

SIEMENS

Ingenuity for life



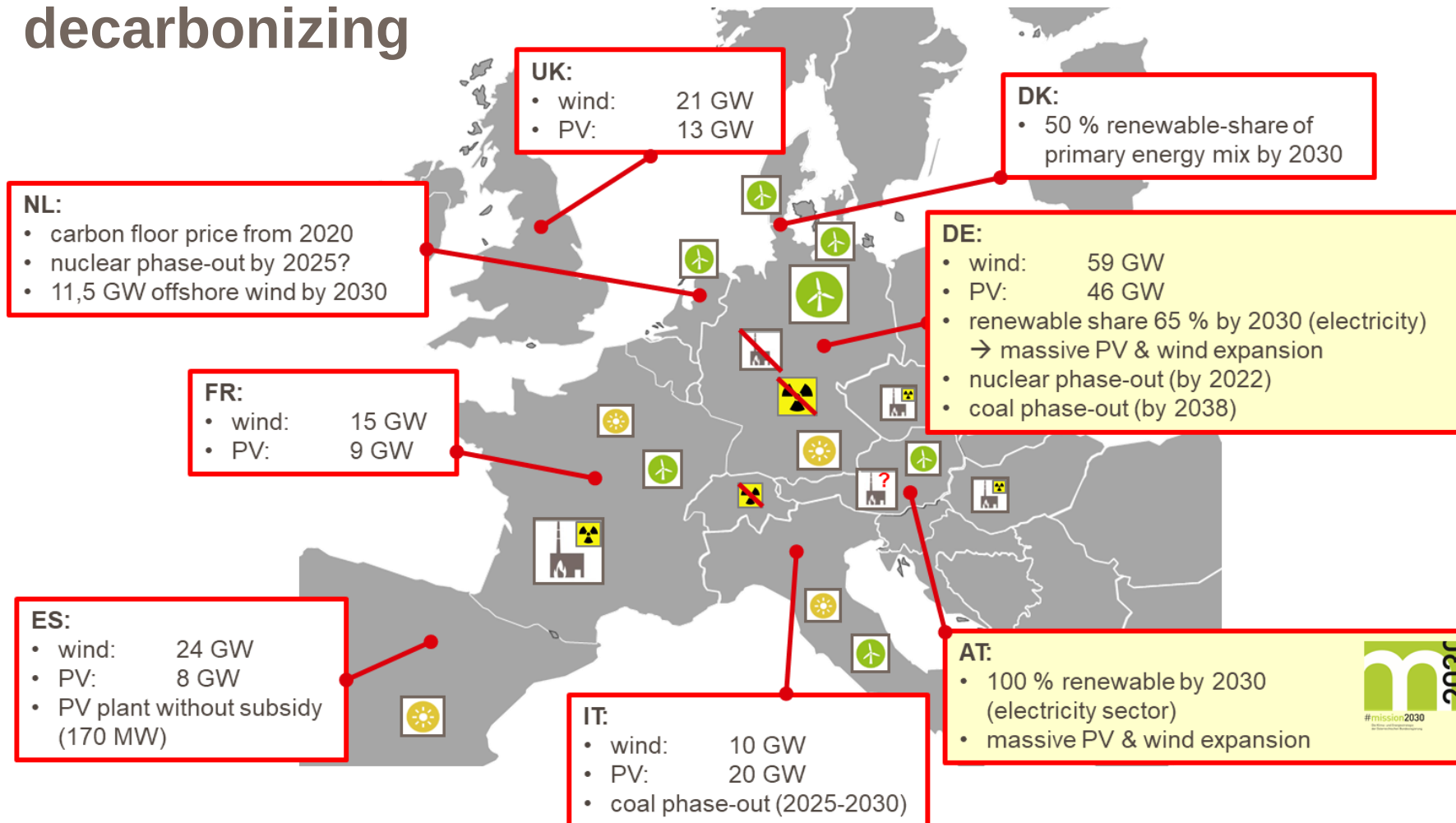
AUSTRIAN POWER GRID
STROM BEWEGT

DIGITAL LOAD MANAGEMENT FOR TRANSFORMERS

Agenda

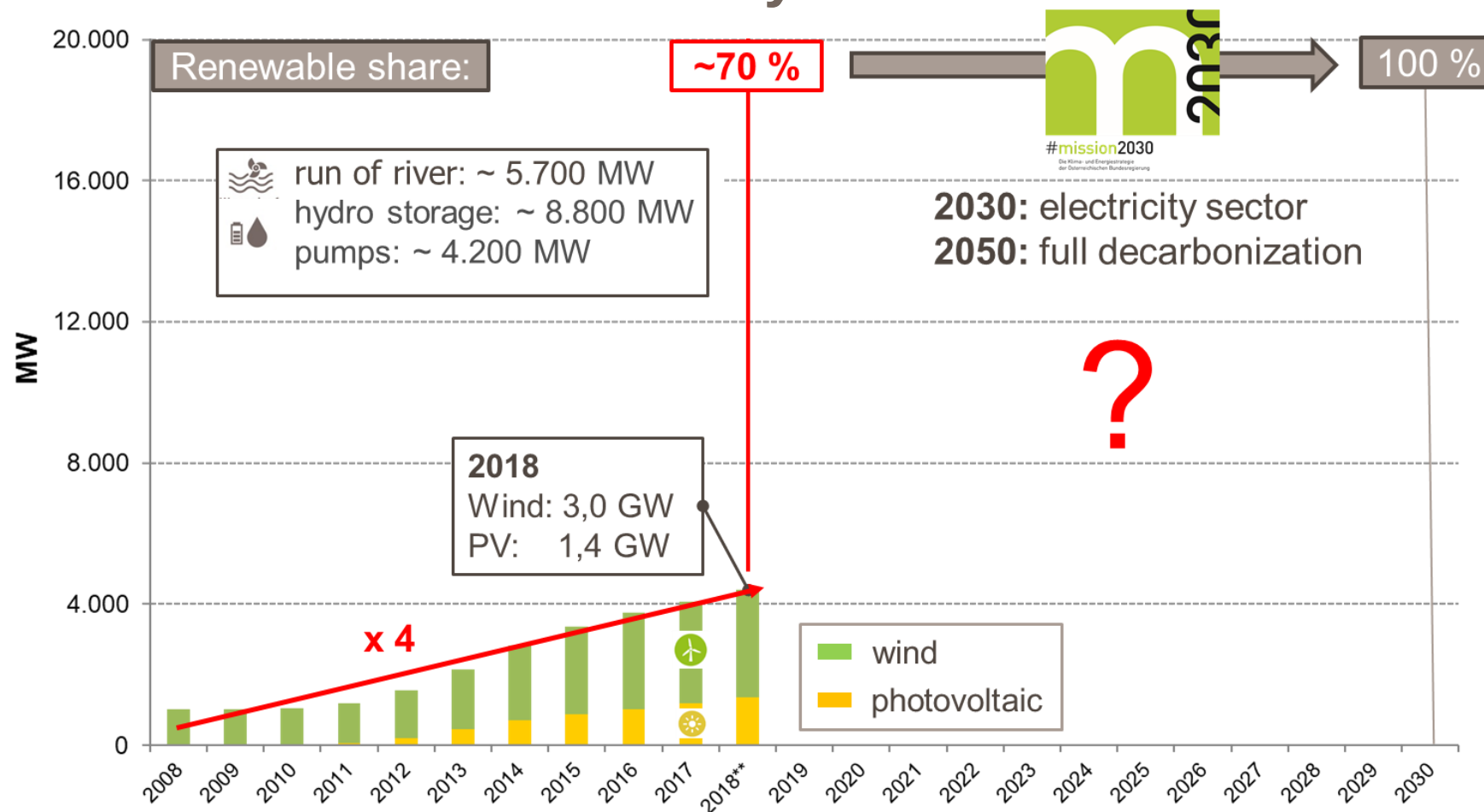
- APG Mission 2030, rapid expansion of renewable energies
- Stage I: Digital twin of transformer
- Stage II: Overload capability of transformers in SCADA and Network Applications
- Stage III: Active Digital Load Management for Transformers

Europe is electrifying and electricity is decarbonizing

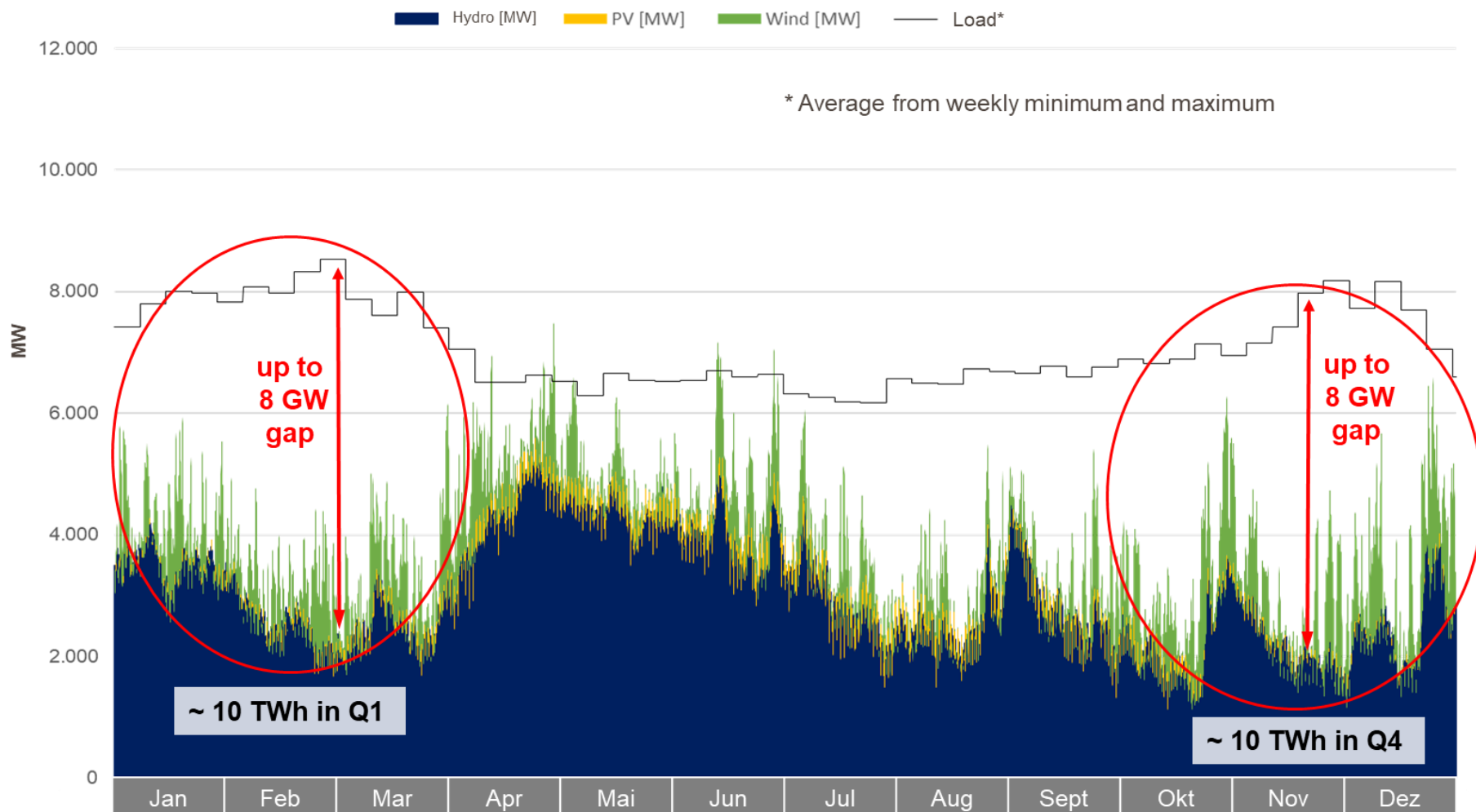


Source: installed capacities (Platts 12.04.2019)

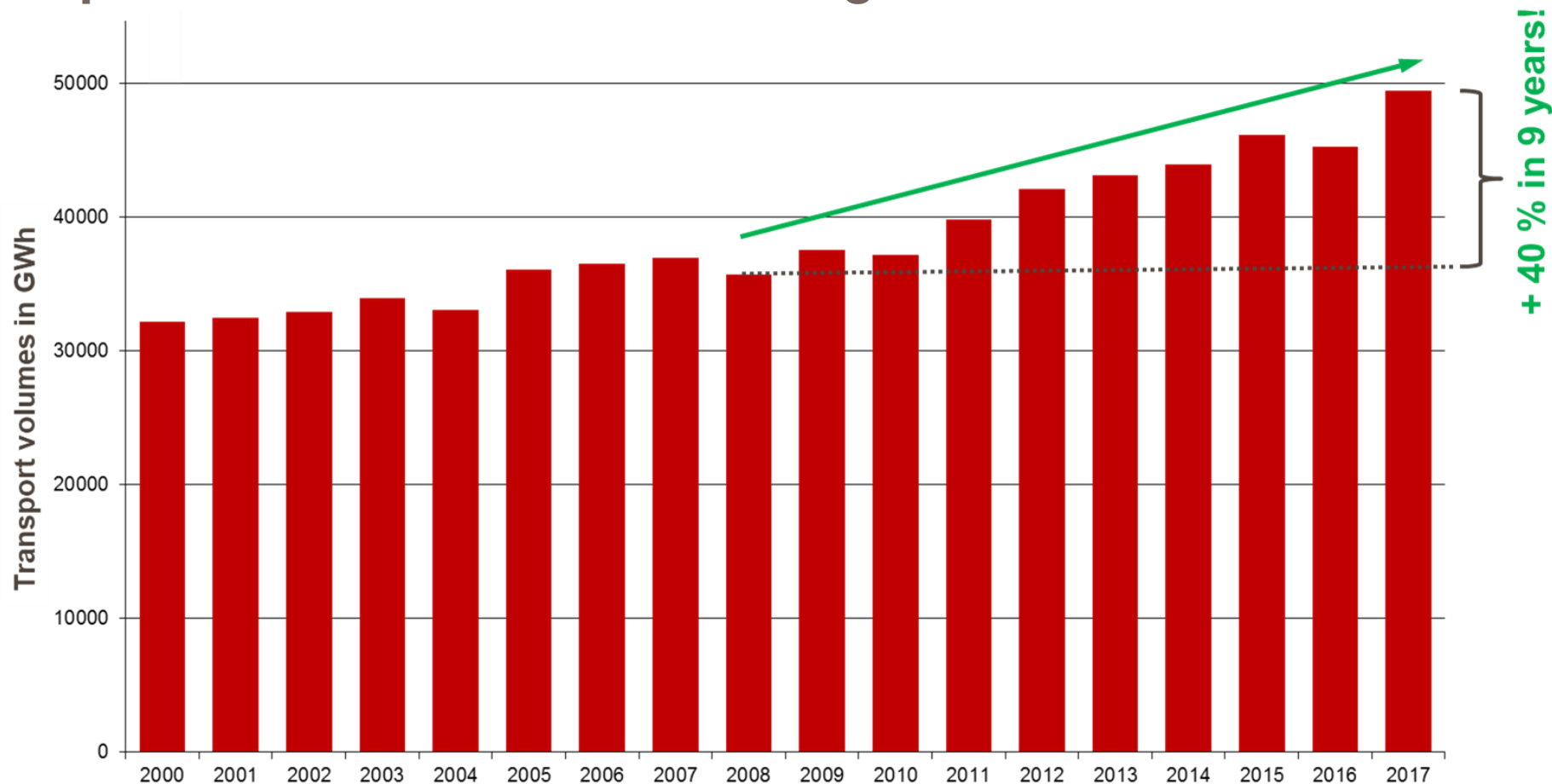
Austria is on its way towards 100 % renewables in the electricity sector



In 2018 full load coverage from renewables was not yet possible



Rising transport volumes⁽¹⁾ emphasize increasing importance of the transmission grid



(1) Transport volumes in the transmission grid of APG (380-kV and 220-kV)

Lacking transmission grid led to increasing emergency measures

Year 2018

Jänner	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Februar	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28			
März	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
April	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Mai	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Juni	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Juli	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
August	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
September	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Oktober	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
November	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Dezember	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

■ weekend
□ weekday

Cost in DE:

- 2017 1.5 bil. EUR
- 2018 1.4 bil. EUR

Days with emergency measures in 2018 ■

Jänner	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
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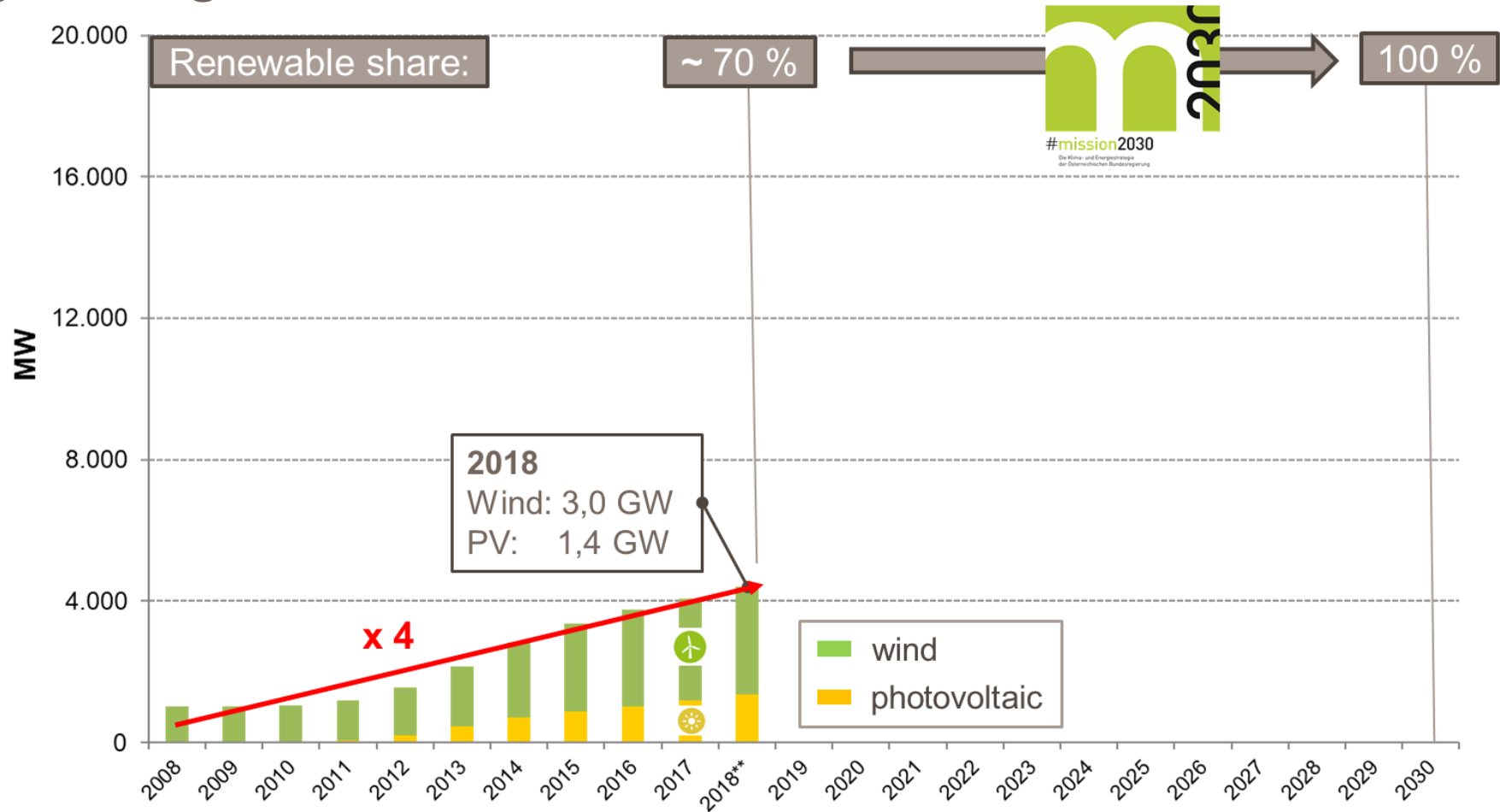
→ 282 days in 2018

Costs in AT

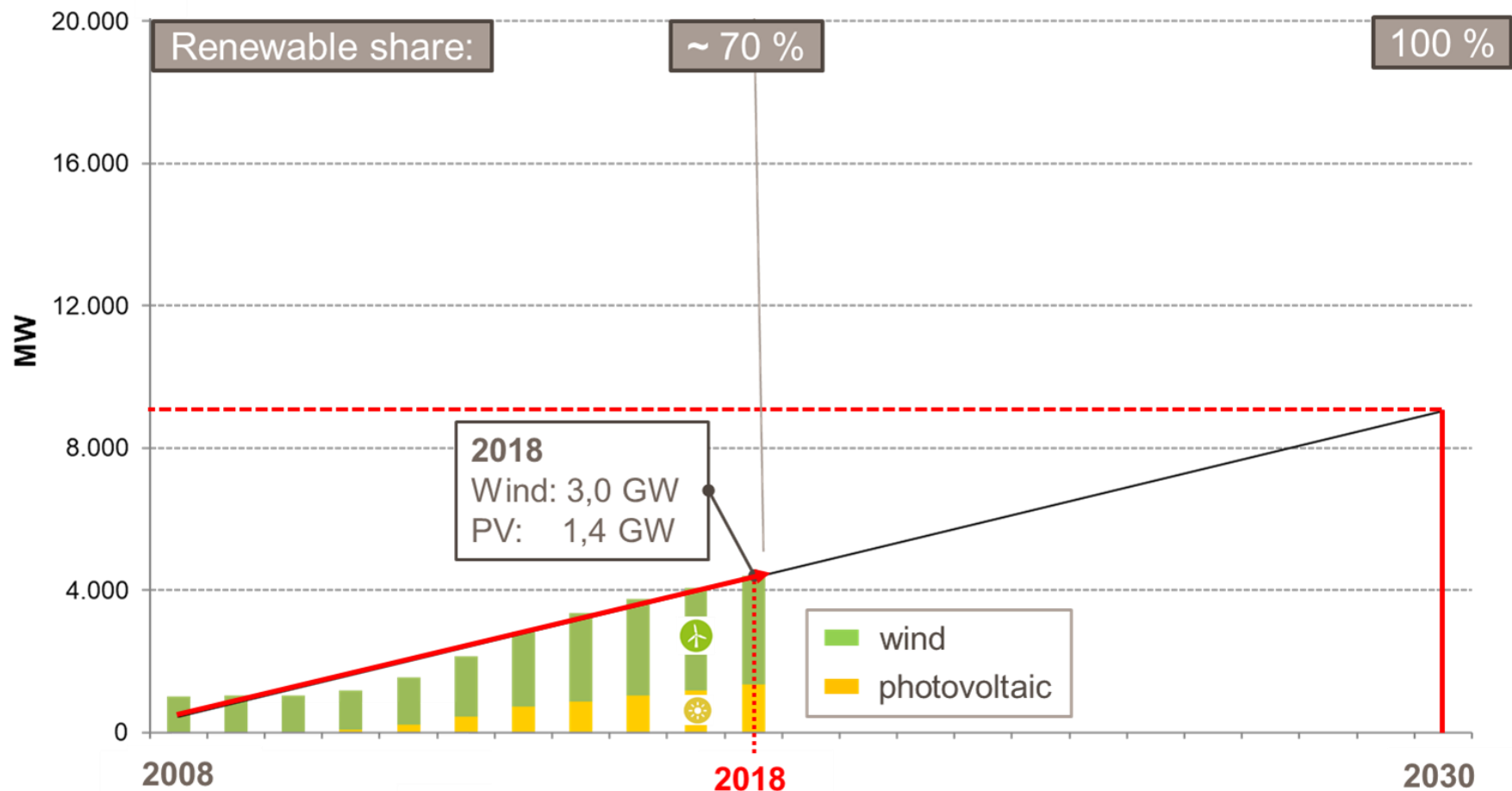
Transmission grid cannot fulfil market demand → costly emergency measures needed ...

- 2017: 92 Mio. EUR
- 2018: 117 Mio. EUR
- monthly ~ 10 Mio. EUR
(borne by Austrian electricity customers)

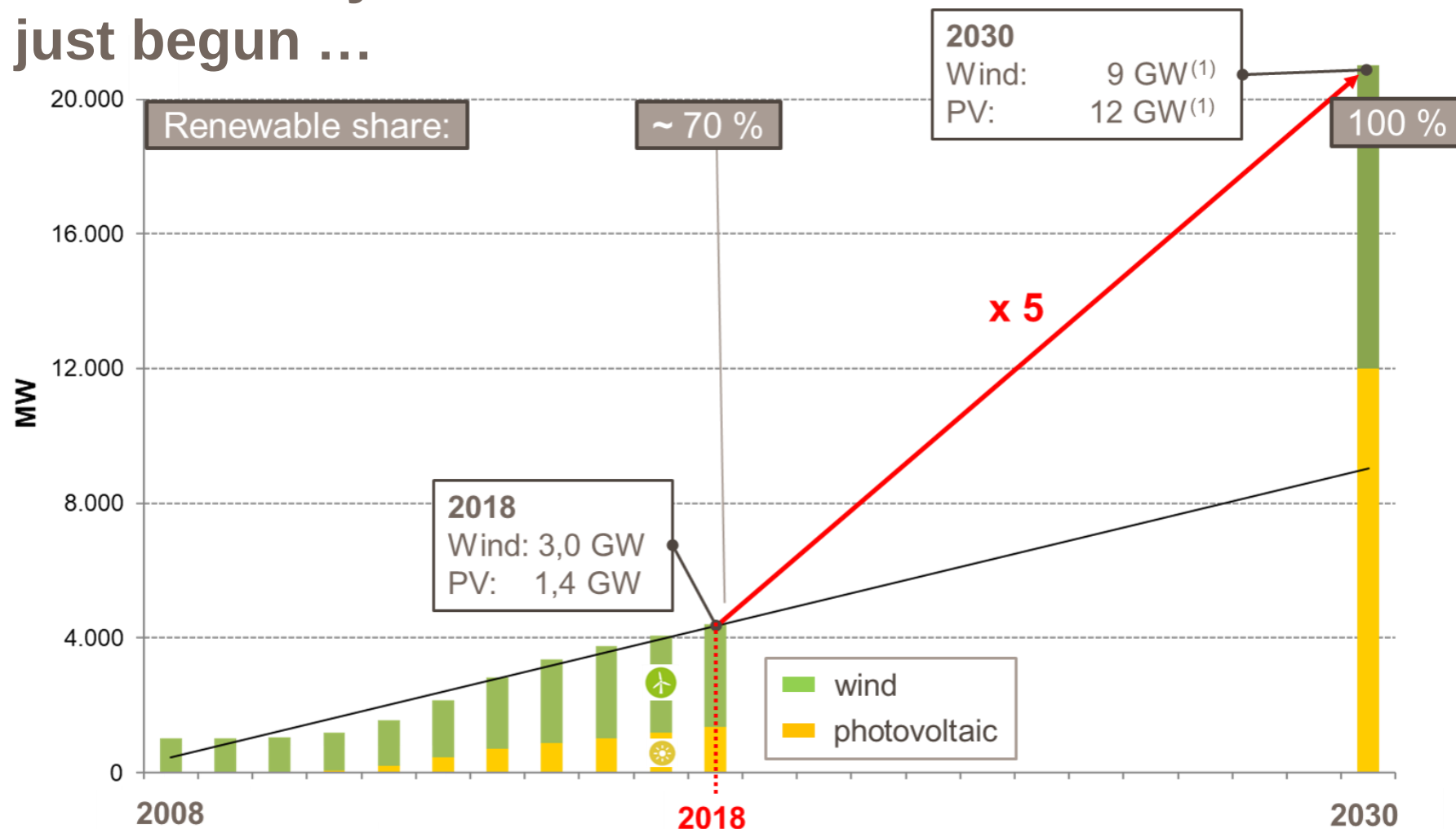
Austria's way to 100% renewables has just begun ...



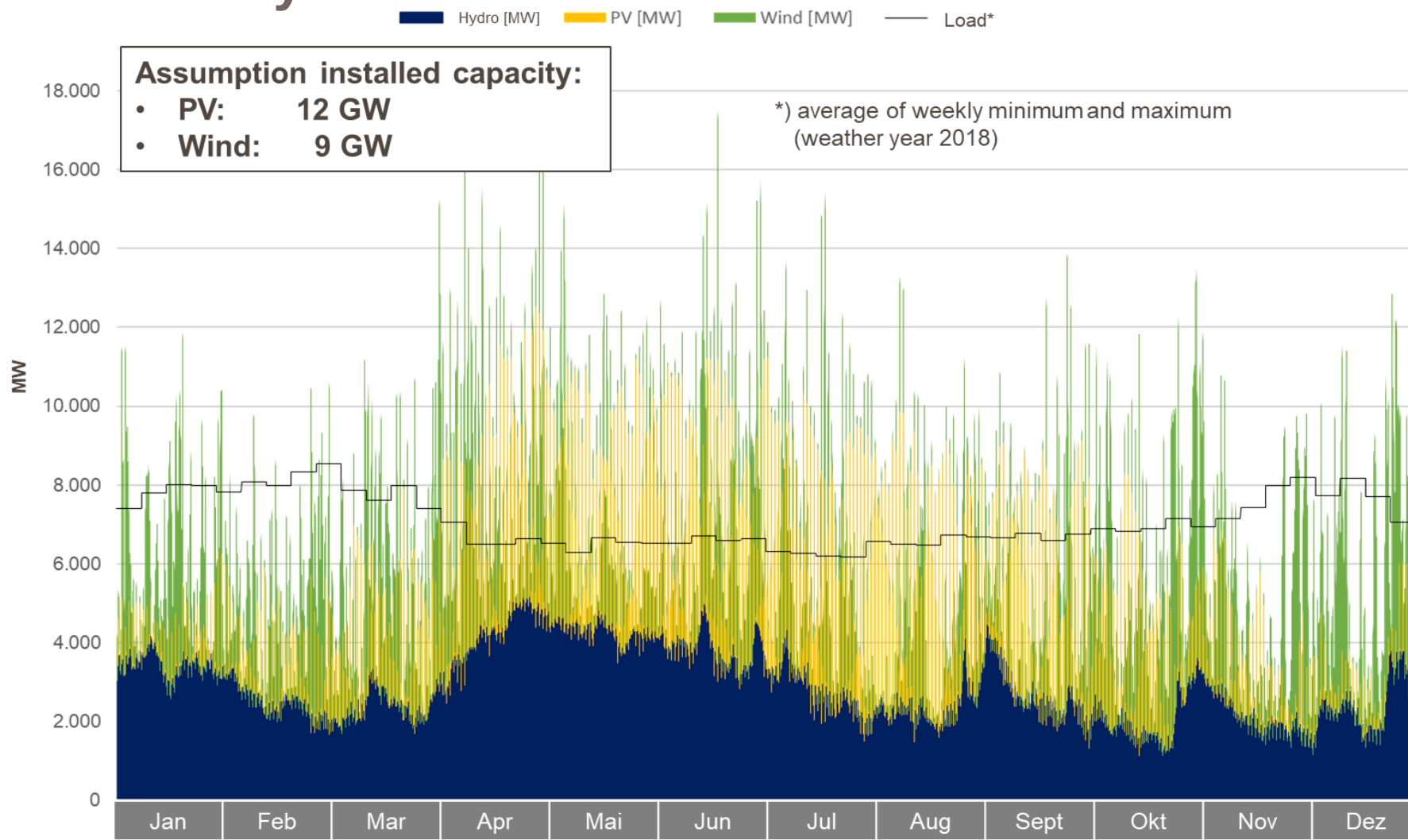
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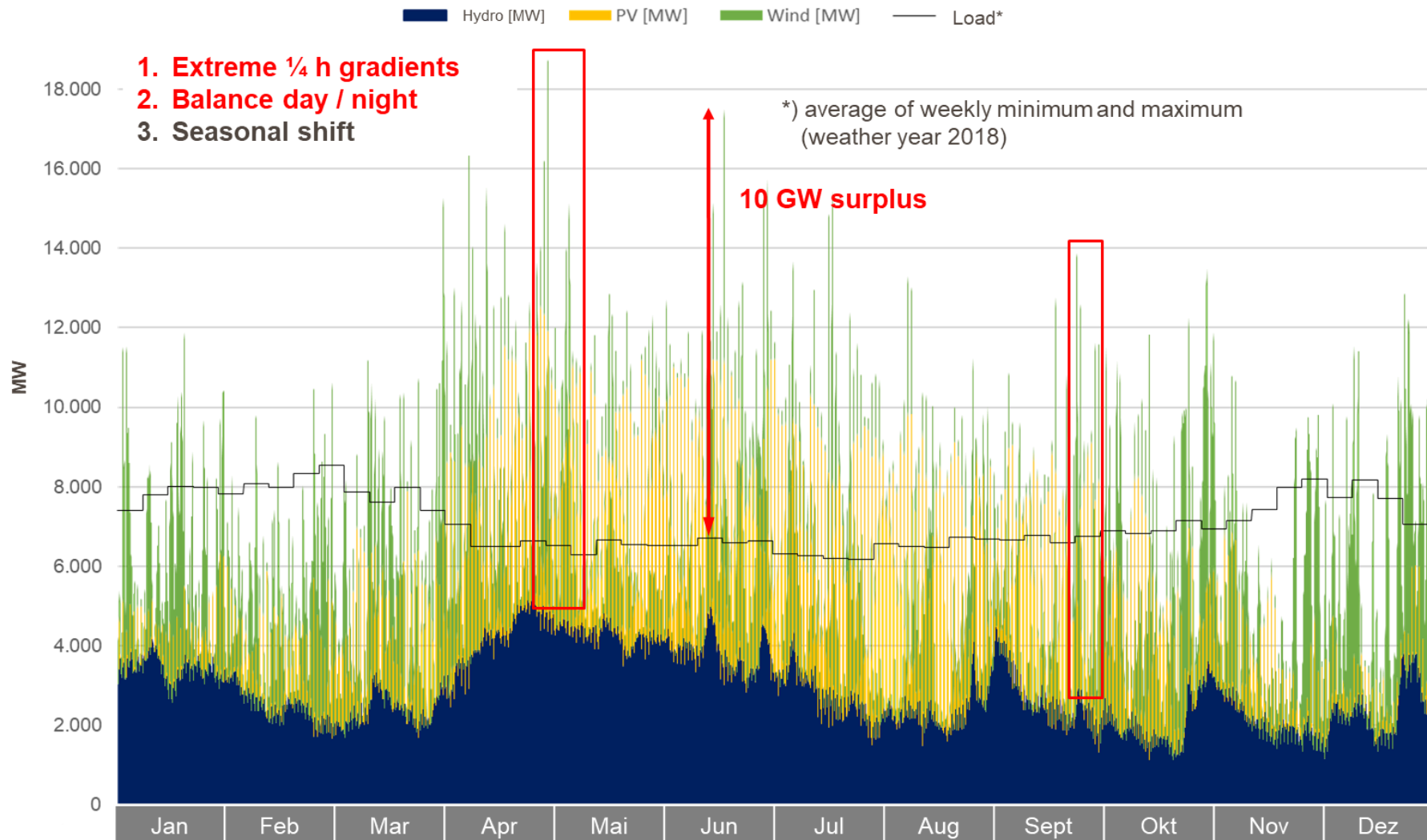
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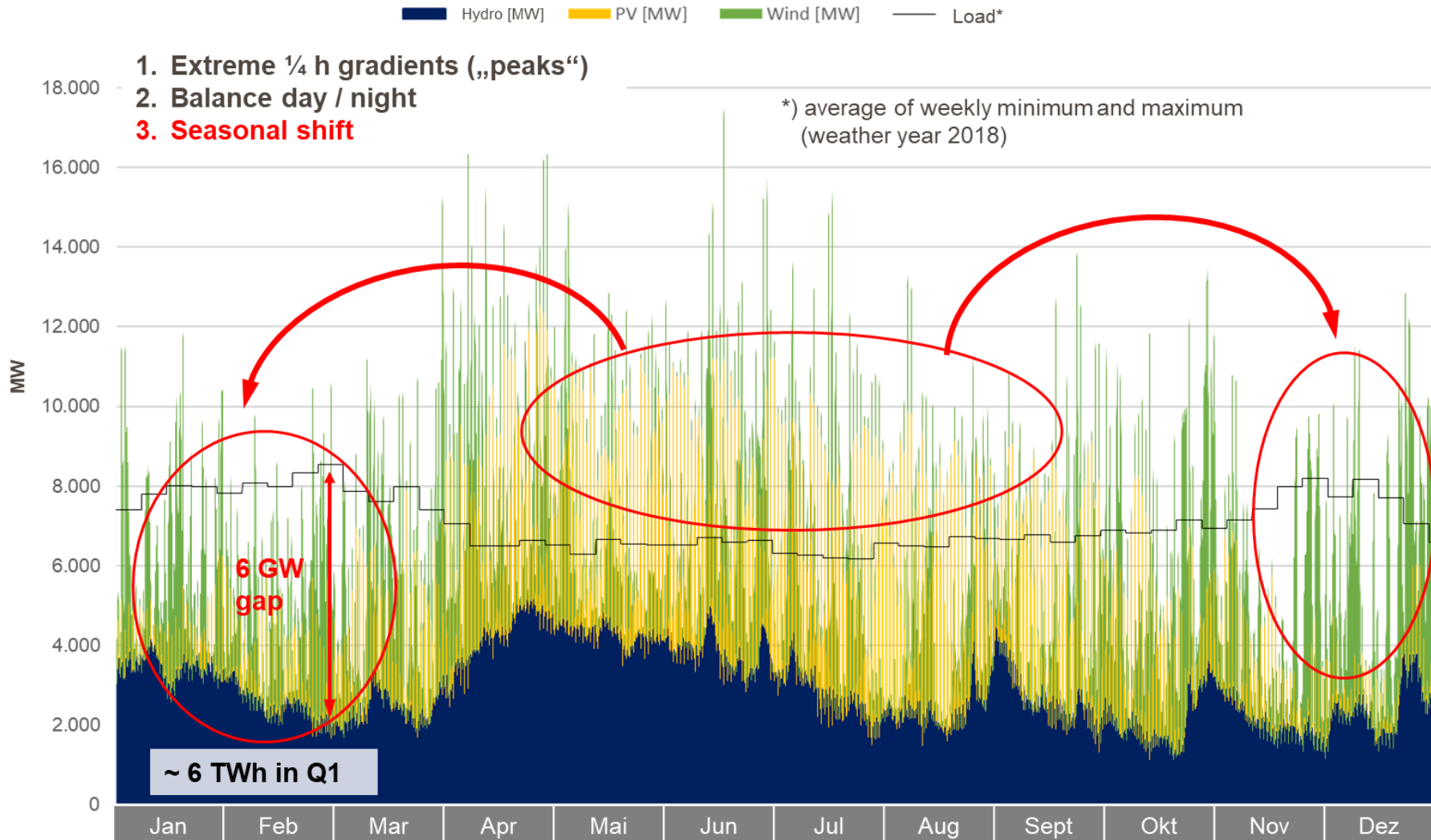
Outlook 2030: 100 % renewables in the electricity sector



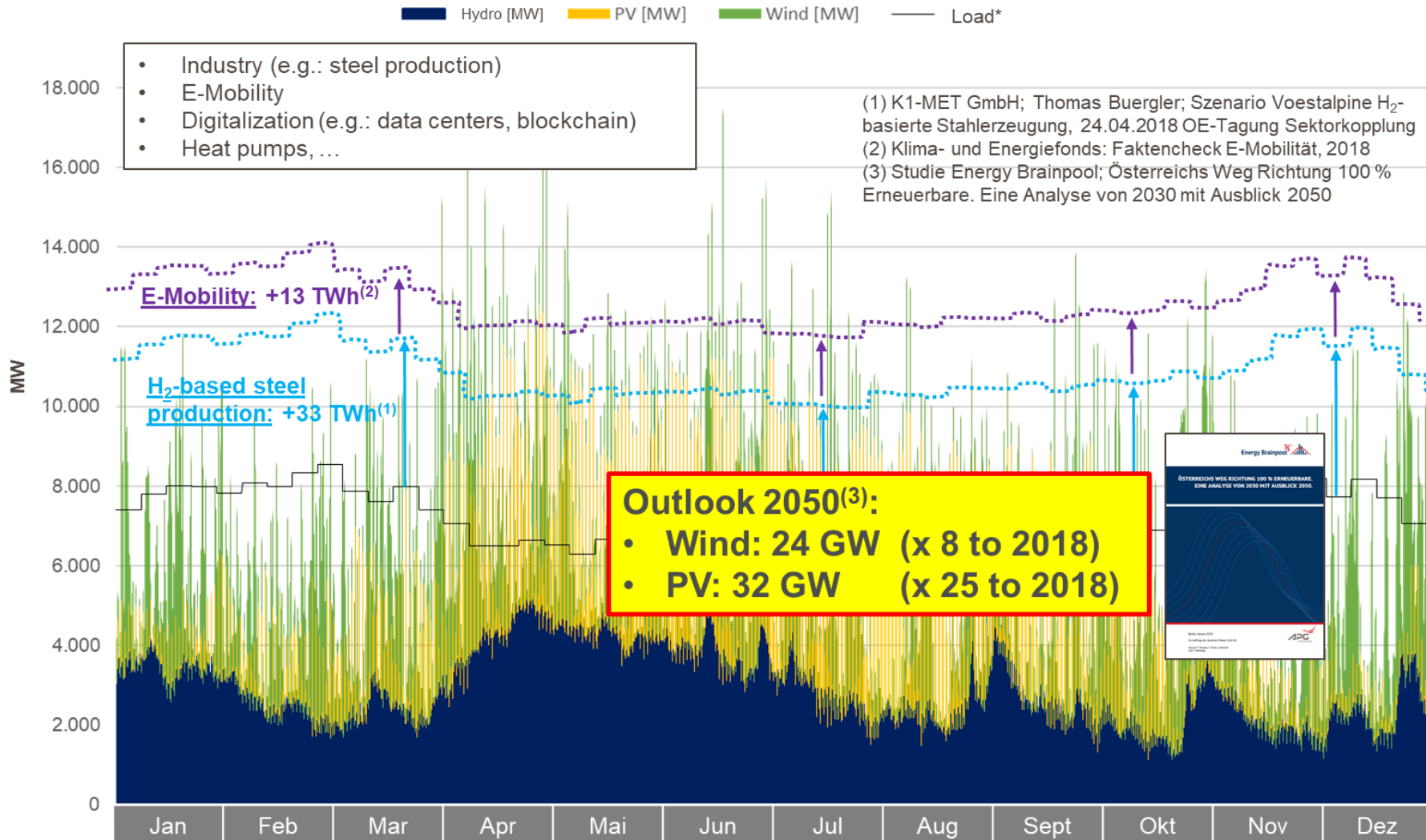
100 % renewables lead to new challenges ...



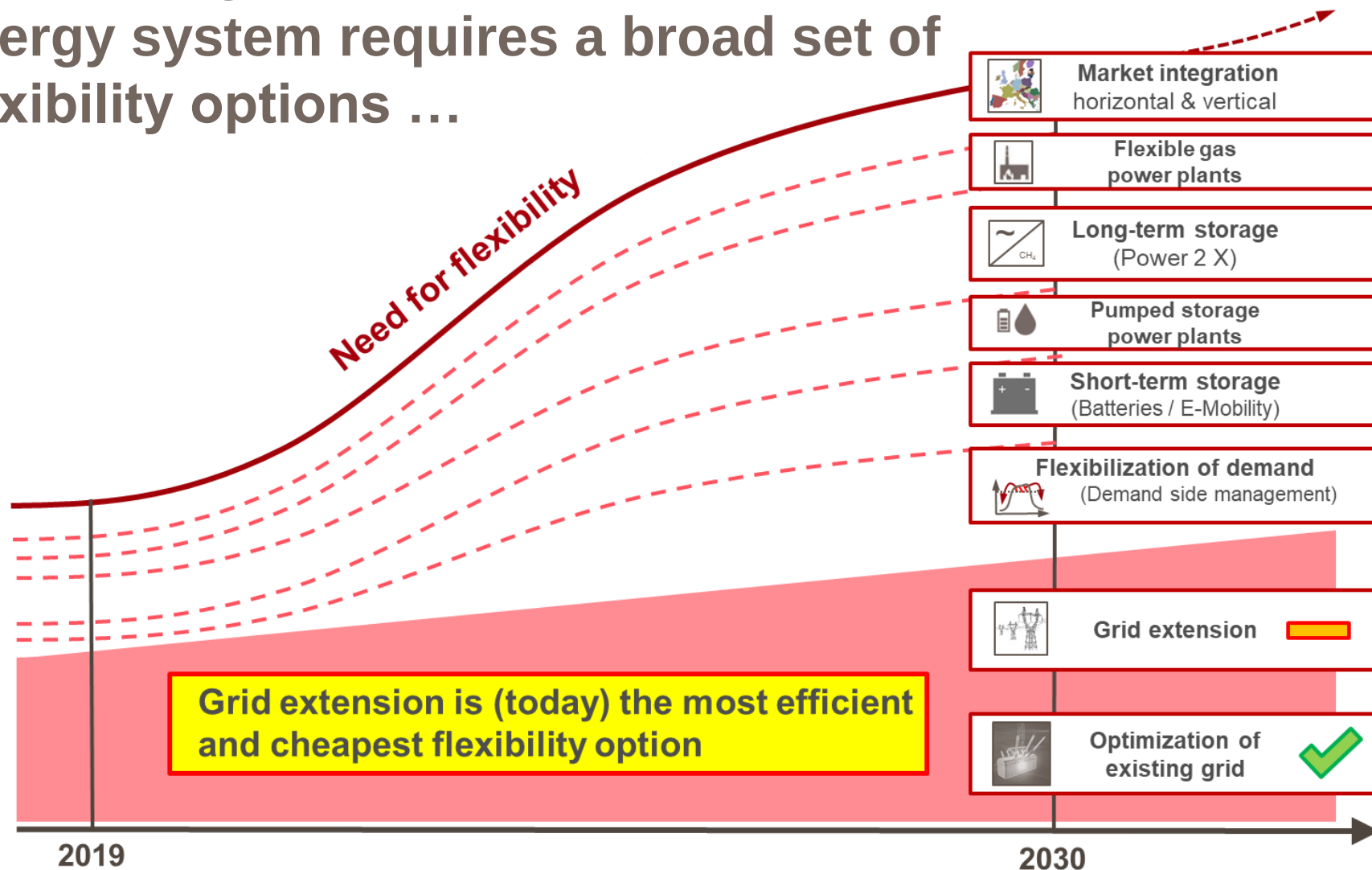
100 % renewables lead to new challenges ...



Decarbonization of the energy system implies increased electricity consumption ...



Succeeding in the transformation of the energy system requires a broad set of flexibility options ...

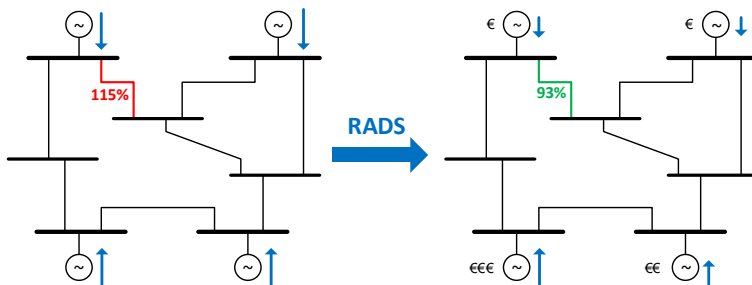


How to ensure grid security?

Equipment	Loading	Scenario
TR42	115%	Scenario 1
TR41	110%	Szenario 2
Line 232	108%	Szenario 3
Line 455	90%	Szenario 4



Redispatch / curtailment

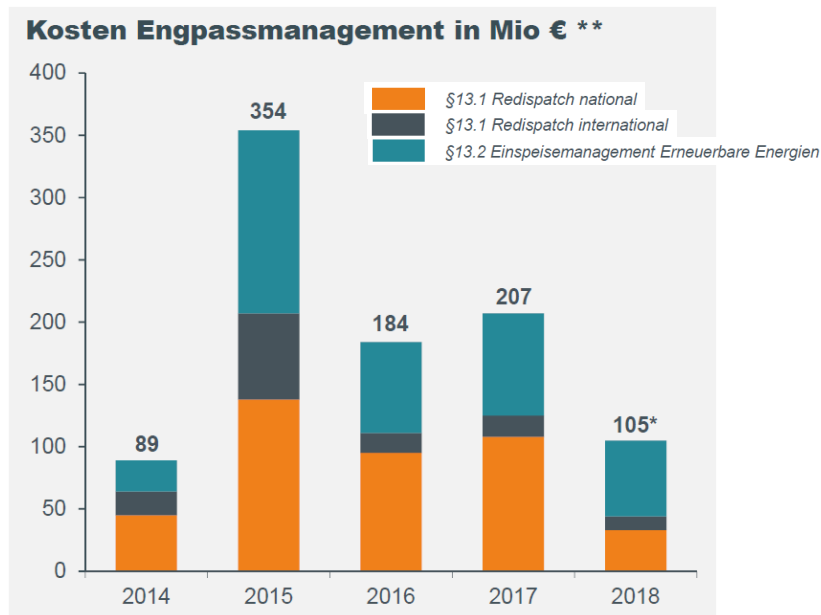


Push the limits of the grid

- Thermal rating for lines
- Digital Load Management for Transformers

Redispatch & curtailment

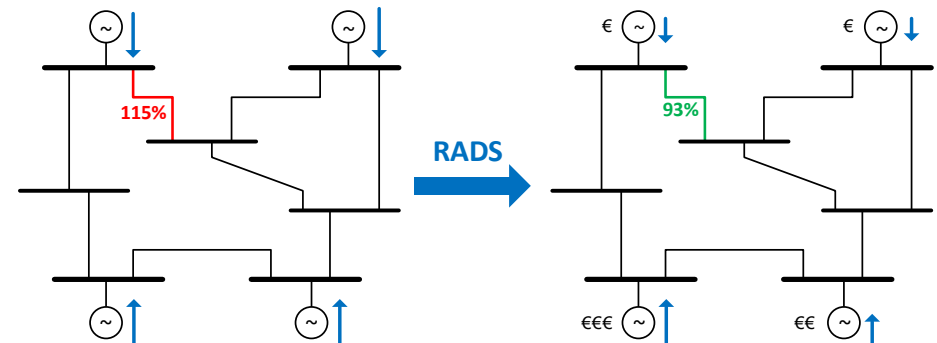
50Hertz (DE) remedial costs



DE in 2018

- 6 TWh curtailment of renewables
- € 800 million curtailment compensation for Wind+PV
- € 1,4 billion total costs of remedial actions

Siemens solution: Remedial Action Dispatching System (RADS)



- Efficiency- and cost-optimised planning of remedial actions
- Support of redispatch actions and curtailment of renewables
- Management and tracking of remedial actions

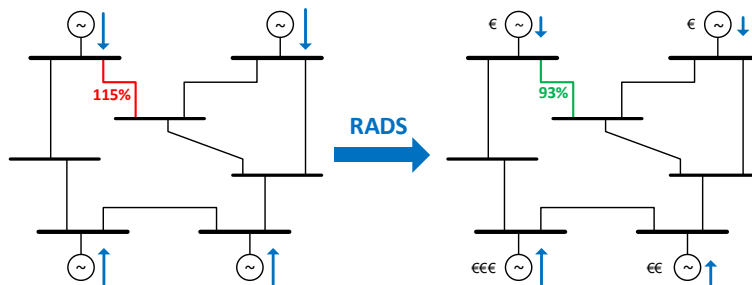
*Vorläufige Daten, Stand 08.01.2019. **Nettokosten, bezogen auf Leistungszeitraum

Source: https://www.50hertz.com/Portals/1/Dokumente/Medien/Pressemitteilungen/20190226_Bilanzpressekonferenz_2018.pdf (17.06.2019)

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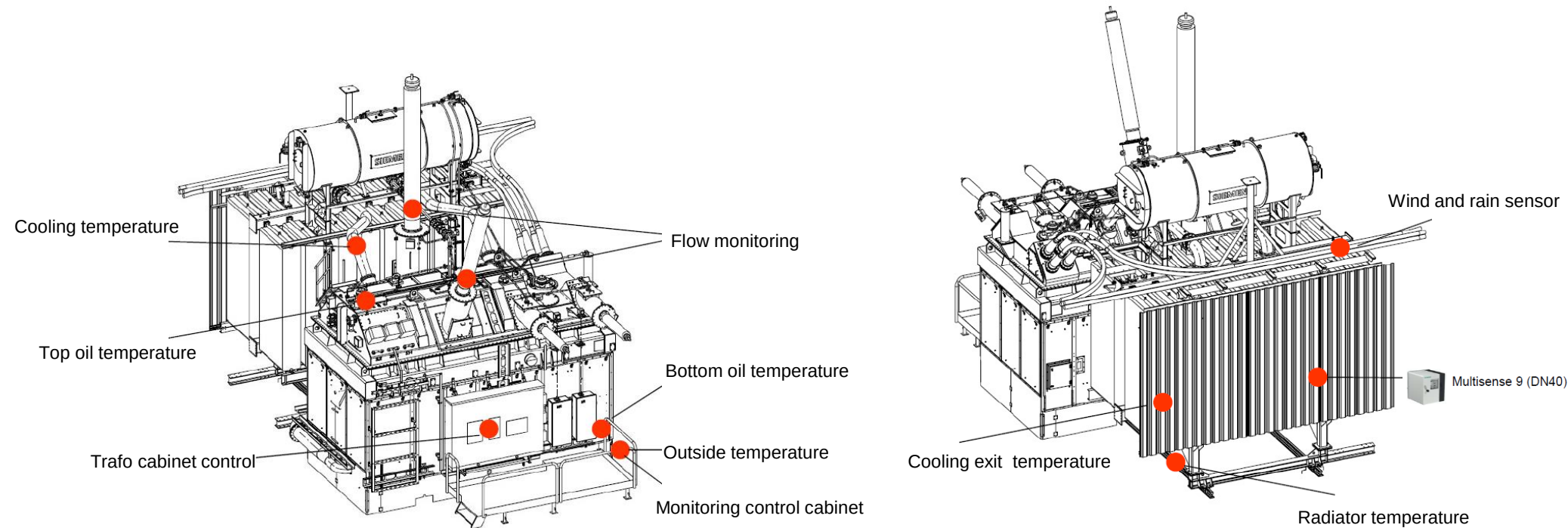
Redispatch / curtailment



Push the limits of the grid

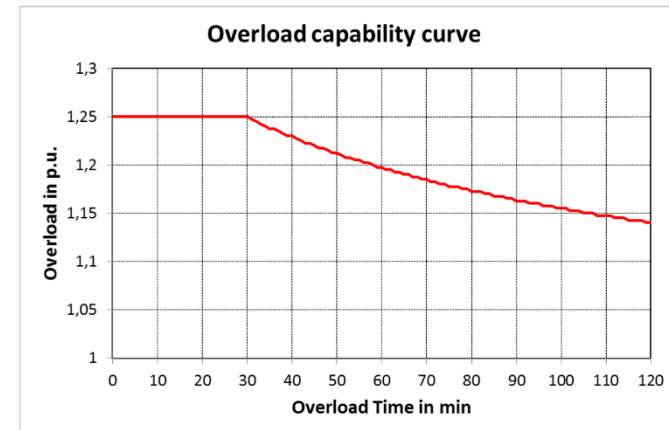
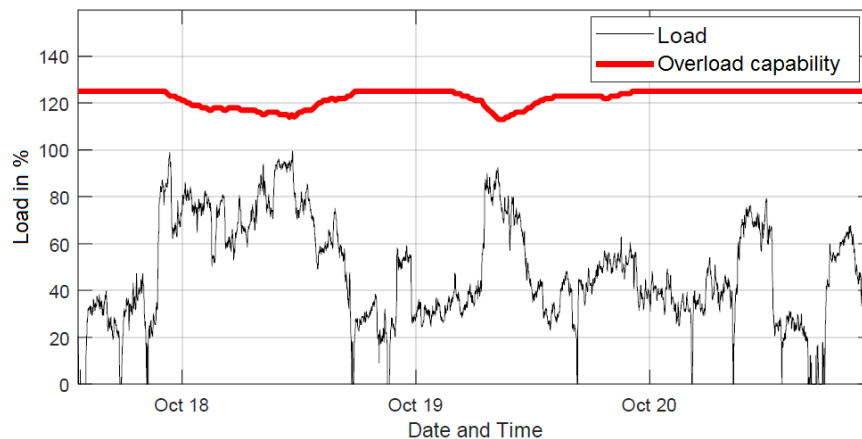
- Thermal rating for lines
- Digital Load Management for Transformers

Create digital twin: Add sensors

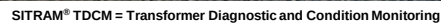


Create digital twin: Refine simulation

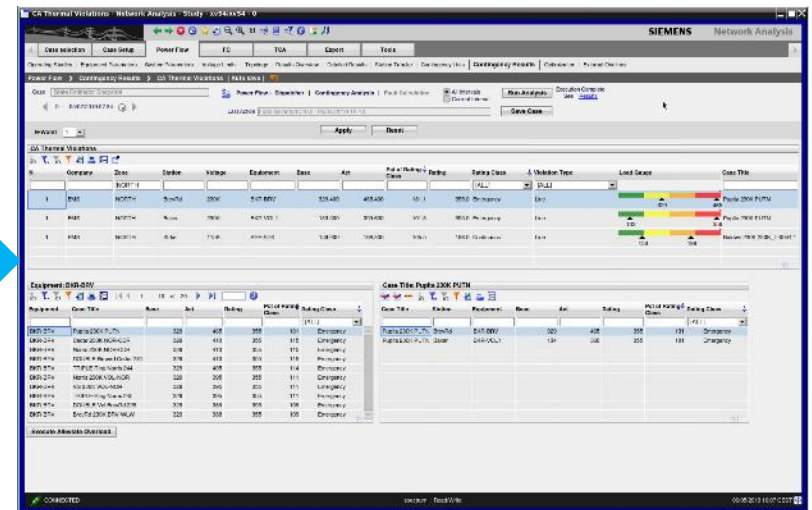
- Refined understanding of
 - the actual overload capability
 - the short & mid term overload capability
 - the effects of active cooling
- Efficient use of the capabilities of the transformers



Transformer



Spectrum Power 4 & 7



Integrated Siemens Systems

Overload capability in SCADA and RT Network Applications

1 Overload capability from digital twin

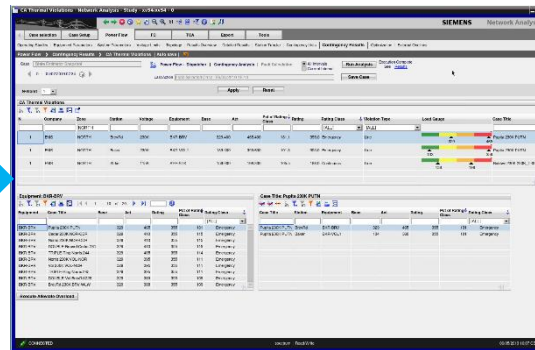
- Based on measurements and refined simulation model

2 Spectrum Power SCADA + NA RT

- Violation checks in SCADA
- Network Applications: SE, PF, CA, OPF, SCS

3 Reduction of redispatch costs

- Fewer violations
- Lower redispatch / curtailment costs



Overload capability in forecast calculations

1 Overload capability forecast

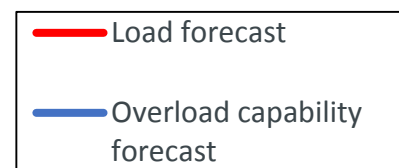
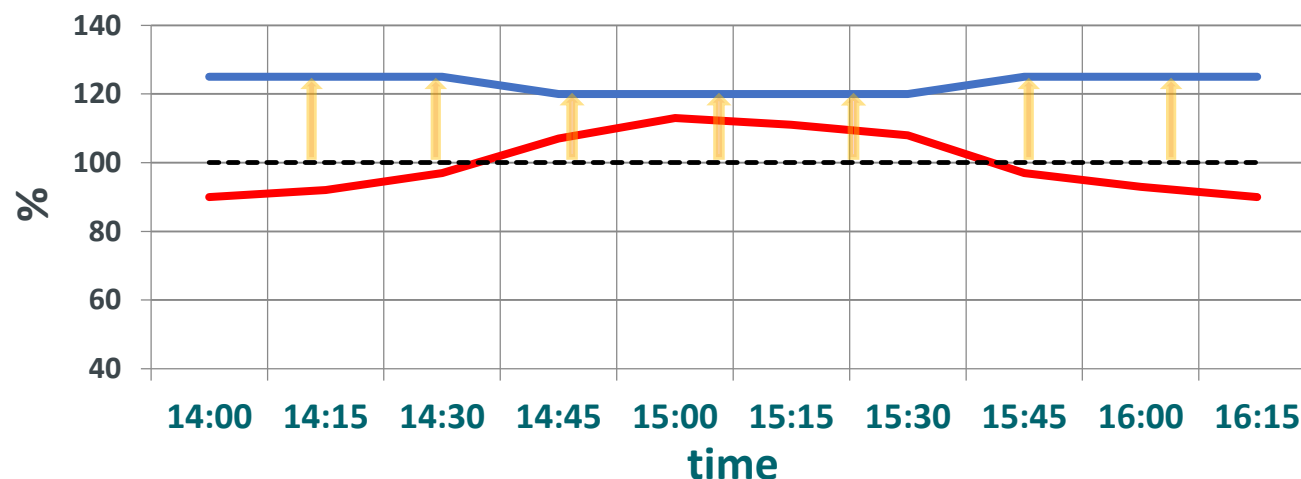
2 Spectrum Power congestion forecast

3 Reduction of redispatch costs

- Based on weather forecast and simulation

- IDCF, DACF, D2CF*

- Fewer violations
- Lower redispatch / curtailment costs



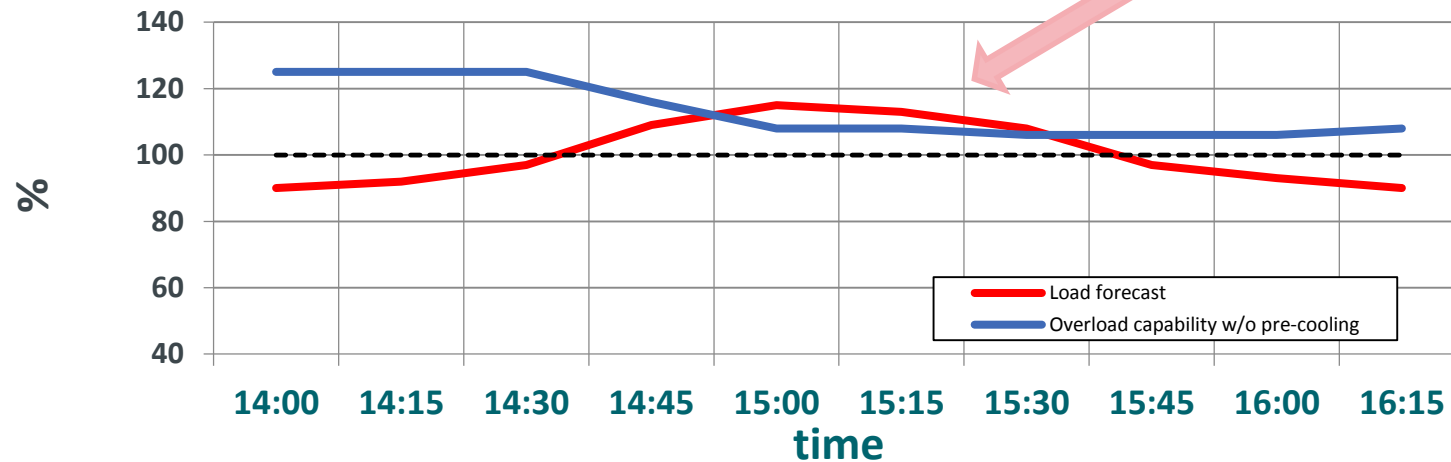
* IDCF = Intraday Congestion Forecast
 DACF = Day Ahead Congestion Forecast
 D2CF= 2 Day Ahead Congestion Forecast

When the capability forecast is not sufficient

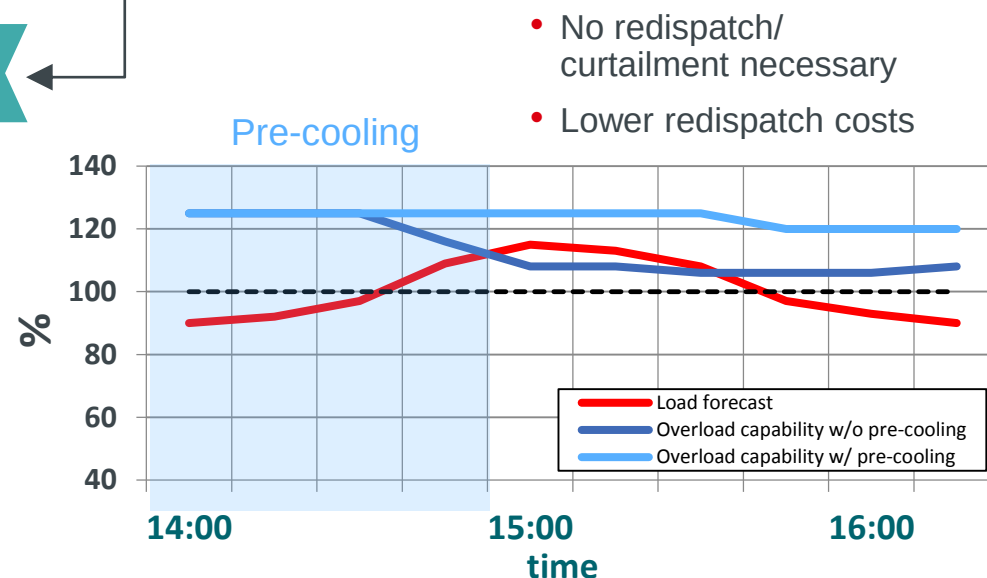
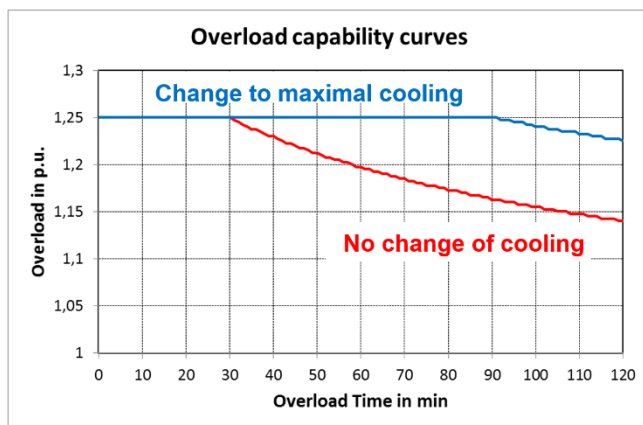
1 Overload capability forecast

2 Spectrum Power congestion forecast

3 (N-1)-violation!

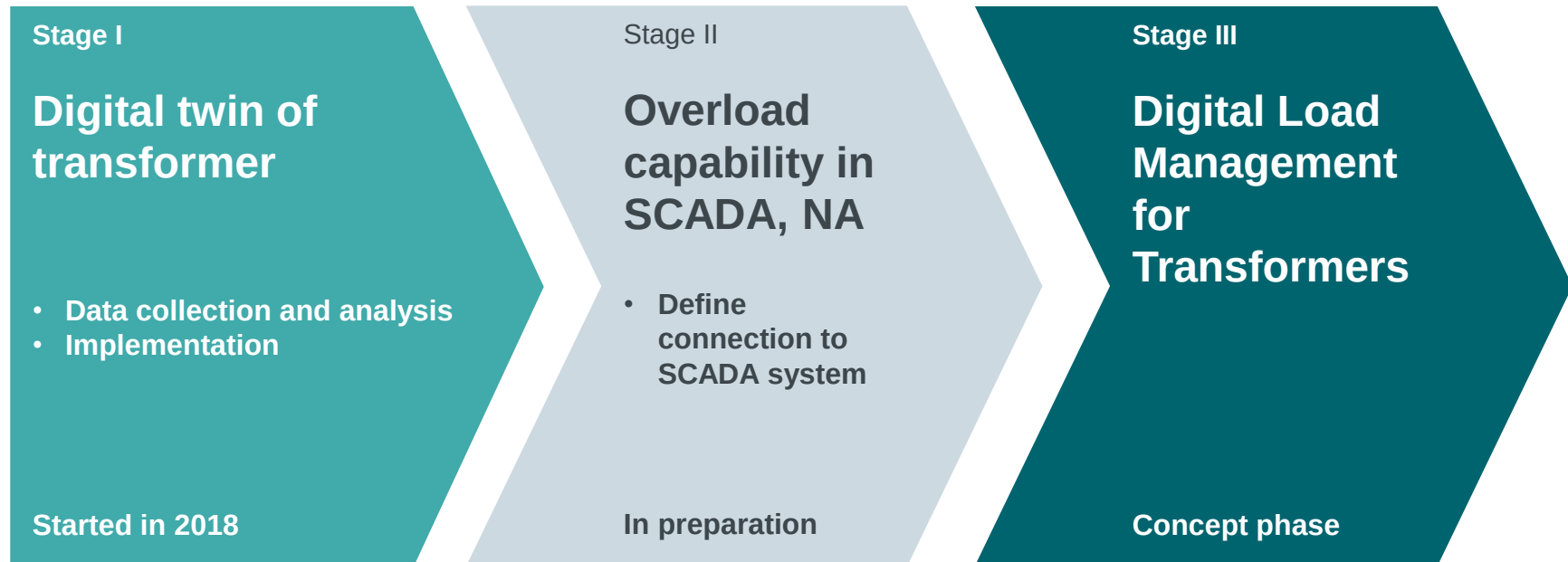


Active Digital Load Management for Transformers



Summary

Support of APG Mission 2030 by Siemens



Thank you!

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