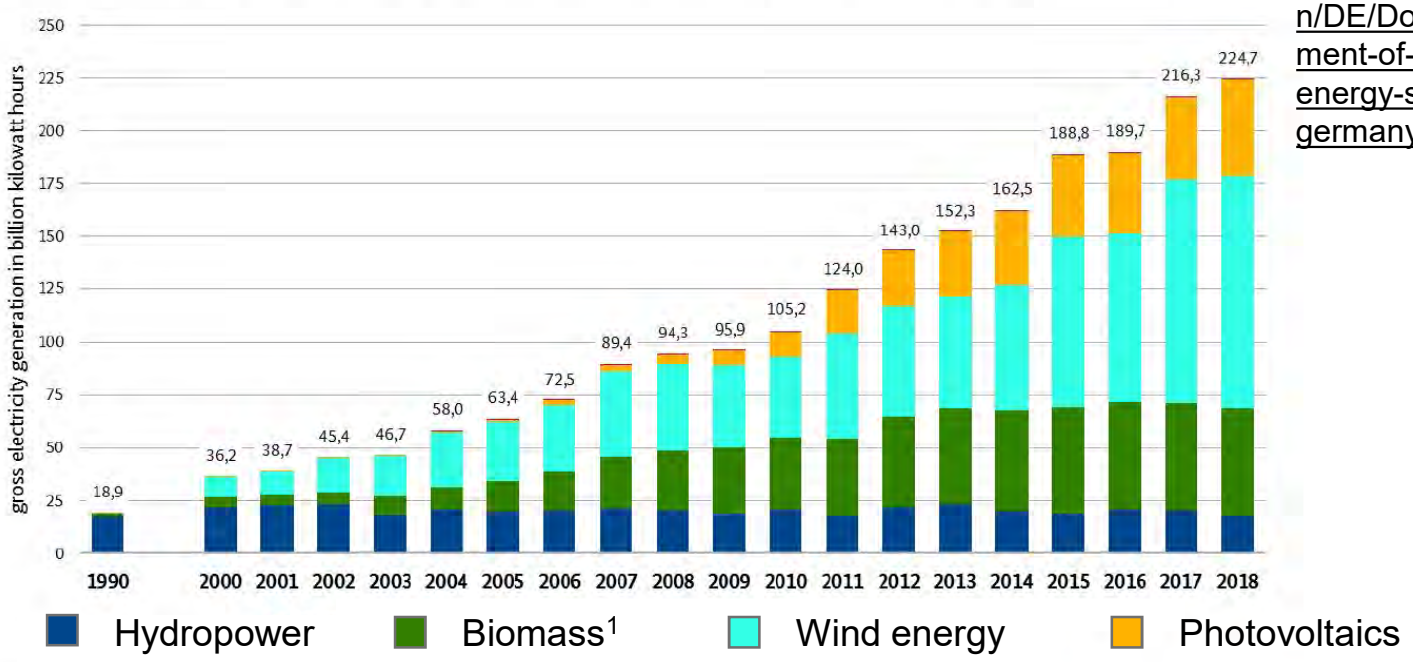
Source: eurostat – statistics explained, renewable energy statistics https://ec.europa.eu/eurostat/statistics-explained/index.php/Renewable_energy_statistics

	2017 (Target 2020)
European Union (EU – 28)	17,5 % (20 %)
Italy	18,3 % (17 %)
Germany	15,5 % (18 %)

Electricity from renewables – Germany

Federal Ministry
for Economic Affairs
and Energy

Development of gross electricity production from renewable energy sources in Germany

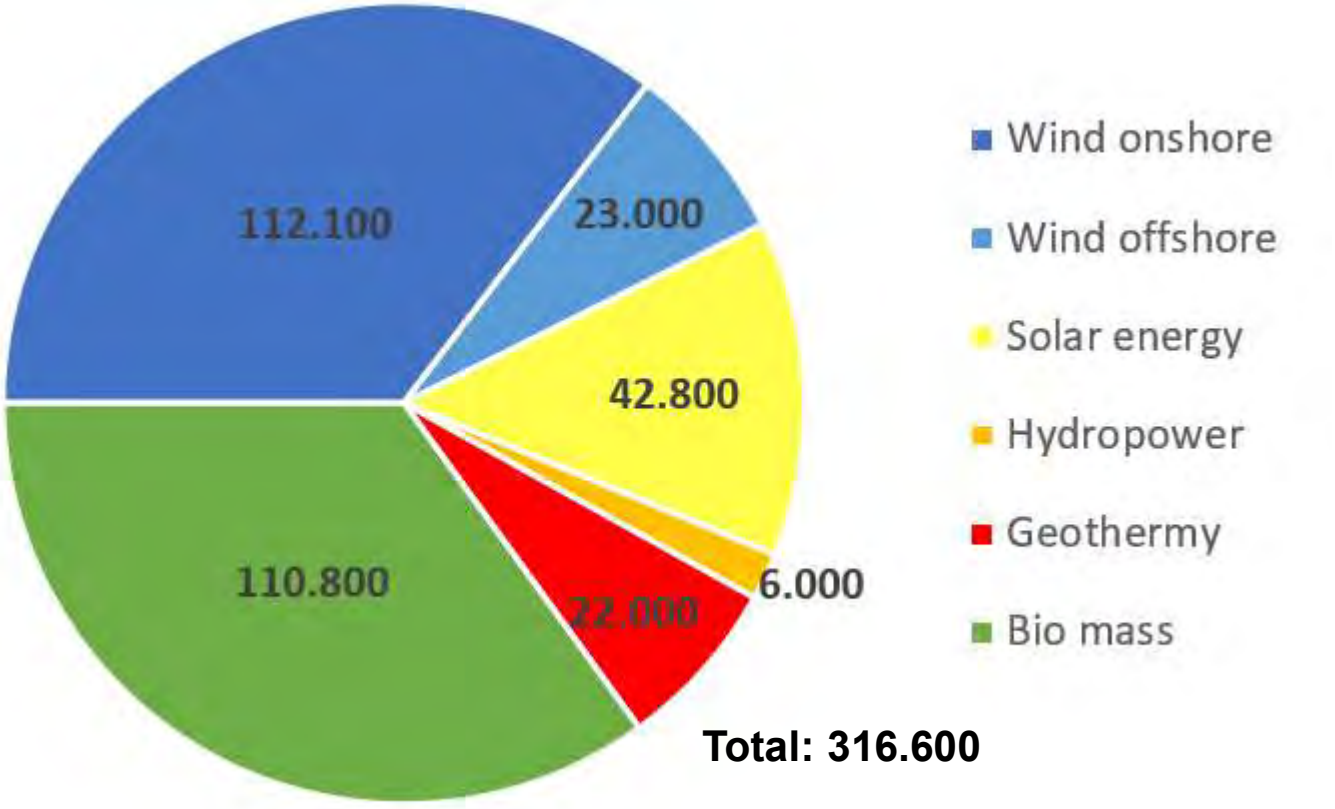


and the biologic fraction of waste (in waste incineration plants estimated at 50 %, from 2008 only municipal waste)

BMWi based on Working Group on Renewable Energy-Statistics (AGEE-Stat); as of August 2019

Source:
https://www.erneuerbare-energien.de/EE/Redaktion/DE/Downloads/development-of-renewable-energy-sources-in-germany-2018.pdf

Renewables – employed persons (Germany 2017)



Total: 316.600

Source: Bundesministerium für Wirtschaft und Energie, Bruttobeschäftigung durch erneuerbare Energien 2000 bis 2017, https://www.erneuerbare-energien.de/EE/Redaktion/DE/Downloads/zeitreihe-der-beschaeftigungszahlen-seit-2000.html

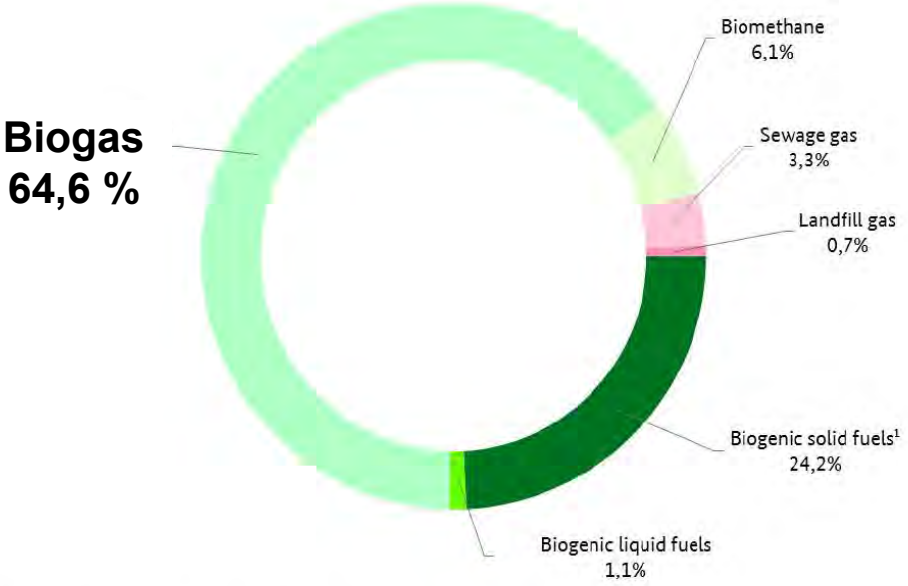
Biomass-based electricity generation – share of biogas

Federal Ministry for Economic Affairs and Energy

Source: https://www.erneuerbare-energien.de/EE/Redaktion/DE/Downloads/development-of-renewable-energy-sources-in-germany-2018.pdf

Gross electricity production from biomass in Germany in the year 2018

Total: 44,6 billion kilowatt hours



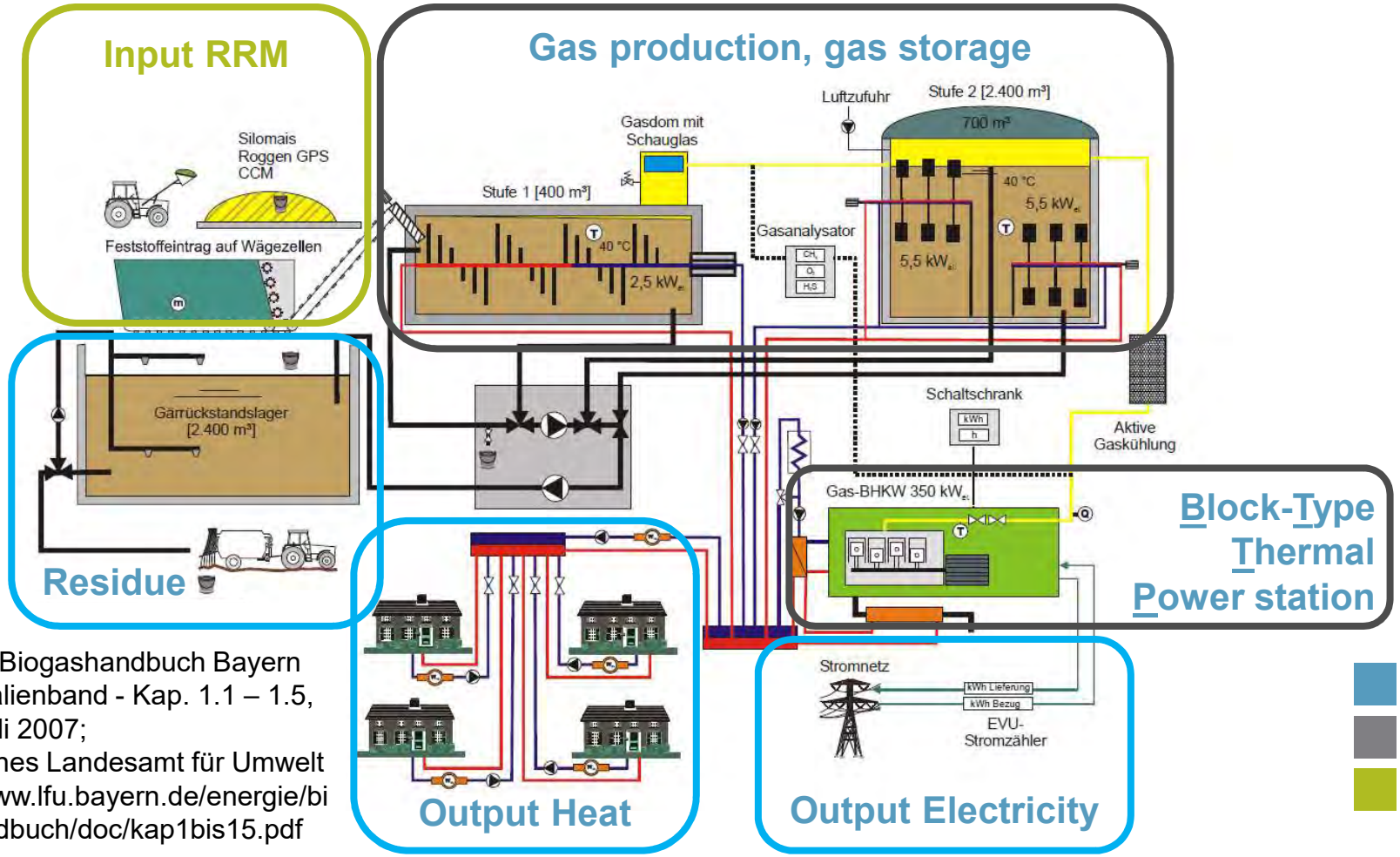
¹ incl. sewage sludge, without the biogenic fraction of waste in waste incineration plants

BMWi based on Working Group on Renewable Energy-Statistics (AGEE-Stat); as of August 2019

Biogas plants in Germany – increase 1992-2018

Source: UBA Hintergrund // März 2019, Biogasanlagen Sicherheitstechnische Aspekte und Umweltauswirkungen, Umweltbundesamt, Fachgebiet III 2.3 „Anlagensicherheit“ III 2.4 „Abfalltechnik, Abfalltransfer“, V 1.3 „Erneuerbare Energien“, ISSN 2363-829X

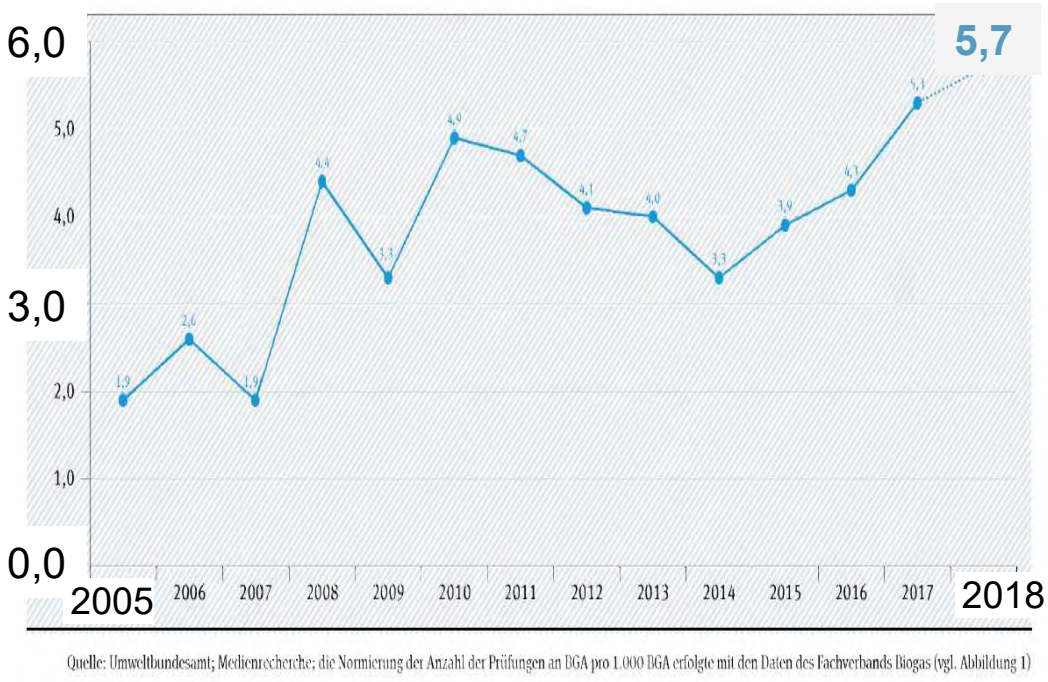
Biogas plant for renewable raw materials (RRM)



Source: Biogashandbuch Bayern – Materialienband - Kap. 1.1 – 1.5, Stand Juli 2007;
Bayerisches Landesamt für Umwelt
https://www.lfu.bayern.de/energie/biogashandbuch/doc/kap1bis15.pdf

Biogas plants: Incidents 2005 – 2018 (Germany)

Incidents per year and per 1000 biogas plants



Source: UBA Hintergrund // März 2019, Biogasanlagen Sicherheitstechnische Aspekte und Umweltauswirkungen, Umweltbundesamt, Fachgebiet III 2.3 „Anlagensicherheit“ III 2.4 „Abfalltechnik, Abfalltransfer“, V 1.3 „Erneuerbare Energien“, ISSN 2363-829X

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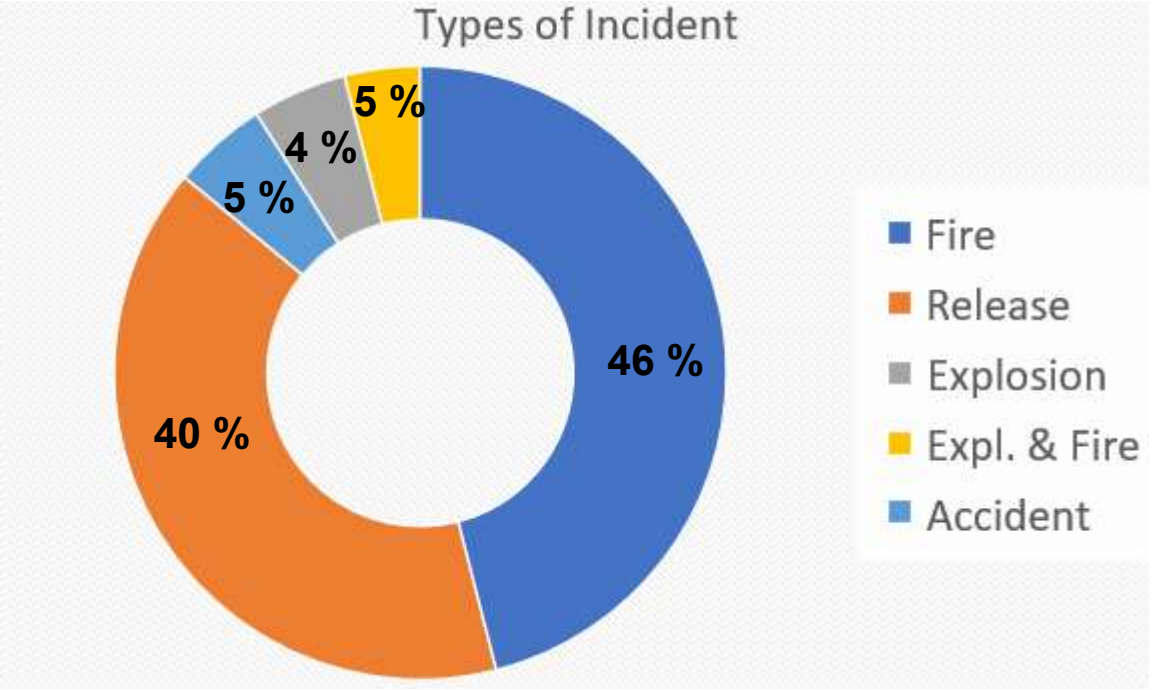


Total: 375 evaluated incidents since 2005

Source: UBA Hintergrund // März 2019, Biogasanlagen Sicherheitstechnische Aspekte und Umweltauswirkungen, Umweltbundesamt, Fachgebiet III 2.3 „Anlagensicherheit“ III 2.4 „Abfalltechnik, Abfalltransfer“, V 1.3 „Erneuerbare Energien“, ISSN 2363-829X

Biogas plants: Hazards

„Common“ hazards

- Mechanical hazards ➔ machinery, e. g. conveyors
- Fall from heights
- Fire (?)
- …

„New“ hazards from process

- Explosion
- Hydrogen sulphide poisoning

Factsheet on explosion protection - ‘Biogas plants’

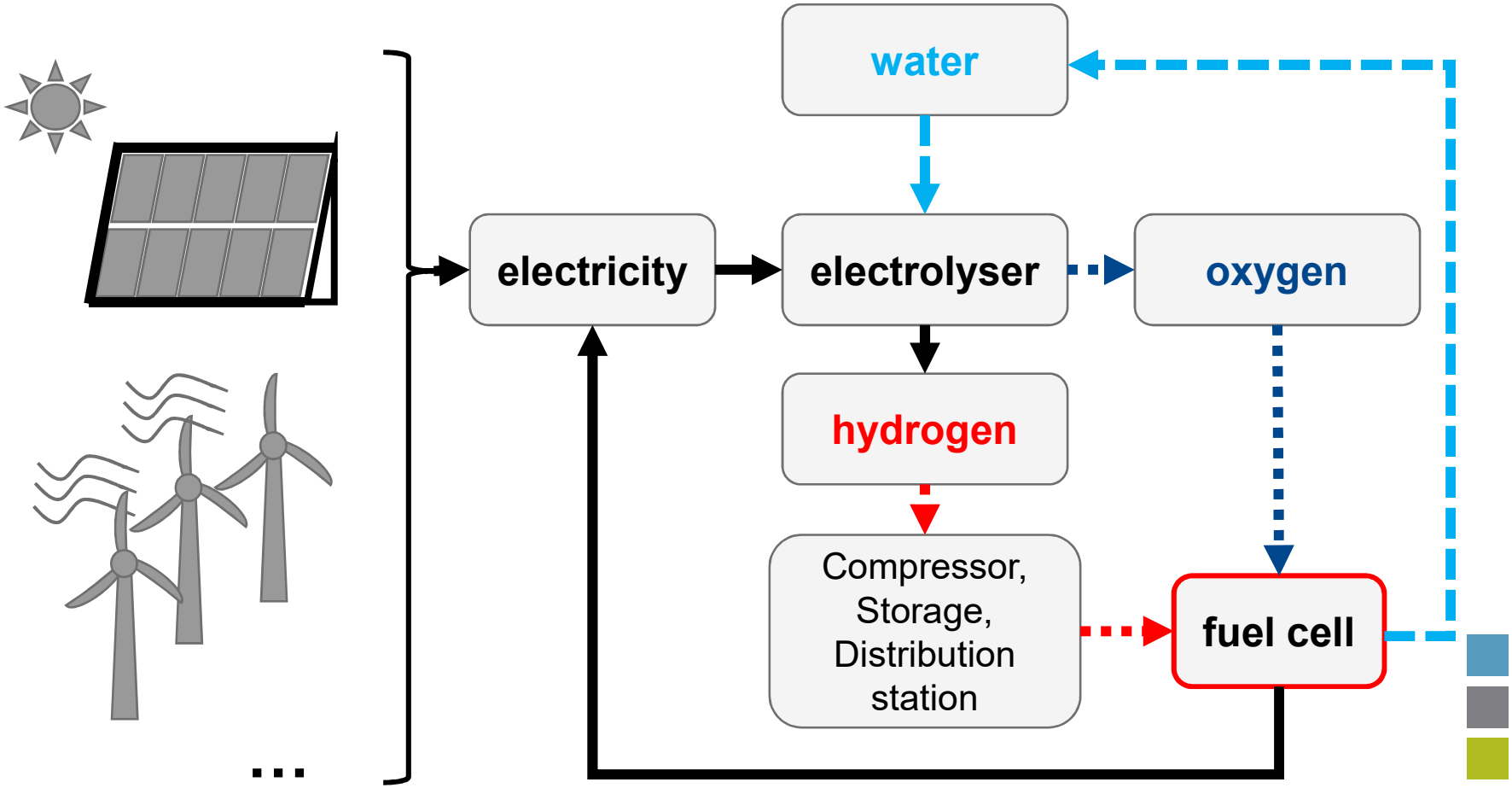
- Introduction
- Hazard
- Prevention
- …
- Further literature

Infoblatt Explosionsschutz
Biogasanlagen
Der sichere Umgang mit Biogas

Fiche technique Prévention des explosions et mesures de protection
Sécurité dans la production et l’utilisation de biogaz

Scheda informativa sulla prevenzione e protezione contro le esplosioni
Impianti di biogas
Uso sicuro del biogas

Electricity storage – concept: electrolysis/fuel cell



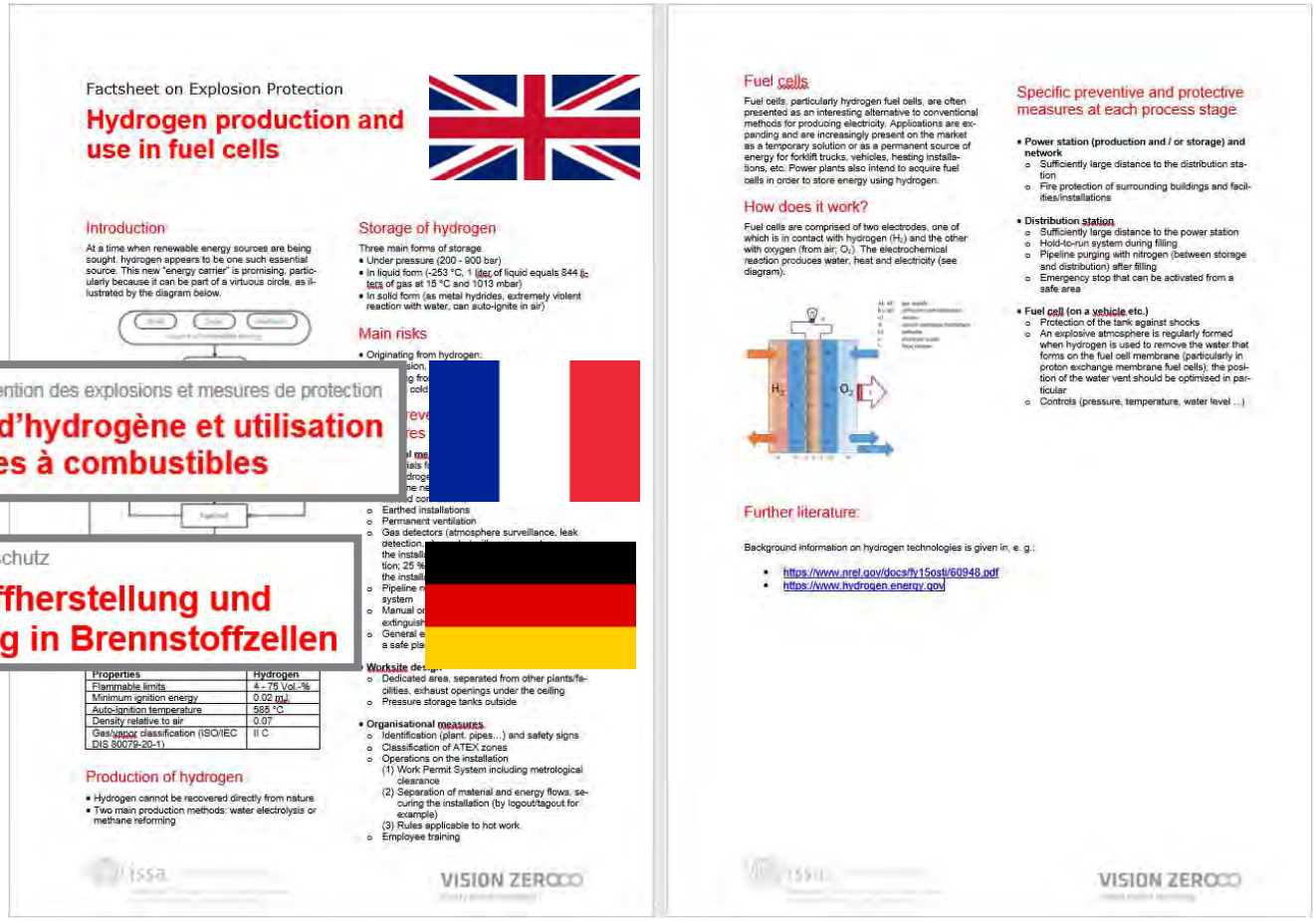
Hydrogen/Fuel cell: Hazards

- **Fire/Explosion**
  - Wide concentration range for explosion hazard: 4 vol. % - 75 vol. %
  - Low minimum ignition energy: MIE = 0,02 mJ
  - Gas/vapor classification (ISO/IEC DIS 80079-20-1): II C
- **Material incompatibility**

From the system:

- **Pressure**
- **Cold Temperature**
- **Electricity**

Factsheet on explosion protection - ‘Hydrogen production and use in fuel cells’



Factsheet on Explosion Protection

Hydrogen production and use in fuel cells

Introduction

At a time when renewable energy sources are being sought, hydrogen appears to be one such essential source. This new “energy carrier” is promising, particularly because it can be part of a virtuous circle, as illustrated by the diagram below.

Storage of hydrogen

Three main forms of storage
- Under pressure (200 - 900 bar)
- In liquid form (-253 °C, 1 liter of liquid equals 844 liters of gas at 15 °C and 1013 mbar)
- In solid form (as metal hydrides, extremely violent reaction with water, can auto-ignite in air)

Main risks

- Originating from hydrogen:
  - Earthed installations
  - Permanent ventilation
  - Gas detectors (atmosphere surveillance, leak detection, the installation; 25 % the installation)
  - Pipeline system
  - Manual or extinguish
  - General a safe pla

Worksite design
  - Dedicated area, separated from other plants/facilities, exhaust openings under the ceiling
  - Pressure storage tanks outside

- Organisational measures
  - Identification (plant, pipes…) and safety signs
  - Classification of ATEX zones
  - Operations on the installation
    (1) Work Permit System including metrological clearance
    (2) Separation of material and energy flows, securing the installation (by logout/tagout for example)
    (3) Rules applicable to hot work
  - Employee training

Properties	Hydrogen
Flammable limits	4 - 75 Vol.-%
Minimum ignition energy	0.02 mJ
Auto-ignition temperature	585 °C
Density relative to air	0.07
Gas/vapor classification (ISO/IEC DIS 80079-20-1)	II C

Production of hydrogen

- Hydrogen cannot be recovered directly from nature
- Two main production methods: water electrolysis or methane reforming

VISION ZERO

Fiche technique Prévention des explosions et mesures de protection

Production d’hydrogène et utilisation dans les piles à combustibles

Infoblatt Explosionsschutz

Wasserstoffherstellung und -anwendung in Brennstoffzellen

Fuel cells

Fuel cells, particularly hydrogen fuel cells, are often presented as an interesting alternative to conventional methods for producing electricity. Applications are expanding and are increasingly present on the market as a temporary solution or as a permanent source of energy for forklift trucks, vehicles, heating installations, etc. Power plants also intend to acquire fuel cells in order to store energy using hydrogen.

How does it work?

Fuel cells are comprised of two electrodes, one of which is in contact with hydrogen (H_2) and the other with oxygen (from air; O_2). The electrochemical reaction produces water, heat and electricity (see diagram).

Specific preventive and protective measures at each process stage

- **Power station (production and / or storage) and network**
  - Sufficiently large distance to the distribution station
  - Fire protection of surrounding buildings and facilities/installations
- **Distribution station**
  - Sufficiently large distance to the power station
  - Hold-to-run system during filling
  - Pipeline purging with nitrogen (between storage and distribution) after filling
  - Emergency stop that can be activated from a safe area
- **Fuel cell (on a vehicle etc.)**
  - Protection of the tank against shocks
  - An explosive atmosphere is regularly formed when hydrogen is used to remove the water that forms on the fuel cell membrane (particularly in proton exchange membrane fuel cells); the position of the water vent should be optimised in particular
  - Controls (pressure, temperature, water level …)

Further literature:

Background information on hydrogen technologies is given in, e. g.:
- https://www.nrel.gov/docs/fy15osti/60948.pdf
- https://www.hydrogen.energy.gov

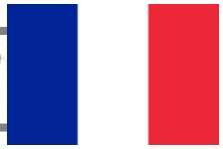
VISION ZERO

Factsheet on explosion protection – work in progress

- **storage of wood pellets**

Infoblatt Explosionsschutz
Lagerung von Holzpellets

Fiche technique Prévention des explosions et mesures de
Stockage de granulés de bois



- **(gas) tightness of components**
  with respect to explosion prevention

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Dichtheit von Anlagenteilen und Verbindungen

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Promoting and Developing
Social Security Worldwide.

Thank you for your attention!

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