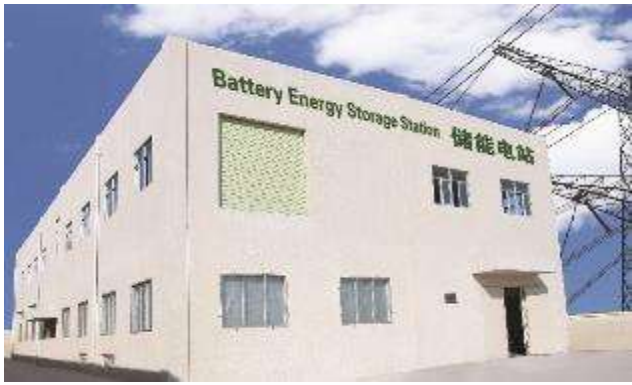
Build Your Dreams

BYD Renewable Energy

May. 2016



Catalog

1 BYD Introduction

2 Solar

3 Energy Storage

4 Electric Vehicle

BYD Milestones






1995
Established in Shenzhen with a 20 staff and $0.3million investment

1998
Became the first Chinese Li-ion battery supplier to Motorola

1999
Set up its first industrial park in Shenzhen, China

2002
Became the first Chinese Li-ion battery supplier to Nokia
BYD Co., Ltd. was listed on the Hong Kong Exchange (1211.HK)

2003
Went into the auto business

2005
BYD F3 launched and started the BYD legend

2007
BYD Electronics (International) Co., Ltd. was listed on Hong Kong Exchange (00285. HK)

2008
Warren Buffett acquired a 10 percent stake in BYD
Launched the world's first dual mode electric car - the F3DM

2010
BYD and Daimler set up a joint venture to develop a pure EV

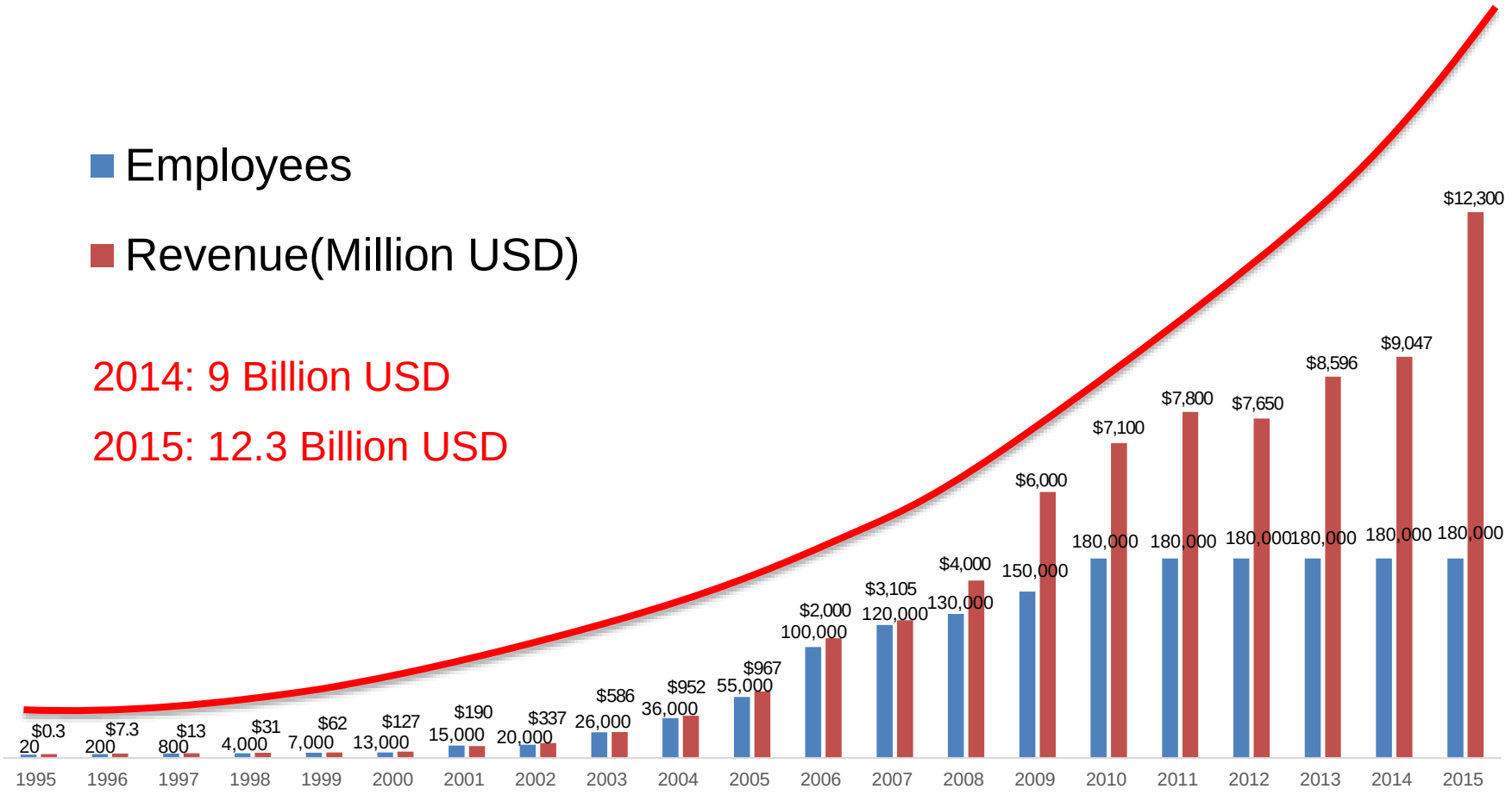
2011
BYD Co., Ltd. was listed on the Shenzhen Stock Exchange (002594. SZ)
BYD North American branch opened

2013
Opened its North American electric bus and Iron-Phosphate Battery factories
Launched the PHEV Qin

2014
Rollout of its first American made ebus
First Denza model launched in to market
EV sales champion in China

2015
EV Sales champion in the world

BYD Growth



BYD Business Areas

Robust Research Institutes

Transportation 50%

- Pure electric and hybrid automobiles
- Pure electric transit buses
- Pure electric fork lift
- Conventional gasoline vehicle

Renewable Energy 7%

- Solar power generation
- Utility scale battery storage system
- Rechargeable batteries

Consumer Electronics 43%

- ODM, OEM
- Laptop and mobile devise components
- Industrial, PC and security cameras
- Power management circuitry
- Others

Transportation

Material Science

Wireless Communication

Electric Power

BYD Global Footprint

18 Plants, 17 Million Sqm, 15 International Office

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BYD PV Introduction

86MW Project in South Africa

Bloomberg - BYD Company ranking Tier 1 PV Module manufacturer

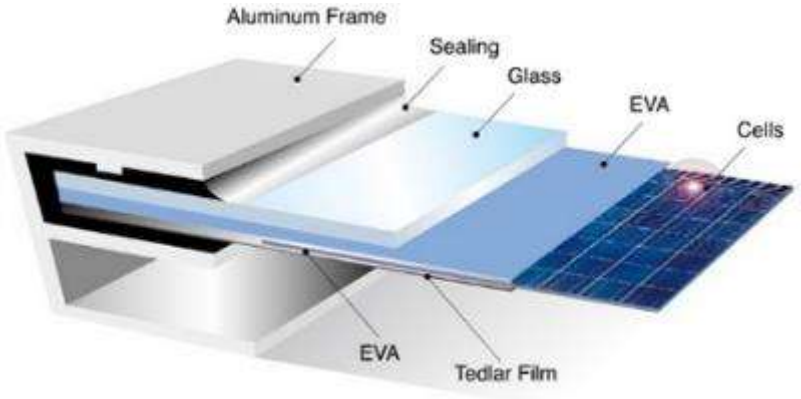
BYD PV Production Chain

Production Capacity

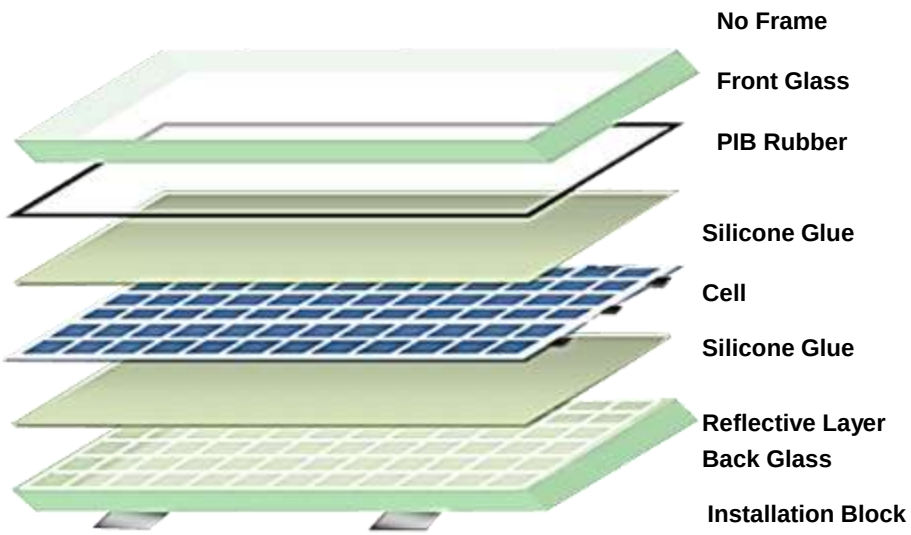
- **1.4GW** Wafer/ Cell
- **1.4GW** Module

Conventional Module & Glass-Glass Module

Conventional Module



Glass-Glass Module

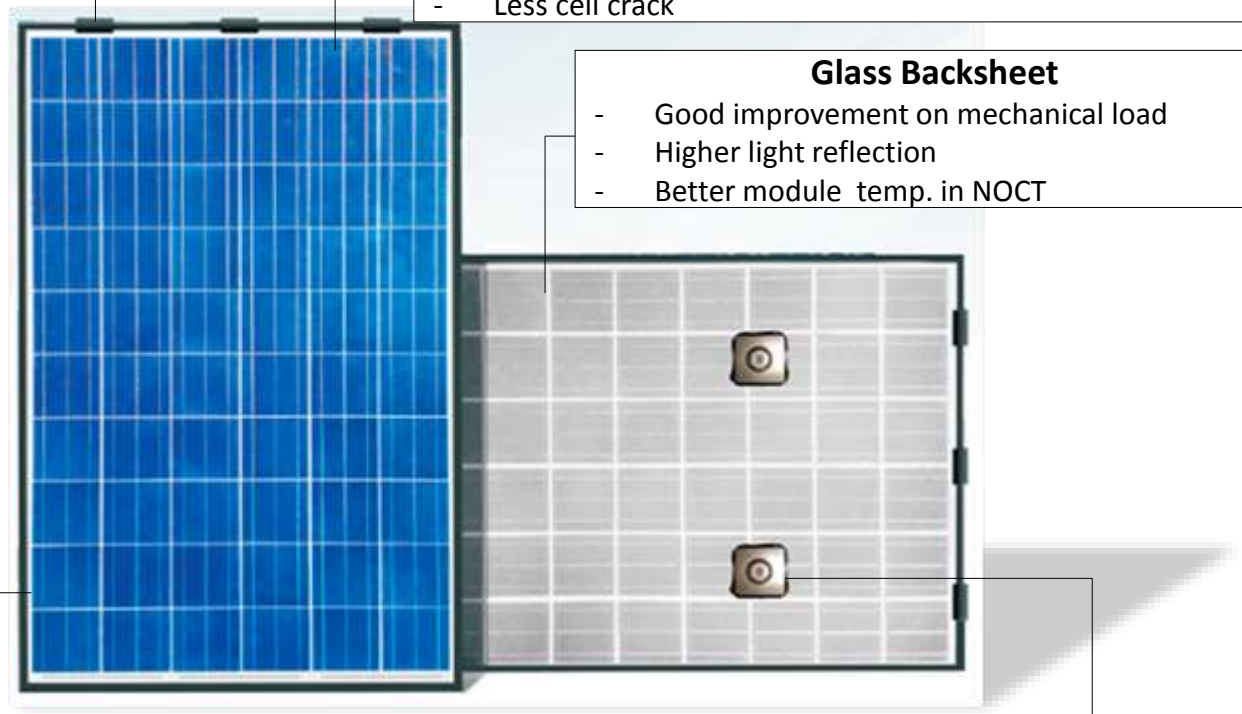


Glass-Glass Module

Three Junction Box
- Lower Resistance

Silicone Encapsulant
- High transparency
- UV stability and lower moisture absorption
- Less cell crack

Glass Backsheet
- Good improvement on mechanical load
- Higher light reflection
- Better module temp. in NOCT

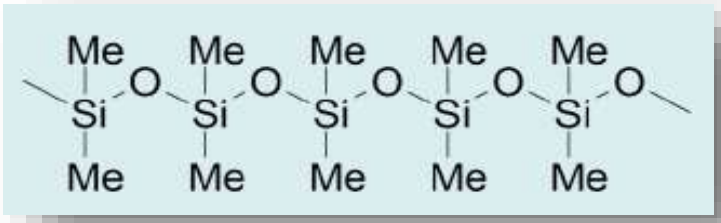


PIB Rubber Edge Sealant
- Excellent waterproof

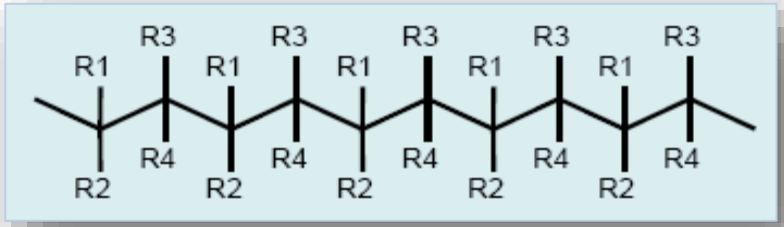
Back Block
- Easy installation
- Good improvement on mechanical load
- Cost efficient for system

Encapsulant---Why Silicone not EVA?

	Silicone Glue	EVA
Transparency	96% , no UV absorber	91%, UV cut off
Moisture Absorption Acetic Acid Snail Trail	< 0.05% N N	0.28% Y Y
Mechanical Characteristic	softness	stiffer
Electrical Characteristic	(1E+15 Ω·cm)	(1E+14Ω·cm)
UV Stability	Stable chemical structure	Degrade after UV absorber exhausted



Silicone Si-O Bond
ΔE=452kJ/mol

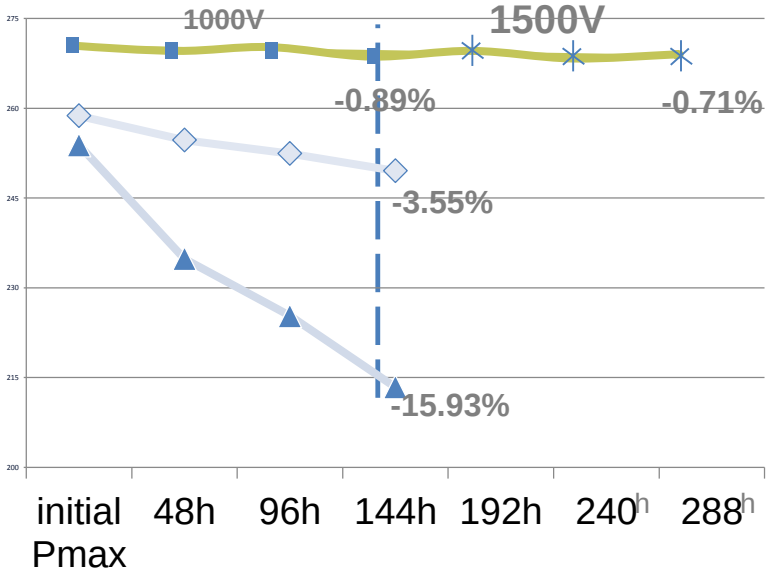


EVA C-C Bond
ΔE=347kJ/mol

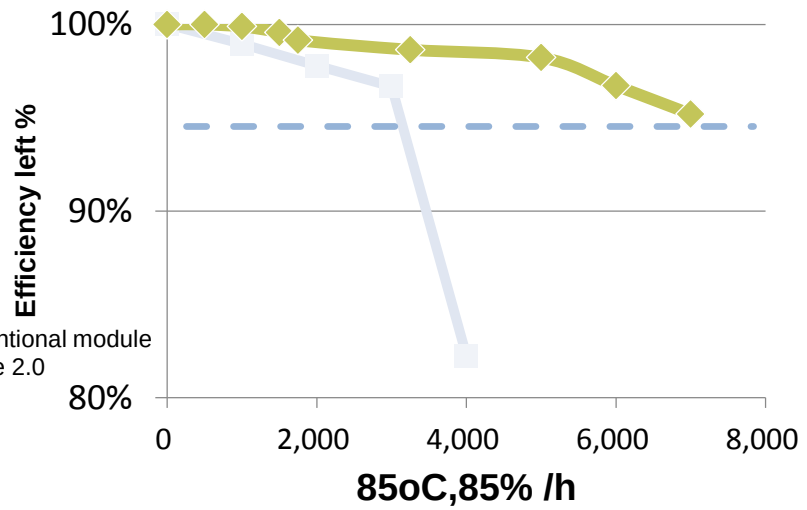
UV light (374kJ/mol)

Reliability Test

PID test



Damp-heat test



PID Standard test condition:

85%/85°C for 96 h under -1000V, power loss <5%

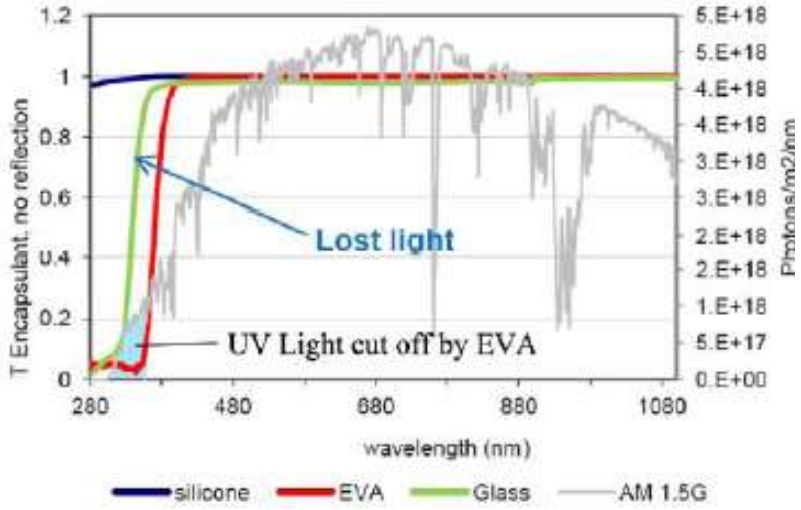
EVA: degradation is more than 5% after 2000hs.

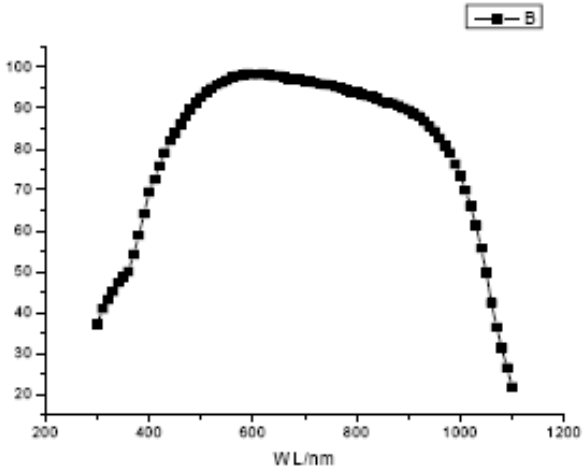
Silicone: degradation is less than 5% after 7,000hs.

Lifetime up to 50 years, PID free

More Electricity Yield

3% to 5.5% More electricity yield than EVA module in the outdoor PV plant for the difference of the UV light transmission rate between the EVA and Silicon, which cannot be tested by the simulator but can be reflected on the generating data.





UV light from 320nm to 380nm (the IV simulator cannot release) can pass through silicone but being cut by EVA. This part of light can be absorbed and convert into electricity by modules with silicone, and with stronger UV light comes generating capacity.

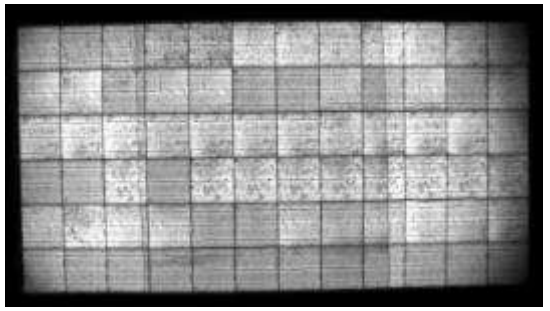
3% to 5.5% More electricity yield

Mechanical load test

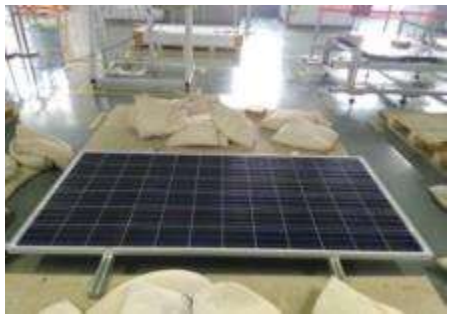
Before test

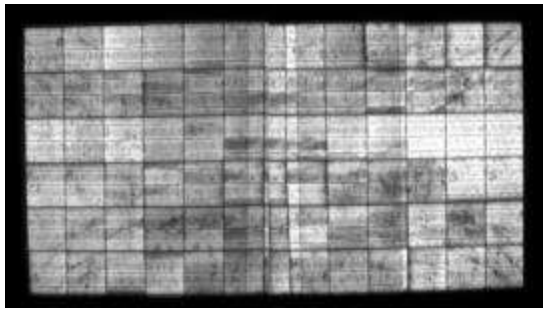
5400Pa loading test

After test



The EL pictures after Mechanical Load test





Robust Mechanical Structure

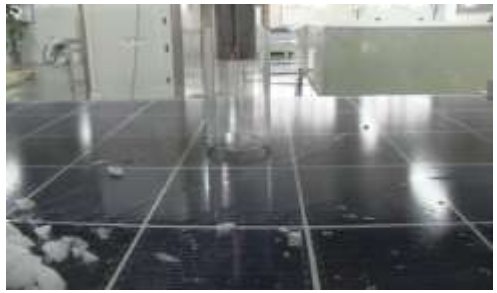
Hail test

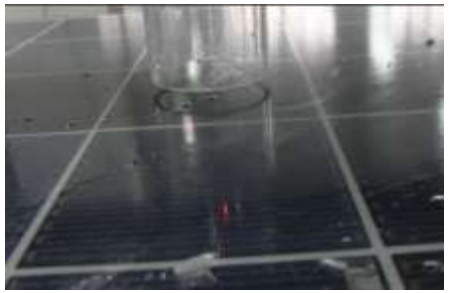
	Diameter D/mm	Velocity V/m·S^{-1}
IEC	30	25
Enhance	50	35

50mm

Conventional module

Dual Glass Module





Robust Mechanical Structure

High System Voltage-1,500V

1,000V  17

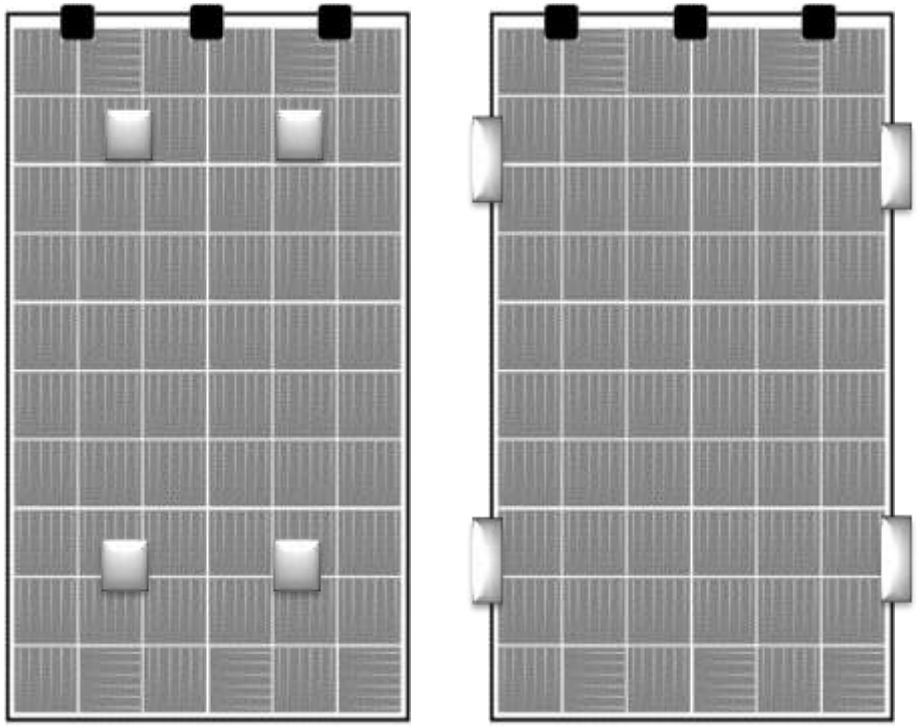
1,500V  25

Lower System Cost

Dual-glass module package

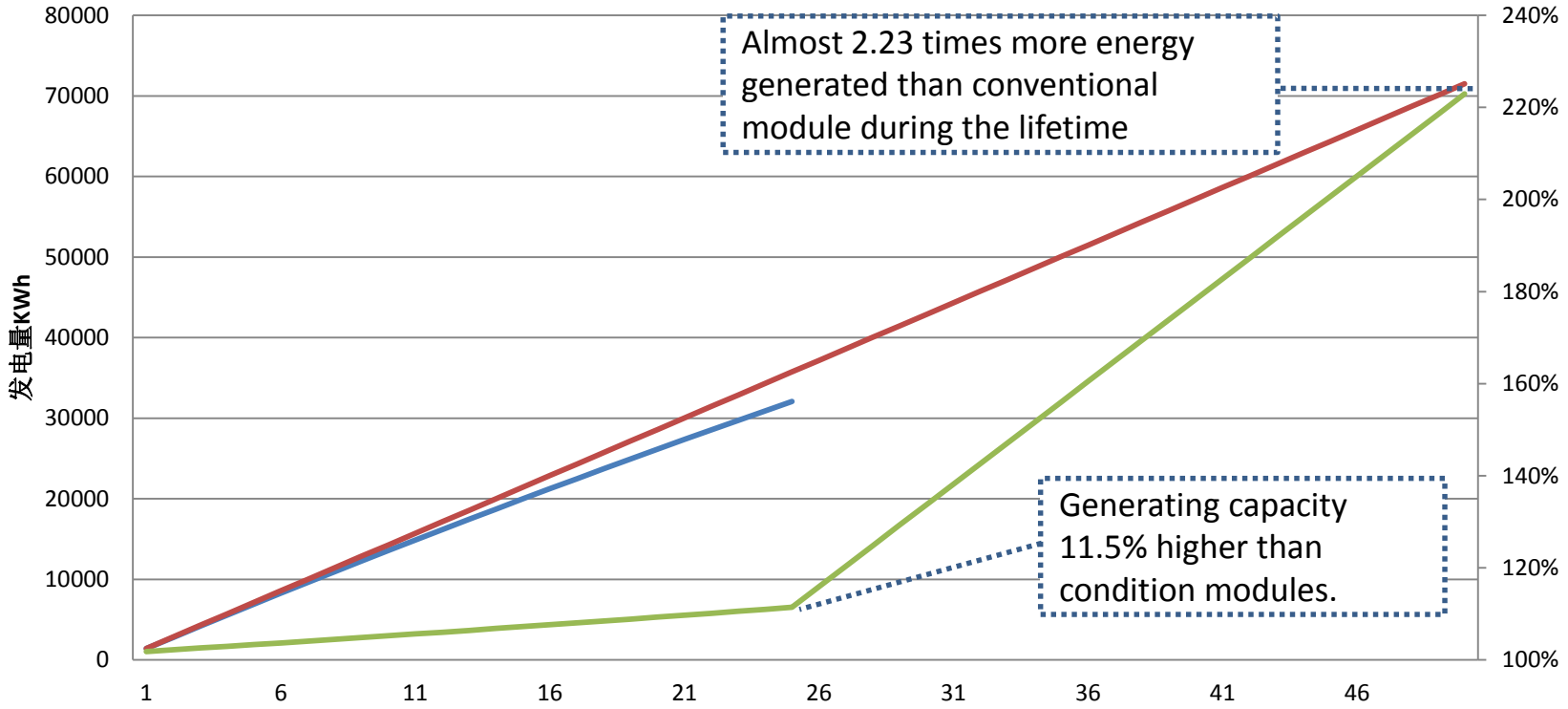
	PCS per pallet	Pallet per container	PCS per container
60cell series	34	24	816
72cell series	32	21	672

Dual-glass module installation



Easier Installation

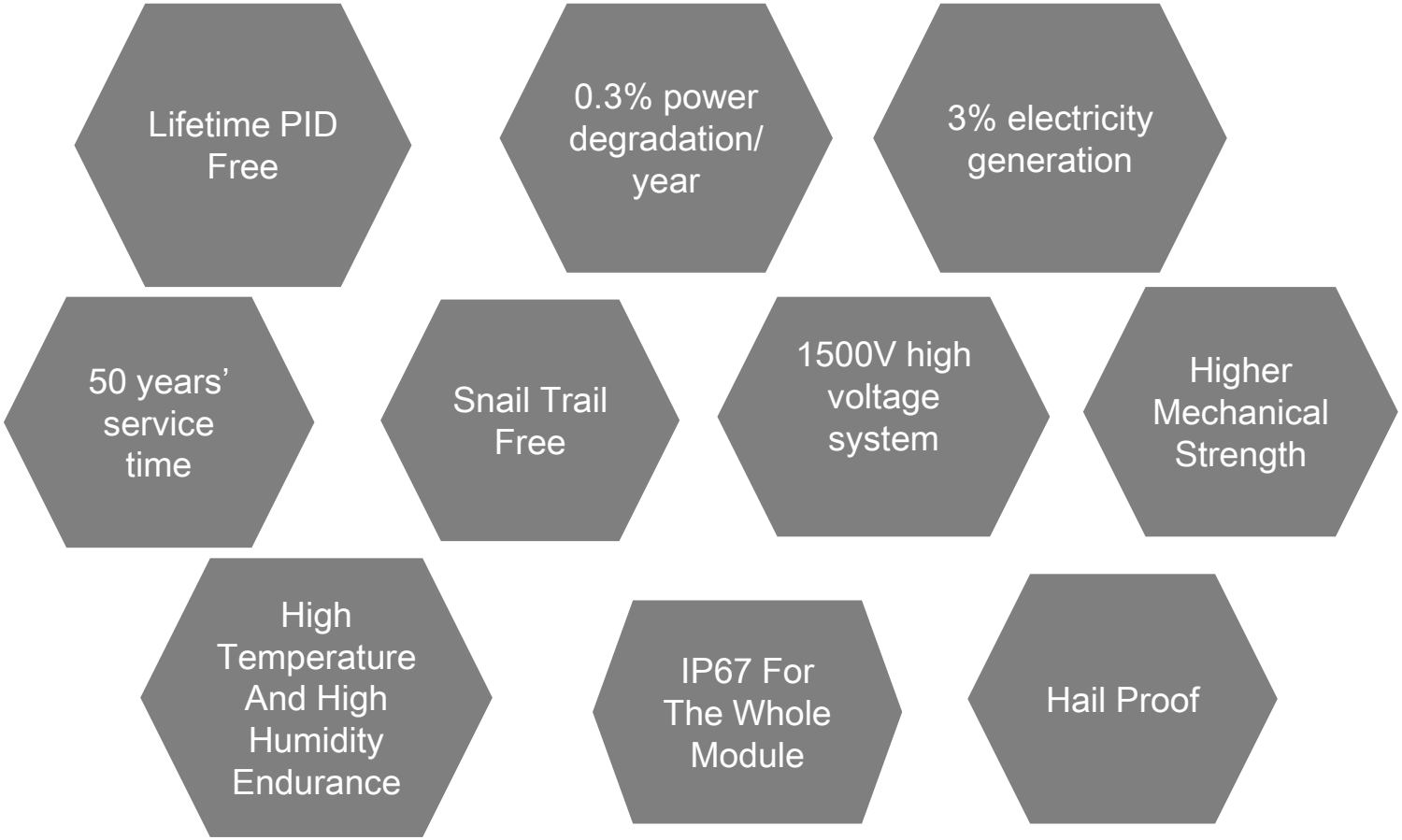
More Electricity Generated -Higher ROI



- 0.3% yearly degradation of Silicone **VS** 0.7% yearly degradation of EVA.

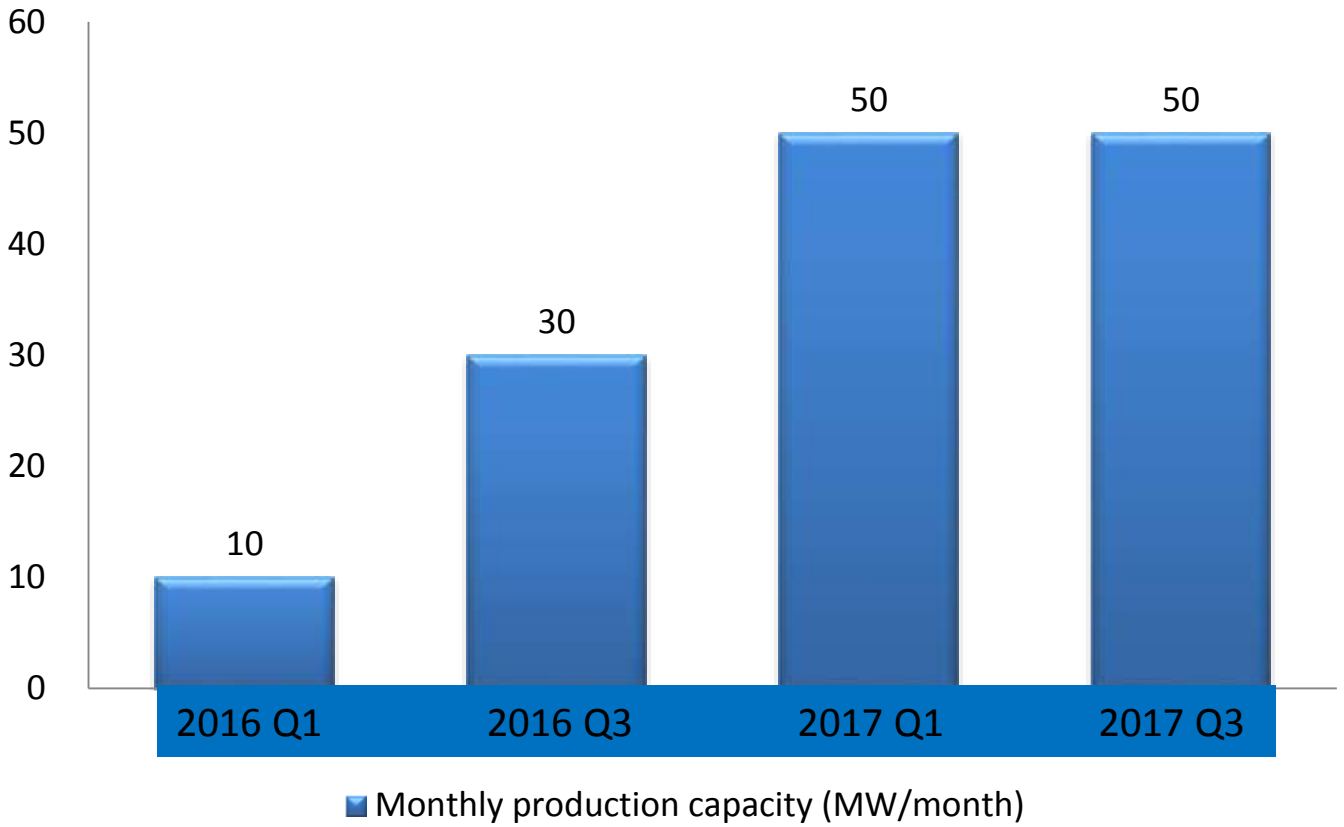
Higher ROI

Glass-glass Module --- Advantage



Outstanding Performance

Glass-glass module---Production capacity roadmap



- Module power is same as conventional module
- TUV certificate ready with 1000V and 1500V DC voltage
- 30 years linear warranty with 0.5% yearly degradation

Mass production now

Solar project reference.

Operating Date	Sep. 2013
Location	South Africa
Project Size	75 MW (Financed by Standard Bank)

Operating Date	June 2015
Location	Uruguay
Project Size	65 MW (Financed by IDB)

Operating Date	Mar 20142015
Location	Charanka Solar Park, Gujarat, India
Project Size	50MW (39MW used BYD module)

Operating Date	June 2016 (ET time)
Location	Honduras
Project Size	59.6MW

Operating Date	Dec 2014
Location	CA, USA
Project Size	26MW + 26MW (Financed by Duke Energy)

Operating Date	June 2016 (ET time)
Location	Jordan
Project Size	43 MW (Financed by EBRD and Proparco)

Solar project reference.

Operating Date	June / July 2012
Location	Herzogtum Lauenburg (Schleswig-Holstein,Germany)
Project Size	24.4MW (Financed by Bremer Landesbank)

Operating Date	Dec 2015
Location	USA
Project Size	21.5 MW

Operating Date	Oct. 2014
Location	TN, the USA
Project Size	20MW

Operating Date	April, 2013
Location	City of Halberstadt, Germany
Project Size	18.2 MW (Financed by DKB)

Operating Date	Mar. 2015
Location	Rolleston Park, Tutbury, Burton-on-Trent, Staffordshire,UK
Project Size	18 MW

Operating Date	Mar. 2013
Location	MIOS (33), France
Project Size	10.4MW

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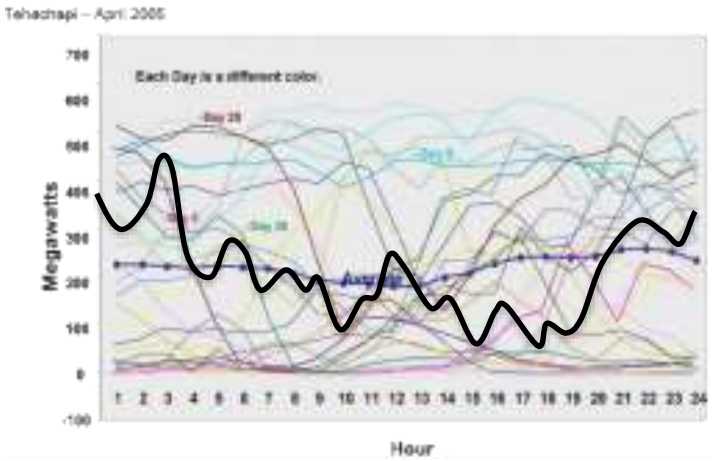
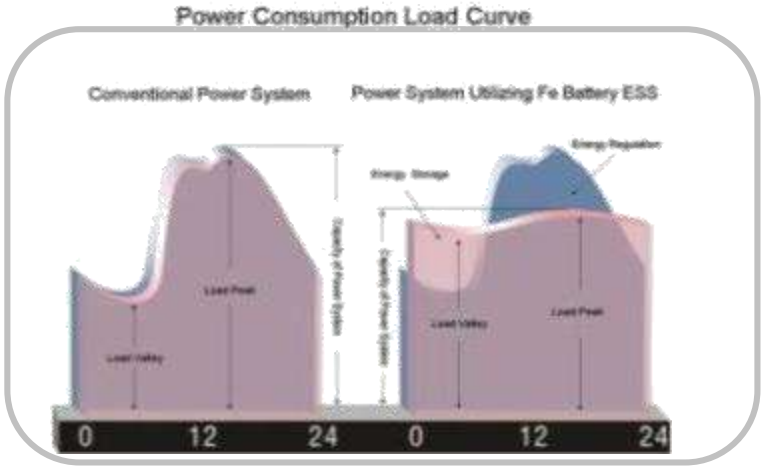
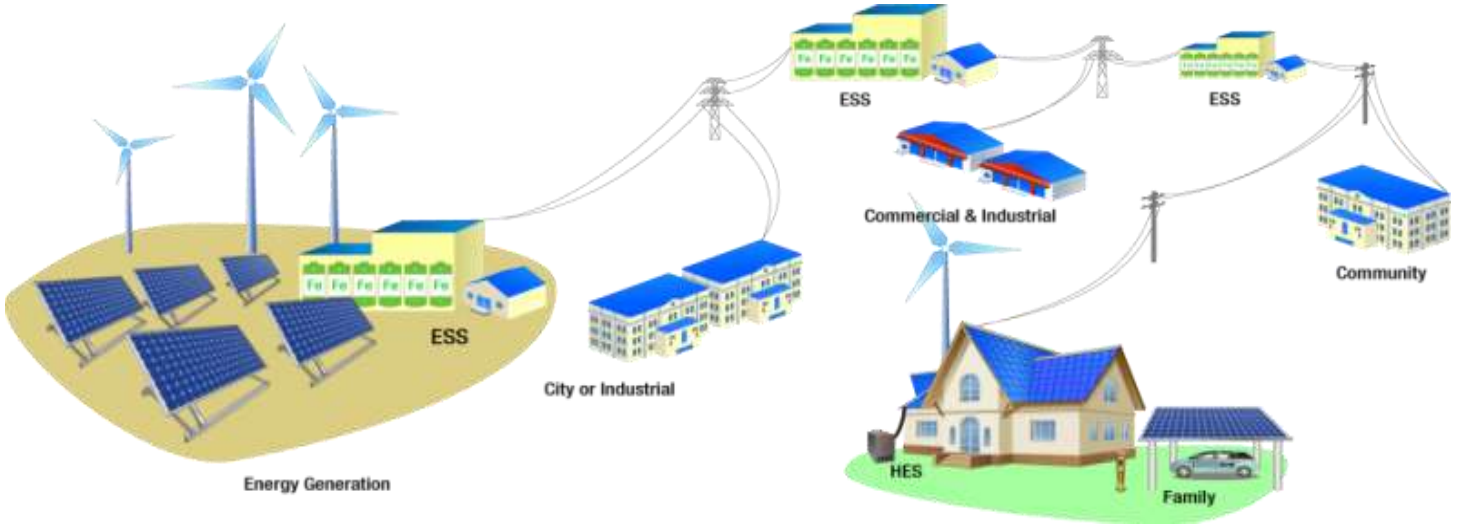
BYD Storage Introduction



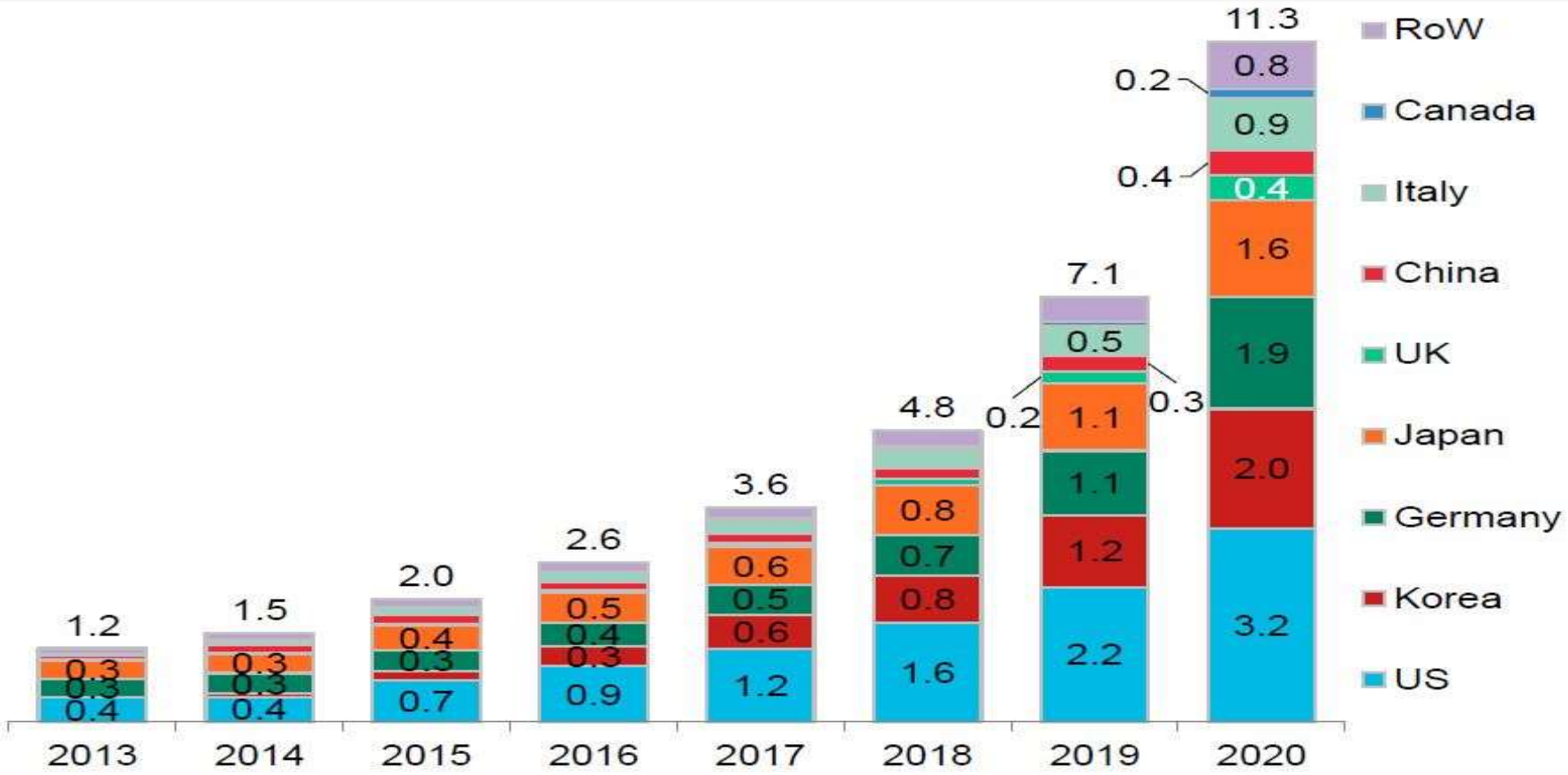


- Smooth fluctuations of the grid.
- Increase the stability and continuity of renewable energy sources.
- Frequency regulation, Improve the electricity quality.

- Peak shaving and valley filling.
- Balance electricity loads.
- Micro grid application.



Global storage market outlook

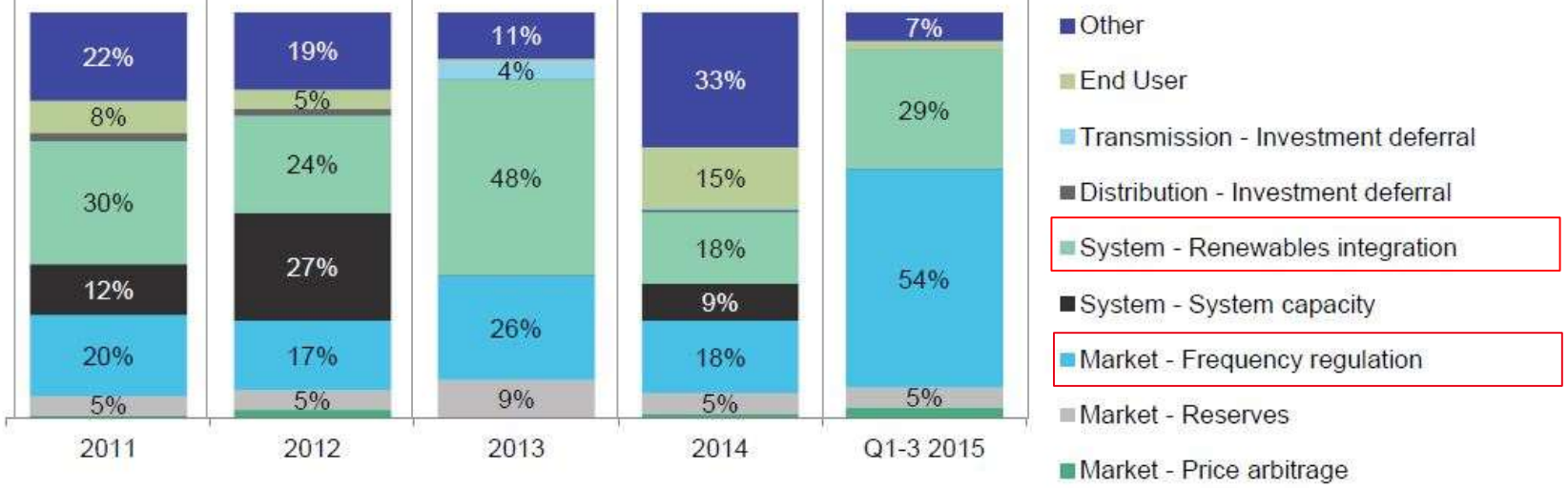


Global storage market _ application mix

Y2011	Y2012	Y2013	Y2014	Y2015
MW: 63	MW: 146	MW: 223	MW: 102	MW: 325

Renewable integration storage segment

Figure 3: Application mix of announced energy storage projects (% by MW)



Source: Bloomberg New Energy Finance Note: For underlying data, including 2009 – 2010, click here.

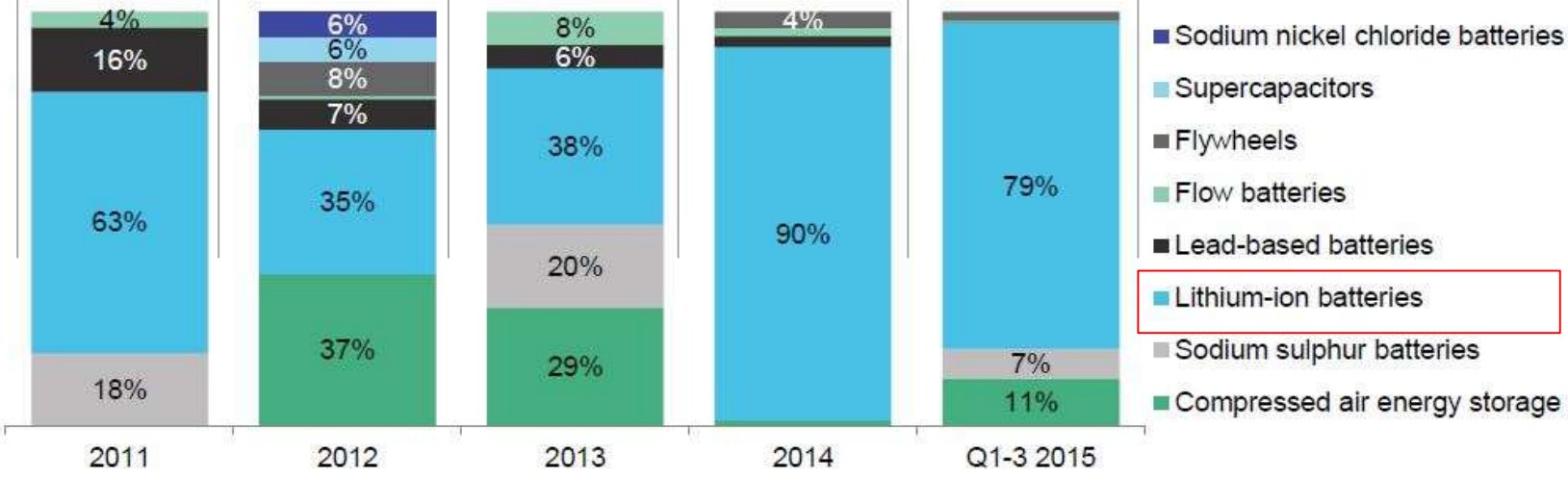
Opportunities with new business mode:
Renewable integration+ System capacity+ Frequency regulation+ Reserves+ Price arbitrage

Global storage market _ technology mix

Y2011	Y2012	Y2013	Y2014	Y2015
MW: 131	MW: 213	MW: 176	MW: 511	MW: 885

Li-ion battery segment

Figure 4: Technology mix of announced energy storage projects (% by MW)



Source: Bloomberg New Energy Finance Note: Only includes projects where the technology is disclosed. For underlying data, including 2009 – 2010, click here.

BYD's Core Technology

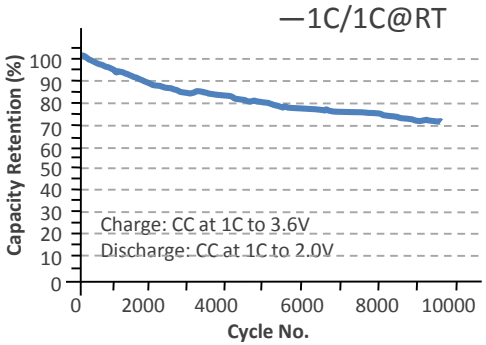
LiFeP04: Lithium Iron Phosphate Battery

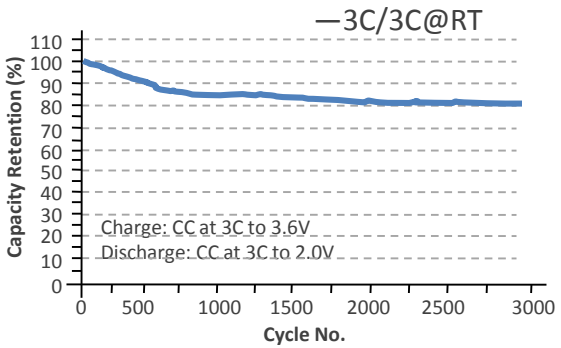
20 Years manufacture experience.

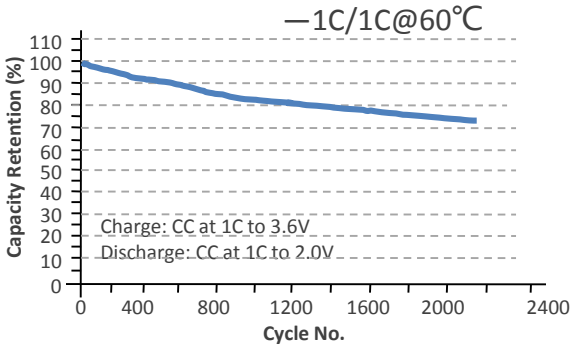
10 GWh production capacity.

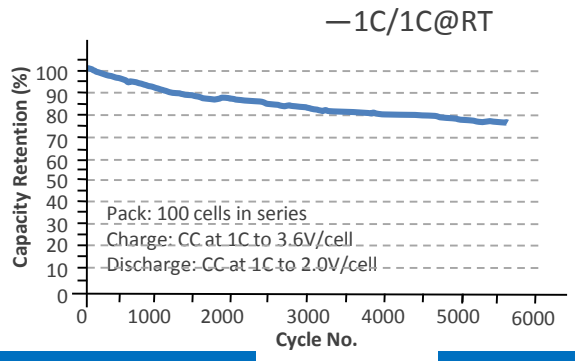
- More than 6,000 life cycles
- Excellent safety
- High power output and high energy density
- Good performance in high temperature condition

Life Cycle Tests



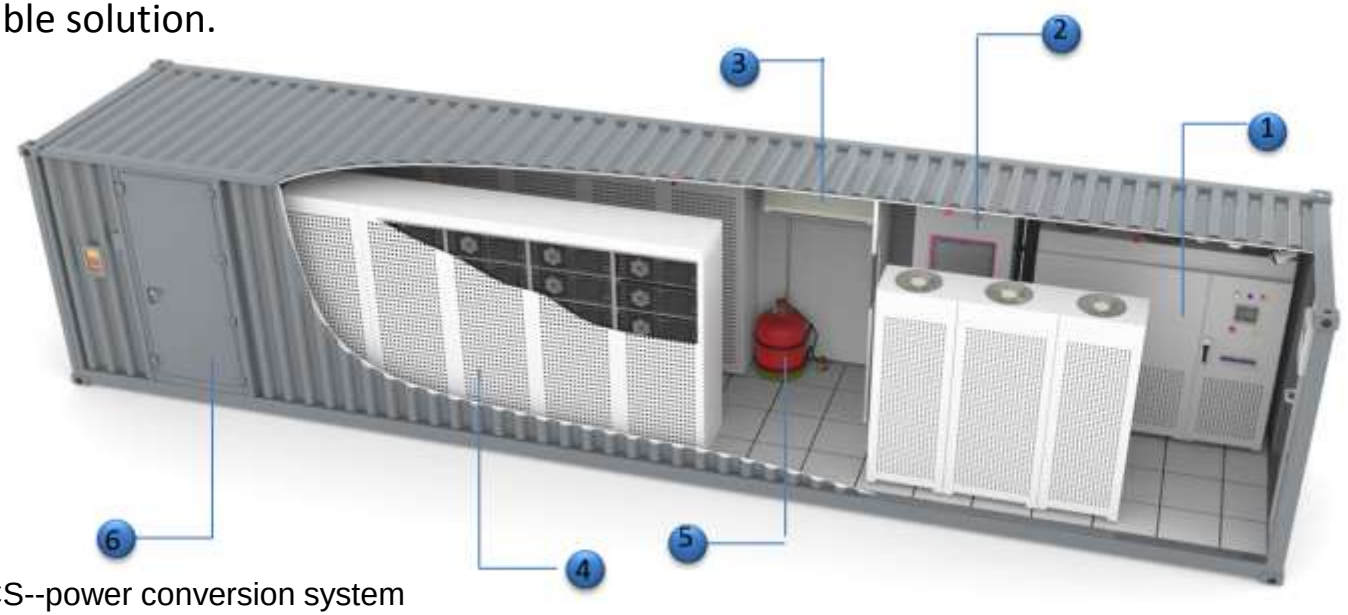






Containerized design

Containerized design based on 20ft (250KW/500KWh) or 40ft (500KW/ 1.2MWh) container for movable solution.



1. PCS--power conversion system
2. Control system
3. Temperature control system
4. Battery & BMS
5. Fire extinguishing system
6. Working door

- Peak Management
- Frequency regulation
- Smart grid
- Black start
- Stabilize new energy
- For remote area
- Voltage support

Scientific Cooling & Aseismicity Analysis, guarantee the Safe and Reliable Operation!

Chicago 31.5MW/12.06MWh

System Specification Parameter:

- System capacity：***31.5MW/12.06MWh***
- Voltage level：0.48kV（AC60Hz）
- Finish time：April, 2015
- Project location：Chicago
- Partner：RES/ Invenergy

Application

- ***20MW PV generation, 210MW wind farm***
- Peak management
- provides ***fast-response regulation service*** to the PJM market
- ***second-largest*** lithium project in the world
- Wins Energy Storage North America's 2015 ***Innovation Award***

Chevron 4MWh Project in San Francisco

Micro-grid Application

System Parameter

- System Capacity: 2MW/4MWh
- Voltage Level: 480V (AC60Hz)
- Round-trip-efficiency: around 91%
- Running since 2012 Spring

http://www.esnaexpo.com/press/release/7

RES 2.6MWh Project in USA and Canada

Frequency Regulation Application

System Parameter

- System Size: 4MW/2.6MWh
- Voltage: 480V (AC60Hz)
- Battery: BYD LFP 1.3MWh x 2
- PCS: BYD 500KW x 8
- Established time: Dec, 2013
- Location: Sunbury Ohio, USA
- Owner: RES Americas

System Parameter

- System Size: 4MW/2.6MWh
- Voltage: 480V(AC60Hz)
- Battery: BYD LFP 1.3MWh x 2
- PCS: BYD 500KW x 8
- Established time: Dec, 2013
- Location: Strathroy Ontario, Canada
- Owner: RES Canada

CGNPC 3.5 MWh Nuclear Power Plant in China

Backup power Application

System parameters

- System Size: 2.5MW/3.5MWh
- Voltage grade: 400V(AC50Hz)
- Battery: BYD LFP 700KWh x 5Units
- PCS: BYD 500KW x 5Units
- Completion time：August. 2013
- Location: Dapeng ,longgang district, Shenzhen
- Owner: CGNPC

The first ESS station as backup power for a Nuclear Station in the world

China State Grid 36MWH Project

Hybrid System Application

100MW Wind + 40MW Solar + 9MW/36MWh ESS

- ZhangBei State Grid Renewable Generation Site was designed by SGCC and is part of the National “Golden Sun” program.

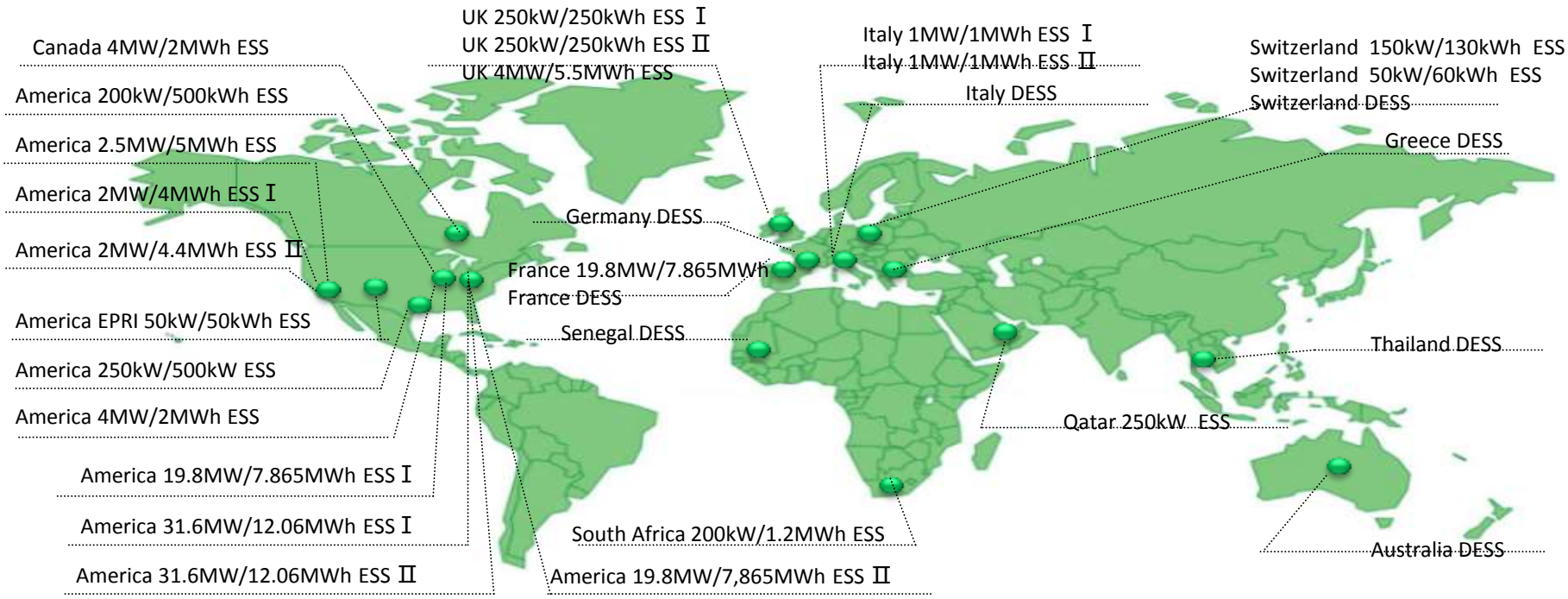
- Lots of wind farms in North of China, but the output is not stable, lots of wind power was waste. Energy Storage is deemed to be a good option to resolve this problem.

- BYD commissioned 36MWh in 12/30/11.

Global Footprints

5 Continents, 13 Countries & Regions, over 50 Cities, over 40 projects.

- **264.06MW**
- **233.645MWh**



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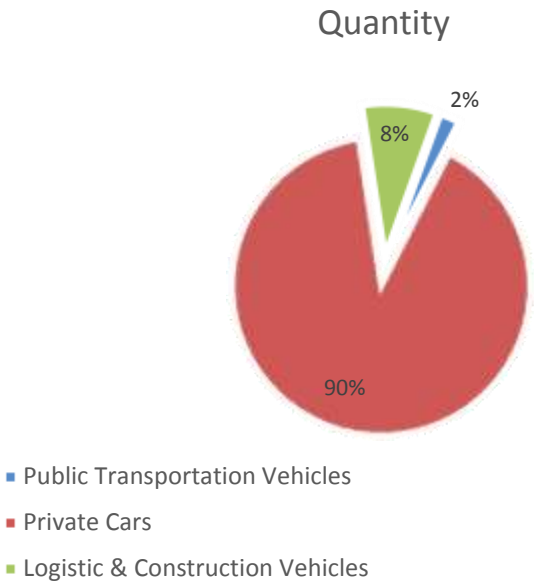
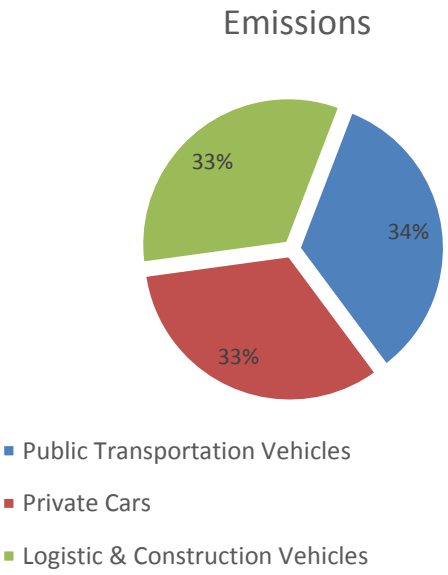
Electrified Transportation

The significance of urban electrified public transportation





Public transportation vehicles take up **2%** of the total urban auto population. But they contribute **1/3** of the total urban auto emissions.

Urgency for Public Transportation Emissions

The Emissions of One Diesel Taxi in a Given Day is Equivalent to **10** Gasoline Private Cars

The Emissions of One Bus in a Given Day is Equivalent to **30** Gasoline Private Cars

BYD Pure Electrical Car and Bus

LONGEST SINGLE TAXI DRIVING RANGE IN THE WORLD

- Driving Range : 400 KM
- Charging Time : 2h
- AC Charging
- >500 Patents

>10,000 running

THE LARGEST OPERATIONAL PURE ELECTRIC BUS FLEET

- Driving Range : 250 KM
- Charging Time : 5h
- In-Wheel Motor
- AC Charging
- >300 Patents

>6,000 running

Hybrid car:

80KM / charge

5.9s / 0~100KM/h

Sales Champion in 2014

Electrified Transportation

Electrified Transportation

In 2010, Benz-Daimler and BYD set up a joint venture to develop a pure Electric Vehicle.

BYD in Philippines---with Filipino Manny Pacquiao

Mr. Pacquiao is a proud owner of a BYD F5 Suri – he is mad about the remote control

Malaysian Transit Service Orders 15 BYD K9 Electric Buses

15 BYD electric buses operating by Rapid KL, a Prasarana subsidiary, as Kuala Lumpur's first BRT line exclusively for electric buses .

BYD with Loxley in Thailand---18th March 2015

High Praise from Prime Minister---8th Jan. 2016

BYD EV GLOBAL FOOTPRINTS

6 Continents, 48 Countries & Regions, Over 200 Cities

No.1 Globally

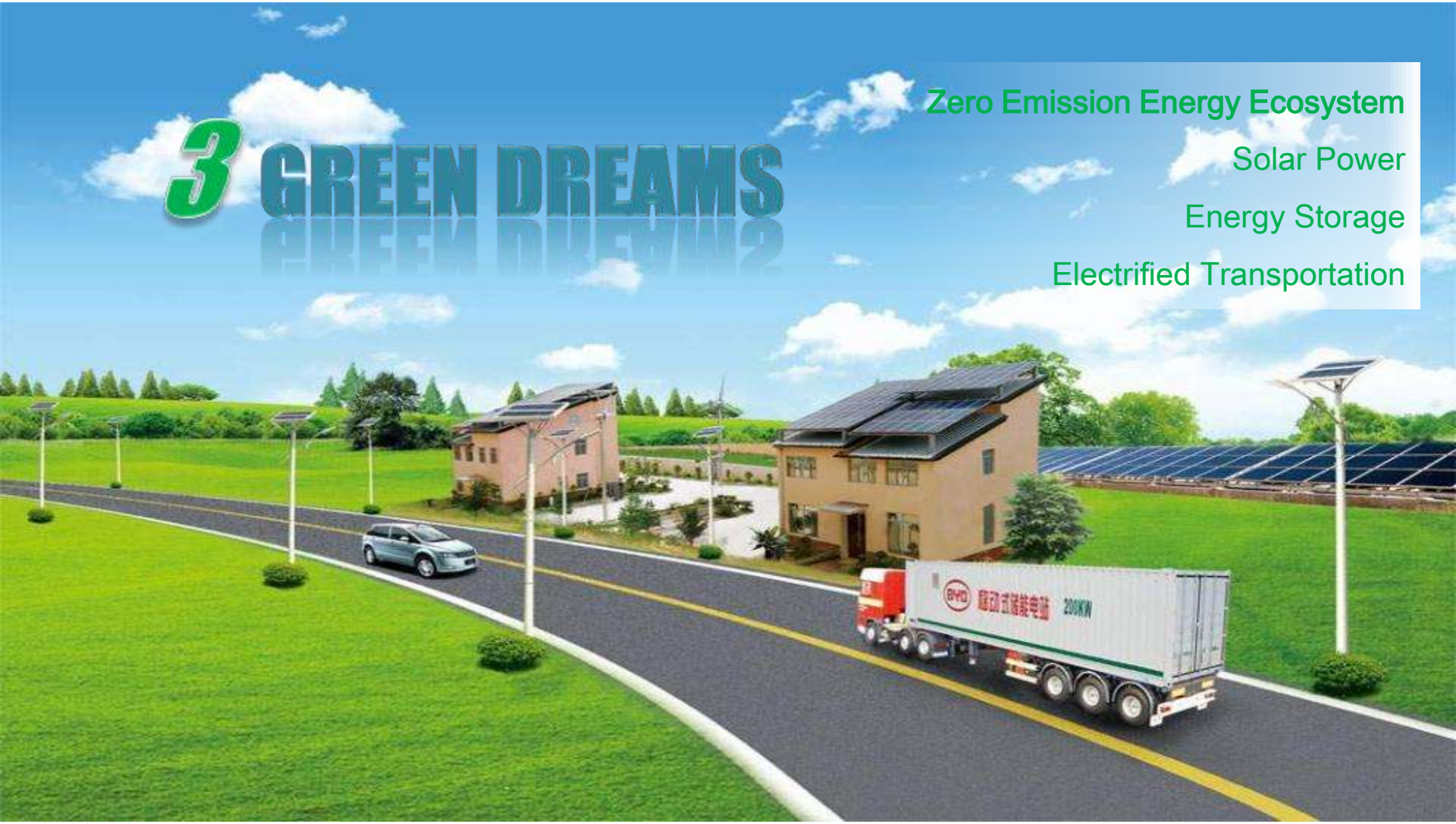
Rank	Manufacturer	Dec 2015	YTD	Global Share	2014 Ranking
1	BYD	10,925	61,722	11	7
2	Tesla	8,275	50,572	9	3
3	Mitsubishi	7,498	48,204	9	2
4	Nissan	3,960	47,671	9	1
5	Volkswagen	7,024	40,148	8	11
6	BMW	6,029	33,412	6	9
7	Kendi	6,201	28,055	5	10
8	Renault	4,234	27,282	5	8
9	Zotye	4,297	24,516	4	13
10	Ford	2,294	21,326	4	5

BYD Wins the “Zayed Future Energy Prize” 2014 —— Three Green Dreams and Green City Solution

BYD Chairman was honored “Lifetime Achievement Award”

6th Zayed Future Energy Prize Award Ceremony

3 Green Dream



Build Your Dreams!