Smart Metering in Germany – A Smart Solution?

Some thoughts to consider

Strommarkttreffen, Berlin, 07.04.2017

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Agenda

A vision of the future - technical challenges of renewable power supply

Smart-Metering – cost-benefit-study

Data security

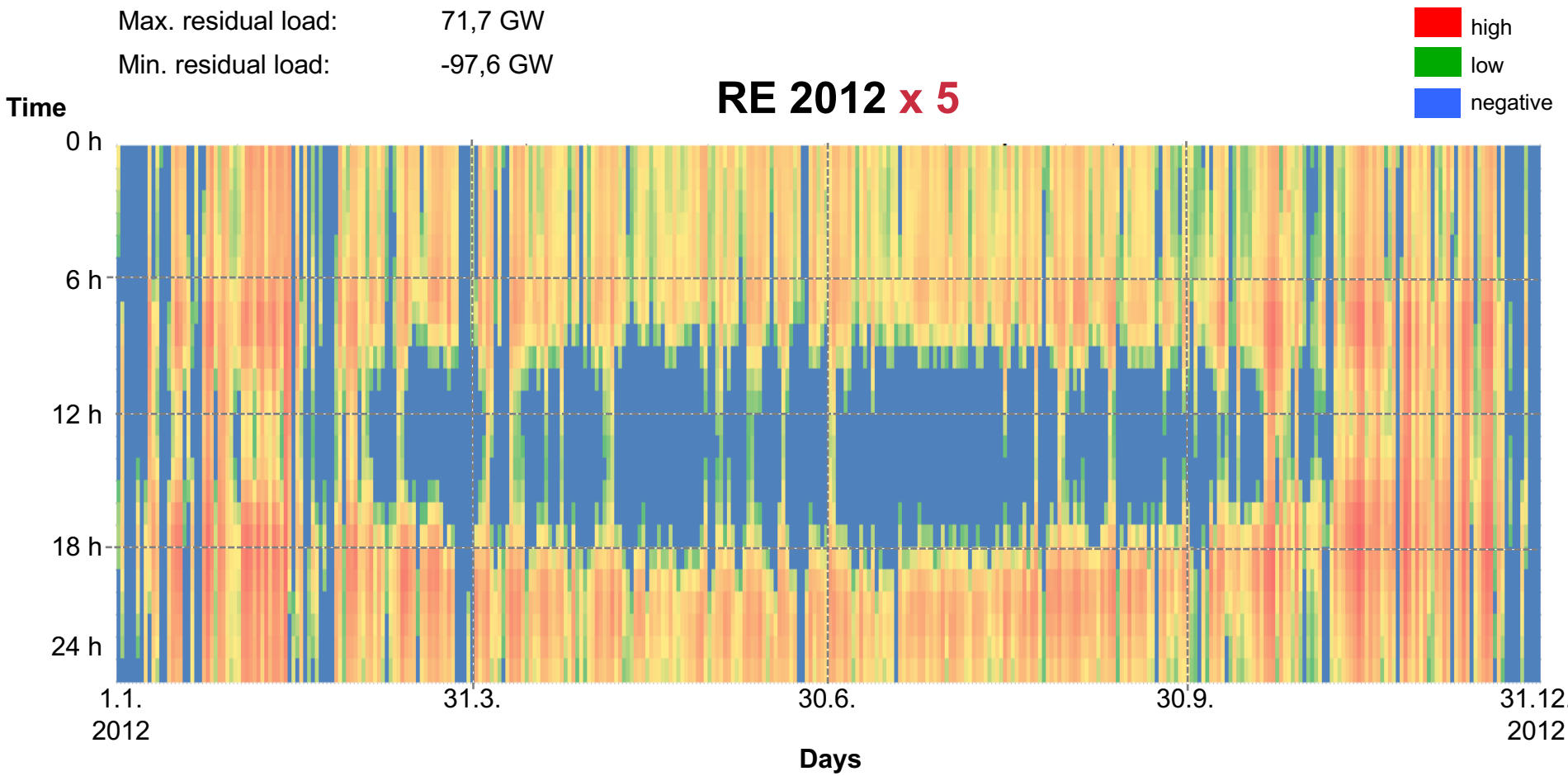
Evaluation

Future residual load in Germany retains above 5.000 hours where renewable production will be insufficient to meet demand

Forecast[1] residual load ~2050

Max. residual load: 71,7 GW

Min. residual load: -97,6 GW



1 Base year 2012, factor 5 represent five times to renewable load of the base year matching current political expansion plans

Source: feed in data ÜNBs, Entso-E, Transparency.eex.com, Analysis Theron

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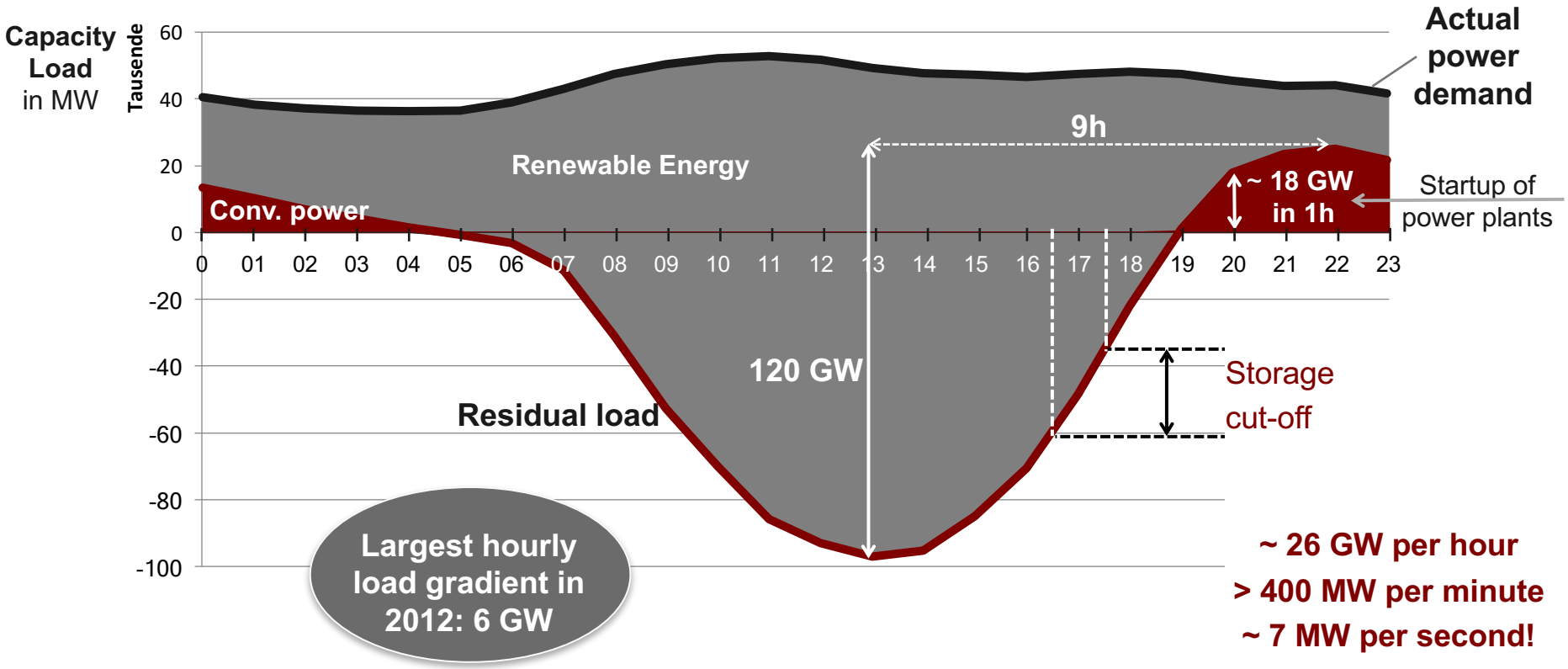
Future grid management will have to deal with significantly higher load gradients which require precise management while under the constraint of the existing grid

LOAD GRADIENTS OF CONVENTIONAL AND RENEWABLE SUPPLY

Extrapolated load development on „June 9th, 2050“



Source: feed in data ÜNBs, Entso-E, Transparency.eex.com, Analysis Theron

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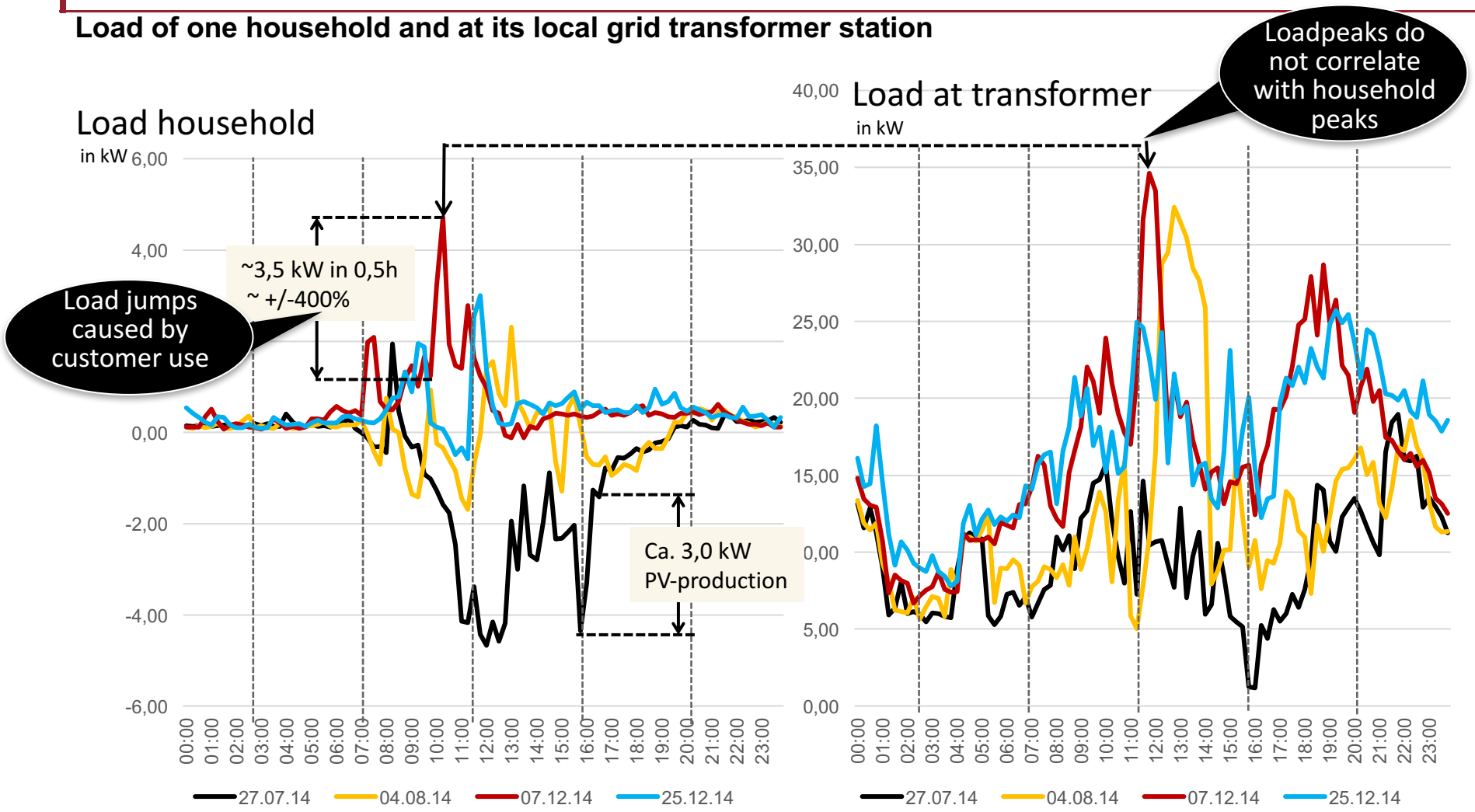
Extreme load fluctuations within a single household do not correspond with local grid load – leading to significant challenges in any central management scheme

Load of one household and at its local grid transformer station



Source: Local measured loads from a specific distribution grid in Germany

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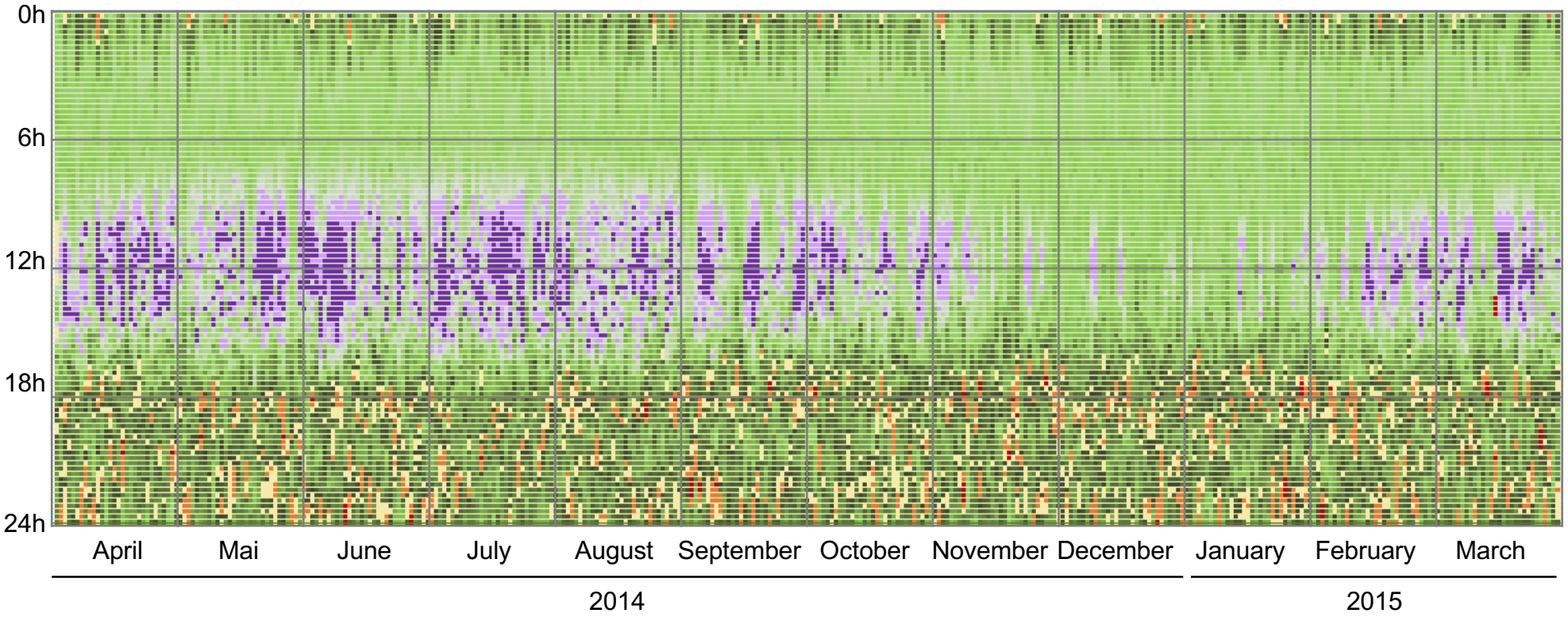
With rising PV installations and growing amounts of EVs, local voltage will surpass acceptable levels in rising amounts of cases

Voltage local distribution grid – unmanaged

12 PV-installations, 12 EVs, grid loop length 740m, 28 households with normal loads



>2.000 events p.a.

>+10%	Lilac dark
+8%-10%	Lilac ligth
	Green gradient
-8%-10%	Yellow
-10-15%	Orange
<-15%	Red

Source: Project MASimBA

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The German cost benefit analyses (CBA) suggested a forced smart-meter roll out with integrated management systems as the only profitable solution

Comparison scenarios E&Y/BMWi cost-benefit-analyses

		EU-scenario	Continuity-scenario	Continuity-scenario +	Rollout	Rollout+
NPV 2016-2032	bn.€	-0,1	-0,6	-1,0	-1,1	1,5
# intelligent measuring-systems 2022 (in %)	mill.	38,5 (80%)	10,9 (23%)	31,6 (66%)	11,9	32,6
Investment measuring systems	bn €	8,5	3,7	6,8	3,9	7,0
Annual operating costs	bn €	12,3	5,2	6,3	5,5	6,7
Costs per measuring system / customer p.a.	€/a	89	109	57	107	58
Operating costs incl. estimated efficiency gains	bn €	5,9	3,1	3,3	3,3	3,3
System cost contribution for all end customers p.a.	€/a	29	14	20	15	21

Source: BMWI (E&Y) Kosten-Nutzen-Analyse für einen flächendeckenden Einsatz intelligenter Zähler 2013; Analyses Theron;

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The only scenario with a positive NPV is very aggressive with its rollout

Key elements of „Scenario Rollout+“

- Until 2022 ~68% of households switched to Smart-Meters (2/3) and measuring systems incl. gateways (1/3)
- 100% penetration until 2029
- Benefit evaluation integrates successful capture of positive cost effects from central direct management of consumer aggregates and renewable production units
- Evaluation limited to 16 years

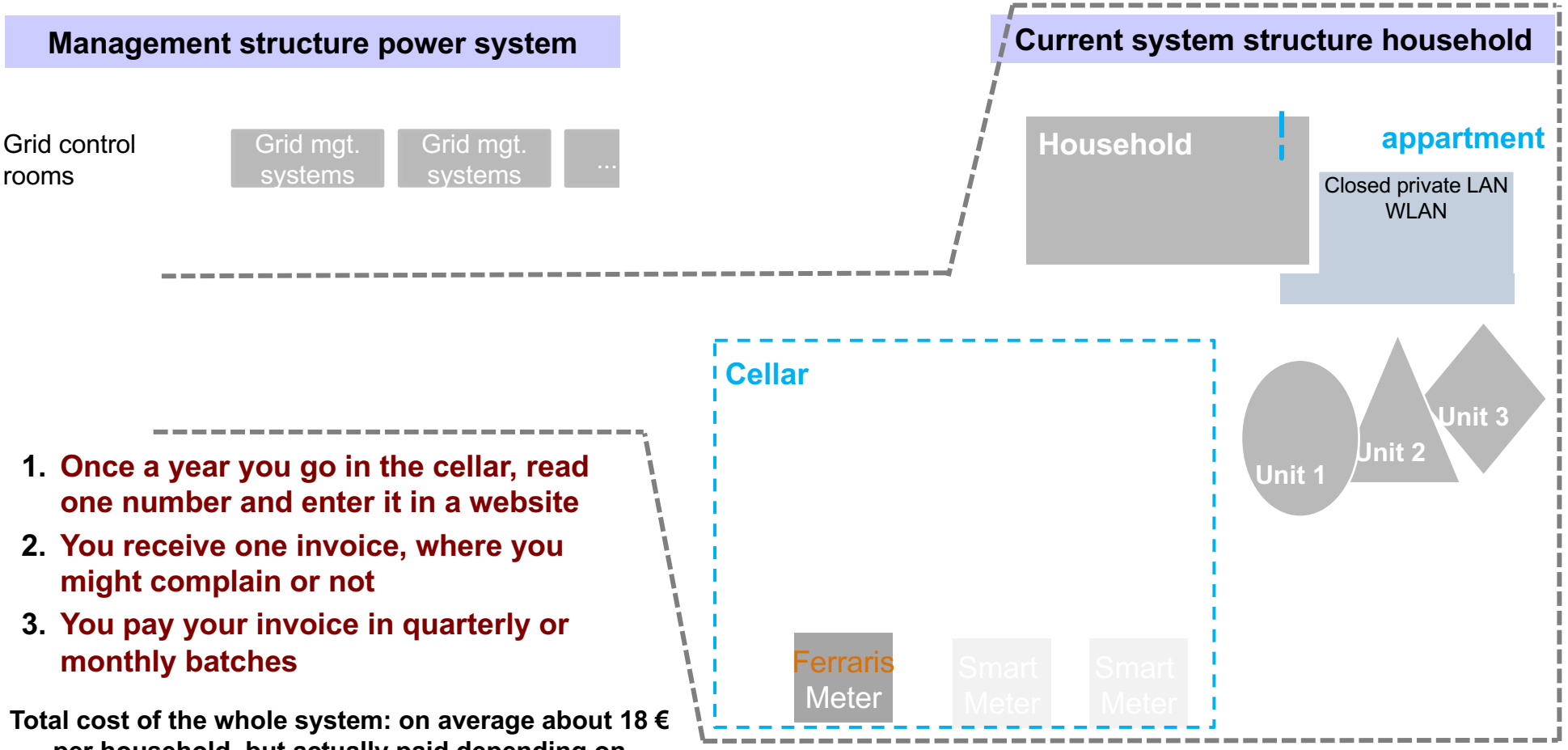
+

The true base case, the status quo without smart meter, was never looked at.

Source: BMWI (E&Y) “Kosten-Nutzen-Analyse für einen flächendeckenden Einsatz intelligenter Zähler 2013”

The current metering system is very cheap

CURRENT METERING STRUCTURE



1. **Once a year you go in the cellar, read one number and enter it in a website**
2. **You receive one invoice, where you might complain or not**
3. **You pay your invoice in quarterly or monthly batches**

Total cost of the whole system: on average about 18 € per household, but actually paid depending on consumption

Source: Theron

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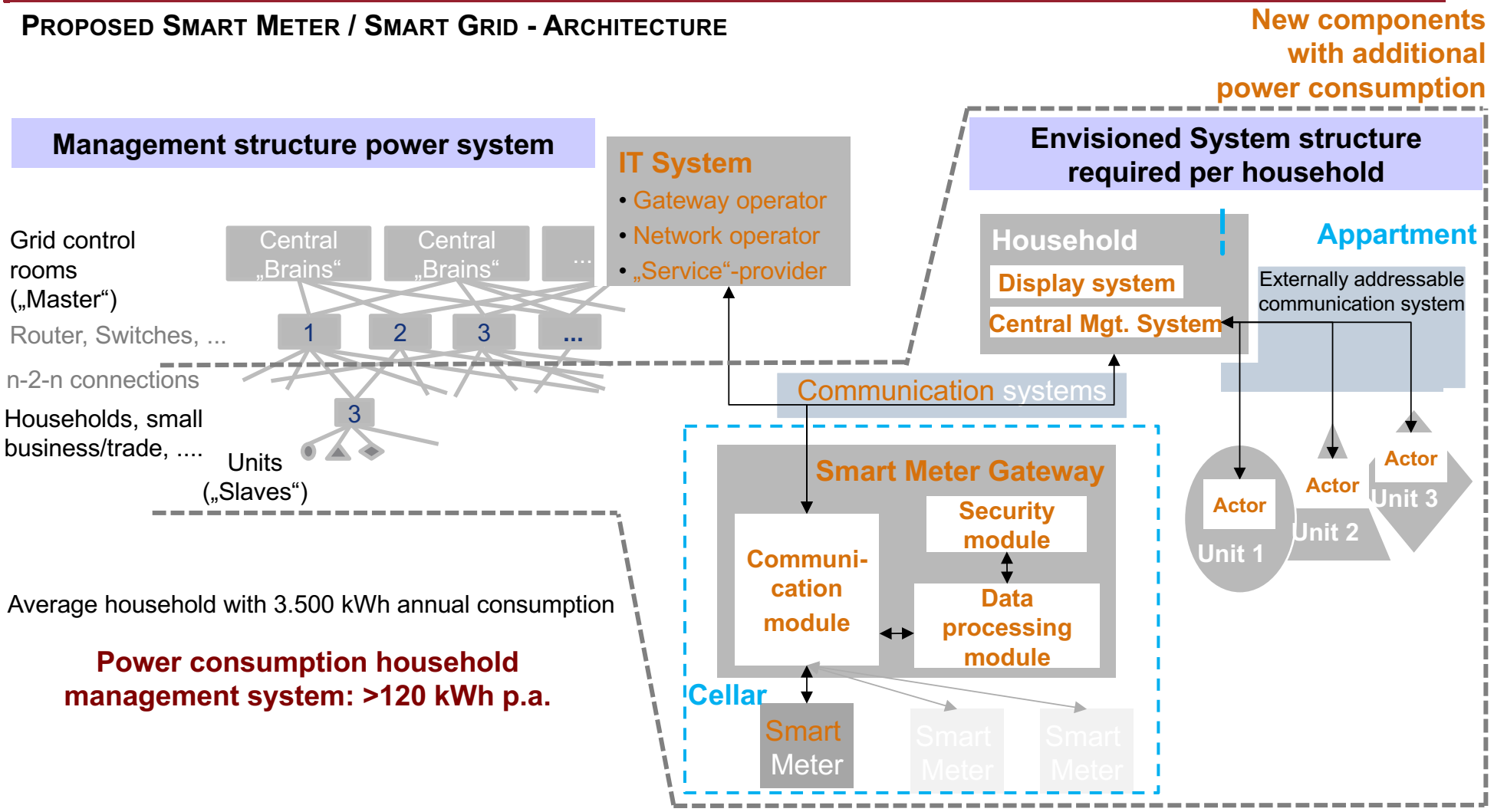
The simple current system is turned into a highly complex system with lots of potential points of failure – and additional power consumption

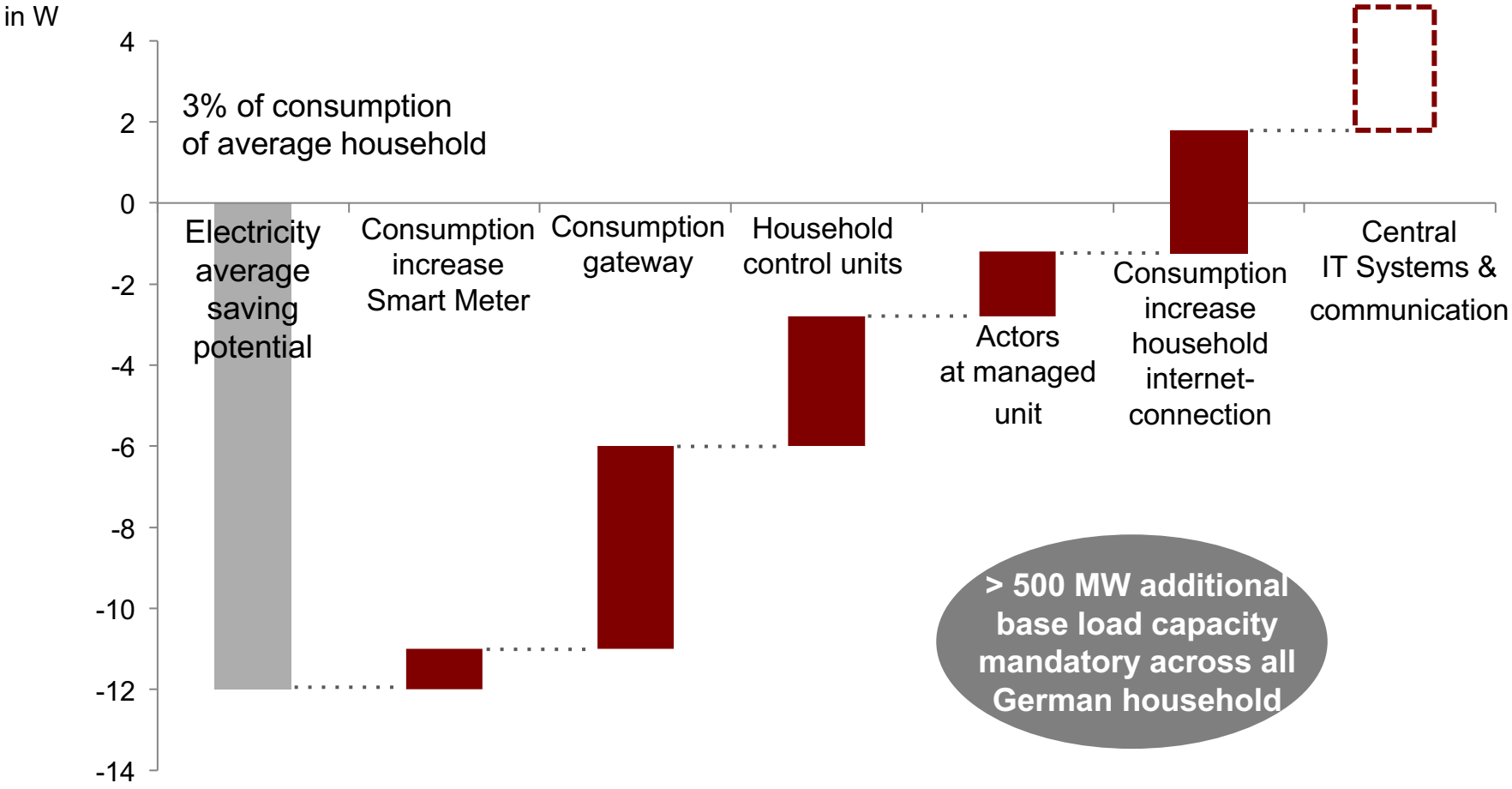
PROPOSED SMART METER / SMART GRID - ARCHITECTURE



Source: CBA Germany, Theron analysis

The proposed management system consumes more power than it is going to save

Evaluation energy savings



Source: Internet, SMART-Metering studies, VKU; KEMA; NPE; Theron

Smart-Meter command twice the price but have a life expectancy of half or less compared to conventional metering systems

Ferraris Meter vs. Smart-Meter

Construction electro mechanical – Expected utilization > 32 years

Ferraris Meter (~30€)

16 years → Additional 16 years → Further extension possible & common

Random sample test OK?

Cost benefit analyses looked only at 16 years

Construction electronics – Expected utilization 8-16 years

Smart-Meter (~50-60€)

8 years → Additional 5-8 years

Random sample test OK?

Statutory forced expansion of the market volume by 300% for manufacturers

Source: E&Y; Theron research

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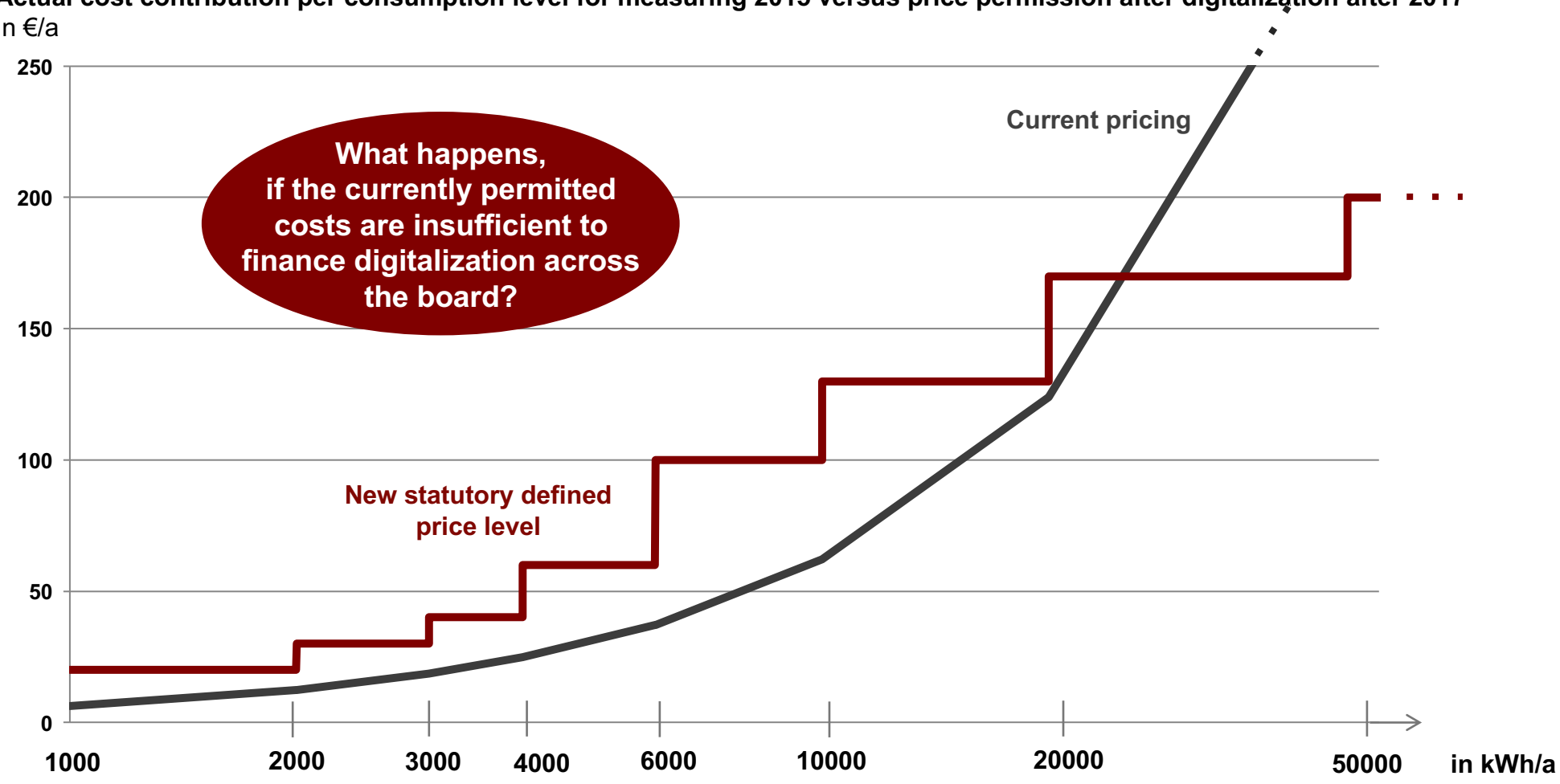
For all normal households the legally defined price levels translate in a massive price increase for measuring electricity consumption

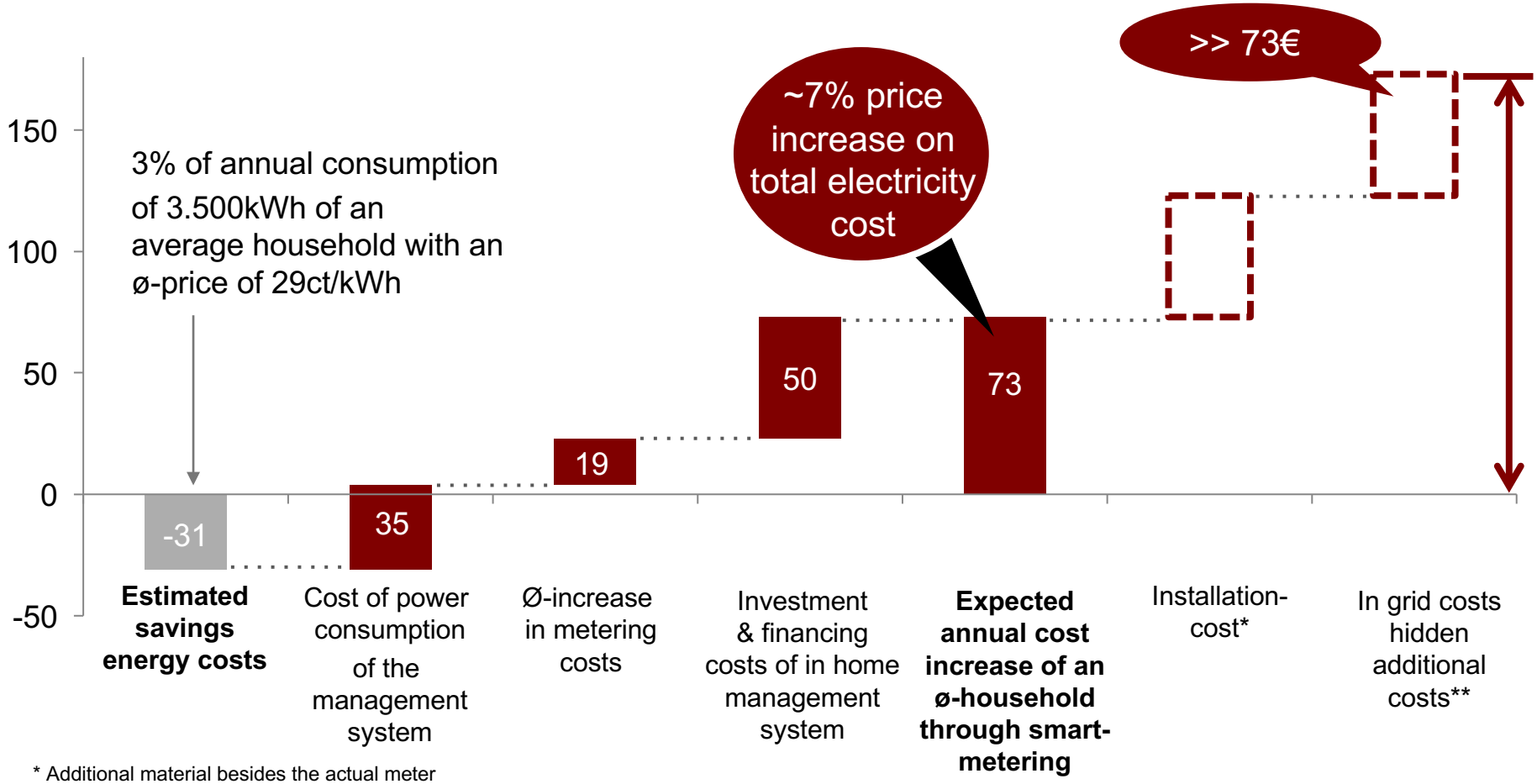
Actual cost contribution per consumption level for measuring 2015 versus price permission after digitalization after 2017



Source: BNetzA Monitoring report electricity 2015; Gesetz zur Digitalisierung der Energiewende

Taking the new digitalization of the energy system law into account there still remains a significant increase in energy costs for each household

Evaluation of resulting cost for an average household with the new energy digitalization law



* Additional material besides the actual meter

** investment and energy consumption of additional communication devices & IT systems

Source: BNetzA; Gesetz zur Digitalisierung der Energiewende; Analyses Theron

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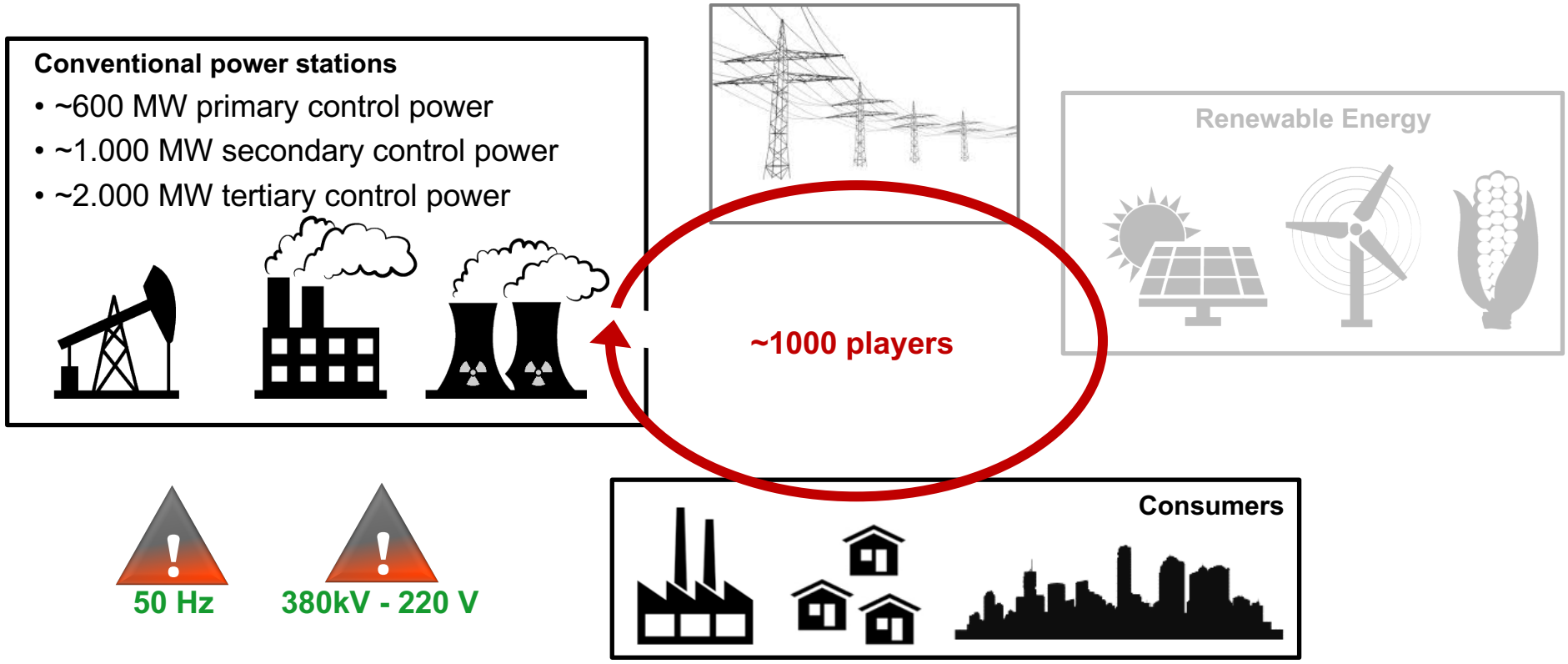
The current energy system is managed with less than 1.000 players involved

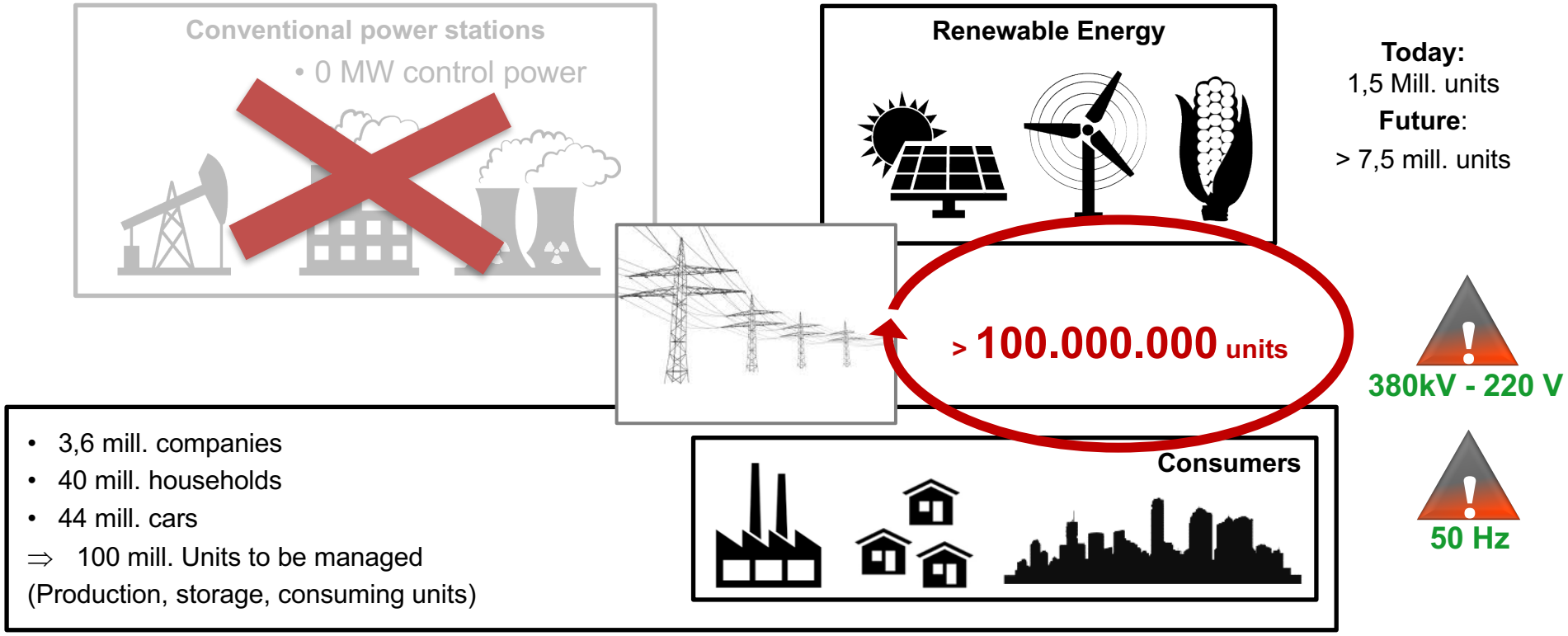
SYSTEM MANAGEMENT TASK – STATUS QUO



Source: Theron

Considering just Germany, the amount of units to be managed will rise above 100 million

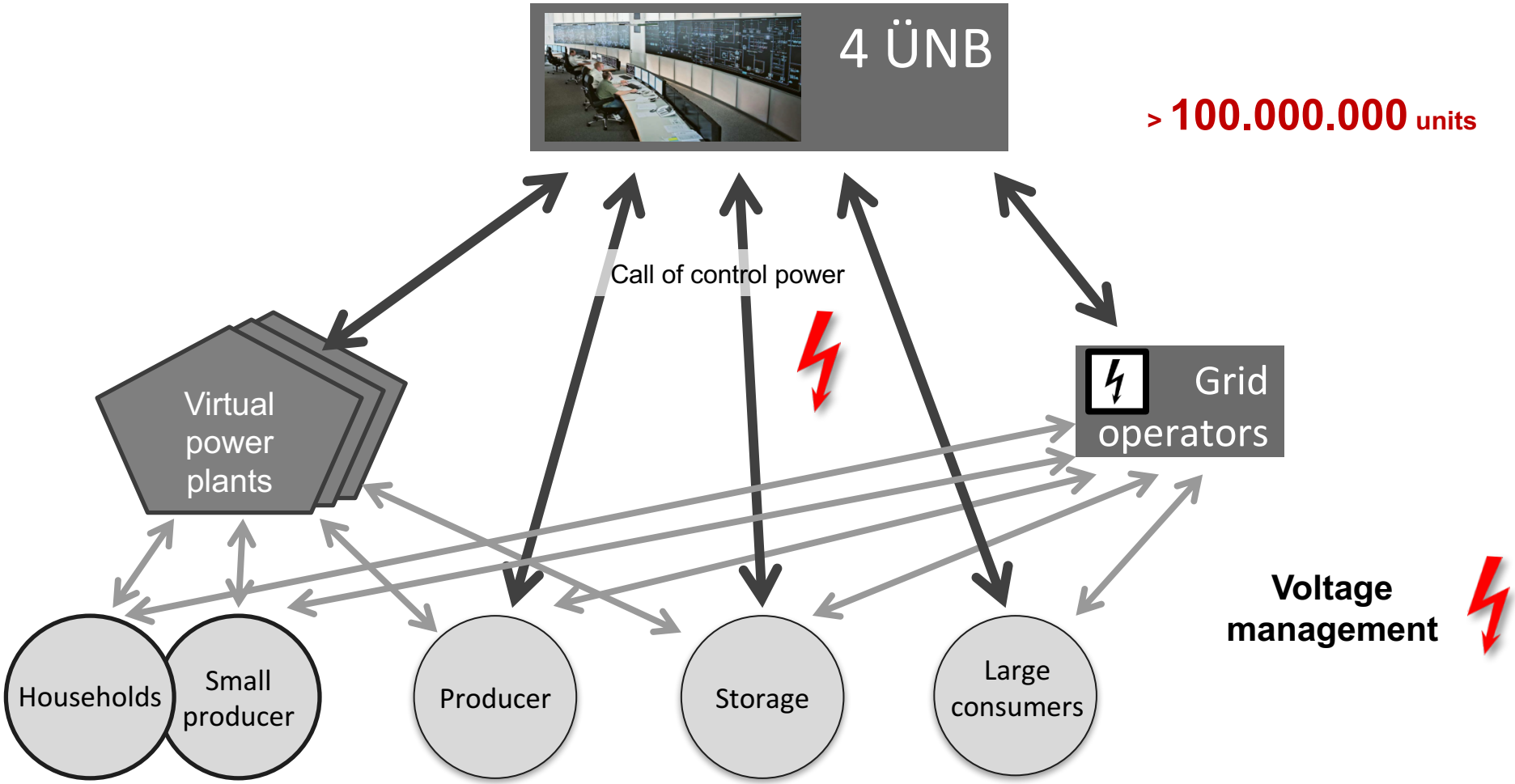
FUTURE SYSTEM MANAGEMENT TASK



Source: Theron

Extension of the hierarchical, central management of every unit

PROPOSED GRID MANAGEMENT APPROACH



Source: Theron

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QUESTION

A good idea?

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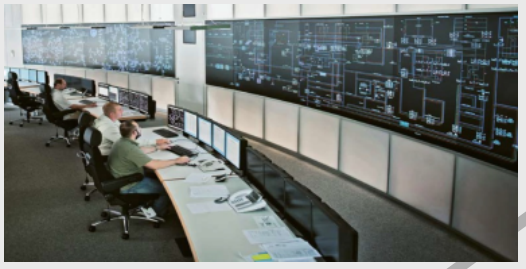
No one would get the idea to manage traffic centrally with each individual car. Why do it in a case of even higher complexity like the power grid?

PROBLEM DIMENSION - COMPLEXITY



Motorized traffic:

Would anyone seriously consider to manage each individual vehicle of the 50 million German motor vehicles from a central control point across German roads?

regate

Aufruf von Regelenergie

Virt
Kraf

gshaltung

Haus-
halte

Kleinst-
erzeuger

Erzeuger

Speicher

Großver-
braucher

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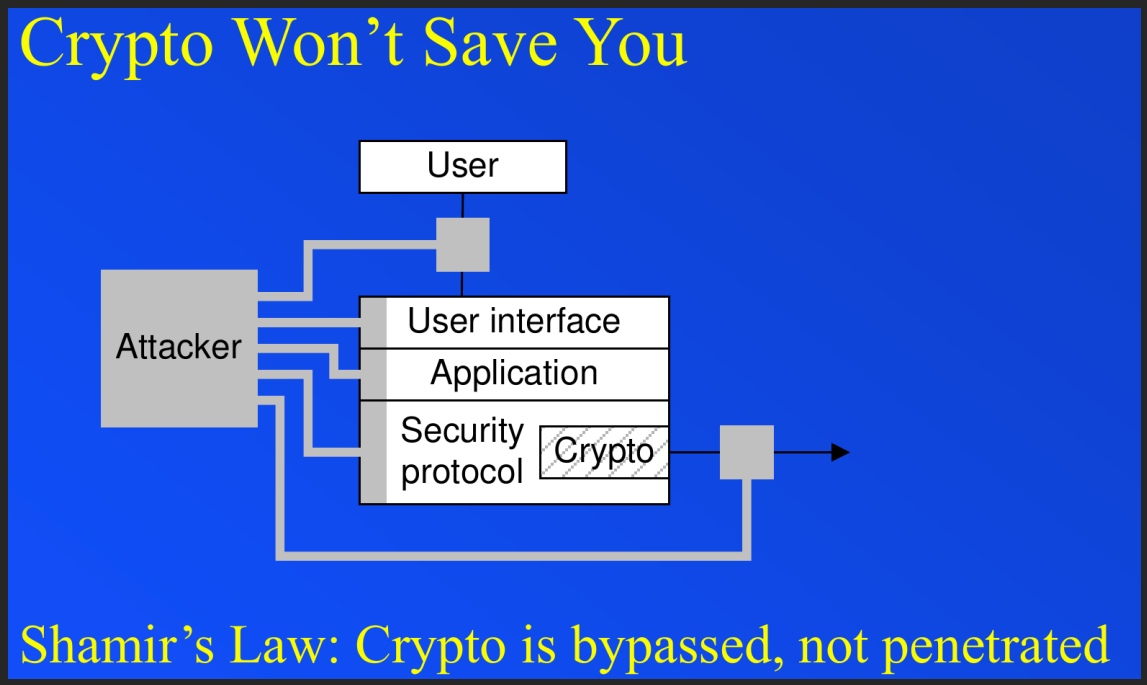
ANY option to break into an IT-system will be used – usually bypassing encryption security measures instead of compromising them

Smart Grid - Security



. Compromised bypassing encryption

- PS3
- Wii
- Xbox (+360)
- Amazon Kindle 2
- HTC Thunderbolt
- Motorola cellphones
- Samsung Galaxy
- Nikon Cameras
- Canon Cameras
- Diaspora
- Google Chromecast TV
- Android code signing
- iPhone/iPad/iOS
- MS WIN RT UEFI + 8 UEFI
- CCC 2011 Badge

. Usage of weak encryption

- Thales
- RSA
- Blackberry
- Certicom (holders of ECC patents)
- Cisco
- GE Healthcare
- Juniper
- Lancope (who only provide EC_DRBG)
- McAfee
- Microsoft
- Mocana
- Openpeak
- OpenSSL (no use - but capable)

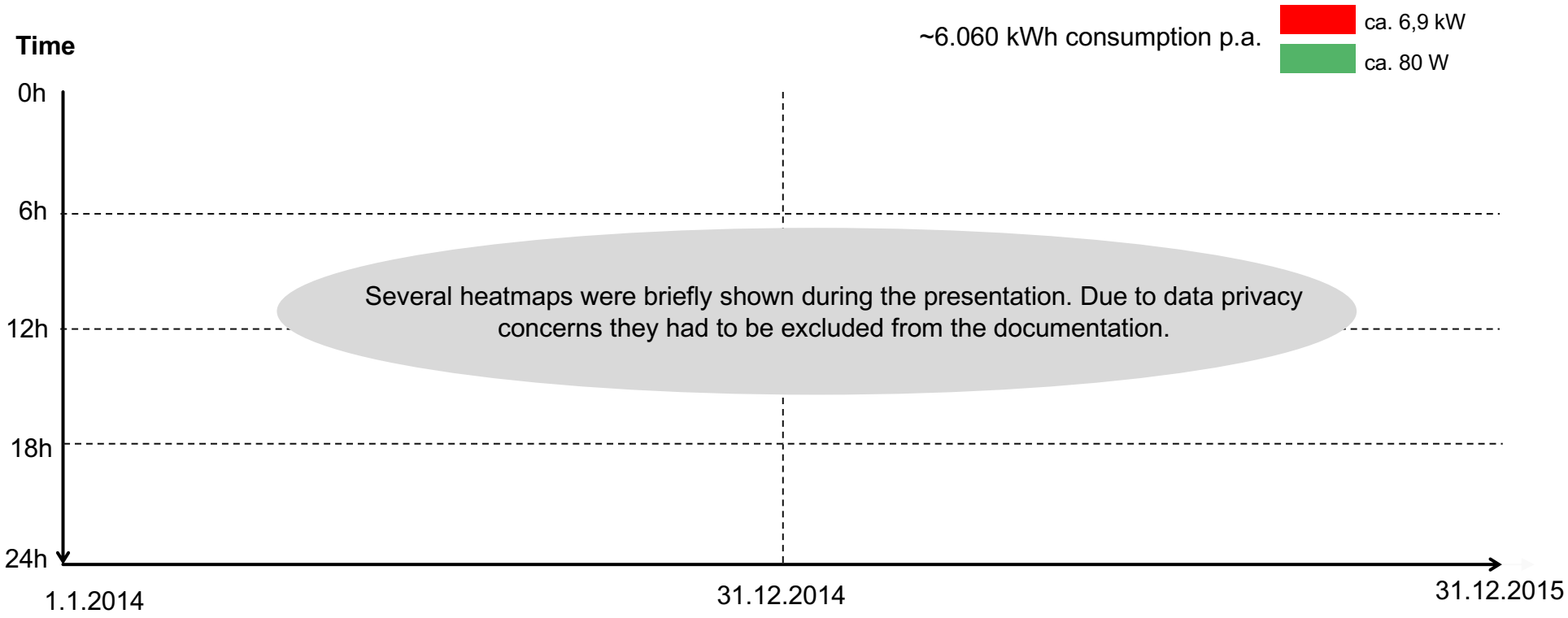
. Bullrun-captured IPsec router software

Cisco, Juniper, Huawei

Source: University of Auckland, 2014, 0955_Perter_Gutman.pdf; Theron; (a 95 page in-depth analyses regarding Network- and Data-Security);

Quarter hours energy value are sufficient to create very detailed personal profiles of individual households

Heatmap of energy consumption of a household A



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Smart-Meter based management of energy grids is a really bad idea – incompatible to the envisioned tasks

Evaluation smart-meter based management approach

Criteria	Smart Meter based (de)central management	
Cost	Investment and operating costs for smart-meter, management systems and actors for devices are significantly higher than status quo	👎
Power consumption	Higher than saving potential by ø-households. Increased base load of management system incompatible to volatile renewable energy supply	👎
Data security	External collection of highly personal data. Safe protection impossible to achieve with existing IT systems	👎
Complexity of management task	Complexity prohibitively high for optimization	👎
Communication load	Danger of overloading the communication grid in any critical power grid situation	👎
Local grid limitations	Even if done locally, for any centralized structure a complexity, communication load and reaction speed problem	👎
Availability	In case of communication network failure no management possible. Current typical reliability of communication networks at 97-99%	👎
Resilience & robustness	None	👎

- **Different & smarter solutions mandatory**
- **Legal enforcement of a none working technical solution is without peers or precedent**

Provocative: A nuclear accident might be better?

The risk

What happens, if a large amount of remote controlled, distributed units is switched on or off simultaneously,
e.g. through a successful cyber attack or mal function/wrong decision of a (de)central management system?

=> Physical damage to the grid is a realistic potential risk…

TAB Report on risks of a large scale power outage in Germany:

„A long lasting (>1 week), large area (one+ federal state) power outage in Germany will in all likelihood lead to the break-down of the society“ (page 3)

“Diese (nationale Katastrophe) wäre selbst durch eine Mobilisierung aller internen und externen Kräfte und Ressourcen nicht »beherrschbar«, allenfalls zu mildern.” (page 27)

Source: TAB Report p.3, **https://www.tab-beim-bundestag.de/de/pdf/publikationen/berichte/TAB-Arbeitsbericht-ab141.pdf**

While smart metering will proof to be a complete failure in the long run, alternative technological solutions are under development

Lessons learned

- Mostly, the right questions are not even being asked
- The real technical-economic challenges of a power system based on fluctuating renewable energy sources and changing demand patterns are not understood
- Smart metering (German version) will aggravate not abate the challenges and risks

- **For consumers smart metering has no benefits, yet they will be forced to use them**
- For some suppliers smart metering is a jackpot multiplying their market potential and/or eliminating price sensitivity of demand through regulatory protective walls

- **There are technical solutions under development, which will solve the technical challenges at a fraction of the cost of smart metering**
- **At current estimate, they will be ready for broad market introduction in 2-3 years**

Source: Theron

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Smart Metering

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