


NAP – Grid connection planning

Presenter:
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Presentation in Auckland | October 15, 2018

Energy transition electrically optimized for customers

Overview

- 1 Team / activities / range of service
- 2 Grid connection as PV and wind energy project developer
- 3 Grid connection as utility grid manager
- 4 Current challenges in Germany
- 5 Possible solutions
- 6 Summary

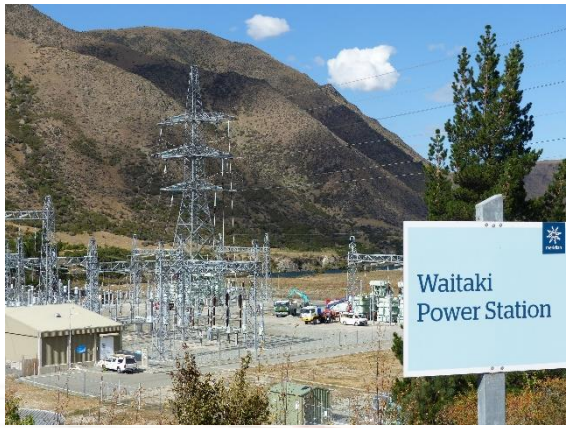
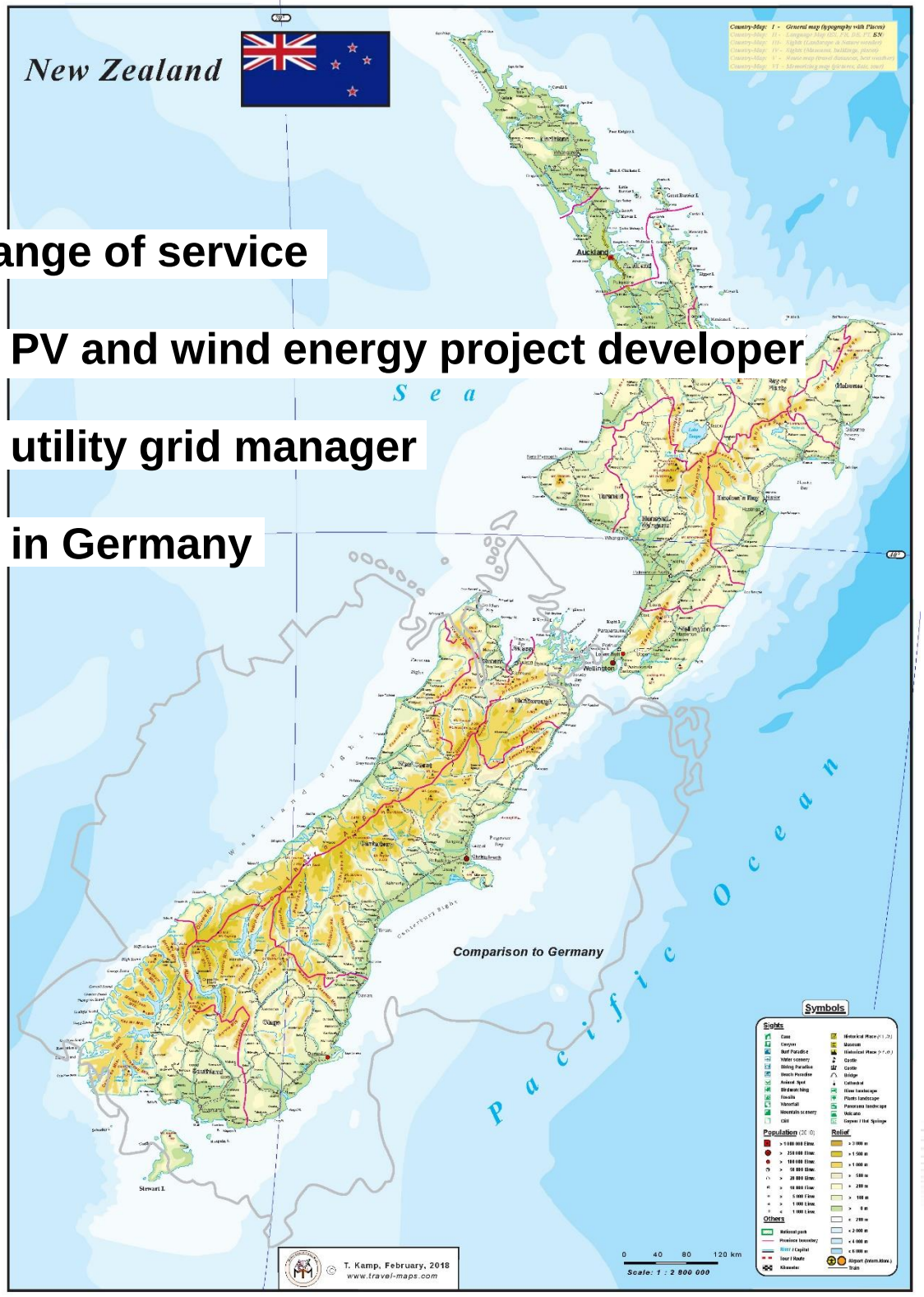
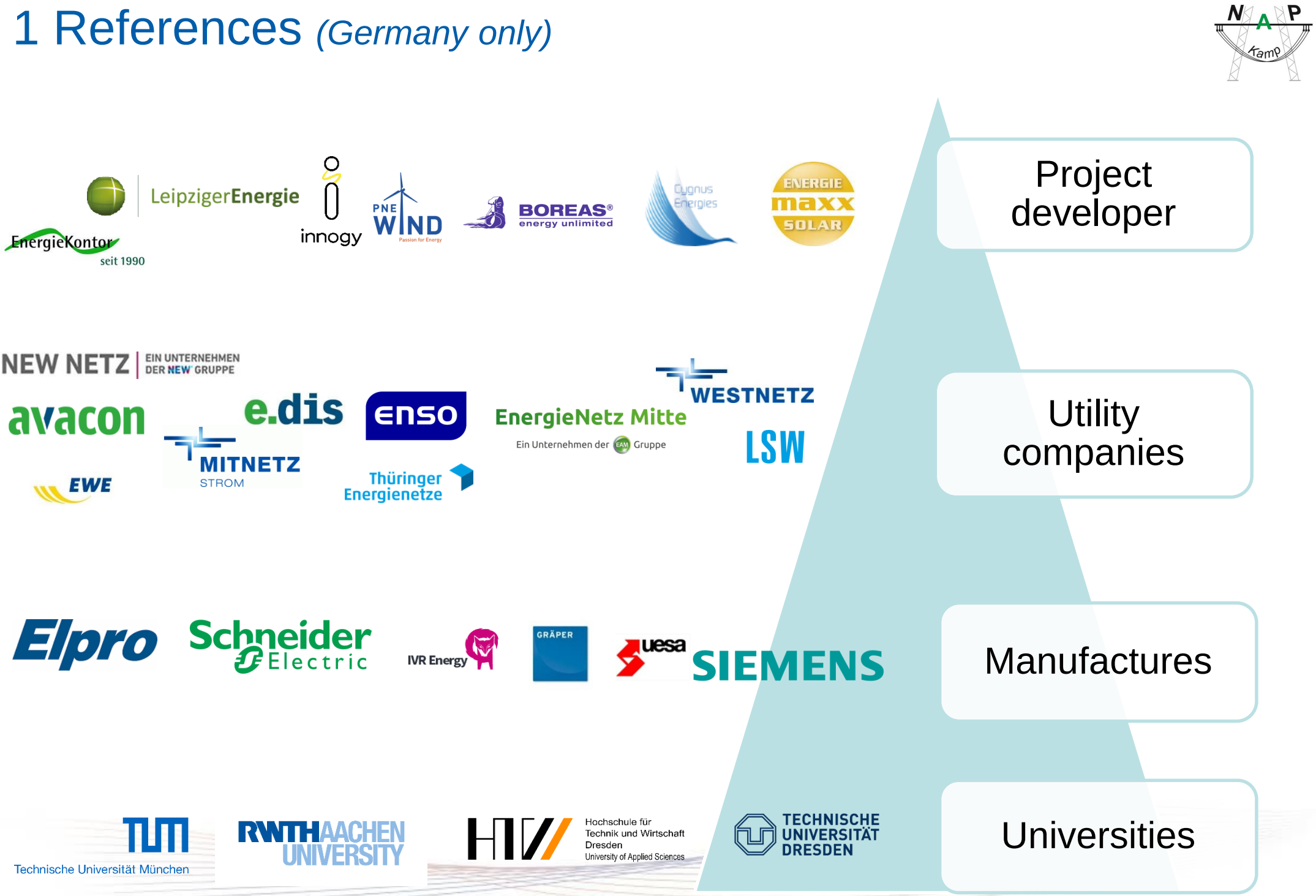


Fig. 0: *Experience in New Zealand*



1 References *(Germany only)*



1 Activities and range of services

What distinguishes us / range of our services:

Project developer

- Assessment of electrical components (costs / performance) as required
- Connection concepts for renewable energy sources (wind, water, solar, bio)
- Special calculations (strength according to IEC 60865-1, EMC, power quality, efficiency storage calculation)

Utility companies

- Grid optimization and digital utility maps with vulnerability analysis
- Configuration of substations and transformer stations
- Grid calculation studies with international background (expert user PowerFactory)

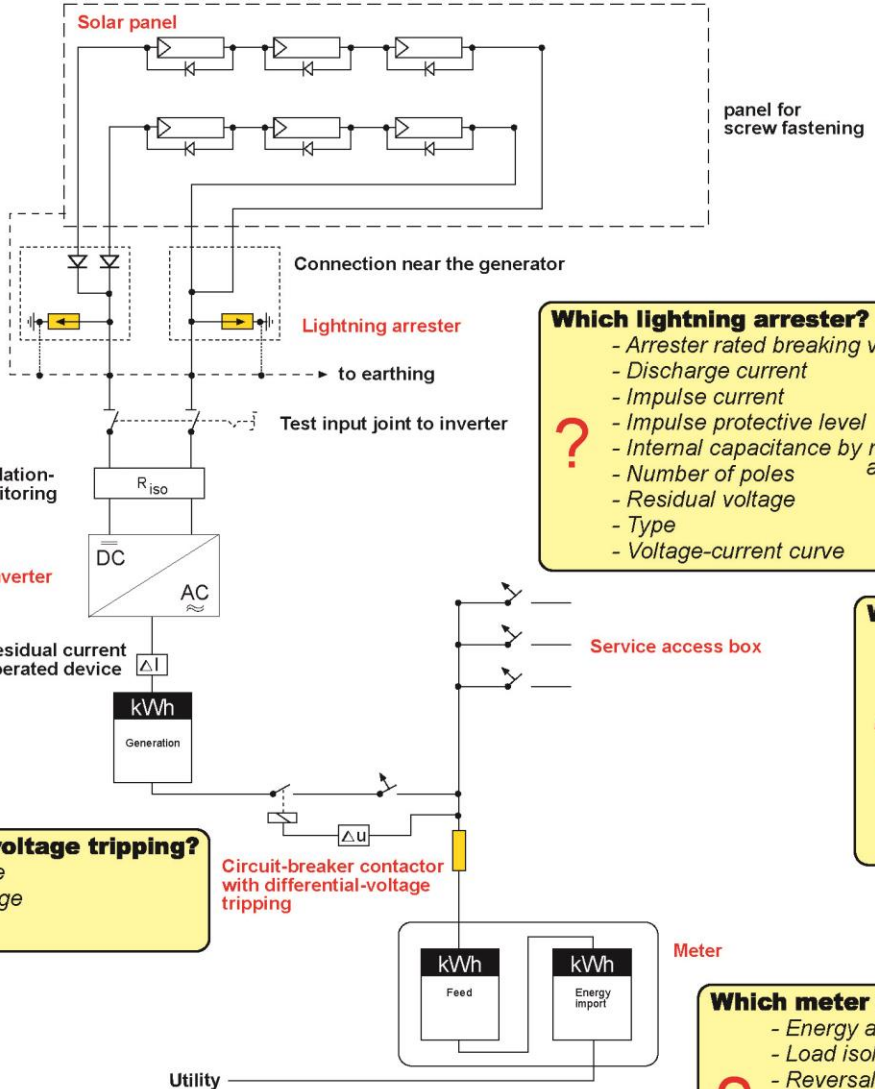
2 Grid connection as PV developer

Solar grid connection (Photovoltaic)

Solar park example (general questions), made in Germany

Glance as Project developer
- Part IV -

Which solar panel
? - *Charge Controller (Shunt / Serial)*
- *Counter-current*
- *Degradation*
- *Energy yield / Location*
- *Generator`s no-load voltage*
- *Interconnection*
- *Maximum Power Point Tracker*
- *Panel-Material*
- *Slope angle / tracking*



Which lightning arrester?
? - *Arrester rated breaking voltage*
- *Discharge current*
- *Impulse current*
- *Impulse protective level*
- *Internal capacitance by metal-oxid arrester*
- *Number of poles*
- *Residual voltage*
- *Type*
- *Voltage-current curve*

Which inverter?
? - *Cut-off voltage*
- *DC/AC-protective equipment*
- *Mains filter characteristics*
- *MPP-control*
- *Nominal capacity (direct current)*
- *Nominal voltage*
- *Rating at closing operation*
- *Relative harmonic content*
- *Switching rate*

Which service access box?
? - *Busing terminal*
- *Coupler*
- *Degree of protection*
- *Differential rating current*
- *Earth-loop impedance*
- *Earthing conditions*
- *Fire protection*
- *Ground-fault protector*
- *Multipole circuit-breaker (MCB)*

Which differential-voltage tripping?
? - *Charging voltage*
- *Differential-voltage*
- *Zener-voltage*

Which meter ?
? - *Energy accounting concept*
- *Load isolating unit*
- *Reversal preventing device*
- *Station demand*
- *Sub-circuit distribution board*
- *Type (Load-current, revers. counter)*

2 Grid connection as Wind farm developer

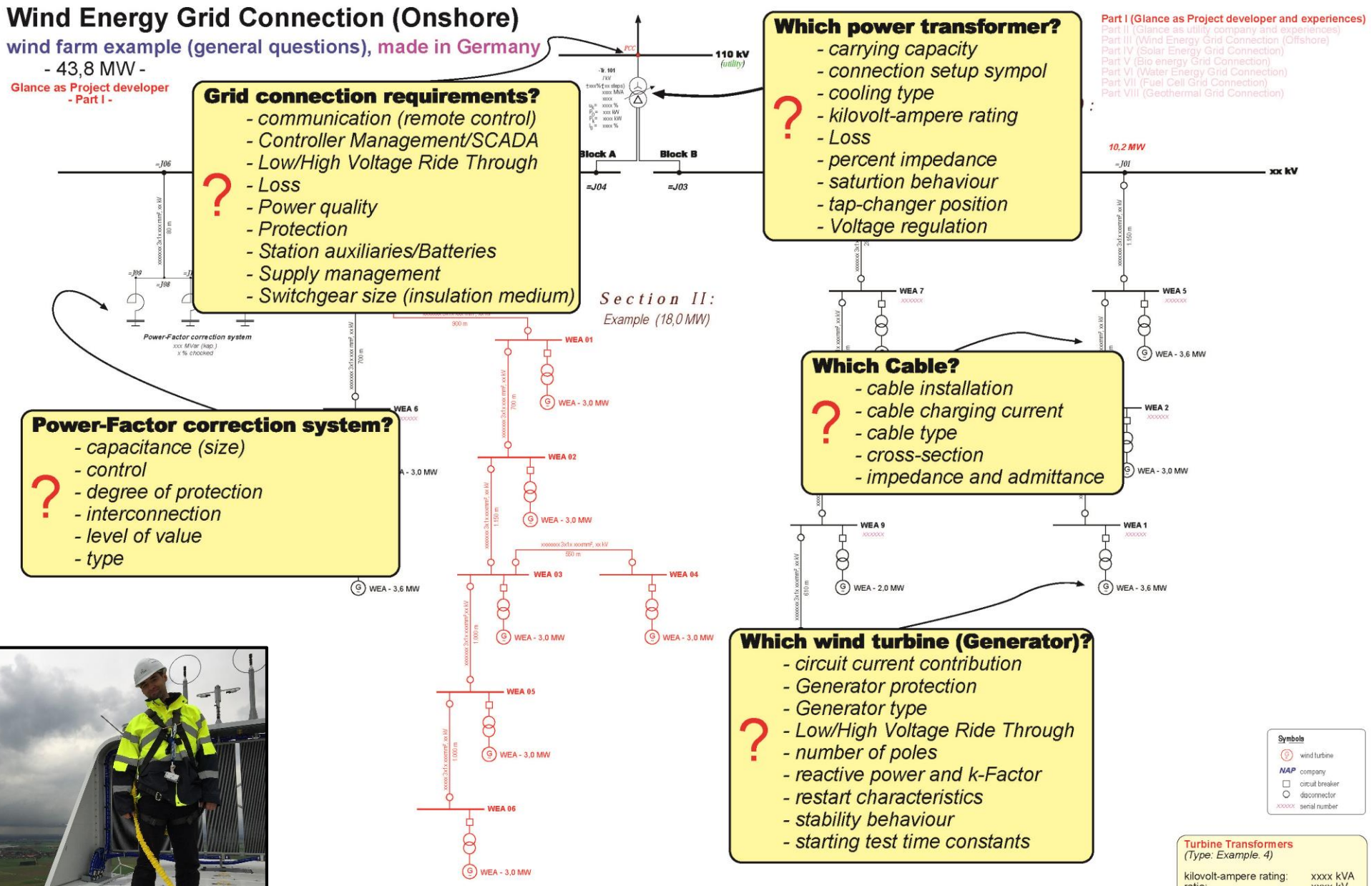
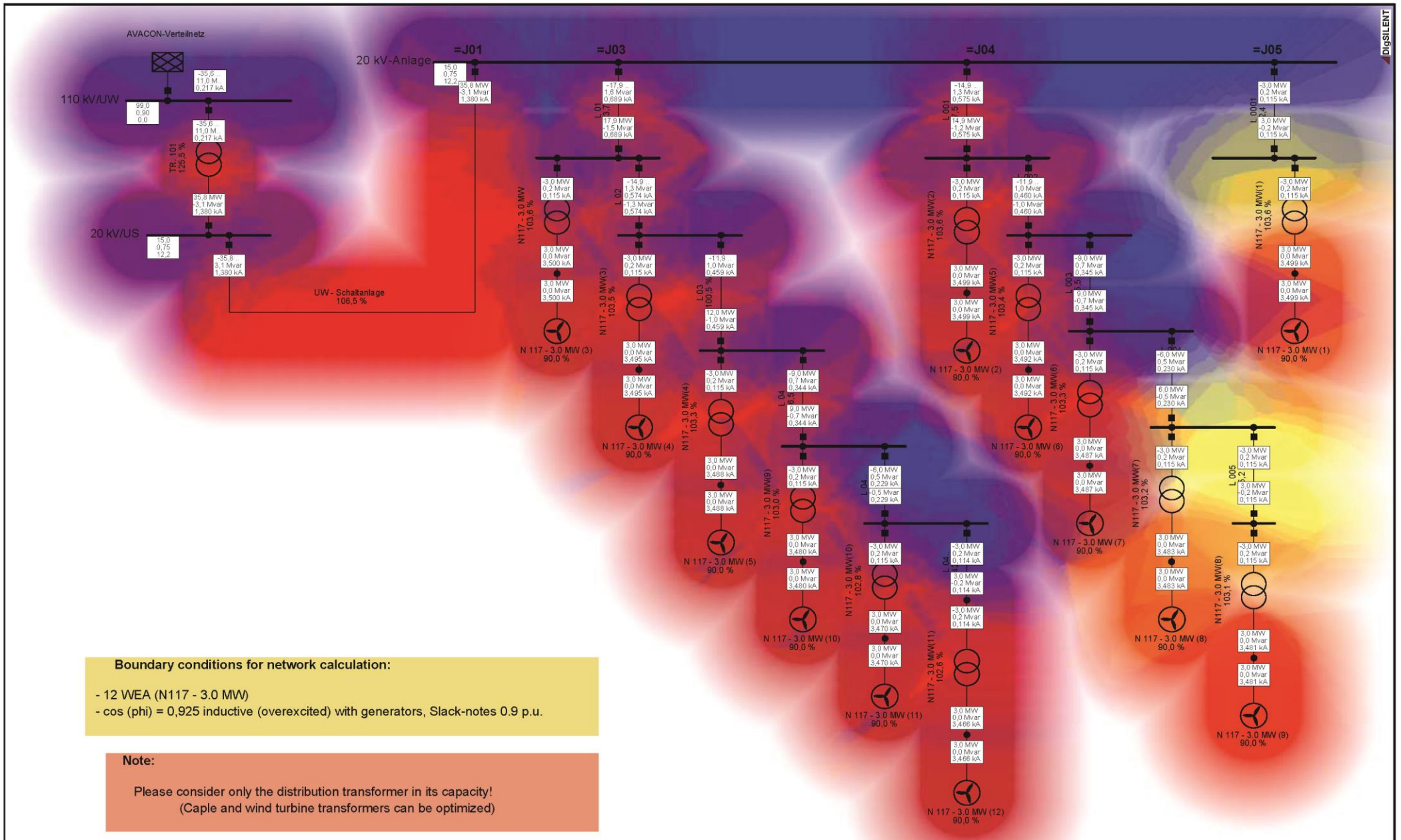


Fig. 1: *Wind turbine inspection*

2 Grid connection as Wind farm developer



Boundary conditions for network calculation:

- 12 WEA (N117 - 3.0 MW)
- cos (phi) = 0,925 inductive (overexcited) with generators, Slack-notes 0.9 p.u.

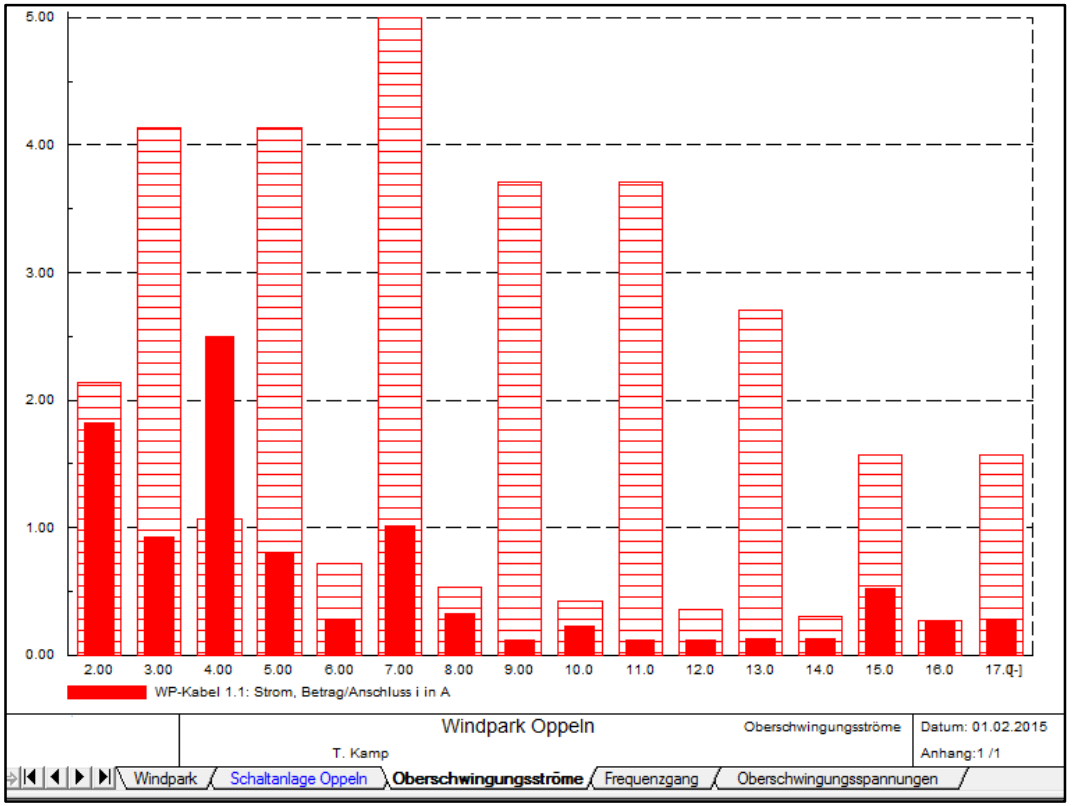
Note:

Please consider only the distribution transformer in its capacity!
(Caple and wind turbine transformers can be optimized)

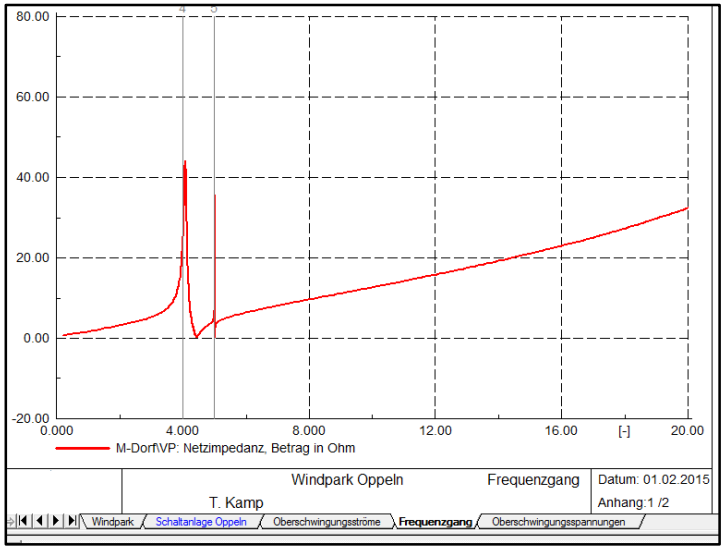
Load flow unsymmetrically	
Knots	Branch elements
Line to line voltage, amount [kV]	Active power [MW]
Voltage, amount [p.u.	Reactive power [Mvar]
]Voltage, angle [deg]	Current, amount [kA]

	Load flow calculation (Newton-Raphson-Iteration)	Project: Altana
	- Verifying a wind turbine substation for 110 kV -	Grafik:
		Date: 30.06.2015
PowerFactory 15.2.4	T. Kamp (M.Sc.)	Attachment

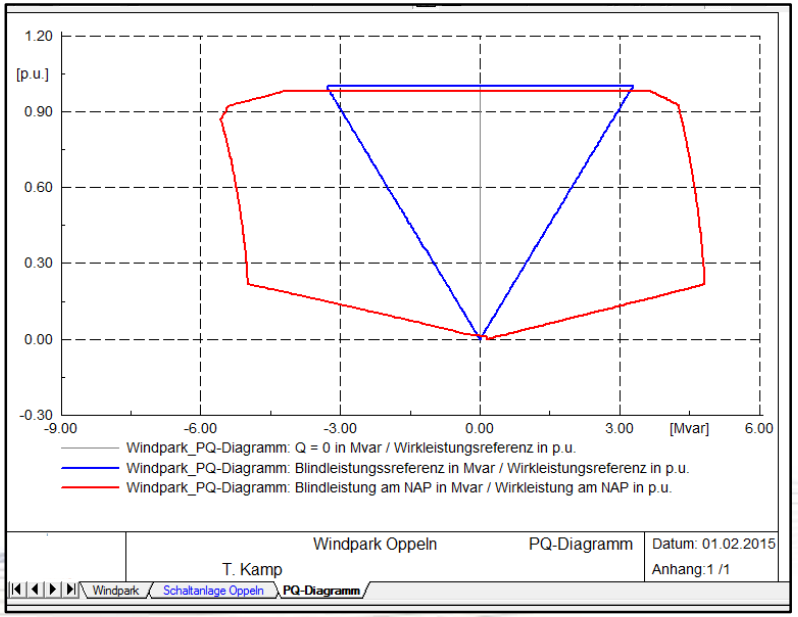
2 Grid connection as Wind farm developer



Grid calculation: *evaluation of harmonic currents*



Grid calculation: *Resonance evaluation*



Grid calculation: *evaluation of compensation devices*

DIN EN 50160:	Characteristics of voltage in public electricity supply networks
DIN EN 60868-0:	Flickermeter – assessment of flicker strength
DIN EN 61400-21:	Measurement and evaluation of grid compatibility for grid-connected wind power plants

3 Grid connection as utility grid manager

Key figures of power grid	
Power grid in total	~70.000 km
… HV-Lines	~10.800 km
… MV-Lines	~20.200 km
… LV-Lines	~38.000 km
Cabling density	61 %
Substations	148
Inclusive custo. stations)	9.600
House connections	1.800 000
Energy consumption	3,4 TWh
Energy feeding (Renew.E)	7,0 TWh

- **Utility:** TEN / Mitnetz
- **Red line** (110 kV overhead line) / **yellow box:** 380/110 kV Substation

3 Services provided by NAP (overview)

Fig. 2: *Old substation dismantling*

Fig. 3: *Arc suppression coil*

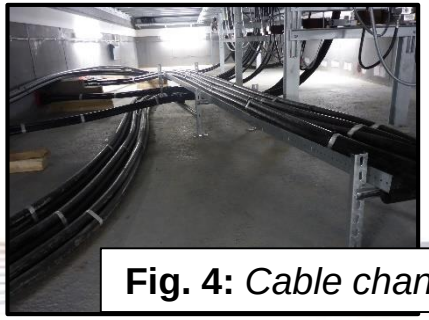


Fig. 4: *Cable channel planning*

Fig. 7: *New substation construction*

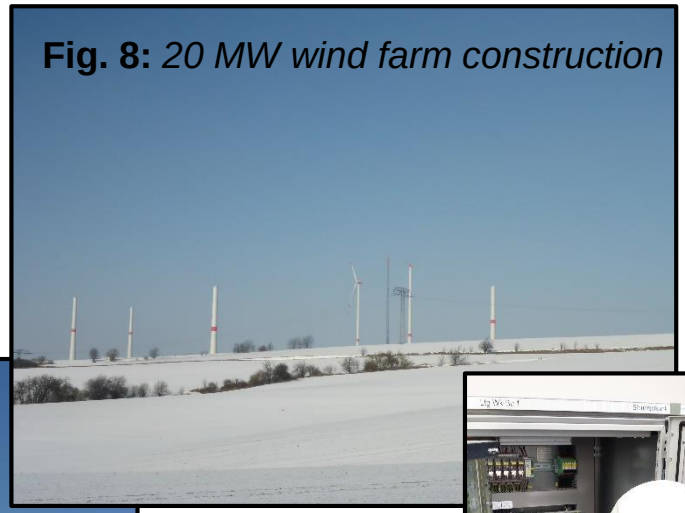


Fig. 8: *20 MW wind farm construction*

Fig. 6: *Remote control testing*

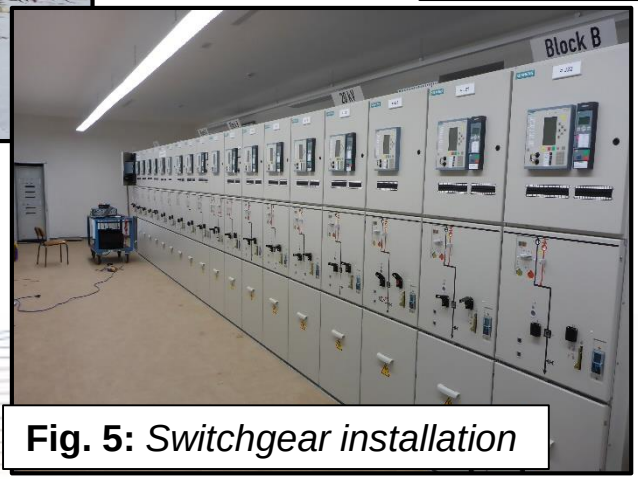


Fig. 5: *Switchgear installation*

4 Current major challenges in Germany

Fig. 9: *Voltage transformer destruction*

Fig. 13: *Mobility (Hydrogen / E-charging)*

Fig. 10: *Network expansion in North Germany*

Fig. 12: *Short-circuit current limiting choke for the wind substations*

Fig. 11: *Elektrolysis Power-to-gas system*

Experience as utility manager (built-up with the renewable energy sources)

Connection provider`s example (general questions), made in Germany

Glance as Utility Manager
- Part II -

Detection of network errors is increasingly more difficult

Congestion management / n-1 criterion adjustment, different to renewable energy plants' capacity

Network opertors often do not work together on the current challenges of energy transition / problem: communication

Nominal voltage of the grid is raised

Short-circuit currents increases

Unbalance of the network increases

Grounding requirements increase

Switching operations increase

Experience in bilateral load flows and HVDC networks is hardly considered *(e.g., railway networks or foreign experience)*

In the past, plant certifiers / unit certifiers developed insufficient connection plans *(lack of operting experience, in particular in network dynamics)*

Requirements for network dynamics/regulating increase

!

Consequences of the renewable energy use
- electrical view -
(selection)

Recycling of old plants and dismantling of conventional energy sources *(renaturation, costs)*

Political changes / approval procedures

Probabilistic grid planning (*how far does locking into the future makes sense, uncertainties)*

Monitoring *(supervising of equipment condition, Industry 4.0)*

Metrology *(interfaces, telegrams, security, costs, tariff formation, liberalization)*

Automation/SmartGrid *(volume of data, data security, standardization, operating experience, costs, load management, real-time capability)*

Electromobility *(creation of infrastructure, loading time, costs, range)*

Excess energy *(curtailment, power-to-heat, power-to-gas, sector coupling, profitability)*

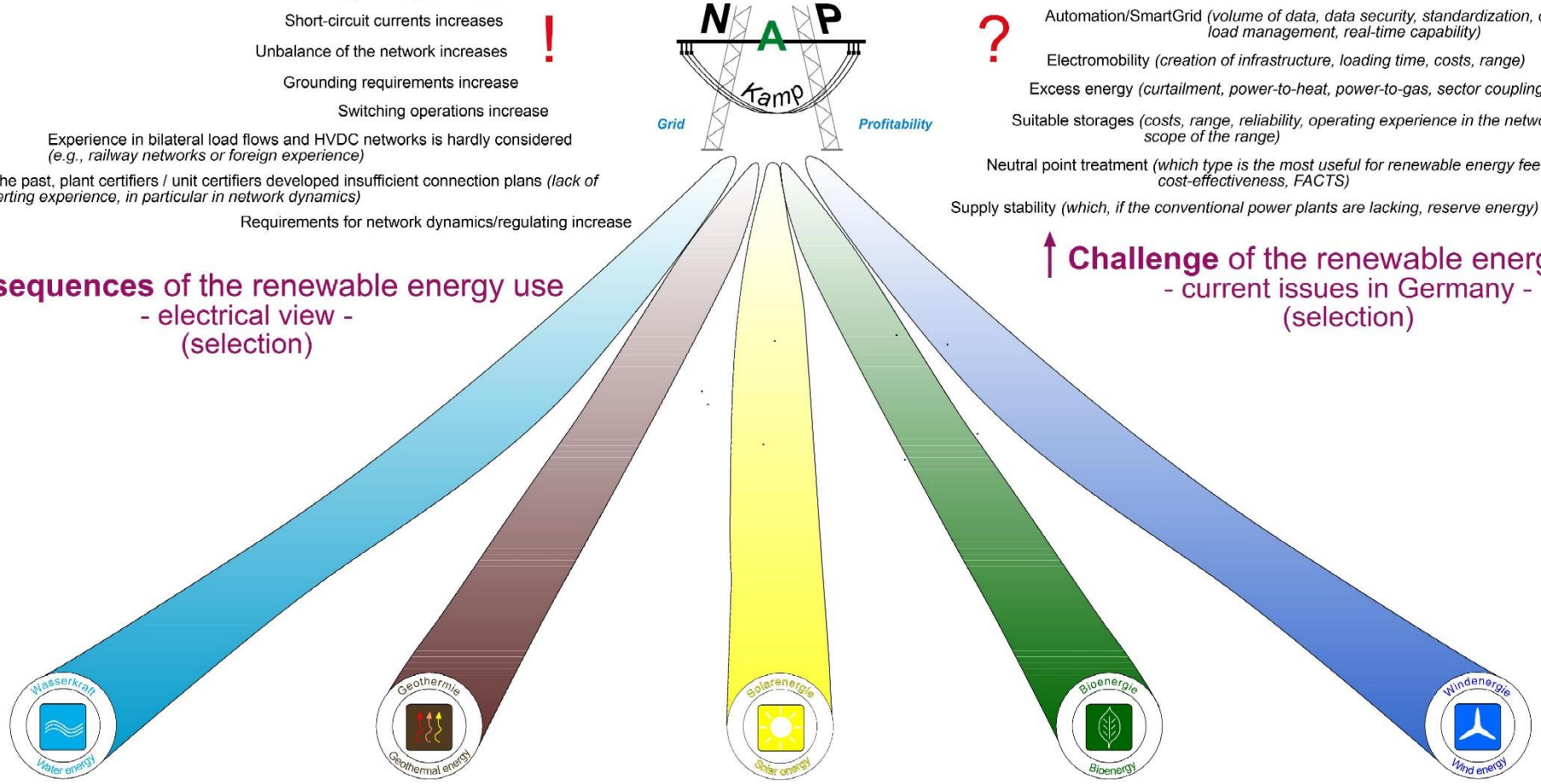
Suitable storages *(costs, range, reliability, operating experience in the network, loading time, scope of the range)*

Neutral point treatment *(which type is the most useful for renewable energy feed-in, conversion costs vs. cost-effectiveness, FACTS)*

Supply stability *(which, if the conventional power plants are lacking, reserve energy)*

?

Challenge of the renewable energy use
- current issues in Germany -
(selection)

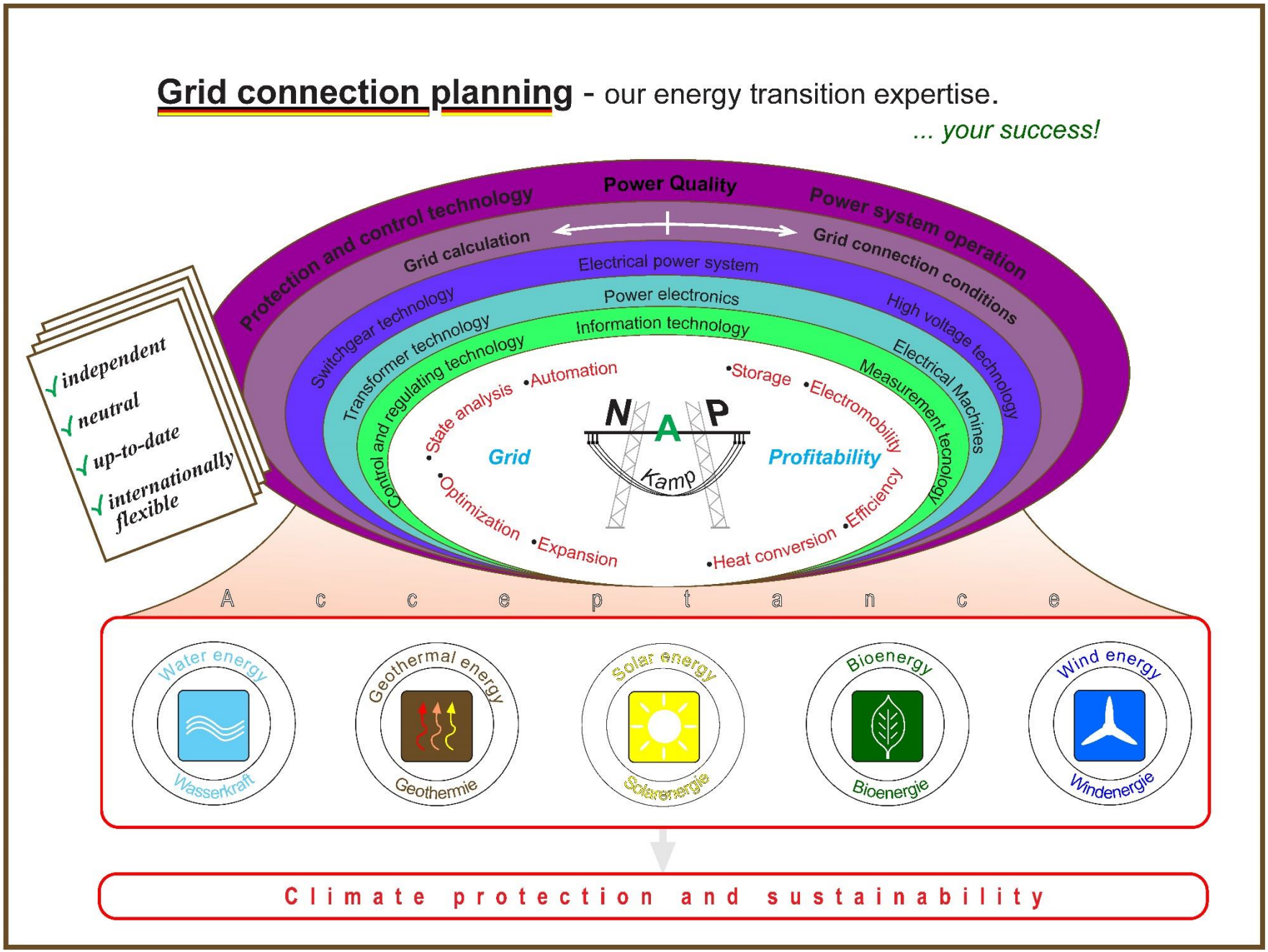


A c c e p t a n c e

(how much may the energy cost and who pays for it?

Electricity assures posperity

5 Possible solutions



Thank you for your attention!

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