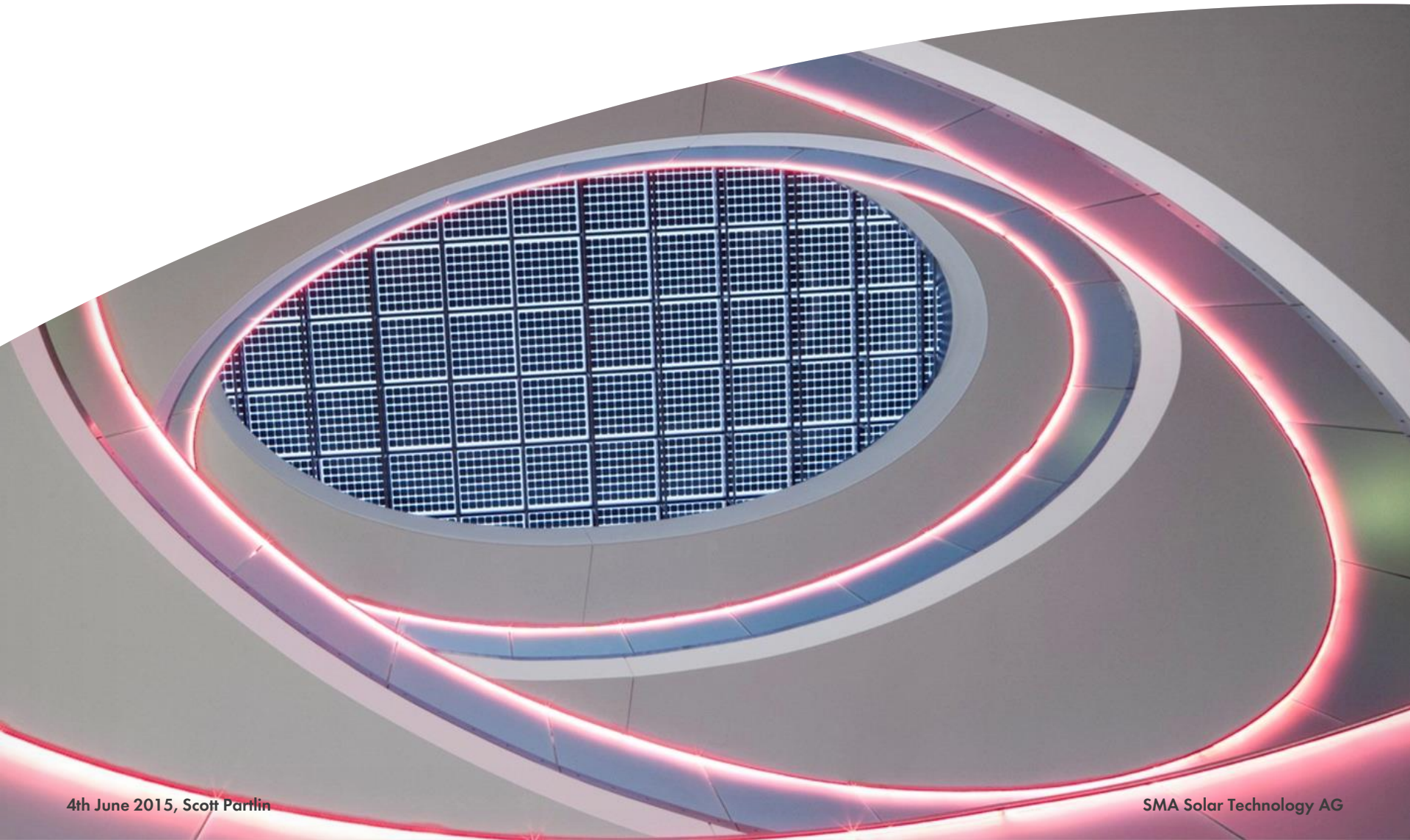
SOLUTIONS FOR ENERGY STORAGE AND MANAGEMENT WITH PV SYSTEMS.



4th June 2015, Scott Partlin

SMA Solar Technology AG

AIM OF THIS PRESENTATION

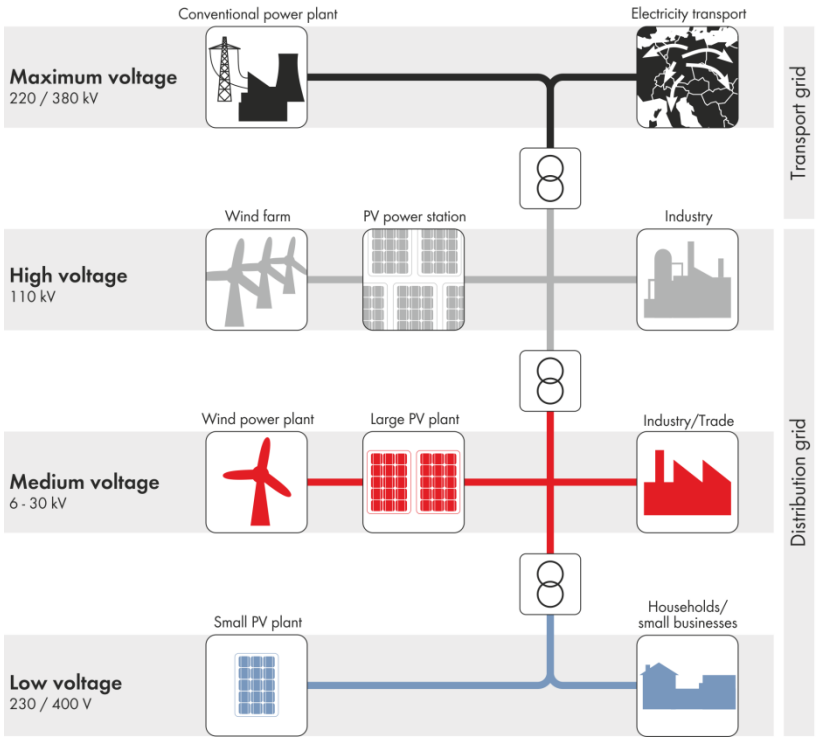
DISCUSSION COVERING

> Energy storage and management at different PV system scales
  - Advantages, disadvantages and challenges
  - What technology and capabilities are required to deliver solutions at those scales
> Importance of SCADA and Modbus/Sunspec to control management
  - Now and in the future
> How are near term market drivers likely to impact storage and its management

> Talk for 15-20 minutes, open for questions & discussion for remainder

> Be “outstanding” and “inspiring”

WHERE CAN STORAGE FIT INTO OUR POWER GRID?



Source: Bundesnetzagentur / Statistisches Bundesamt (Destatis)

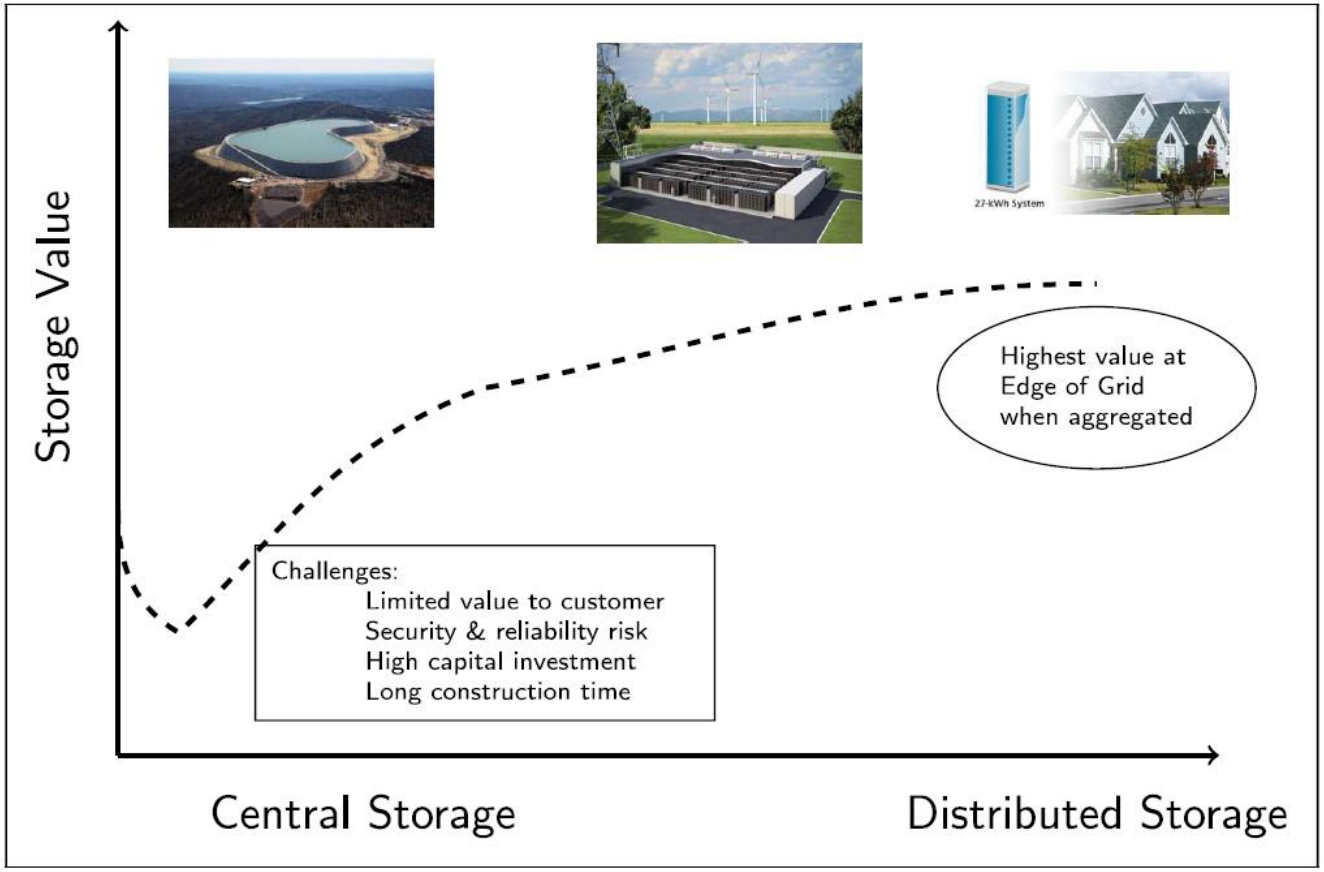
> UTILITY

> COMMERCIAL

> DISTRIBUTION

> RESIDENTIAL

DIFFERENT STORAGE AT DIFFERENT LOCATIONS

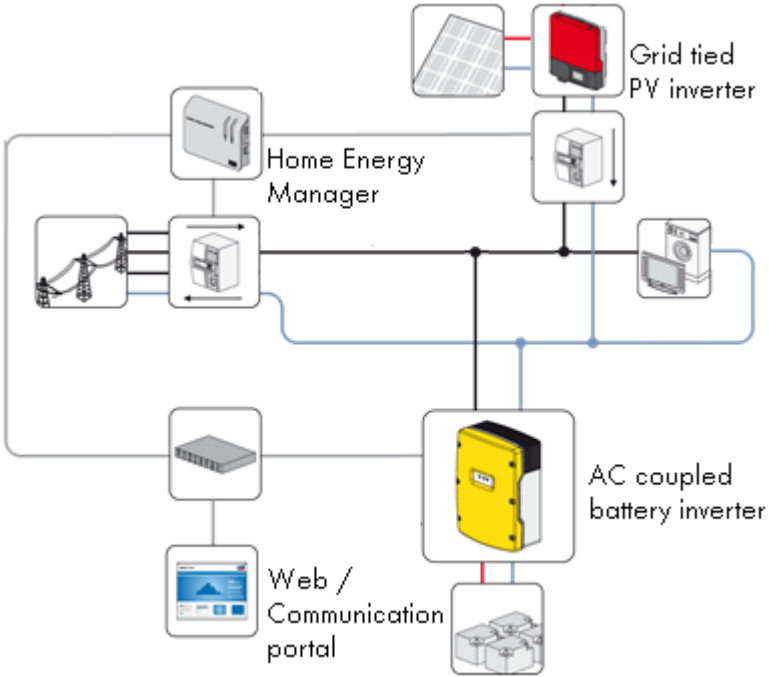


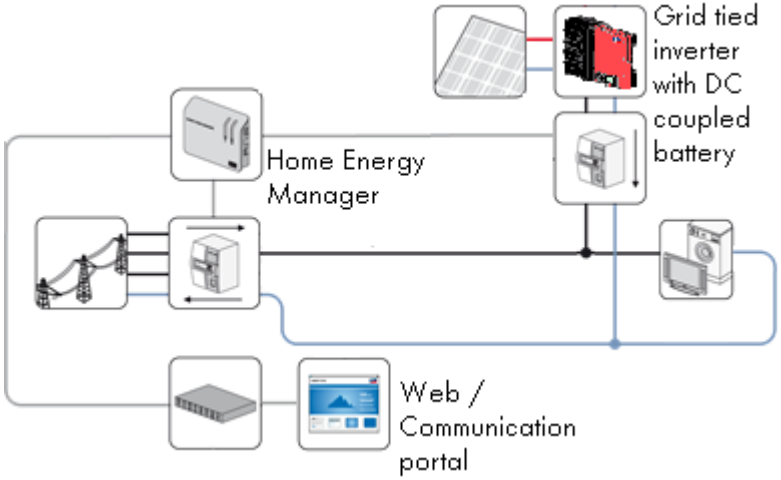
Source: DNV-GL blog: Where is the energy storage market heading and where is the disruptive change? (Part 1)

› The technical and economic value of storage are not always aligned...

RESIDENTIAL STORAGE & MANAGEMENT

- Energy management and PV array optimisation often overlooked
  - Load control OR East-West PV array
- Monitoring of power and energy flows are essential
- Storage integrated or separated, DC or AC coupled
- Control of storage managed ON-SITE
  - Manual or Automated
  - Increased self-consumption; Tariff optimisation; capacity reduction





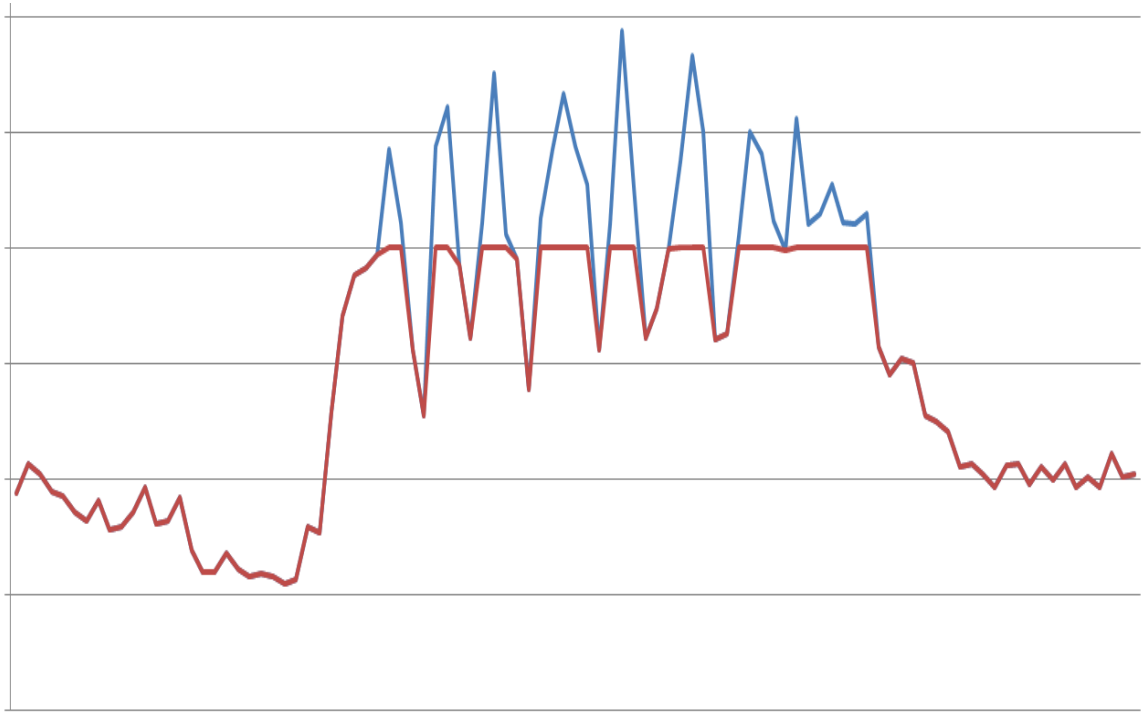
COMMERCIAL STORAGE AND MANAGEMENT

> Main driver for commercial is not energy, but capacity and quality

- Measurement on-site essential
- On-site measurement and control via the system (system specific TCP/IP most likely)
- Size does not need to be overly large

> Space is more of an issue for commercial operation

- Floor space costs, plus there are different HSE requirements
- Ability to disconnect and move asset more desirable



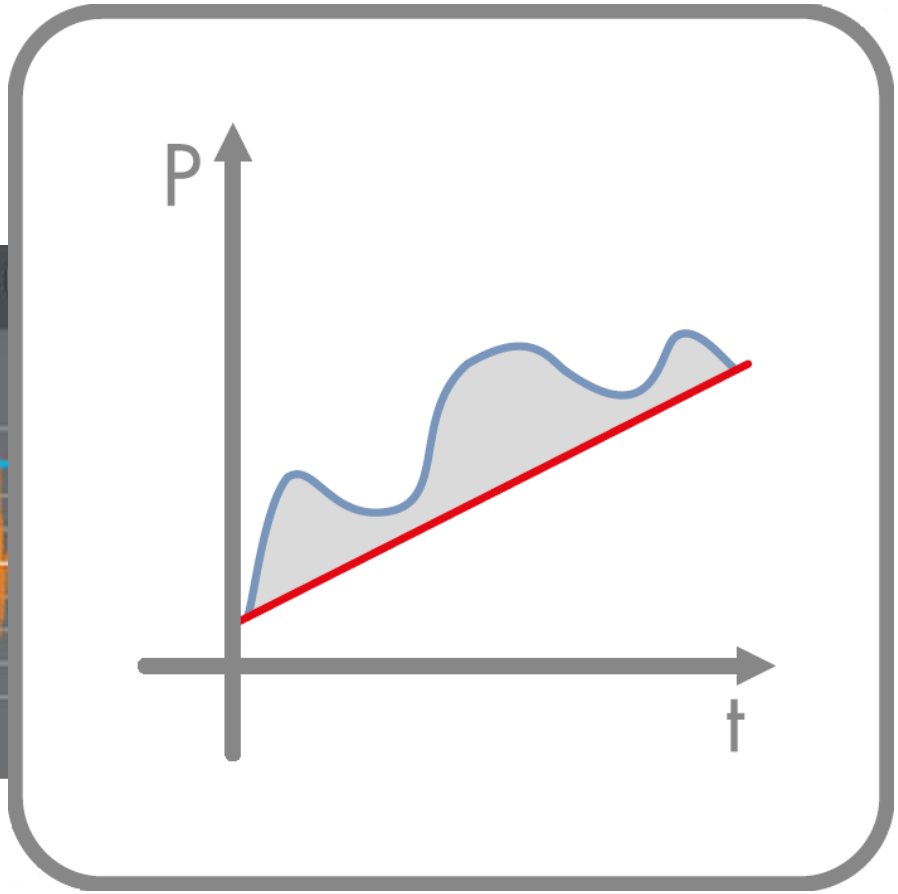
> **Commercial operations are more likely to invest on the basis of a financial case for storage**

UTILITY STORAGE AND MANAGEMENT

> Ramp control, Spinning Reserve & Black Start, Frequency Regulation

> Control managed centrally via utility

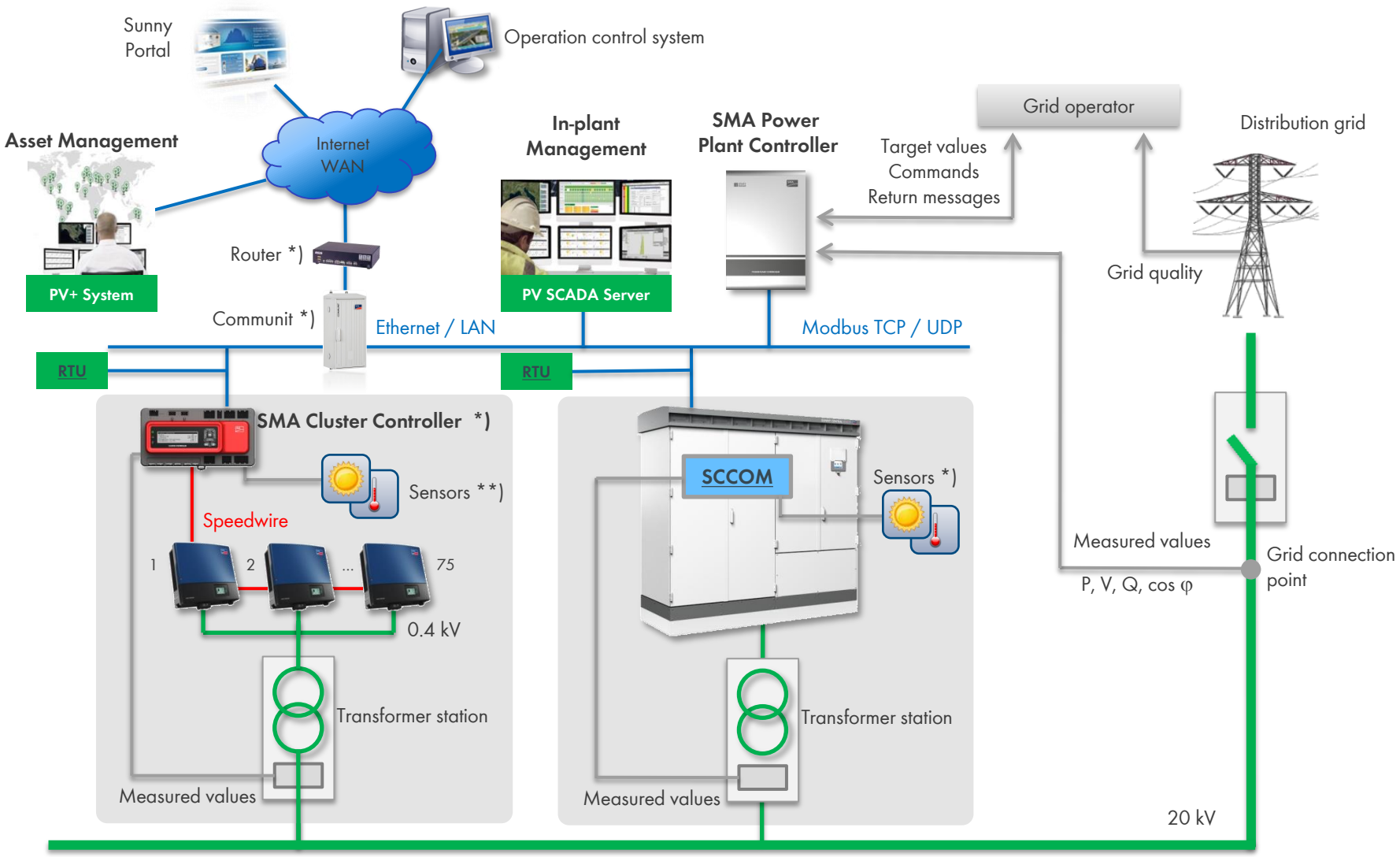
- Via existing SCADA networks



Ecoult Grid Ancillary Service Solutions

> **Until prices reduce greatly, utility scale storage for large energy demand is unlikely**

SCADA FOR PV PLANTS (EXAMPLE)
WITH OR WITHOUT STORAGE, THE SOLUTION IS THE SAME



*) Integrated into the COMMUNIT **) temperature sensor PT100/PT1000; irradiation sensor with current output 0...20mA; ***) Meteo station compatible with Sunspecs Alliance profile

SCADA AND MODBUS (SunSpec)

> Supervisory Control And Data Acquisition (SCADA)

- To efficiently control and monitor requires standardisation
- All plants (large and small) will likely need to be integrated into future SCADA for the management of distributed energy generation and storage

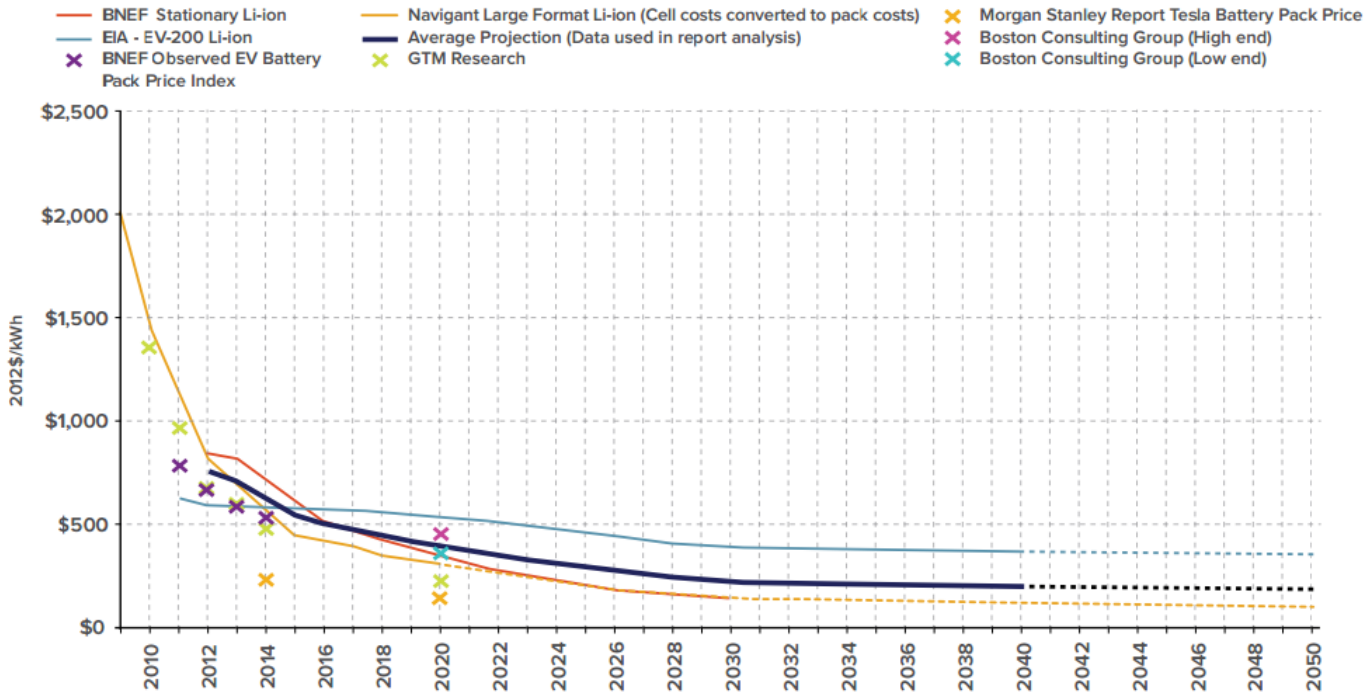
> SunsSpec is the best attempt to date achieve standardisation of Modbus

SUNSPEC ALLIANCE

> **Developing hardware around SunSpec makes the solution inverter agnostic, better for business and better for the grid**

MARKET DRIVERS: BATTERY PRICES

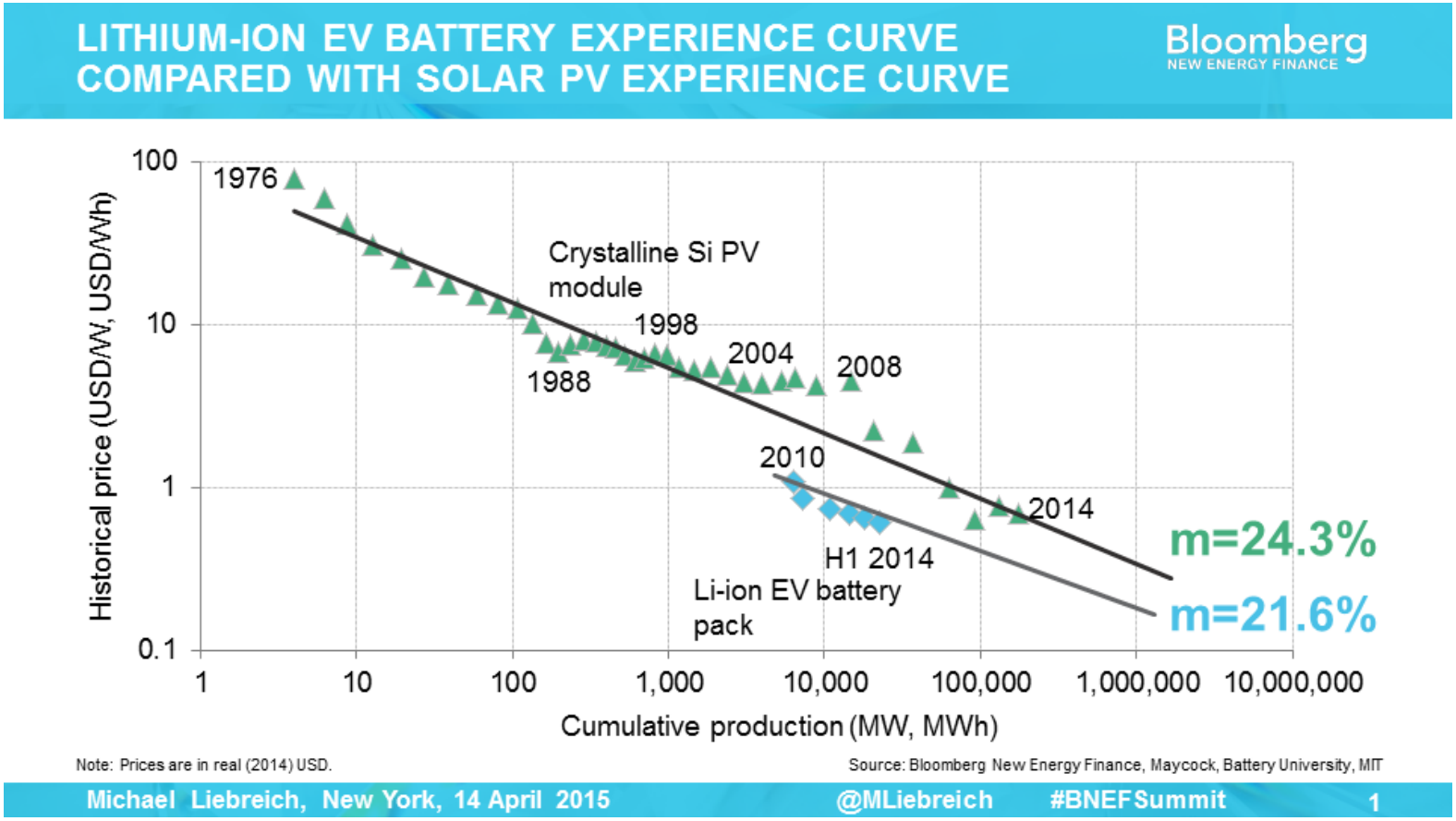
LITHIUM-ION BATTERY PACK PRICES: HISTORICAL AND FORECASTED



Source: The economics of load defection, RMI, April 2015

› **Battery Costs Reductions** (85kWh battery systems for cars will require very low battery costs to compete)

MARKET DRIVERS: BATTERY PRICES



› Batteries are tracking the history of a technology we know well...

MARKET DRIVERS: NETWORK OPERATORS AND NEW MARKETS

> New markets could change how storage is managed
  - Ancillary services
  - Demand response / contra-demand

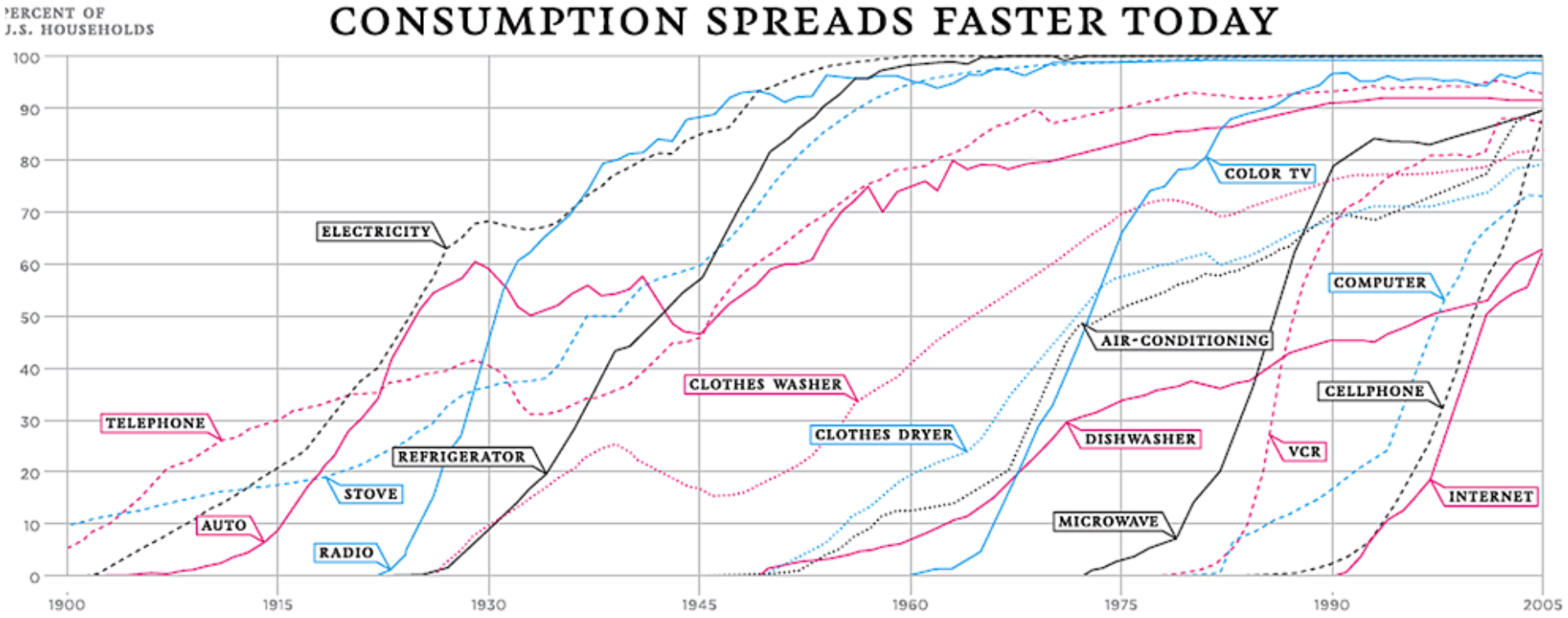
> Aggregators likely to arise (e.g. PJM, NthEast USA)
  - Change from on-site to centrally controlled
  - Change in the use of storage from self-consumption to revenue maximisation

> Sub-station level storage for phase balance / peak shift

> 3rd party Home energy management is likely to be "Pay TV" service of the future for homes

> **The PV & Storage industry is continuing to undergo great change**

TECHNOLOGY ADOPTION CURVES



Source: http://www.nytimes.com/imagepages/2008/02/10/opinion/10op.graphic.ready.html

› **This is an exciting era, as change over the next decade is likely to dwarf the previous decade**

QUESTIONS (AND ANSWERS)

ENERGY
THAT
CHANGES

SOCIAL MEDIA
www.SMA.de/Newsroom