Smart Grids Model Region Salzburg

ISGAN Webinar, 5 December 2013

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Contents

Austria

Multi Utility Company Salzburg AG

Business Fields & Customers

Public Transport
48 Mio. Passengers

Internet
63,000 Customers

Cable-TV
123,000 Customers

Telephone (VOIP)
21,000 Customers

Electricity
422,600 Customer installations

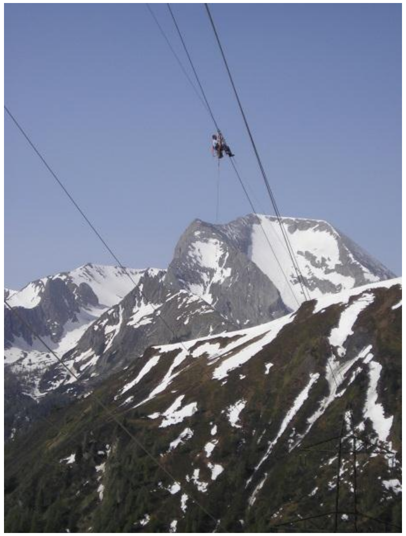
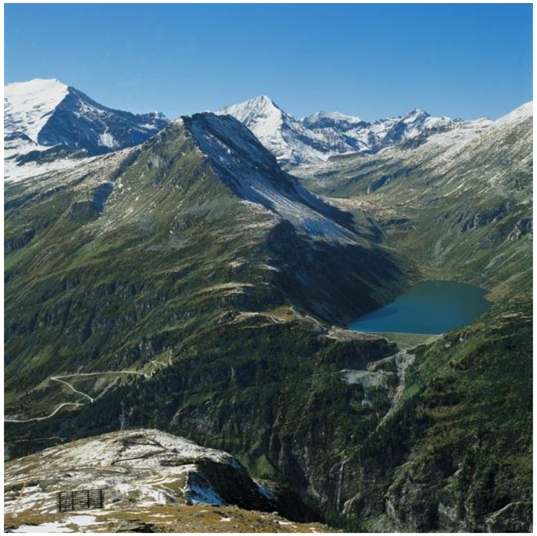
Gas
35,800 Customers

District Heating
13,700 Customers

Water Supply
156,000 Inhabitants

Business Volume 2012: 1,477 Mio €
Employees 31.12.2012: 2,041

Some impressions…

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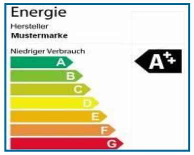
SMARTGRIDS Model Region Salzburg

Why Smarter Grids?

Energy and climate policy
EU-20-20-20 targets;
Energy Roadmap 2050: -80% CO2



Energy system transition

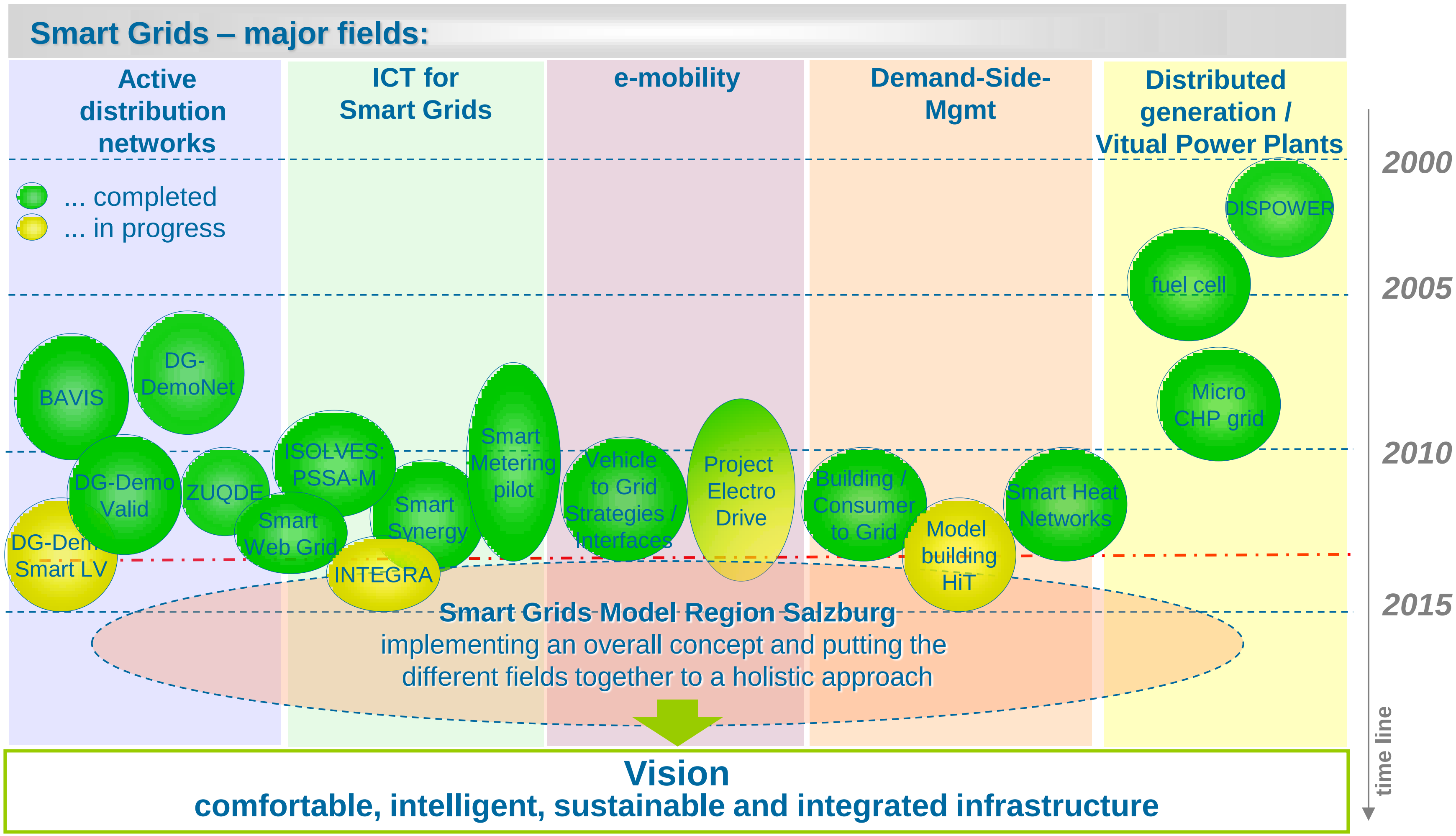
ICT revolution,
Internetisation,
Internet of Things,
miniaturization,
networking

Social Trends
Individualization,
ambition to be
self-sustaining,
environmentalism

The traditional structure of the energy industry will be turned upside down!

Development of the Model Region

combining 5 major fields to a holistic approach



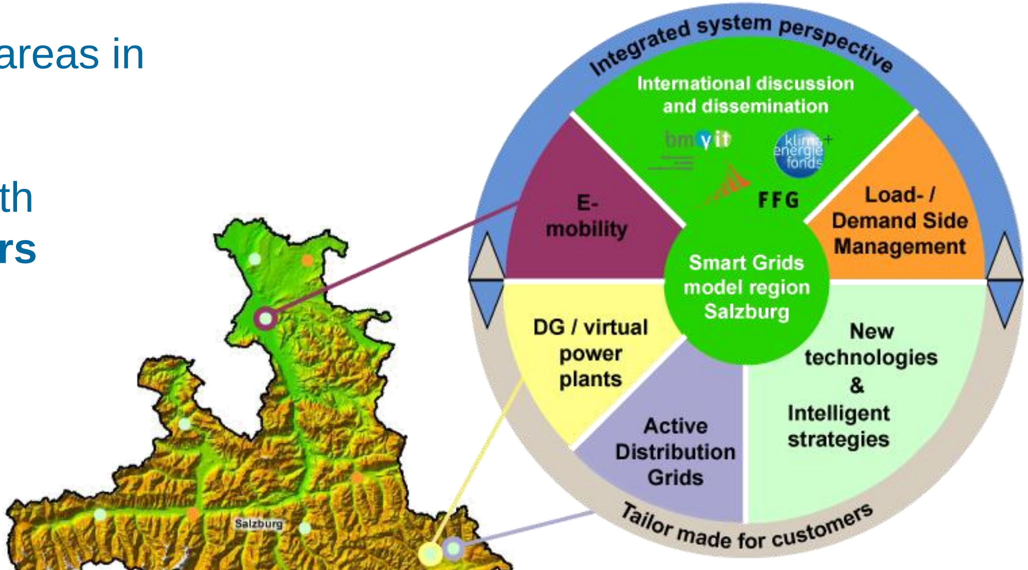
SMARTGRIDS Model Region Salzburg

Smart Grids Model Region Salzburg

In December 2009 Salzburg was awarded „1st Austrian Smart Grids Model Region“ by the Climate and Energy Fund.

Objectives of the Model Region program

- Gather a **critical mass** of **Smart Grid applications:** analyze synergies, dependencies and interchange
- Integrate challenges from different areas in **an integrated system solution**
- Realization in network segments with **real-world challenges** & **customers**
- Implementation of **demo projects**, where many applications and their synergies become visible



source: Wolfgang Prüggler, TU Vienna

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The Consortium

Salzburg AG

network operator (DSO) / utility
Leader of the consortium

Salzburg Wohnbau

building developer & operator
buildings
as test objects:
link to costumers

SIEMENS

equipment & ICT supplier
Industrial partner, components, solutions, tools

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY

research
active distribution grids, distributed generation, integration of buildings …

TU WIEN

research
Business models
IT-architecture;
business cases

cure

research
human-computer interface
customer acceptance
socio-economic aspect

FICHTNER IT CONSULTING

support
consulting,
international
networking

Contents

- Smart Grids Model Region Salzburg – Overview (Daniel)
- **Demand Side Management (Sara)**
- Active Distribution Grids / Integration of Renewables (Daniel)
- ICT for Smart Grids (Daniel)

Demand Side Management

What is Demand Side Management?

DSM is a mechanism to ensure the stability of the grid by offering its capacity to keep the balance between supply and demand

DSM is a set of interconnected and flexible programs which allow customers an active role in the evolved electric energy system and liberalized energy market

DSM is used as an umbrella term covering several objectives, including load shifting (Demand Response) and energy efficiency

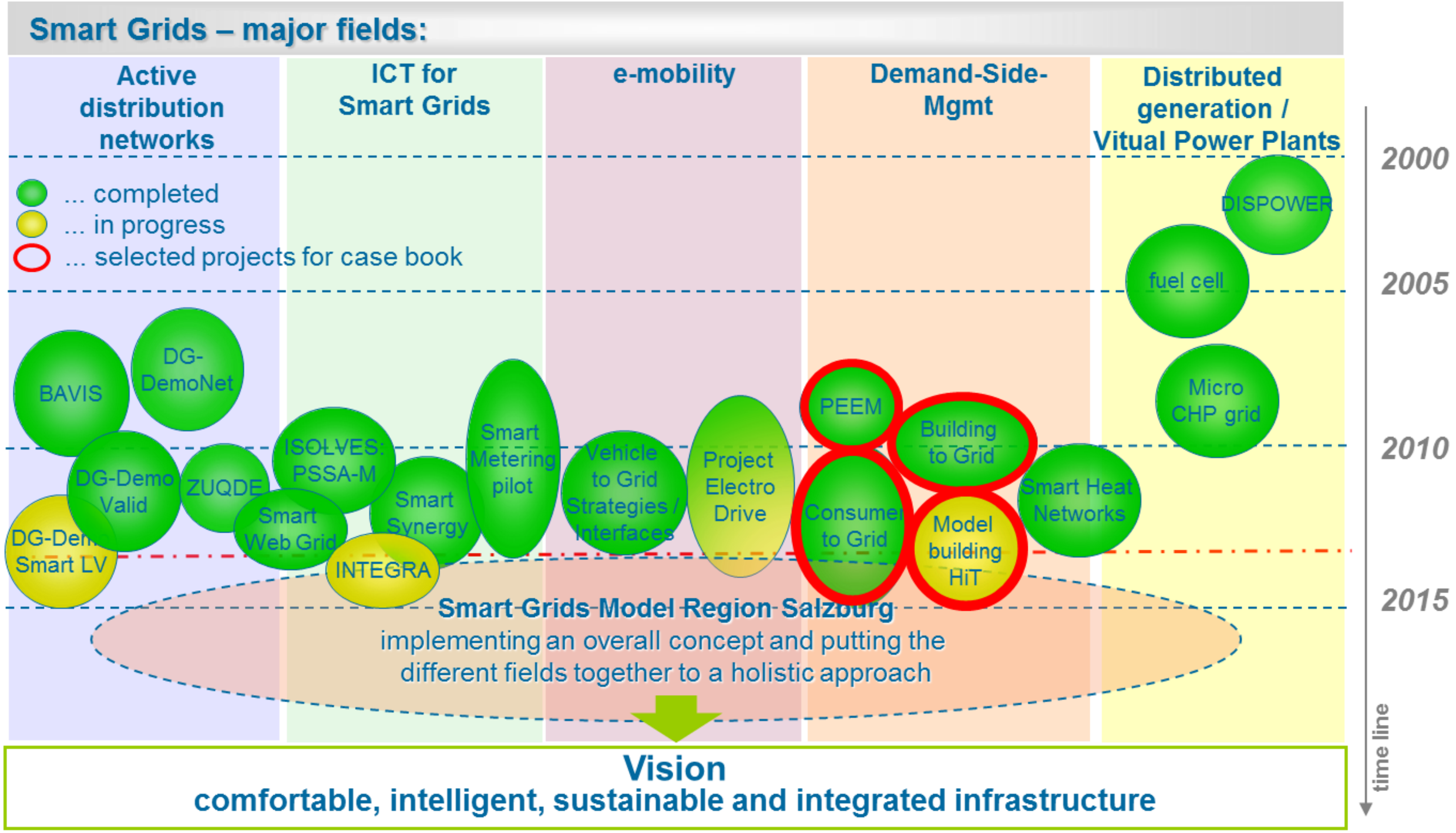
Demand Side Management

DSM solutions:

- Feedback system by taking the consumer in the loop
  - Feedback about the energy consumption (Energy efficiency)
  - Additional feedback about the availability of renewable resources and/or grid congestion (manual load shift)

- Energy management system by taking the building in the loop (automated demand response)

Demand Side Management



C2G – Consumer to Grid

Key Question:

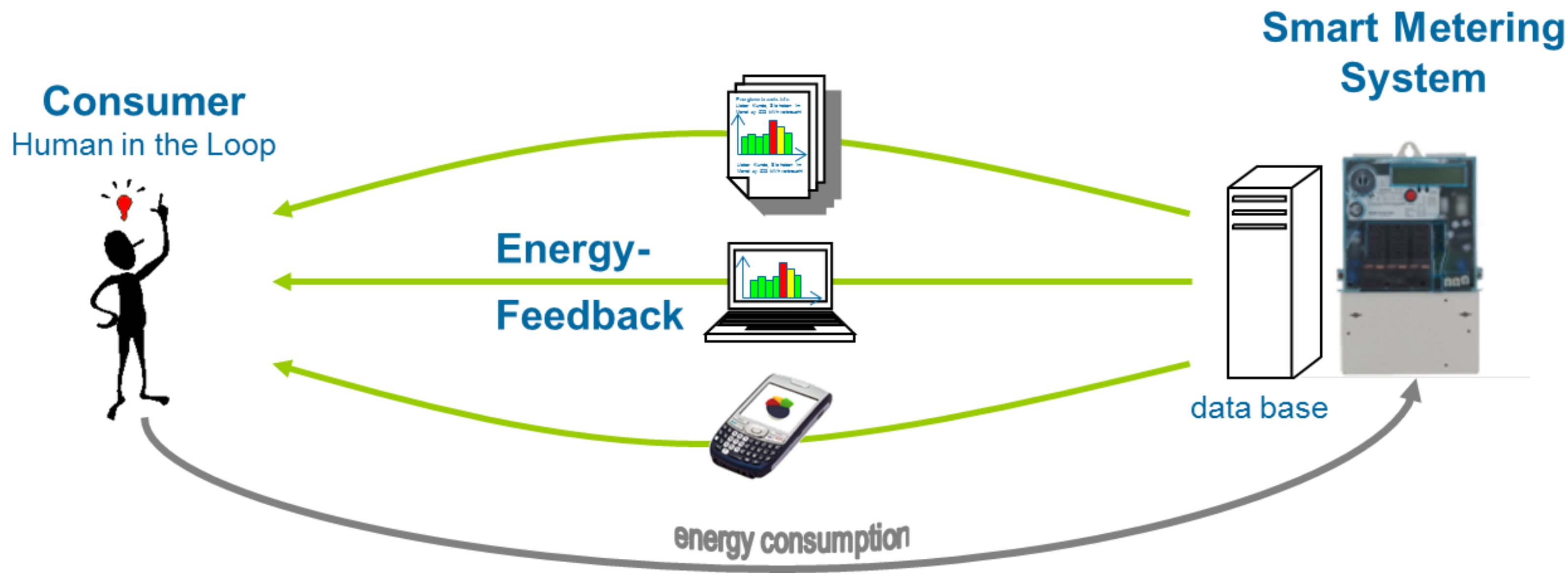
- Is it possible to encourage customers to reduce their electricity consumption effectively by energy feedback?

Methodology:

- state-of-the-art: Easy to implement combined with minimal investment cost
  - Annual bill, Monthly bill, Webportal,…
- Innovative: Use synergies derived from more innovative methods that balance out the advantages and disadvantages of the individual methods and meet the newest technological standards

Field test: 288 households

C2G - Concept


Consumer
Human in the Loop
Energy-
Feedback
Smart Metering
System
data base
energy consumption

Feedback method	Frequency	Ave. consumption 2011 [kWh]	Ave. consumption 2012 [kWh]	Saving potential [%]
yearly bill	yearly	2508	2441	-3
monthly bill	monthly	2427	2367	-2
webportal	previous day values	2226	1983	-11
home-display	near real time values	2774	2662	-4
Wattson	real time values	1891	1841	-3

C2G - Results

- Visualizing the energy consumption using feedback systems and engaging consumers in the household sector, reduces the total electricity consumption by about 7% per year
- Energy feedback systems raise awareness of users at home
- At the beginning, users question their own behavior which leads to change their pattern of consumption but the response faded over the course of time
- Using energy feedback system solely has no lasting value to the user

C2G - Conclusion

→ **Permanent presence of the feedback is advantageous**

→ **Beside electricity-use feedback, additional functionalities should be provided to obtain user interest over the long term**

PEEM - Persuasive End User Energy Management

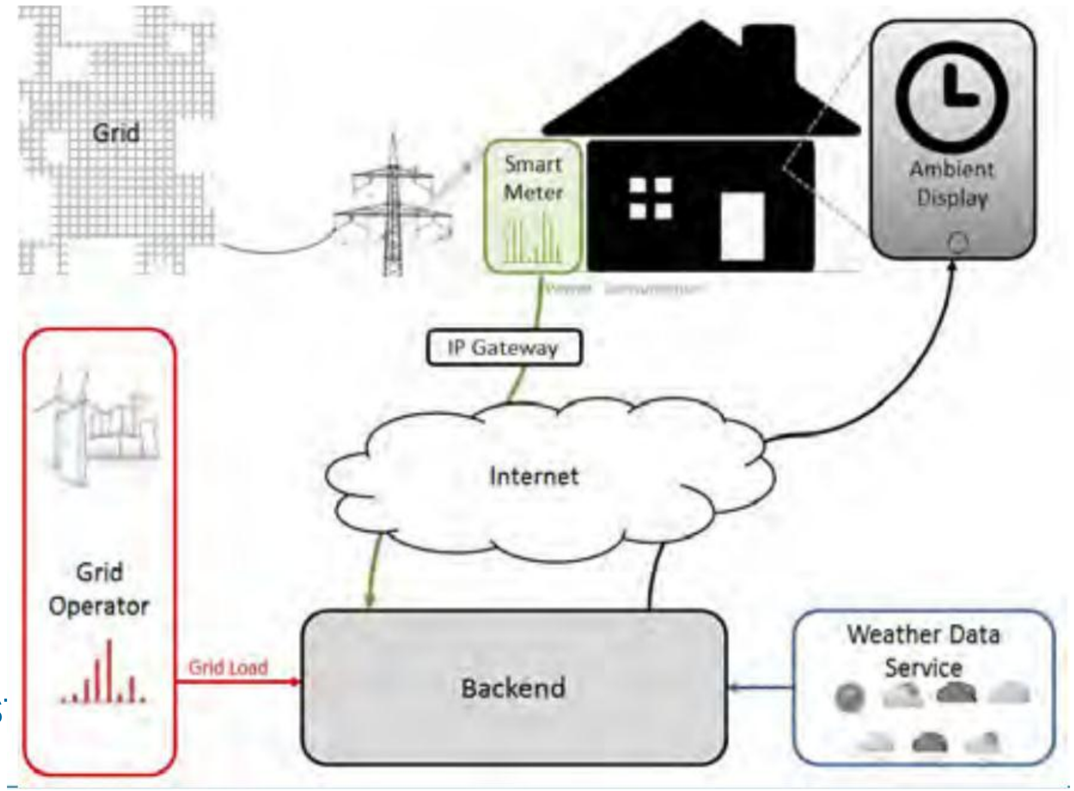
Key Question: How can you encourage customers to shift their electricity consumption to favorable times?

Methodology:

- Innovative feedback method
- Development of FORE-Watch

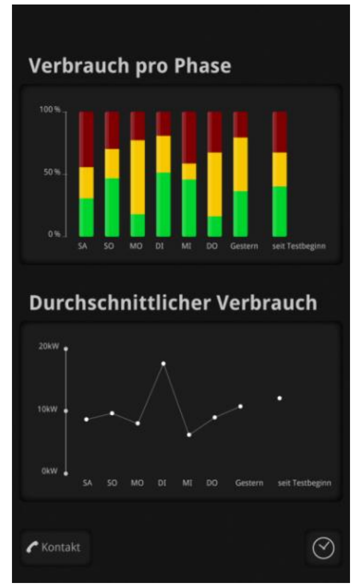
Field test:

- 24 customers
- 6-month field trial
- 2 feedback groups:
  - Group1: Wind energy forecast
  - Group2: Grid load forecast



PEEM - Concept

color indicates when energy should preferably be consumed



Feedback: consumption per color (time zone) / daily average consumption

- Following persuasive strategies are applied
  - Simple presentation of the information (Reduction / Simplicity)
  - Abstracted information is included into the ambience (Ambient)
  - Tailored suggestion for the next hours (Tailored Suggestion)
  - Direct feedback on actual energy consumption (Cause and Effect)

PEEM - Results

- By including external information like the availability of renewable resources or grid congestion to the feedback system, the consumer responded to the received signals continuously without losing interest.
- Consumer responded to received information and adopted use of household appliances like dishwasher, washing machine, dryer,… as much as they could
- The response of group1 was dependant to the information of FORE-Watch, since the information they recieved change every day but the group2 were able to adopt their consumption after learning phase even without using FORE-watch.
- Loss of comfort and habit changes were the main obstacles for the consumers

PEEM - Conclusion

→ Clearly new feedback system has perceptible benefits if the color indicators assigned to time of use tariffs

→ Integrating the proposed feedback system into automated control system of electrical appliances like home automation can boost the beneficial results

B2G - Building to Grid

Key Question: How can buildings contribute to peak load reduction and enhanced energy efficiency in power grids by intelligent load management?

Methodology:

- ***Direct load control:*** switched on/off of the controllable devices (electric heating and hot water system) by the grid operator
- ***Flexible home automation system:*** take this process within the building automation system in order to shift flexible loads automatically considering comfort range and external parameters like outdoor temperature

Field test: 10 real-life buildings

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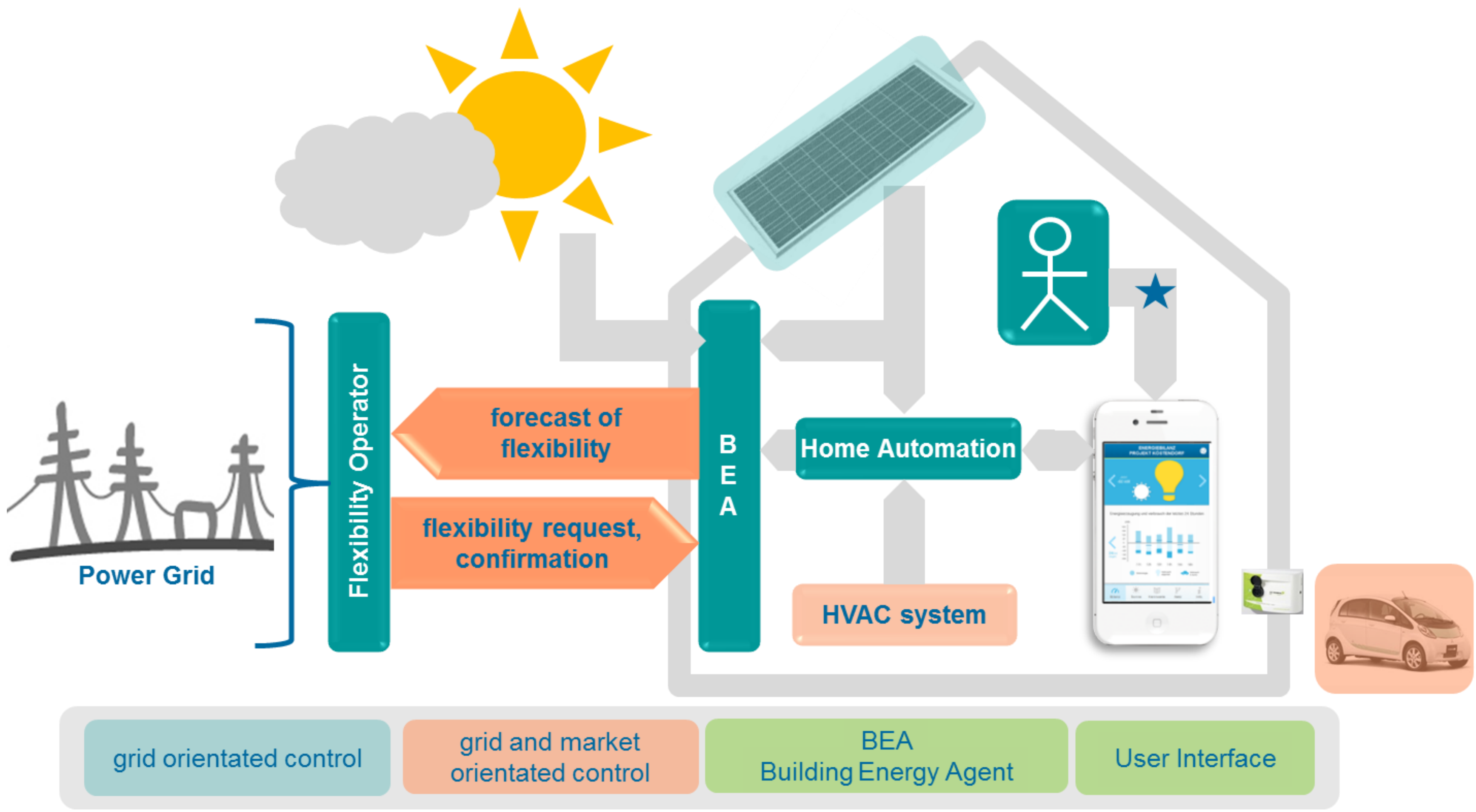
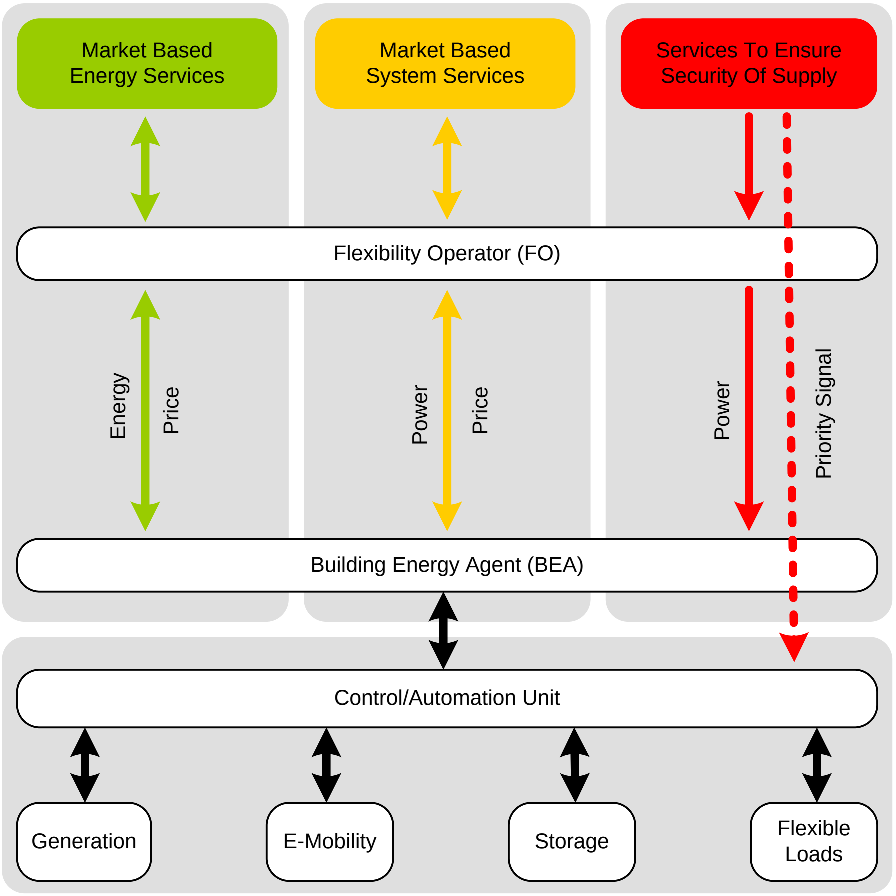
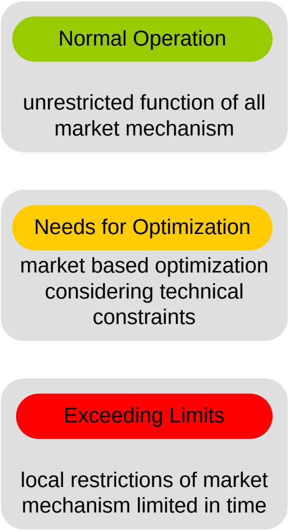
B2G - Functional Concept



Traffic light model



Legend of Network Condition



B2G - Building to Grid

- Building envelope in passive house quality + heat pump + PV system
- Results of the building simulation for the “critical room”:

Ambient temperature in °C	-20	-3	1	10
Duration of cooling down from 22°C to 20°C in hours	10	17	22	44

Service building St. Johann with critical room

heat pump ~8 kWel

PV system 5 kWp

There are plentiful “degrees of freedom” for optimizing the operation times of the heat pump without compromising the user-comfort!

B2G - Results

- Direct load control:
  - Can save up to 10% of the peak load in parts of the grid with high density of installed electric heating
  - Does not get any feedback from the indoor/hot water temperature
  - Does not consider the comfort of the consumers in the building
  - Is considered as non-flexible solution which is also limited to predefined hours within a day
- Flexible home automation system:
  - Using building energy agent can save about 350 kW for 10 selected buildings
  - For one building including 5 residential flats technically and practically it is possible to curtail loads up to 3.7 kW within 6 hours

Time interval	Average Demand response potential (kW)	Deviation (kW)
6:00 – 12:00	2.5	0.2
12:00 – 18:00	3.3	0.3
18:00 - 24:00	3.7	0.7

  - However, this potential varies with outdoor temperature

B2G - Conclusion

→Direct load control is a non-flexible solution for load curtailment

→Integration of feedback system into the home automation system enhance and assure the response of end users

HiT – Buildings as interactive smart grid Participants

Key Question: How can various smart grid applications in the context of buildings be grouped together in an innovative housing community?

Methodology: Optimized planning, construction and operation of the Rosa Zukunft (engl. “rosy future”) block of flats in Rosa-Hoffmann-Straße, Salzburg Taxham.

Field test: central energy system + 33 specially equipped flats

HiT – Buildings as interactive smart grid participants

(acronym “HiT” is German)

- **Combination of all smart grid elements in an innovative housing area.**
- **The building project “Rosa-Hofmann-Straße” is planned, constructed and operated in a smart-grid-optimized way.**

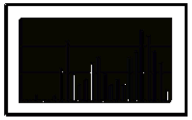
on-site Distributed Generation
micro-CHP
photovoltaic

HiT buildings

storage

energy-feedback & interaction with customers

demand response
control of heat pump
controlled charging of EVs
Home automation



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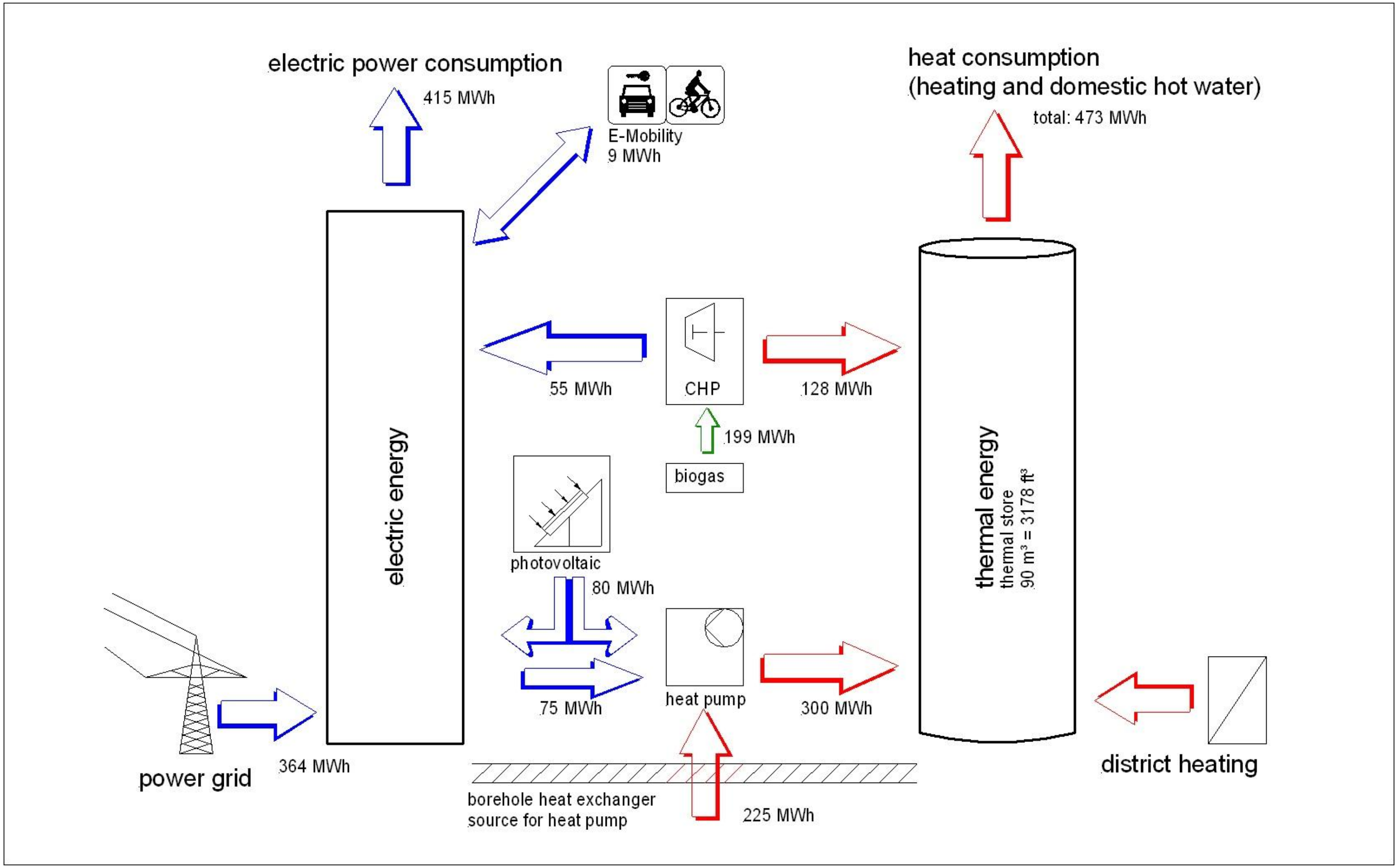
HiT: the energy concept

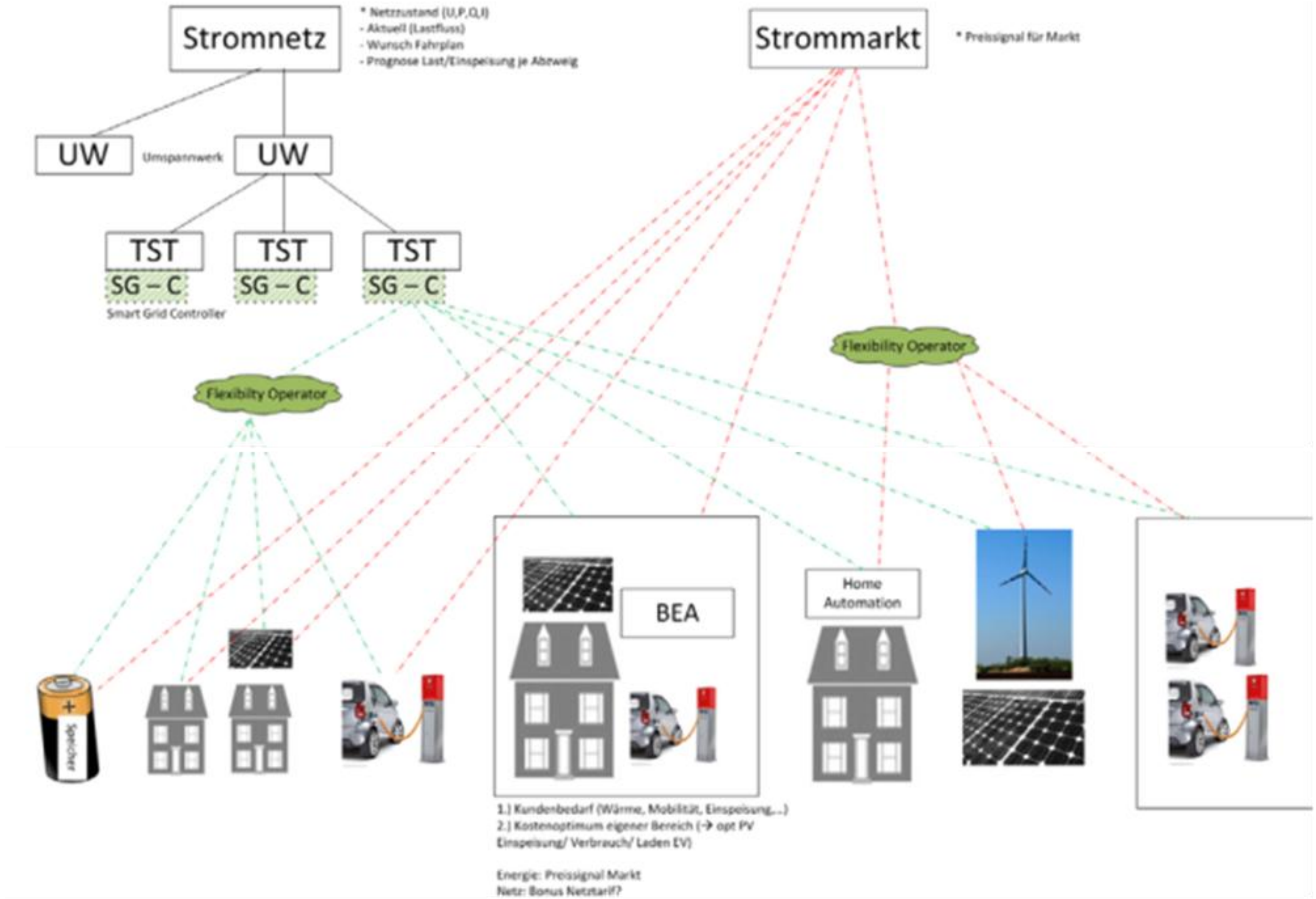


HiT: Interaction with customers

intended implementation based on findings of C2G and PEEM

- Integration of the interface in ambient device (kitchen clock)
- permanent presence and recommendation
- combination with other services
  - energy feedback (including heat and water)
  - home automation / HVAC control
  - e-car sharing – booking platform
- combination with smart grid ready household appliances (5 flats)
- incentive tariff: bonus for shifting consumption to green periods

HiT: Optimize the building response



HiT: the building project

130 flats for different user groups

- young families
- elderly people
- ambient assisted living

- construction started in April 2012
- energy system commissioned in November 2013
- handover of flats during December 2013
- field test March 2014-February 2015

ROSA ZUKUNFT
WOHNEN AN DER ROSA-HOFMANN-STRASSE

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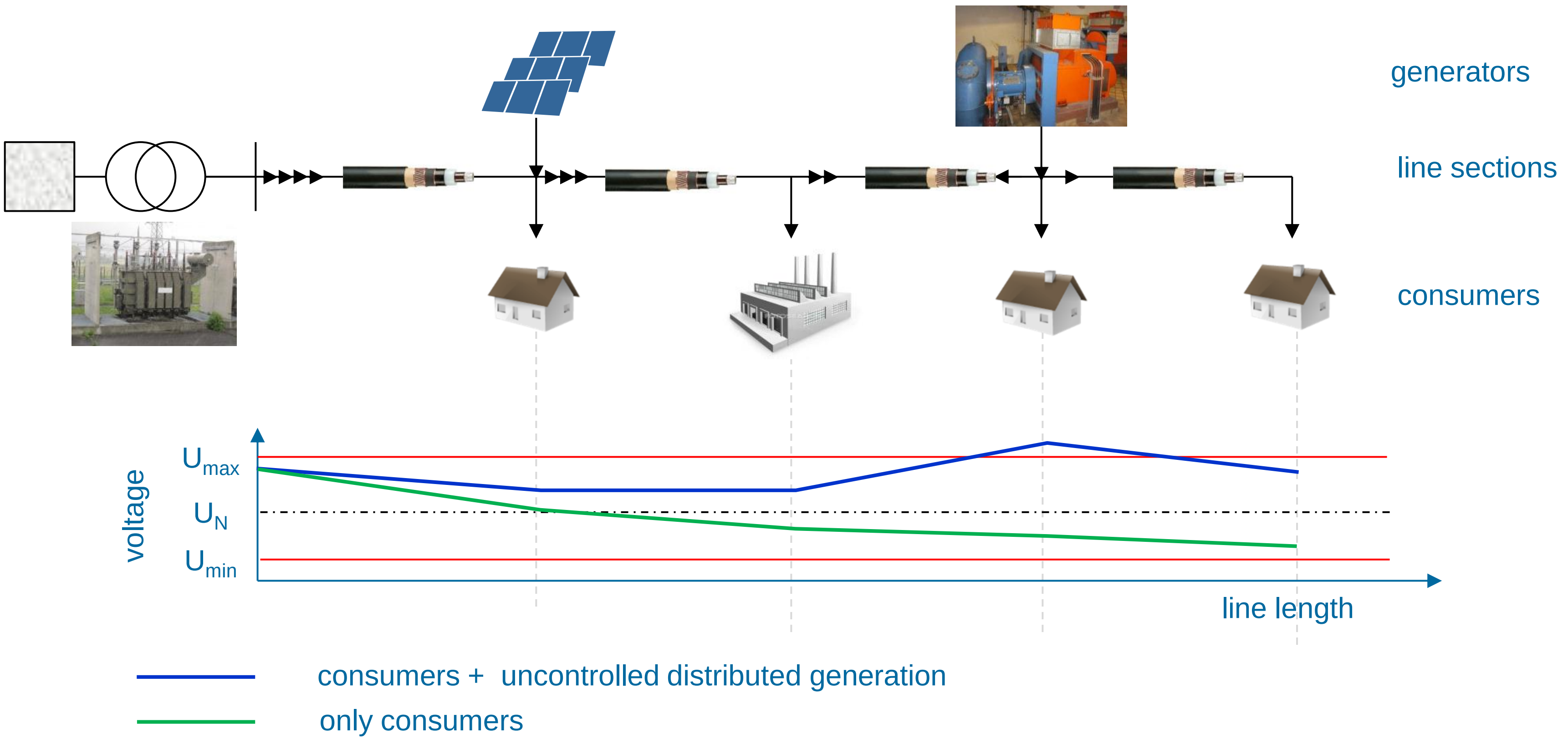
DSM - Conclusion

- → Customer Integration has to be combined with additional services, not necessarily from the energy domain
- → Also operators of DG can be „smart customers“
- → We see an additional strategy in optimizing buildings and grid infrastructure together

Contents

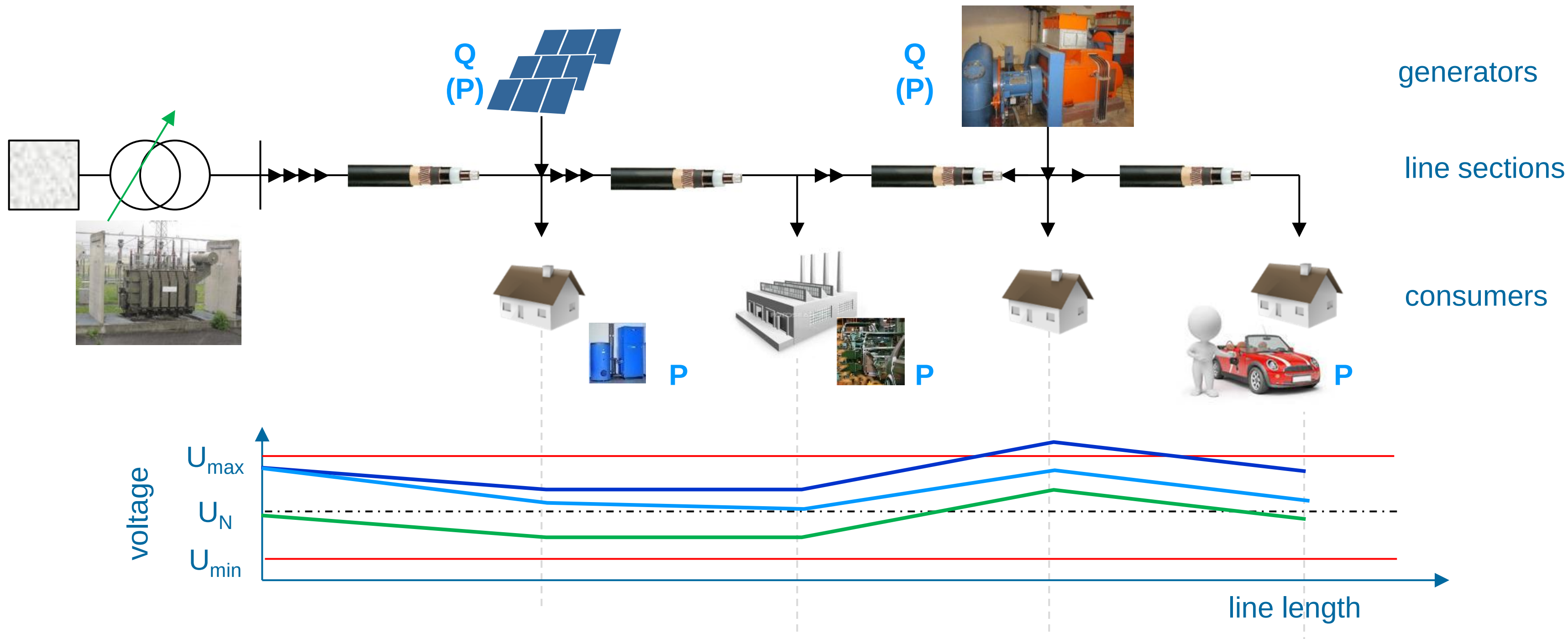
Integration of RES in Distribution Systems

maintaining the permissible voltage bands



Integration of RES in Distribution Systems

voltage control options



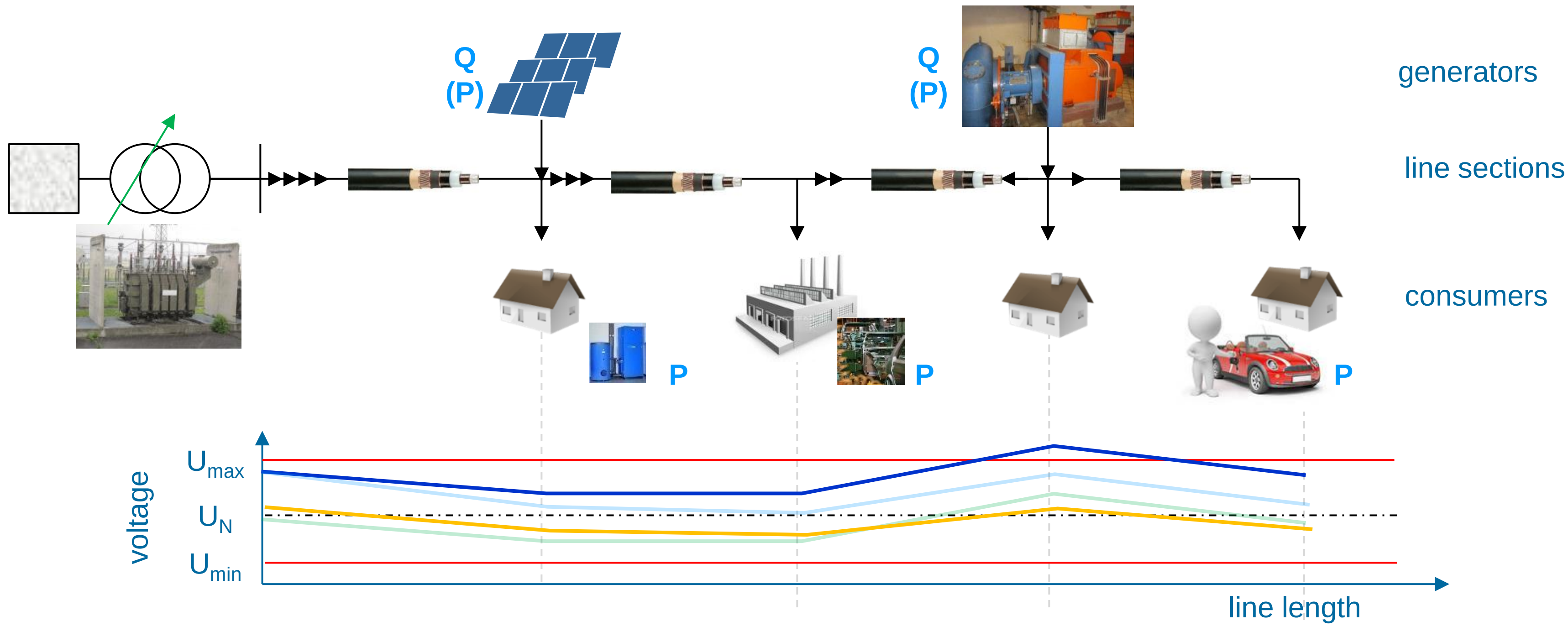
consumers + uncontrolled distributed generation

consumers + uncontrolled distributed generation + on-load tab changer (OLTC) transformer

consumers + distributed generation with reactive (and active) power control

Integration of RES in Distribution Systems

voltage control options



consumers + uncontrolled distributed generation

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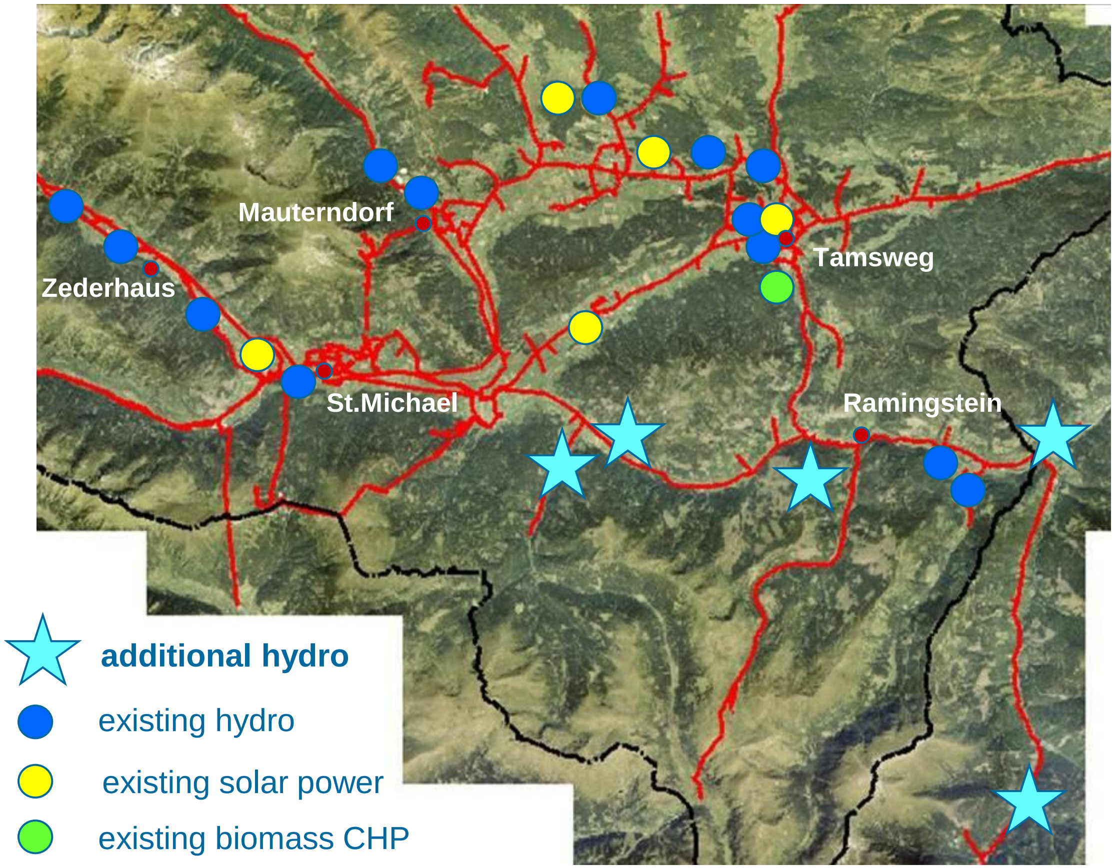
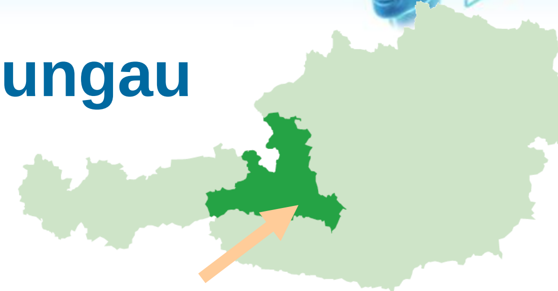
consumers + distributed generation with reactive (and active) power control

consumers + distributed generation with reactive (and active) power control + OLTC transformer

The case of the medium voltage grid Lungau





- maximum load ~23 MW
- distributed generation at the moment ~5,6 MW
- **additional distributed generation 6,6 MW**

→ **Problems with voltage control**

→ Necessary means**:**
  - **conventional** investment in the network (reference scenario)
  - **or innovative**, intelligent of voltage control

Example: 30 kV medium voltage network in Lungau (part of Salzburg) with current and expected distributed, renewable generators

The case of the medium voltage grid Lungau

Problem statement

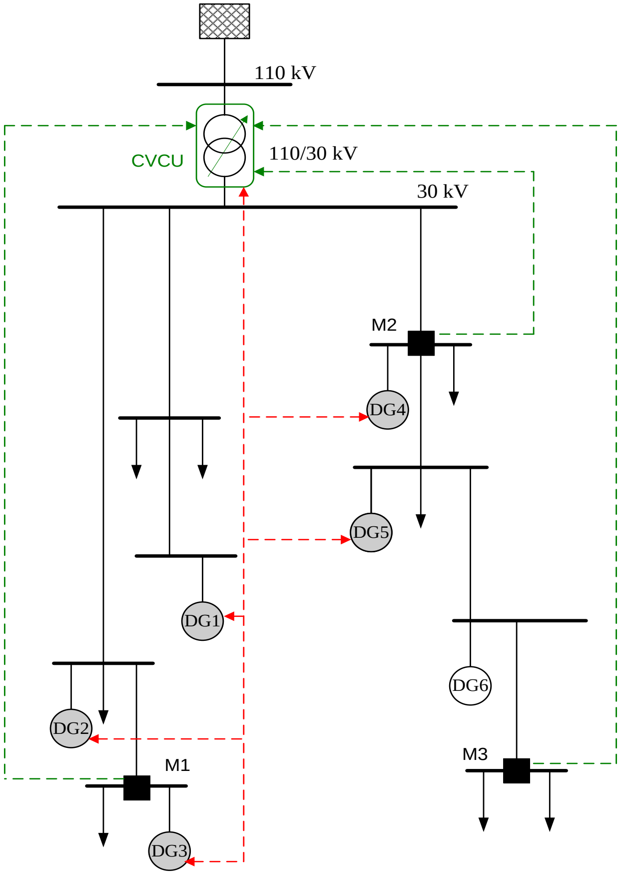
- Voltage band is exhausted: additional small hydro power plants can only be connected to the grid with additional measures

Possibilities

- Conventional line reinforcement
- Intelligent voltage control

Objective

- Integrating as much distributed renewable energy sources as possible into the distribution grid without grid reinforcement



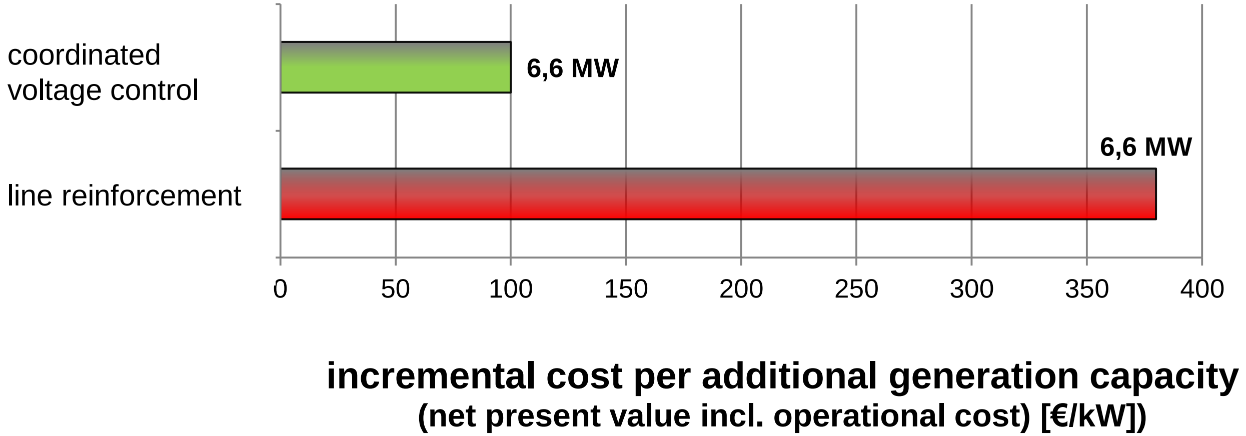
Schematic overview coordinated voltage control
(Qu.: AIT H. Brunner)

The case of the medium voltage grid Lungau

Result of the grid simulation and economic evaluation (Project DG DemoNet Concept)

cost reduction ~75%

for this specific case – not generally scalable; additional cost for equipment of the power plants not covered sufficiently



innovative solution of coordinated voltage control reduces connection costs significantly compared to grid reinforcement (based on model calculation)

Smart Grid demo project - medium voltage grid Lungau

A prototype of the innovative voltage / VAR control was implemented and in closed loop operation from 01/2012 to 10/2013

- dynamic control of
  - transformer on-load tab-changer
  - reactive power of 4 small hydro power plants
- comparison of two approaches
  - central solution based on SCADA with online state estimation (**project ZUQDE**)
  - regional solution with controller in the transformer station (**project DG DemoNet Validation**)

110/30-kV-transformer Lungau, 32 MVA

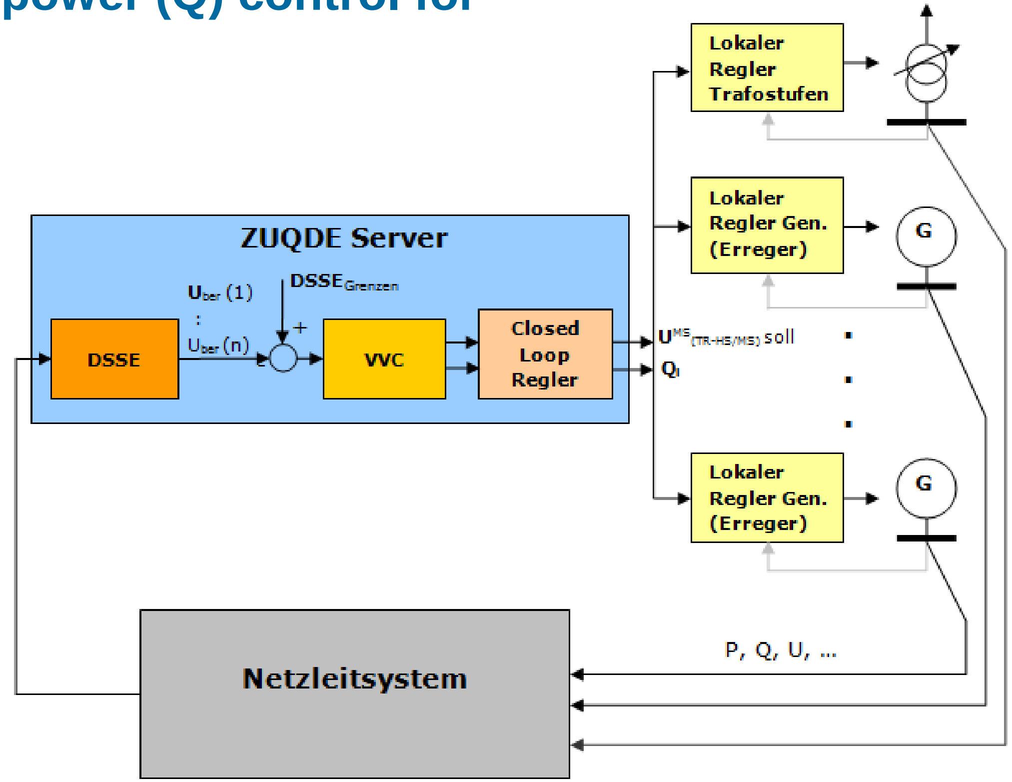
hydro power plant Graggaber (1,1 MW_EPL)

motor potentiometer hydro power plant Graggaber

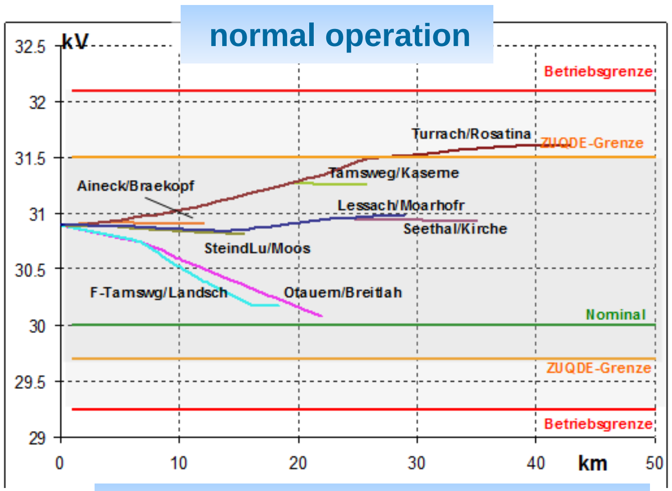
ZUQDE

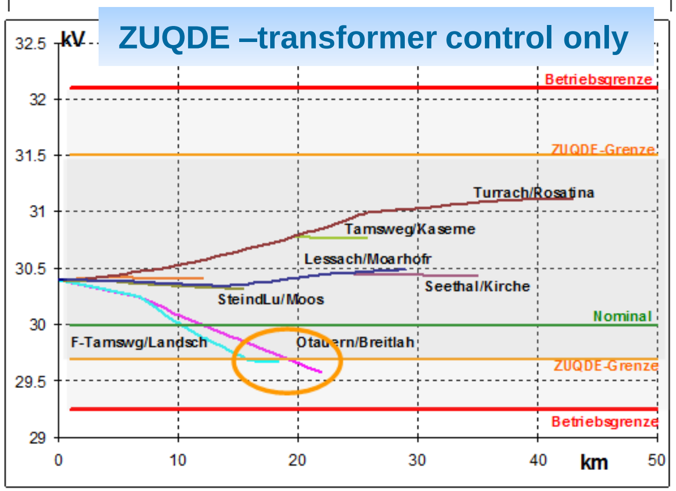
Central voltage (U)- and reactive power (Q) control for distributed generation

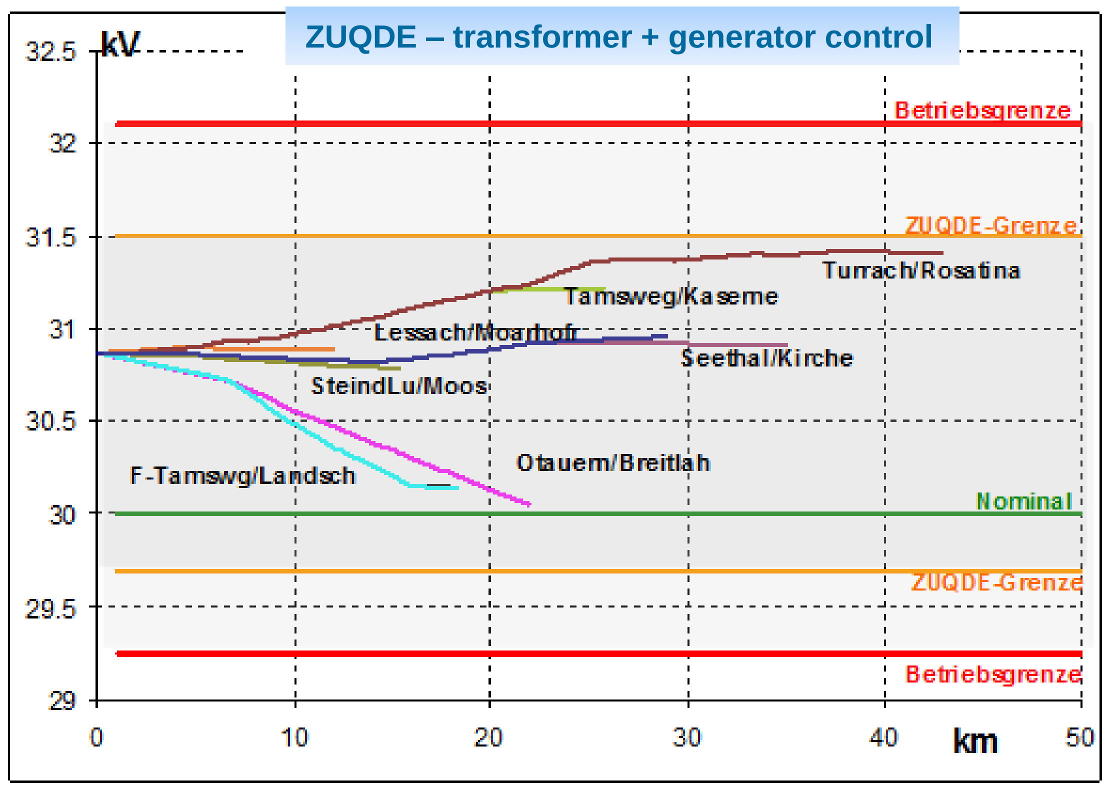
- State Estimator:
  Online state estimation and matching with measurements
- Open Loop operation:
  set-point is approved manually
- Closed Loop operation:
  closed control loop without manual check
- Different target functions possible
  - voltage band compliance
  - minimization of losses
  - reactive power delivery / coverage



ZUQDE Closed Loop Operation
Field experience







DG DEMO NET
SMART LV GRID

- Key Question: How can a high share of photovoltaic systems and electric vehicles be optimally integrated in **low-voltage networks** using intelligent planning, real-time monitoring and active network management?
- Consortium: AIT (Lead) + 4 DSOs + 2 technology vendors
- Duration: 3 years 03/2011-02/2014
- Three **field tests** with different focus at Linz AG, Energie AG (Eberstalzell) and **Salzburg Netz (Köstendorf)**

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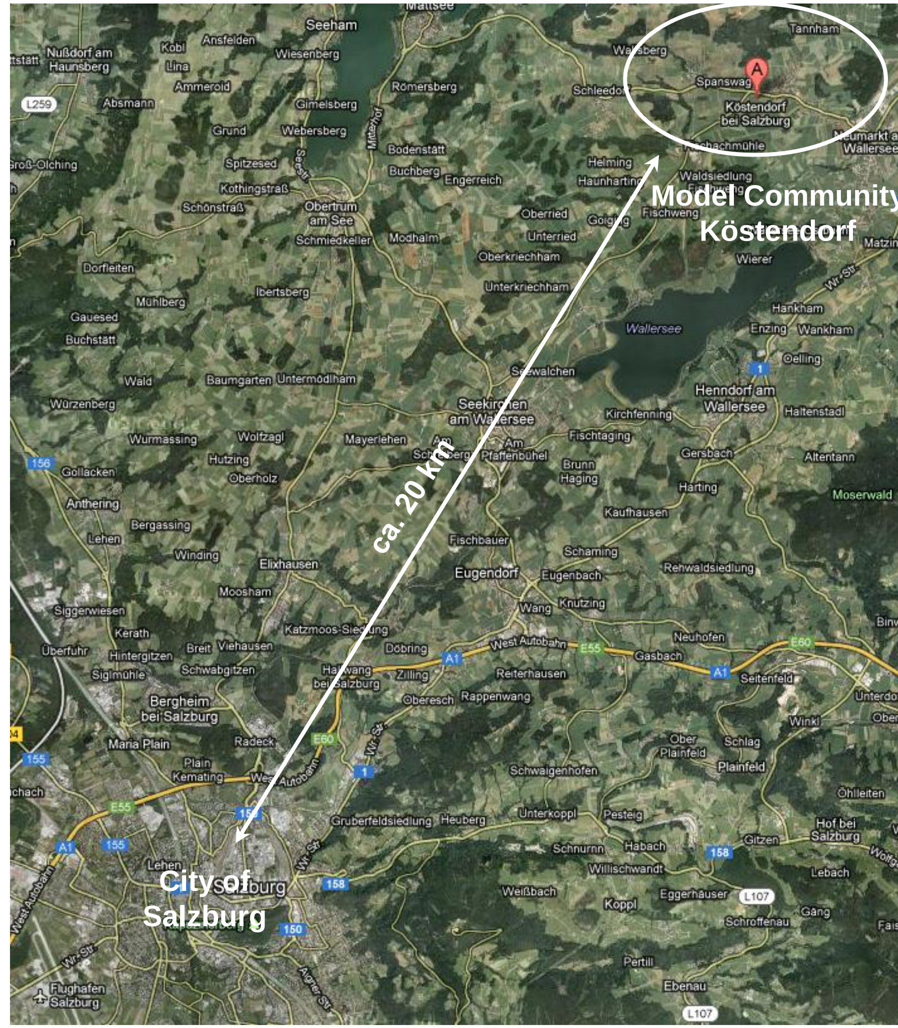
Smart Grids Model Community Köstendorf



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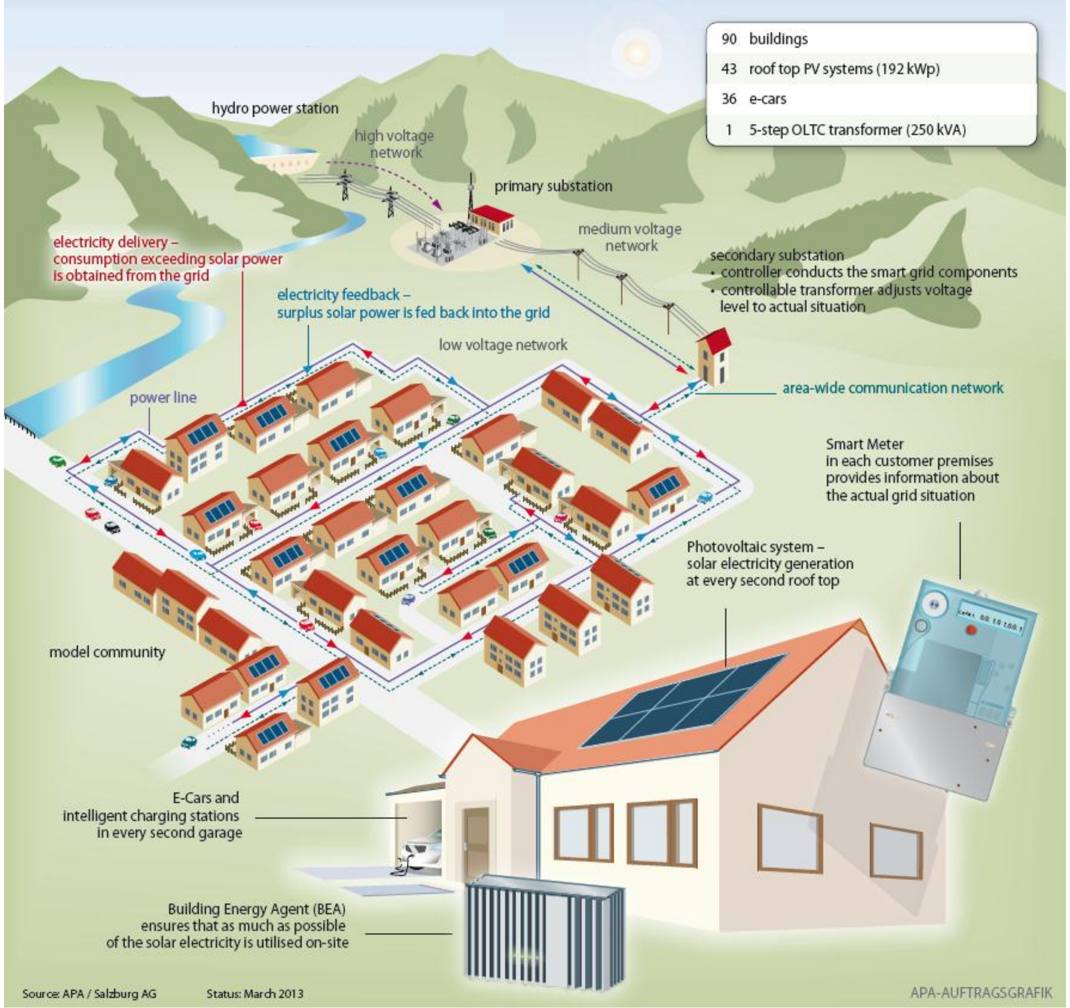
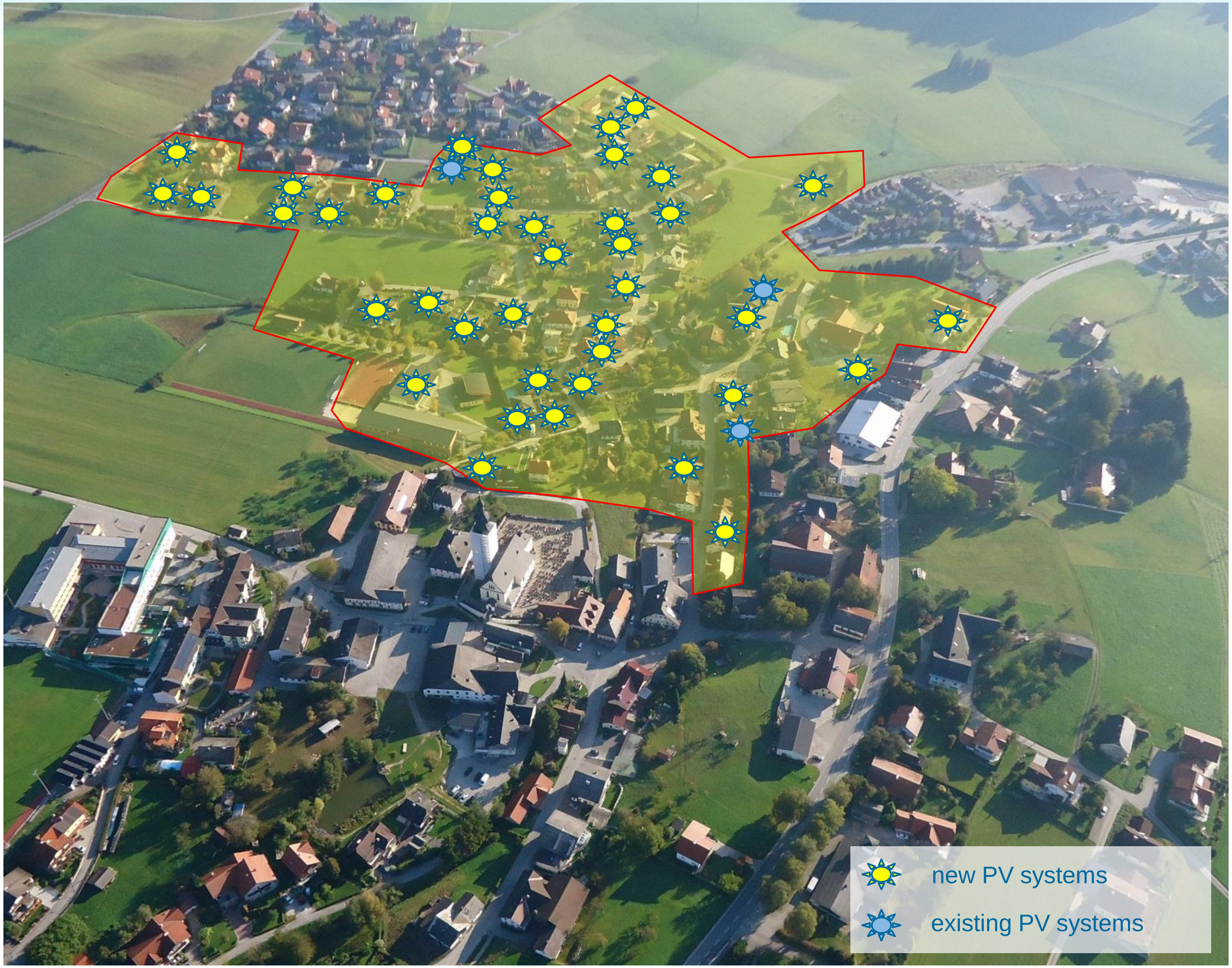
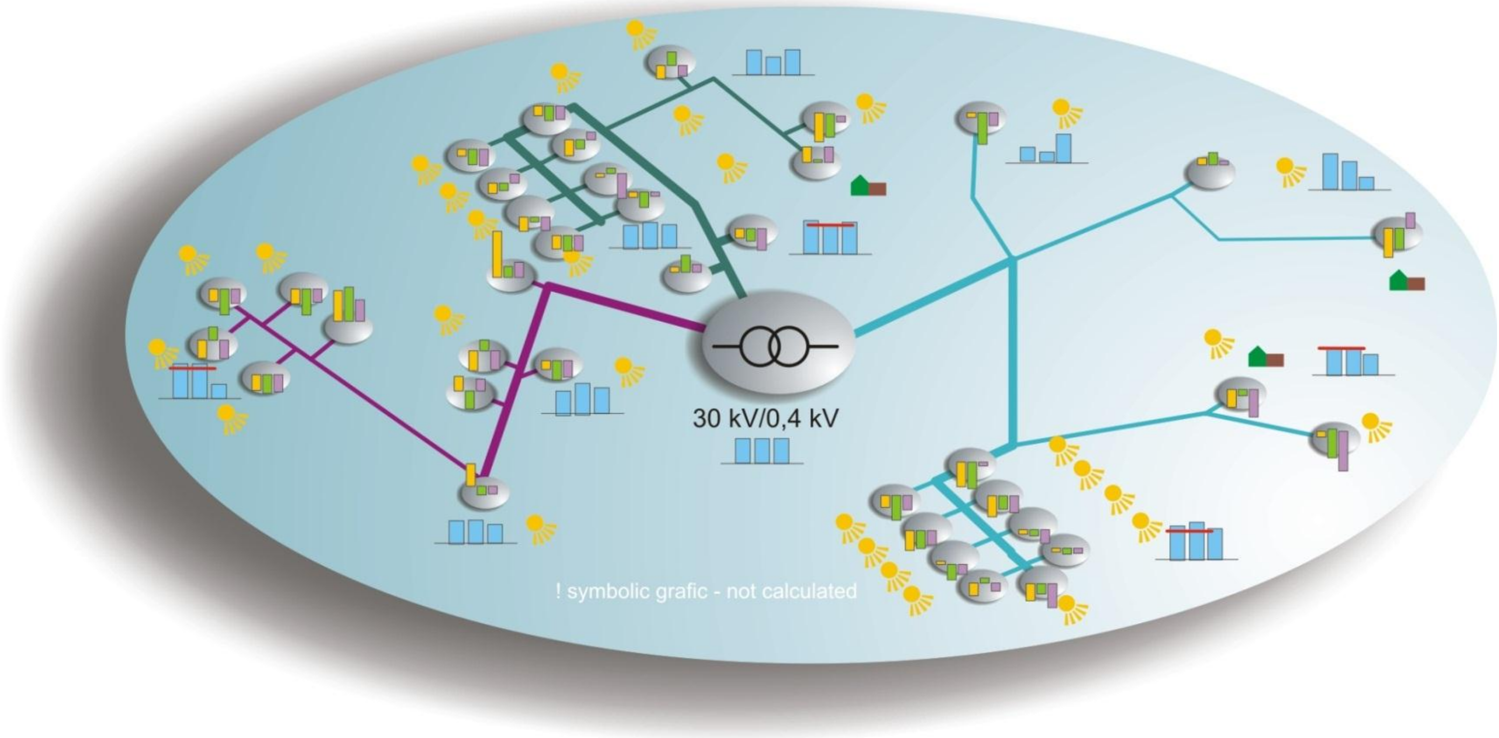


In a dedicated demo area supplied by a 250 kVA secondary substation:

- PV system at every second roof top
- Electric vehicle in every second garage
- Field test of an integrated smart grid solution for low voltage grids
- "anticipating the future"
- funded by Austrian Climate and Energy Fund & Province of Salzburg


new PV systems
existing PV systems

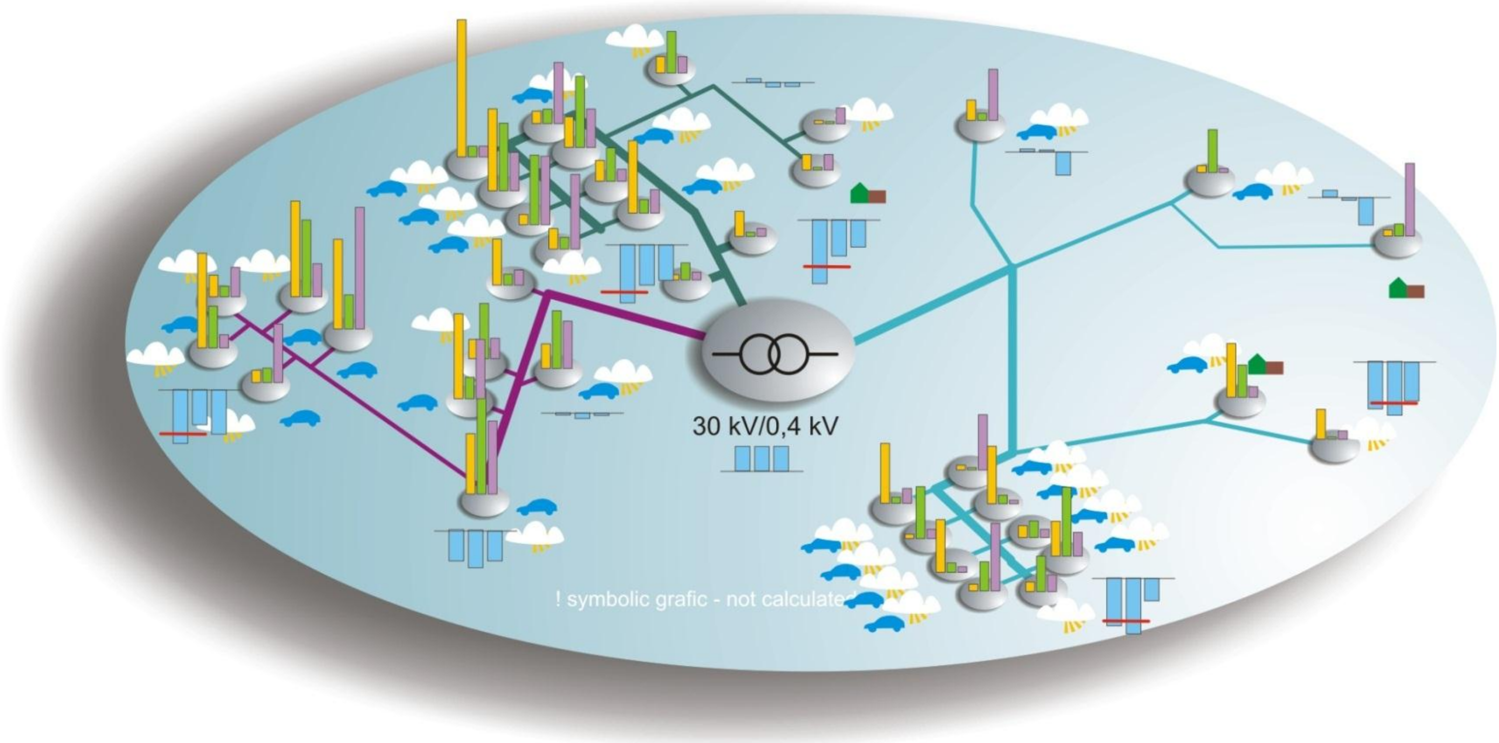
High share of PV and EV in low voltage grids: scenario without control



Sunny Sunday afternoon: high solar generation and low consumption can lead to voltage levels above EN 50160 criteria (Power Quality)

Source: A. Abart, Energie AG

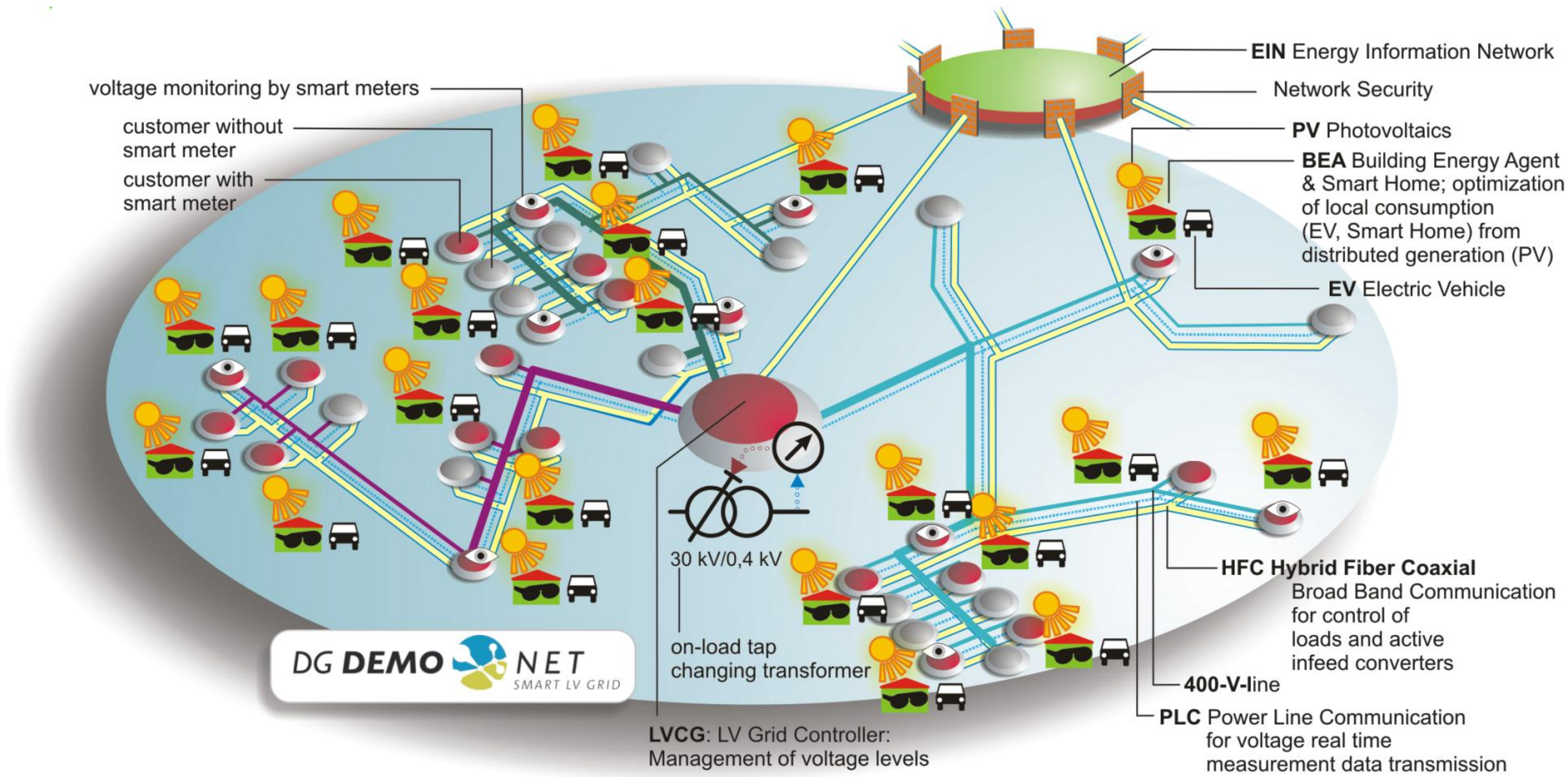
High share of PV and EV in low voltage grids: scenario without control



Winter workday evening: uncontrolled e-car charging with no solar generation can lead to voltage levels below the EN 50160 criteria (Power Quality)

Source: A. Abart, Energie AG

Control concept: Smart Low Voltage Grid



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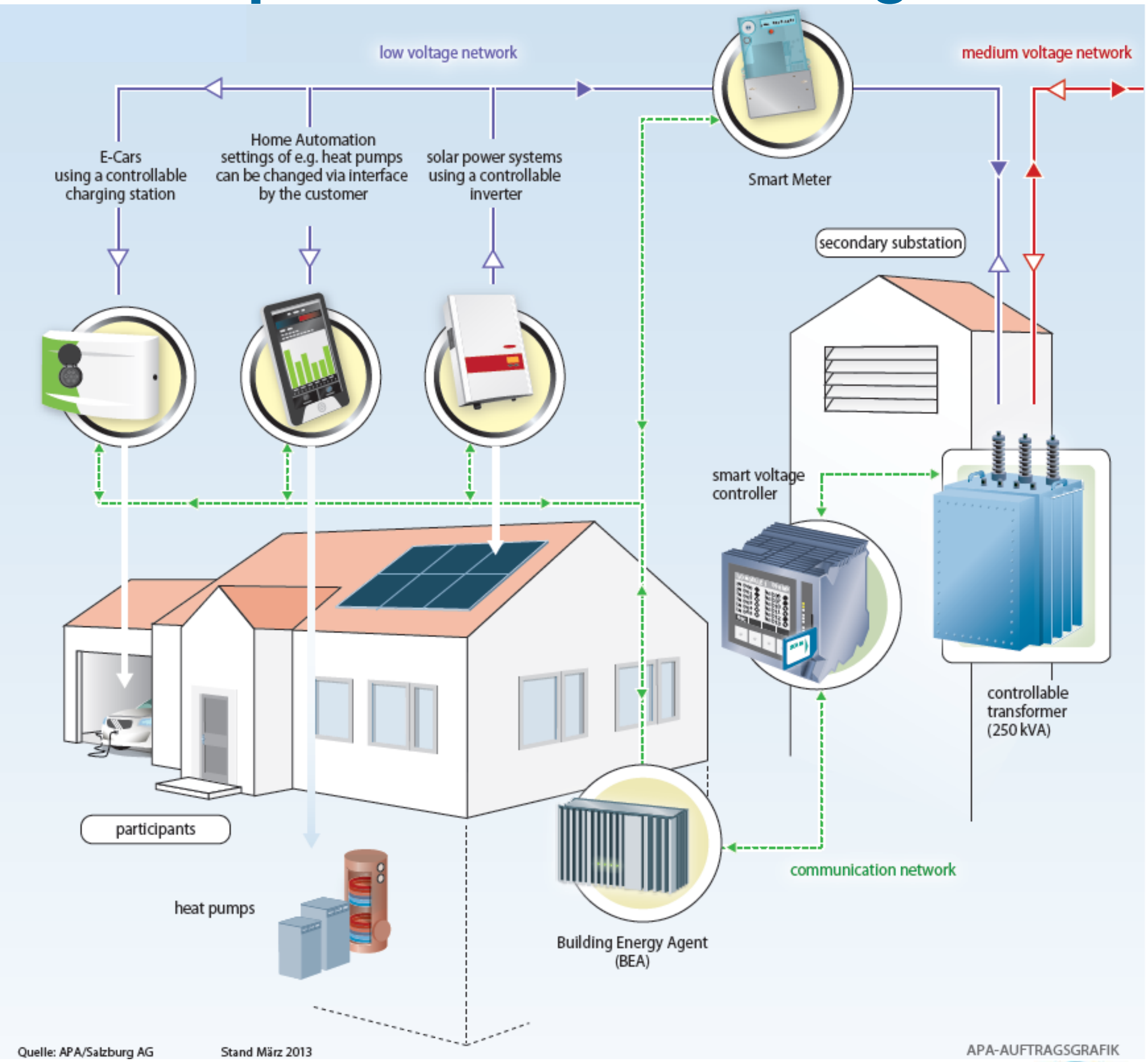
Control concept: Smart Low Voltage Grid



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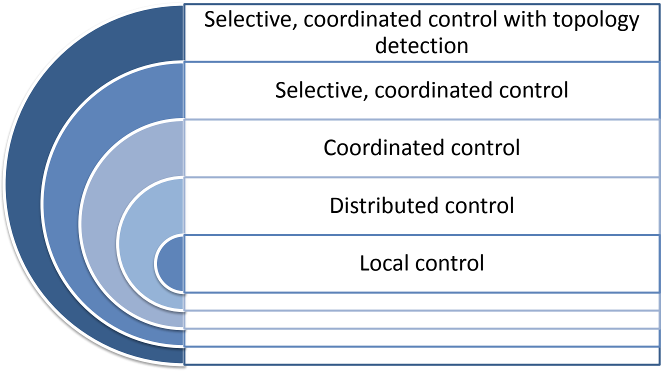
Control concept: Smart Low Voltage Grid

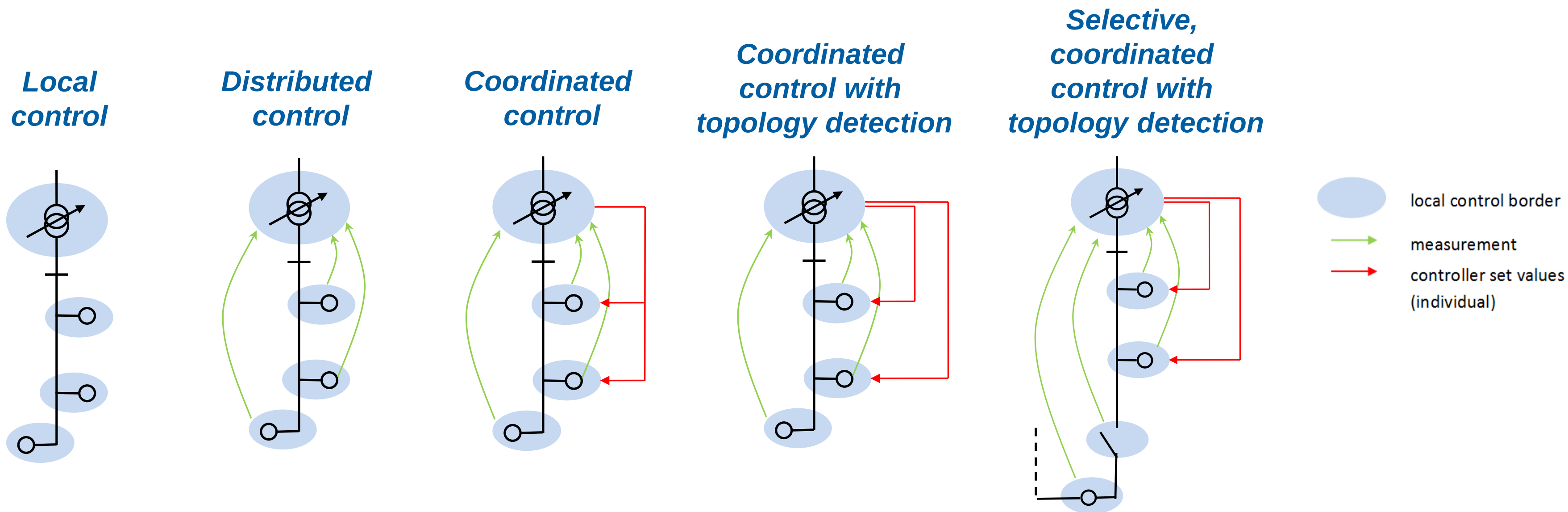
Stepwise implementation & validation

- limit the complexity
- different stages build upon each other
- quality of control and also complexity of solution is growing from stage to stage.

Design proposition

- fulfil the requirements with high quality with the lowest possible engineering effort and system complexity.





Smart Grids Model Community Köstendorf

The inhabitants are supporting the project!

- Already on the first day all offered PV systems and e-cars were contracted!

the mayor at an public project information event

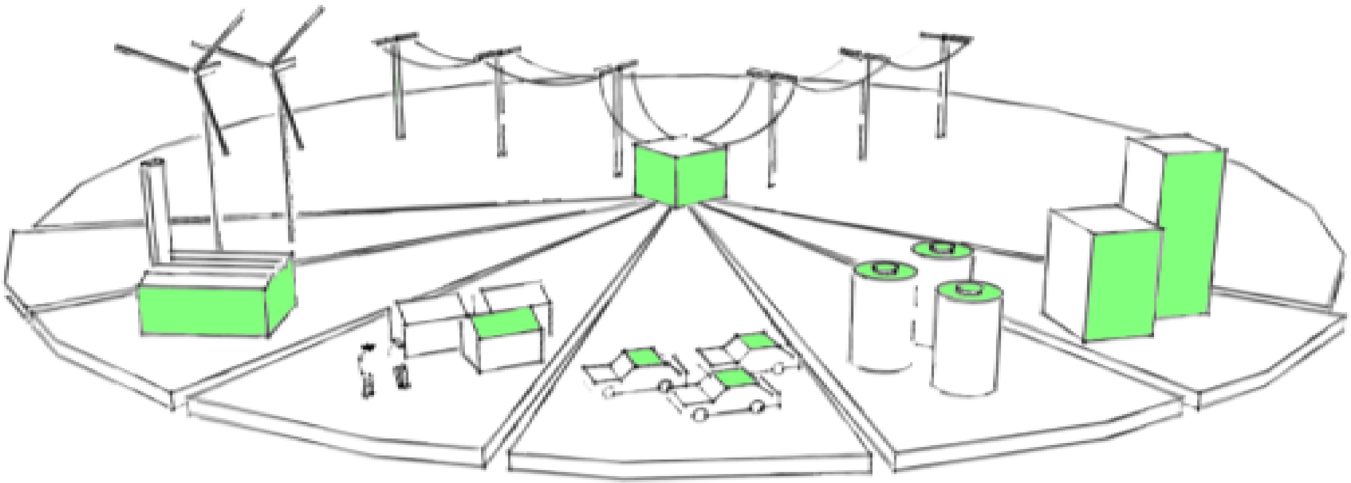
participants proudly presenting their e-cars

Contents

ICT for Smart Grids - Projects

Smart Synergy

- Analysis of synergy potentials and best available technologies for the common use of ICT infrastructure by different smart grids applications
- Around 30% cost savings of best case (especially multiple use of fiber optic or cable TV connection) compared to worst case



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ICT for Smart Grids - Projects

Smart Web Grid

- concept for a universal, interoperable platform for effective data exchange between the different smart-grid participants
- proof of concept:
  - smart web grid core: platform for managing and sharing data access permissions (based on SOA - web services)
  - apps for 4 different use cases:
    - energy feedback
    - PV monitoring
    - energy balance Köstendorf
    - smart EV charging
  - security and privacy by design

ICT for Smart Grids – exemplary findings

- **Extension of ICT systems to the customer and public domain requires:**
  - Ensure informational self-determination of residential customers
  - Distribution system operator (DSO) as a neutral “data hub”: provision of e.g. consumption data to customers and their contracted service providers
  - application-specific and device security instead of access security
- **Security, privacy and integrity have to be considered from the very beginning (Security & Privacy „by design“) → Smart Web Grid project**
- **Generic and easy-to-extend reference architecture required, as basis for**
  - ensuring the most uniform data transport possible and utilization of synergies
  - ensuring a high degree of flexibility,
  - ensuring security, data protection and data authenticity as well as data integrity.
- **IP as preferable convergence layer for implementation for ICT for smart grids**

International cooperation and visibility

IGREENGrid Project

- EU FP7-project (Lead Iberdrola)
- analysis of scaling-up and replication possibility of 6 European smart grid demo project, amongst others SGMS
- 01/2013-12/2015
- More info: http://www.igreengrid-fp7.eu/

EEGI Core Label

- EEGI Core Label acknowledges that a specific project is in fully line with the spirit Functional Objective of the EEGI (European Electricity Grid Initiative)
- SGMS is one of so far only two national funded projects labeled as EEGI-Core project

Conclusions

Added Value of SGMS

- Systematical merging of all types of smart grid activities
  - in one region
  - perspective of all main interest groups
  - in one ICT layer

- Real life field tests – laboratory for innovative smart services and applications

“the whole is more than the sum of its parts”

Interested in more details?

- Report on results and findings of SGMS (May 2013) – also in English

- All final reports of sub-projects

available at www.smartgridssalzburg.at