



(주)두산

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# Fuel cells as a Clean Distributed Generation Solution

## 燃料电池，作为清洁分布式发电的解决方案

2nd International Forum on Low Carbon Development for Cities

Asia Development Bank

第二届城市低碳发展国际论坛

亚洲开发银行

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Millennium Seoul Hilton

Seoul, South Korea

September 3rd, 2019

千禧首尔希尔顿酒店

韩国首尔

2019年9月3日

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Doosan Fuel Cell

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业务战略团队

斗山燃料电池

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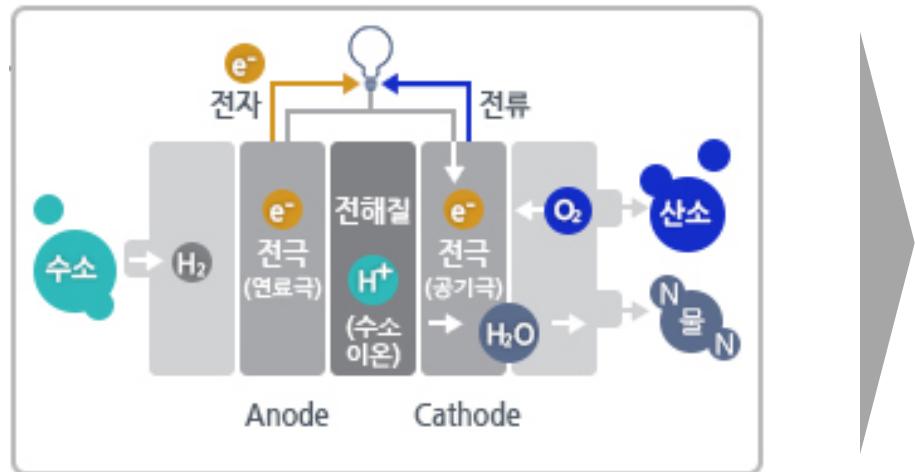
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## ■ Fuel Cell Overview 燃料电池简介

## ■ Doosan Fuel Cell Overview 斗山燃料电池介绍

# WHAT IS FUEL CELL? 什么是燃料电池？

Produce electricity, heat and water through electrochemical reactions such as oxidation and reduction of hydrogen and oxygen  
通过电化学反应产生电、热和水，例如氧化和还原氢和氧



## Anode 阳极

- Hydrogen supply electrode 氢作为电极
- Hydrogen separated into ions and electrons 氢分离成离子和电子
- Hydrogen ions move to Cathode via electrolyte 氢离子通过电解质移动到阴极

## Electrolyte 电解液

- A substance that can only pass ions, not electrons 一种只能传递离子而不是电子的物质

## Cathode 阴极

- Air supply electrode 空气作为电极
- Hydrogen ions and electrons are combined with oxygen 氢离子和电子与氧结合
- Reaction produces heat and water 化学反应产生热量和水

# DOOSAN FUEL CELL SPECIFICATIONS 斗山燃料电池规格

**PSS**  
(Power supply system)  
**供电系统**  
Generate electricity and heat  
产生电能和热能

**FPS**  
(Fuel processing system)  
**燃料处理系统**  
Converts fuel to H<sub>2</sub>  
将燃料转化为氢气

**TMS/WTS**  
(Thermal mgt/ water treatment system)  
**热管理系统/水处理系统**  
Maintain the thermal balance  
Generates hot water (120°C, 60°C)  
保持热平衡  
产生热水 ( 120°C, 60°C )

**ESM**  
(Electrical system module)  
**电气系统模块**  
Converts DC to AC  
将直流电转化为交流电

	NG 天然气	H2 氢气
Size 尺寸	• 8.3 x 2.5 x 3.0 m	
Electrical Output 电输出	• 440 kW	
Heat Output 热输出	• HG (120°C)	• HG (120°C)
Efficiency 效率	• LG (60°C)	• LG (60°C)
	• Total : 90% -E : 43% -H : 47%	• Total : 90% -E : 48% -H : 42%

• Ultralow CO<sub>2</sub> and air emissions  
• 超低二氧化碳和空气污染排放  
• Low noise and vibration  
• 低噪音和振动

# CLEAN AND QUIET 清洁且安静

## Clean 清洁

NO<sub>x</sub> (lbs/MWh)  
氮氧化物 ( 磅/兆瓦时 )

CO<sub>2</sub> (lbs/MWh)  
二氧化碳 ( 磅/兆瓦时 )



PureCell®  
Hydrogen  
氢气



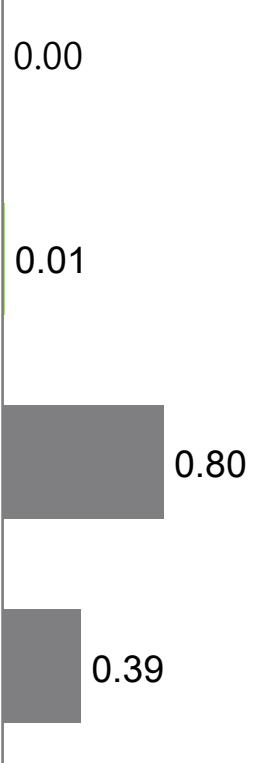
PureCell®  
NG / Biogas  
天然气/沼气



Gas Engine<sup>1)</sup>  
燃气发动机



Microturbine<sup>2)</sup>  
微型燃气轮机



## Quiet 安静

Noise @10m, dB 10米处的噪音分贝

65

65

80

70



Piano Sound  
钢琴声



Factory Noise  
工厂噪音



Piano Sound  
钢琴声

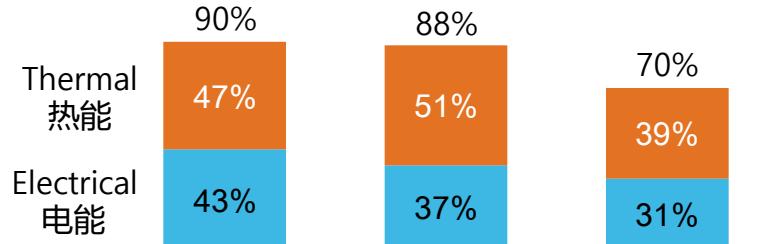
1) 600kW (Source: DOE)  
2) 320kW (Source: DOE)

# EFFICIENT & STABLE SUPPLY OF ENERGY

## 高效及稳定的能源供应

### Higher efficiency and stability 高效稳定

#### Electrical Efficiency by Sources 各能源方案的产能效率



PureCell®  
System

燃料电池



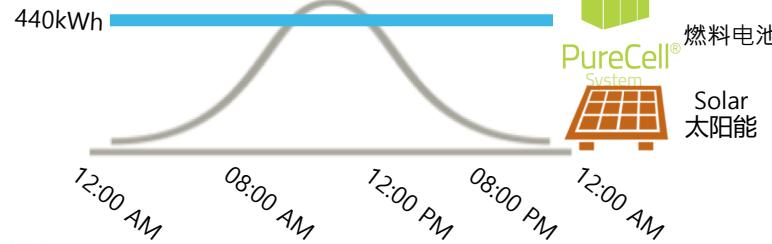
Gas engine  
燃气发动机



Microturbine  
微型燃气轮机

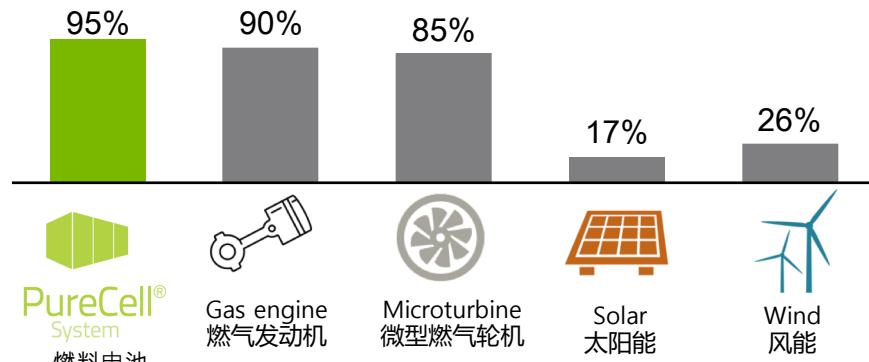
#### Hourly electricity generation vs. Solar 与太阳能相比每小时产电量

Continuous, onsite power generation 持续的现场发电

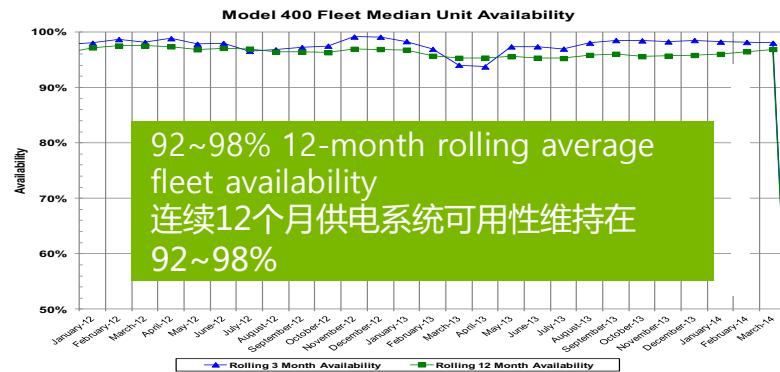


### Superior availability 可用性强

#### Availability by Sources 各能源方案的可用性



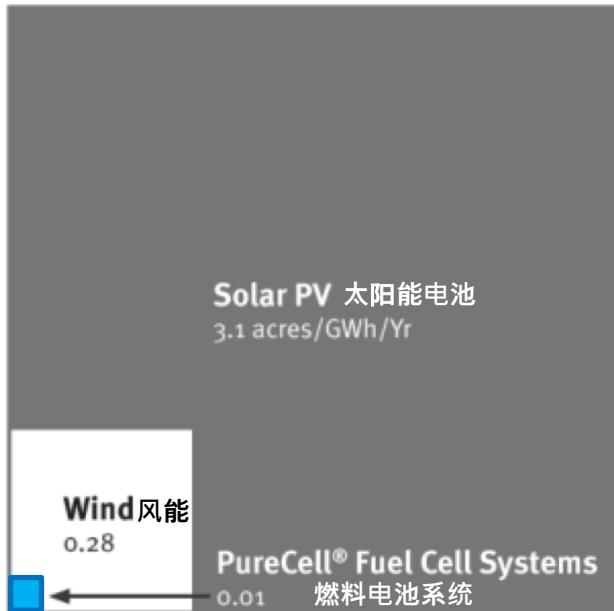
#### Monthly FC availability 燃料电池供电系统每月可用性



# FLEXIBLE INSTALLATION 安装的灵活性

## Superior space efficiency 高效的空间利用

Fuel cells require 300x less land than solar PV  
安装燃料电池所需的土地面积是太阳能电池的300分之一



## Installation Flexibility 安装的灵活性

The container box sized module (8.3m x 2.5m x 3.0m) can be installed virtually everywhere  
燃料电池仅有容器盒大小（8.3米x 2.5米x 3.0米），几乎可以被安装在任何地方

### Indoor 室内



### Rooftop 屋顶



# PRODUCT PORTFOLIO 产品介绍

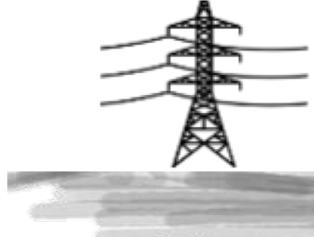
## Natural gas / Biogas Model 天然气/沼气模型

*Currently available*  
可用产品



## LPG Model 液化石油气模型

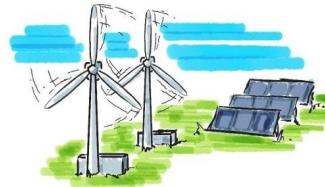
*Currently available*  
可用产品



Remote area or islands apart from the central grid  
远离中心地区的偏远地区或岛屿

## Hydrogen Model 氢气模型

*Currently available*  
可用产品



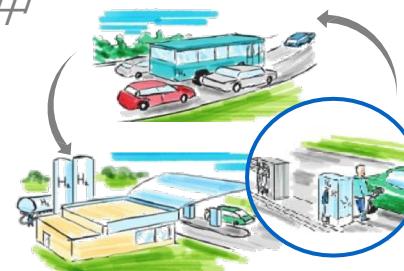
H<sub>2</sub> from renewables  
来自可再生能源的氢气



H<sub>2</sub> from facilities  
来自设备中的氢气

## Tri-Gen Model/ SMR for HRS 第三代模型/加氢站的蒸汽甲烷重整技术

*In the process of development*  
正在开发中



Power electric vehicle, hydrogen vehicle, and the nearby residents at once  
即时为电动汽车、氢能源汽车和附近居民充电

# FUEL CELL APPLICATIONS 燃料电池的应用

Application 应用场景	Main driver of using fuel cells 使用燃料电池的主要原因	Usage 使用范围	Major Clients 主要客户
Hospitals 医院	<i>Sustainable, 24/7 resilient, and safeguards quality patient care / server secure</i> 可持续、全天可用、保障高质量的患者看护/服务器安全	• Own use 自用	NHS  SAINT FRANCIS Hospital and Medical Center 
Data Centers 数据中心			1 First National Bank One with You. 
Universities 大学	<i>Sustainable, resilient, and quiet</i> 可持续、弹性、安静	• Own use 自用 • Excess energy sold to nearby areas 多余的能量销往附近地区	UCONN UNIVERSITY OF CONNECTICUT 
Buildings 建筑物			360 state  Hilton 
Municipals 市政	<i>Low-emission energy</i> 低排放能源	• Nearby areas 附近地区	ABERDEEN CITY COUNCIL 
Utilities 公共设施			KHNP
O&Gs 石油和天然气	<i>Byproduct Hydrogen utilization</i> 副产物氢的利用	• Own use 自用 • Nearby areas 附近地区	Hanwha  TOTAL 
DOOSAN			

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## Key Figures 关键数据 (2018)

\$18.2B

### Revenue

- Global: \$12.3B (60% of total)

**营业利润182亿韩元**

- 海外 : 123亿韩元 ( 占总量的  
60% )

39.4K

### Employees

(KOR + Global)

**3.94万名员工**  
( 韩国+海外 )



## DOOSAN CORPORATION 斗山公司

- Fuel Cell BG 燃料电池商业集团
- Electro-Materials BG 电子材料商业集团
- Industrial Vehicle BG 产业车辆商业集团
- Mottrol BG Mottrol商业集团

\*BG : Business Group 商业集团

## DOOSAN HEAVY INDUSTRIES 斗山重工业

Power solutions and generation equipment  
电力解决方案和发电设备

## DOOSAN INFRACORE / BOBCAT 斗山工程机械/山猫

Construction equipment, portable power and  
hydraulic components  
施工设备、移动动力和液压装置

## DOOSAN CONSTRUCTION 斗山建设

Civil and architectural works and oil and gas  
plant equipment manufacture  
土木和建筑工程 , 以及石油和天然气工厂设备制  
造商

## DOOSAN ENGINE 斗山发动机

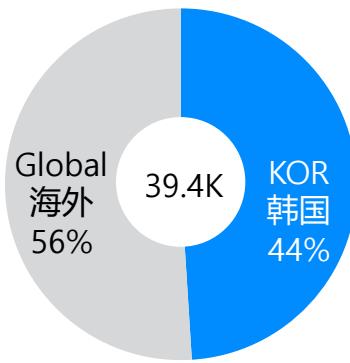
Wide range of engines of all sizes to  
generate for a variety of industrial uses  
可用于各种工业用途的各种尺寸的发动机



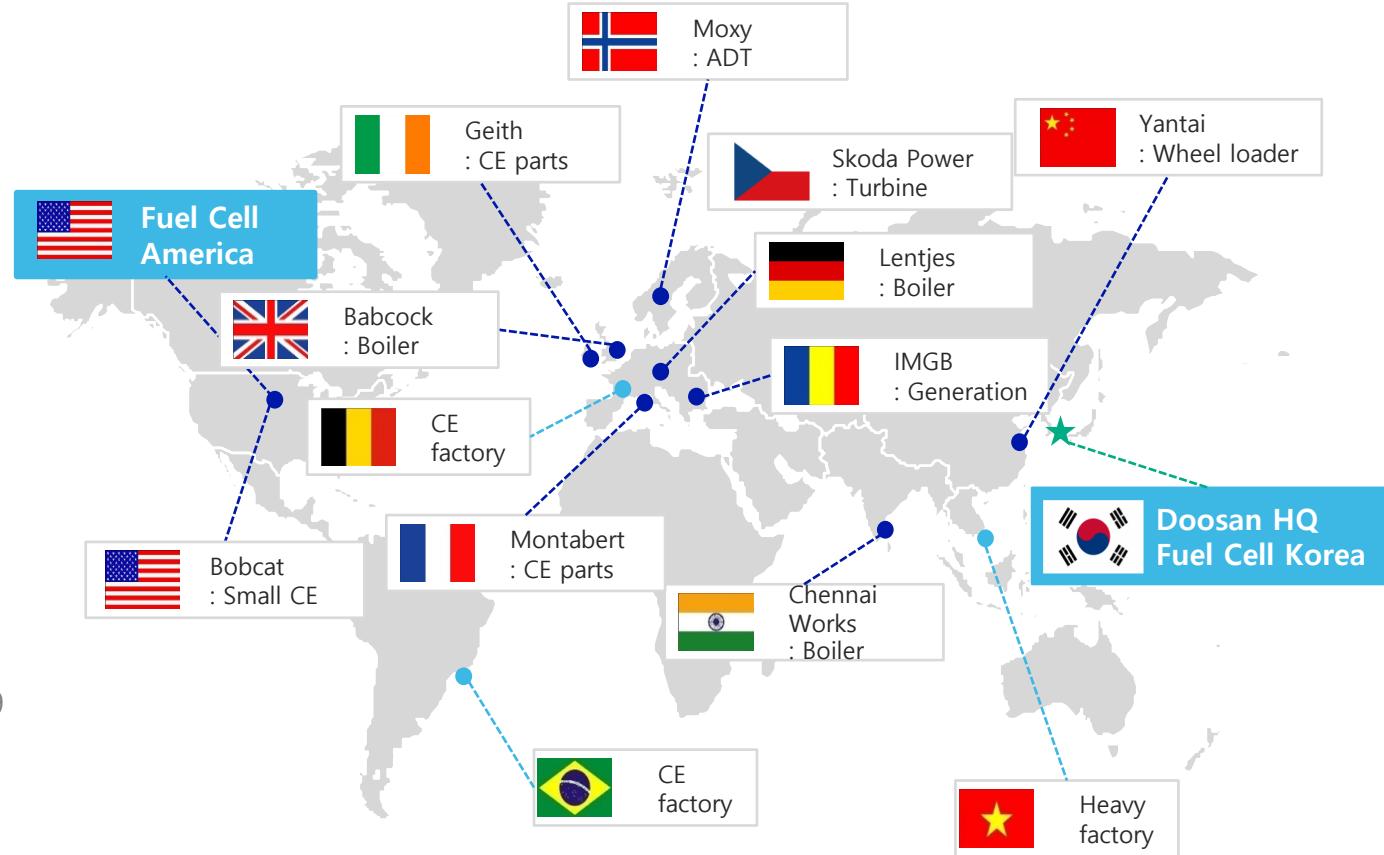
# DOOSAN GROUP GLOBAL PRESENCE

## 斗山集团在全球的分布

Employees (2018)  
2018年员工分布



- ✓ Overseas affiliate 海外子公司 36
- ✓ Overseas entity 海外实体 109



# DOOSAN FUEL CELL 斗山燃料电池

50  
Years

Fuel Cell experience

50年在燃料电池领域的经验

Founded in '14 following the acquisition of  
UTC power

收购联合技术动力公司后，于14年成立

300+

Innovative employees

超过300名富有创造力的员工

Based in Korea and U.S.

办公地点设在韩国和美国

250+

Patents

超过250项专利

Largest stationary fuel cell IP portfolio, thanks  
to the leading-edge R&D staff

凭借领先的研发人员，拥有最大的固定式燃料电池  
产品的知识产权

+285  
MW

of Installed Capacity

超过285兆瓦的装机容量

Doosan has focused on being #1 global  
leader in Fuel Cells

斗山一直致力于成为燃料电池领域的全球领导者 (2019)



# GLOBAL PureCell 400® FLEET

## 全球PureCell-400型磷酸燃料电池供电系统

In operation :

运营中：

170 MW (395 units)

170兆瓦 ( 395个 )

Under construction : 227 MW (514 units)

建设中：

227兆瓦 ( 514个 )

US 美国



C&I\* centric market  
市场以商业和工业建筑为主

- In operation : 36 MW (89 units)
- 运营中 : 36兆瓦 ( 89个 )
- Contracted & Awarded: 29MW (64 units)
- 已签约 : 29兆瓦 ( 64个 )
- Major application 主要应用



Data Center  
数据中心



University  
大学



Commercial Bldg  
商业建筑

Korea 韩国



Utility centric market

市场以公共设施为主

• In operation : 134 MW (306 units)

• 运营中 : 134兆瓦 ( 306个 )

• Under construction : 197 MW (447 units)

• 建设中 : 197兆瓦 ( 447个 )

• Major application – Utilities 主要应用 – 公共设施



UK 英国



C&I\* centric market  
市场以商业和工业建筑为主

- Under construction : 1.2 MW (3 units)
- 建设中 : 1.2兆瓦 ( 3个 )
- Major application 主要应用



Commercial  
Bldg  
商业建筑



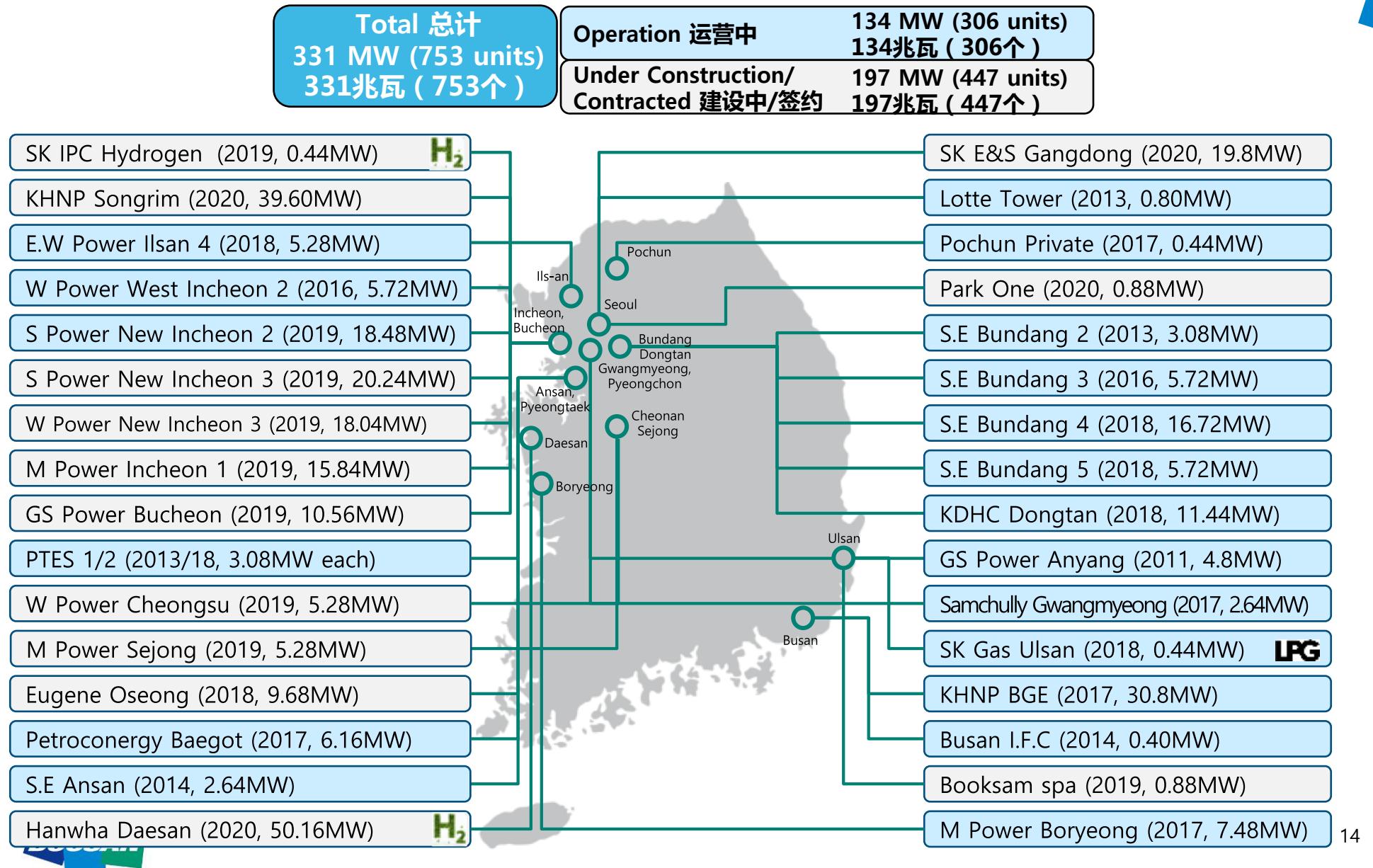
Hospital  
医院



Wastewater  
Facilities  
废水处理设施

# KOREA PureCell 400® FLEET

## 韩国PureCell-400型磷酸燃料电池供电系统



# MANUFACTURING FACILITY 生产设施

**120 MW production facility 120兆瓦的生产设施**

*with over 50 years of manufacturing experience  
拥有超过50年的制造经验*



**1<sup>ST</sup> FACTORY** Connecticut, U.S.

60MW production facility

**第一家工厂位于美国康涅狄格**  
60兆瓦的生产设施



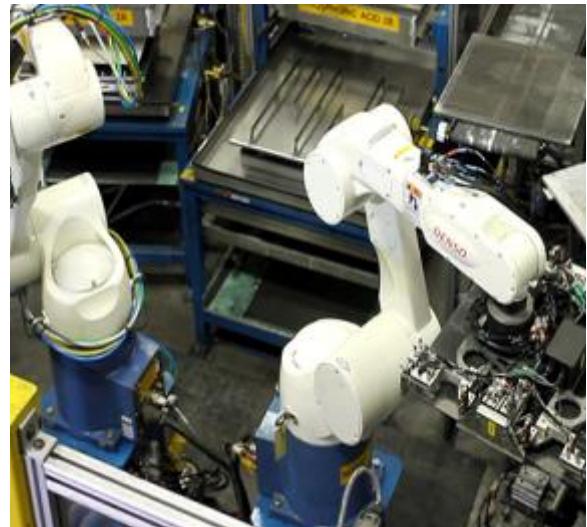
**2nd FACTORY** Iksan, Korea

60MW production facility

**第二家工厂位于韩国益山**  
60兆瓦的生产设施

**World-Class Quality System**  
**世界一流的质量体系**

*Leveraging aerospace legacy  
利用航空航天遗产*



- Automated cell stack fabrication and assembly

- Long term strategic suppliers

- State-of-the-art factory performance test

- ISO 9001 & ISO 14001 Certified

- 自动化电池堆制造和组装

- 长期战略供应商

- 通过最先进的工厂性能测试

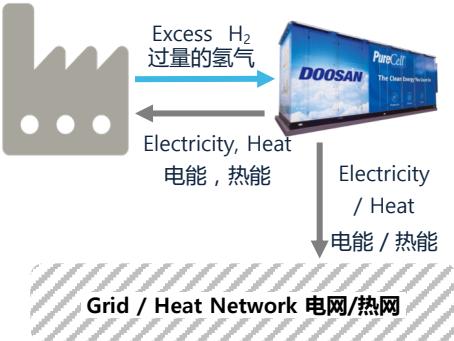
- 通过ISO 9001和ISO 14001认证

# NEW APPLICATIONS 新应用

## Description 详情

### By-product H<sub>2</sub> from chemical plants 来自化工厂的副产物氢

- Vent-off H<sub>2</sub> from Petrochemical plants etc. can be utilized to supply captive energy by using FC
- 通过燃料池，可以利用石化厂等排放的氢气来提供能量

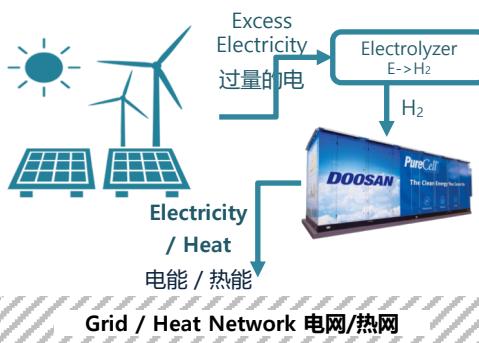


## Advantages 优势

- Commercial utilization of excess H<sub>2</sub>
- 'Zero' emission
- Improved Air Quality
- 对于过量氢气的商业利用
- “零”排放
- 改善空气质量

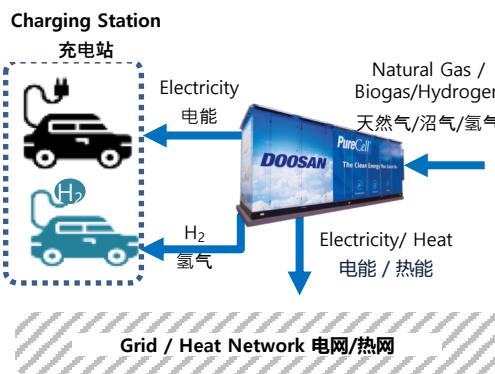
### Power To Power 能量间的转换

- Hydrogen is produced with the electricity from the renewables then the hydrogen can be used to generate electricity with fuel cell
- 利用来自可再生能源的电力产生氢气，然后氢气可用于燃料电池发电



- Compliment intermittency
- Improved flexibility options (hydrogen can be stored)
- 间歇间的补充
- 提高选择的灵活性 ( 氢可以存储 )

### Tri-Gen 第三代



- Better financial stability
- Reduced Carbon
- Improved Air Quality
- 更好的财务稳定性
- 减少碳排放
- 改善空气质量



Thank You.  
谢谢