



# Future of Energy

## Value Proposition

# Table of Contents

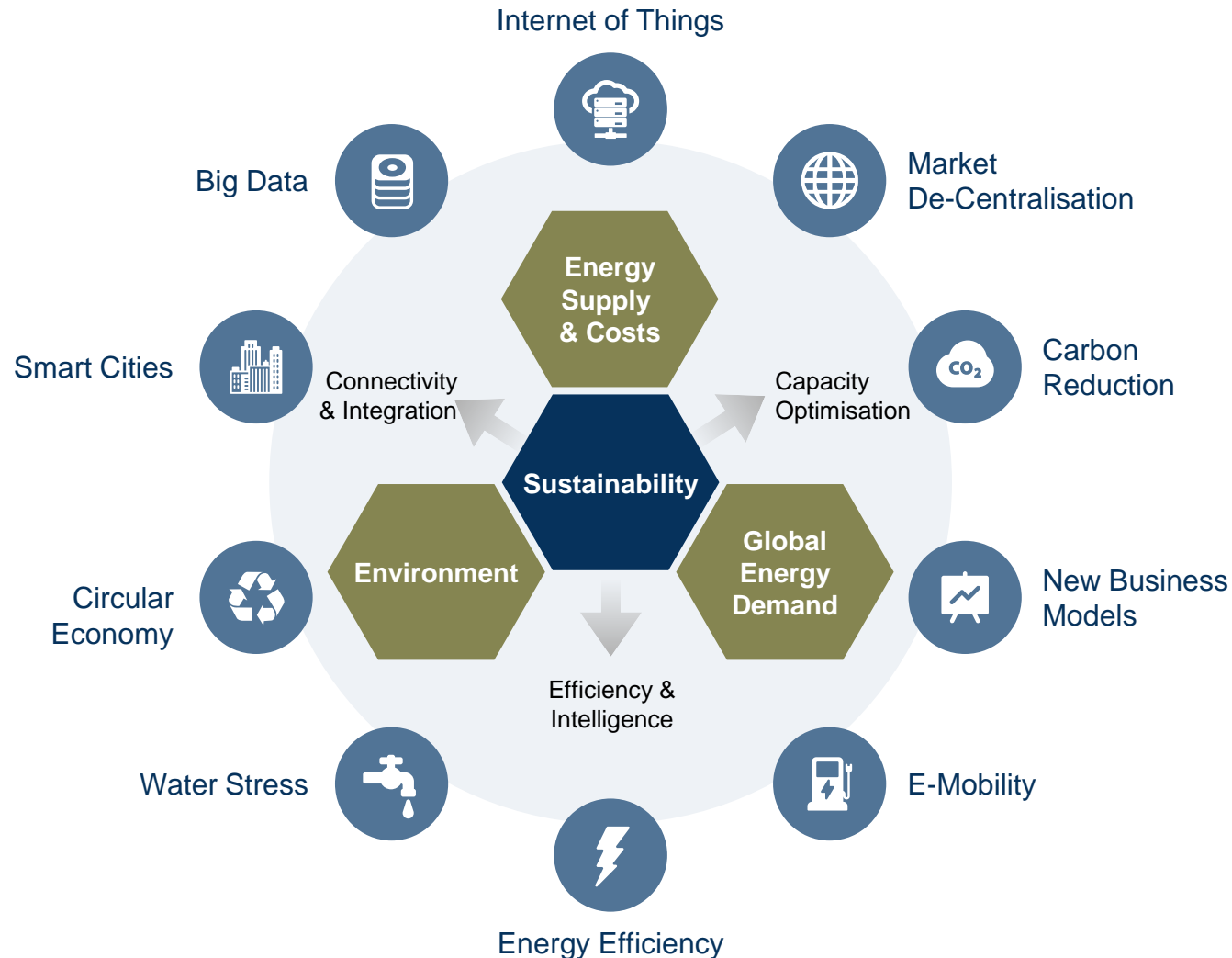
Mega Trends that will Transform the Energy Industry	3
Convergence of the Power and Automotive Sectors	9
Digital Energy	14
Why Frost and Sullivan is the Right Partner	17
Sample of Recent Research Titles	20
Growth Consulting Case Studies	25
About Frost and Sullivan	28
Contacts	31

# Megatrends that will Transform the Energy Industry



# Top 10 Converging Factors Defining the Future of Energy

*Connectivity and integration are driving new energy technologies, industry structures and business models with sustainability at the core.*



Source: Frost & Sullivan

# The Future of Energy ... the 3Ds

*Energy will be cleaner, more accessible, intelligent, connected and responsive; Digital transformation will converge with business transformation.*



## DECARBONISATION

Shifting generation, transmission, distribution and usage towards a lower carbon future.

*Renewable energy, e-Mobility, energy efficiency, new and future fuels, demand side management, etc.*



**44%** of global generating capacity from renewables by 2025

**1,600 GW** of renewables capacity added between 2017 & 2025



## DECENTRALISATION

New DG models with a proliferation of distributed and connected generation, closer to the point of use.

*Distributed generation, energy storage, microgrids, prosumers, VPPs, P2P, etc.*



**12%** of global generating capacity from DG by 2025

**65%** of DG investments will be distributed Solar PV



## DIGITALISATION

Digital technologies to provide infrastructure for more flexible, intelligent, connected & responsive energy systems.

*Smart grid, asset optimisation, demand response, automated trading, active energy management, etc.*



**50 Billion** connected devices – or 'things' - globally by 2025

**>\$1 Trillion** economic value of IoT impact in energy by 2025

Source: Frost & Sullivan

# Top Transformational Markets



## Prosumer to Pro-user

- Self-Consumption and Energy Communities (P2P)
- ESCOs, HEMs/BEMs and Connected Homes/Buildings
- DER (PV kits, BIPV, Micro-Wind)
- Behind-the-Meter Storage (Res. & Com.)
- EMS, BMS Systems and Cloud Services
- V2H, Self-Charging
- Nano-Grids



## Digital and Flexible Grids

- DSR Aggregation & Trade
- VPPs
- Micro-Grids & Nano-Grids
- Balancing Markets
- Smart-Grids (Monitoring, Control and Automation)
- Utility Scale Storage
- RE Charging & Energy Harvesting
- Thin-Film/New Form Factor Batteries



## EVs as a Grid Asset

- Vehicle-to-Grid
- Charging Infrastructure & Storage (multi-application business models)
- Second-Life Batteries
- EV Fleet Charging (Logistics, Municipal)
- RE Charging & Energy Harvesting

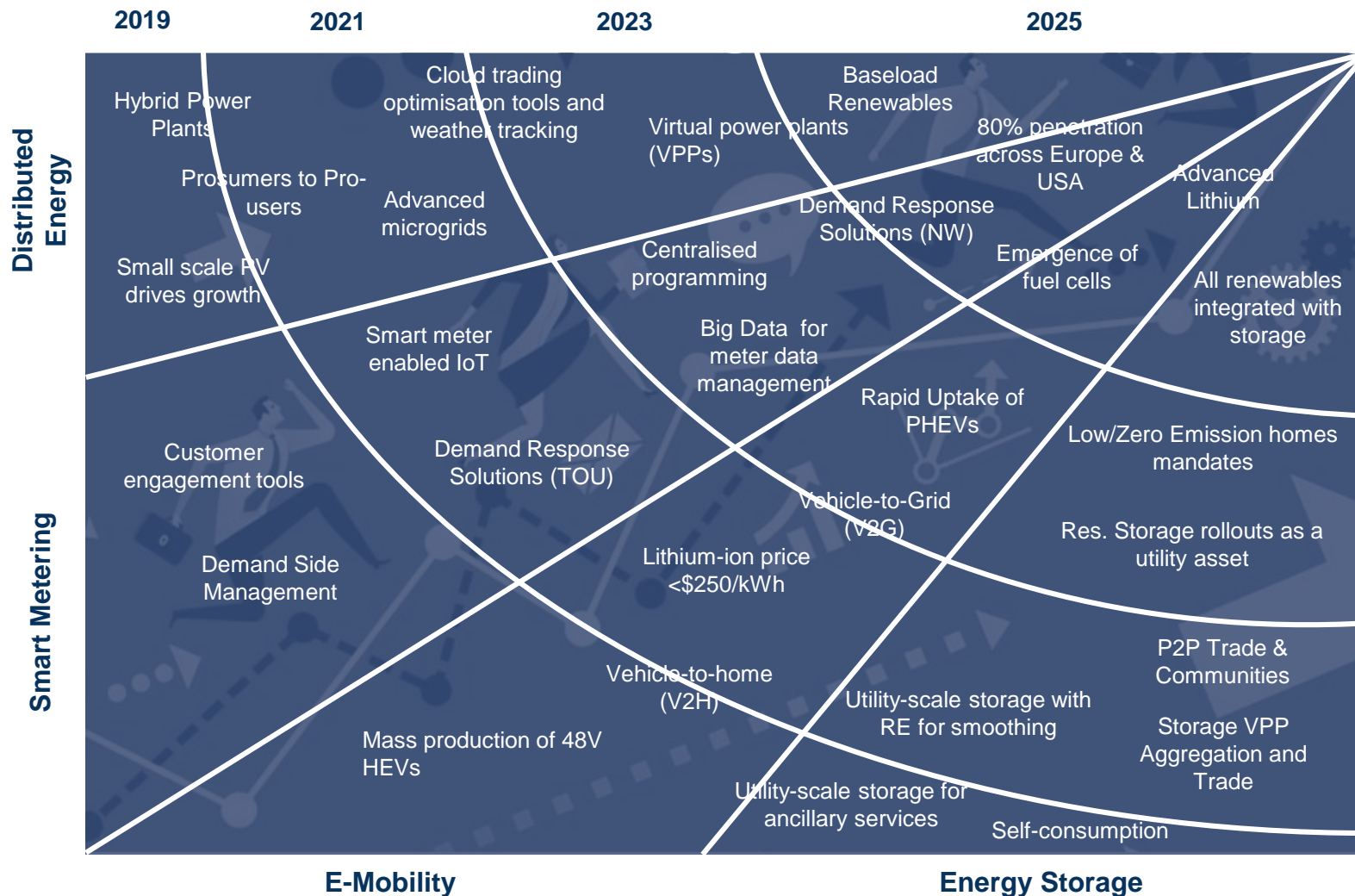


## Industrial Efficiency and Control

- Industrial Efficiency & Power (Industry 4.0, CHP, Energy Harvesting)
- Hybrid Power & Energy Clusters
- Industrial Storage – Power, Heat, CAS
- DSR Aggregation & Trade

# Future of Energy Roadmap

*Four game changers have emerged that will have the biggest impact on the digital energy roadmap: energy storage; smart metering; electric mobility; and distributed energy*

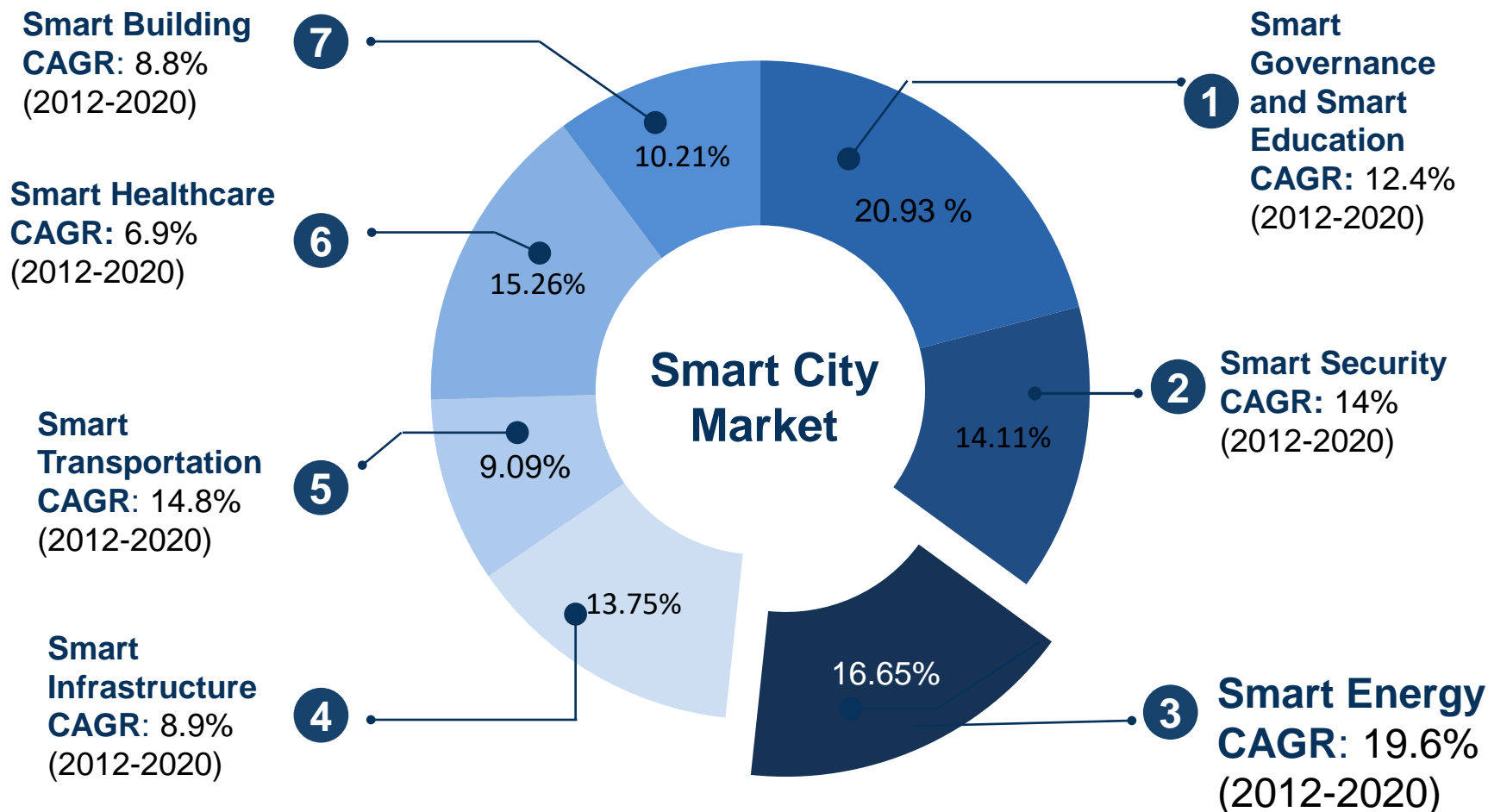


Source: Frost & Sullivan

# These markets will create a \$250 billion by 2020

Smart cities to create huge business opportunities worth \$1.5 Trillion In 2020.  
16.7% is expected to be attributed to smart energy markets.

Smart City Market by Segments, Global, 2020



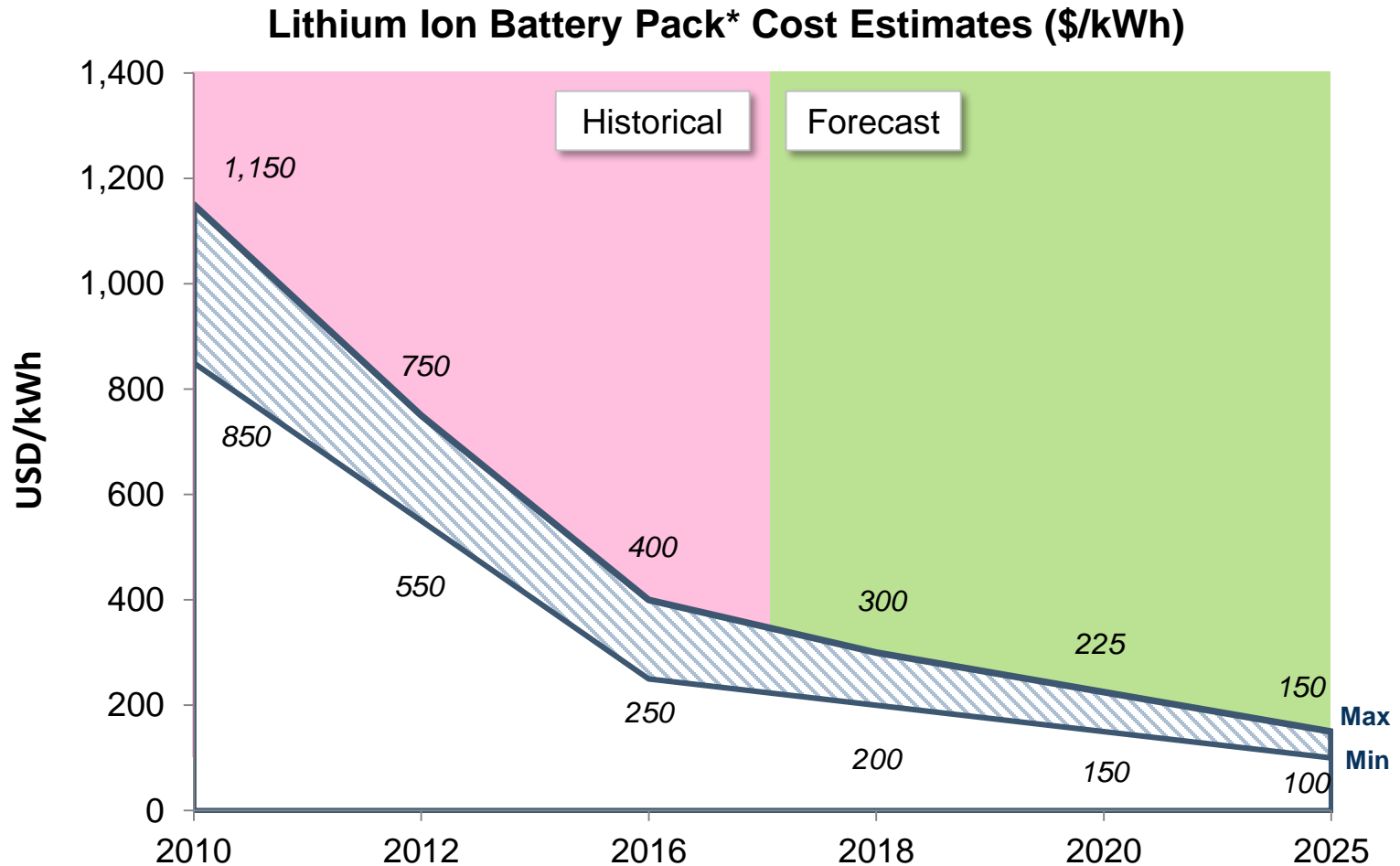
Source: Frost & Sullivan analysis.

# Convergence of the Power and Automotive Sectors



# Energy Storage - A Core Component of the Future Energy Mix

*Declines in battery prices will drive uptake of stationary storage systems and electric vehicles.*



Source: Frost & Sullivan

# Global Gasoline and Diesel Bans

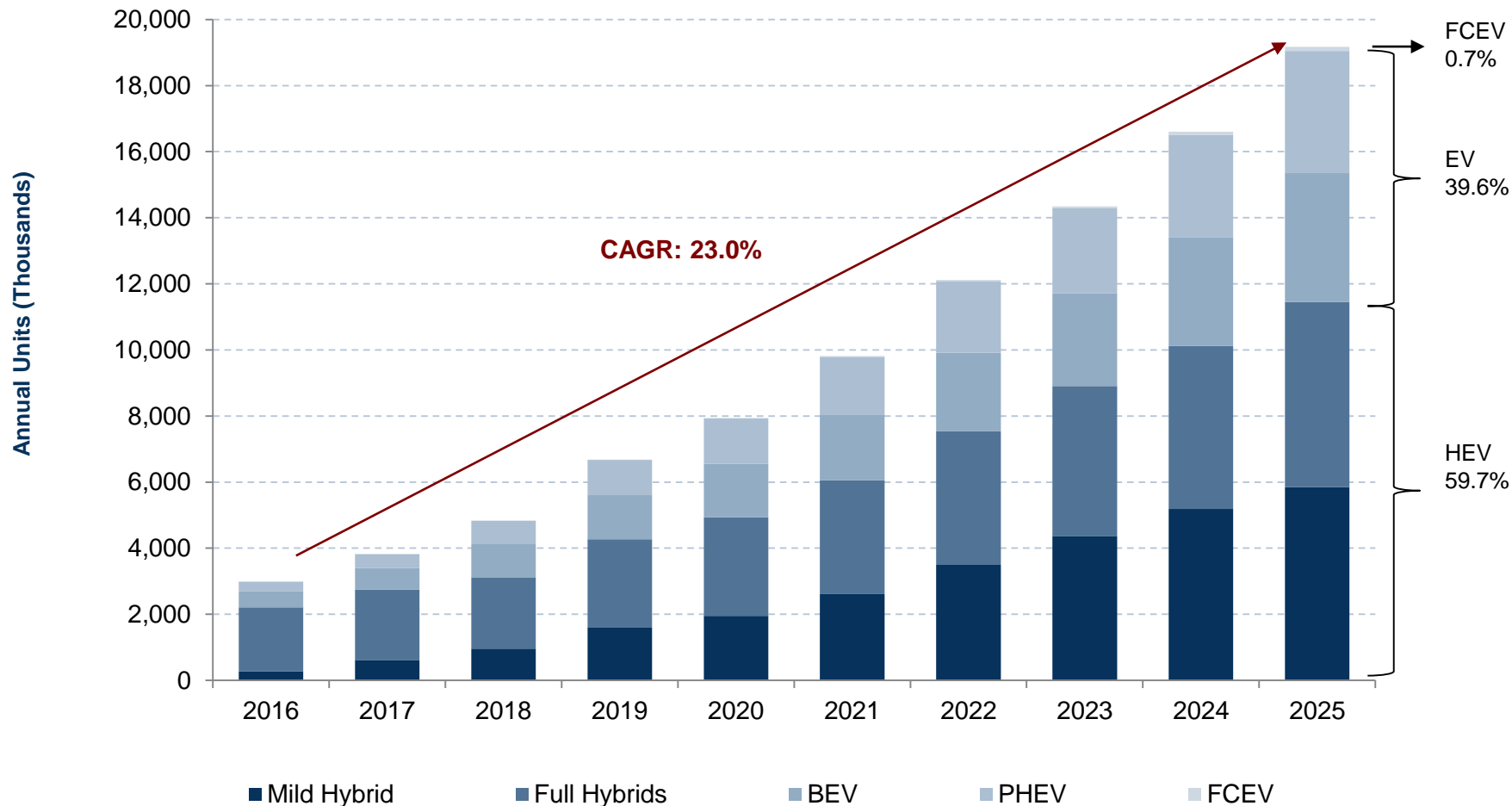
*Bans on gasoline and diesel engines are expected to significantly accelerate uptake of electric vehicles and charging infrastructure in key cities and countries.*

<b>Norway</b> <b>2025: All ICE ban</b>	<b>Amsterdam</b> <b>2017:</b> Ban of Diesel < Euro 3 <b>2018:</b> Ban of Diesel taxi built < 2009
<b>Netherlands</b> <b>2025: All ICE ban</b>	<b>London</b> <b>2017:</b> £10 charge for ICE < Euro 4 <b>2019:</b> £12.5 charge for Diesel < Euro 6 and Gasoline < Euro4
<b>Germany</b> <b>2030: All ICE ban</b>	<b>Oslo</b> <b>2017:</b> Ban on diesel when high pollution <b>2019:</b> Ban on private cars in city center
<b>India</b> <b>2030: All ICE ban</b>	<b>Brussels</b> <b>2018:</b> Ban of Diesel < Euro 2 <b>2020:</b> Ban of Diesel < Euro 4 <b>2022:</b> Ban of Diesel < Euro 5 <b>2025:</b> Ban of Diesel < Euro 6
<b>United Kingdom</b> <b>2040: All ICE ban</b>	<b>South Korea</b> <b>2030: All diesel ban</b>
<b>France</b> <b>2040: All ICE ban</b>	<b>Mexico</b> <b>2025: All diesel ban</b>
	<b>Paris</b> <b>2016:</b> Ban of Diesel < Euro 2 <b>2017:</b> Ban of Diesel < Euro 3 <b>2025: All Diesel ban</b>
	<b>Madrid</b> <b>2025:</b> Ban Diesel < Euro 6 and Gasoline < Euro 2 <b>2025: All diesel ban</b>
	<b>Athens:</b> <b>2025: All diesel ban</b>

# Market Growth of Electric Vehicles

*Driven by price reductions, improvement in mile range, and government policies the electric vehicle market is expected to grow to over 19 million unit sales per year by 2025.*

**Total EV Market Sales Forecasts (Global), 2016–2025**

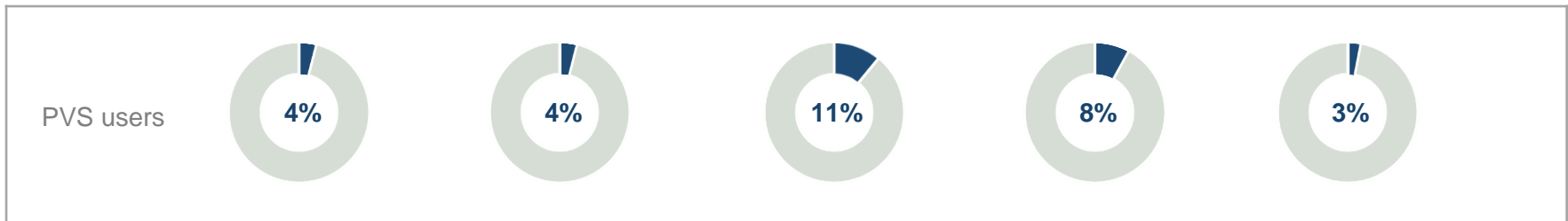


# EV Adoption to drive distributed PV and storage

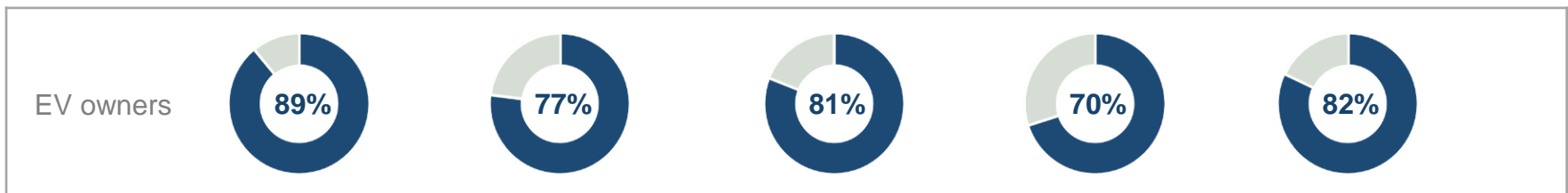
70 – 90% of private vehicle owners own electric vehicles and 60-80% of these see benefit in residential storage.



## Share of PVS Users with Battery Energy Storage in Household



## PV System Possession by EV Ownership



## Perceived Benefit of Charging Electric Vehicle (EV Owners)

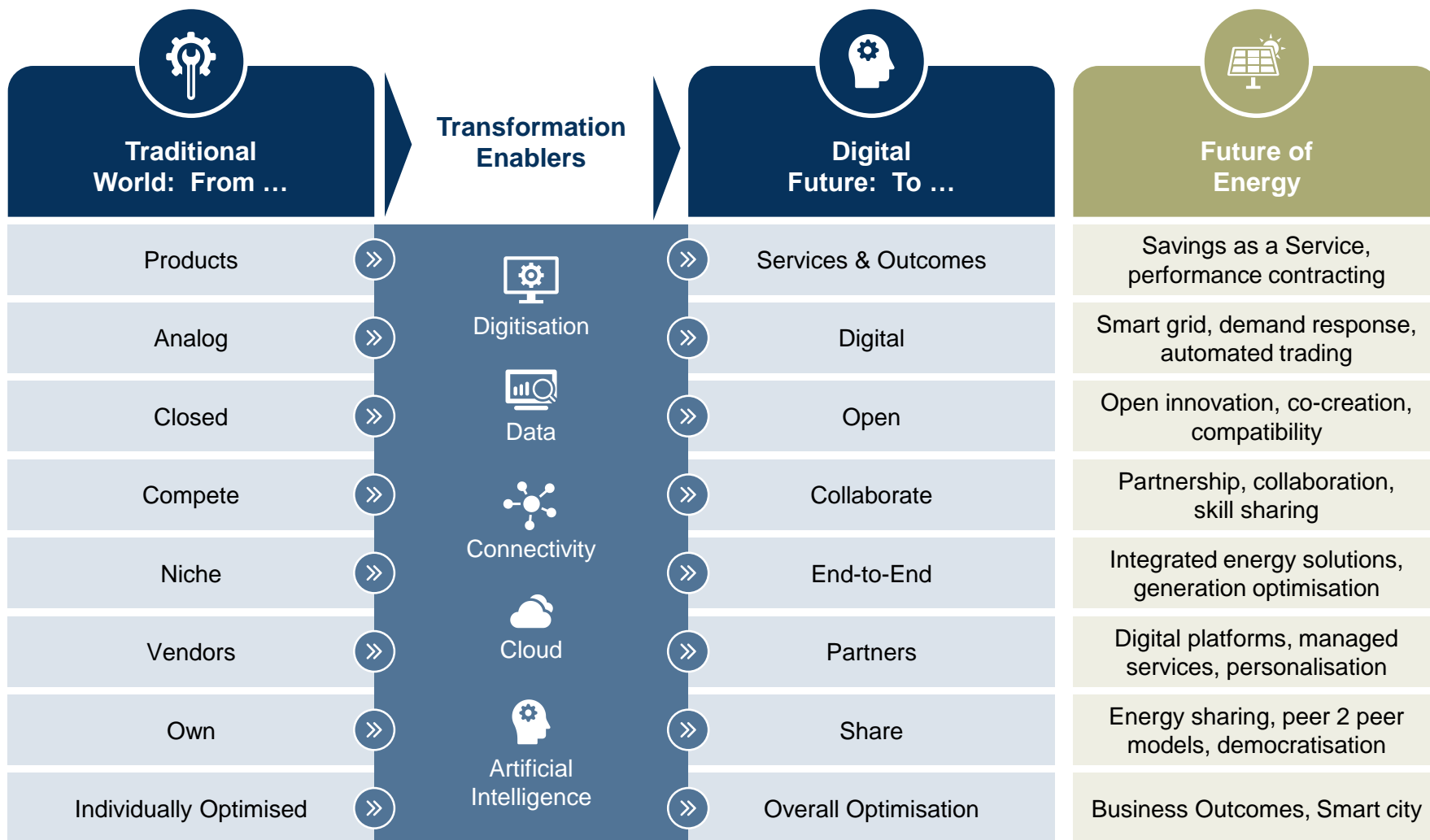


# Digitisation to Empower Industry Transformation



# The Core Elements of Digital Transformation

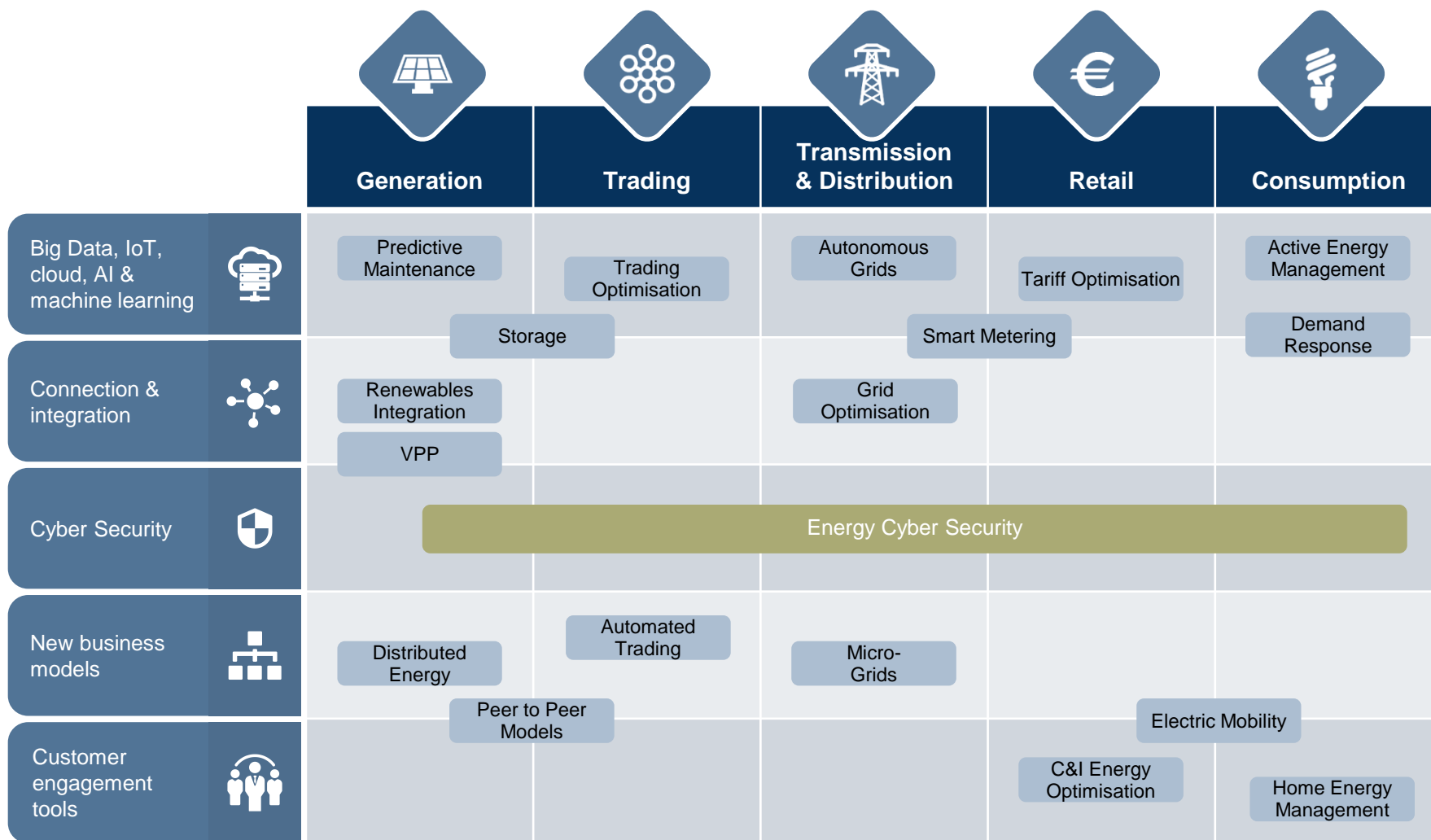
*The digitalisation of energy technology and systems is generating new customer centric business models leading to democratisation of energy.*



Source: Frost & Sullivan

# Digital Energy Innovation Hotspots

*The highest intensity of innovation is focused on leveraging Internet of Things technology across the energy ecosystem.*



Source: Frost & Sullivan

# Why Frost & Sullivan is the Right Partner



# Why should you partner with Frost & Sullivan?

Frost & Sullivan has established itself as a thought leader in the energy sector and has worked on a number of innovation based assignments as the market evolution gains pace



1. Frost & Sullivan has over 55 years experience in research and consultancy covering a wide range of technologies and solutions within the energy sector. This expertise gives us a deep understanding of a client's major markets, the intricacies of the conditions they operate in and the potential opportunities and challenges in its markets in the future.
2. The energy sector in the next five years will undergo more change than in the past fifty years, with the rapid electrification of transport, mounting pressure to decarbonise the electricity industry, commercial viability of storage and the continued evolution of the utility business model all key factors in driving this change. Frost & Sullivan has authored a number of pieces of significant research analysing these factors and others. A selection of our key thought leadership titles are shown below:
  - Global Power Industry Outlook
  - Future of Smart Grid
  - Innovation Benchmarking in Energy Utilities
  - Residential Energy Storage Market
  - Blockchain in Energy
3. Frost & Sullivan has been selected as a trusted advisor on numerous high-value consulting and advisory service engagements, ranging from market growth opportunity prioritisation, strategic scenario planning, thought leadership whitepapers to showcase new technology and innovation, and supporting utility innovation teams with future energy trends.
4. Frost & Sullivan has an experienced global network of consultants and analysts that have the relevant market expertise for any engagement.

# Why should you partner with Frost & Sullivan?

Frost & Sullivan leverages its extensive internal expertise to deliver power strategies to its clients via five core services



# Sample of Recent Research Titles



# Smart Energy Universe

Research built around identified value propositions



## Digital and Flexible Grids

Utilities & grid operators see grid flexibility as essential to sustain RE growth into the future

Analysis of European Electricity Balancing Markets

Digital Disruption in Utilities

Growth Opportunities for DG and Off-grid Power in Africa

The Future of Energy Storage in Africa

Innovation Benchmarking in European Energy Utilities

Global Energy Storage Industry Outlook, 2017

Global Flow Battery Market

Next Generation of Energy: European Demand Side Response

Global Smart Electricity Meter Market

European DC Power Distribution Markets

Growth Opportunities for Enterprise Asset Management (EAM) Solutions

Opportunities for Utility Services Sector in Africa's Smart Cities

Future of Utilities

Innovation Profile: Enel

Innovation Profile: RWE

Global Battery Energy Storage Market for Industrial Applications, Forecast to 2022

Global Battery Energy Storage Market for Utility Applications, Forecast to 2022

# Smart Energy Universe

Research built around identified value propositions



## Prosumer to Pro-user

From FiT driven generators of power to users of turnkey cloud-enabled energy solutions

European Residential & Commercial Battery Storage Market

US, Japan and Australia Residential & Commercial Battery Storage Market

Emerging Participants and New Entrants in Energy Management Markets

World LED Lighting Markets (2017 Update)

Global Homes & Buildings Industry Outlook, 2017

Li-Fi Communication Opportunities in Homes & Buildings

European Home Automation Markets

Powerwall - the New UPS?

Connected Homes: Opportunities and Solutions for Assisted Living

Emerging Players and New Entrants in Energy Management Markets (2017)

Global HEMS & BEMS Markets

Global Lighting Controls Markets

Global Smart Thermostats Markets

Growth Opportunities in the UK Facility Management Market

The Future of Energy Management

Transformational Trends in the Building Energy Management Solutions Industry (2017)

European Integrated Facility Management (IFM) Markets

Global Lithium Ion Batteries Market, Forecast to 2022

# Smart Energy Universe

Research built around identified value propositions



## Industrial Efficiency and Control

Digital grids, IoT & storage opening opportunities for increased efficiency, cost-saving & reliability

Planned 2017

Global Power Industry Outlook, 2017

The Case for Industrial Internet of Things (IIoT)- A Journey into the Future of Manufacturing

Advanced Analytics and Service Models for the Future

Industrial Automation Outlook 2017 Report

The Cognitive Factory - A New Digital Evolution

Understanding the Role of Governments in Promoting IIoT in APAC

Intelligence at the Edge- The Emerging Market for Edge Analytics in Industries

Opportunities in Vietnam for Automation and Control System Manufacturers (2016)

Opportunities in Indonesia for Automation and Control Manufacturers

Cybersecurity Initiatives in IIoT in Asia Pacific

Digital Oilfields and Predictive Analytics: What is the impact of data driven process optimization?

SEA and ANZ Automation Services Market

Opportunities in Malaysia for Automation and Control Manufacturers

# Smart Energy Universe

Research built around identified value propositions



## EVs as a Grid Asset

EV OEMs & utilities investigating new business models to maximise electric vehicle value proposition

2017 Powertrain Outlook

2017 Electric Vehicle Market Outlook

Comparative Benchmarking of Total Cost of Ownership (TCO) of ICE and electrified powertrains

RDE and WLTP Testing Requirements in Europe and Technology Outlook for Compliance

Strategic Analysis of Electro Mobility Market in Poland

Technology roadmap for Particulate Matter (PM) compliance for GDI engines in Europe

Transformation in Retail Strategies and Formats for Electric Vehicles

European Consumers' Attitudes & Perceptions Towards Environment, Diesel Cars, H & EV & Exhaust After treatment Tech

2017 EV Database, Forecast to 2025

Ultra-fast Charging - Insights on Disruption in EV Charging Station Infrastructure

Executive Report on Global EV Sales, H1 2017

City access Restrictions in Europe and its Impact on Powertrain Mix

# Growth Consulting Case Studies



# We are Market Experts who Provide Innovative Growth Advisory Services – Smart Energy

## Developing Pictures of The Future in the Power Market

### Client Need

A leading engine component manufacturer wanted to understand the market outlook for reciprocating diesel engines to 2030 and assess the threat from alternative 'green' technologies. In addition, our client wanted advice on how to change its business model in order to double its revenues over this time despite adverse market conditions.

### Our Approach

We analysed the entire reciprocating diesel engine value chain and had detailed discussions with over 60 leading market stakeholders. Our analysis comprised 3 key steps:

1. Develop a market snapshot and short term view
2. Develop 'Pictures of the Future' on the basis of scenarios with a working model
3. Identify business opportunities to help our client grow its revenues and provide recommendations

### Benefit

Our client will use the results in their long term strategy planning to make key decisions on their business model. They will use our early warning steering system to understand what scenario is emerging.

## Prioritising Growth Opportunities in the Energy Sector

### Client Need

A tier 1 European power utility wants to adapt its business in line with the disruptive changes taking place in the energy market. It has an open and highly innovative approach to diversifying its future business and wants to look at and prioritise potential opportunities.

### Our Approach

We have fully leveraged our expertise across our 12 industry verticals and that of our Visionary Innovation team, which tracks mega trends and assesses their impact on specific industries. We have used our extensive published research content to conduct Growth and Innovation workshops on the key opportunities and implications across various industries. The opportunities are then prioritised according to the level of strategic attractiveness of our client's capabilities and objectives.

### Benefit

The work has been ongoing for the past 2 years and we hold regular sessions with the client, which feed into their strategy and product development initiatives. The client has already invested in key opportunities.

## Assessing Customer Adoption for Residential Batteries

### Client Need

With rapid growth expected in the global residential battery storage market, leading market participants required a global understanding of the needs and perceptions of consumers driving their decision to adopt home storage systems in order to better align product development road-maps and marketing activities.

### Our Approach

A comprehensive supply-side analysis and voice-of-customer analysis was conducted across eight leading countries in the residential storage market consisting of 3,250 consumer interviews along with in-depth interviews with leading system suppliers and distributors

### Benefit

The research developed as become a cornerstone of leading suppliers in the residential storage market in their establishment of their value propositions, business models and distribution structures in the primary global growth markets

# We are Market Experts who Provide Innovative Growth Advisory Services – Vehicle as Grid Asset

## Future Plug-in Hybrid Electric Vehicle Prospects

### Client Need

Understand whether the recent development of Electric Vehicles with large batteries as well as charging issues could jeopardize the future of Plug-In Hybrid Vehicles

### Our Approach

Electric vehicle expert interviews with a mix of vehicle manufacturers, trade associations and government organisations to get an exhaustive picture of PHEV future prospects

- Assess potential of PHEVs to disappear with BEVs equipped with large batteries
- Understand the opportunities & risks associated to PHEVs
- Assess drivers and restraints for PHEV charging by customers and identify “out of the box” solutions to encourage charging

### Benefit

- Benefits & challenges associated to the development of BEVs, PHEVs and FCEVs
- Model comparison by affordability, metal independence, oil independence, charging infrastructure availability, energy efficiency and highway range
- Recommendations to drive PHEV sales

## Ultra-fast Charging & Smart Grid Development Opportunities

### Client Need

Our client plans to launch BEV with large batteries and had to take technical decisions for its future EV models regarding high speed charging as well as smart grid compatibility

### Our Approach

Comprehensive review of published material and in-depth interviews with key stake-holders in the electric vehicle industry to discuss the future prospects of ultra-fast charging and its impact on EV specifications

- Analyse ultra-fast charging development in Europe, US, Japan & China
- Assess electricity grid capability to handle the additional load from ultra-fast charging
- Comprehensive review of initiatives of EV connectivity to Smart Grids

### Benefit

Comprehensive analysis of the Electric Vehicle market and future prospects as well as electric vehicle charging infrastructure developments with a focus on ultra-fast charging and smart grids and its impact on technical architecture they should adopt

## Opportunity for Electric Motors for Light Electric Vehicles

### Client Need

Our client wanted to assess the business opportunity for electric motors for light electric vehicles and get technical specifications of electric motors used in such vehicles

### Our Approach

5-years bottom-up forecast for light electric vehicle with 3 scenarios based on market drivers - identified through detailed discussions with electric vehicle OEMs and electric motor suppliers

- Understand market drivers (regulations, incentives ...)
- Identify the most interesting opportunities for electric motor in light electric vehicles
- Quantify the business opportunities for our client with electric motors in 2025

### Benefit

- Understanding of the market environment and its drivers and which vehicle segments to concentrate effort on.
- Quantification of business opportunities identified in 2025
- Recommendations on next steps for the most promising opportunities

# About Frost & Sullivan



# About Frost & Sullivan

50 years of global expertise in over 40 offices

---

- 50 years+ of experience
- 40+ offices worldwide ⇒ global coverage & local expertise
- Sector-based organisation ⇒ 12 core divisions, including Energy & Power
- 1,500+ employees across the globe, of which >800 consultants & analysts



# Industry Convergence

Comprehensive Industry Coverage Sparks Innovation Opportunities



Aerospace & Defence



Measurement &  
Instrumentation



Consumer  
Technologies



Information &  
Communication Technologies



Automotive  
Transportation & Logistics



Energy & Power



Environment & Building  
Technologies



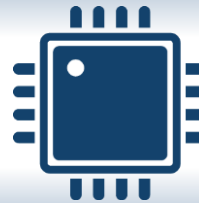
Healthcare



Minerals & Mining



Chemicals, Materials  
& Food



Electronics &  
Security



Industrial Automation  
& Process Control

# Contact Details

FROST & SULLIVAN

## Ross Bruton

Programme Manager & Principal  
for Smart Energy Systems

+44 20 899 68547

[ross.bruton@frost.com](mailto:ross.bruton@frost.com)

FROST & SULLIVAN

## Thomas Houareau

Director, Consulting Services

Energy & Visionary Science

+44 20 8996 8548

[thomas.houareau@frost.com](mailto:thomas.houareau@frost.com)

FROST & SULLIVAN

## Livio Vaninetti

Director of the Accelerated Program

+39 02 4851 6135

[livio.vaninetti@frost.com](mailto:livio.vaninetti@frost.com)