# Overview of simulation-based results

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# Introduction

In total, 13 improved business models have been developed in the BestRES project.

| | | |
|---|---|---|
| (1) Automation and control | (5) Providing decentralized units access to balancing markets | (9) Demand Side flexibilization of small customers |
| (2) “Peer-to-peer” (local) energy matching | (6) Market renewables on multiple market places | (10) Invest and market distributed generation of customers in apartment houses |
| (3) Dispatch flexible generation under changing market design on multiple markets | (7) Trading PV and Wind power | (11+12) Activation and marketing of end user’s flexibility. (PT + ES) |
| (4) Suppling „mid-scale“ customers with time variable tariffs including grid charges optimization | (8) Using flexibility of customers as third party | (13) Pooling flexibility for local balancing market and energy service provision. |

DSM residential

DSM commercial and industrial

RES generation flexible

RES generation volatile

Energy community

# Methods

For the simulation-based analysis the Femto-Toolbox (developed at TUW-EEG) has been used:

- Framework for techno-economic Mixed Integer Linear Programming (MILP) optimization models and simulation models for Aggregators
- Flexibly adaptable to different technology portfolios (energy producers, energy storage systems, flexible loads, e-mobility)
- Consider (multiple) different markets (day-ahead and intraday, balancing markets)

# Automation and Control - Good Energy (UK)

Uses innovative smart home technology to offer domestic customers insights of their energy usage and benefits through real time pricing.

- Shifting of individual load components:
  electric shower, fridge, kettle, microwave, toaster and washing machine
- Two tariff scenarios:
  Improved (TOU with two price levels) and Advanced (hourly RTP)

| | Improved | Advanced |
|---|---|---|
| Cost for energy purchase for customer | -0.6 % | -1.2 %* |
| $CO_2$ | -0.12 % | -0.37 % |

* (-17.6 % compared to TOU tariff)

# Dispatch flexible generation under changing market design on multiple markets – Next Kraftwerke (DE)

Impact of the change from weekly to four-hourly reserve market products on the operation of flexible generation (biogas power plant).

- Two production cost assumptions: 100 / 140 EUR/MWh
- Auctioned market premium support mechanism
- Operation on day-ahead spot and aFRR markets

| Cost assumptions | 100 EUR/MWh | 140 EUR/MWh |
|---|---|---|
| Annual Profit (4h vs weekly) | +18.7 % | +19.3 % |
| Offered +&- aFRR reserve (4h vs weekly) | +7.9 % | +8.8 % |

# Supplying mid-scale customers with time variable tariffs including grid charge optimization – Next Kraftwerke (DE)

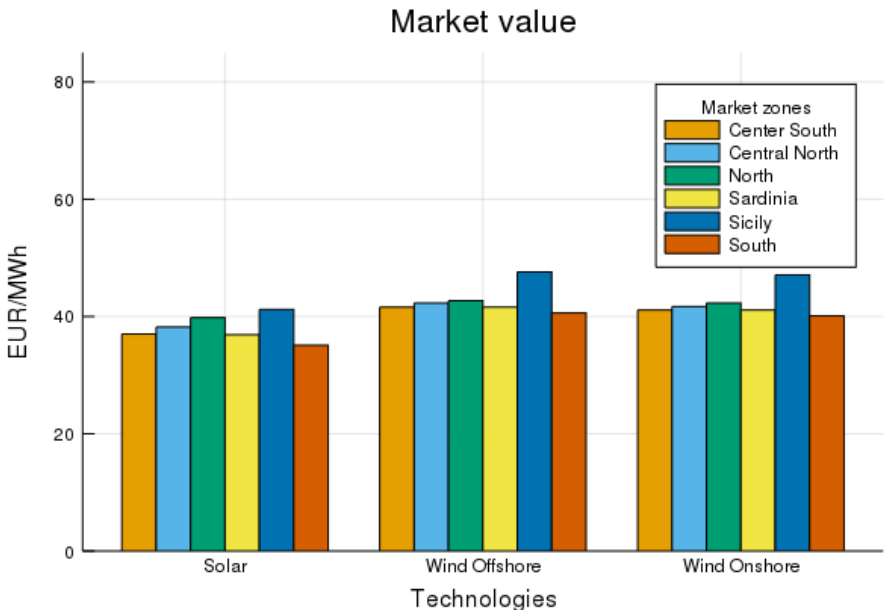
Helps customers to benefit from market signals through time variable tariffs but also takes into account peak-load-pricing of grid charges.

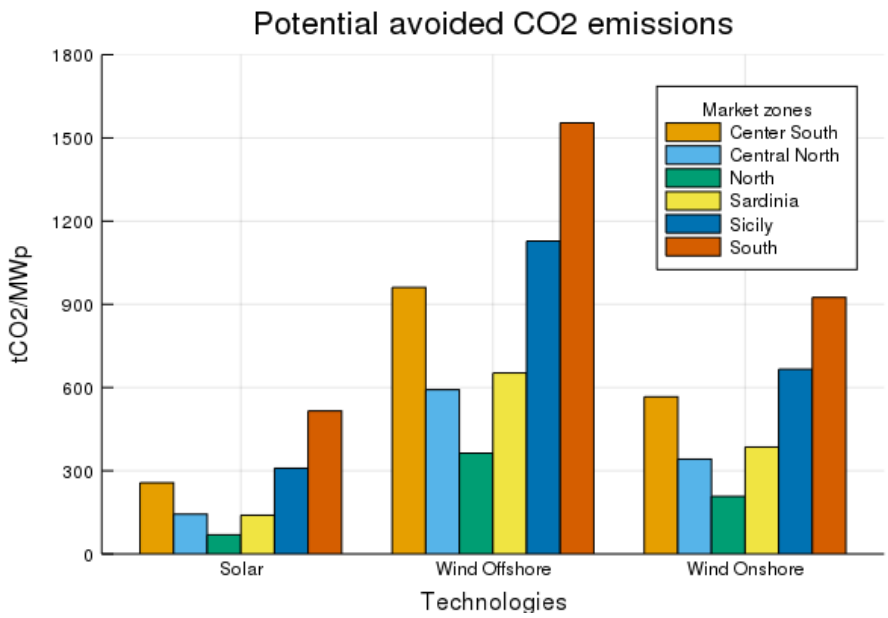
- Spot-only (baseline) vs Spot+Grid (improved) optimization
- Two tariff scenarios: Yearly and Monthly peak-load-pricing

| | Yearly | Monthly |
|---|---|---|
| Annual Cost | -10.5 % | -20.7 % |
| Peak Load | -36.5 % | -36.5 % |
| $CO_2$ | +0.6 % | +0.8 % |

# Market renewables on multiple marketplaces- Next Kraftwerke (IT)

Analysis of the market value of RES for different technologies in new market areas:



# Trading PV and wind power from third party assets - Next Kraftwerke (BE)

Trade energy from renewables on short term markets and make use of portfolio effects. Use the intraday market to reduce imbalance cost.

- Three scenarios:
  - Baseline (no intraday market trades, only imbalance cost)
  - Improved (trade imbalances)
  - Optimal

| Revenues | Technology | Improved | Optimal |
|---|---|---|---|
| 2015 | Solar (BE) | -1.3 % | +4.8 % |
| | Solar (NKW) | +1.8 % | +11.7 % |
| | Wind Onshore | +1.2 % | +8 % |
| | Wind Offshore | -2.9 % | +10 % |
| 2016 | Solar (BE) | -1.1 % | +5.7 % |
| | Solar (NKW) | -0.7 % | +12.4 % |
| | Wind Onshore | -0.01 % | +8.1 % |
| | Wind Offshore | +2.1 % | +10.2 % |

# Using flexibility of customers as third party – Next Kraftwerke (BE)

Using the flexibility of customers can influence the imbalances and billing of their retailer. Bilateral contracts are required, to ensure non-opportunistic behaviour.

## *Baseline*

| Customer Cost [kEUR] | Supply |
|---|---|
| Lighting | -94,1 |
| Cooling | -97,7 |
| Industry | -60,4 |
| Total | -252,2 |

| Supplier Profit [kEUR] | Supply | Day Ahead | Total |
|---|---|---|---|
| Lighting | 94,1 | -94,1 | 0,0 |
| Cooling | 97,7 | -97,7 | 0,0 |
| Industry | 60,4 | -60,4 | 0,0 |
| Total | 252,2 | -252,2 | 0,0 |

## *3rd party spot optimization*

| Customer / Aggregator Profit [kEUR] | Supply | Day Ahead | Supply Transfer | Total |
|---|---|---|---|---|
| Lighting | -90,2 | 4,0 | -4,0 | -90,2 |
| Cooling | -94,8 | 2,9 | -2,9 | -94,8 |
| Industry | -52,2 | 8,1 | -8,1 | -52,2 |
| Total | -237,2 | 15,0 | -15,0 | -237,2 |

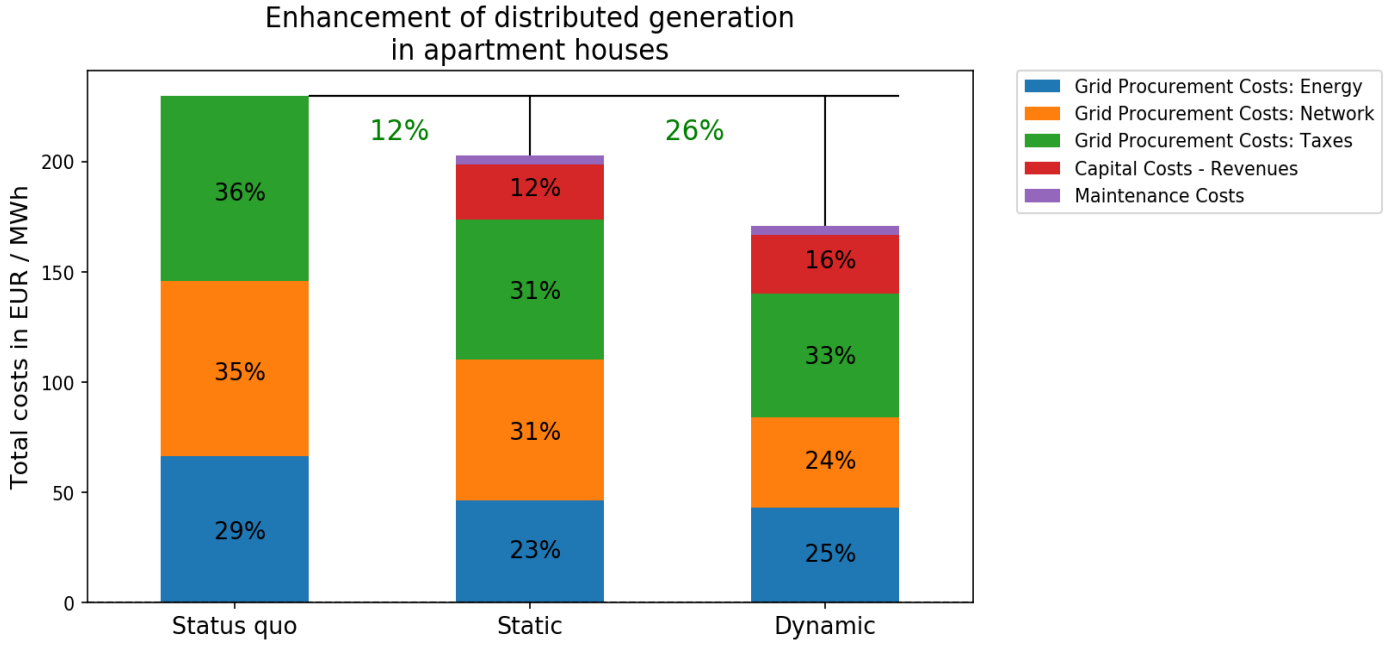
| Supplier Profit [kEUR] | Supply | Day Ahead | Supply Transfer | Total |
|---|---|---|---|---|
| Lighting | 90,2 | -94,1 | 4,0 | 0,0 |
| Cooling | 94,8 | -97,7 | 2,9 | 0,0 |
| Industry | 52,2 | -60,4 | 8,1 | 0,0 |
| Total | 237,2 | -252,2 | 15,0 | 0,0 |

# Valorize distributed generation of customers in apartment houses - Oekostrom (AT)

Investing in and marketing distributed generation by customers in multi-apartment buildings.

Two scenarios:

- Static (Each resident owns a fixed share of the PV system)
- Dynamic (Trading of PV generation among residents is possible)



# Activation and marketing of end user's flexibility – EDP (PT)

Use the flexibility of end users to reduce energy procurement cost on the day-ahead spot market or to reduce imbalanaces.

3 load types: Heat, Water, Other

3 scenarios: Spot, Imbalance and Optimal

| Cost Reduction | Spot | Imbalance | Optimal |
|---|---|---|---|
| Spot market [EUR/MWh activated flexibility] | -7.7 | 0.0 | -0.4 |
| Imbalance cost [EUR/MWh activated flexibility] | 0.0 | -9.7 | -22.6 |
| Total [EUR/MWh activated flexibility] | -7.7 | -9.7 | -15.9 |

| Change in CO2 emissions | Spot [%] | Imbalance [%] | Optimal [%] |
|---|---|---|---|
| Heat | +0.1 | -0.0 | 0.0 |
| Water | +4.8 | -1.8 | +0.9 |
| Other | +1.8 | +0.3 | +0.9 |
| Total | +1.0 | -0.1 | +0.4 |

# Summary and Conclusions

- Using demand side flexibility to react on price signals (flexible tariffs, expected imbalances, market prices) can create value and reduce cost for the customers.
- The profitability of DSM business models depends very much on the characteristics and availability of the flexibilities and the prices
- For flexible RES producers (like biogas power plants) balancing markets are more suitable than energy-only markets due to high short-run marginal costs.
- The feasibility of business models with volatile RES production depends on the opportunity cost: Market value vs end user bill.
- No clear recommendation between intraday and imbalance market could be identified for forecast errors of volatile RES.
- 3rd party activation of flexibility can contribute to agent engagement and total system felxibility but requires bilateral contracts or a suitable legal framework.

# Thank you!

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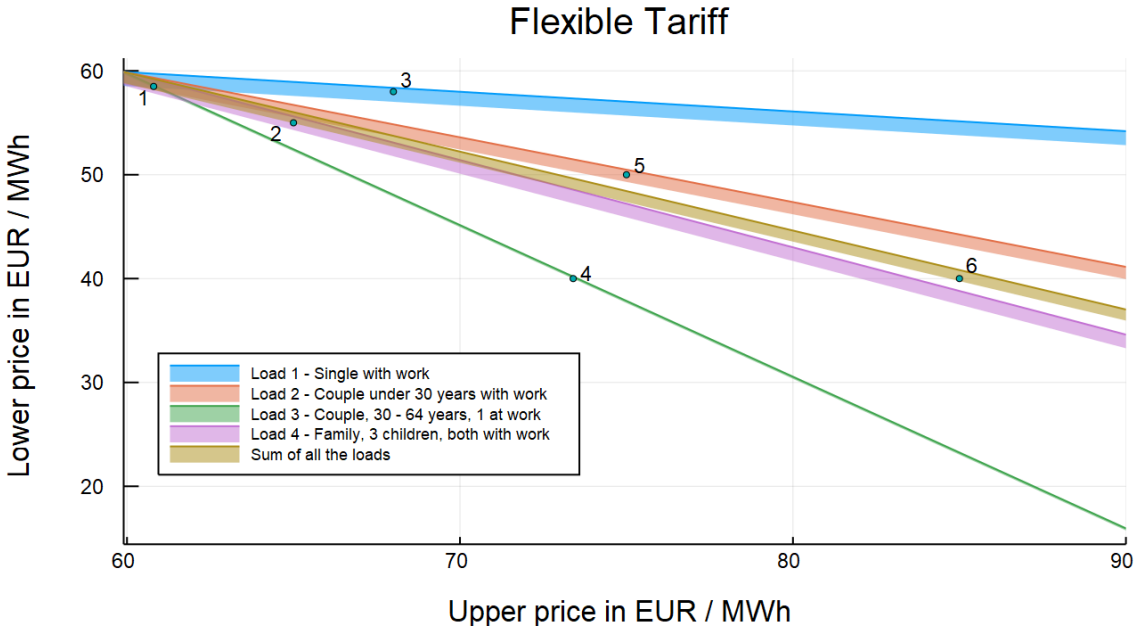
# Demand side flexibilisation of small customers – Oekostrom (AT)

Design a tariff with two price levels to incentivize demand side flexibilization.

Find win-win situations between the retailer and different customer groups.



# Activation and marketing of end user's flexibility – EDP (ES)

3 load types: HVAC, Water, Other

3 scenarios: Spot, Imbalance and Optimal

| Cost Reduction | Spot | Imbalance | Optimal |
|---|---|---|---|
| Spot market [EUR/MWh activated flexibility] | -9.7 | 0.0 | -9.7 |
| Imbalance cost [EUR/MWh activated flexibility] | 0.0 | -1.1 | -5.5 |
| Total [EUR/MWh activated flexibility] | -9.7 | -1.1 | -9.7 |

| Change in CO2 emissions | Spot [%] | Imbalance [%] | Optimal [%] |
|---|---|---|---|
| HVAC | 0.1 | -0.1 | -0.0 |
| Power | -1.0 | -0.2 | -1.2 |
| Lighting | -0.1 | -0.0 | -0.1 |
| Total | -0.7 | -0.1 | -0.8 |