



Cleantech Forum **Asia**

Singapore | November 13-14, 2018



Cleantech Forum **Asia** | Singapore

The “Next-Gen Energy”
Innovation Showcase:
Meet International Innovation
Companies Looking for Capital &
Partners



Cleantech Forum **Asia** | Singapore

“Next-Gen Energy” Innovation Showcase



JULES BESNAINOU
Director, Cleantech Group



Cleantech Forum **Asia** | Singapore

“Next-Gen Energy” Innovation Showcase



THOMAS ESSER

Director Investor Relations & Partnering, Sigen

The world needs off-grid power

Siqens is set to replace the diesel generator



Key enabler: patented methanol fuel cell technology

Plug-and-play battery charging solution, noiseless and emission free

SIQENS



- Internationally patented IP
- CE certified commercial product
- Compatible with all batteries

- 3000 h service interval
- 70% reduced fuel cost
- >99% reduced emissions

Commercial early adopters: stationary off-grid systems

Market access through system integrators -replacing fuel cells and conventional generators



Wind industry



Traffic surveillance



Flight security



TETRA network



Why our clients buy:

- Profitable business cases
- Up to 70 % lower fuel cost than Diesel generators
- Runs on any methanol
- All climatic zones: -30-+50° C
- Deployment in < 3 h
- Unattended monitored operation
- No Hydrogen cylinder rental
- Lower cost and more power than other fuel cells
- Highest efficiency

Why we scale: Sigen's can save \$956,000,000/y on Diesel fuel

Our methanol fuel cell is key to reduce Telecom Network OPEX & emissions



India Telecom networks 2017

400,000 towers

720,000,000 l Diesel

Fuel cost:

Diesel: 1,06\$/l

Methanol 0,26 \$/l

China

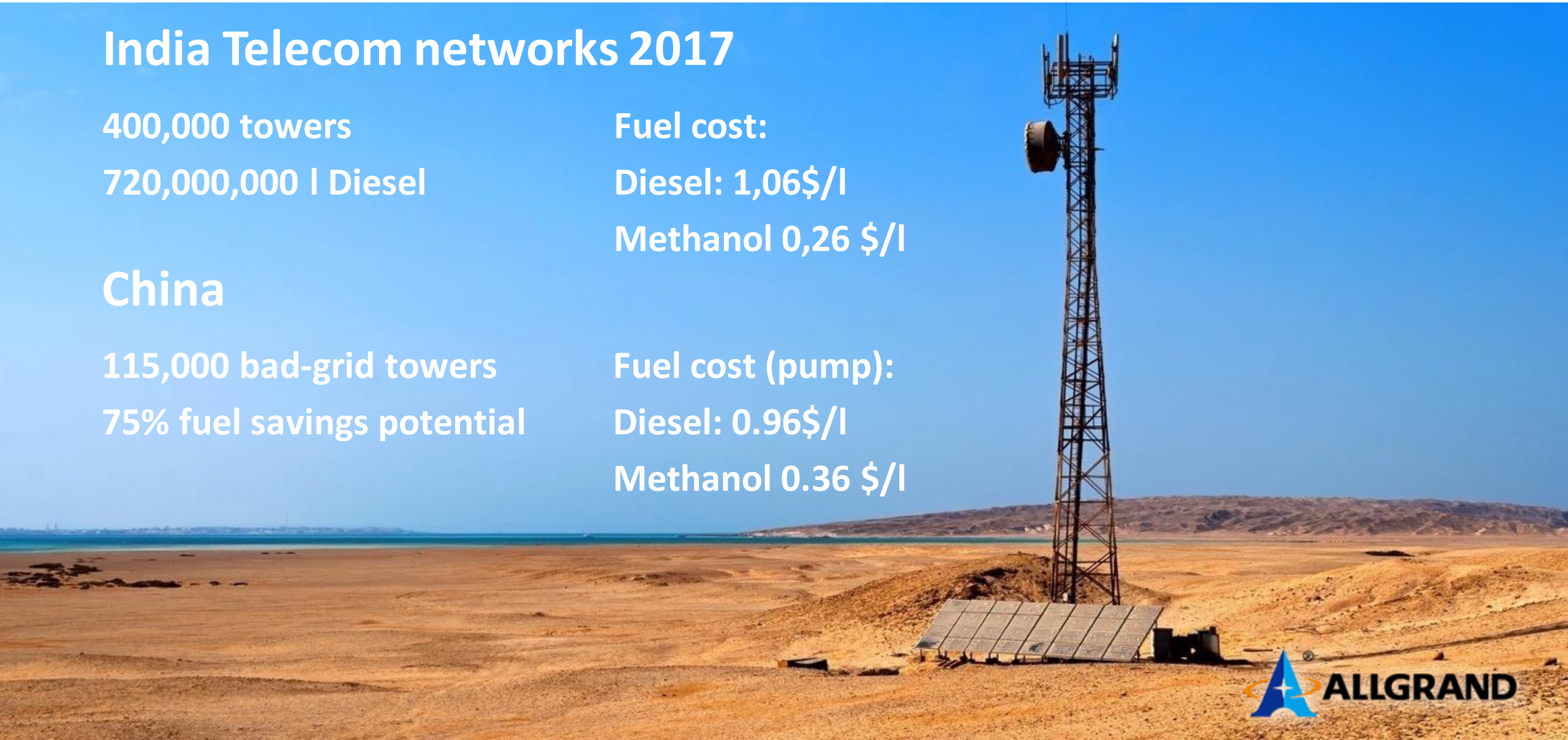
115,000 bad-grid towers

75% fuel savings potential

Fuel cost (pump):

Diesel: 0.96\$/l

Methanol 0.36 \$/l



Megatrend: e-delivery services and urban electric mobility

Our methanol fuel cell enables new mobility visions



Electricity



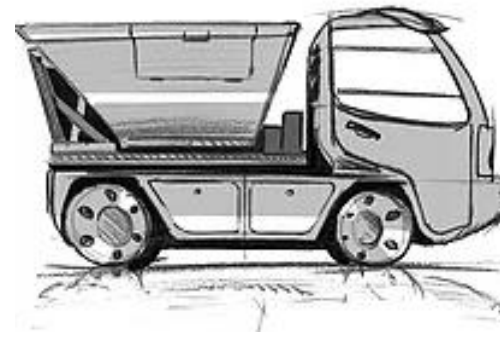
Waste heat



70% more range



Independence of charging infrastructure



Heating for the driver cabin and batteries



© MUP technologies GmbH

Maintains the cooling chain for food e-delivery

Megatrend: autonomous vehicles and urban mobility

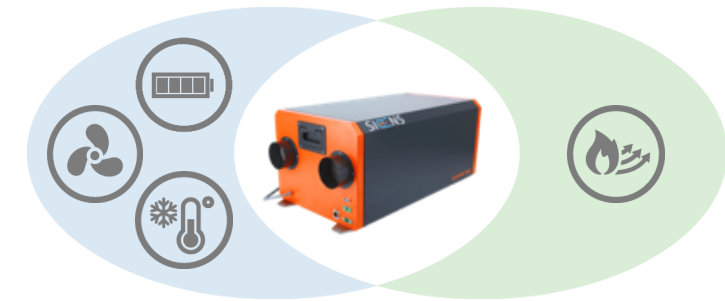
Our methanol fuel cell enables new mobility visions

SI⁺ENS



Electricity

Heat



Independence of charging infrastructure for the future of urban mobility

Our Key to success: The #1 future fuel is Methanol

Globally available hydrogen carrier from conventional and renewable feedstock



\$\$ Up to 70% cheaper than Diesel



Worldwide available commodity, 99% lower cost infrastructure



Strategic reduction of oil imports



#1 Power to liquid electro fuel in Germany, #1 future fuel in China & India



Pathways to clean fuel: CO₂ capture, non-food biomass, waste to fuel

**Eilhard
Stohldreier**
Director R&D

Volker Harbusch
CEO, Founder

Stefan Weis
CFO

Thomas Esser
Director Sales
& Investor Relations

Klaus Wanek
Director Production
& Operations

SIENS

**Our Investment
board members**



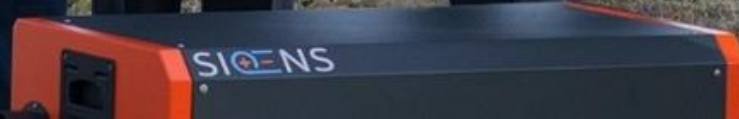
Peter Auner



Michael Kesper

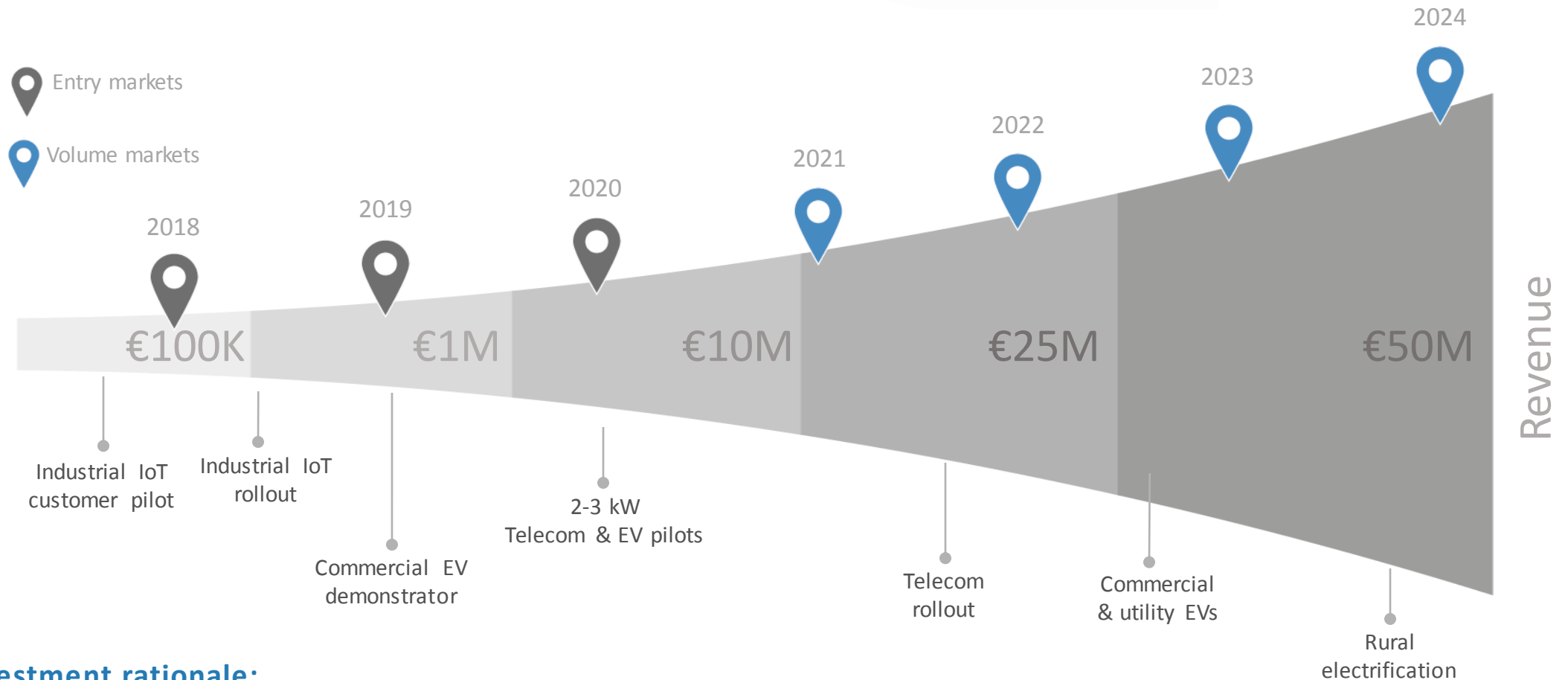
The right mix to build our business

Our management team combines diversity and operational excellence with more than 70 years of fuel cell experience



Our market roadmap to a >€10,000,000,000 opportunity

We need €3 M to achieve market proof and become cash flow positive.



Investment rationale:

- Existing product – low technological risk
- Low barriers – existing fuel infrastructure
- Protected IP
- Proven team
- Cost reduction by volume & known technologies
- Target price <€4,000/kW @ 10,000 units



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SKI MILBURN

Founder & CEO, VAIREX Air Systems

VAIREX-高性能燃料电池 空气压缩机

从此，人类即将与火力发电
的时代告别



能源使用：全面电气化

Urban Transport

Renewable Energy

Hydrogen & Fuel Cells



什么是燃料电池？

Electricity Without Fire



- Hydrogen & Other Fuels
- Phones to Powerplants
- Urban Transport in China

Growing Fast in ROW: 40% /yr

Faster in China: >100% /yr

燃料电池应用之一

Urban Autos, Trucks & Buses

- Urban Air Quality / Climate Change
- Proposal to Ban Sale of ICE Vehicles ASAP
- Aggressive Incentives: Pivot From BEV to FCEV

1 Million Fuel Cell Vehicles in 5 Years



Company Description

Manufacturer of Advanced Fuel Cell Compressors

- **Strongest Critical Factors**

Developed for Needs of Fuel Cell Industry

Best Technology, Best Value

Fuel Cell Focus: Over 10 Years in Industry

Globally Respected Brand, Now Available in China !



燃料电池应用之二

Fuel Cell Forklifts

- **24/7 Warehouse & Manufacturing Sites**
First Big Market in USA, China Has Largest Need
- **VAIREX Working With Top 4 FC + China**

Shipping 1,000's, Growing Fast



燃料电池应用之三

Fuel Cell Hybrid Electric Vehicles

- **Based on Existing Battery Evs**
 - Adds Small Fuel Cell to Double Range
- **VAIREX Working with Top 3 + China**

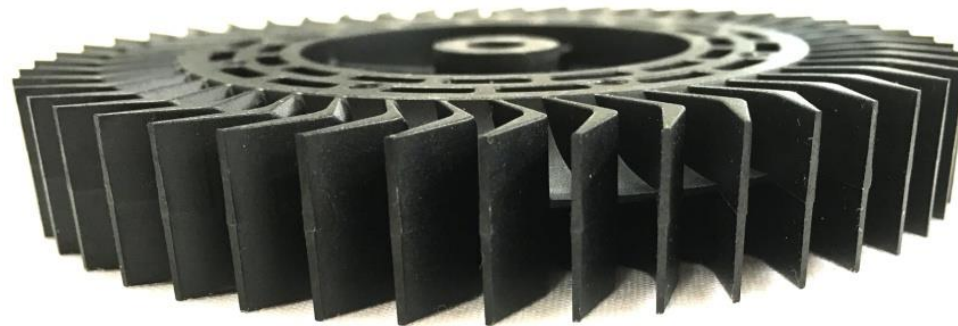
Shipping 100's, Growing Fast



突破性技术

Radical Simplicity Drives Business Model

**We didn't start with complex technology
and try to make it cheap enough**



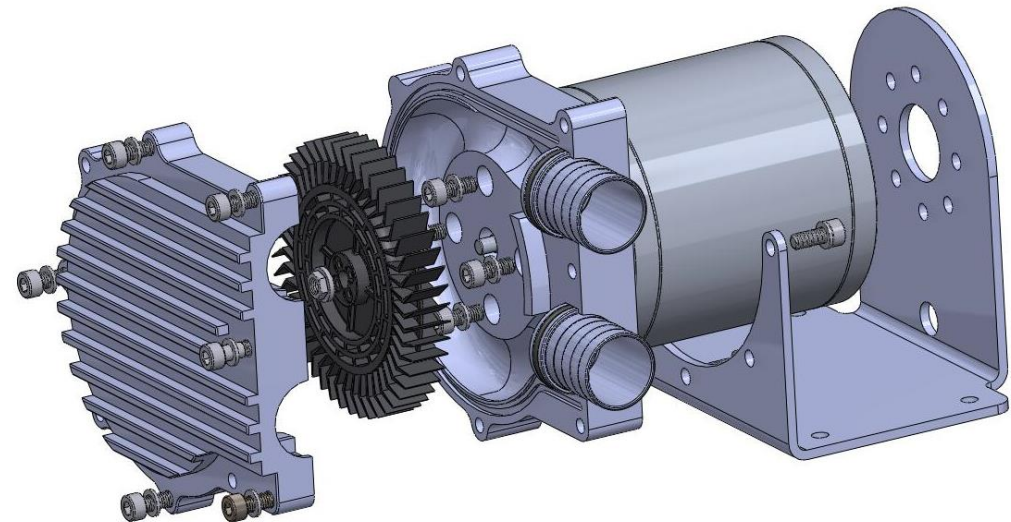
**We started with the simplest possible technology
and made it good enough**

突破性技术

Most Simple Solution

- **Patented Regenerative Compressor**
Only One Moving Part
Inexpensive to Tool & Manufacture
Low Cost, Long Life, Compact

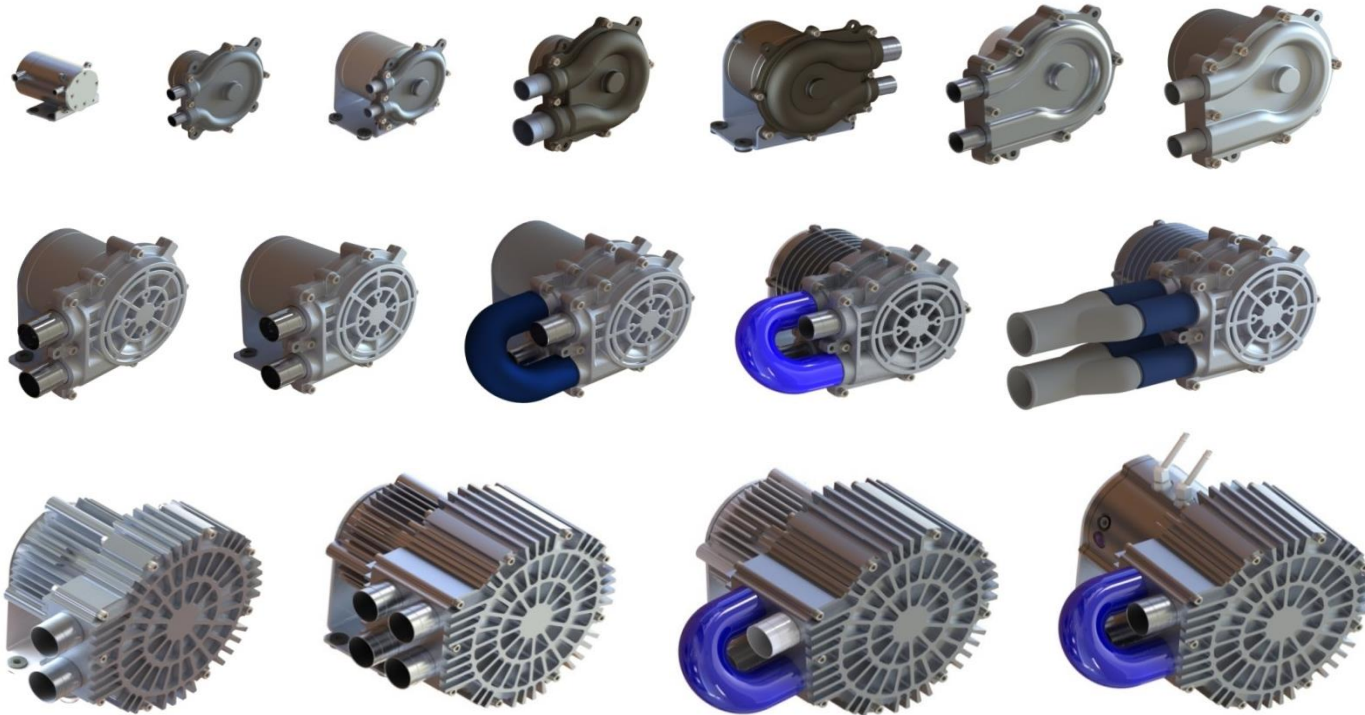
Technology Leader



高性能空压机产品系列



Products for 1-30 kW Fuel Cells



7,000 Compressors Delivered
10's of Millions of Hours of Operation

中国市场产品系列

For 45 kW Fuel Cells & Up

- Cathode Air Compressors
- Hydrogen Recirculation Blowers

Fuel Cell Vehicles Need One of Each



CAB VRC44, VRC64



HRB HRB16, HRB32

世界一流的生产技术

Simple, Fast High Precision Assembly

- **VAIREX Colorado HQ**
Capacity >60,000 Units / yr
Assembly Time < 15 min (Test 100% of production)
- **Low Cost Manufacturing System**

Manufacturing in China ASAP



中国与世界市场前景



China Emerging as Our Largest Market

- **Assumptions**

China AT&B Grows @ 3% /yr:	50 m by 2040
China AT&B Market:	100% EV by 2040
Fuel Cell Market Share	33% of EV Market
VAIREX Market Share	40%

China Non-AT&B & ROE Fuel Cell Revenues Excluded

VAIREX Projected China Revenues

CNY 100 Million in 2019

CNY 2 Billion in 5 years

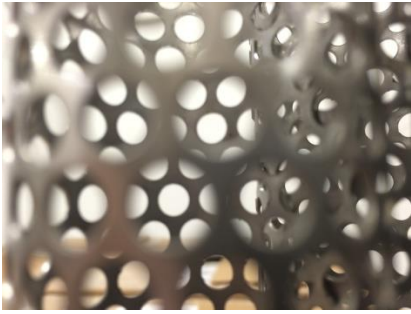
现阶段在中国的寻求目标

Capital and Manufacturing Partners

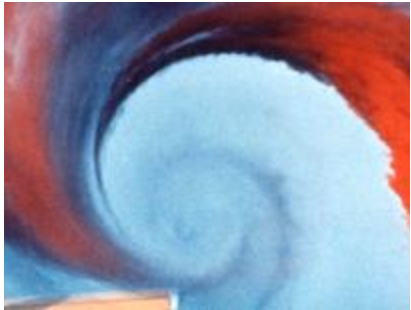
- **Build Our Existing Global Business**
- **Aggressively Pursue China Market**

Looking for the Best Partners





Ski Muir Milburn
Chief Executive Officer
 VAIREX air systems
 Boulder, Colorado
 USA
milburnski@vairex.com



Jim Hishinuma
President
 VAIREX asia pacific
 Tokyo
 Japan
jim_hishinuma@vairex.com



Eric Wu
Sales Manager
 MOOG Components Group
 Shanghai
 China
ewu@moog.com



Sammy CHOI
President
 Choi Technics
 Seoul
 Korea
choi@choistechnics.com

VAIREX

高性能燃料电池压缩机



迄今为止已获得的奖项

- **State of Colorado Grants 2015**
- **President's Export Award 2016**
- **Governor's Export Award 2017**
- **InnoSTARS Best in Show 2018**



经验丰富的管理团队



Ski Milburn 苗彬

首席执行官 CEO

40+ yrs Serial Cleantech Entrepreneur, Senior Executive
B Architecture (Honors), University of Colorado



Joel Oakman

首席技术官 CTO

30+ yrs Aerospace & Auto Engineering & Manufacturing
BS Mechanical Engineering (Special Honors), University of Colorado Denver



Kathy Heidebrecht

首席运营官 COO

25+ yrs Operations Management, Software Engineering
MS Comp Sci, University of Illinois, BS Comp Sci RPI (Cum Laude)



Tom Tunner

首席财务官 CFO

25+ yrs Consulting CFO, CPA, Tax Accounting
BS Accounting, University of Denver



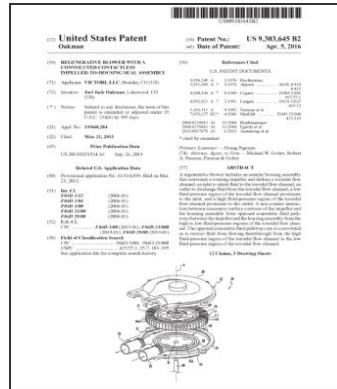
Jim Hishinuma

亚太区总裁 Asia Pacific

35+ yrs Diesel Industry Senior Executive
Tokyo Business School

知识产权保护

Rapidly Evolving Body of Work



- **US Patent 9,303,645 B2**
Regenerative Blower With Convoluted Contactless...
Pending in EU, Japan & Korea

- **US Provisional Patent Application**
Regenerative Blower-compressor With ...
In Preparation for EU, Japan, Korea & China



- **US Trademark**
Trademark Applications Approved in China, Pending in Korea
- **Know-How & Trade Secrets**

竞争优势

再生式与双螺杆式压缩机的对比

Half the Weight

A Quarter of the Cost

An Eighth of the Parts

And None of the Complexity

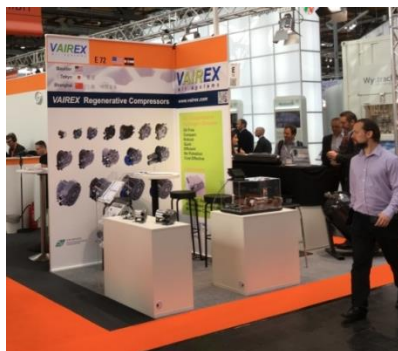


销售策略



长期合作、相互信任、面对面直销

- **Direct Sales/Technical Support Model**
VAIREX HQ in Boulder, Colorado, USA
Most Sales Contacts Start at www.vairex.com
- **Trade Show Presence**
Hannover, Tokyo, Beijing
- **Local Sales Offices**
Tokyo, Seoul, Shanghai



中国燃料电池现状总结

世界燃料电池竞赛最可能的优胜者：中国

- **Strongest Critical Factors**

 - Critical Need: Urban Air Quality Crisis

 - Opportunity to Leapfrog Technology

 - Demonstrated Ability to Rapidly Scale Industry

 - Strongest Government Commitment

- **Requires Rapid Technology Acquisition**

 - Lack of Domestic Fuel Cell Technology Base

 - Tech Transfer Well Underway

 - Process Proven in Wind, Solar, HS Rail etc





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SUNITTYAGI

Chief Technology Officer & Co-Founder, igrenEnergy

igrenEnergi: Optimizing Energy Storage & Use

- **Goals**

- Increase adoption of clean energy and storage
- Improve storage performance in Cost, Capacity, Life ~ 2x
 - Batteries for EVs and seamless second life use

- **Status**

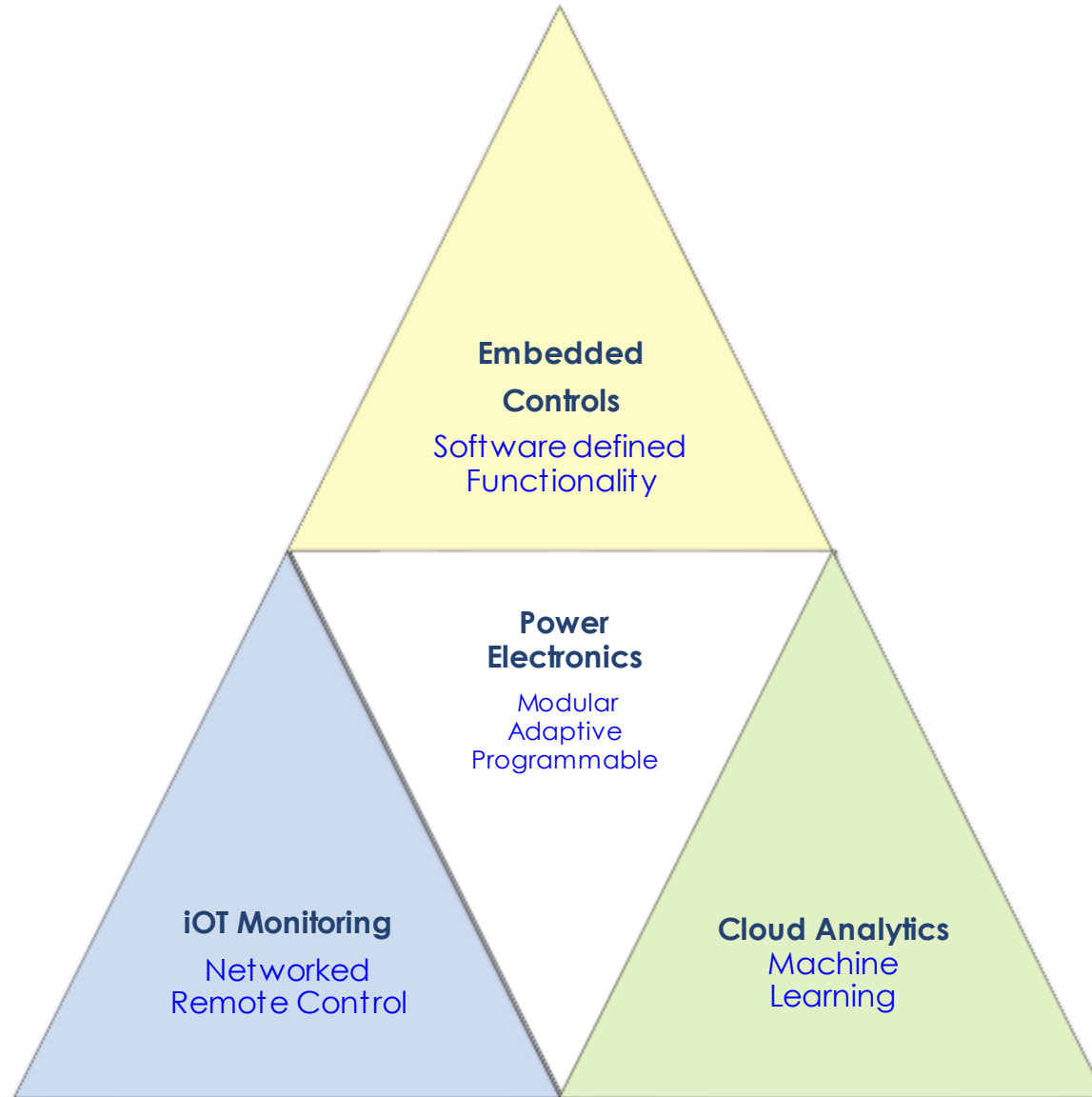
- Field proven technology platform for smart power ready for Solar
- igrenEnergi is developing smart bricks of smaller sized cells
- Hierarchical modular battery & smart BMS with our technologies

- **Aims**

- Expand our strategic partnerships and B2B channels
- Reduce costs using innovative technology & integration roadmap
- Seeking Series A or Strategic Partners



Proprietary Technology Platform



Awarded 3 US Patents
Several provisional filed

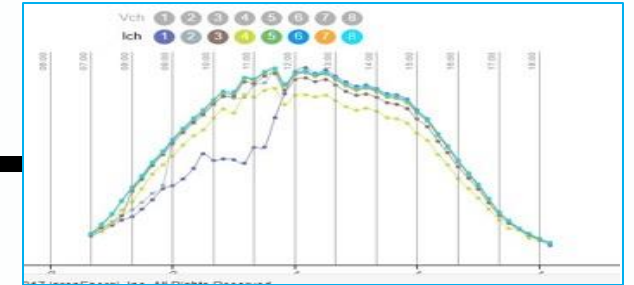
Solar Optimizer

Optimizer

I-o-T Gateway

Cloud Platform

Analytics App



To generate more Energy from solar modules

Conventional Series connection:
Bad panel blocks good panels



igrenEnergi solution:

- Bad panels don't block good panels
- Use optimizers only where needed
- Retrofit with existing inverters

Increased plant energy by using optimizers in only subset of panels

\$\$ Paid Installations: igrenEnergi Solar Optimizer

India
Indian Railways



Japan
I-o-T Square



Installations in Four Countries
Hundreds of devices in the field
Increased output
Predictive maintenance
Clients e.g. Siemens, Bosch, Tata, GE.



India
Tata Power DDL



San Diego, CA, USA
University of California



Validation of Architecture

8-module solar optimizers being sold commercially in India/Japan/Belgium

Prototypes of Inverters, Storage manager and integrated storage



Solar Optimizer Product



Cloud Management
Analytics
ML & Deep Learning

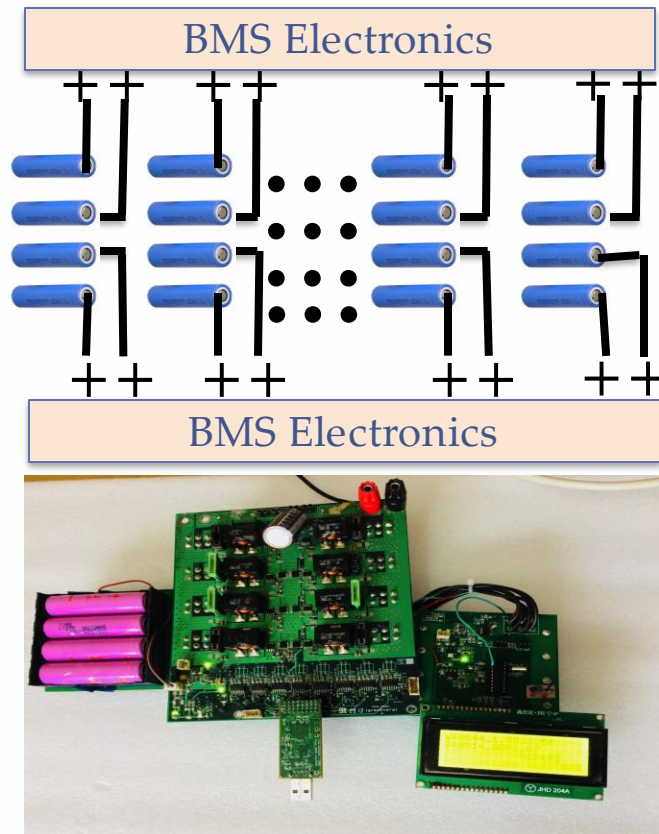


Prototype BMS
**Pilot with cell
Manufacturer**



Key Enabling Concept for Storage

ALL cell blocks electrically isolated by switched electronic circuits

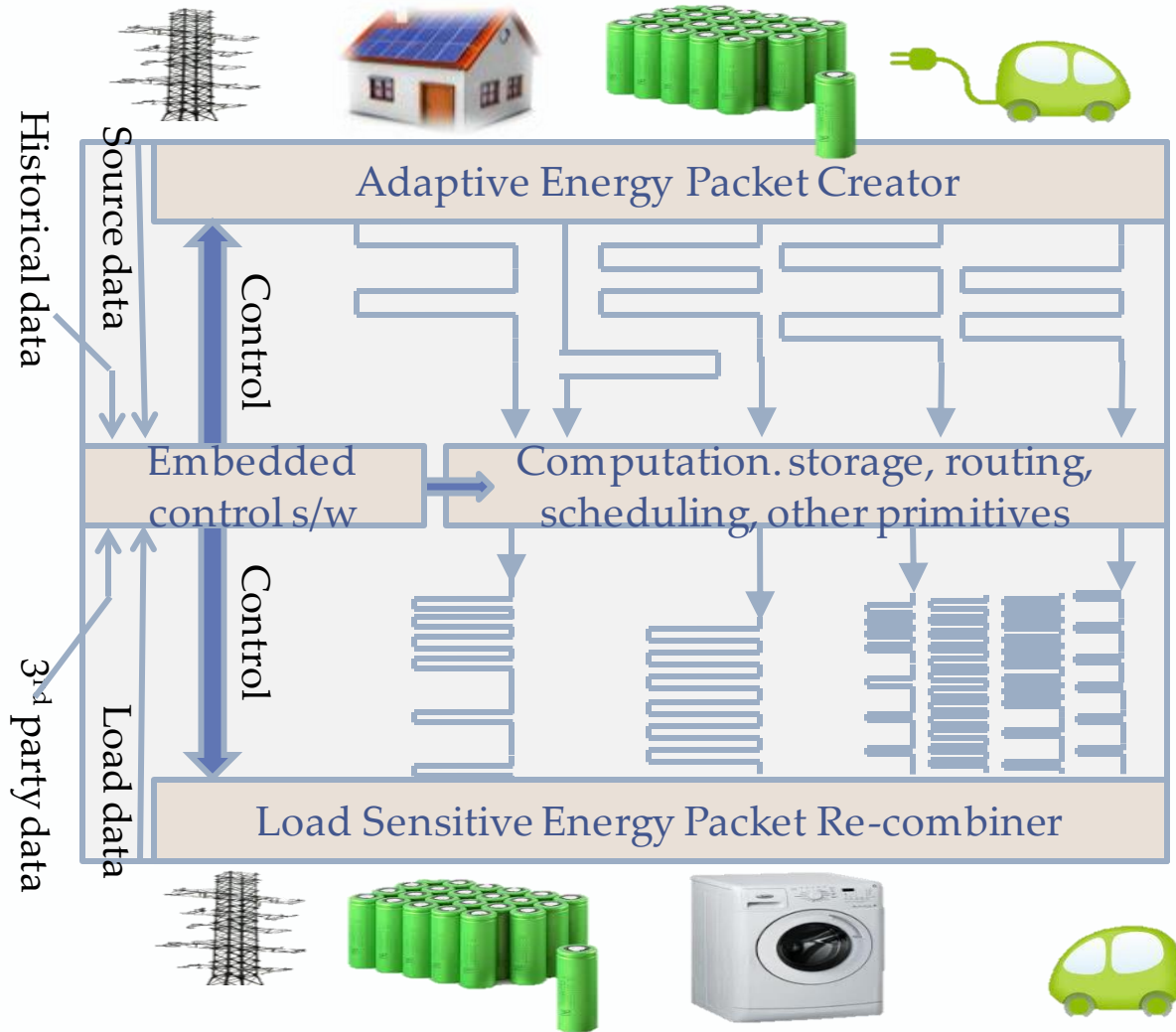


- Independent cell blocks monitored, charged & discharged
- One weak/dead cell block cannot restrict contribution of others
- Dead cell block cannot drain energy from others
- No energy and time is wasted in cell balancing
- Platform architecture delivers cost effective feature rich design
- Pilot underway with a leading Cell manufacturer
- Target BMS market \$7 B in 2022

igrenEnergi Battery Prototype

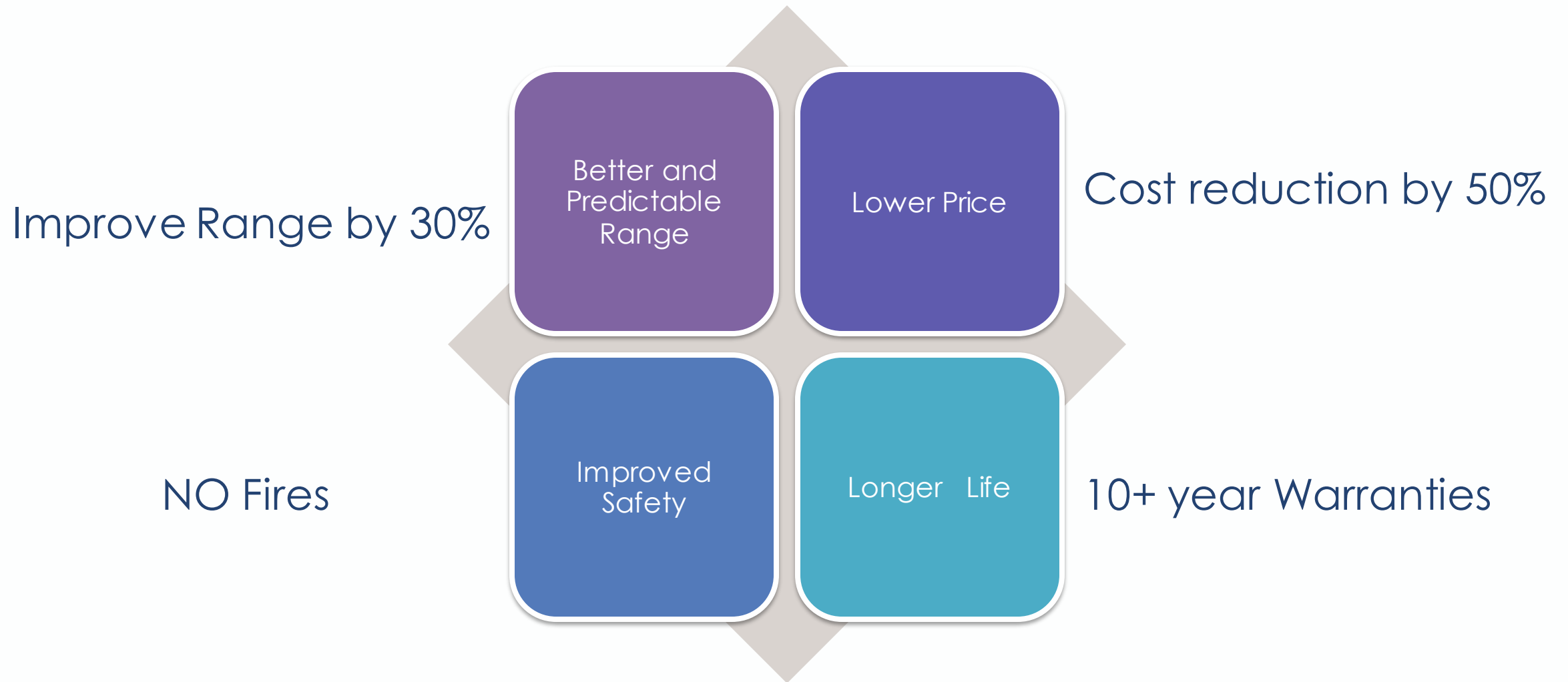


igrenEnergi's "Secret Sauce"

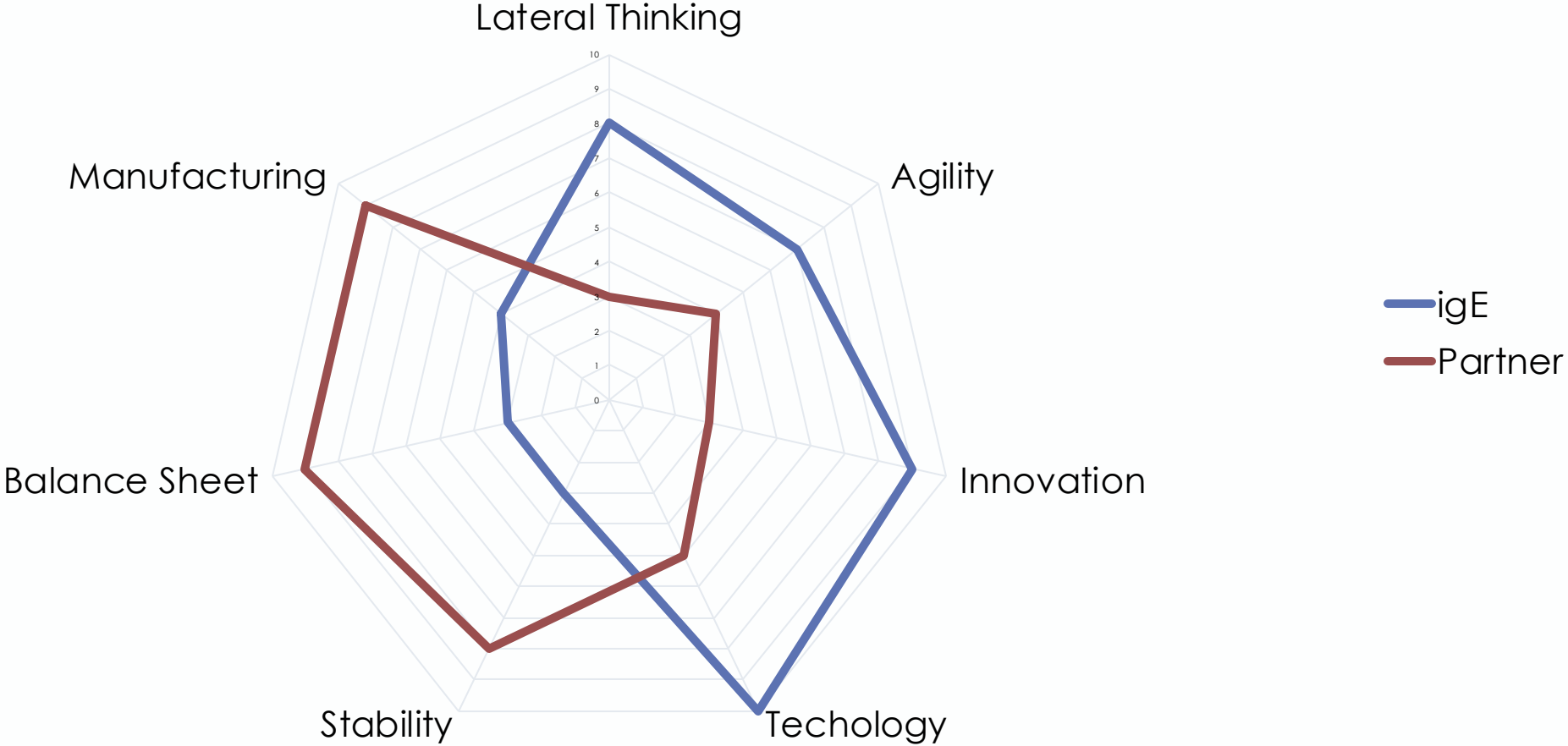


- “MAP” Modular Adaptive Programmable Architecture
 - Software Defined Energy Packetization
 - Independent & Optimized software-controlled charging & discharging of heterogeneous sources and loads
 - Proprietary Technology Platform
 - Smart Power Electronics + IOT + Cloud + Analytics/ML
 - Differentiated–Versatile–Efficient
- Awarded US Patents 8552587 & 9577548
Several provisional filed

Electric Vehicles End-user Pain Points



Go-to-market Strategy: Partnering and Licensing



Build strategic partnerships and best leverage our strength to improve capital efficiencies

igrenEnergi Confidential and Proprietary



Current Status and Path Forward

Intelligent BMS for EV and other batteries:

- **Co-development partnership with \$14B manufacturer**
 - Long term commitment to this market including manufacturing
- igrenEnergi technology is critical in their plans for EV and other batteries
- Defining product specifications with global clients
- Joint development underway for early product thru March 2019
- Strong possibility of strategic investment by partner in 1H'19

Solar Products:

- Hundreds of **optimizers** installed globally operating in field over years
- Clear proof of value proposition
- Scaling of sales and manufacturing to meet needs of our marquee clients like Tata Power, Siemens, etc.
- **Solar Inverter** products developed for a key partner/client with royalties/licensing model



Sizing our Partnering Opportunities

	Storage & BMS	Solar Optimizer	Inverter OEM
Product	Intelligent BMS for EVs, and stationary storage	Solar Optimizer	Solar Inverter
Cumulative Available Market by 2021	3M EVs with average 20 kWhr battery	Rooftop solar ~10 GW	Rooftop solar ~ 10 GW
Source	Target of Society of EV Manufacturers India	Bridge to India 12/2018 Rooftop Solar Map	Bridge to India 12/2018 Rooftop Solar Map
Price/Unit	\$20/ kWhr (10% of battery is BMS)	4.4 cents/Wp	5 cents/Wp
Product sales	\$1.2B	\$475M	\$500 M India
igE Partner sales (2021)	\$120M for three years \$60M in 2021	\$50 M in India	\$50M in India
Royalty Revenue	@2.5% → \$1.5M in 2021	@5% → \$2.5M	@2.5% → \$1.2 M
GP @60% margin**	\$0.9M	\$1.4M	\$1 M

**Over 10 year period ended 03/2018 Qualcomm GM has ranged from 57% - 70%: Gurufocus.com

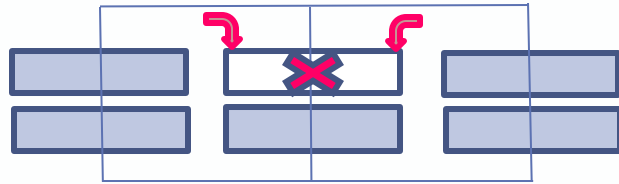


igrenEnergi
Optimizing Energy Storage & Use
• • •
BACK UP FOILS

Impact of Cell Mismatch on Range



Series connected weak cell limits currents



Parallel connected weak cell loads other cells

Poor Cell Capacity Matching

Impedance Variations

Heat – Self discharge doubles for 10°C rise

Non-Uniform Thermal Stress

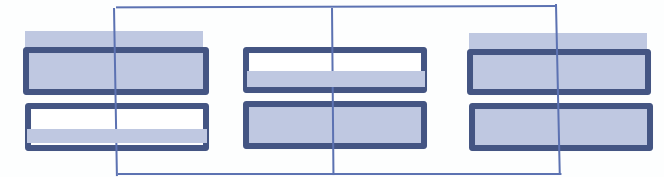
Non-Uniform Electrical Loading Chemical

Efficiency Variations

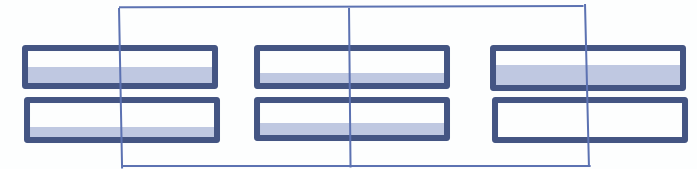
High discharge rates

Tesla owners reported
2% to 14% battery
capacity/range
degradation in just 2 to 3
years

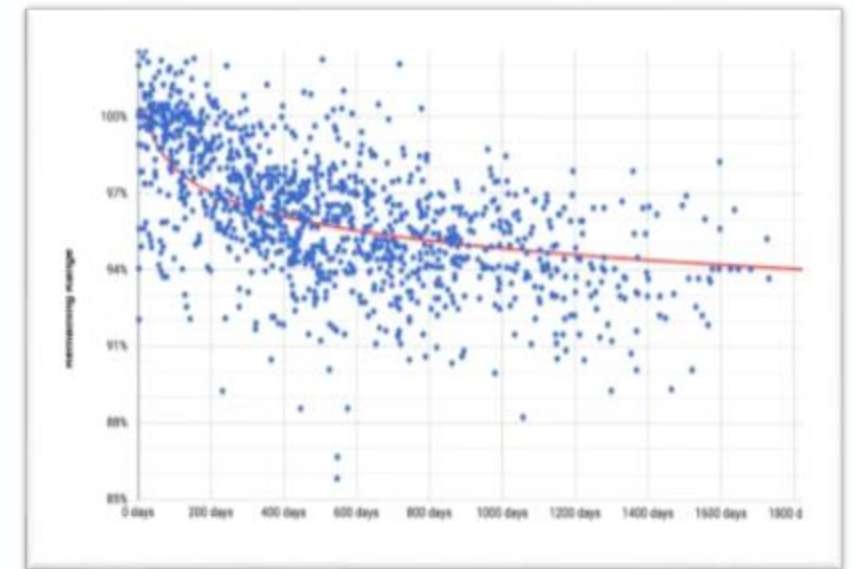
Source: 'MaxRange Tesla Battery
Survey', by Maarten Steinbuch,
Merijn Coumans, & the Dutch-
Belgium Tesla Forum



Over Charging of strong cells



Discharging weak cells beyond limits



Maximizing Energy Extraction

Balancer Circuits try to overcome capacity mismatch!

Balanced battery pack all the cells have the same State Of Charge.

Balancing to match energy/charge of all the cells, is done at the beginning, end of cycle.

Two main type of Balancing circuits available

Passive (dissipative) balancing: Extra is removed from the pack and wasted as heat.

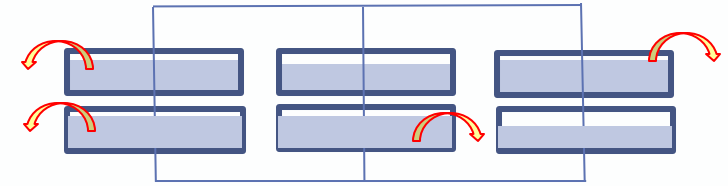
Active takes the extra energy/charge from the stronger cells and gives it to the weaker cell, forcing equal SOC.

igrenEnergi EMS actively controls each individual cell. Weaker cells can give lesser current to load.

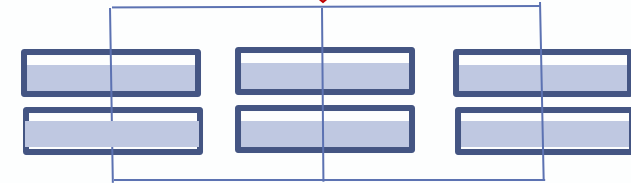
Stronger cells give higher currents to load as required

Individual cell discharge rate is controlled continually

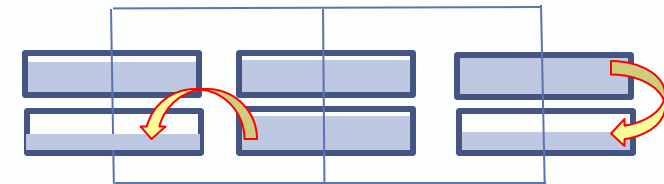
Optimal extraction of maximal energy!



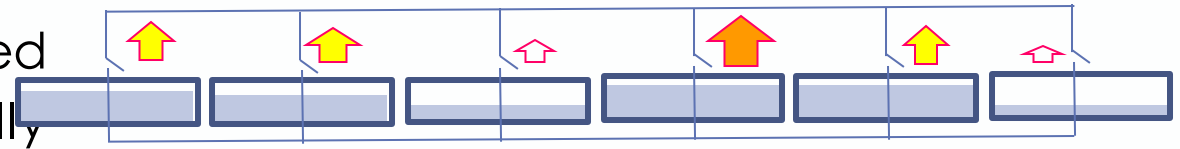
Dissipative Balancing → Remove extra charge from stronger cells



Balanced pack but with lower energy



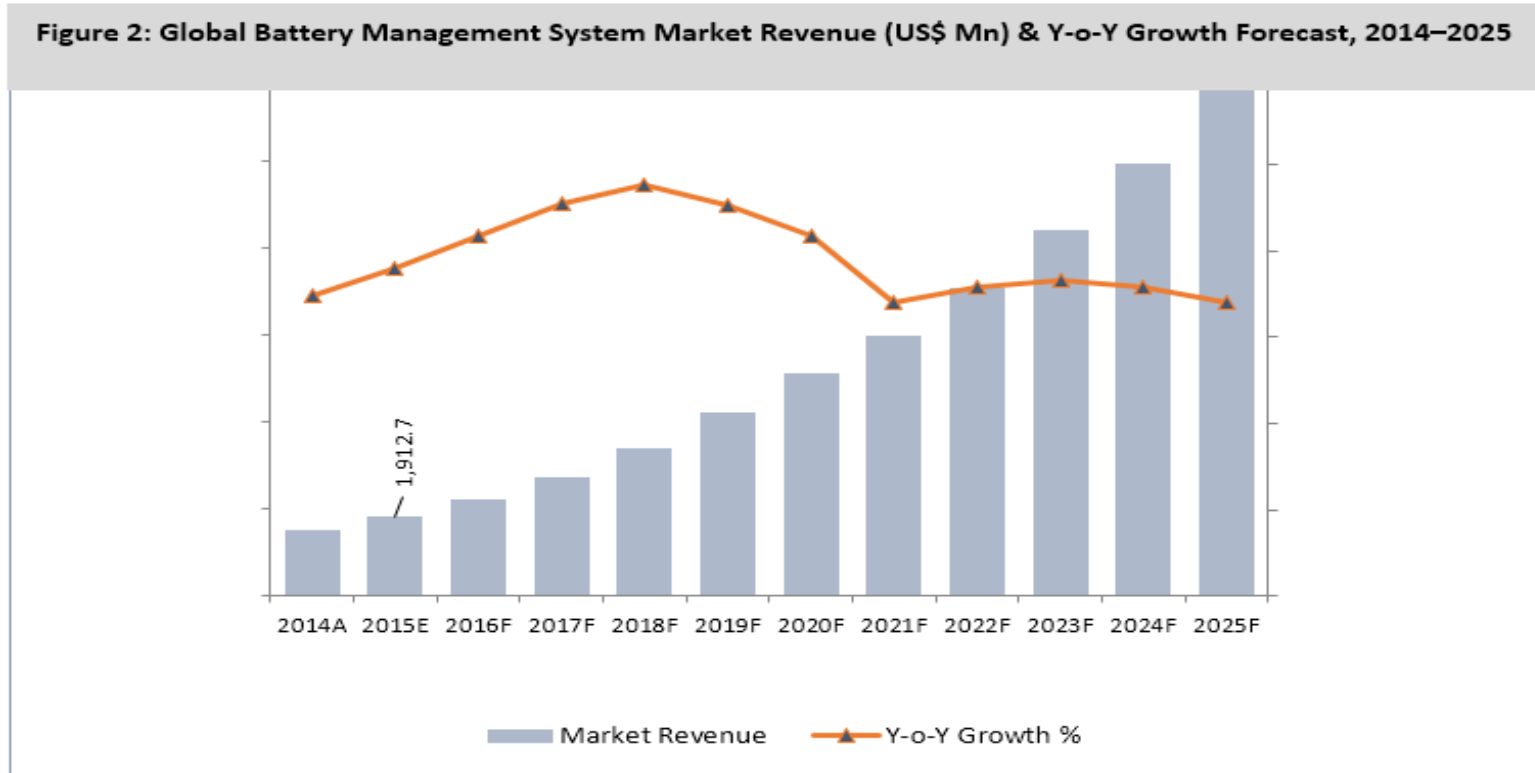
Non dissipative balancing transfer extra charge from stronger cells to weaker cells



Cell Level EMS, extracts maximum energy from individual cells. Dynamically adjusting individual cell currents to ensure balanced aging



Market for Battery Management System



Source: FMI, 2015

FutureMarketInSights.com

Battery Management System (BMS) Market

7.25 Billion USD by 2022 MarketandMarkets

11.7 Billion USD by 2025 FutureMarketInSights.com

EV and Solar highest market share

CAGR 20%

