

**FEE**

# Industrial On-Site Generation of Electricity: Relevance and Potential

Patrick Dossow, M. Sc.

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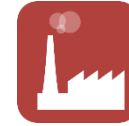
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**2019**

# Today's Agenda

## ➤ Part 1

### Status Quo of Industrial On-Site Generation



- 1.1 European Situation and Characteristics
- 1.2 Differences on a National Level

## Part 2

### Potential of Market Integration

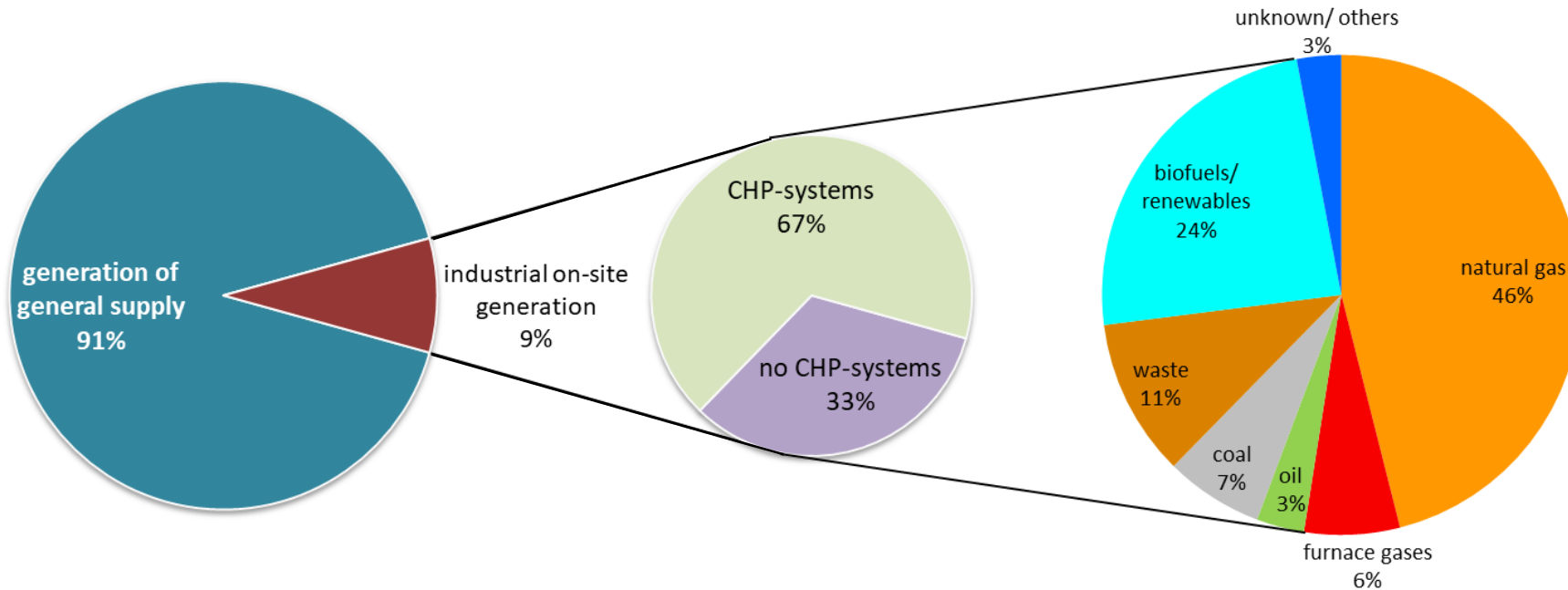
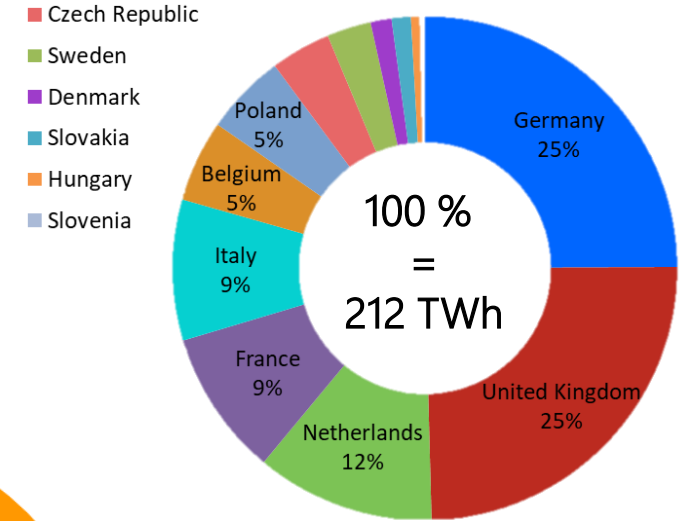


- 2.1 Basic Concept and Integration Procedure
- 2.2 Results and Consequences

# Satus Quo of Industrial On-Site Generation

## European Situation and Characteristics (2017)

- Net on-site electricity generation in 13 analysed countries: 212 TWh
- 36 % of the overall electricity demand in industry is generated on-site
- More than two thirds of the electricity is generated by CHP-systems
- Fossil fuels account for 59 % of industrial on-site generation

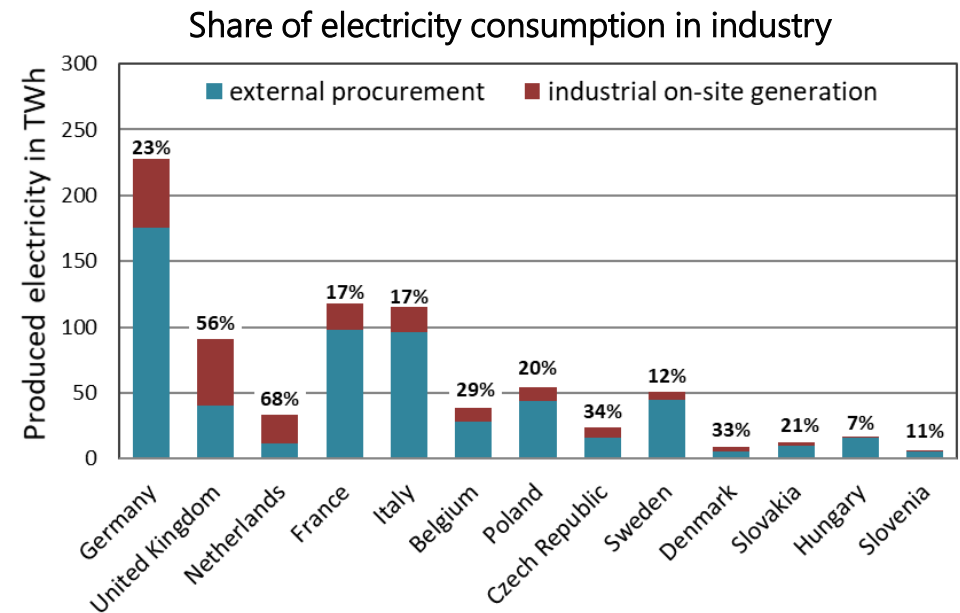


A high relevance of industrial on-site generation in Europe is determined

# Satus Quo of Industrial On-Site Generation

## Differences on a National Level (2017)

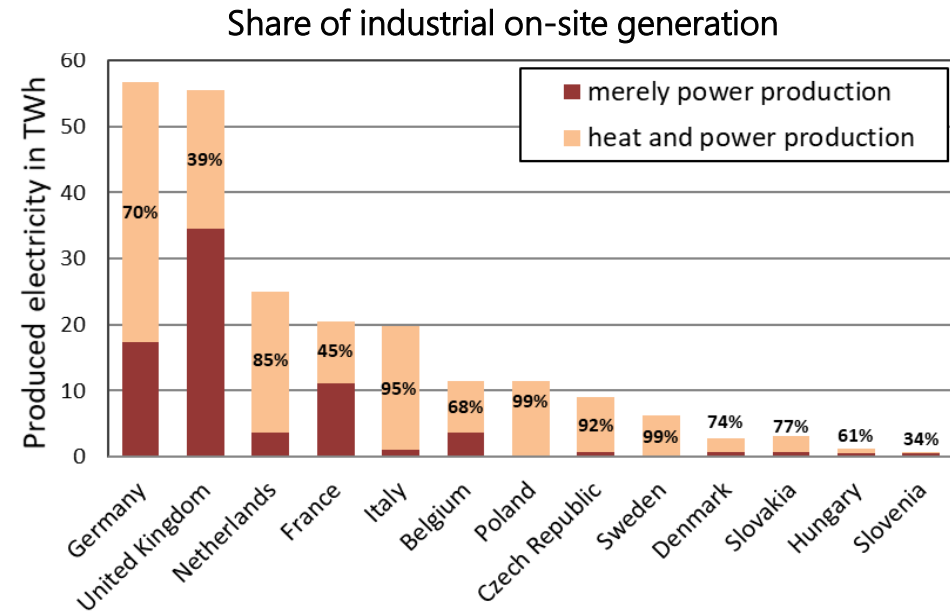
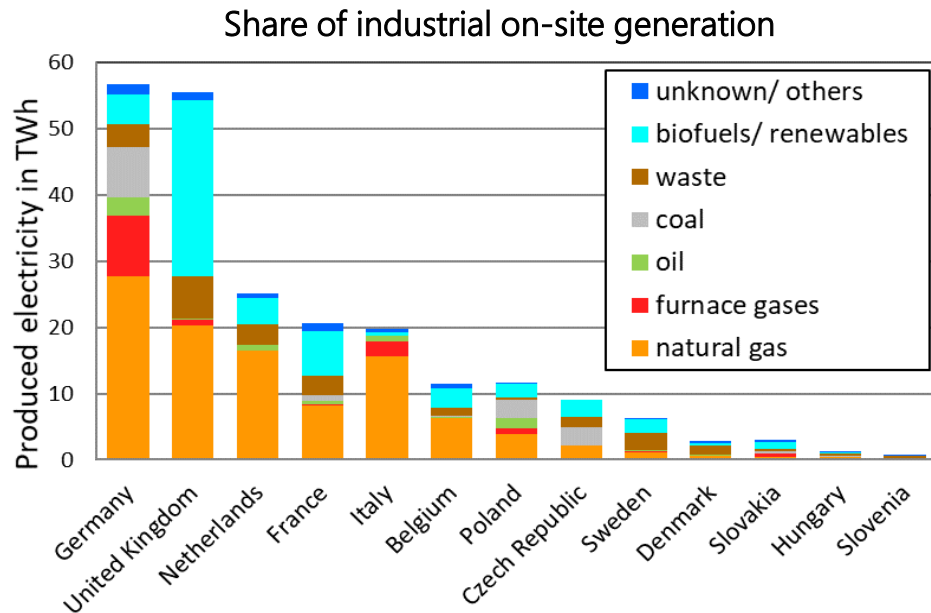
- Share of on-site generation varies between 7 % and 68 %
- Differences in the extent of industrial on-site generation are mainly due to resource availability, industrial structure and national regulatory conditions



# Satus Quo of Industrial On-Site Generation

## Differences on a National Level (2017)

- Share of CHP-systems varies between 45 % and 99 %
- Differences in the extent of industrial on-site generation are mainly due to resource availability, industrial structure and national regulatory conditions
- Share of fossil fuels varies between 20 % and 85 %



A heterogeneous generation structure between countries is apparent

# Satus Quo of Industrial On-Site Generation

## Key Findings and Implications

- Generally high shares of CHP-systems compared to generators of public supply
- Generally high shares of fossil fuels compared to generators of public supply
- National regulations significantly determine the extent of industrial on-site generation
- Considerably high amounts of full load hours without any relation to electricity market prices

➡ Changes in electricity market prices do not affect industrial on-site generators

➡ Fossil fuel based industrial power plants operate during times of high shares of renewables

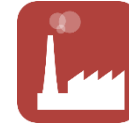
➡ For the future electricity system, industrial on-site generation represent an CO<sub>2</sub>-emitting element separated from the markets, which will not diminish through low-cost renewables

On-site generating plants operate fundamentally different than electricity generators of public supply

# Today's Agenda

## Part 1

### Status Quo of Industrial On-Site Generation



1.1

European Situation and Characteristics

1.2

Differences on a National Level

## > Part 2

### Potential of Market Integration



2.1

Basic Concept and Integration Procedure

2.2

Results and Consequences

# Potential of Market Integration

## Current System Design

Industrial on-site generation



- Industrial on-site generators operates with no regard to wholesale electricity markets
- From a overall system perspective, electricity generation costs are **not** minimised due to this separation

Wholesale electricity market



## Concept of Market Integration

- Previously on-site generated electricity can be purchased at the wholesale market
- Free generating capacities in industry can be offered at the wholesale market
- For CHP-systems, heat is produced separately whenever on-site generation is paused
- Some former market participants are now forced to purchase their electricity elsewhere

Industrial on-site generation



Wholesale electricity market



## Methodical Procedure

Real generation load profiles of industrial power plants are combined with marginal costs of electricity generation in industry



Real bidding curves are modified hourly to integrate on-site generation into the spot market



New market prices are determined resulting in a new generation structure each hour of the year



Resulting implications and conclusions are discussed

Consequences of market integration depend on national characteristics



# Potential of Market Integration

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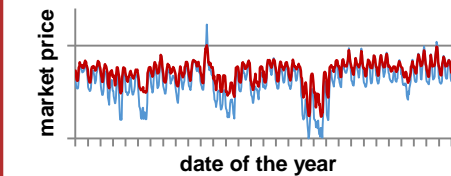
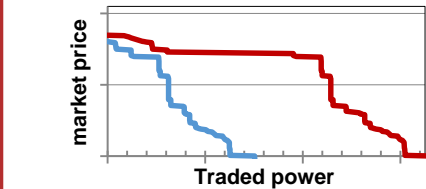
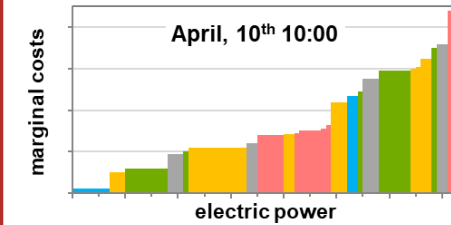
Industrial on-site generation



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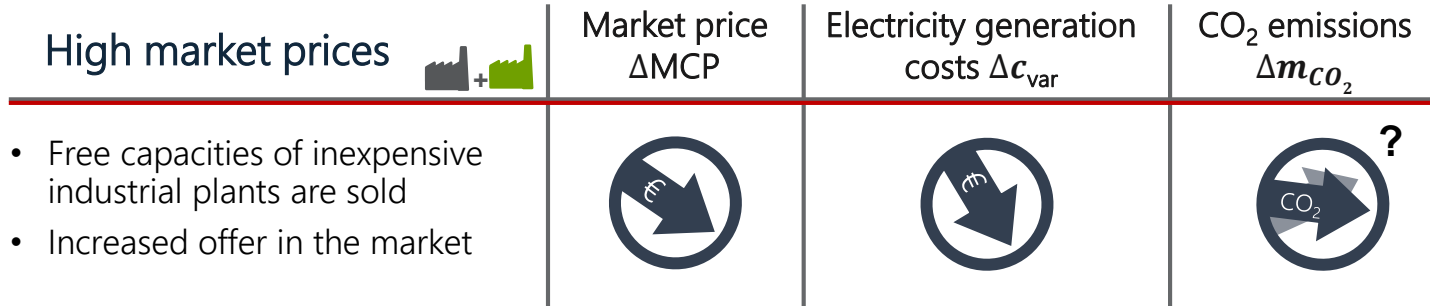
## Methodical Procedure



$\Delta$ MCP	$\Delta$ Costs	$\Delta m_{CO_2}$

Consequences of market integration depend on national characteristics

# Potential of Market Integration

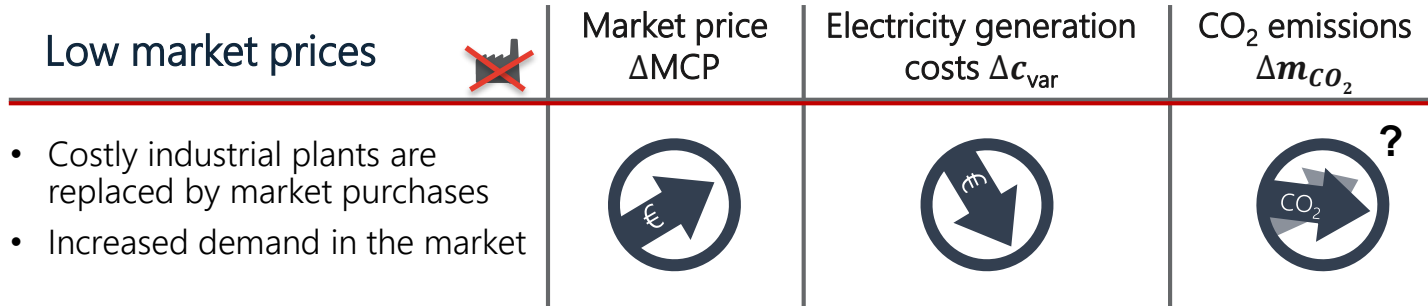


## Needed data for integration:

- National statistical data regarding the amount and composition of industrial on-site generation is needed
  - National generation load profiles of a representative amount of industrial power plants are needed
  - National spot market bidding curves of each hour of the year are needed
- ➔ Sufficiently accurate data is so far available for Germany only

Market integration is conducted for Germany as an example

# Potential of Market Integration



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# Potential of Market Integration

Results for Germany, 2017

Changes in electricity generation structure	Market price $\Delta MCP$	Electricity generation costs $\Delta c_{var}$	CO <sub>2</sub> emissions $\Delta m_{CO_2}$
<ul style="list-style-type: none"> <li>• Some of the costly industrial plants are replaced</li> <li>• Some free capacities of inexpensive plants are sold</li> <li>• Competition in the market is increased</li> </ul>	 + 2 €/MWh		

➔ 11 % of the previously on-site generated electricity is now replaced by market purchases

➔ The increased demand causes wholesale electricity prices to rise

➔ The increased competition causes overall electricity generation costs to drop

➔ Some of the industrial plants are replaced by high-emission generators of public supply

Market integration is conducted for Germany as an example

# Potential of Market Integration

Results for Germany, 2017

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## Consequences

- Costs for electricity consumers generally increase
- Electricity generation costs decrease in general and in particular for the industrial sector
- CO<sub>2</sub> emissions generally increase for the current market situation

➔ Electricity system framework and national regulations determine the concrete form of consequences

Consequences of market integration vary greatly with changing circumstances

# Summary and Prospects



## European Status Quo

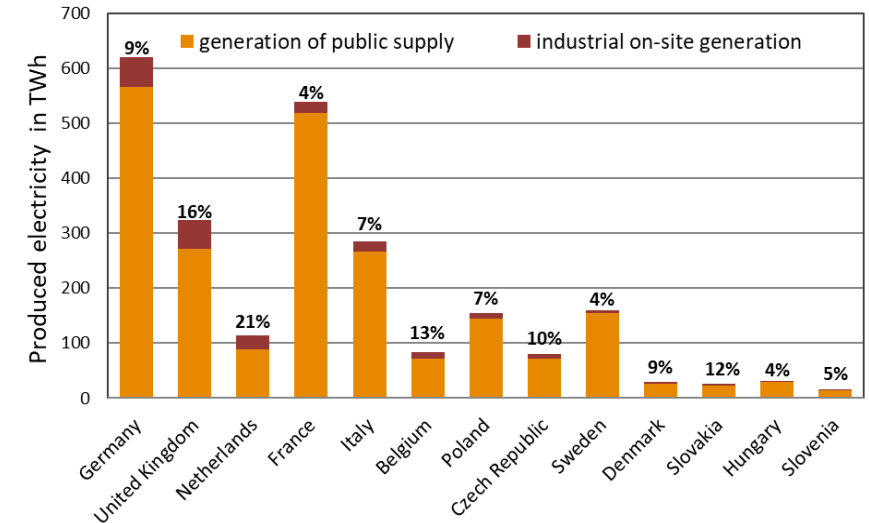
- Industrial on-site generation plays a significant role in each of the investigated countries
- National differences concerning diverse generation structures are linked to regulatory conditions and availability of energy sources
- Separation of industrial on-site generators and generators of public supply does not lead to minimised generation costs nor minimised emissions



## Potential of Market Integration

- The integration of on-site generation into the wholesale market leads to minimised overall generation costs
- Due to a general increase in electricity demand, wholesale market prices rise on average
- In the example of Germany, CO<sub>2</sub> emissions are generally increased
- Outcome of the market integration approach highly depends on market conditions and national regulations

Share of national overall electricity generation



The future role of industrial on-site generation remains controversial



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