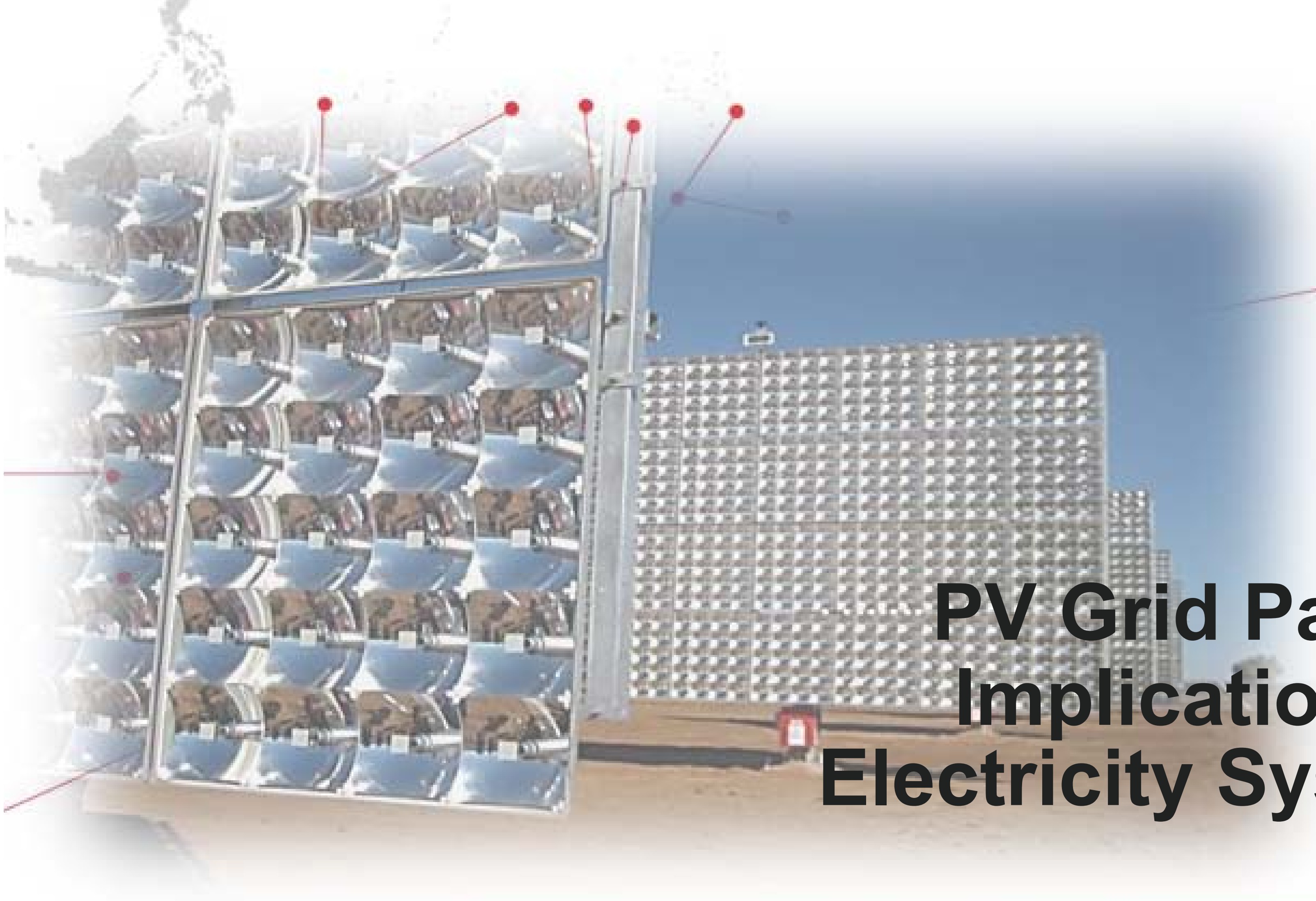

PV Grid Parity & Implications for Electricity Systems

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IEA-PVPS Workshop, PVSEC22, Hangzhou

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IT Power Renewable Energy Consulting itp

Outline

- Definitions of Parity
- PV prices and market trends
- Implications of grid parity
  - Economic
  - Technical
  - Social
  - Regulatory
- New opportunities

Photo: Bushlight system at Kakadu

Definitions of Grid Parity

Some options

- PV LCOE = retail tariff
- PV electricity gets paid the same as retail tariff
- PV ROI < projected LCOE of electricity purchases over 25 years
- PV pays for itself in less than customer's economic planning cycle (residential 7-10 years, commercial 2-5 years?)
- PV LCOE = wholesale electricity price
- PV delivered at < wholesale price + distribution savings

All site, regulation and customer dependent

305 kWp PV system on Alice Springs Crown Casino
Photo: SunPower Corporation

PV Prices & Market Trends

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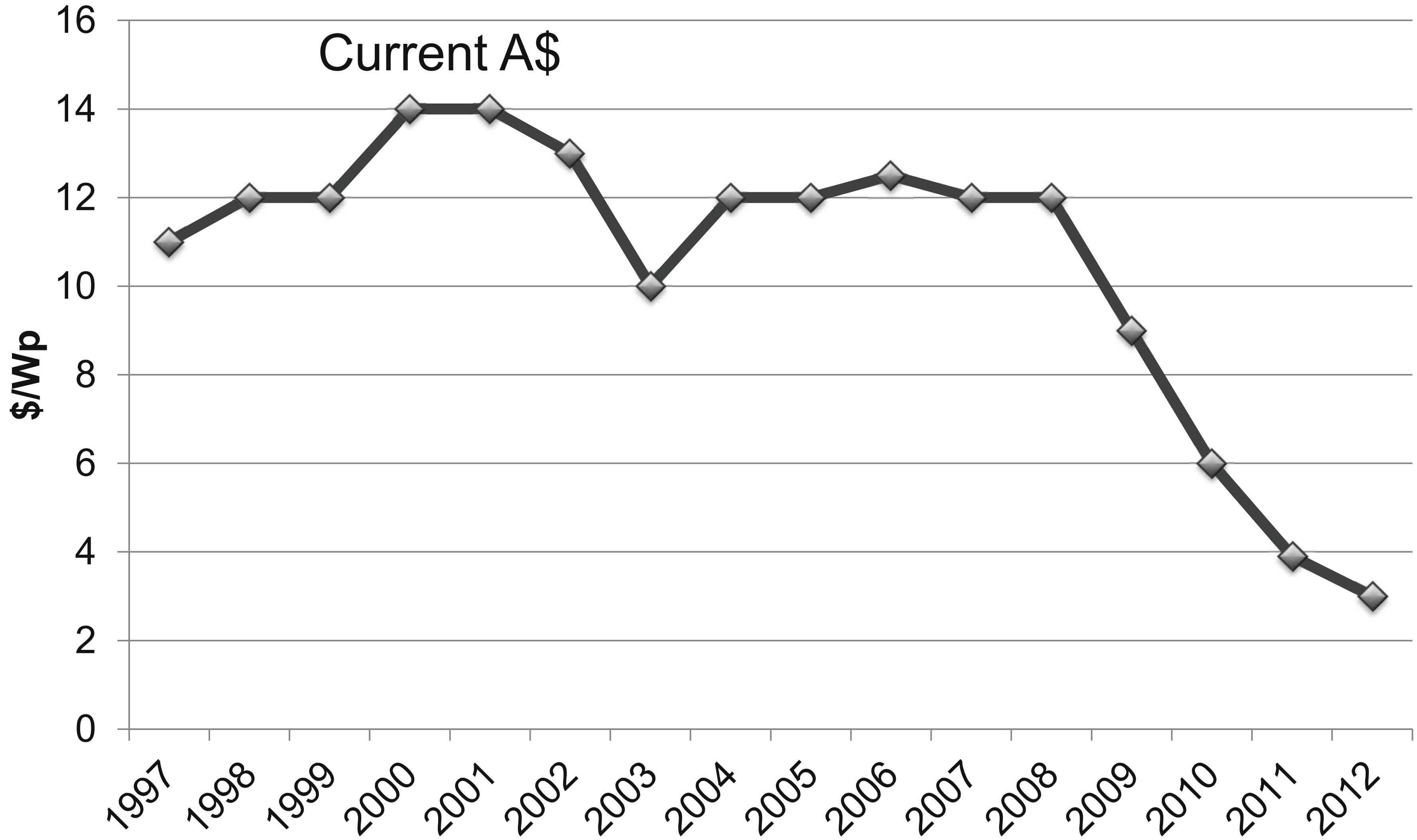
Grid System Price Trends (APVA, 2012)



Evolution of grid-connected installations
(PVPS, 2012)

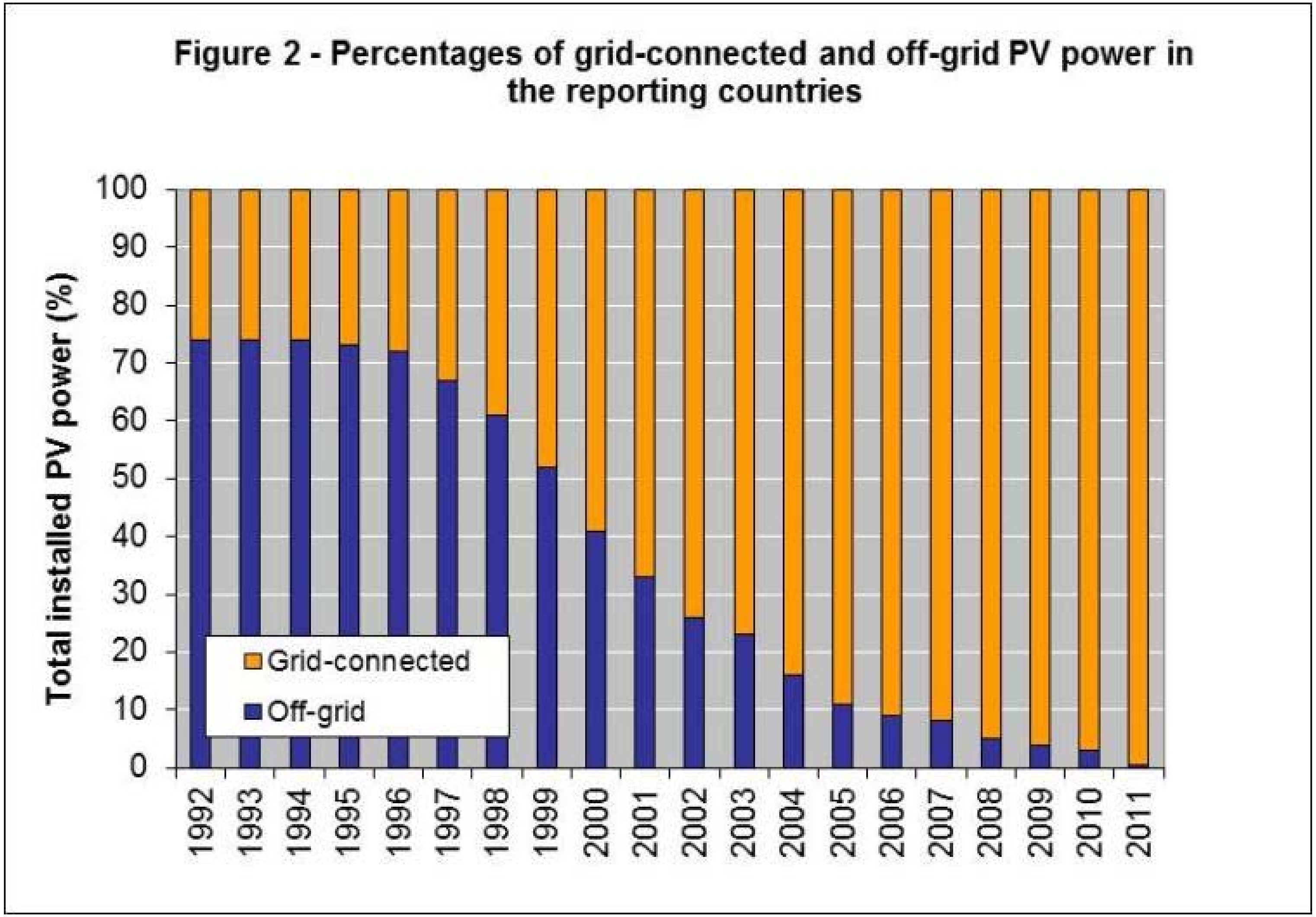
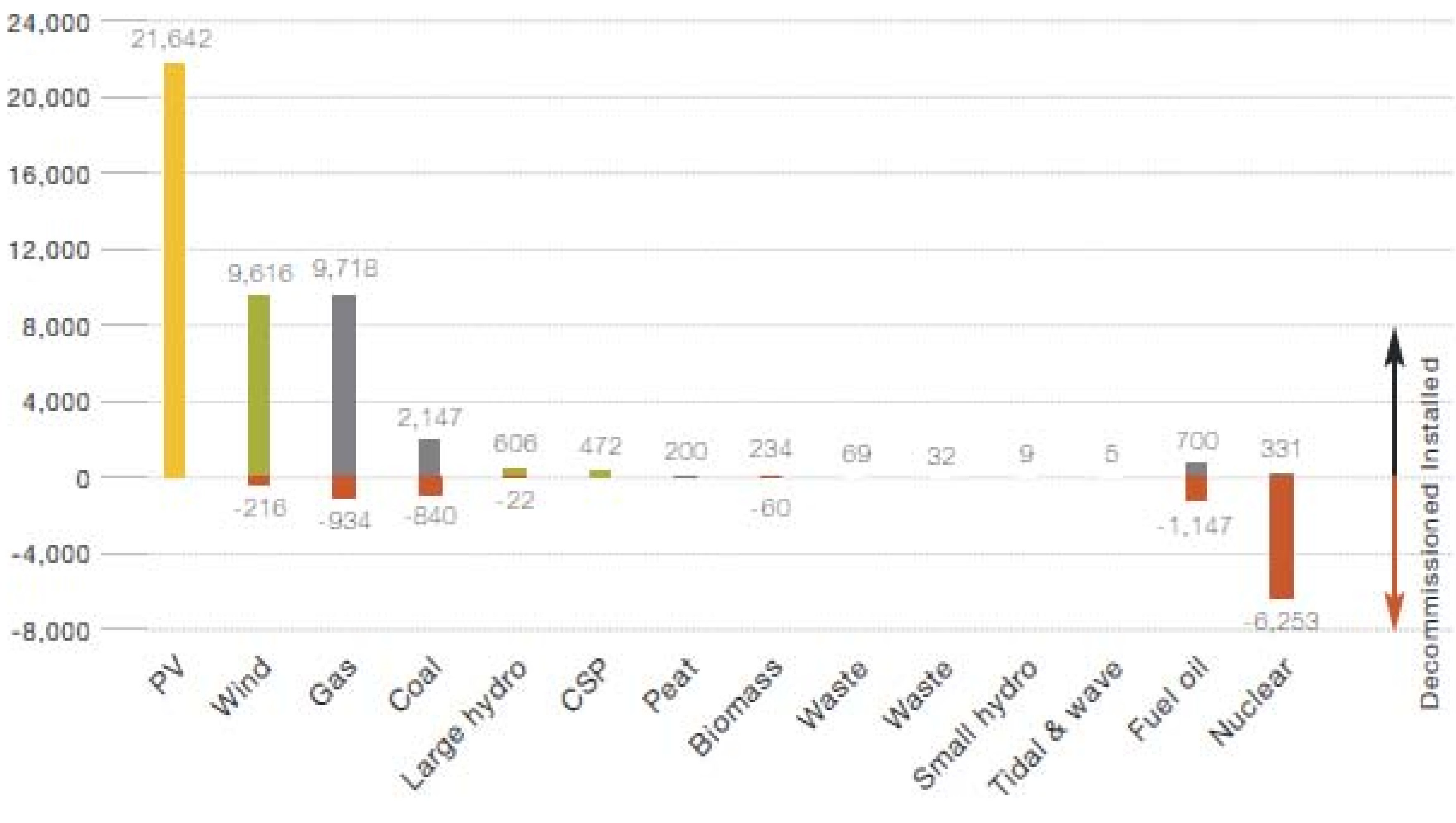


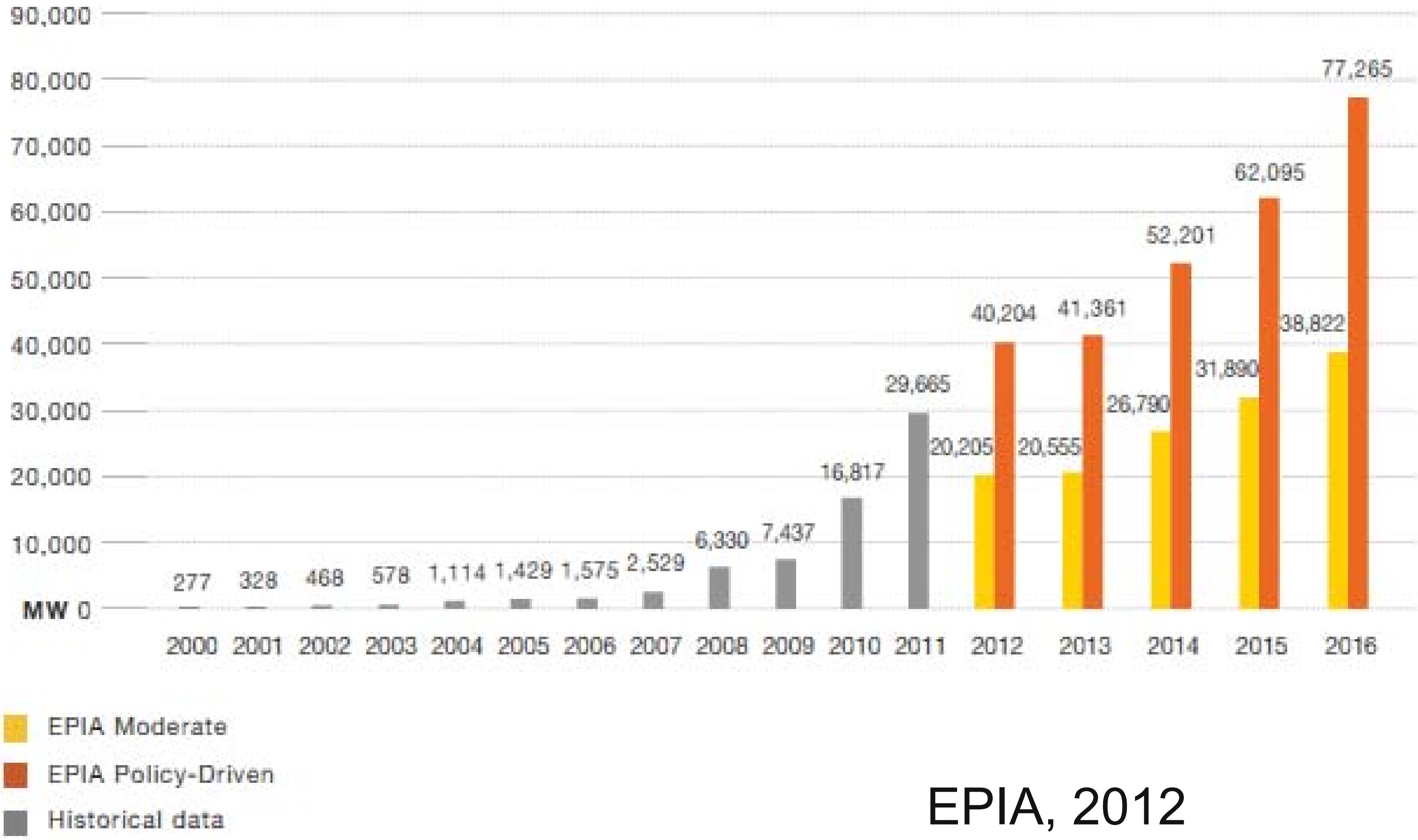
Figure 41 - Power generation capacities added in the EU 27 in 2011 (MW)



source: EPIA, EWEA

EPIA, 2012

Figure 28 - Global annual market scenarios until 2016 - Moderate and Policy-Driven (MW)



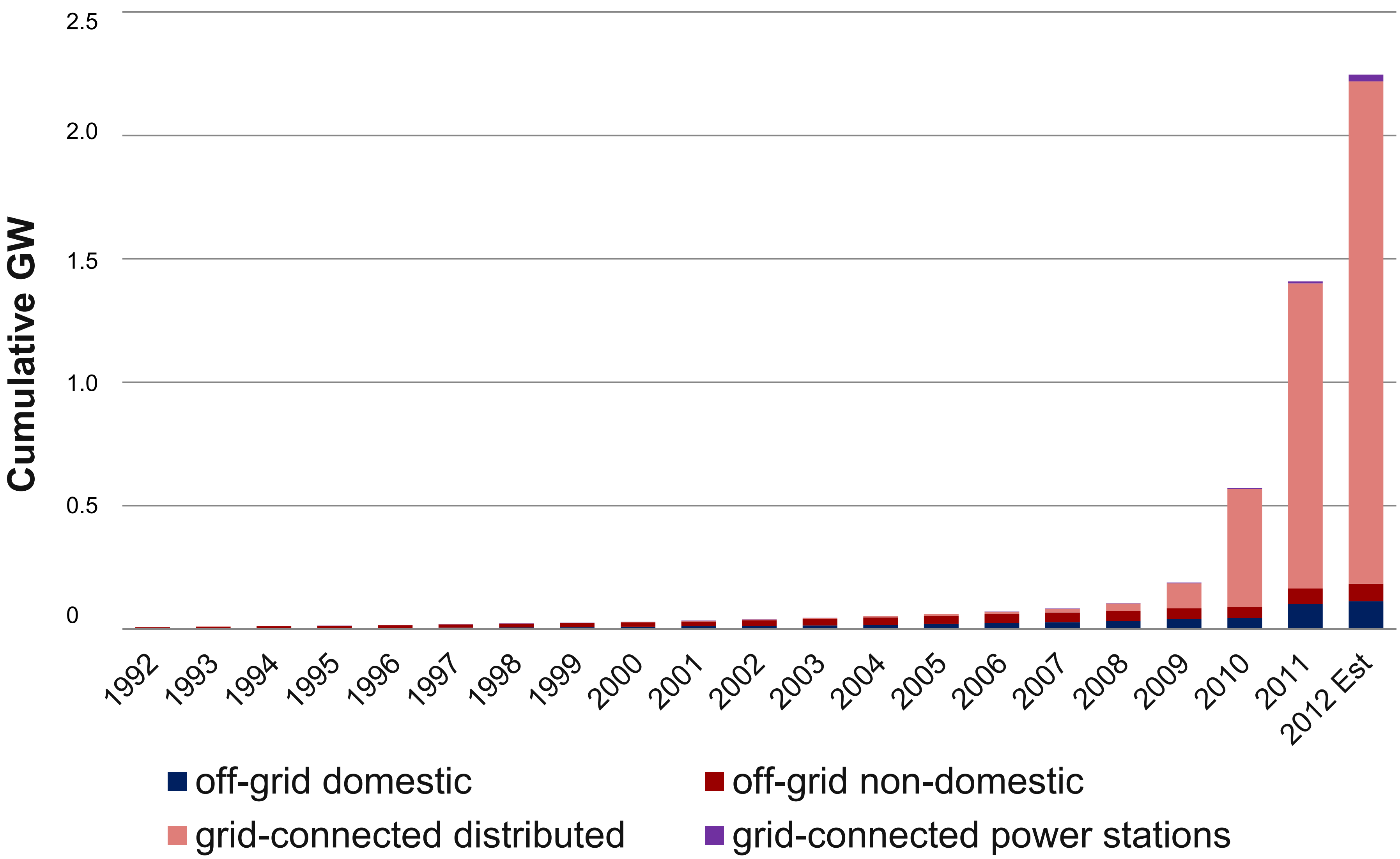
EPIA, 2012

Some International PV Targets
(PVPS, 2011 & 2012)

Markets expected to change, but remain strong:

- China: 15 GW by 2015; 50 GW by 2020
- France: 5.4 GW by 2020; 25,000 new jobs
- India: 20 GW solar by 2022, 100 GW by 2030 (90% grid)
- Italy: 23 GW by 2016
- Japan: 28GW by 2020, 53 GW by 2030
- Saudi Arabia: 15 GW by 2032
- Spain: 3.6% of electricity by 2020

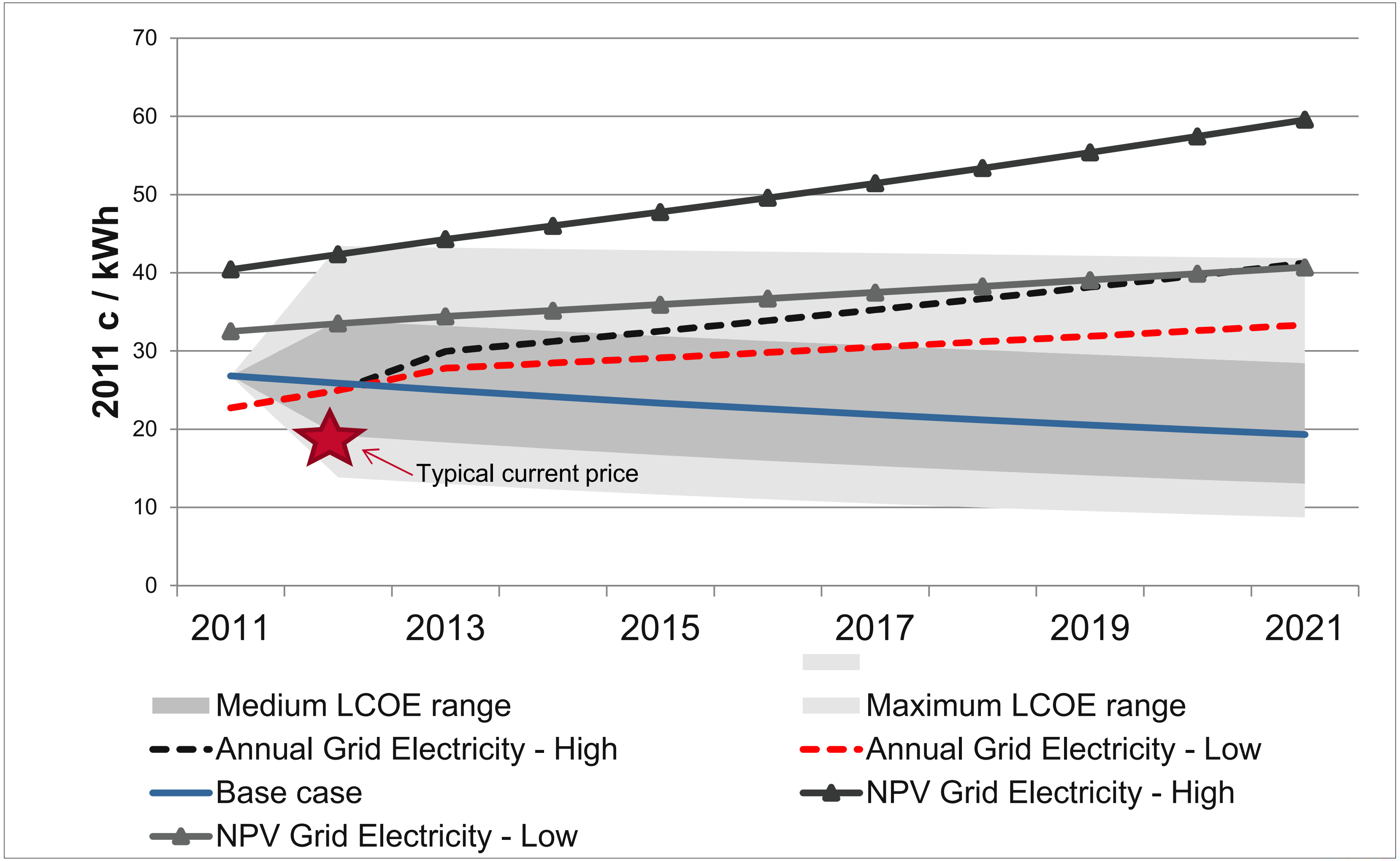
Australian PV Market
– with 2012 projections (APVA, 2012)



Adelaide showground Photo: First Solar

Implications of Grid Parity - Economic

Australian Residential LCOE trends and Grid Parity Projections (APVA, 2011)



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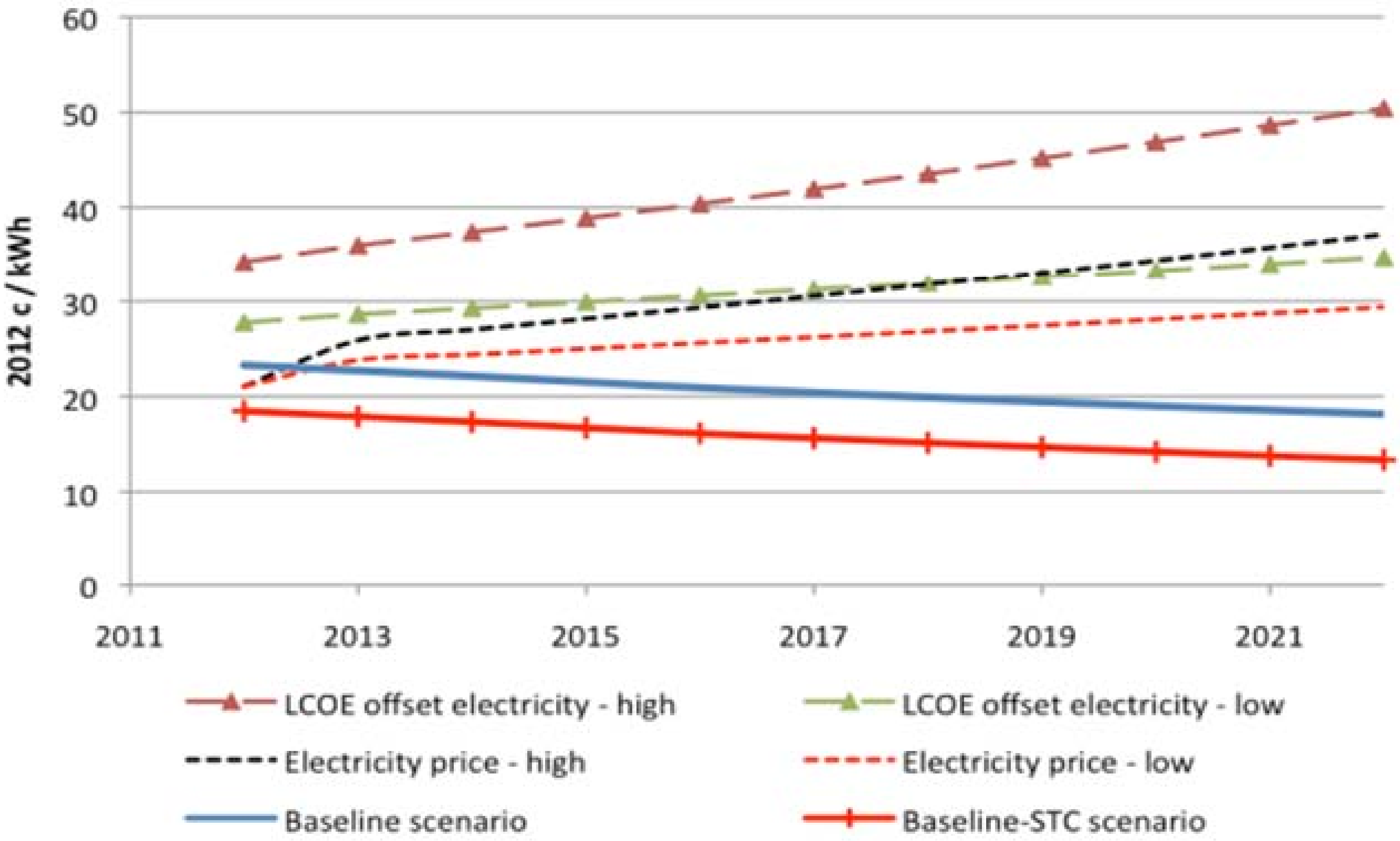
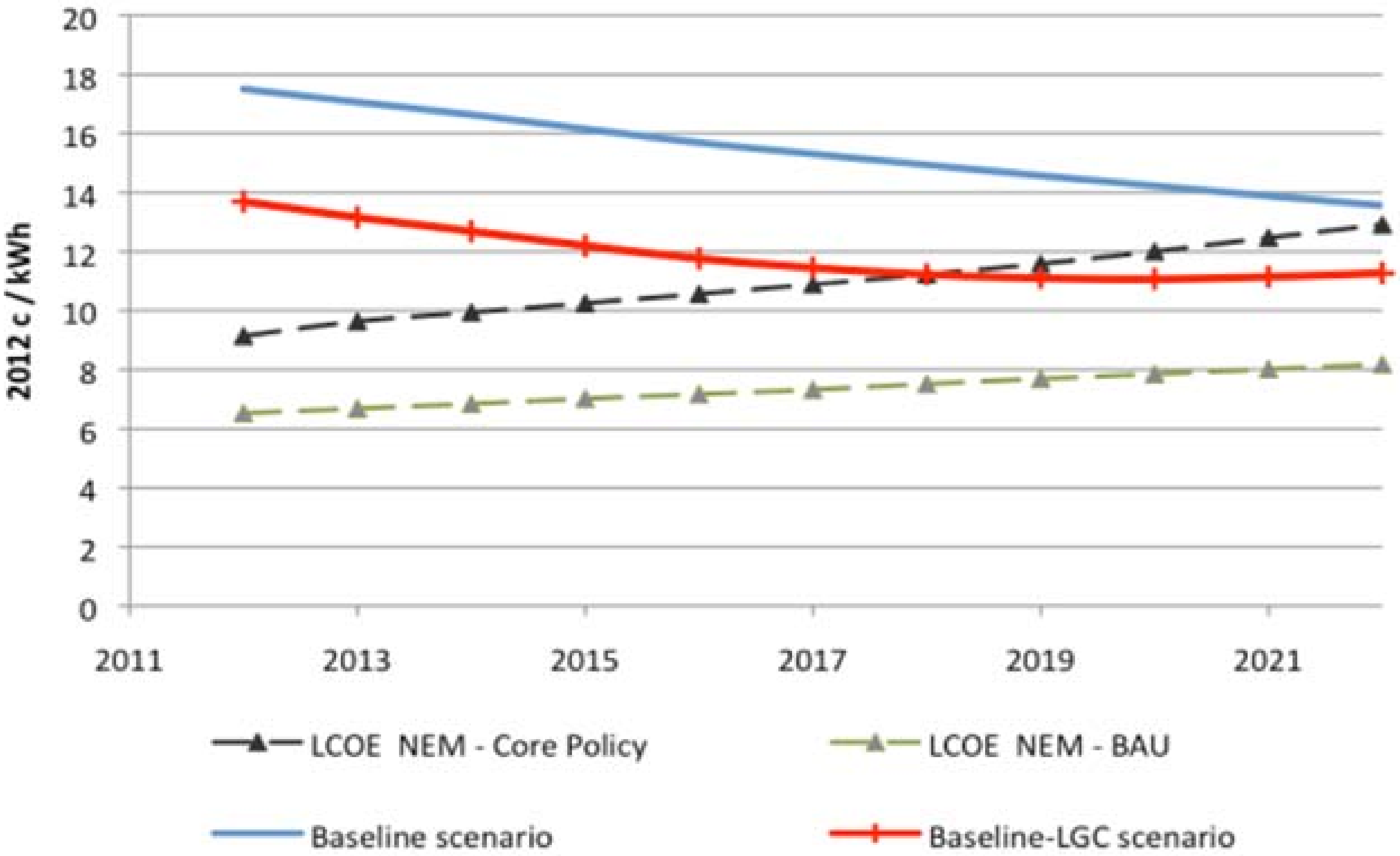
Australian Commercial Sector Grid Parity Projections (APVA 2012)



Australian Utility-Scale grid parity projections

(APVA, 2012)



Economic Issues

Even once retail price parity is reached:

- Guaranteed PV connection or grid export not always available
- Parity can be countered by:
  - Increasing network cost components of tariffs, so energy is a smaller %
  - Increasing daily connection fees
  - Forced gross metering of PV output at bulk supply rate
- Non-transparent connect costs, procedures & timelines
- Energy market & network savings not passed back to PV owners (or even to customers)
    - Low or zero buy-back rates

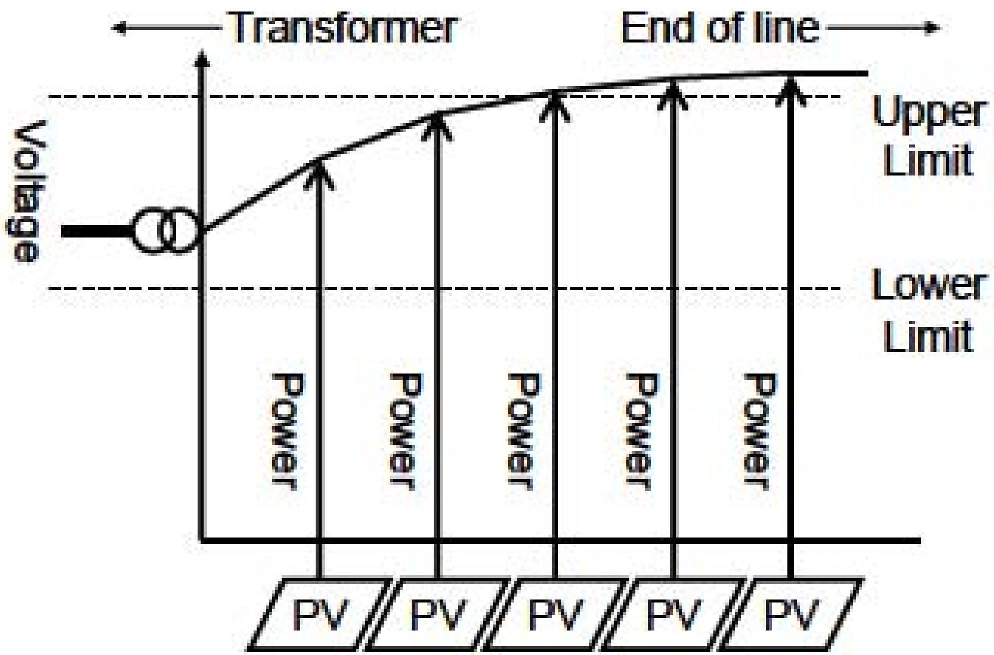
Note that price gap remains for larger-scale systems connected to the transmission network

- Needs more installations, R&D, short-term gap support

1.22 MWp PV system, University of Queensland

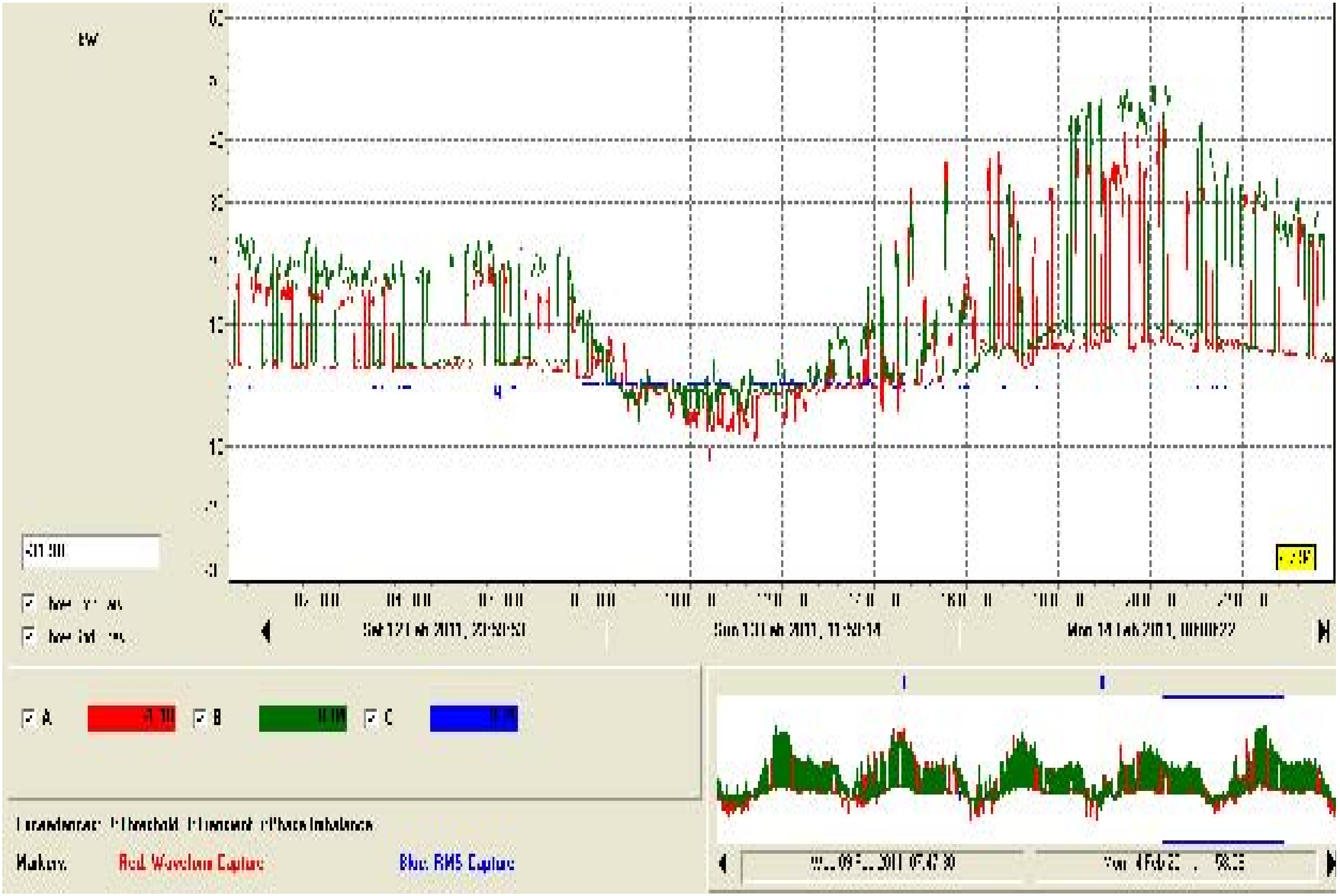
Implications of Grid Parity - Technical

Voltage rise



Y.Ueda (2009)

Reverse Power Flow / Reactive Power

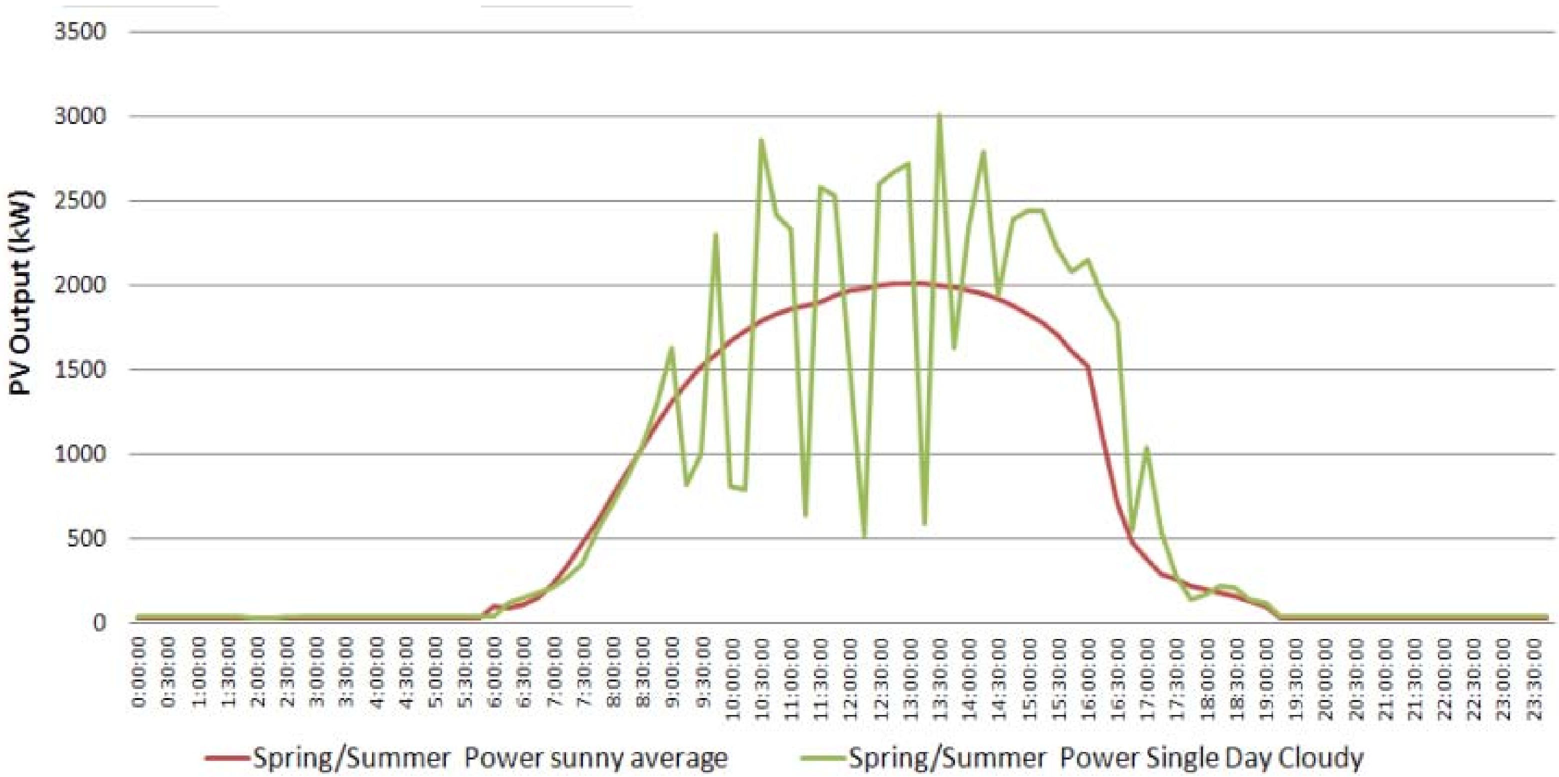


APVA/CEEM, 2012

Harmonics

Source: APVA/CEEM, 2012

Cloud issues



Source: APVA/CEEM, 2012

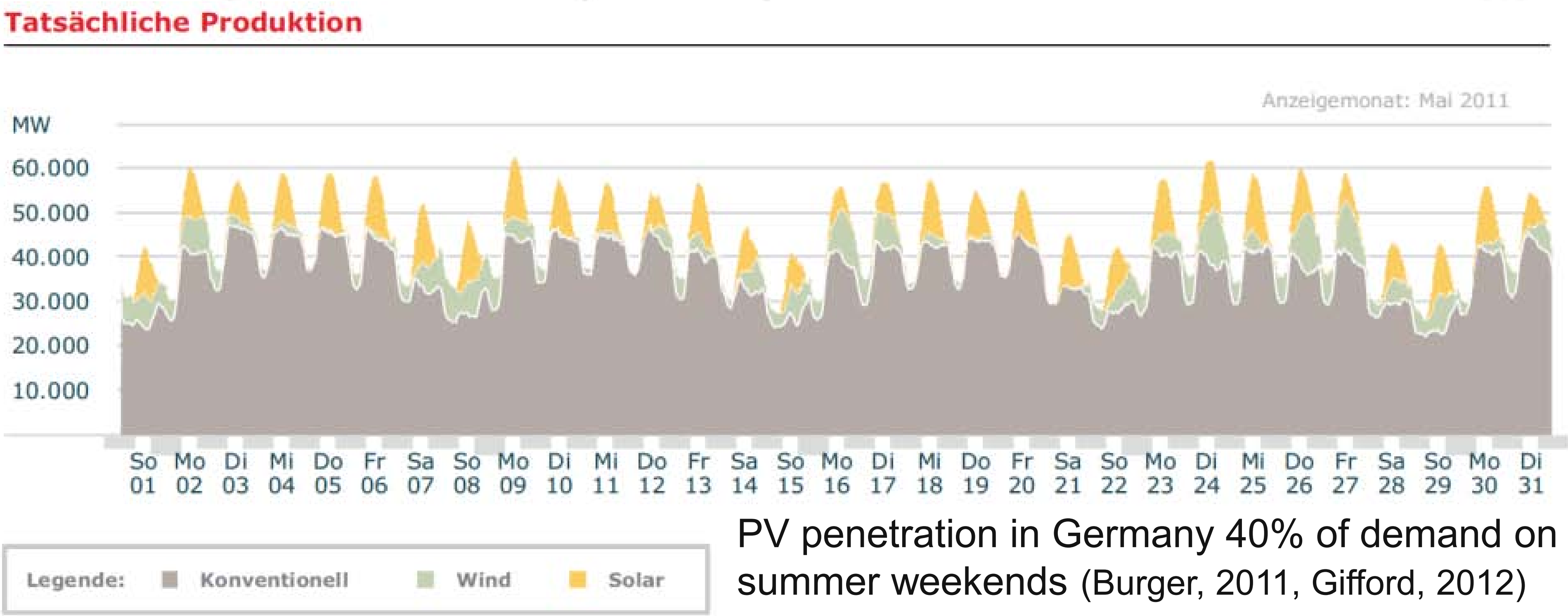
Implications of Technical Issues

- More difficult for countries with relatively inflexible coal and nuclear generation bases to accommodate PV than for those with more hydro & gas
- Installations already being limited because old networks are not designed for distributed generation / reverse power flow
- Network upgrade one option but:
  - DE (PV, EE & DSM) can often provide a lower cost solution
  - Stranded grid assets possible if trends to energy efficiency and self-sufficiency continue
- Smart grids needed
  - Not just TOU meters, but also smart inverters, communications & storage
- We need a very different type of grid

Implications of Grid Parity - Social

Social Issues

- Customers now have an option, since DE is readily available, can be cheaper than grid power & provides long term electricity cost certainty
- Electricity retail market structures and network assets often publicly owned and are hence vulnerable if:
  - Buildings trend to zero energy
  - Electricity usage drops with DE uptake
  - Customers opt for on-site storage and purchase from the grid only in off-peak periods
- Can equity and electricity access issues be resolved?
- NIMBY for larger systems, as has happened with wind?
  - Or will it be WIMBY??
- Legal rights to solar access need to be established

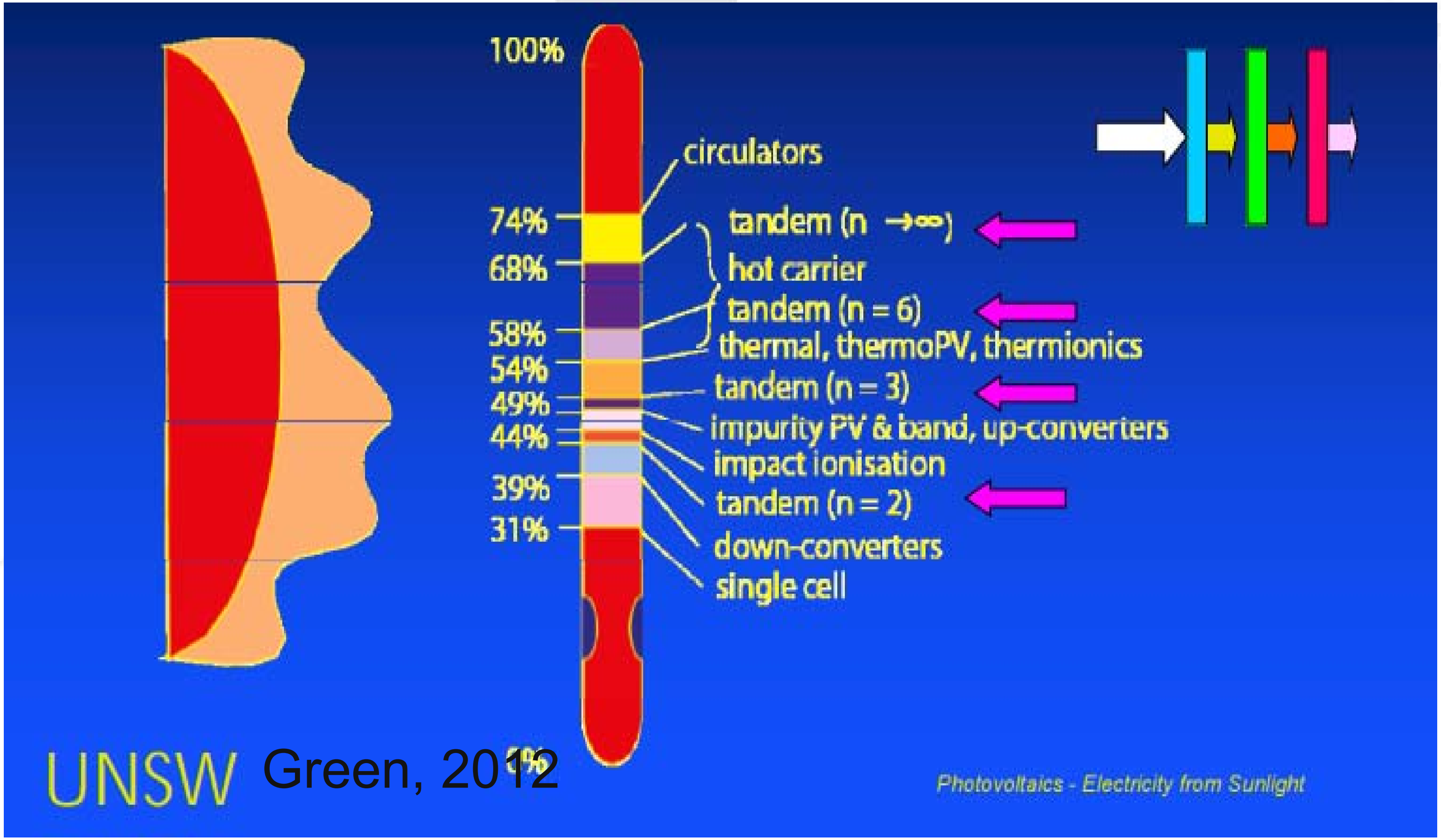


PV penetration in Germany 40% of demand on summer weekends (Burger, 2011, Gifford, 2012)

Implications of Grid Parity - Regulatory

Regulation / market design issues

- Electricity markets typically designed for central generation
- No incentive or inherent right to value distributed energy
  - Monopoly distribution businesses earn money by kWh transmission and can pass through all increased costs
  - Retailer earnings based on kWh sold
- New market designs needed which gives equal value to supply and demand options
  - Transparency to allow markets to operate and for customers to be able to choose the best options
  - Rights and technical standards for connection
  - Ancillary service requirements and rewards
  - Appropriate setting of network use charges
  - Defined roles and regulation for new energy service providers
  - Mechanisms which allow energy and network benefits from DE to be passed to system owners and/or customers generally
  - Californian Integrated Resource Planning model may be appropriate



New Opportunities

New Technologies, Businesses, Markets, Skills

- New supply and demand markets and businesses
  - Active end-user participation
  - Wide range of energy service providers
- Modern power electronic devices with services besides active power injection
  - Fault Ride-Through – Dynamic grid support
  - Active voltage and reactive power control
  - Use of PV inverter as active filters
- More detailed forecasting of supply and demand
- Energy self-reliant communities
  - Mini-grids
  - Zero energy buildings
  - Rural electrification without large grid extension
  - Disconnecting high cost, low volume portions of existing distribution grids
- More PV technologies and applications
  - New PV device types
  - New transmission grids to high Renewable Energy sites

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