

Gas Flows and Gas Prices in Europe: What is the Impact of Nord Stream 2

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M/Wasser M/Bäder M/Strom M/Fernwärme M/Erdgas M/net

Why analysis of global gas markets at SWM?



- ▶ Electricity: generation, distribution, sales
- ▶ Natural gas: production, transport, distribution, sales



- ▶ District heating: generation, distribution, sales
- ▶ Water: collection, distribution, sales



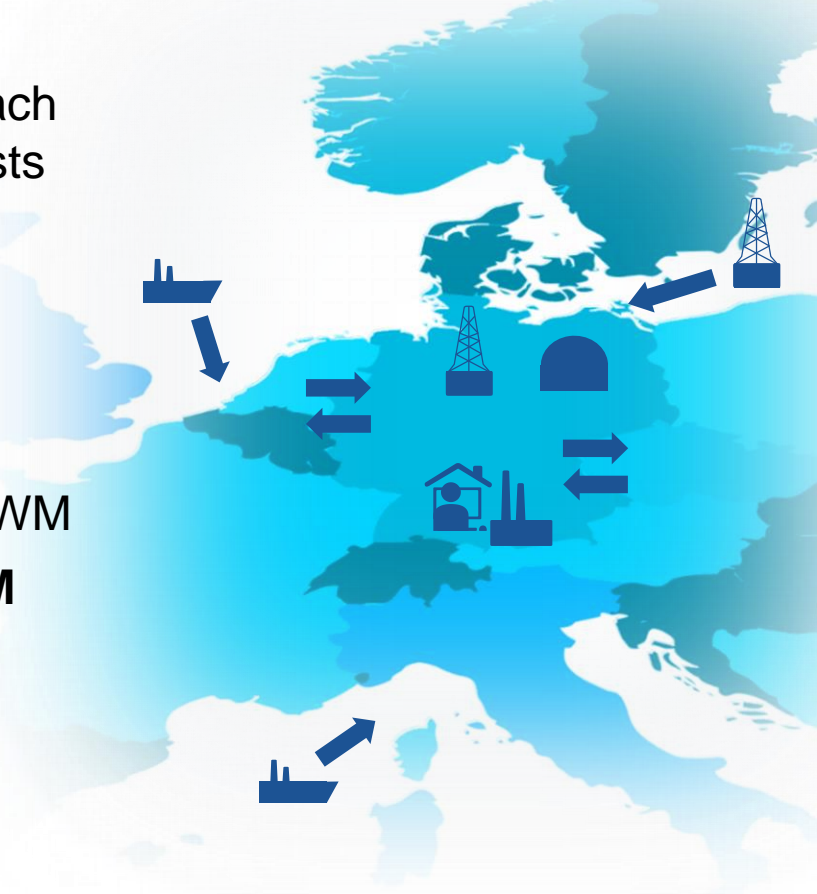
- ▶ Swimming pools: indoor pools, open-air pools, saunas, ice skating



- ▶ Mobility: subway, tram, bus, cycle rental system, etc.
- ▶ Telecommunications: Internet, phone and TV with fibreoptic technology

WEGA delivers gas flows and gas price development

- ▶ WEGA is the abbreviation of '**Weltweites Gasmarktmodell**'
- ▶ Worldwide model in daily resolution 2018-2040
- ▶ Goal of optimization → cover the demand in each zone/country/hub at each day at minimized costs
- ▶ The model was developed by PÖYRY Management Consulting (here: Pegasus)
- ▶ Linear Programming with Xpress from FICO
- ▶ Source code and dataset was purchased by SWM
- ▶ **The complete dataset was modified by SWM**
→ Results are an own view of SWM

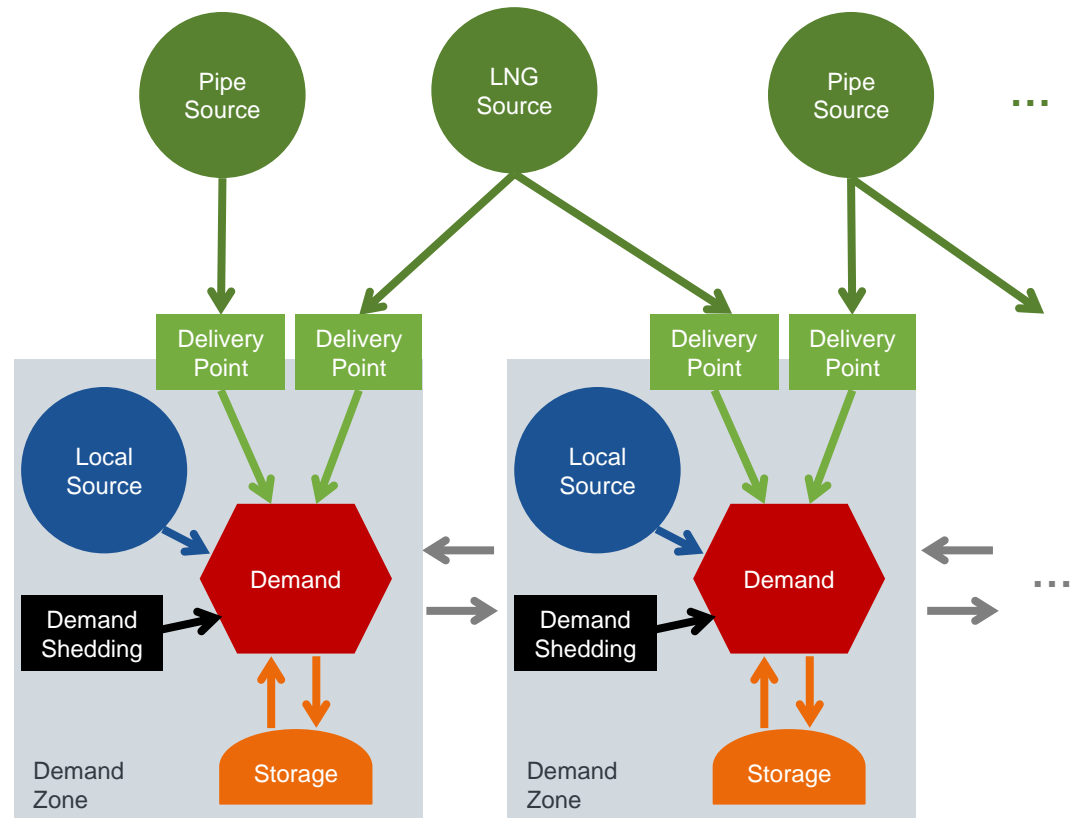


Modification of parameters by SWM

- ▶ Oil price and EUR/USD exchange rate
- ▶ Pipelines, Interconnections
- ▶ LNG terminals
- ▶ Storages
- ▶ Gas demand / own fundamental electricity model
- ▶ Costs (commercial databases for CAPEX, OPEX, transport costs)
- ▶ Contracts (CEDIGAZ, BNEF LNG contract database)
- ▶ Production volumes and flexibility of gas fields
- ▶ Actual gas flows and backtesting

Worldwide gas market as a grid of nodes and edges

- ▶ Source: pipeline or LNG
- ▶ Source: indigenous production
- ▶ Source: demand shedding
- ▶ Delivery point: pipeline or LNG
- ▶ Demand zone: country / region / rest of the world
- ▶ Storage: in demand zone
- ▶ Interconnection: between demand zones



User interface of WEGA

Optimization Modeler Analyst Client

File Edit Run Dashboard Admin Developer Help

Repository

- 018 = 2017 Dtlle bei 2008weg
- 019 = 2017 Tsl bei 2000weg
- 020 = 2019 mech mal 2050
- RI_002 = mit VGV und ST
- 021 = 200 (FINA) FH hoher
- 022 = 200 mit HH vor 021
- 023 = 201 aller hoher
- 024 = 201 vorne hoher
- 025 = 024
- 026 = 021
- 027 = 026
- 028 = 027
- 029 = 200 mit FOYEV-Faktor korrekt
- IRIS_01 = CDC ORISIN/4 mit Fehlerkor
- IRIS_02 = IRIS_01 mit HH niedriger
- IRIS_03 = IRIS_01 mit HH hoher
- IRIS_04 = IRIS_01 FK = 1.0
- IRIS_05 = IRIS_01 FK = 1.1
- IRIS_06 = IRIS_01 FK = 1.2
- IRIS_07 = IRIS_01 +12% demand Europ
- IRIS_08 = IRIS_01 -10% demand Europ
- IRIS_09 = IRIS_01 LNG Cap 1 Jahr frue
- IRIS_10 = IRIS_01 LNG Cap 1 Jahr frue
- IRIS_11 = IRIS_01 Wetter 2012 und 2013

New Editor

Pegasus

Item Editor

Regions: Germany, Germany_NCG

Types in Germany, Germany_NCG

- All Nodes Routes Contracts
- Demand zone (2)
- Indigenous source (6)
- Interconnection point (9)
- Pipe DP (3)
- Storage (61)
- Interconnector (47)
- Pipe (15)
- Contracts (220)
- Liquefaction terminal (0)
- LNG Source (0)
- LNG terminal (0)

Storage in Germany, Germany_NCG

- Krummhorn
- EtzeleKB
- EpeEON
- Empeide
- Hahnlein
- Stockstadt
- Sandhausen
- Bierwang
- Eschenfelden

Properties

- Node Name < complete >
- Node Grouping < complete >
- Node Longitude < complete >
- Node Latitude < complete >
- Node Active < complete >
- Node Market < complete >
- Node Class < complete >
- Node Cost to Market < null >
- Node Cost from Market < null >
- Storage Volume < complete >**
- Storage Capacity In < complete >
- Storage Capacity Out < complete >

Table for Storage Volume

| Storage Track | Node | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
|---------------|--------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Central | Krummhorn | 228 | 228 | 228 | 228 | 228 | 228 | 228 | 228 | 228 | 228 | 228 | 228 | 228 |
| Central | EtzeleKB | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 |
| Central | EpeEON | 1874.94 | 1874.94 | 1874.94 | 1874.94 | 1874.94 | 1874.94 | 1874.94 | 1874.94 | 1874.94 | 1874.94 | 1874.94 | 1874.94 | 1874.94 |
| Central | Empeide | 169 | 169 | 169 | 169 | 169 | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 |
| Central | Hahnlein | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 |
| Central | Stockstadt | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 | 135 |
| Central | Sandhausen | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| Central | Bierwang | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Central | Eschenfelden | 48.03 | 48.03 | 48.03 | 48.03 | 48.03 | 48.03 | 48.03 | 48.03 | 48.03 | 48.03 | 48.03 | 48.03 | 48.03 |
| Central | Kraak | 280.8 | 280.8 | 280.8 | 280.8 | 280.8 | 280.8 | 280.8 | 280.8 | 280.8 | 280.8 | 280.8 | 280.8 | 280.8 |
| Central | Allmenhausen | 62 | 62 | 62 | 62 | 62 | 62 | 62 | 62 | 62 | 62 | 62 | 62 | 62 |
| Central | Lehrte | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Central | Dotlingen | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Central | Harsefeld | 119 | 119 | 119 | 119 | 119 | 119 | 119 | 119 | 119 | 119 | 119 | 119 | 119 |

Graph

Aggregation Track

Views

- Multi Scenario Table
- Multi Scenario Chart
- Menu
- Start
- Create Tracks
- Item Editor
- Backup SQL.html
- Restore SQL.html
- Profile Viewer
- Run
- Run Summary
- Aggregation
- Run Settings
- Inputs - Miscellaneous
- Historical Years
- Branch properties
- Branch weights
- Inputs - Scenarios
- Scenario definition
- Demand tracks
- Production tracks
- Storage tracks
- Routes tracks
- Cost tracks
- Contract tracks
- Inputs - Nodes
- Node properties
- Node costs to market
- Node class properties
- Inputs - Routes
- Route properties
- Route capacity
- Route usage
- Route costs
- Route class properties
- Route class definition
- Aggregated Routes
- Route capacity (agg)
- Route cost (agg)
- Inputs - Demand zones
- Demand volume
- Demand component properties
- Demand profiles

Nord Stream 2

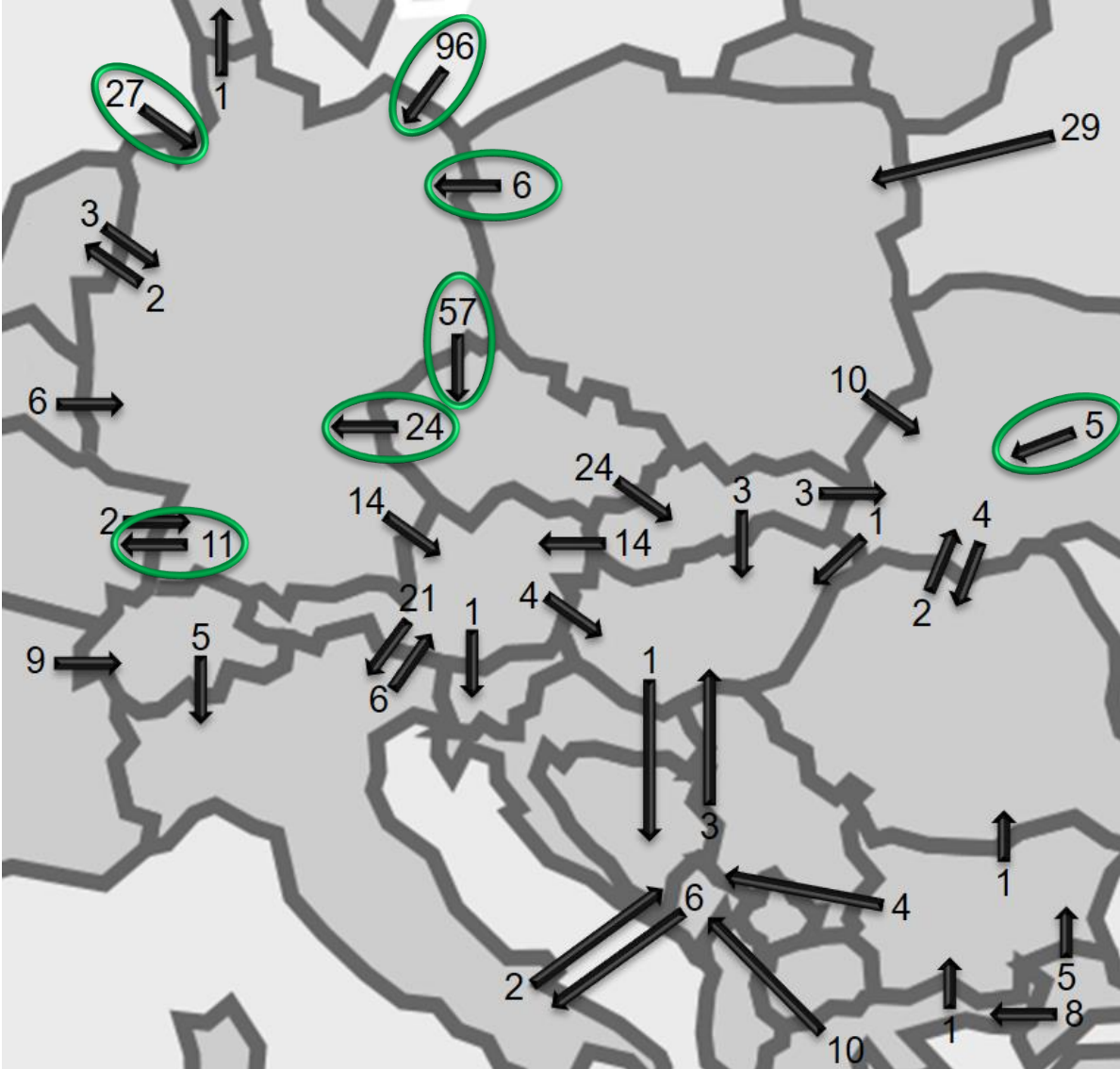
- ▶ Two strings
- ▶ Capacity 55 bcma
- ▶ European gas demand -15% until 2040
- ▶ Transit flows Ukraine limited, but > 0



- ▶ Calculated average price difference in EUR₂₀₁₇/MWh on wholesale gas prices in the period of 2020 till 2040 if Nord Stream 2 would not be built

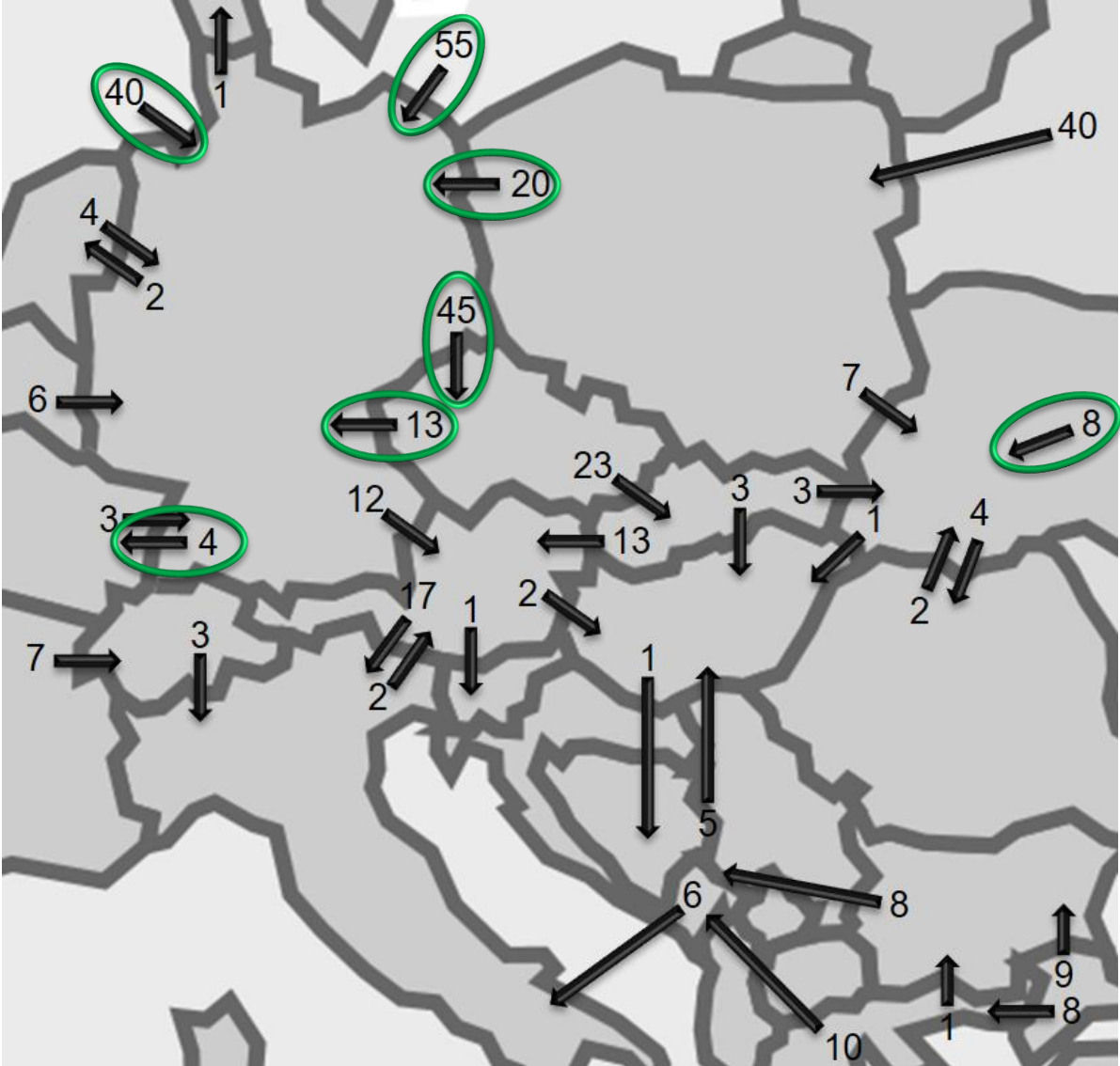
| United Kingdom | France | Netherlands | Germany | Czech Republic | Poland | Italy | Bulgaria | Romania |
|----------------|--------|-------------|---------|----------------|--------|-------|----------|---------|
| 0.66 | 0.70 | 0.79 | 0.80 | 0.89 | 0.70 | 0.55 | 0.39 | 0.15 |

Pipeline flows in 2028 with Nord Stream 2



rounded volumes in bcm; only gas flows ≥ 1 bcma

Pipeline flows in 2028 without Nord Stream 2



rounded volumes in bcm; only gas flows ≥ 1 bcma

Conclusion

- ▶ With North Stream 2 in the presented Base Case
 - ▶ North Stream 2 is not fully utilized on an annual level
 - ▶ Gas flows from Norway to Germany are directed to Northwest Europe
 - ▶ Ca. 20 bcm of LNG are pushed out of the merit order in Northwest Europe in 2028
 - ▶ More transit flows via Germany (+17 bcm in 2028)
 - ▶ Less gas flows from Poland to Germany (-14 bcm in 2028)
 - ▶ Moderate reduction of wholesale gas prices in Europe
- ▶ Transit contract between Gazprom and Naftogaz expires; uncertainty about transit flows via Ukraine in long-term
- ▶ Transit flows via Ukraine are only a last option for Russia

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