



GLOBAL LEADER IN  
**ULTRACAPACITOR-BASED**  
ENERGY STORAGE

September 2018



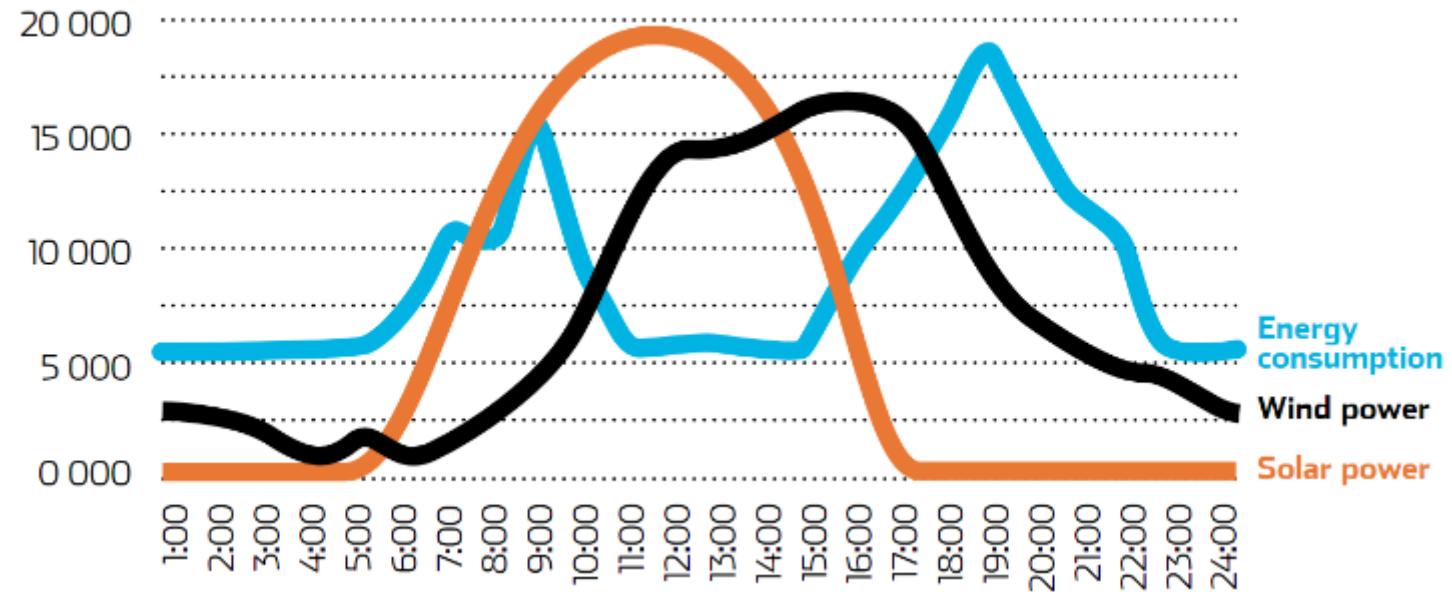
ULTRACAPACITORS AND RENEWABLES



# AGENDA

- + CHALLENGES
- + ULTRACAPS & RENEWABLES
- + ULTRACAPS AT A GLANCE
- + ENERGY STORAGE SOLUTIONS

**SKELE+ON**  
TECHNOLOGIES



# CHALLENGES

"ONE OF THE BIGGEST CHALLENGES FACING ENERGY SYSTEMS BASED ENTIRELY ON CLEAN, ZERO-EMISSION WIND, WATER AND SOLAR POWER IS TO MATCH SUPPLY AND DEMAND WITH NEAR-PERFECT RELIABILITY AT REASONABLE COST"

Mark Delucchi, research scientist at the University of California, Berkeley.

# ULTRACAPS & RENEWABLES

SOUTH AUSTRALIA Sept 2016

- + Significant blackout mainly caused by
  - + Storm damaging infrastructure
  - + Incorrect anticipation of demand
  - + Wind power decrease during demand increase
  - + Nearby gas power station shut down protectively
- + Problem solved by
  - + Adding a large battery to store energy for adverse weather conditions.
  - + Better monitoring of the grid situation.
- + Adding ultracapacitors in the mix would prevent brownouts and blackouts by ensuring the delivery from renewables is as smooth as possible during mix transitions

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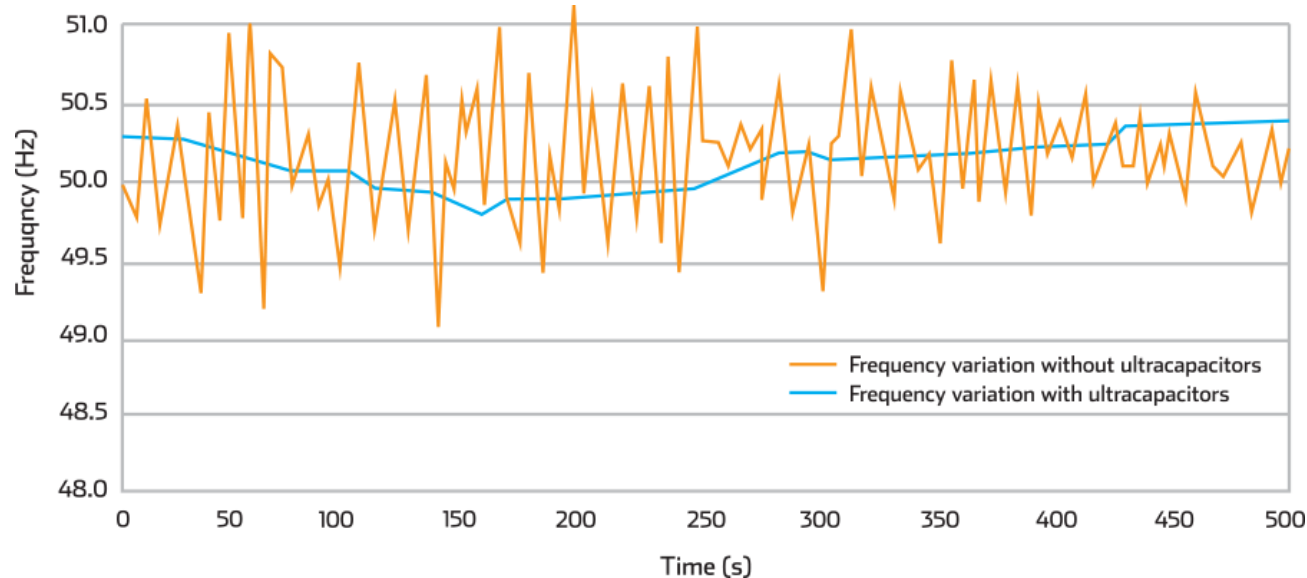


# ULTRACAPS & RENEWABLES

## ISLAND GRIDS

An island grid powered by renewable energy doesn't have enough inertia to keep the grid frequency steady, so it needs energy storage to support it.

Ultracapacitors are ideally suited to frequency regulation due to their practically instant reaction time and lifetime of more than a 1 000 000 cycles.



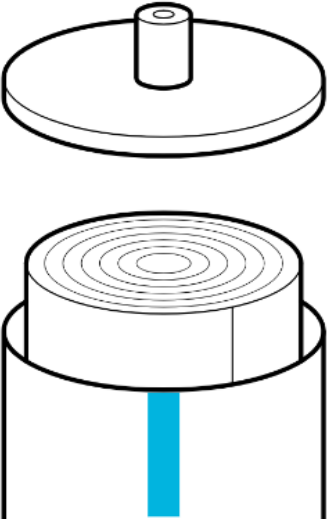
# ULTRACAPS & RENEWABLES

## QUICK SUMMARY



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ULTRACAPACITOR-BASED  
ENERGY STORAGE SYSTEMS  
CAN ELIMINATE THESE ISSUES  
AND CAN HELP ENSURE GRID  
STABILITY BY PROVIDING



**FREQUENCY  
SUPPORT**  
to stabilize the  
grid powered by  
intermittent  
renewable energy  
sources.



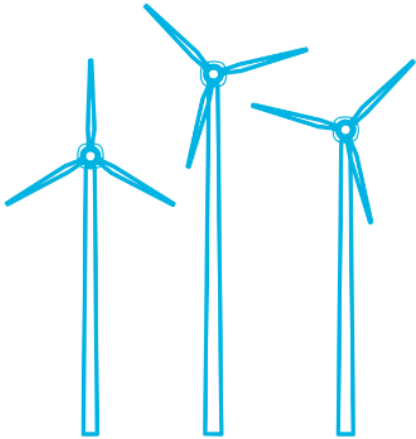
**VOLTAGE  
SUPPORT**  
to provide local  
stabilization  
when needed



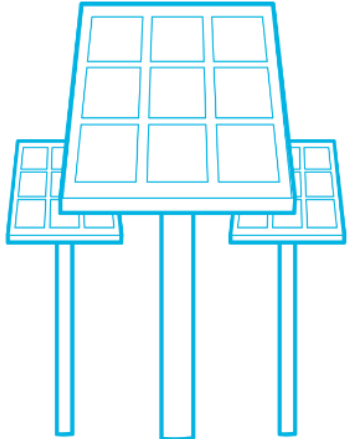
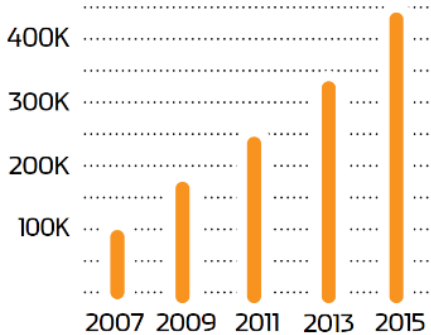
**FACTORY-  
LEVEL  
SUPPORT**  
to eliminate  
voltage dips and  
peaks, and  
flickering



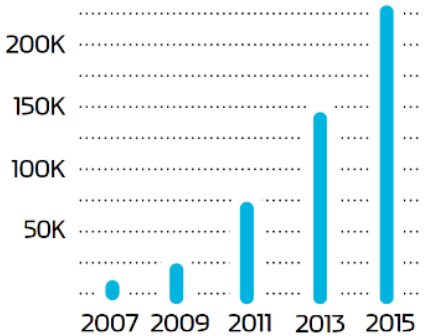
eliminate  
**BLACKOUTS  
and  
BROWNOUTS**  
by responding  
to peak electricity  
needs



**Wind Power**  
Capacity(MW) per year



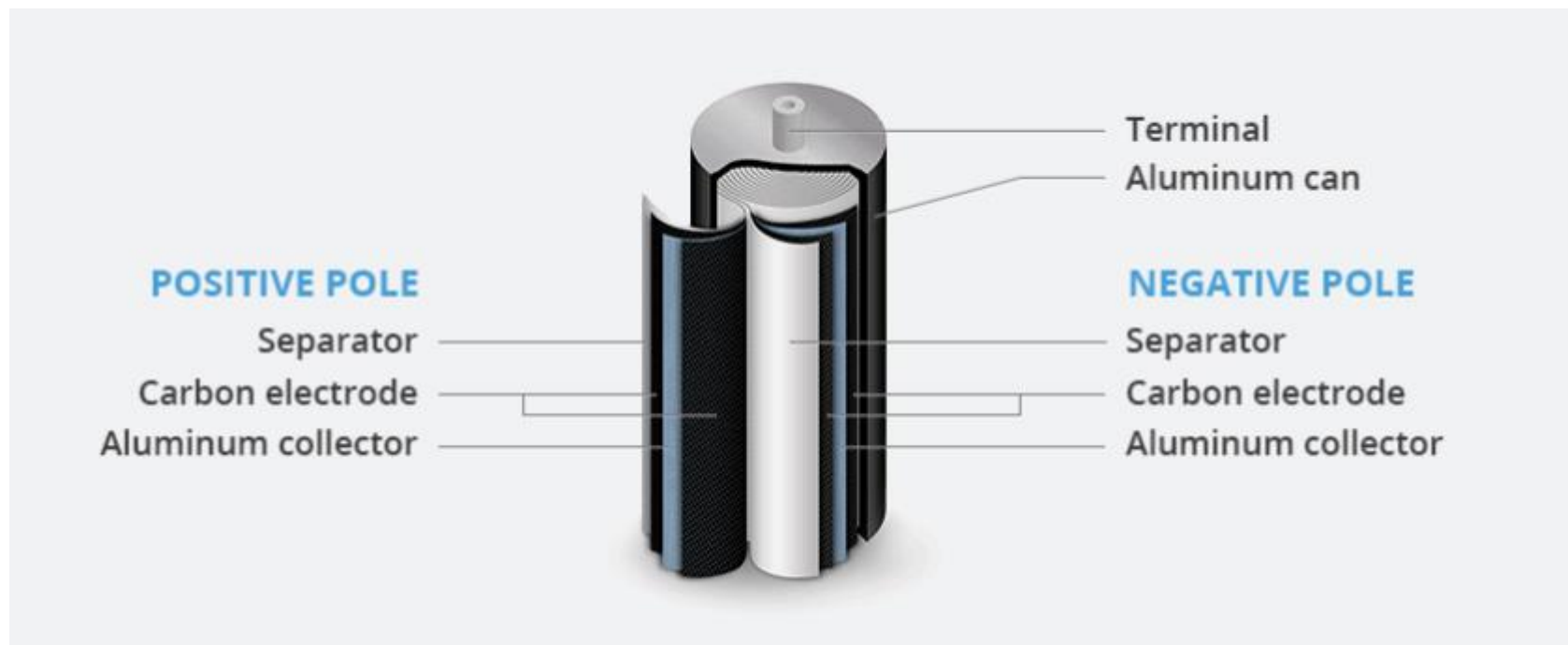
**Solar Power**  
Capacity(MW) per year



# ULTRACAPS AT A GLANCE

## CARBON & ALUMINIUM

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Skeleton Technologies' patented curved graphene is changing the world of energy storage.





# ENERGY STORAGE SOLUTIONS

## ULTRACAPACITOR & BATTERY

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### POWER

**ULTRACAPACITORS USE AN ELECTRIC FIELD TO STORE ENERGY**

- + Very high power density
- + Almost instant charging and discharging
- + Lifetime > 10 years with over 1 million cycles
- + Maintenance free

### ENERGY

**BATTERIES USE A CHEMICAL REACTION TO STORE ENERGY**

- + High energy density
- + Chemistry limits charge and discharge rate
- + Lifetime of a few thousand cycles
- + Careful management of charge discharge





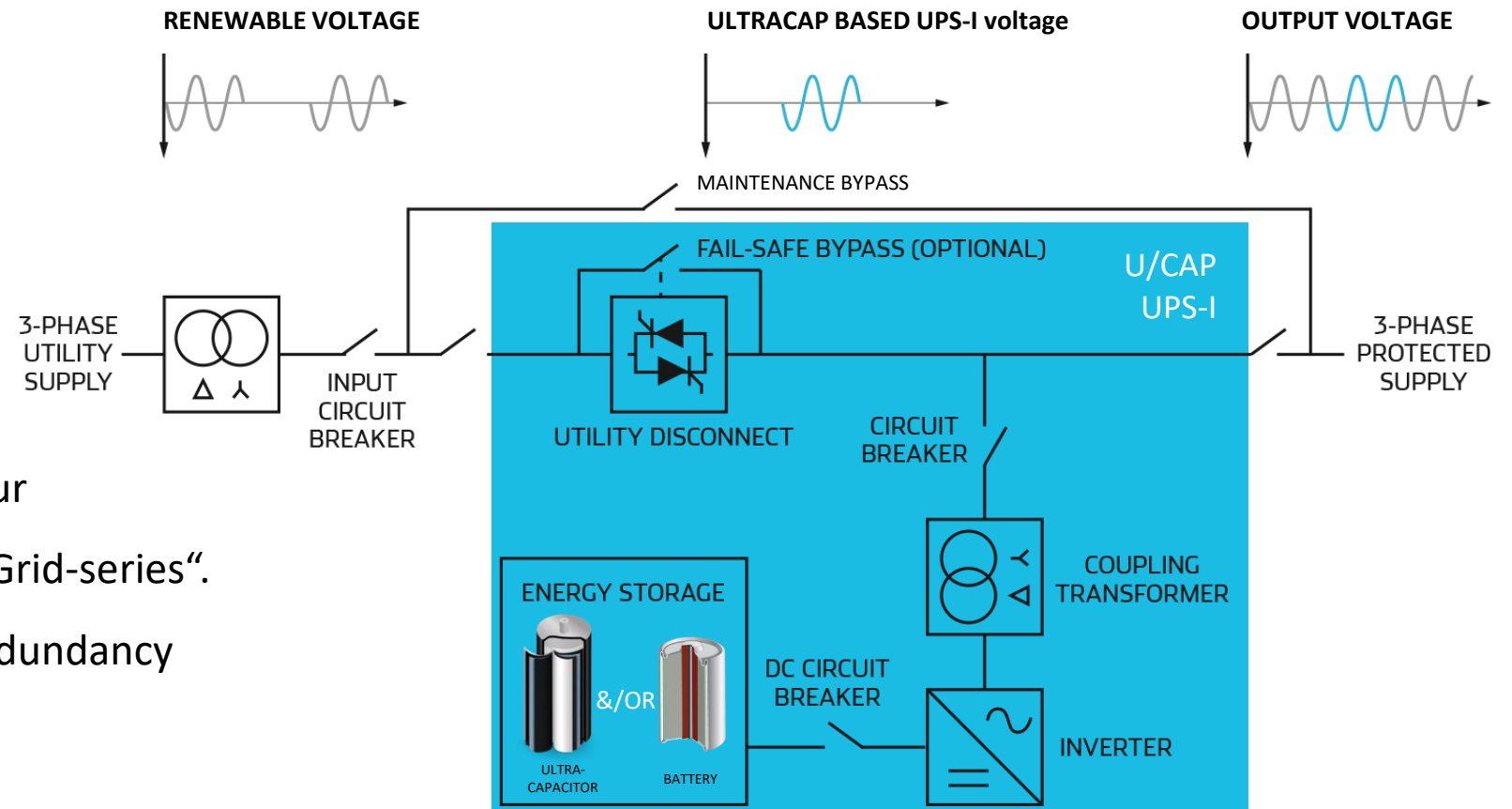
# ENERGY STORAGE SOLUTIONS

## BLACKOUT PREVENTION - UPS

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### GENERAL APPLICATION REQUIREMENTS

- + Application time: 100ms -> 9s
- + Power > 200 kW to 60MW
- + Usually less than one cycle per hour
- + Topology: „Grid-parallel“ and/or „Grid-series“.
- + Increased reliability with added redundancy mechanisms.



# ENERGY STORAGE SOLUTIONS

## SKELETON TECHNOLOGIES



+ SkelGrid 1MW



+ SkelRack 440 kW



+ SkelGrid Container 60MW



+ Omni up to 2 MW

# QUESTIONS

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# WE HELP TO SAVE ENERGY

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