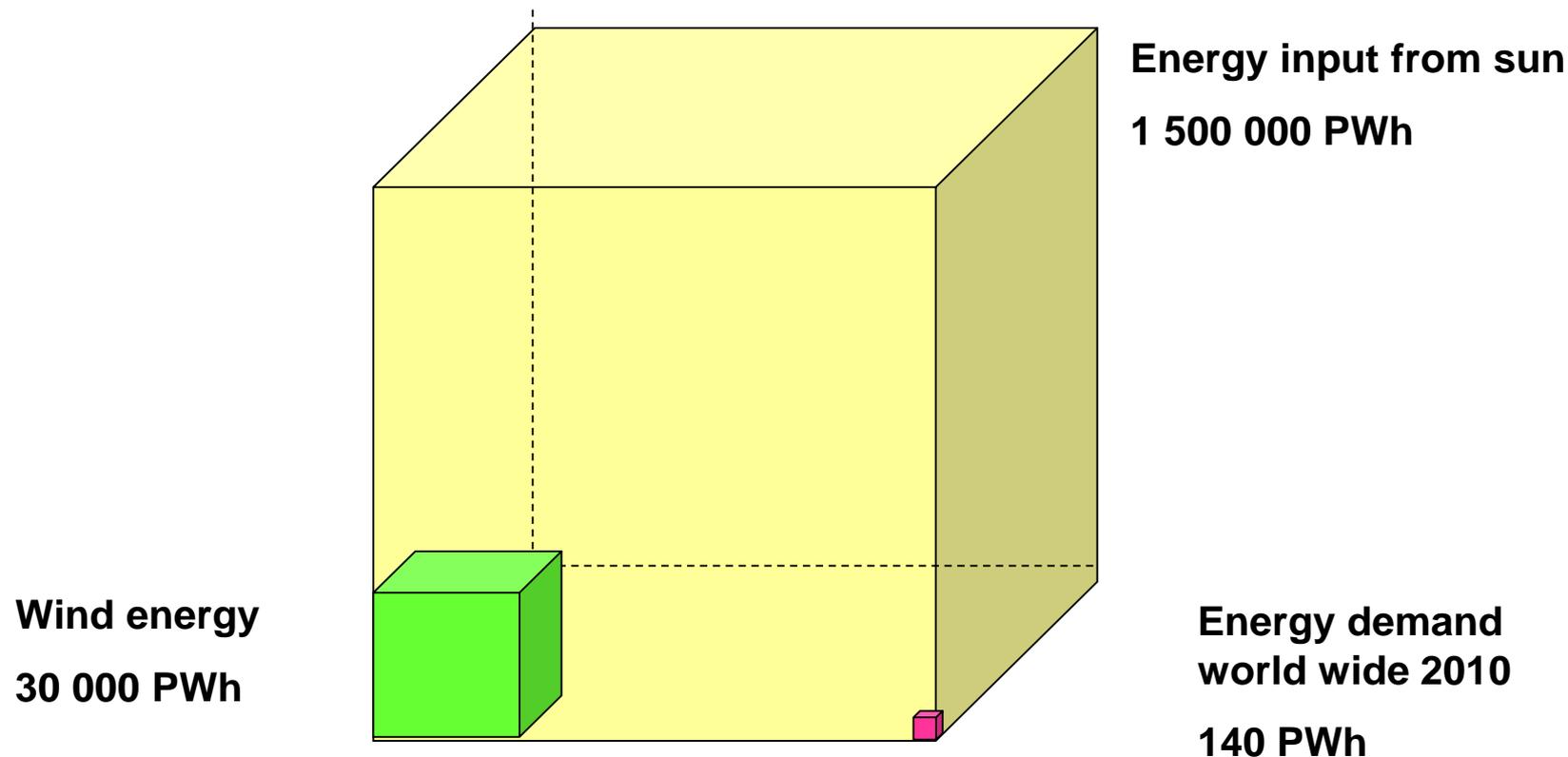


SIEMENS

IRENA Innovation Week

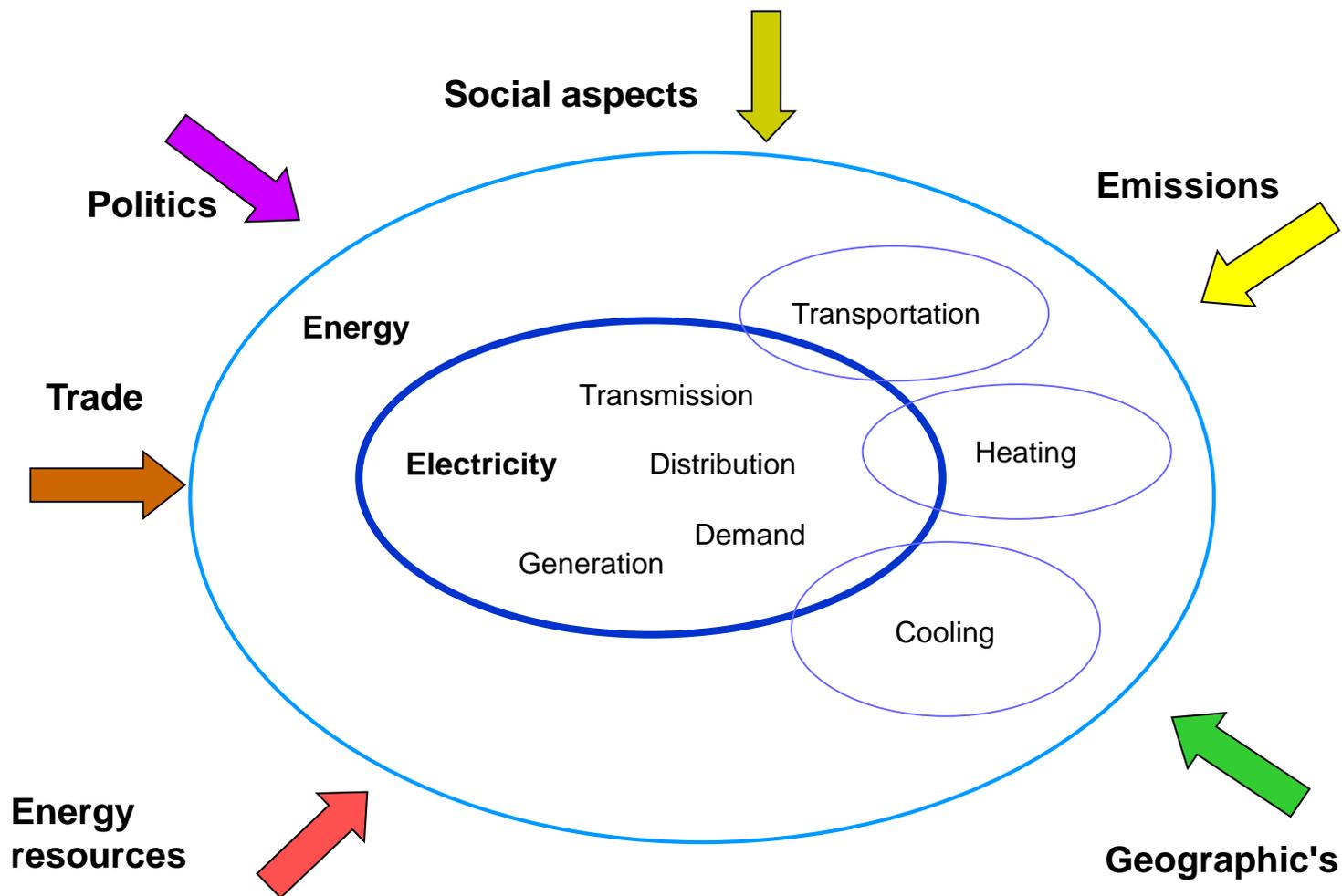
Energy system modelling and planning

Availability of renewable energy

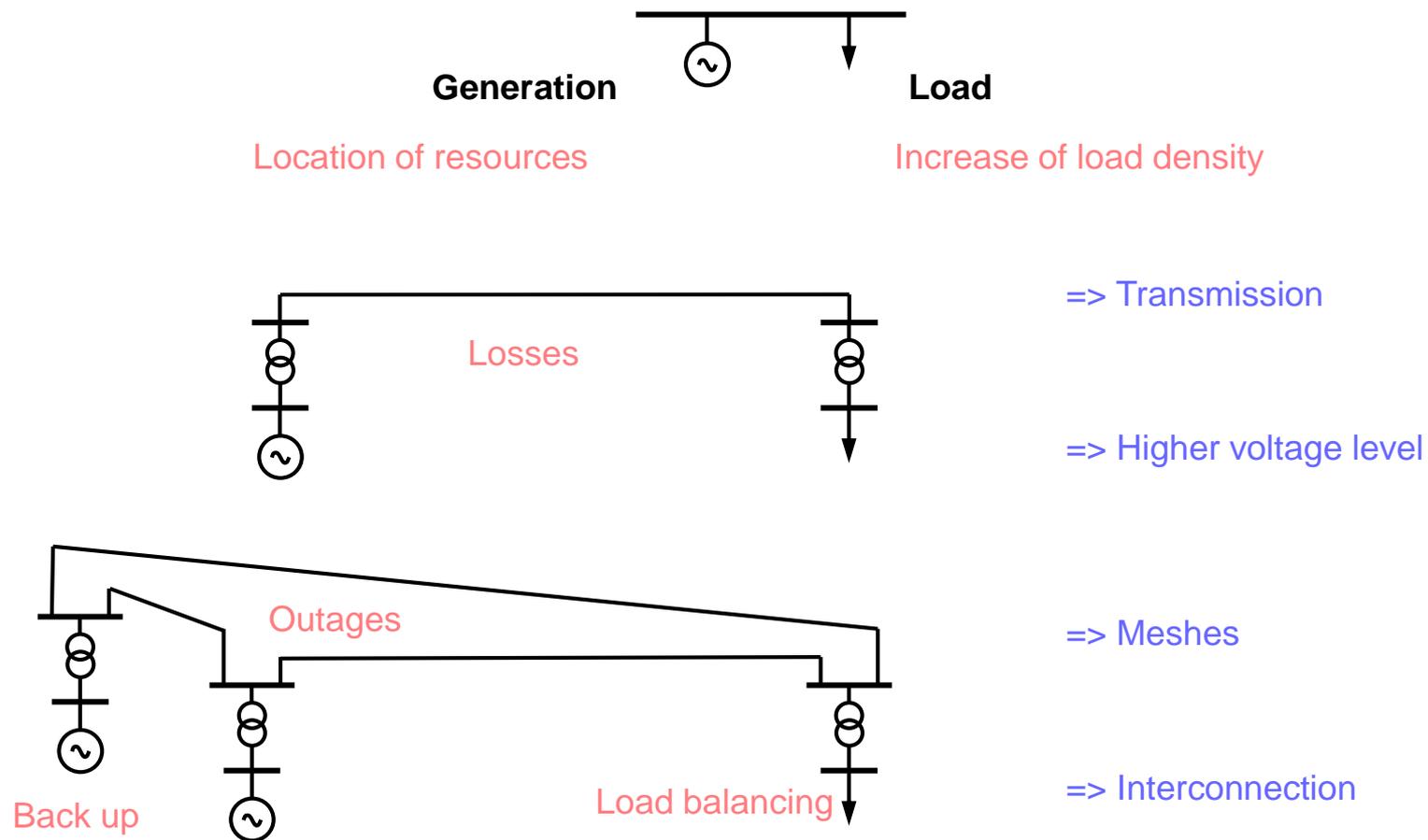


Quelle: BEE

Electricity in the energy focus

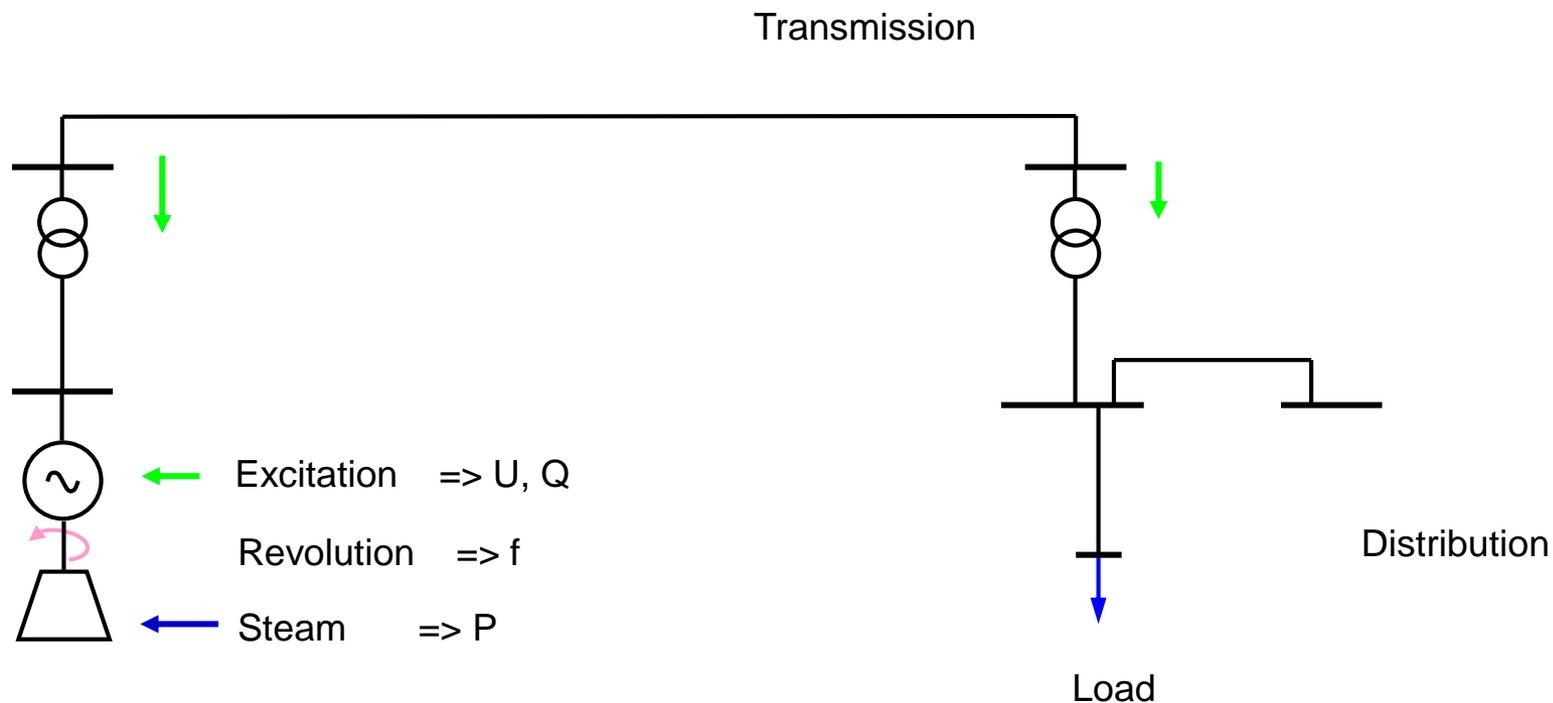


From island supply to interconnection



Principle of electricity supply

Up to now no large scale storage of electricity possible !



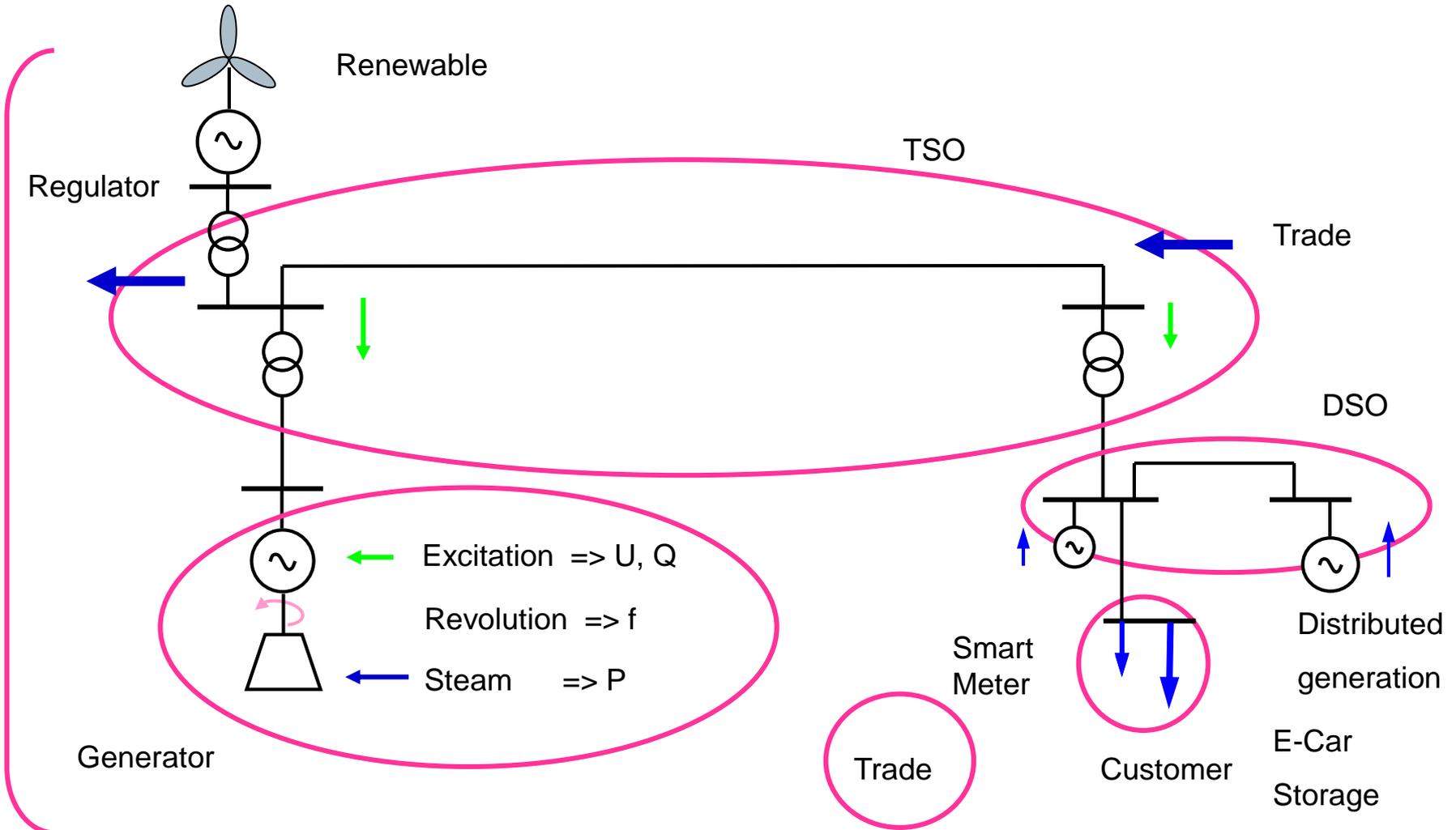
Generation

Schedule

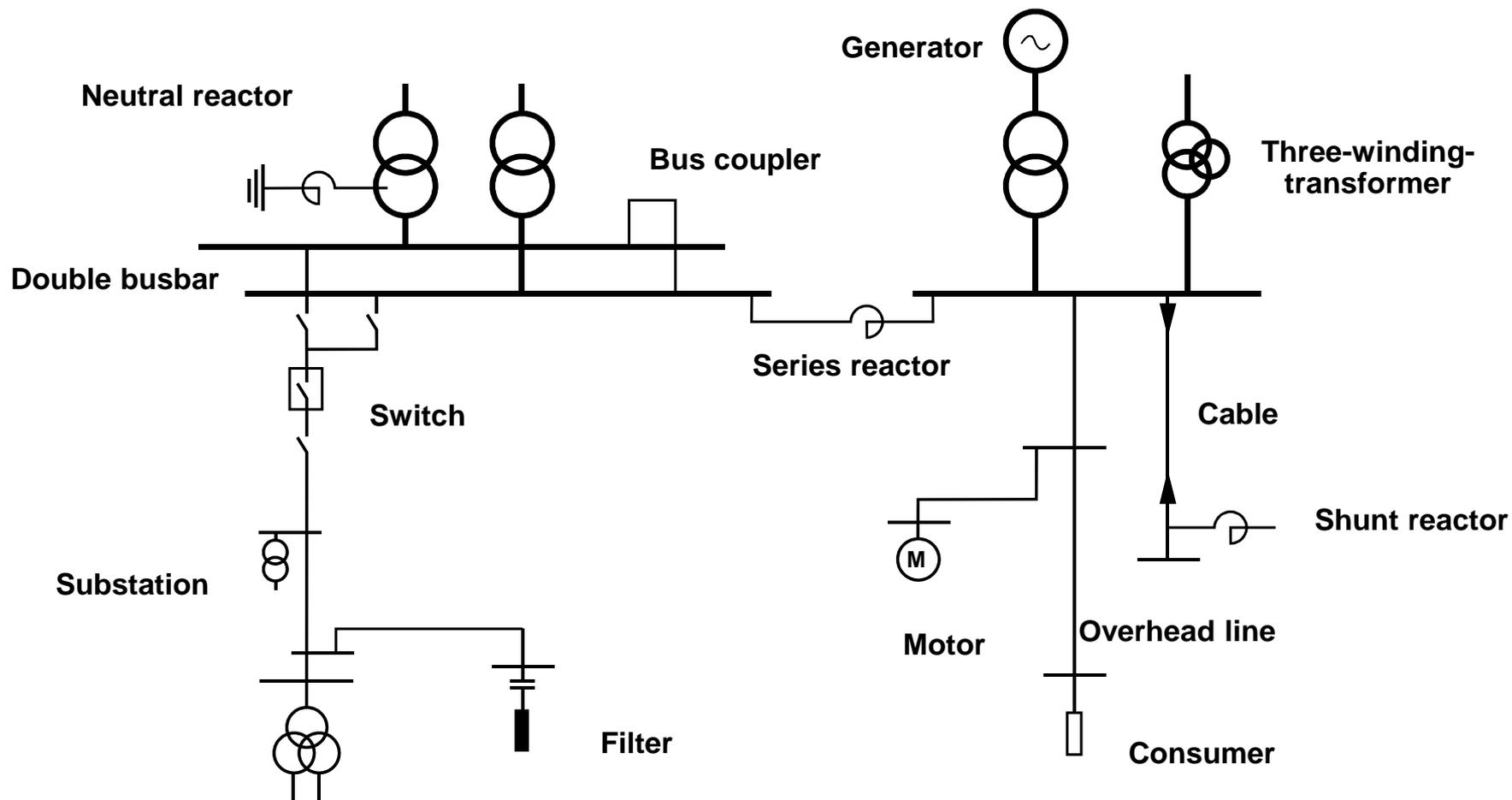
Stochastic Load

=> Predictable Load

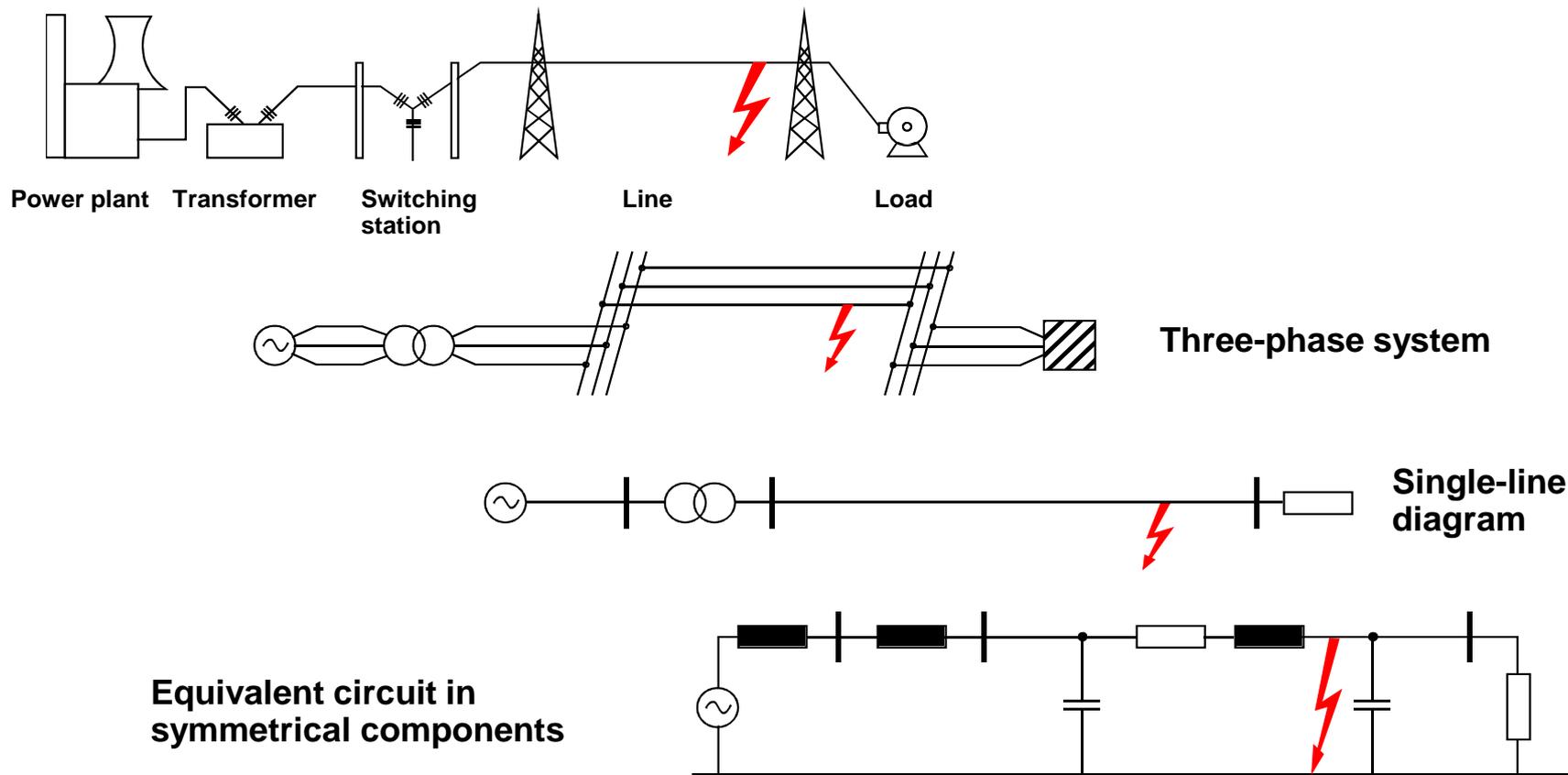
Challenges of future grids



Typical network elements



Grid modelling



Subjects of network analysis

Load flow

Short circuit

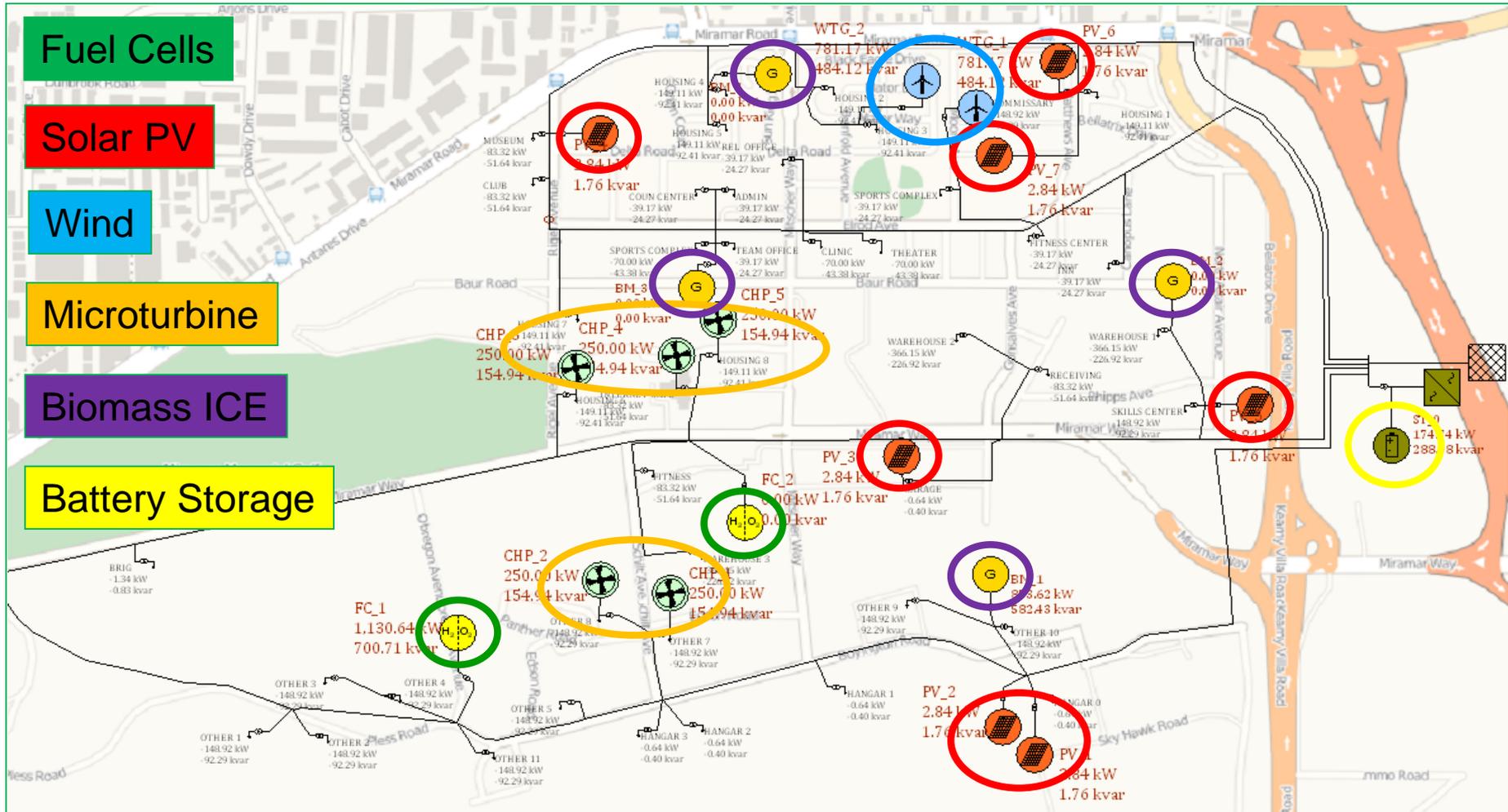
Dynamic

Transient

Operation

- Fault current contribution (max / min)
- Reactive power control
- Voltage profile (steady state / dynamic)
- Element loading (normal operation / contingency)
- Losses
- Protection concept
- Harmonic distortion
- Supply reliability
- Switching operation
- Insulation coordination
- Start up procedure

Grid modelling



PSS®SINCAL Element Models for all tasks

The model complexity varies from simple (short circuit) to normal (load flow) and expert (dynamics, control systems)

The screenshot displays the PSS/SINCAL software interface with several configuration windows open over a power system diagram. Red arrows point from the diagram to the configuration windows.

State - Harmonics Configuration:

- Quality - R constant: Quality - R constant
- Quality - R Constant: $\alpha = 1.0 \quad 1$
- Voltage Source: (none)
- Current Source: (none)

Basic Data Configuration (DFIG):

- Node: Wind DFIG
- Element Name: DFIG
- Network Level: 0.69 (0.7 kV)
- Standard Type: (none)
- Out of service:

Machine Data (DFIG):

- ASM Input: Pn
- Rated Act. Power (mech.): Pn = 2.0 MW
- Rated Voltage: Vr = 0.7 kV
- Rated Speed: rn = 1.4750 1/min
- Pole-Pair Number: p = 2.0 1
- Nominal Power Factor: cosphi_n = 0.85 1
- Rated Efficiency: eta_n = 0.95 p.u.
- Current Ratio at Start-Up: Ia/I_n = 5.0 p.u.
- Resistance/Reactance: R/X = 0.15 p.u.

Operate State (DFIG):

- Load Flow Type: DFIG (P, Q and slip)
- Active Power: P = 1.0 MW
- Reactive Power: Q = -0.1 MVar
- Slip: s = -20.0 %
- Factor P: IP = 1.0 1
- Factor Q: IQ = 1.0 1
- Manipulation Factor: μ = (none)

Short Circuit Behavior (DFIG):

- Type of Machine: Single
- qValue for Tripping Cur.: qtc = 0.0 p.u.
- Time Constant: beta = 1.0 s

Dynamic Parameters (DFIG):

Description	Parameter	Value	Unit
Armature resistance	#RA	.0047	pu
Armature stray reactance	#XA	.1	pu
Rotor resistance r2(S=Sn)	#R2	.008	pu
Rotor stray reactance x2(S=Sn)	#X2	.08	pu
no load current Iu/IInenn	#ILEER	.32	pu
Converter reactive power	#QC	0.0	Mvar
Start-up time	#TA	10.	s
Reinforcement of the pilot control	#VST	.03	pu
Crowbar short circuit resistance	#RK	0.03	pu
Crowbar release time	#TCROW	.3	s
Internal resistance voltage converter	#RI	.001	pu
PI integration time constant	#P_I	8.	s
PI Reinforcement factor	#P_V	.05	pu
Pitch control (0: OFF, 1: ON)	#PITCH	0.	
Voltage correction (0: OFF, 1: ON)	#UCORR	1	

Dynamic Parameters (Equivalent nom.):

Type of Input Data	Equivalent nom.	Value	Unit
Equiv. Reactance X2	x2	4.4865	p.u.
Equiv. Reactance X3	x3	0.061	p.u.
Equiv. Reactance X4	x4	0.06972	p.u.
Equiv. Reactance X4	x4	0.08942	p.u.
Equiv. Reactance R5	r5	0.3967	p.u.
Equiv. Reactance X5	x5	0.01	p.u.
Beg. Saturation Current	lea/Ar	0.22	p.u.
Saturated Reactance	xsat	0.75	p.u.

Basic Data Configuration (SS1-C):

- Node: SSI-C
- Element Name: DC38
- Network Level: LowVoltage (0.4 kV)
- Out of service:

Operate State (SS1-C):

- DC Infeeder Type: Photovoltaic
- Installed DC-Power: Pdc = Fuel cell
- Factor DC-Power: Pdc = Battery
- Manipulation Factor: μ = (none)
- Losses until Inverter: pldc = 15.0 %
- Efficiency Inverter: eta = 97.0 %
- Reactive Power Inverter: q = 2.0 %
- Rated Voltage Inverter: Vr = 0.4 kV
- Controller Power: Pctrl = 0.0
- Minimum Voltage: Vmin = 80.0 %
- Maximum Voltage: Vmax = 110.0 %
- Switch Off Time: toff = 0.01 s

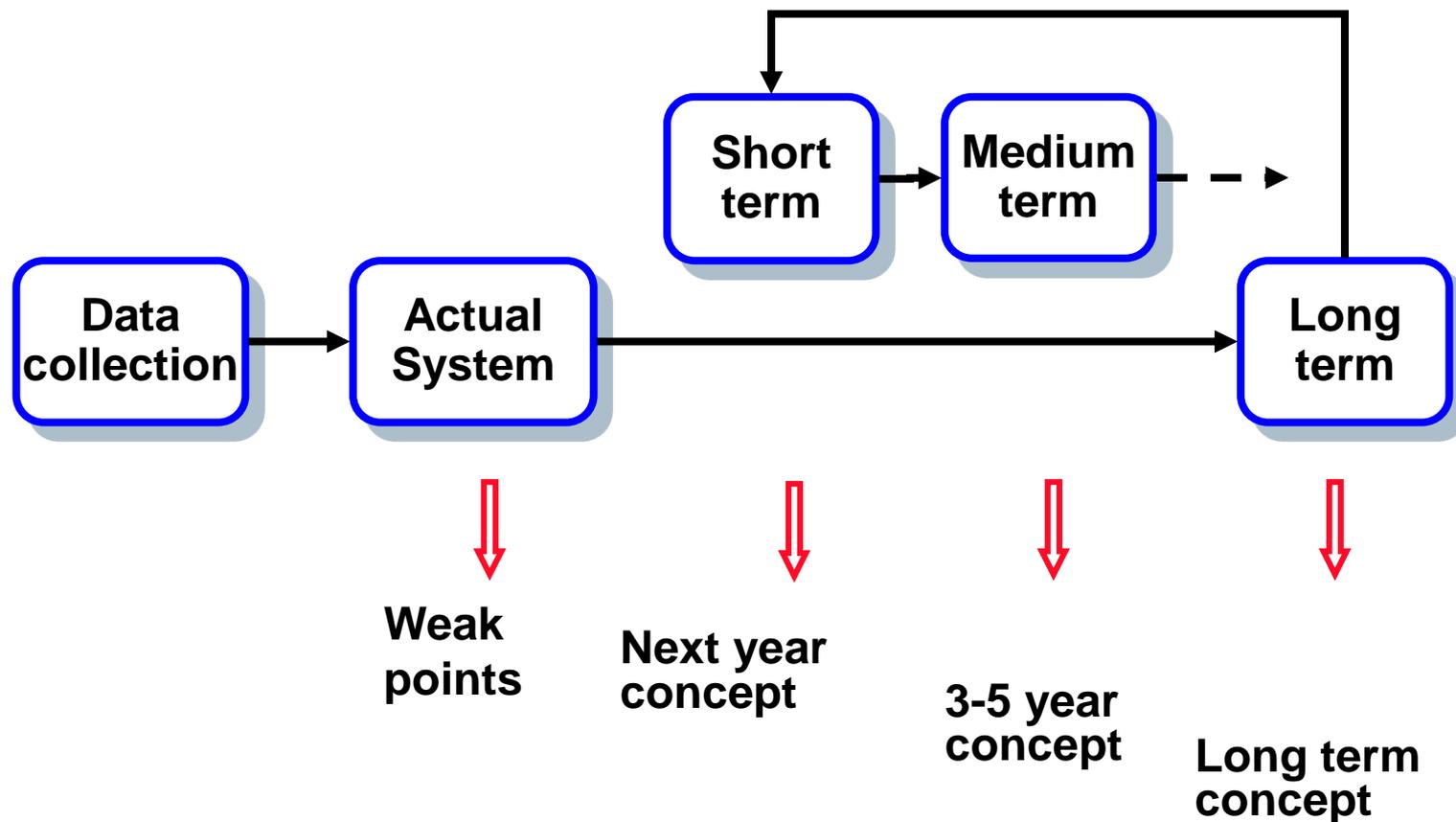
Load Profile (SS1-C):

- Daily Series: (none)
- Weekly Series: (none)
- Yearly Series: (none)

Transformer (SS1-C):

- Connecting: Directly
- Rated Voltage Netside: Vm = 0.4 kV
- Rated Apparent Power: Sr = 25.0 kVA
- Rel. Short Circuit Voltage: vk = 10.0 %
- Ratio R/X: R/X = 0.0

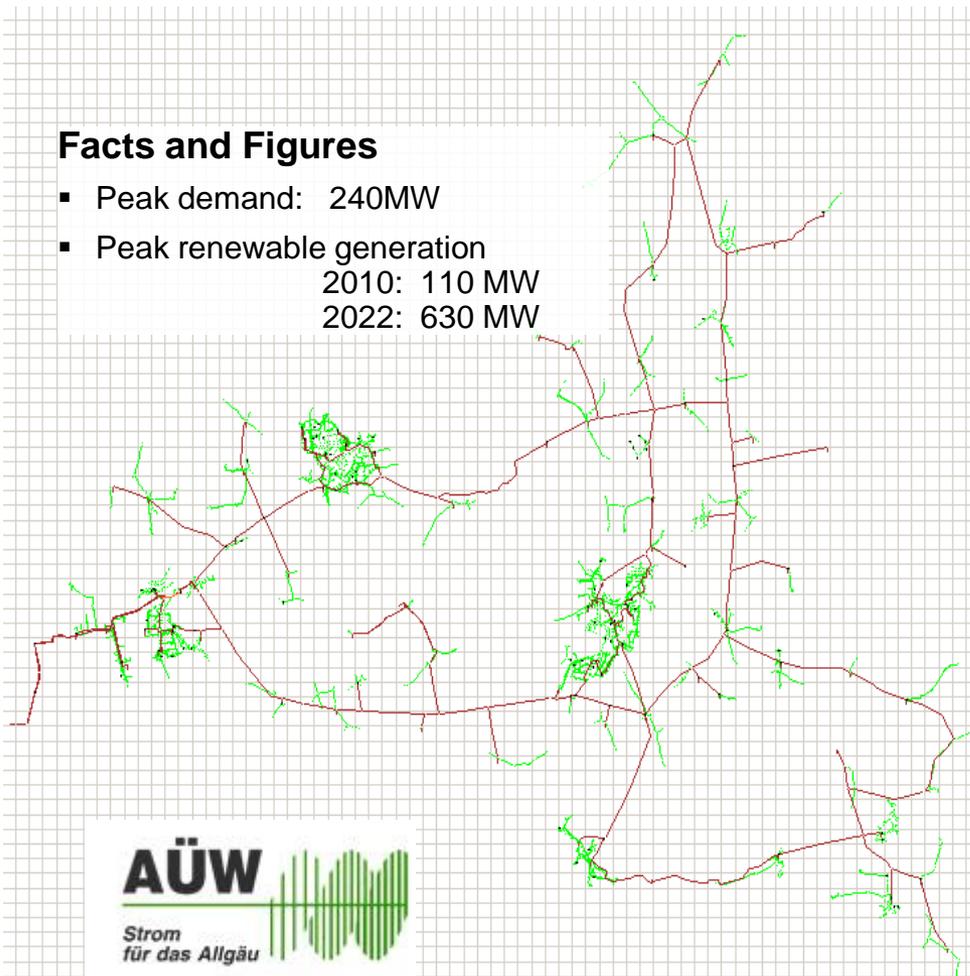
Planning Loop



Example of renewable integration

Facts and Figures

- Peak demand: 240MW
- Peak renewable generation
 - 2010: 110 MW
 - 2022: 630 MW



Challenges

- Integration of large amount of renewable generation (PV, Wind) in existing network structures
- Minimization of costs in grid extension

Siemens solutions

- Determination of minimum required grid extension by comparison of DER integration in various voltage levels:
 - LV (0.4 kV), MV (20 kV), HV (110 kV)
- Comparison of conventional versus smart grid extension measures in terms of costs:
 - Storage, Load Management, Regulated Distribution Transformers, Controllable Converters

Customer benefits

- Maximum renewable generation integration
- Effectiveness of smart grid components for reducing grid extension costs
- Determination of costs of energy transition

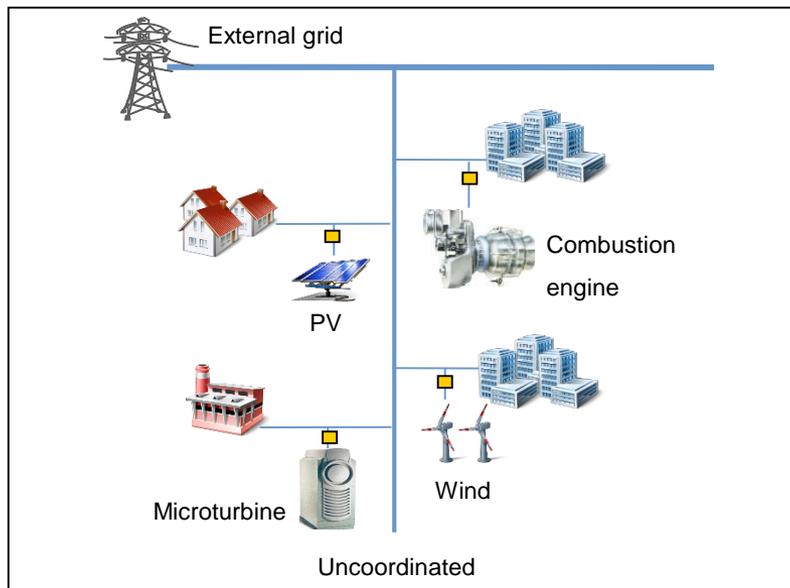
Source: Siemens AG, EM DG PTI

Micro Grid

Comparison between distributed generation and Micro Grid

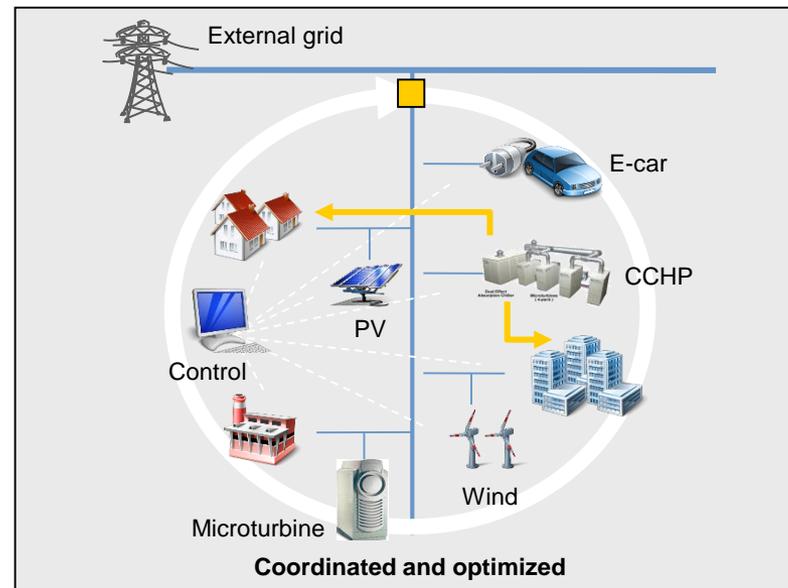
Conventional distributed generations

- Several points of coupling
- Generation sources are not coordinated / optimized
- Adverse impact on main grid

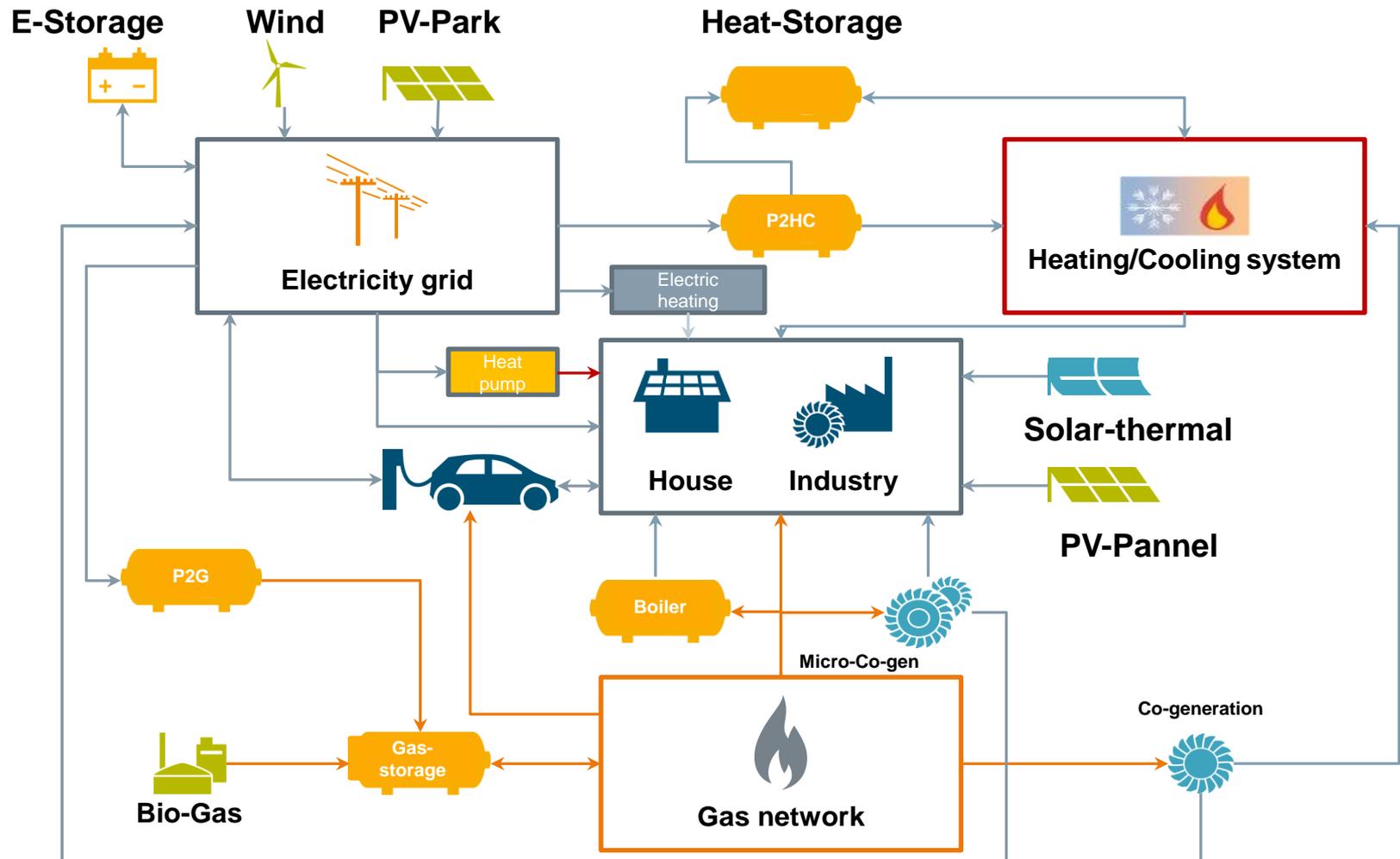


Micro Grid

- Common point of coupling
- Presents to grid as an aggregated load / energy source
- Energy sources including thermal are coordinated / optimized



Hybrid system



Thank you for your attention



Theodor Connor
Strategic Relationship Manager
EM DG PTI
Freyeslebenstr. 1
91058 Erlangen
Germany
Phone: +49 (9131) 7 – 33715
E-mail:
theodor.connor@siemens.com

[siemens.com/power-technologies](https://www.siemens.com/power-technologies)