# Stadtwerke Wunsiedel (GOFLEX og FEVER projekterne)

*Erfaringer og planer for lokal fleksibilitet i en tysk multiforsyning når nettet udfordres af sol- og vindenergi*

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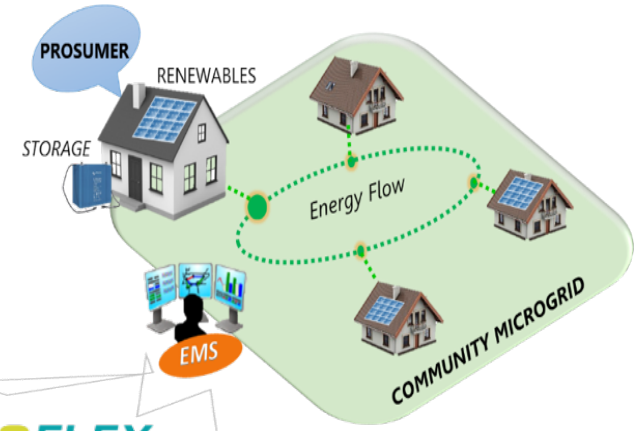
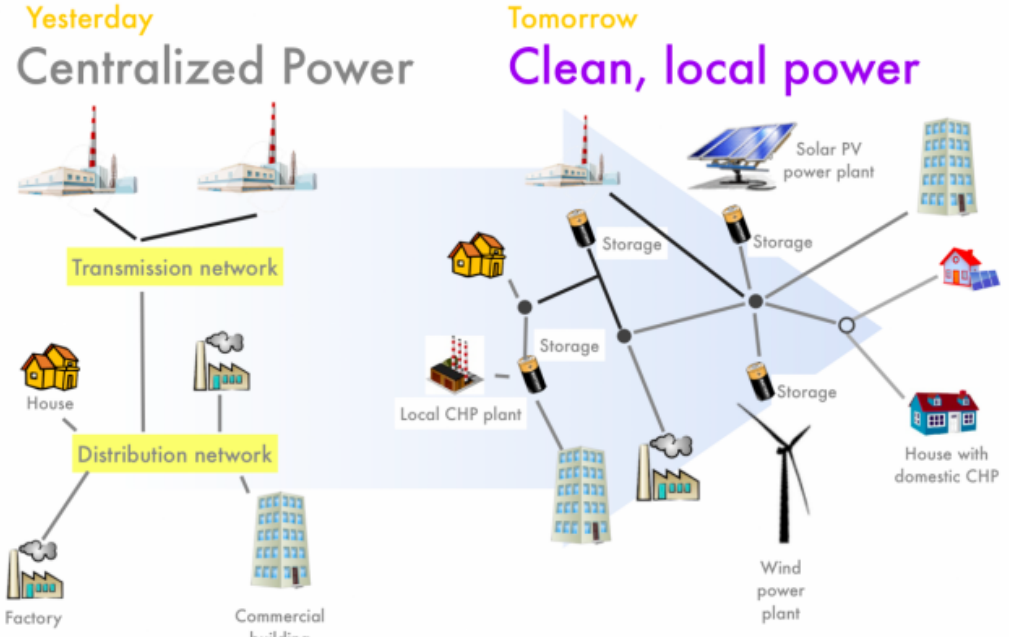
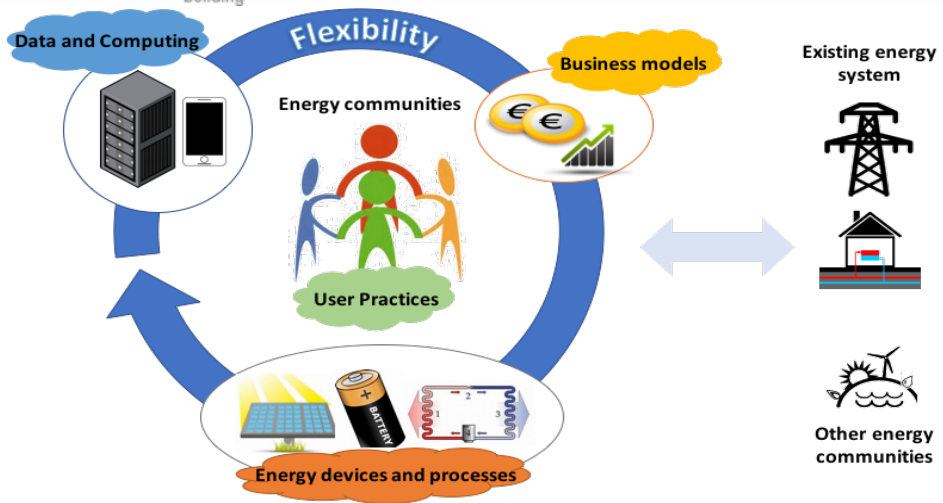
The project Generalized Operational FLEXibility for IntegratingRenewables in the Distribution Grid (GOFLEX) has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731232.

# Towards a ”bottom up” energy system

- Energy is produced ”bottom up”
  - Local RES
  - Micro-grids
  - Energy communities
- Should also be controlled ”bottom”

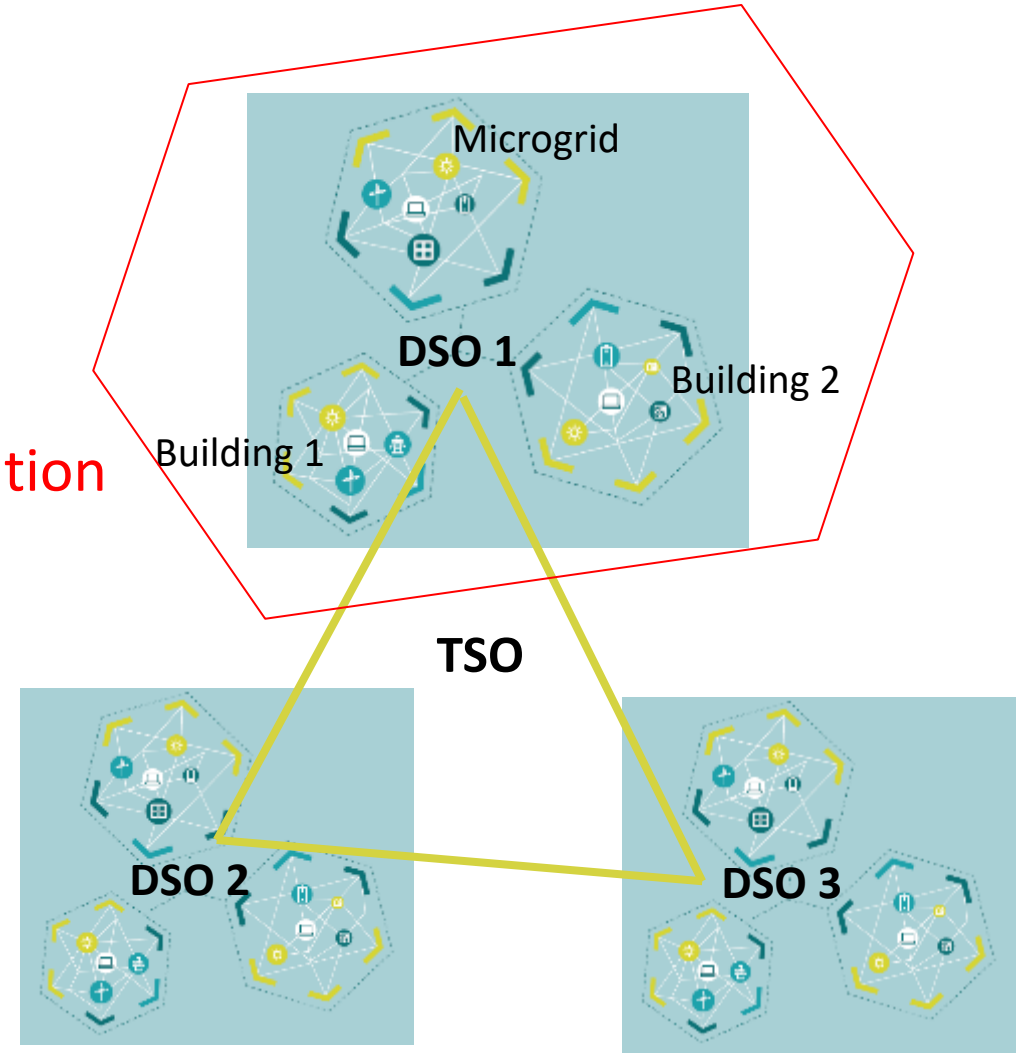


# Cellular energy systems

Autonomous operation or controlled islanding mode

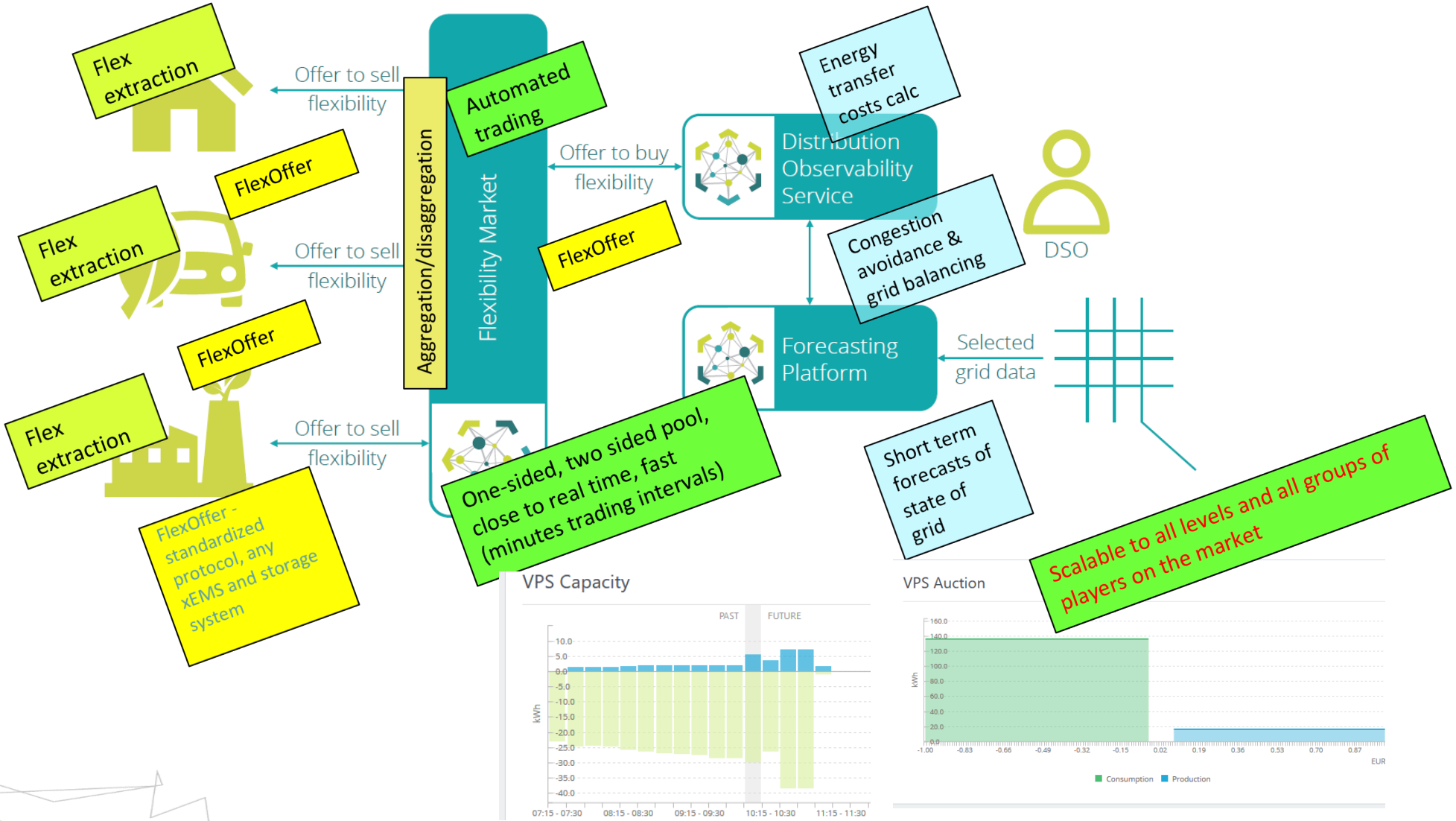



- Each cell aims to reach optimal local energy self sufficiency (while not in islanded mode)
- Cells interact with other cells on peer level
- Higher grid levels act as „safety net“ for the lower levels

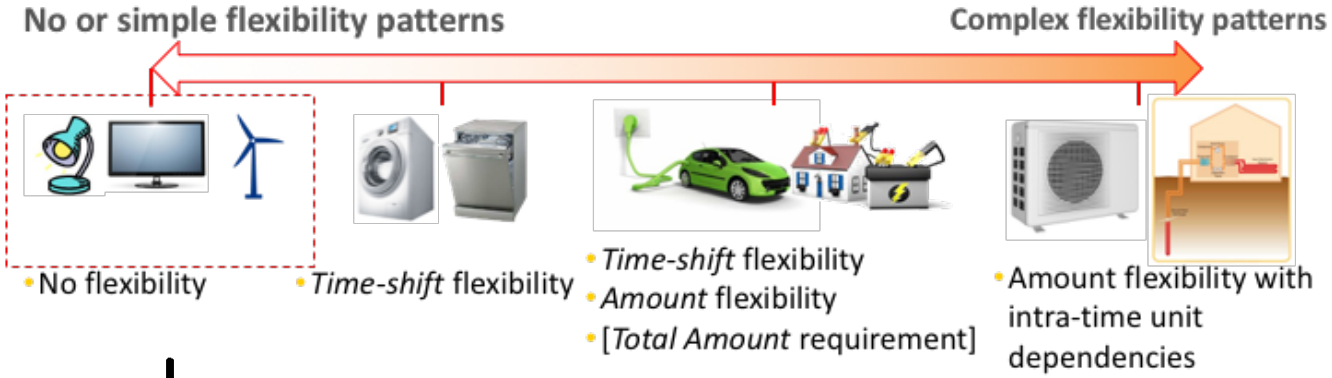
# GOFLEX FlexOffer Video

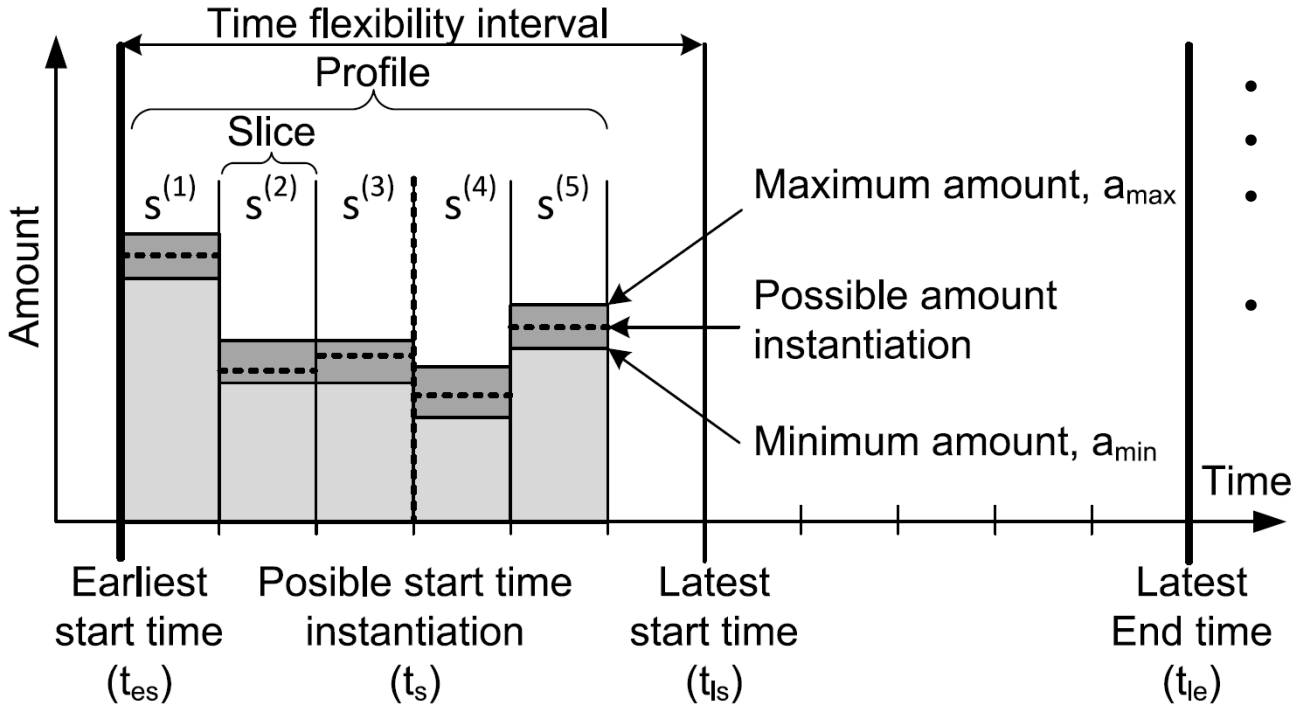
- https://goflex-project.eu/video/2737_BAUM_FLAT_D2001_DE_final_01.mp4

# Enabling technologies and solutions - GOFLEX Integrated solution platform (example: DSO Use case)

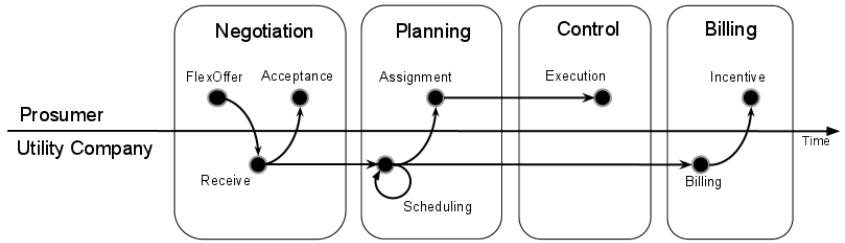


# Capturing ALL Flexibilities with FlexOffers



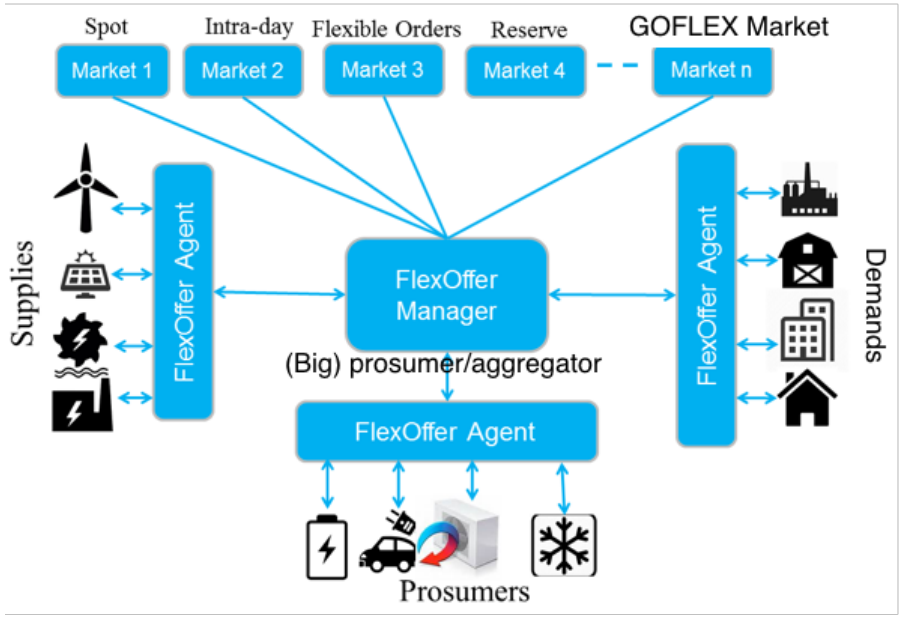

- Exact **location** (meter, radial, transformer,…)
- **Aggregatable**
- **Options**: total energy, slice dependencies, **production/mixed**, grid capacity,…
- It is an **OFFER** from prosumer to flex purchaser
  - **No** force/**curtailment**
  - **Explicit offer** with commitment
  - Well-defined **protocol**



# Next Step: **Open** FlexOffer Community

## Using FlexOffers - In GOFLEX and beyond

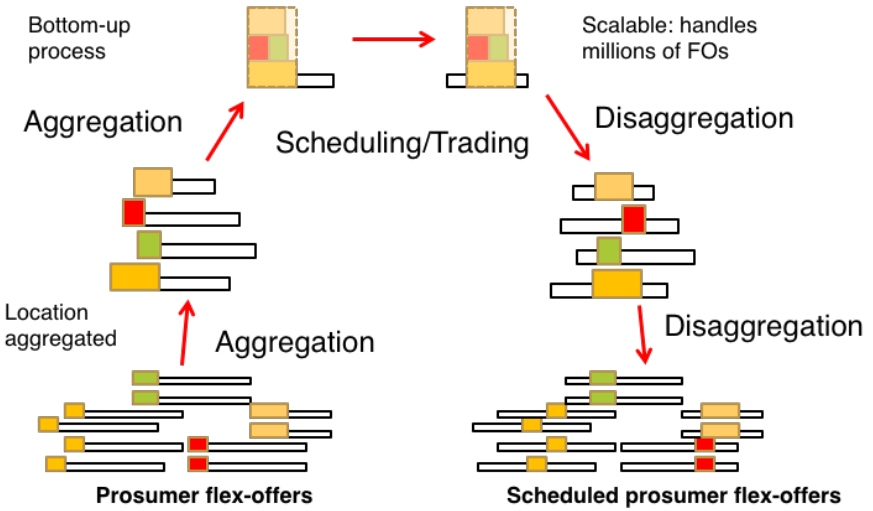
- **GOFLEX: standardized, configurable end-to-end system** with standard components
- General integration of **many types of loads** with **many markets**
- **Scalable (dis)aggregation**
- GOFLEX FlexOffer Market **matches** auto-predicted **DSO needs with offered flexibility** (as FOs)

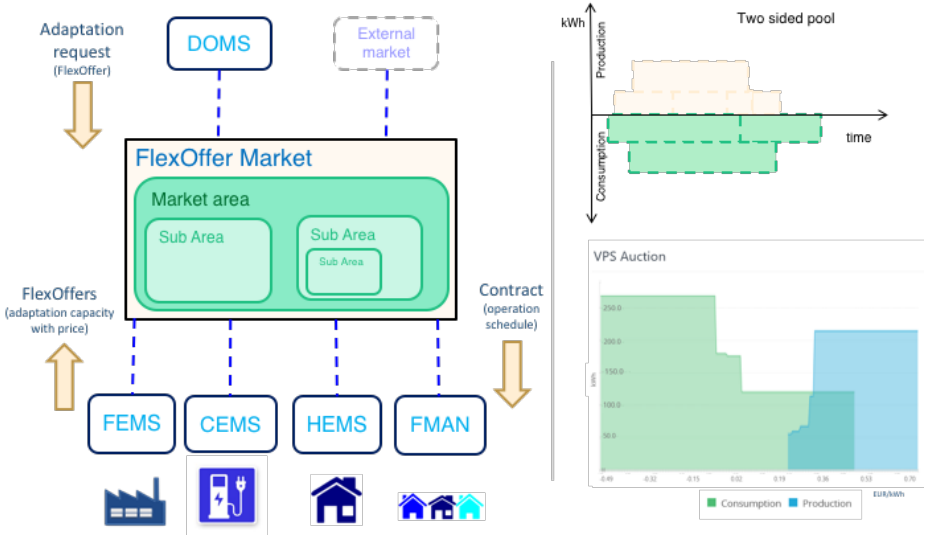



Interfacing of flexibility market components.

Developed/used/validated in:

- MIRABEL (FP7) 2010-13
- Totalflex (DK) 2012-16
- KIBERnet (SI) 2013-16
- Arrowhead (FP7) 2013-16
- DiCyPS (DK) 2015-20
- GOFLEX (H2020) 2016-20
- Flexible Energy Denmark 2019-23
- GIFT (H2020) 2019-23
- FEVER (H2020) 2020-23
- domOS (H2020) 2020-23



# GOFLEX demo sites (demonstration, not sim)


**Deploy flexibility to have a self-sufficient energy supply**

- Meeting energy needs of residential & commercial customers with 100% renewable & regionally produced energy


**Explore flexibility offered by the public sector**

- Testing the microgrid case of a university as local energy community


**Use flexibility to reduce the need of upgrading grid infrastructure**

- Optimising the balance for the DSO to reduce corrective costs
- Using demand-side management to reduce peak loads on the distribution grid

**GOFLEX** Integrated platform Demo projects

- **3 locations: Germany, Cyprus, Switzerland**
- **Different DSO-centric Use cases: Congestion management and energy balancing in DSO grids, local energy community**
- **Prosumers:** appr. **500 prosumers of all types: environmental, industrial, residential, EVs**

GOFLEX

# PROFILE SWW

- **Multiutility:** DSO, supplier of energy (**Regional Ökostrom)**, heat, water and gas
- **Vision: local, green energy community**: focusing on the consistent production, use and expansion of renewable energy and sustainable technologies (e.g. solar/wind energy, cogeneration, wood as raw material)
- **high RES penetration**, which consists of approximately **1.000 PV sites of all sizes, several wind parks**, about hundred heat pumps, battery systems, hydrogen applications (Power-to-Gas (2020); Fuel Cell (2021) and EV charging stations
- consumer/prosumer population covers all types of infrastructures, such as industries, SME, professional RES sites, farms, multifamily residences with common installations and single homes
- furthermore, SWW has taken first steps into flexibility marketing and end user integration through participation in the GOFLEX project.
- Other projects; SPARKS, cloud|E, LEITNING, EdgeFLEX

# Results from SWW (by Gerhard Meindl)


- Wunsiedel site: GOFLEX platform (including DOMS) with access to
  - 21 FEMS, 22 HEMS, 154 home appliances not connected to EMS
  - 5 public electric vehicle charging stations
  - 1 private electric vehicle charging station
- trial period: 01.10.2019 to 16.01.2020
- 90 MWh flexible energy traded on GOFLEX platform >>> upscaled to a year 500 MWh worth 32.800 EUR
- sensed requested flexibility on the market: 6,500 MWh >>> upscaled to 33,500 MWh per year worth 2.2 mio EUR (at assumed price 0.066 €/kWh)

>>> obviously applied pricing model didn't allow prosumers to sell more FlexOffers

but: rough calculation came up with 5 mio EUR extra gross profit for SWW if bringing power of their own and local prosumers' generators to the local market

# Impact 1

| Quantity | Target Value | Achieved Value |
|---|---|---|
| Safe increase of installed capacity of renewable energy sources | >15 % | 59,2% |
| Adaptability of energy load with respect to peak demand | >15% | 24,8% |
| Estimated profit(revenue?) from supplying/activating aggregating demand response | >€35,000/MW/year<br>+ €200/MWh | 85.297€*<br>2.218€* |
| | | |
| Reduction in peak demand | >15% | 13% |
| Increase in self-consumed energy | >10% | 10% |
| Coverage of grid state variables of interest with distribution observability and management system | >80% | 82% |
| Likelihood of correct prediction of congestion | >90% | 80,53% |
| Accuracy of forecasts at substation level | <10% | n/a |
| Accuracy of forecasts at BRP level | <5% | 1,54% |
| Service platform query response time | < 1 minute | 1.25 seconds |
| Service platform availability of observations | < 5 minutes | 0.23 seconds |
| Service platform availability of next forecast update | < 30 minutes | 26 seconds |
| Variation of electric vehicle charging load at public stations | +10 / -30 % | >30% for both directions |
| Variation of electric vehicle charging load at private station, depending on parking time | 2 hours: +/- 10%<br>8 hours: +/- 25% | +10%<br>+12% |
| Reduction in electric vehicle charging time and peak load at private station | >15% | Not needed due to strong prosumer grids |

# Impact 2

| Steps | Business KPIs | Target value during GOFLEX test phase |
|---|---|---|
| Step 1-4 | KPI 1.1 Level of self-generation in % Target: 100% | 75%<br>155%* |
| Step 1-4 | KPI 1.2 Deviations from balance in the balance group in % | 5%<br>0% |
| Step 1-4 | KPI 1.3 Amount of flexibility achievable in kWh | 60.558.669 kWh<br>79.000.000 kWh (+)* |
| Step 1-4 | KPI 1.4 Amount of flexibility achieved in kWh | 60.558.669 kWh<br>33.550.825 kWh* |
| Step 1-4 | KPI 1.5 Amount of money achieved for flexibility in EURO | 10.516.000 €<br>2.217.710 €* |
| Step 1-4 | KPI 1.6 Flexibility out of storage | 20.000.000 kWh<br>Not applied in project |
| Step 1-4 | KPI 1.7 Earnings out of Virtual Power Plant (VPP) | 1.000.000 €<br>Not applied in project |
| Step 1-4 | KPI 1.8 Earnings out of aggregation of flexibility | 1.350.000 €<br>2.218.304€* |
| Step 1-4 | KPI 1.9 Number of new PV-installations | >5%<br>35%* |
| Step 1-4 | KPI 1.10 Number of new battery operators | 10<br>17* |
| Step 1-4 | KPI 1.11 Number of Prosumers that provide energy data | 50<br>55* |

# Cost Benefit Analysis SWW

**D9.2 (2017)** For SWW the calculated prize for “tradable” flexibility based on business data of **2016** was calculated with **0.0267€/kWh** and the calculated prize for avoided procurement was **0,0629 €/kWh.**

**D9.4 (2019)** For **2018** the calculated prize for “tradable” flexibility in SWW based on business data of **2018** is calculated with **0,0475€/kWh** and the calculated prize for avoided procurement is **0,0661 €/kWh.**

# Cost Benefit Analysis SWW and Prosumer

**SWW** Re-Calculating the 2018 Business case in electricity by using the assumptions shown, results in an **increase of contribution margin from 2.822.000€ to 7.720.144€** when introducing flexibility trading

**Prosumer** Under the assumption of SWW offering the prosumers to split profits for “traded” flexibility 50/50, the share is **1.108.855€ for the 210 prosumers/participants in one year**.

# ROIs

- **Factory Energy Management System** (FEMS) group

21 FEMS achieving 9.242.761kWh

0,0331€/kWh ea accounts to 305.935€

average FEMS operator earned 14.568€

28.000€ CAPEX and 500€ per year OPEX

29.000€ for 2 years

**2 years of ROI**

# ROIs

- **Direct control group (direct device control, smart plugs)**

154 DirCon achieving 3.378.440kWh

0,0331€/kWh ea accounts to 111.826€

average DirCon operator earned 726€

1.350€ avg CAPEX (some much smaller) and 50€ per year OPEX

1.450€ for 2 years

**2 years of ROI**

# ROIs

- **Home Energy Management Systems (HEMS)**

Due to a breakdown of battery in early stage

22 HEMS achieving only 28.902kWh

7.500€ CAPEX and 250€ per year OPEX

8.000€ for 2 years (battery not included)

To achieve a **breakeven** with the CAPEX and OPEX figures shown above we need a period of **5 years with a 10 kW battery**

# ROIs

- SWW (half & half)

achieving 1.110.532€ with 210 partners

average share per partner 5.228€

1.726T€ CAPEX and 140T€ per year OPEX

8.888€ for 2 years

**1,7-1,8 years of ROI**

Rough pre-calculatory guess for starting flexibility business as a DSO

# Model for island operation in Wunsiedel

- Maximum positive / negative demand side flexibility needed:
  10 MW / -13.7 MW (65 % / 90 % of maximum demand)
- Accumulated needed demand side flexibility equivalent to a (central or distributed) energy storage with capacity of 2.0 GWh
- Ratio between the maximum accumulated flexibility and instantaneous flexibility shows: flexibility must be rather from a long-term storage like power-to-gas than a lithium-ion battery or other short-term flexibility.

# Decentral vs. central flexibility provision

- cold reserve Irsching:
  - most effective gas power station
  - maximum call off: 800 MW
- Wunsiedel maximum negative demand side flexibility: -13.7 MW

>>> 60 Wunsiedels to replace 1 Irsching

# SWW Extended Observability Period

- SWW is so happy with the GOFLEX system that they will **pay themselves** to continue running it
  - *The **first time** this happens for a Horizon 2020 project*?
  - 3 year period March 2020-February 2023
  - Tech partners contracted
    - INEA (platform integrator, flexibility trading, EMSs , device integration)
    - IBM (distribution observability system)
    - FlexShape (flexibility management, aggregation, device integration)
    - ETREL (EV charging stations)
    - Robotina (Home energy management)

# Marco Krassner video

- SWW CEO Marco Krassner shares his experiences with and plans for the GOFLEX system at SWW
- https://www.youtube.com/watch?v=VbbAl8MV94s

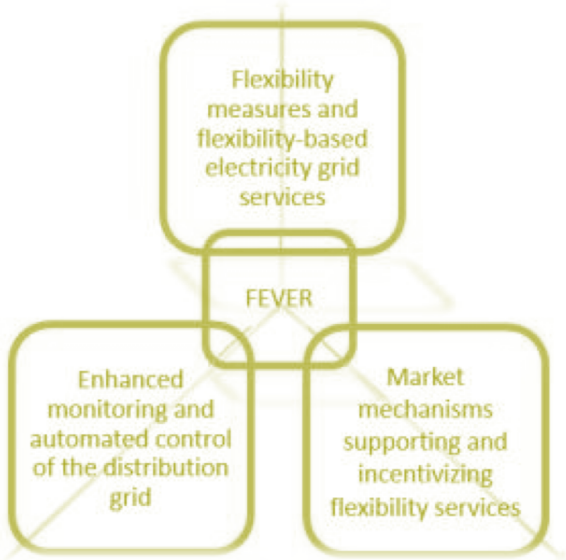
# Flexible Energy Production, Demand and Storage-based Virtual Power Plants for Electricity Markets and Resilient DSO Operation (FEVER)

- **FEVER Summary**
  - ✓ *Topic* *"LC-SC3-ES-1-2019: Flexibility & retail market options for the distribution grid"*
  - ✓ *~10 M€ Project duration* *42M 01/02/20*
  - ✓ The "**bottom-up**" project in this H2020 call
  - ✓ Sister project: "**top-down**" Platone
  - ✓ Planned collaboration about joint standard (FlexOffers and protocols) => the de facto European standard for (local) flexibility?

# FEVER Scope

Develop, implement and demonstrate almost market-ready solutions and services aiming to increase distribution grid security and resilience by leveraging energy flexibility towards supporting grid operation under normal, critical and emergency conditions

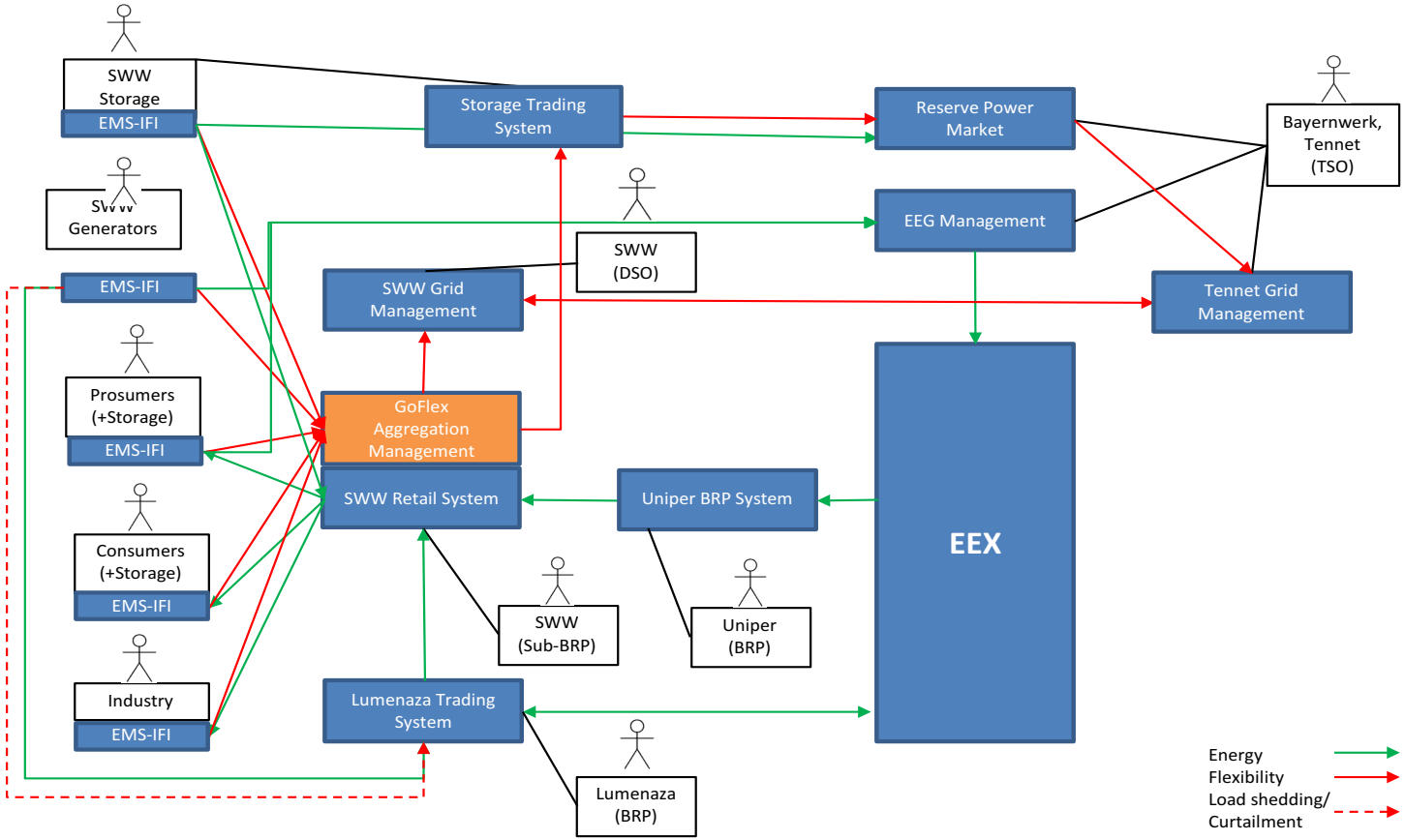
- ✓ *Spatio-temporal extraction, aggregation & management of distributed flexibility capacities for supporting distribution grid & market operation*
- ✓ *Advanced monitoring and management tools/services implemented on the top of DSO's legacy systems*
- ✓ *Advanced market mechanisms enabling flexibility trading at local and market level*



# SWW IN FEVER

GOFLEX
goflex-community.eu

## SWW DSO (Step 1 Initial)



# FLEXIBILITY BRIDGE BETWEEN SWH AND SWW

# Acknowledgments and Contact


- Many slides from Gerhard Meindl, SWW and other GOFLEX/FEVER colleagues



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The project Flexible Energy Production, Demand and Storage-based Virtual Power Plants for Electricity Markets and Resilient DSO Operation (FEVER) receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 864537.