FIEE

29ª FEIRA INTERNACIONAL
DA INDÚSTRIA ELÉTRICA, ELETRÔNICA,
ENERGIA E AUTOMAÇÃO.

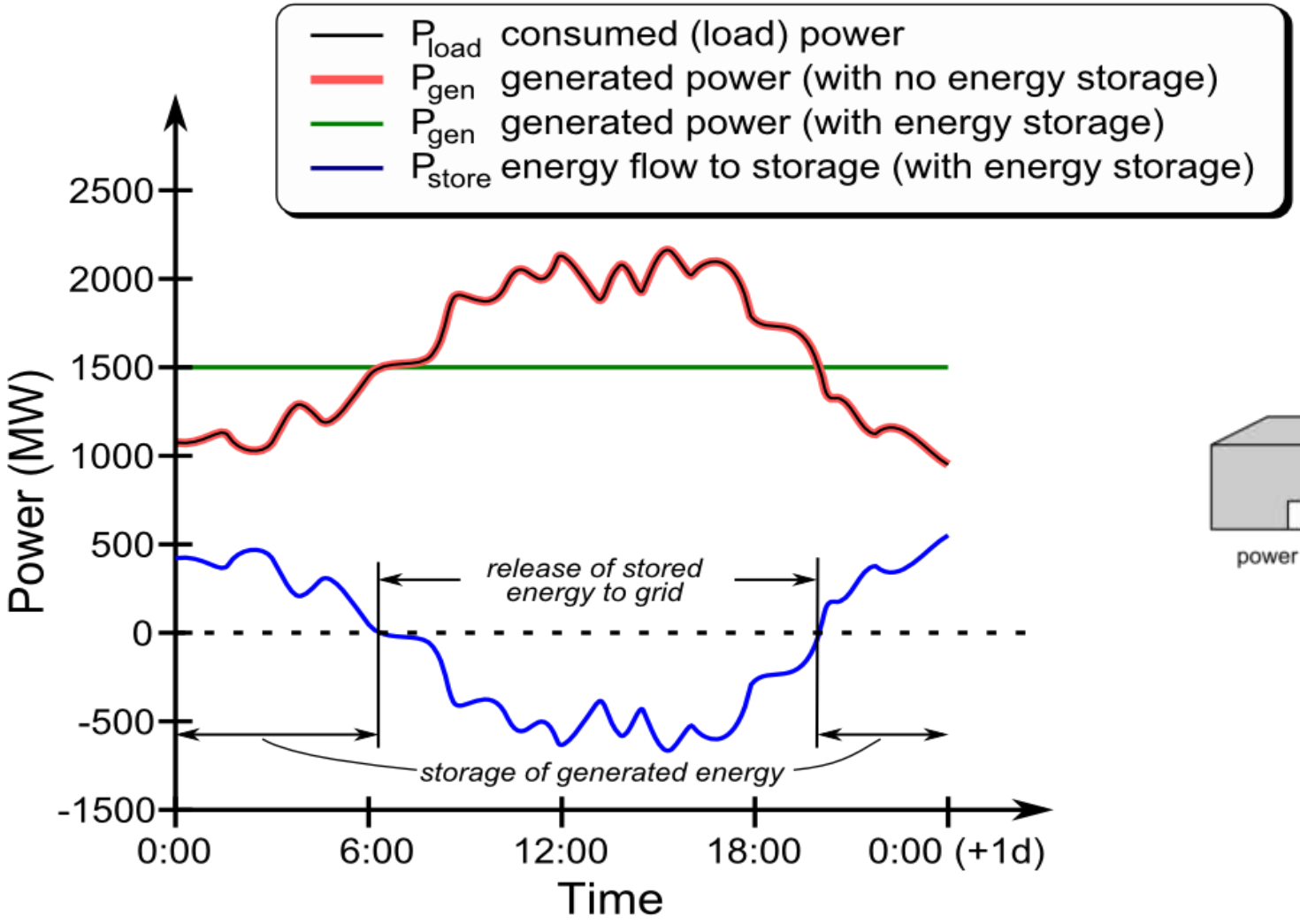
abinee 2017 TEC

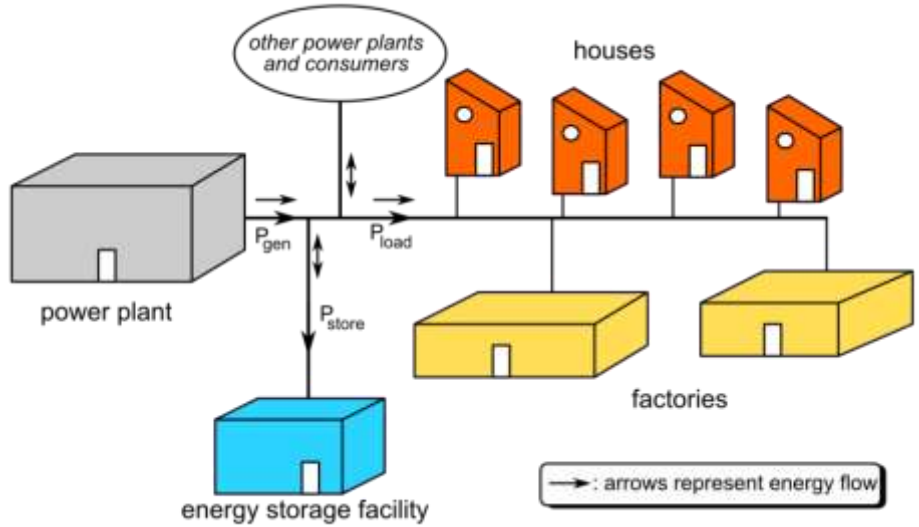
GTDC
GERAÇÃO, TRANSMISSÃO, DISTRIBUIÇÃO
E COMERCIALIZAÇÃO DE ENERGIA

Baterias para Armazenamento de Energia no Setor Elétrico - Perspectivas e Mercado

Raul Beck - Fundação CPqD

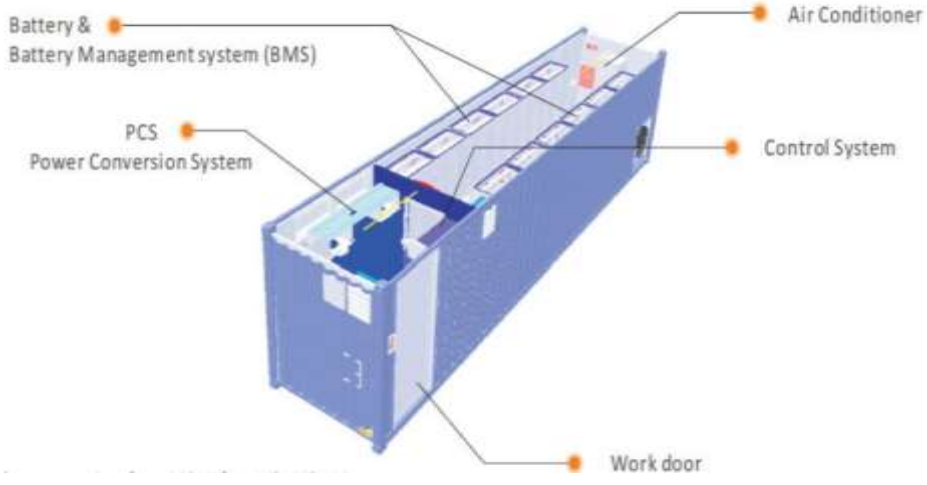
BESS (*Battery Energy Storage System*) na rede elétrica

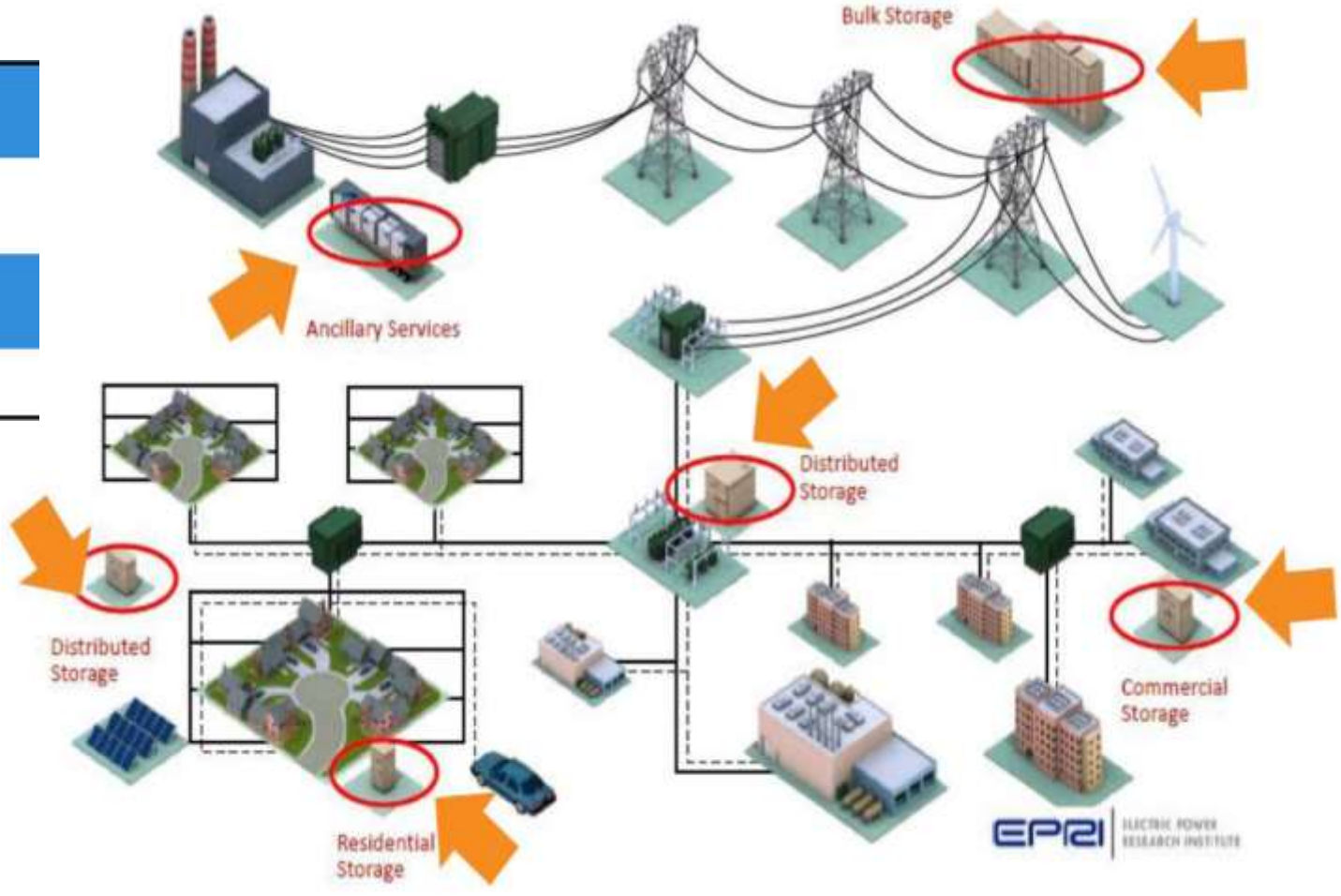




BESS no sistema elétrico

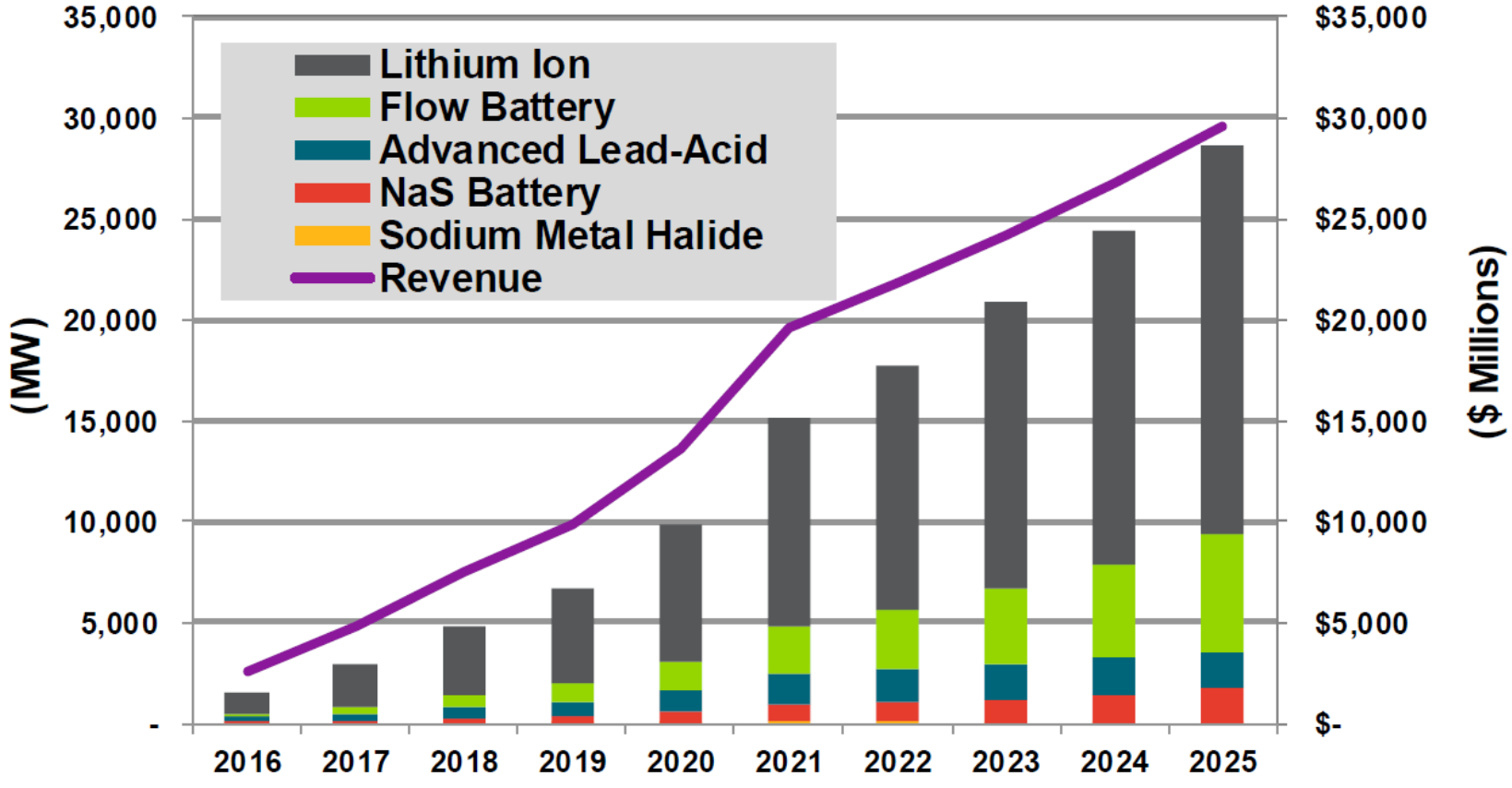
Armazenagem na geração	10s MWh ~ 10s GWh	10s MW~10s GW
Transmisão – Subestação	MWh ~ GWh	MW ~ GW
Armazenamento Comunidade	10s kwh ~ 100kwh	10s kw ~ 100s kw
Consumidor final	Few kwh ~ 10s kwh	Few kw





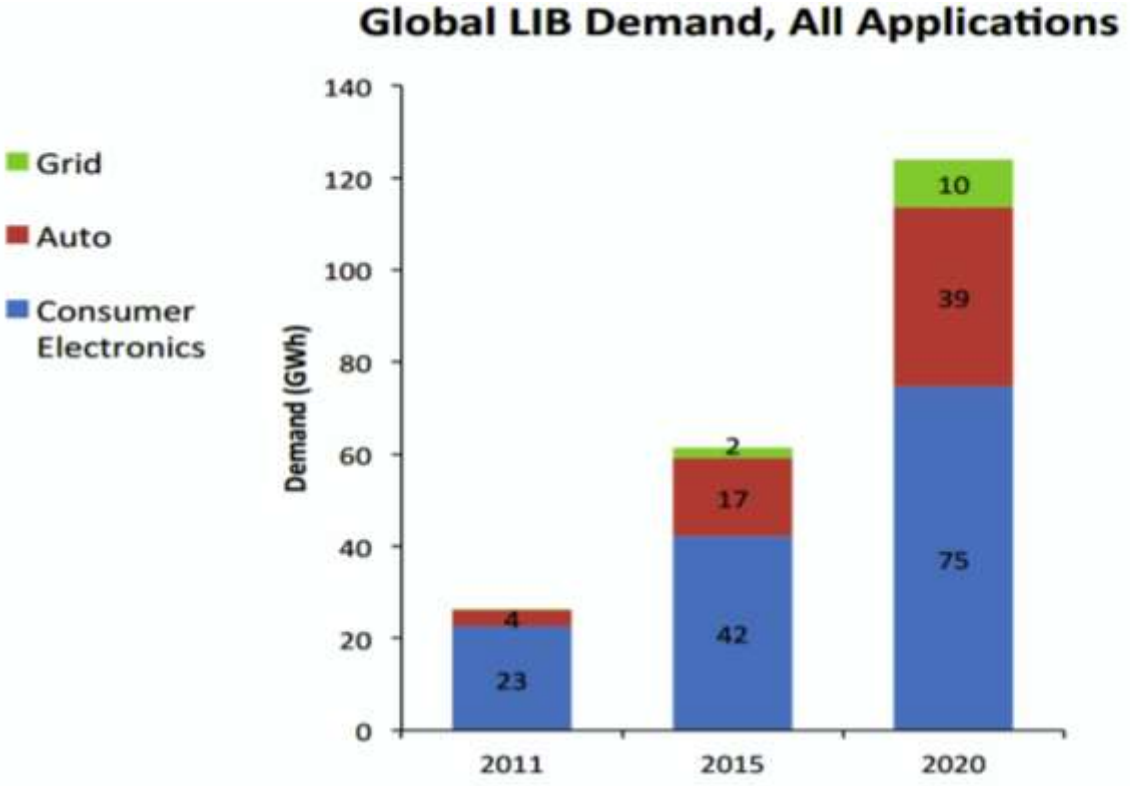
Tecnologias de BESS no setor elétrico

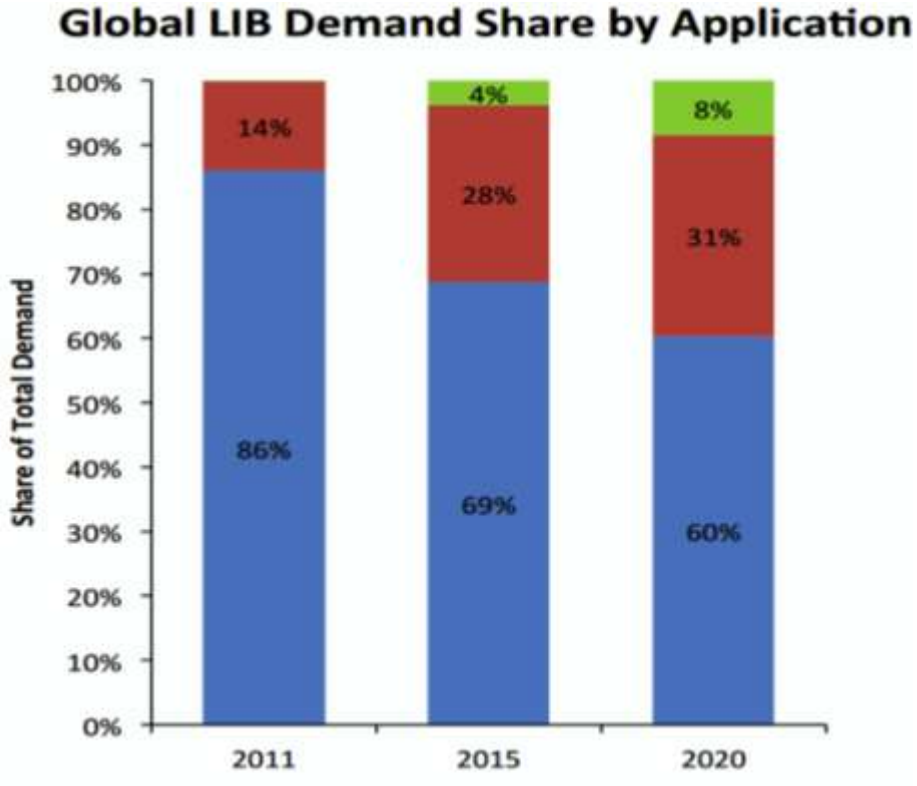
Chart 1 *Distributed and Utility-Scale Energy Storage Power Capacity and Revenue by Technology, World Markets: 2016-2025*



(Source: Navigant Research)

Demanda mundial de LiB



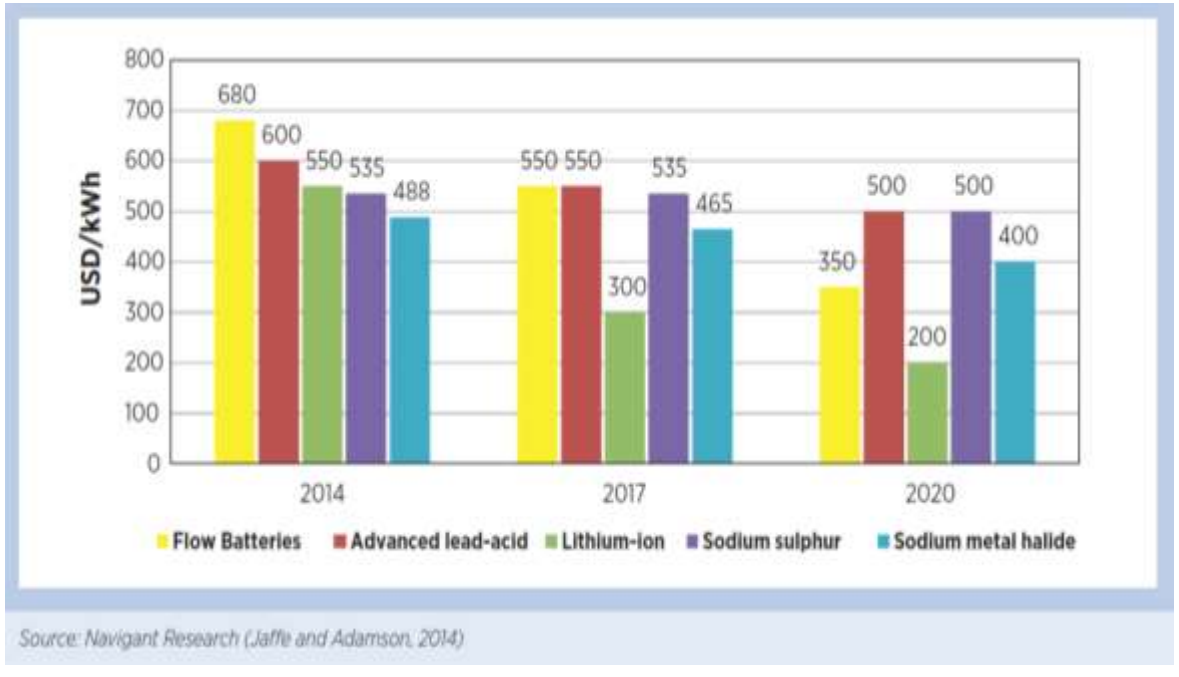


- Competitive advantages for automotive LIB producers emerged from incumbent firms supplying consumer electronics (CE) applications; these advantages may persist, at least in the near-term.
- While automotive demand is expected to grow, the majority of demand for LIBs may continue to be driven by CE applications.

Sources: Roland Berger (2012); Pike Research (2013); AAB (2013); CEMAC analysis

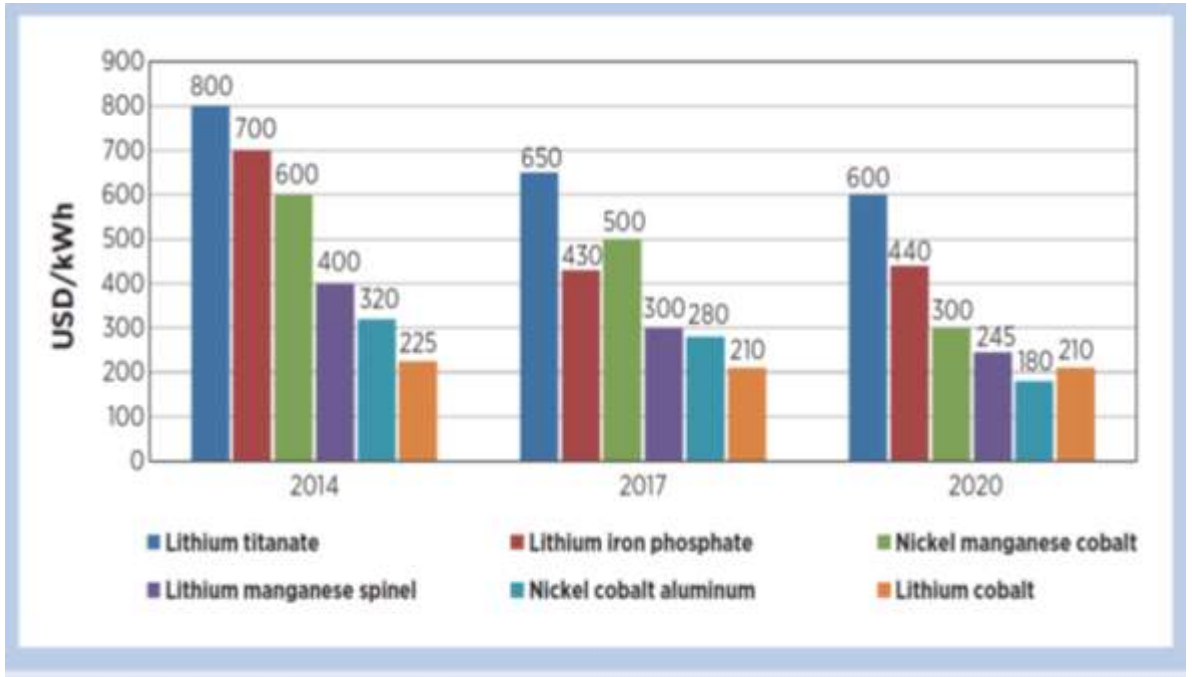
Projeção custo baterias avançadas

Projeção custo <u>tecnologias</u> em escala BESS



Source: Navigant Research (Jaffe and Adamson, 2014)

Projeção custo <u>células LiB</u> em escala BESS



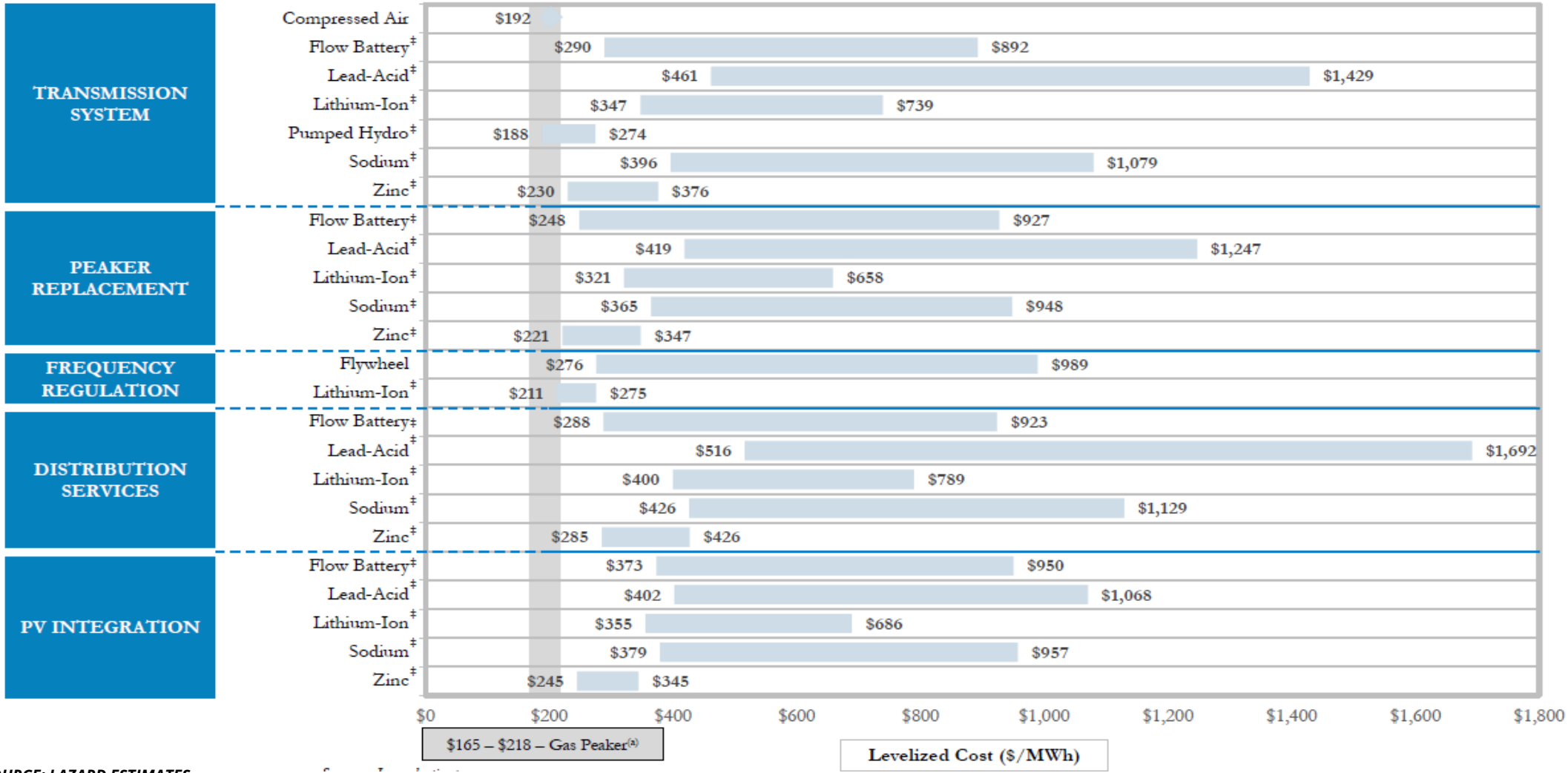
Source: Navigant Research (Jaffe and Adamson, 2014)

Custo das tecnologias BESS grande porte

Technology	Manufacturer	Power [MW]	Energy [MWh]	Price [M€]	P/P [M€/MW]	E/P [M€/MWh]
Na-S	NGK	35	232	106	6,6	0,5
Li-ion	BYD, Samsung, Toshiba, SAFT, Siemens	10	7,2	17	1,7	2,4
NA-NiCl2	FIAMM, GE	5	7	16	3,2	2,3

Technology	Source/year	USD/W	Assumptions
Lead acid battery	IRENA / 2012	$1.50 - $2.00	3-20MW in size, 10 seconds to 4 hours of storage
Lead acid battery	EPRI / 2012	$2.50 – $5.00	50kW to 10MW in size, total installed cost
Flow batteries (VRB)	IRENA / 2012	$3.00 - $4.00	50kW to 10MW in size, up to 8 hours of storage
Li-ion battery	IRENA / 2012	$2.50 - $3.00	Up to 5MW in size, 15 minutes to 4 hours of storage
	EPRI / 2012	$2.00 - $6.00	50kW – 1MW in size, total installed cost
	AECOM / 2015	~$1.00-1.80	Current market price based on recent tenders MW scale systems (includes balance of plant costs) 15 mins to 1 hour storage
NaS battery	EPRI / 2012	$2.50 - $3.00	1MW – 50MW in size, total installed cost
PHS	IRENA / 2014	$1.05 - $4.00	Average cost of large pumped hydro plants
CAES	IRENA / 2012	$0.80 - $9.00	Large applications using ideal sites (assuming cheap, natural underground caverns) and applications which require ground in-vessel storage.
CSP (storage)	California energy Commission / 2011	$2.30	Solar Power Tower – mid cost case with 11 hours of storage
	IRENA / 2010	$2.50 - $5.20	Parabolic trough, 6 hours of storage (storage cost only, assume existing plant)

Comparativo de custo das tecnologias



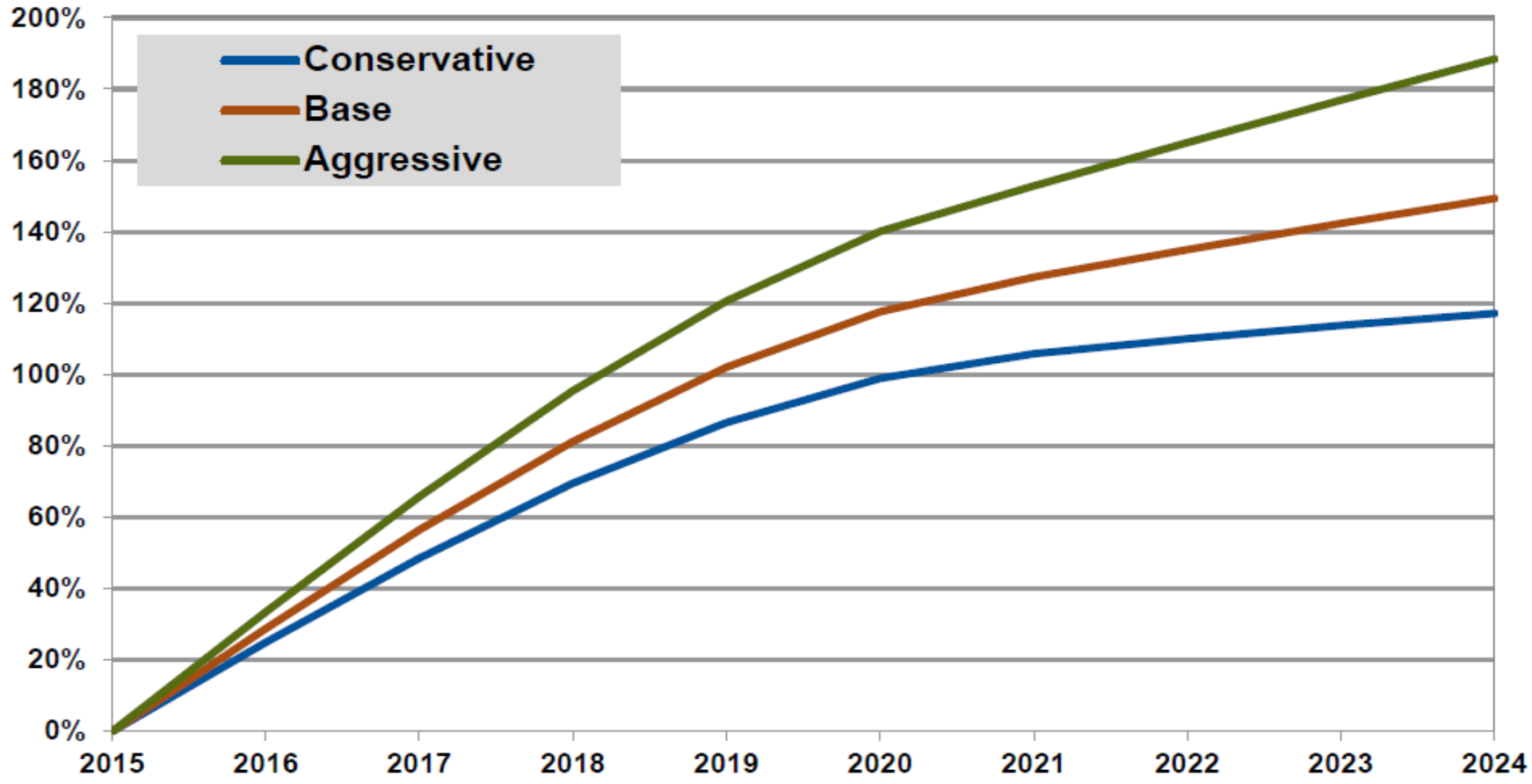
SOURCE: LAZARD ESTIMATES.

NOTE: ANALYSIS ASSUMES 20% DEBT AT 8% INTEREST RATE AND 80% EQUITY AT 12% COST FOR ALL TECHNOLOGIES AND USE CASES. ASSUMES SEVEN YEAR MACRS DEPRECIATION UNLESS OTHERWISE NOTED.

‡ INDICATES BATTERY TECHNOLOGY.

Projeções densidade de energia LiB

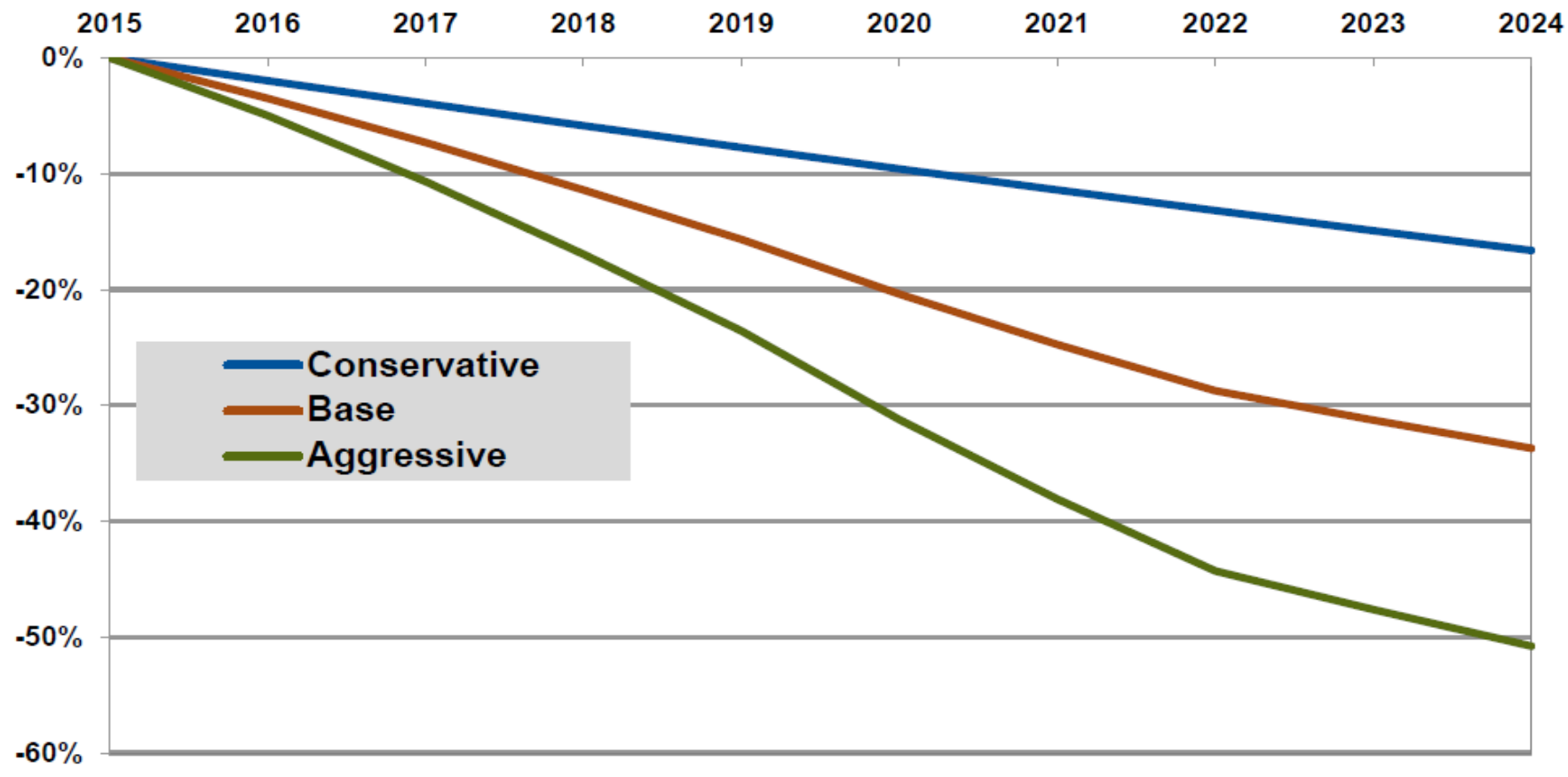
Chart 2.3 Li-Ion Battery Pack Energy Density Improvement by Scenario, World Markets: 2015-2024



(Source: Navigant Research)

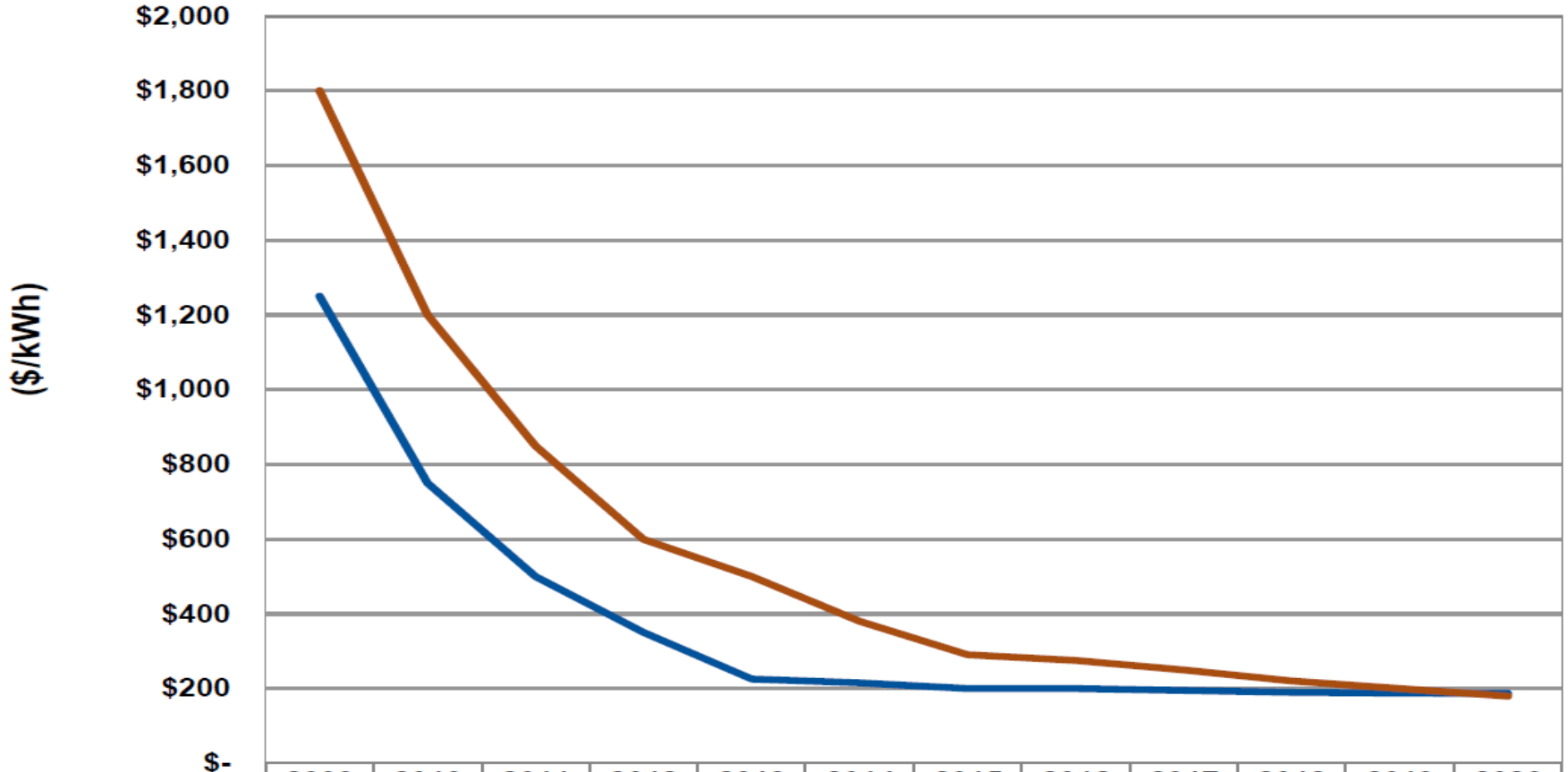
Projeções de preços LiB

Chart 2.1 Li-Ion Battery Price Decline by Scenario, World Markets: 2015-2024



(Source: Navigant Research)

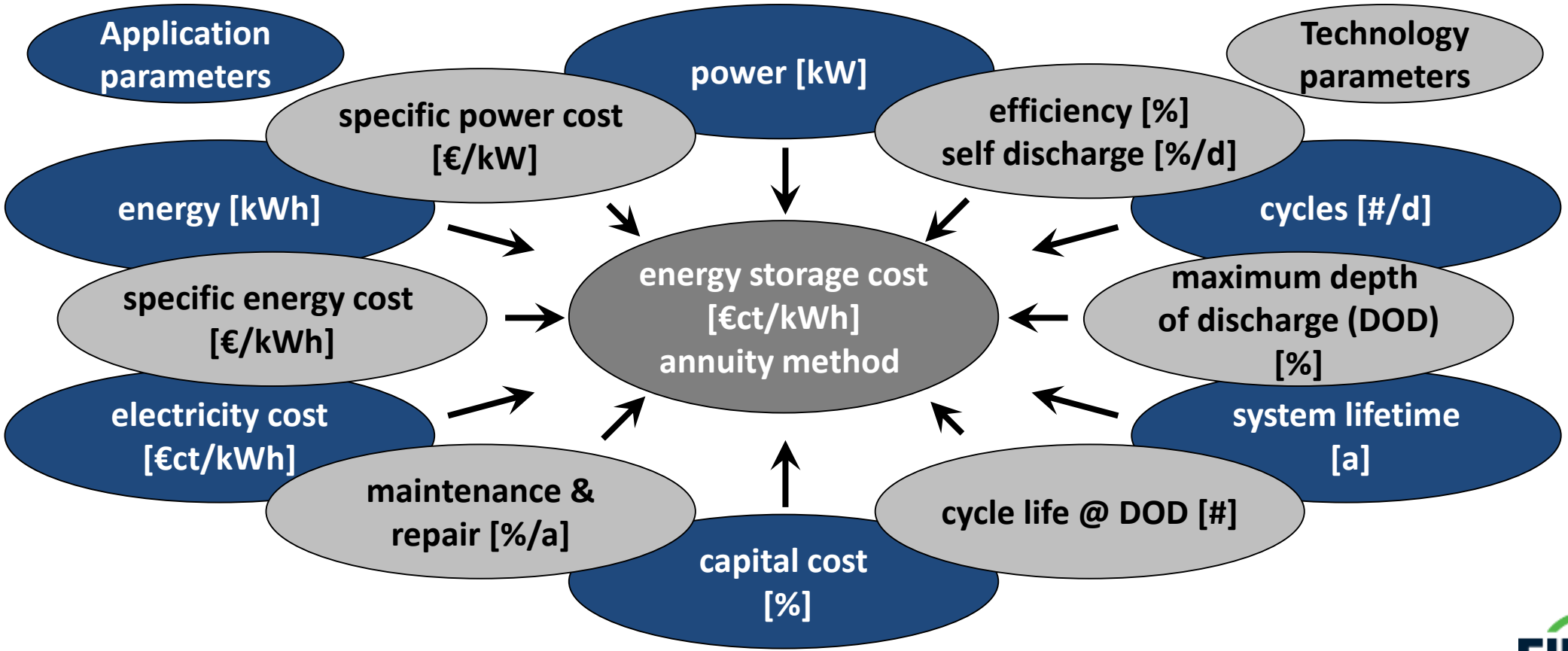
Projeção custo de LiB (consumo e grande porte)



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Consumer Electronics Li-ion	1,250	750	500	350	225	215	200	200	195	190	188	187
Large Format Li-ion	1,800	1,200	850	600	500	380	290	275	250	220	200	180

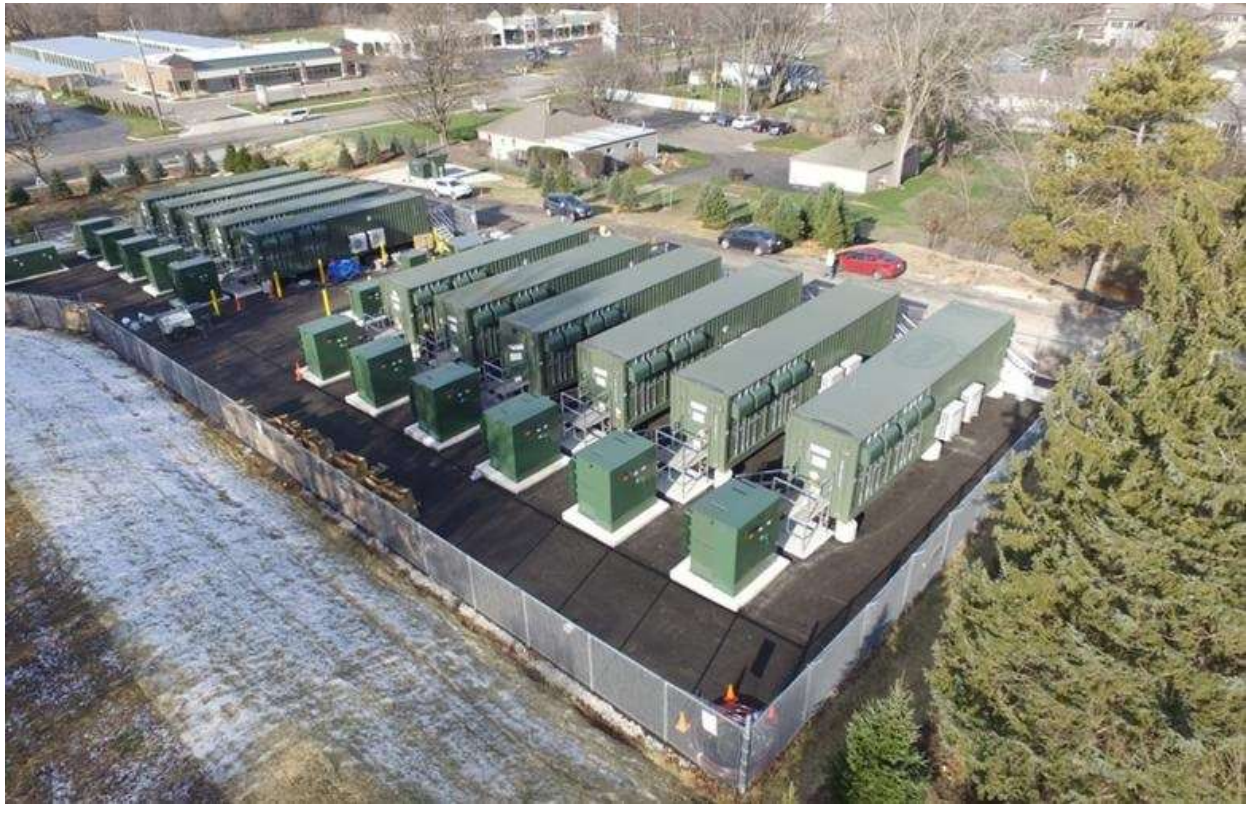
(Source: Navigant Research)

Composição dos custos do BESS



BESS grande porte conectados à rede

EDF 20 MW BESS (BYD America cells) em Illinois / USA



Kokam 56 MW Energy Storage na Coréia do Sul

BESS grande porte conectados à rede

LG Chem 10 MW BESS em Feldheim / Alemanha

AES 10 MW (of 100 MW) BESS na Irlanda do Norte

BESS para micro-GD conectados à rede

Conclusões

- Bateria de lítio-íon industrial é um produto consolidado
- Pesquisas e inovações continuam em busca de:
  - Aumento da densidade de energia e potência
  - Aumento da segurança
  - Diminuição do preço
- A Ásia, principalmente a China, domina toda a cadeia de produção
- No Brasil temos projetos em desenvolvimento da bateria (BMS, empacotamento mecânico e térmico), mas utilizando célula importada

CPqD
Campinas - SP

www.cpqd.com.br

Obrigado!

Raul Fernando Beck
raul@cpqd.com.br

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