THE FUTURE OF ENERGY

Singapore
24 November 2015

Presentation to 9th Capacity Building Programme for Officers of Indian Electricity Regulatory Commissions

Ashish Sethia

APAC Lead – Power & Gas

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10 RESEARCH THEMES

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1. **Utility strategies and new power sector business models**
   New retail strategies, distributed generation, unbundling assets
2. **Power, renewable energy and carbon market reform**
   Capacity markets, auctions, tariff reforms, trading schemes
3. **Changing electricity demand patterns**
   Prosumers, peak demand shifts, energy efficiency, decoupling electricity and GDP
4. **The impact of oil and other commodity prices on the energy system**
   Oil–gas price links, oil impact on distributed generation, manufacturing inputs and EVs
5. **Region-specific gas supply/demand, and power market implications**
   US shale, European pipelines, LNG, and competitiveness of gas in the merit order
6. **Technology innovation and (component) cost declines**
   Experience curves, process improvements, optimisation
7. **The market opportunities for solar PV combined with energy storage**
   Integrated distributed generation and storage, new solar+storage business models
8. **Integrating renewable generation and maintaining system flexibility**
   Intermittency, system balancing, energy storage, demand response
9. **The ‘connected home’ and the ‘connected car’**
   “Internet of things”, smart homes, energy management systems, EVs
10. **Financial innovations for clean energy deployment**
    Yieldcos, Green Bonds, securitization, corporate direct investment

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NEW NORMAL: GROWING RENEWABLES

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GLOBAL POWER DEMAND GROWTH, 2012-40

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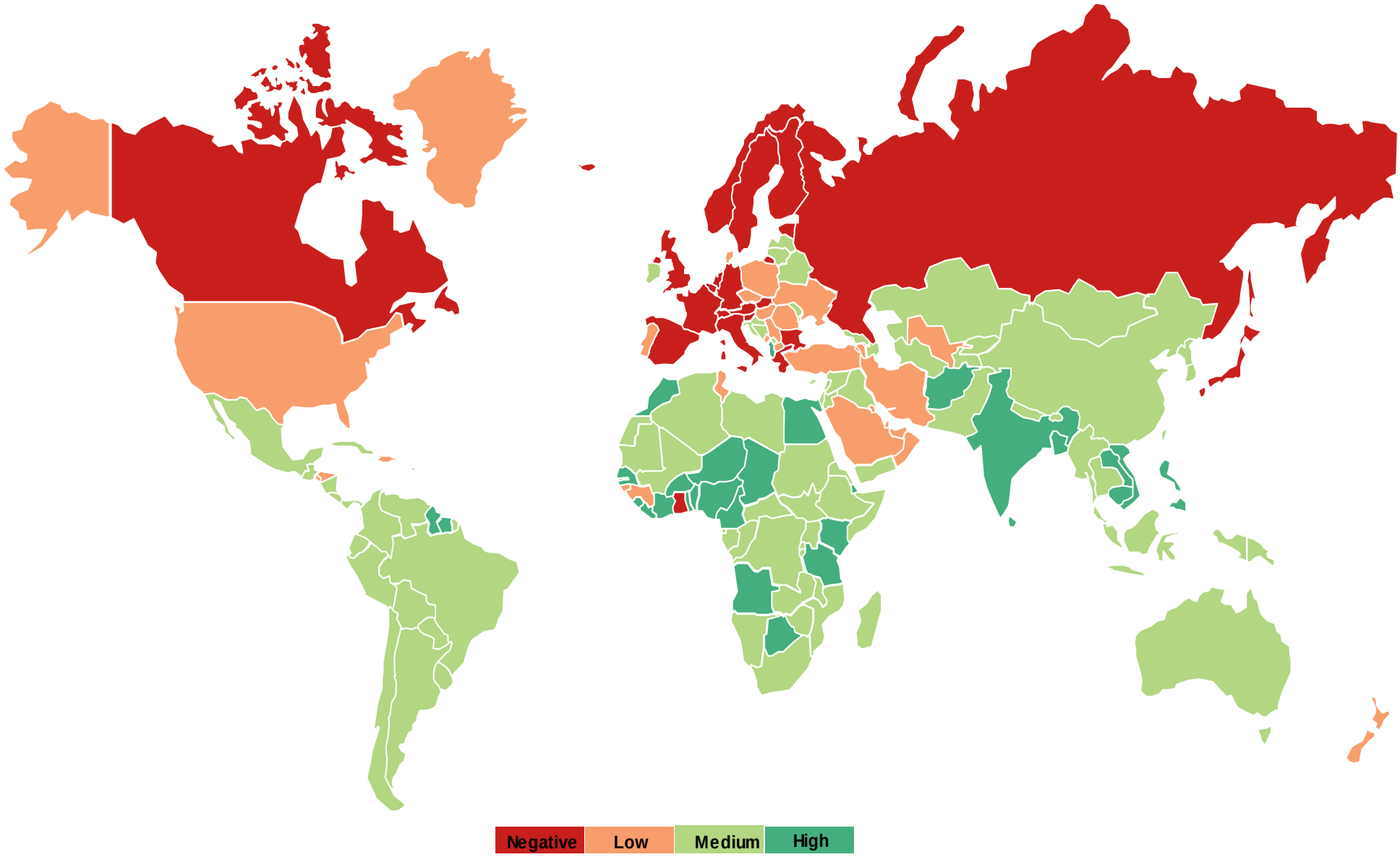

Note: low < 0.5%, Medium 0.5-4%, High >4%

Source: Bloomberg New Energy Finance

H2 2015 LEVELISED COST OF ELECTRICITY

CENTRAL AND REGIONAL SCENARIOS ($/MWH)

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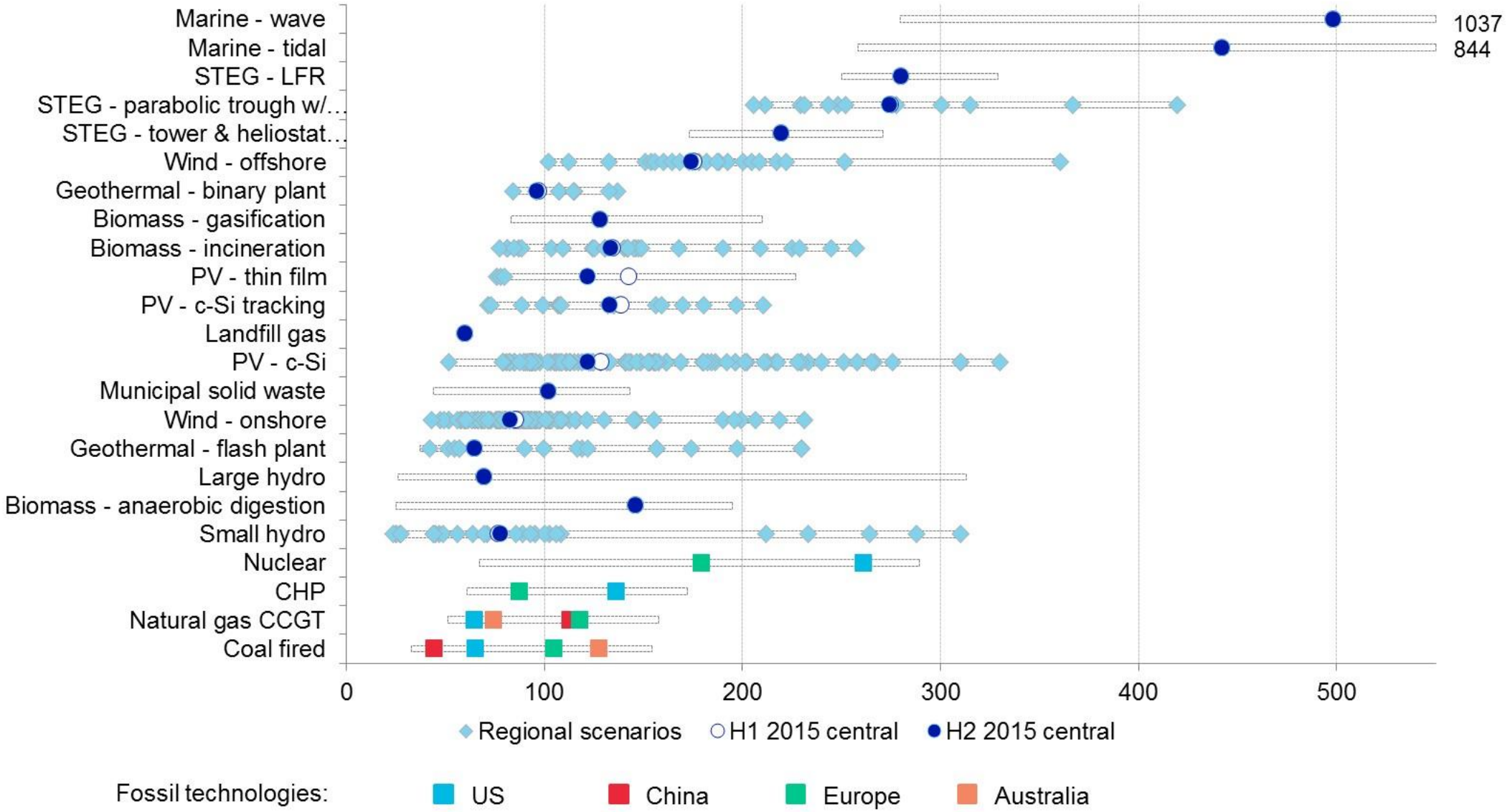


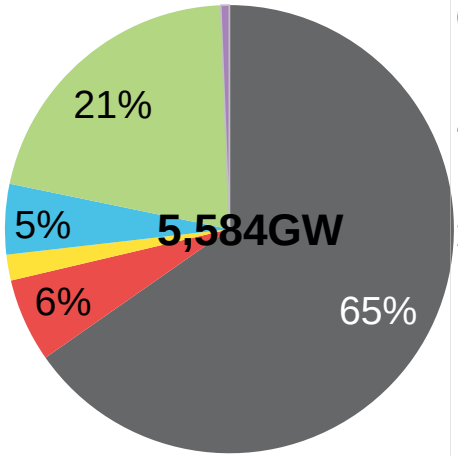
Note: STEG = solar thermal electric generation

Source: Bloomberg New Energy Finance

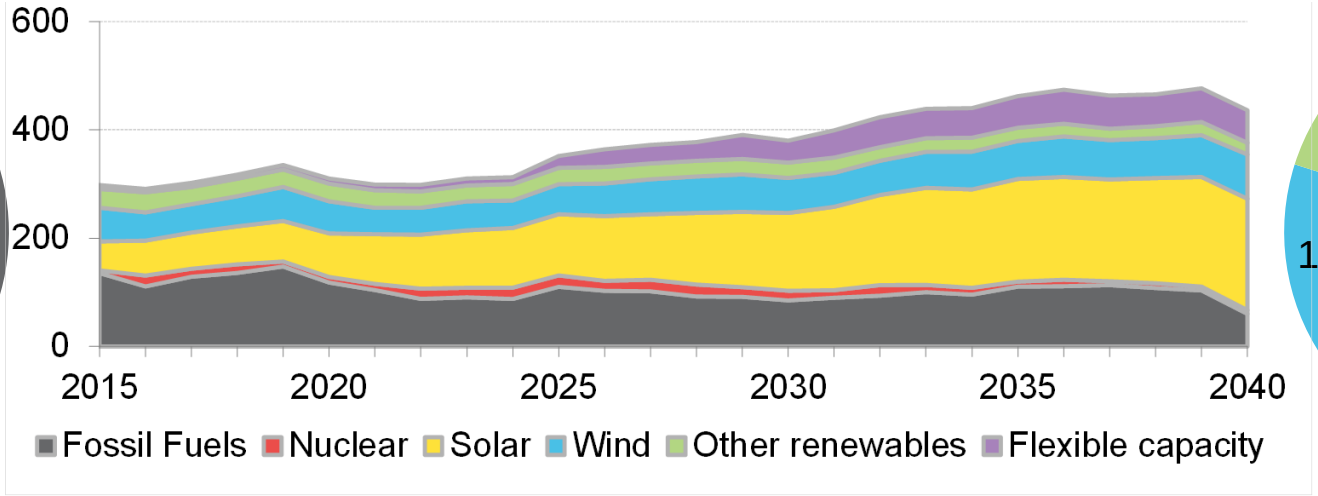
GLOBAL INSTALLED CAPACITY 2012 AND 2040 AND PROJECTED CAPACITY ADDITIONS, BY TECHNOLOGY (GW)

Bloomberg NEW ENERGY FINANCE

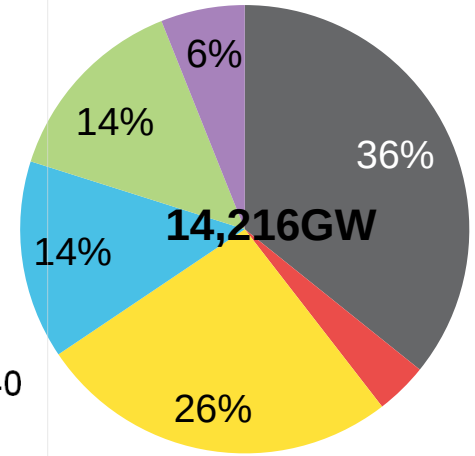
2012



Annual capacity additions, 2015-40



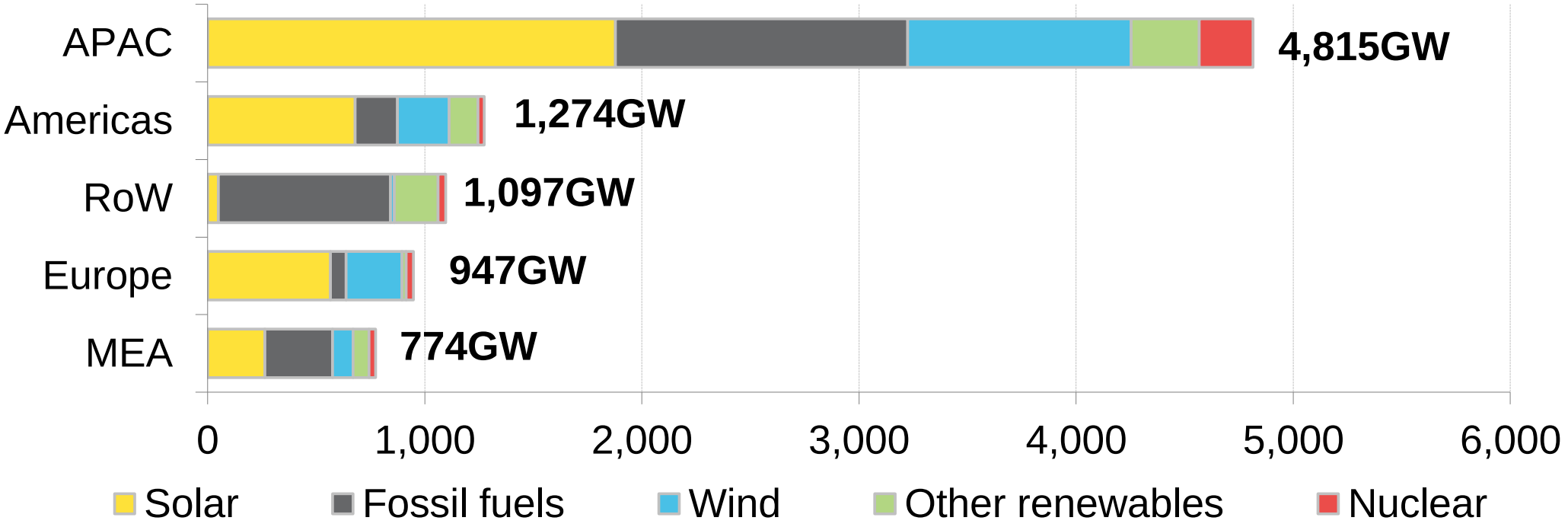
2040



Source: Bloomberg New Energy Finance

GROSS CAPACITY ADDITIONS BY REGION AND BY TECHNOLOGY, 2015-40 (GW)

Bloomberg NEW ENERGY FINANCE



Source: Bloomberg New Energy Finance

CHINA CUMULATIVE INSTALLED CAPACITY BY TECHNOLOGY, 2012-40 (GW)

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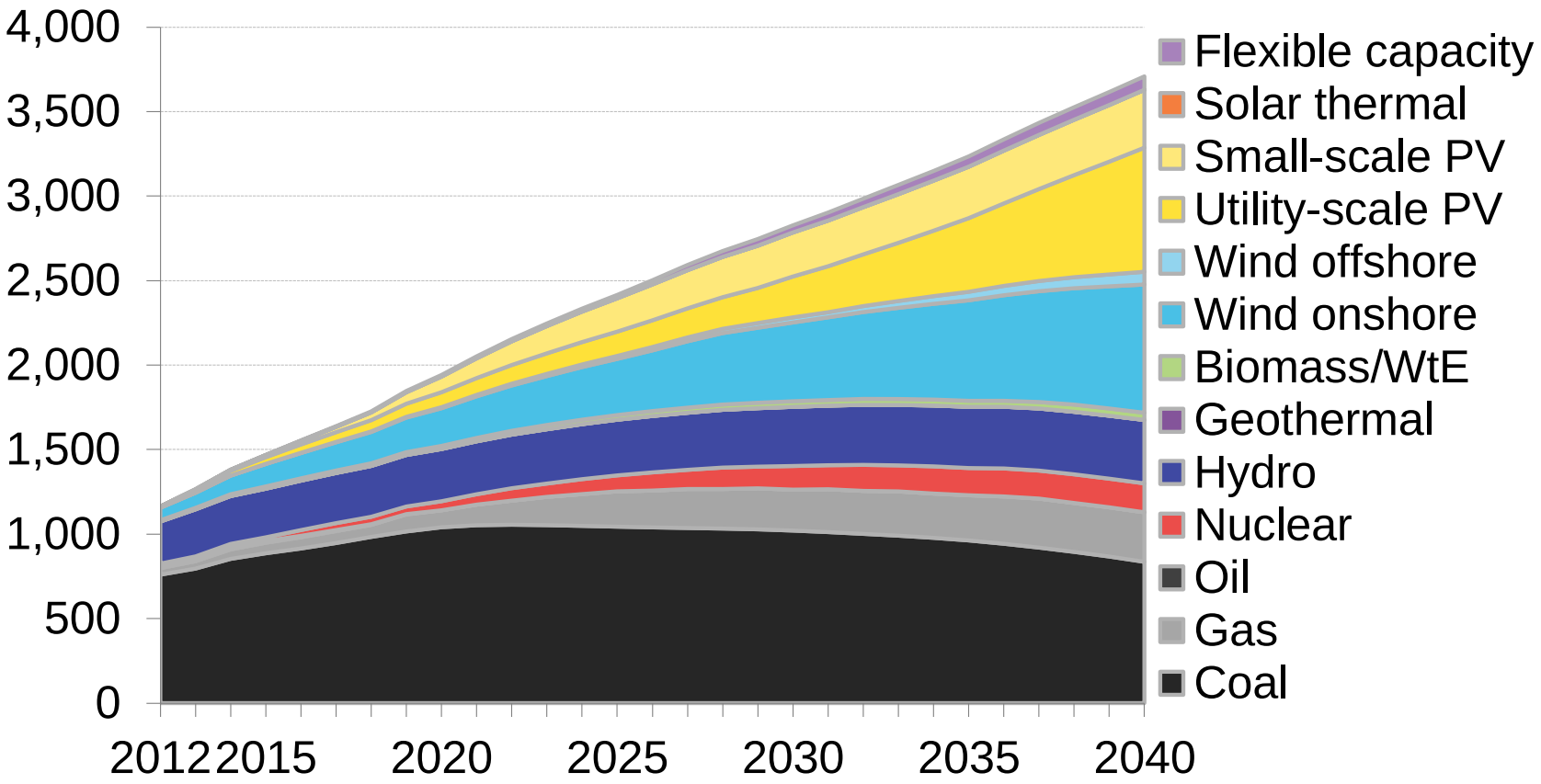
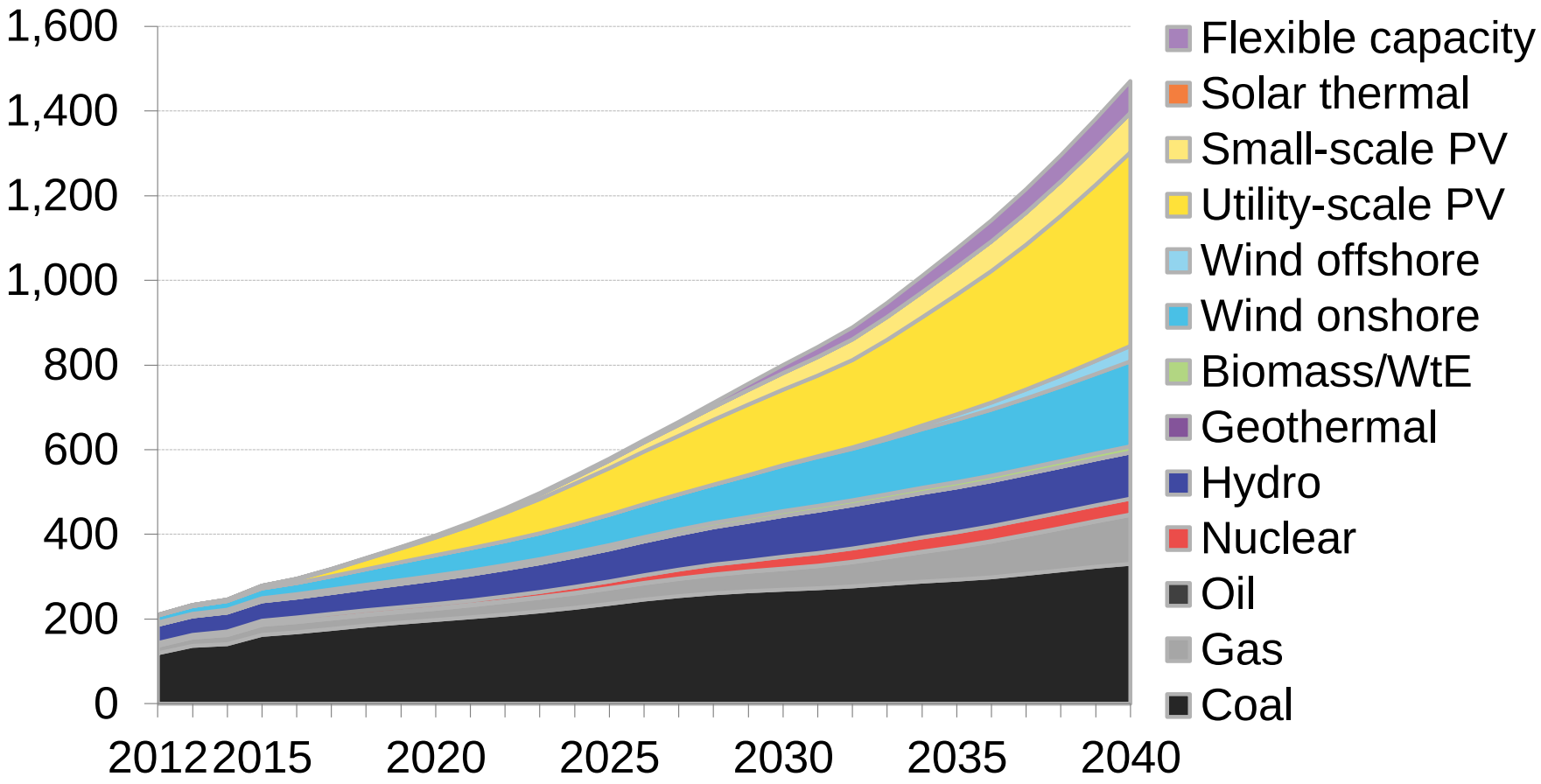


Source: Bloomberg New Energy Finance

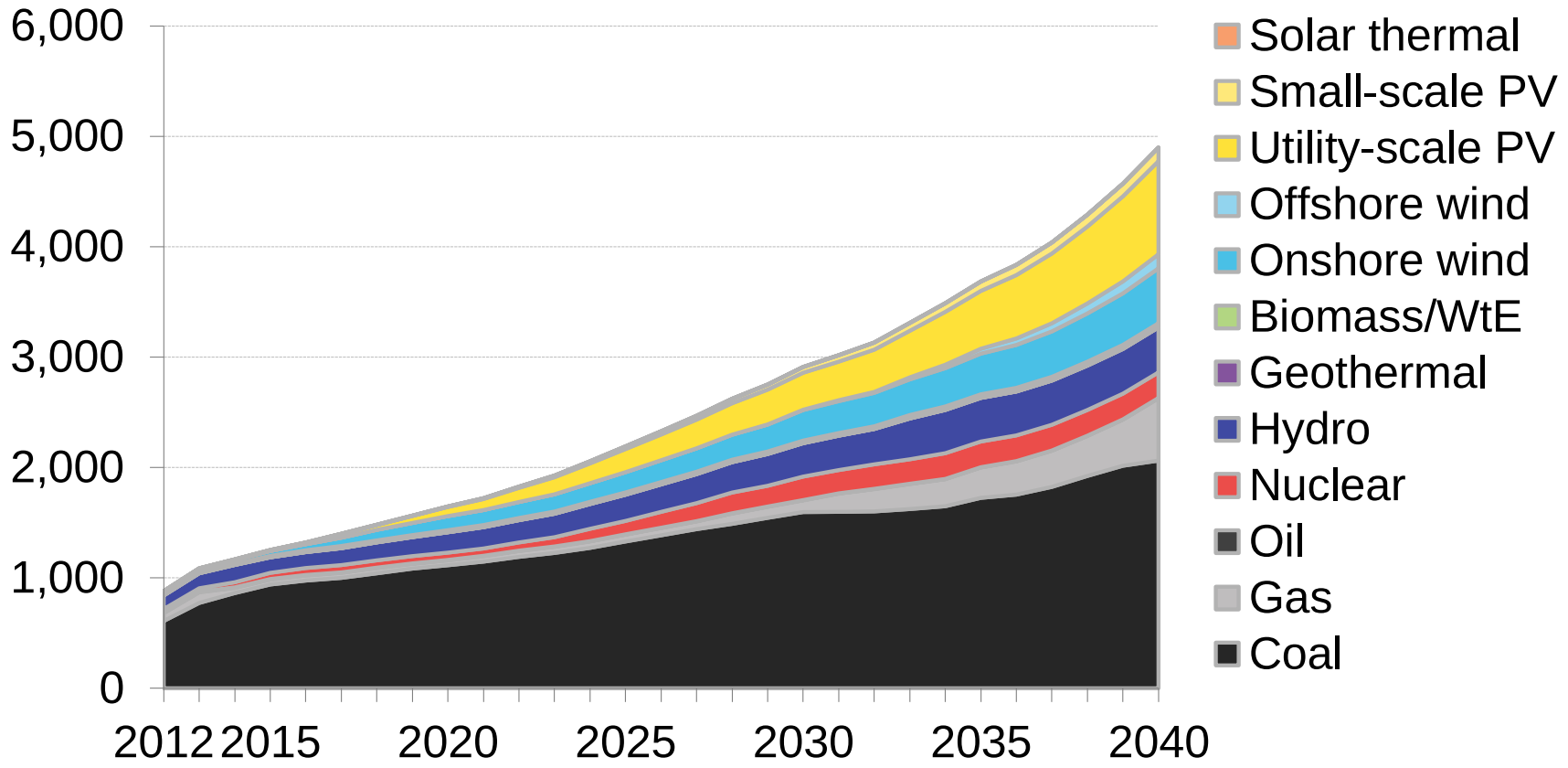
INDIA CUMULATIVE INSTALLED CAPACITY BY TECHNOLOGY, 2012-40 (GW)

Bloomberg NEW ENERGY FINANCE



Source: Bloomberg New Energy Finance

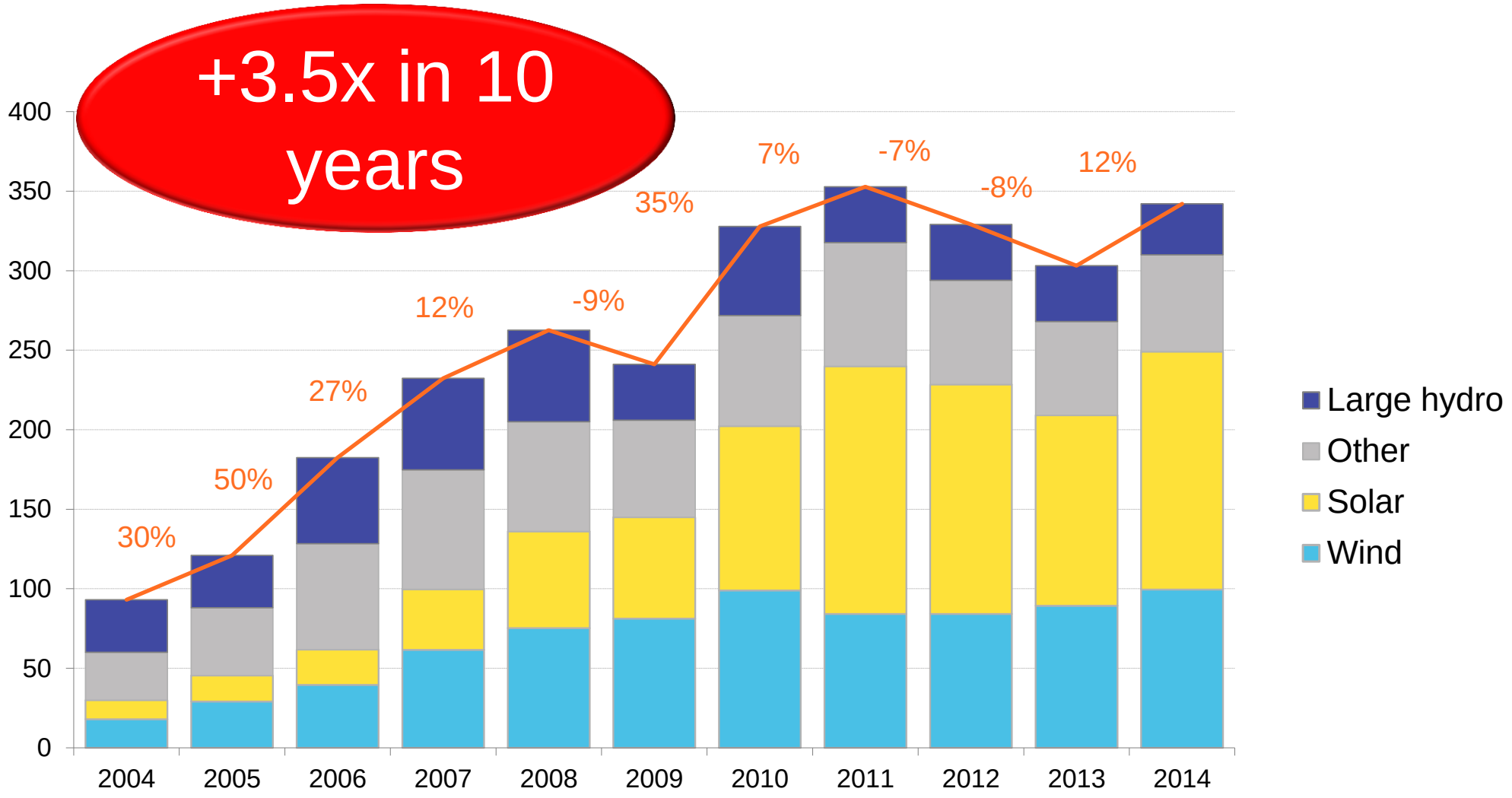
INDIA POWER GENERATION BY TECHNOLOGY, 2012-40 (TWH)



Source: Bloomberg New Energy Finance

NEW INVESTMENT IN CLEAN ENERGY
2004–14 ($BN)

Bloomberg NEW ENERGY FINANCE



Note: Total values include estimates for undisclosed deals. Includes corporate and government R&D, and spending for digital energy and energy storage projects (not reported in quarterly statistics), as well as a BNEF estimate for large hydro investment.

Source: Bloomberg New Energy Finance

RENEWABLE ENERGY (INCL. LARGE HYDRO) AND FOSSIL FUEL INVESTMENT VOLUMES 2008-14 $BN

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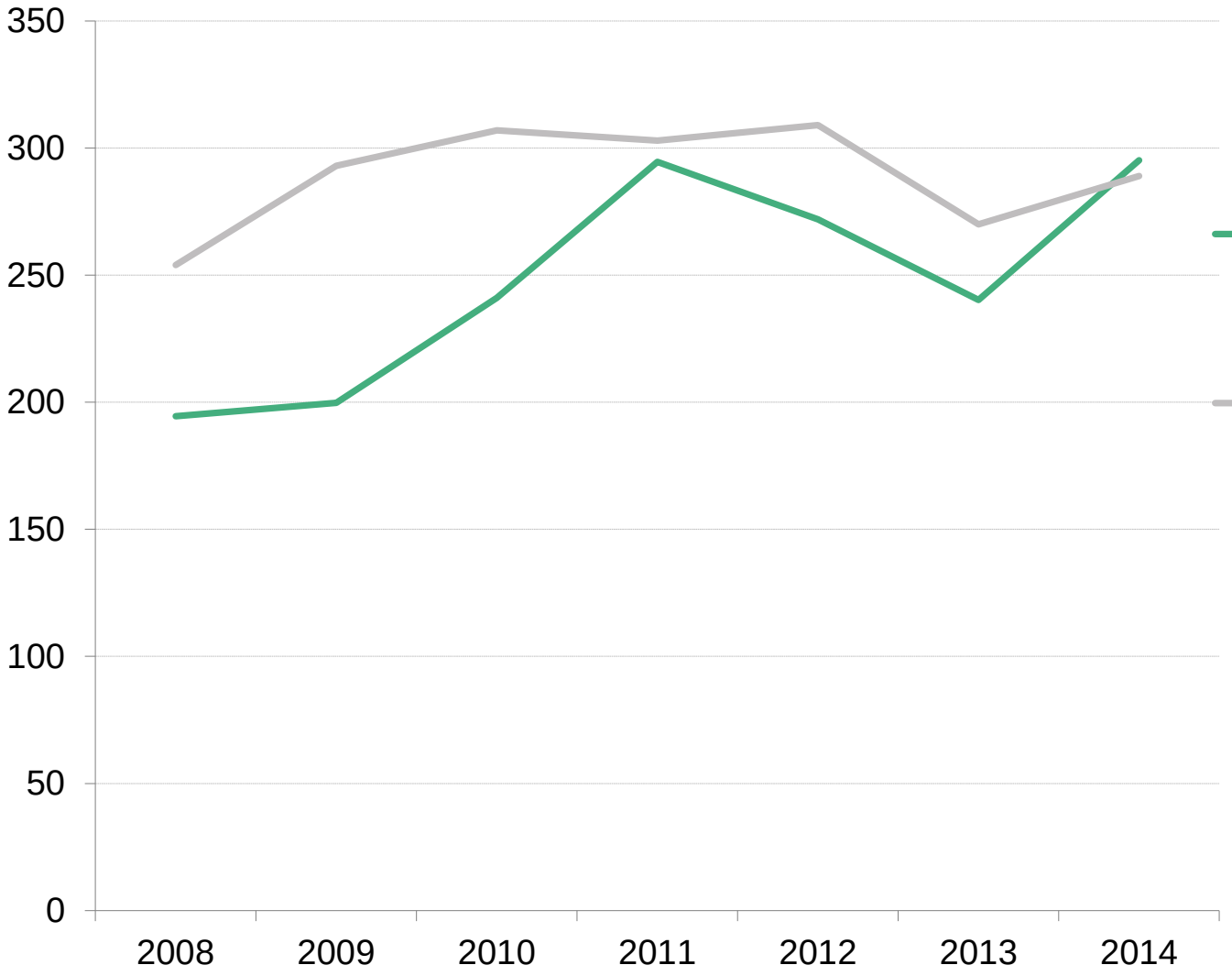


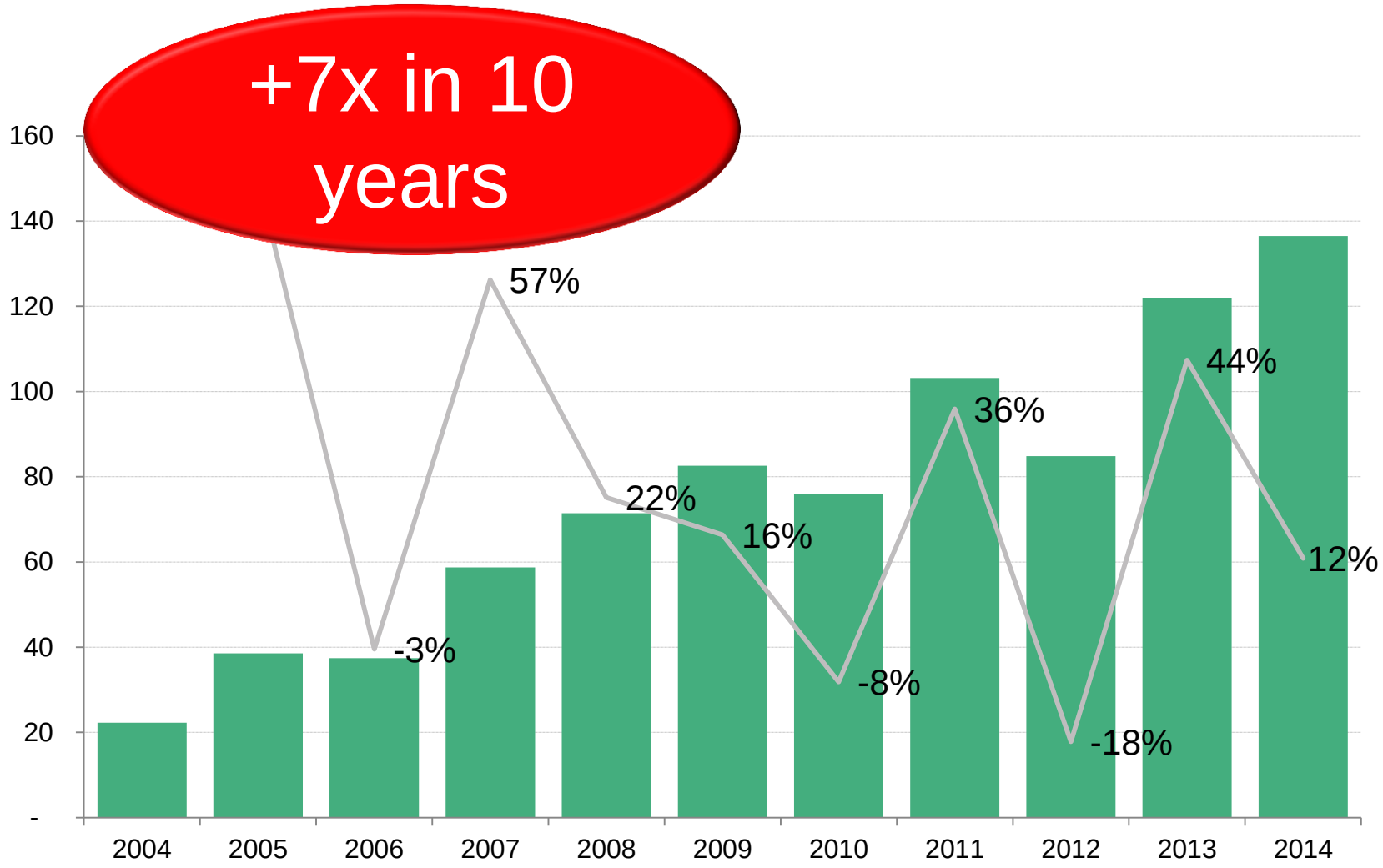
2014

$295bn

$289bn

Source: Bloomberg New Energy Finance

NEW INSTALLATIONS IN CLEAN ENERGY
2004–14 (GW)



Note: include large hydro

Source: Bloomberg New Energy Finance

WIND AND SOLAR CAPACITY FORECASTS SINCE 2010
BNEF, IEA

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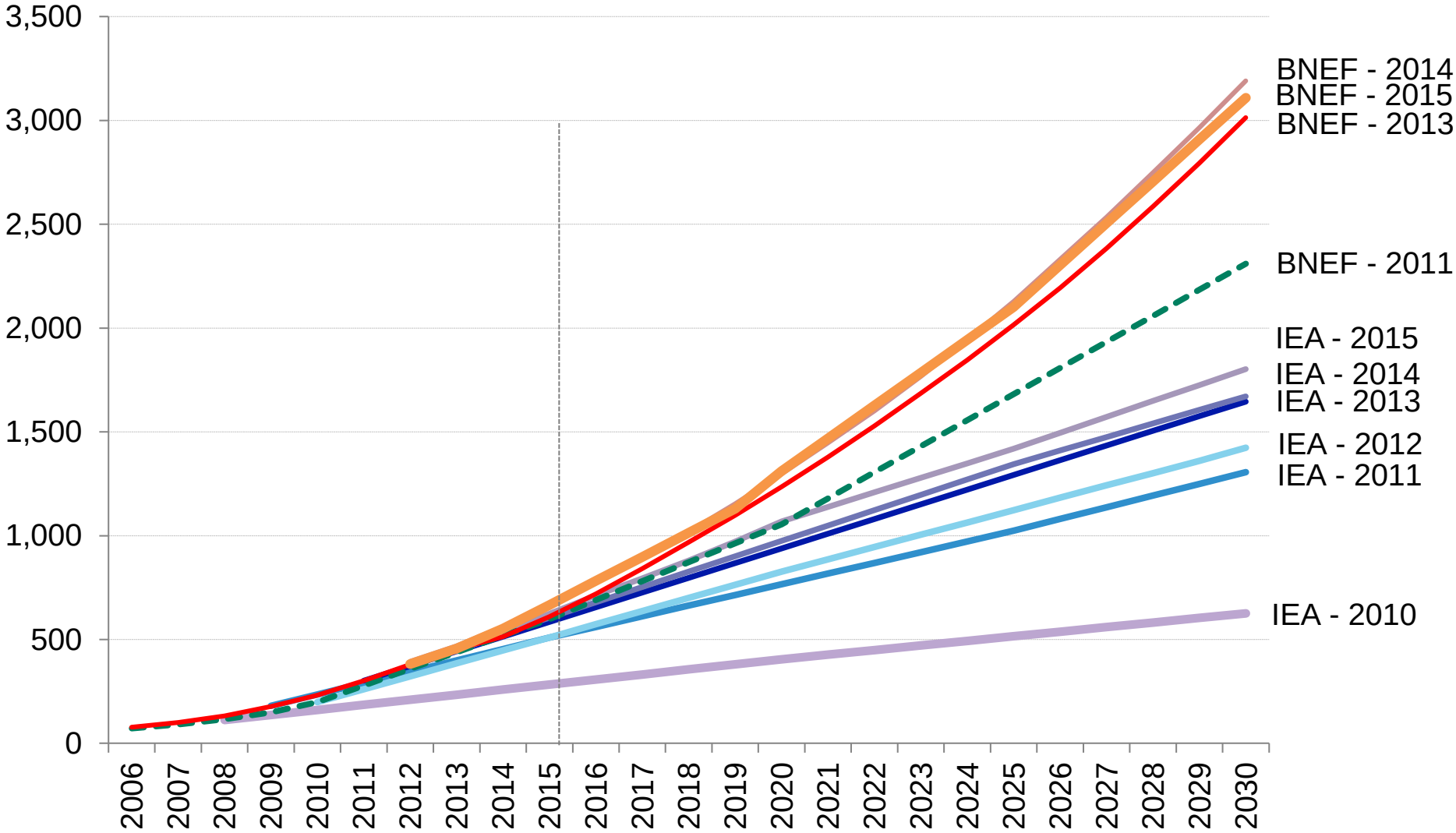
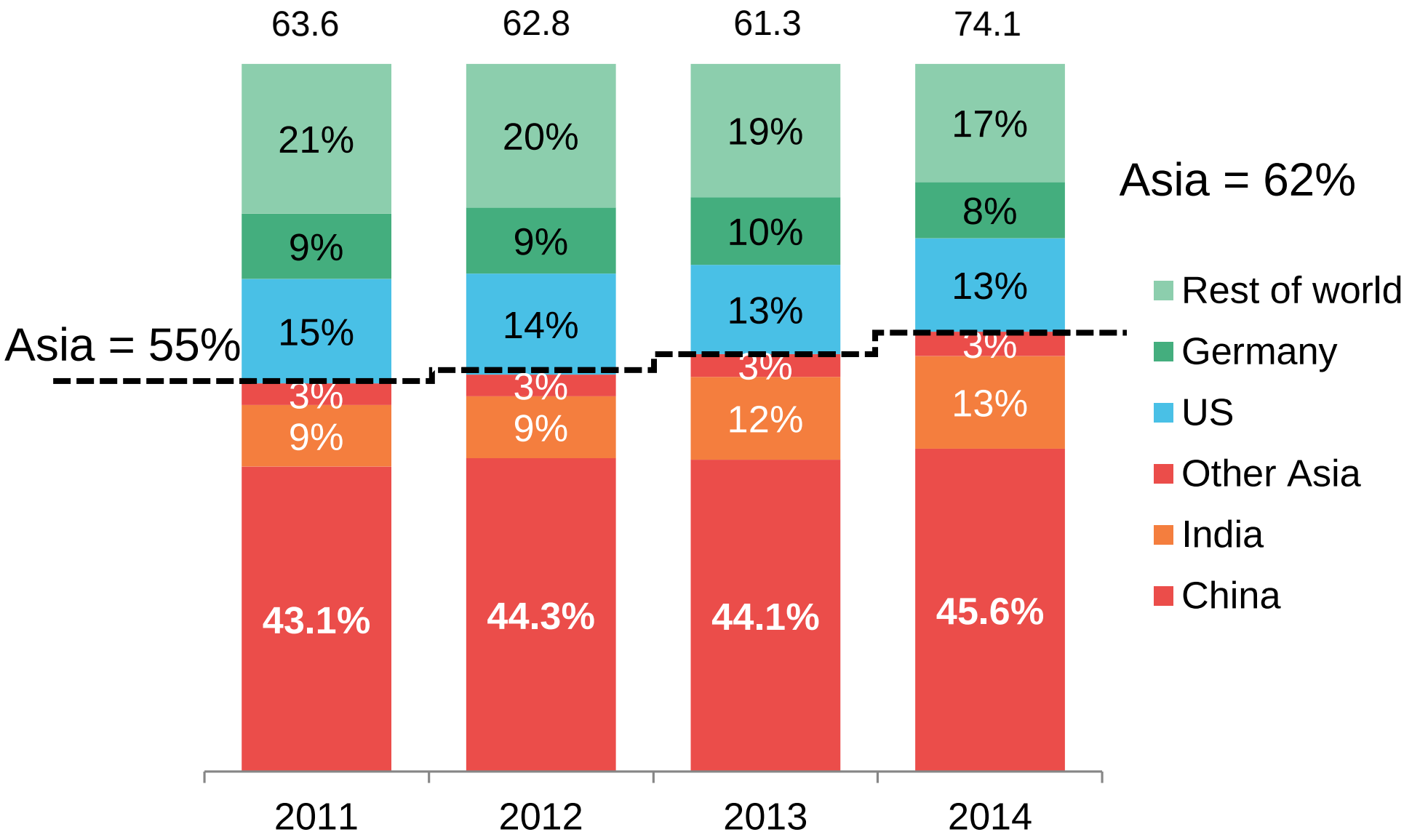


BNEF renewables forecasts have always outpaced IEA forecasts, and were closer to actual installed wind and solar capacity.

Source: Bloomberg New Energy Finance, IEA

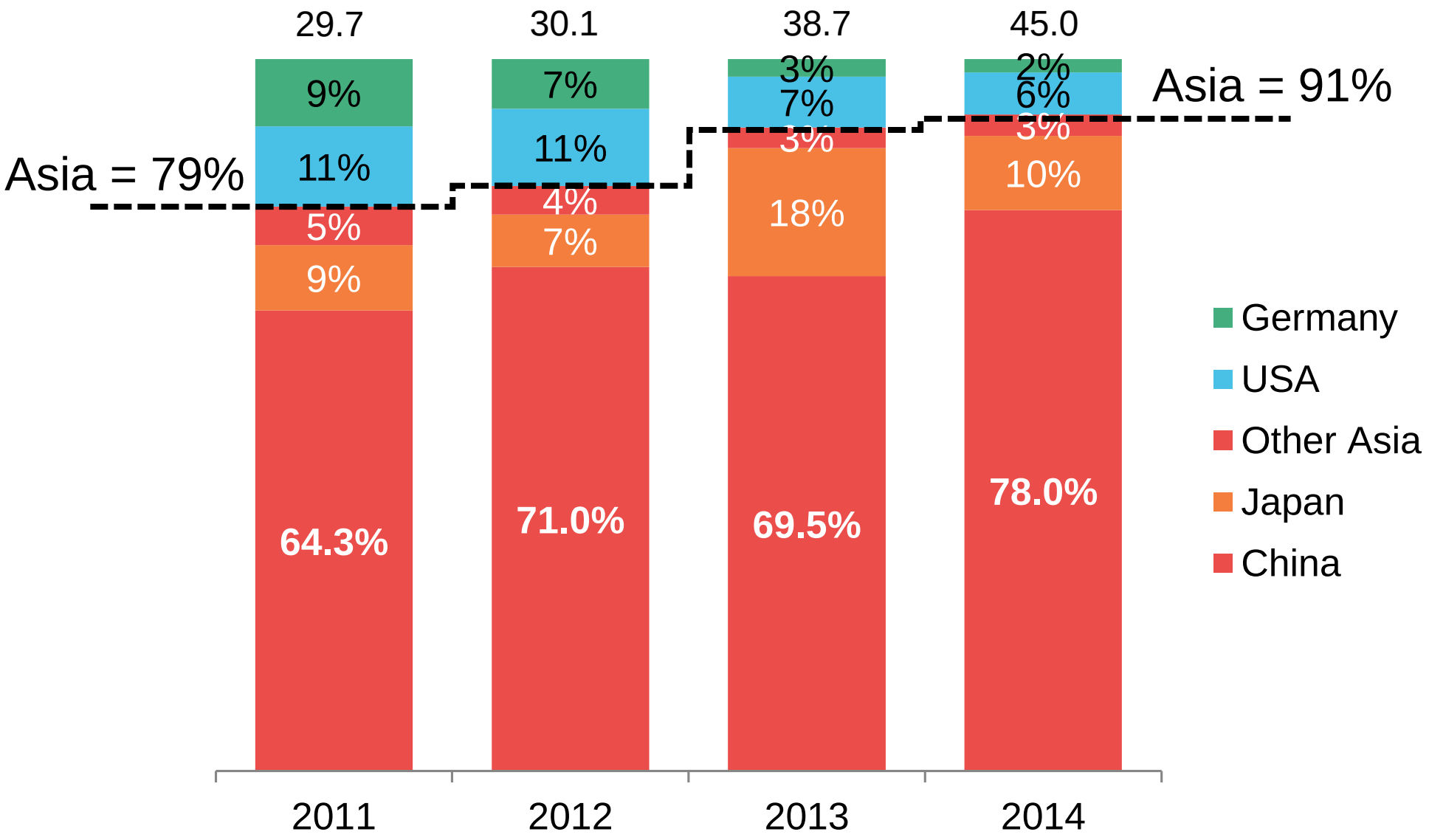
ESTIMATED GLOBAL WIND TURBINE SUPPLY
2011-14 (%, GW)



Source: Bloomberg New Energy Finance. Note: Nameplate capacity represents the companies' announced production capacity. Discounted capacity represents our best estimation of actual available capacity. For details see our Wind Turbine Manufacturing Supply Model

PV MODULE PRODUCTION BY COUNTRY

2011-2014 (%,GW)



Source: Company reports, statements and Bloomberg New Energy Finance estimates

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> There is an urgent need to develop sources of renewable energy

Pope Francis

Picture: Wikimedia

FOSSIL FUELS: SHIFTING BATTLEGROUNDS

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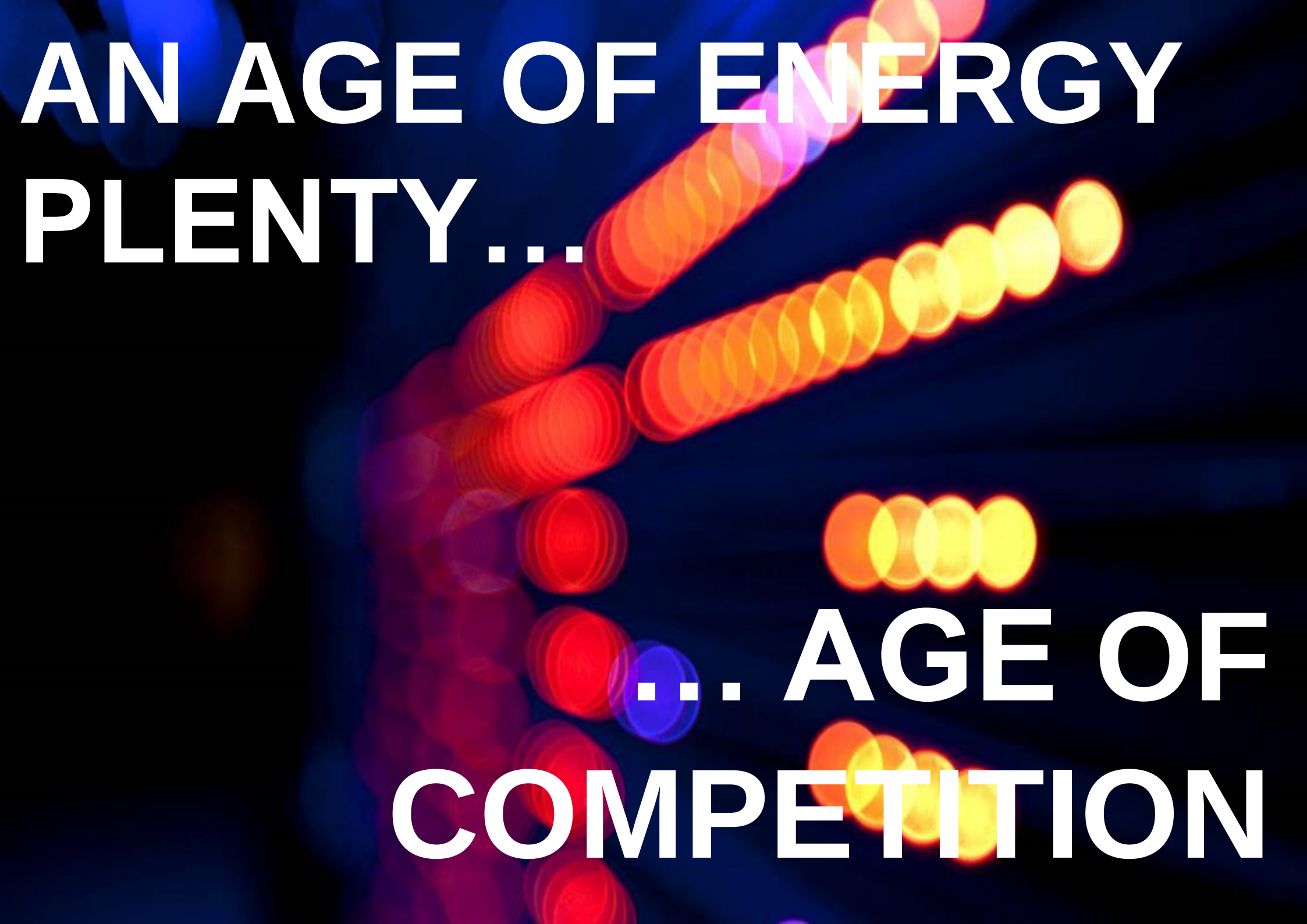
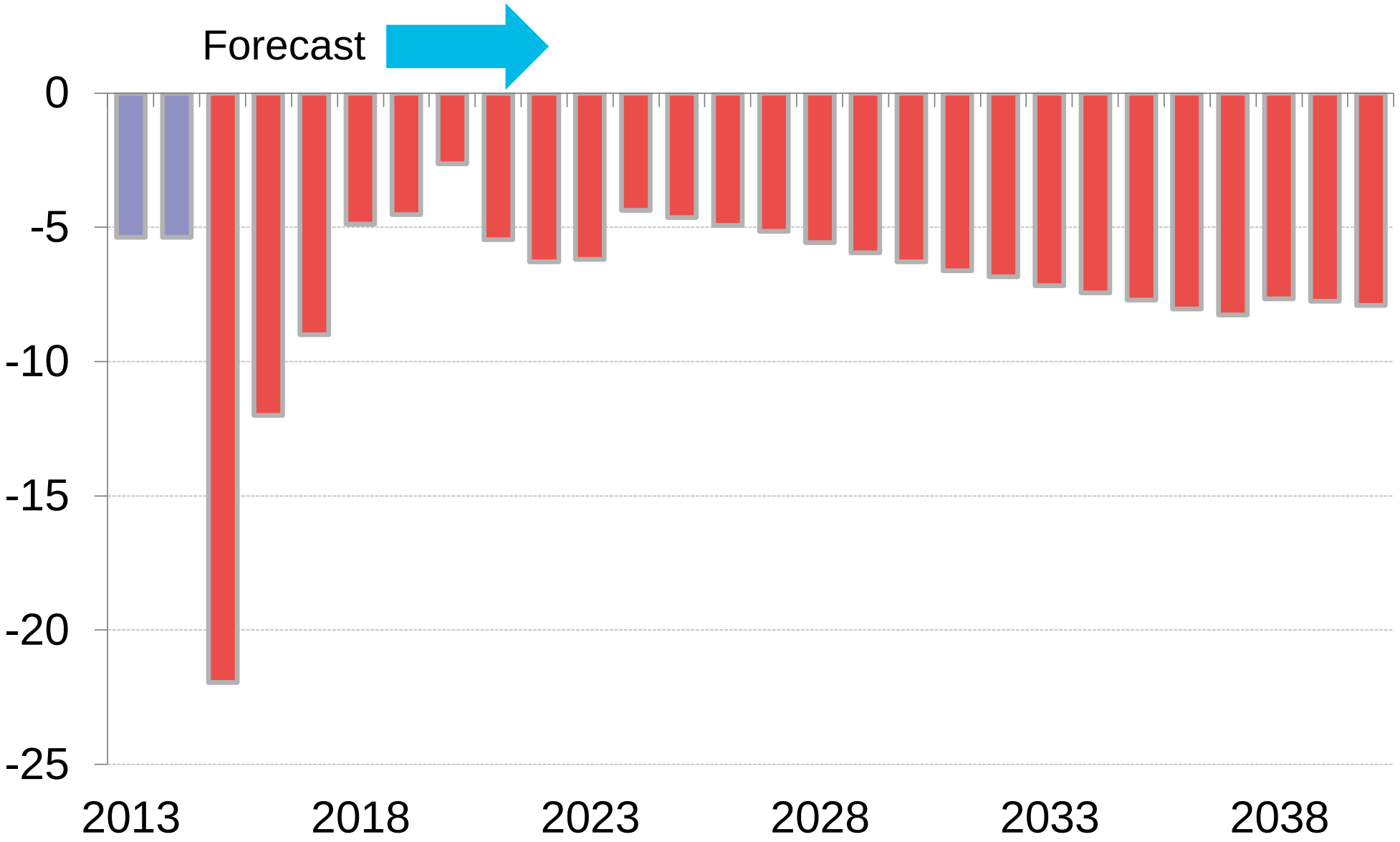
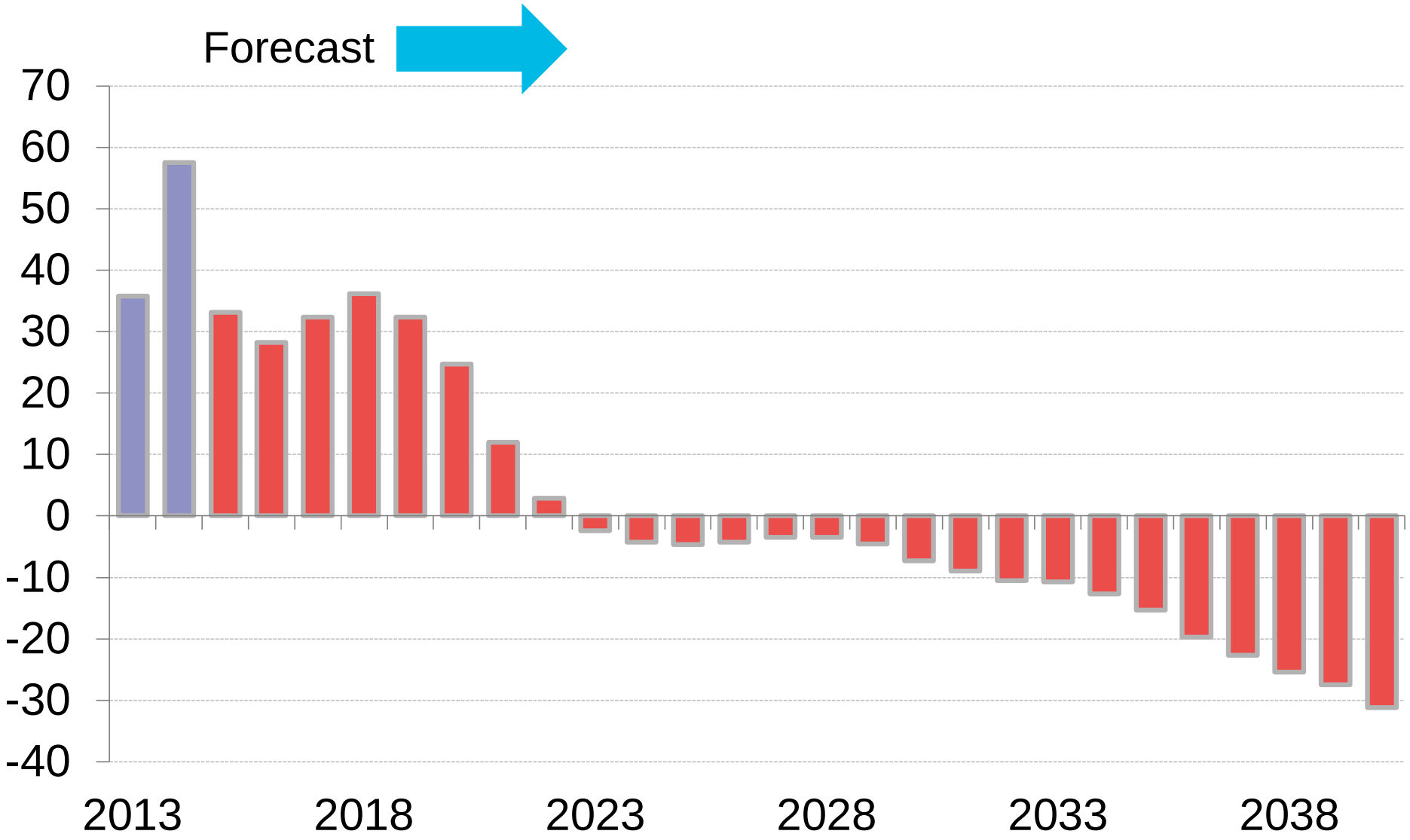

AN AGE OF ENERGY PLENTY…
…AGE OF COMPETITION

US NET COAL CAPACITY ADDITIONS
2013-40 (GW)



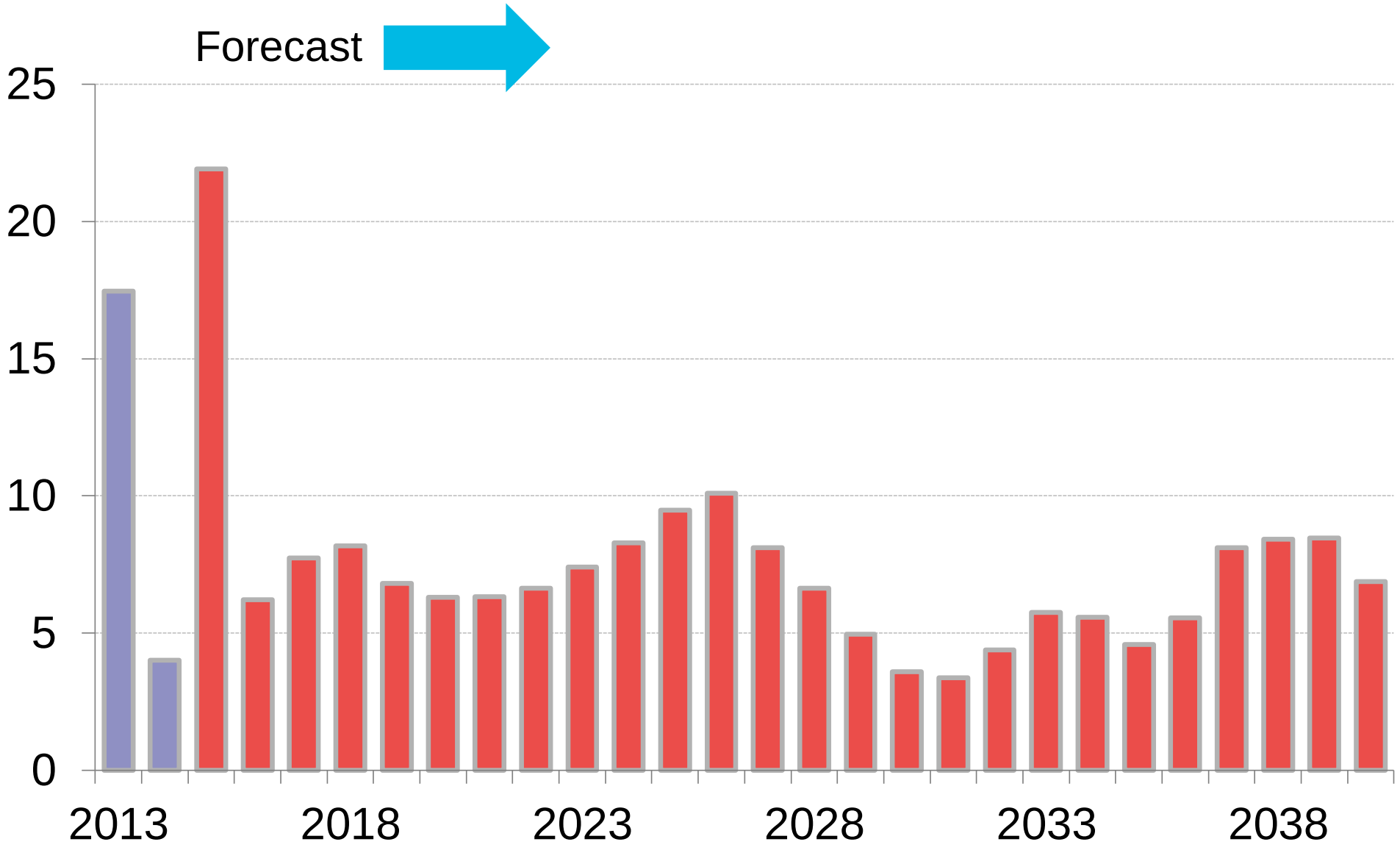
Source: Bloomberg New Energy Finance NEO 2015

CHINA NET COAL CAPACITY ADDITIONS
2013-40 (GW)



Source: Bloomberg New Energy Finance

INDIA NET COAL CAPACITY ADDITIONS
2013-40 (GW)

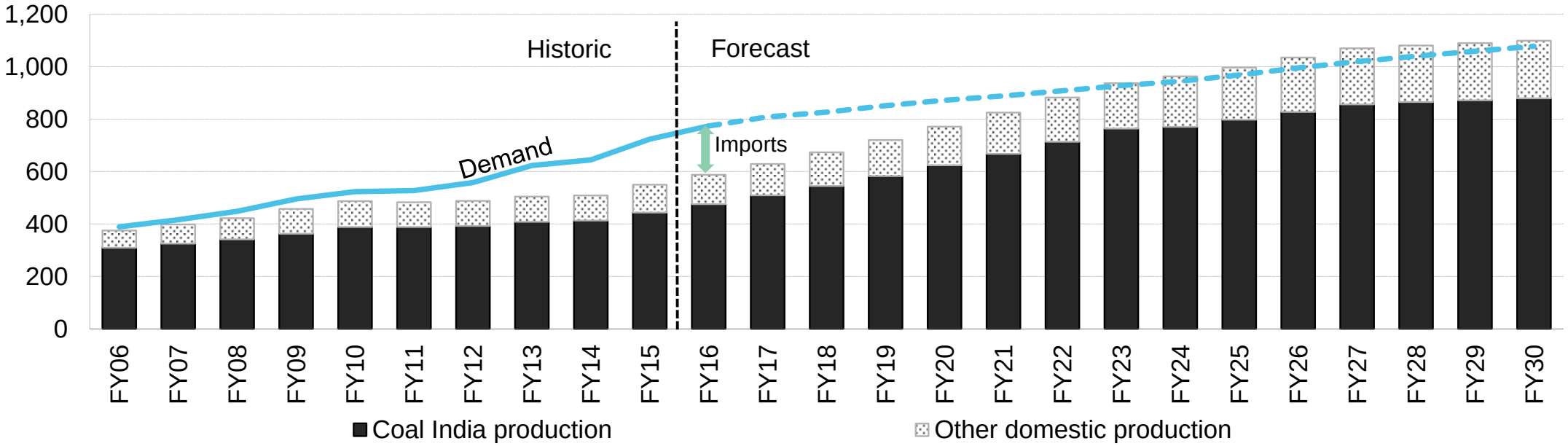


Source: Bloomberg New Energy Finance NEO 2015

INDIA WILL NOT BAIL OUT SEABORNE COAL

- **In FY2015 (April 14 – March 15), India imported the largest amount of thermal coal ever – 174Mt, 24% of its demand.** Some think that this trend will continue and India can act as a counterweight to the decreasing imports in China. Two issues will, however, make this impossible:
- **First: fast growth in renewable energy will reduce growth rates of coal power production (and hence coal demand)**. Our NEO2015 analysis predicts that India will produce 75% more electricity from coal-fired generation in 2030 than in 2015 – a 2.7% CAGR compared to 3.9% in the last decade. Moreover, improvements in thermal efficiency of India's coal-fired generation fleet will result in demand increasing only by 50% to 2030.
- **Second: government wants to obliterate thermal coal imports by 2017** by doubling production of Coal India Ltd (which already has a 80% market share) by FY2020. That may be too good to be true. However, our realistic base case production forecast reveals that **India's imports likely peaked in the last fiscal and it will cease thermal coal imports in the year 2022**.

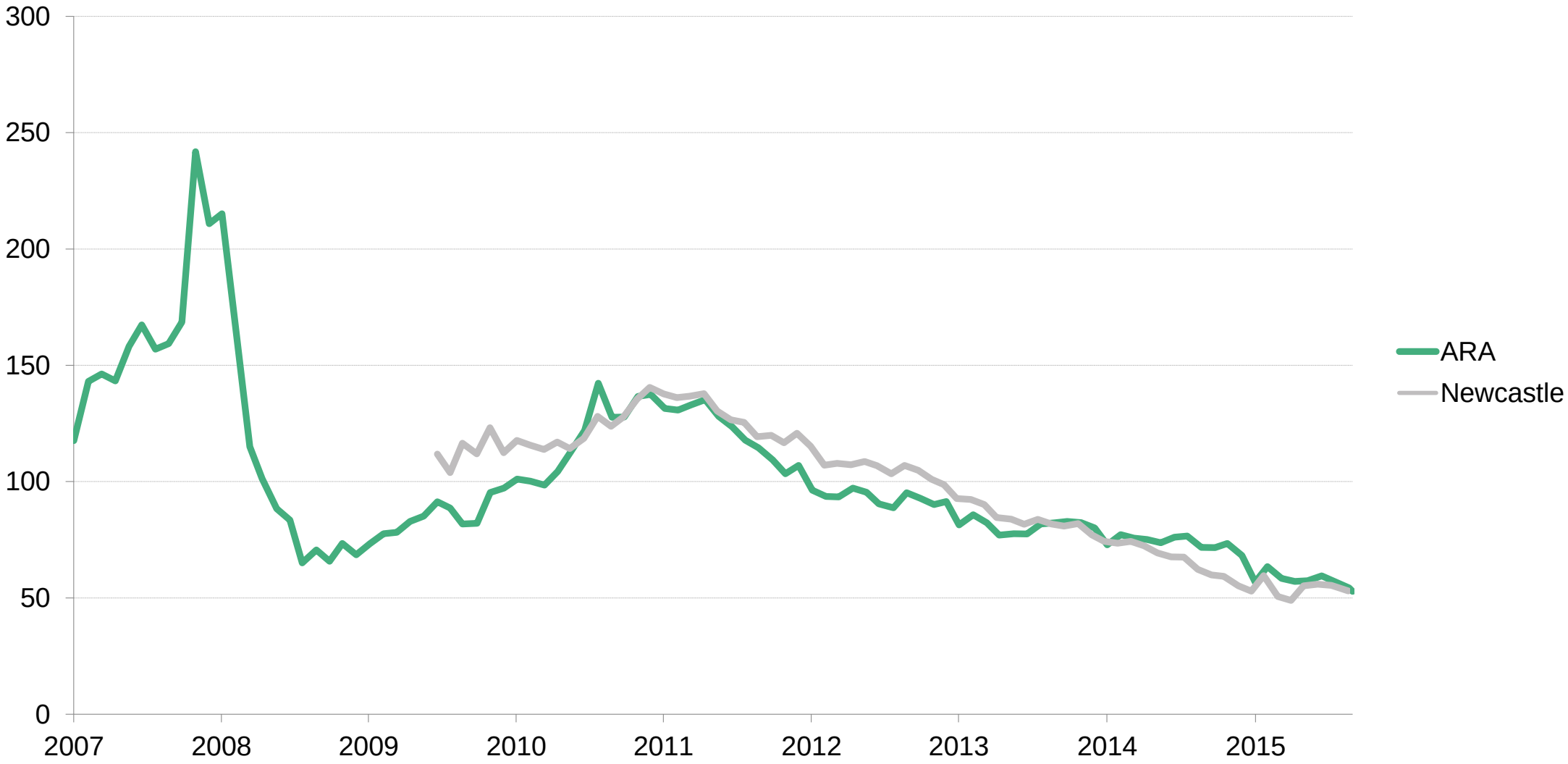
Thermal coal demand and supply projections in base case production scenario (FY06-30), Mt



Note: our base case production forecast assumes a 7% CAGR in domestic coal production.

Source: Ministry of coal, Coal India, Bloomberg New Energy Finance

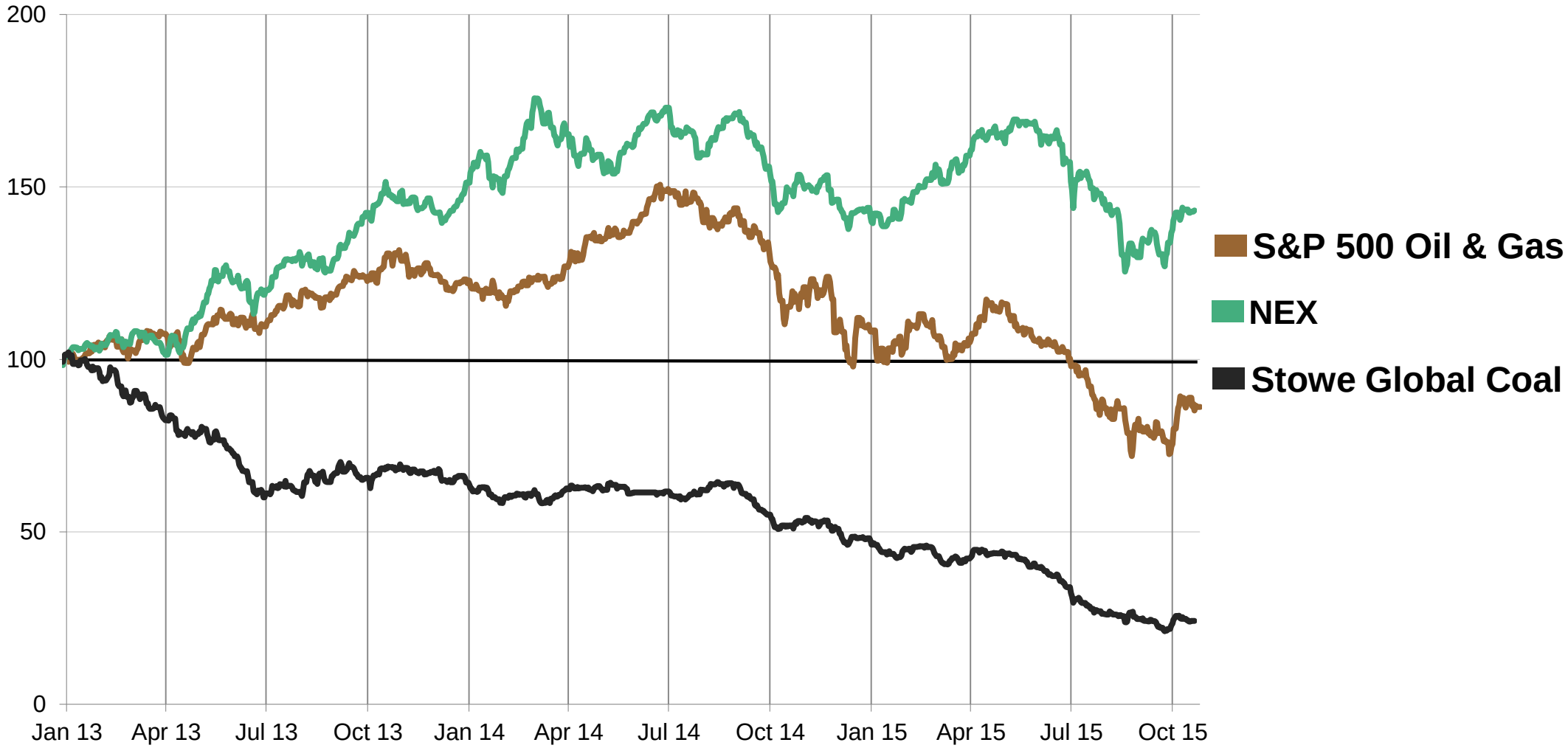
ARA AND NEWCASTLE COAL PRICE 2007–2015
(2014 US$/TONNE)



Note: Prices have been adjusted for inflation according to YoY CPI Index from UK Office of National Statistics

Source: Bloomberg New Energy Finance, ONS

NEX CLEAN ENERGY INDEX 2013 – 2015 YTD



Note: Values as of 26 October 2015; Stowe and S&P 500 rebased to 100 on 01 Jan 2013

Source: Bloomberg New Energy Finance

COAL BANKRUPTCIES

Bloomberg NEW ENERGY FINANCE

Image: various company sources

THE ECONOMIST COVER, "SHEIKHS VERSUS SHALE" DECEMBER 2014

Bloomberg NEW ENERGY FINANCE

Source: *The Economist*

WTI CRUDE OIL PRICES, 2000–2015
($2015 / BARREL)

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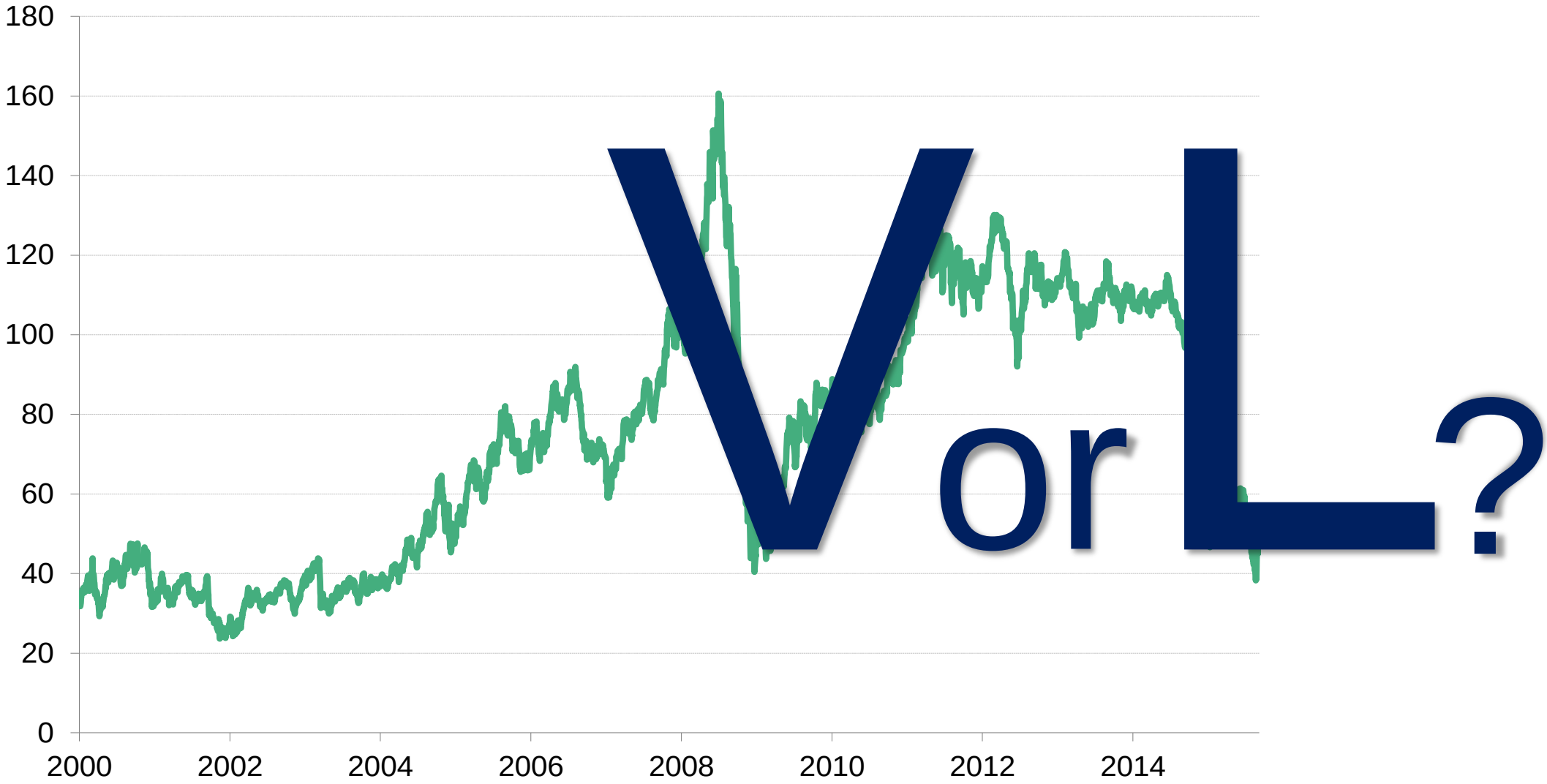
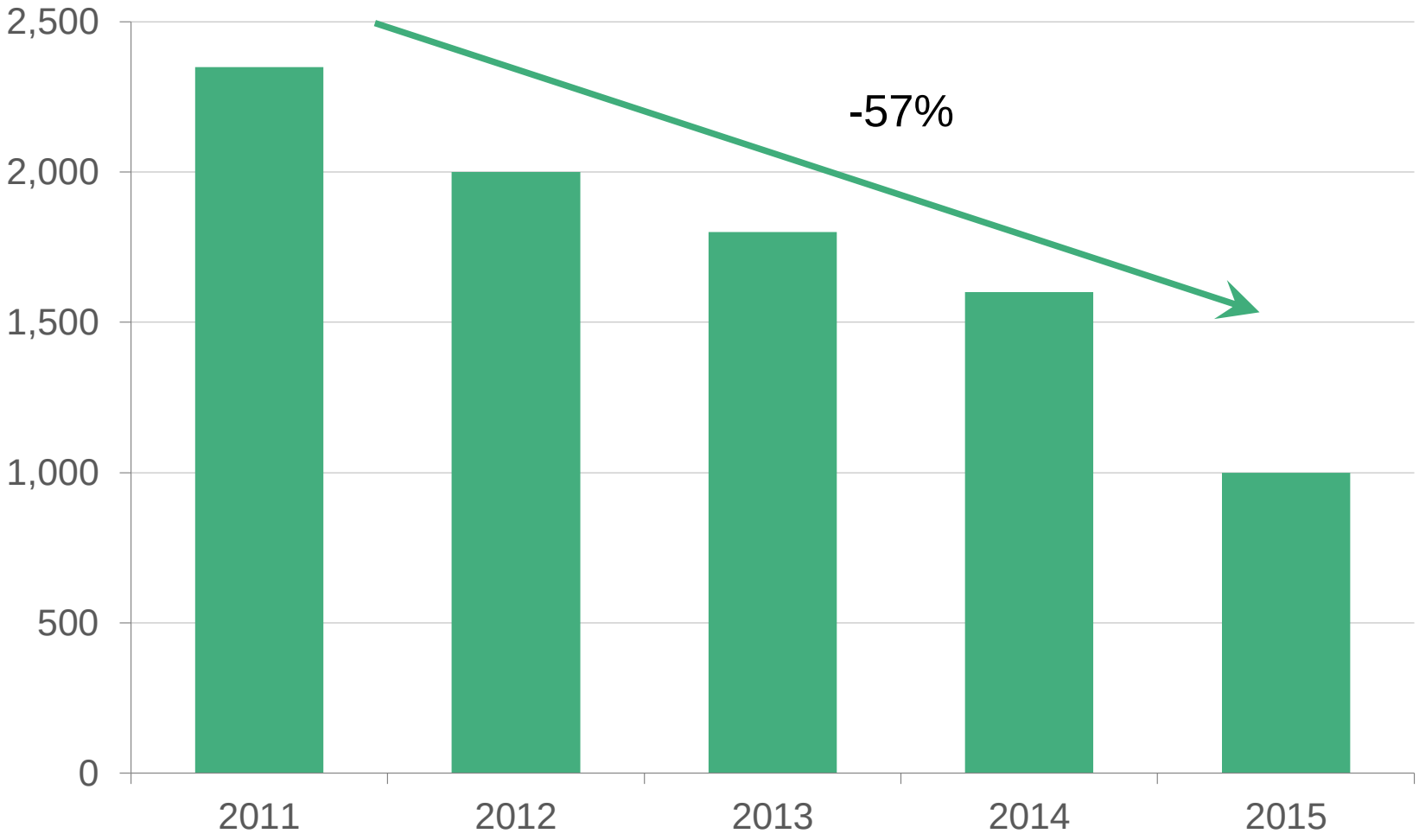


Note: The Green line represents the WTI Spot price, and has been adjusted for inflation and is represented here in real 2015 US$

Source: Bloomberg New Energy Finance, EIA, World Bank

WELL COST/LATERAL LENGTH ($/FOOT)



http://www.slideshare.net/MarcellusDN/range-resources-company-presentation-july-28-2015

Range Resources, 28 July 2015 , Bloomberg New Energy Finance

US SHALE GAS PRODUCTION BY FIELD
2000–2015 (BCFD)

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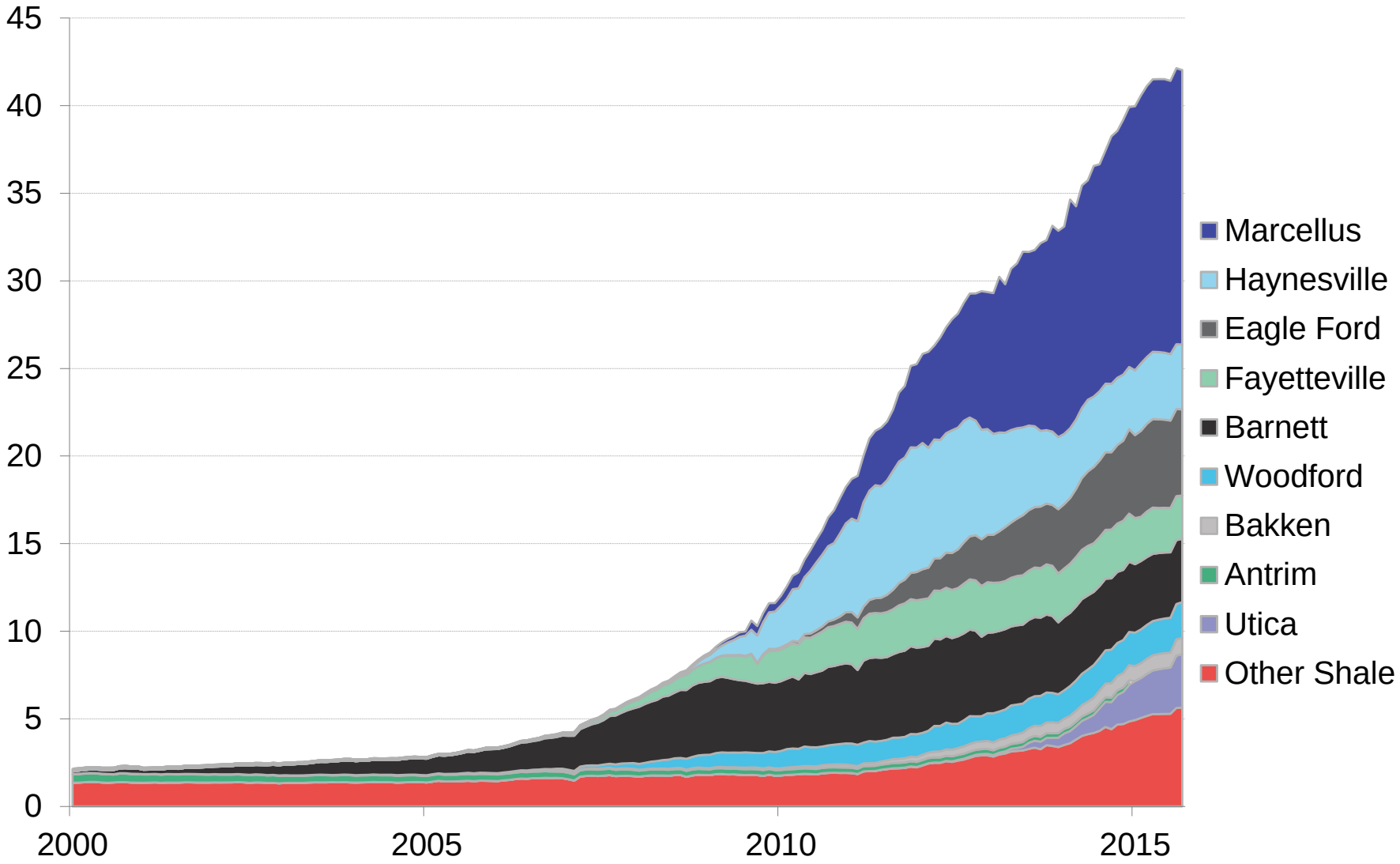
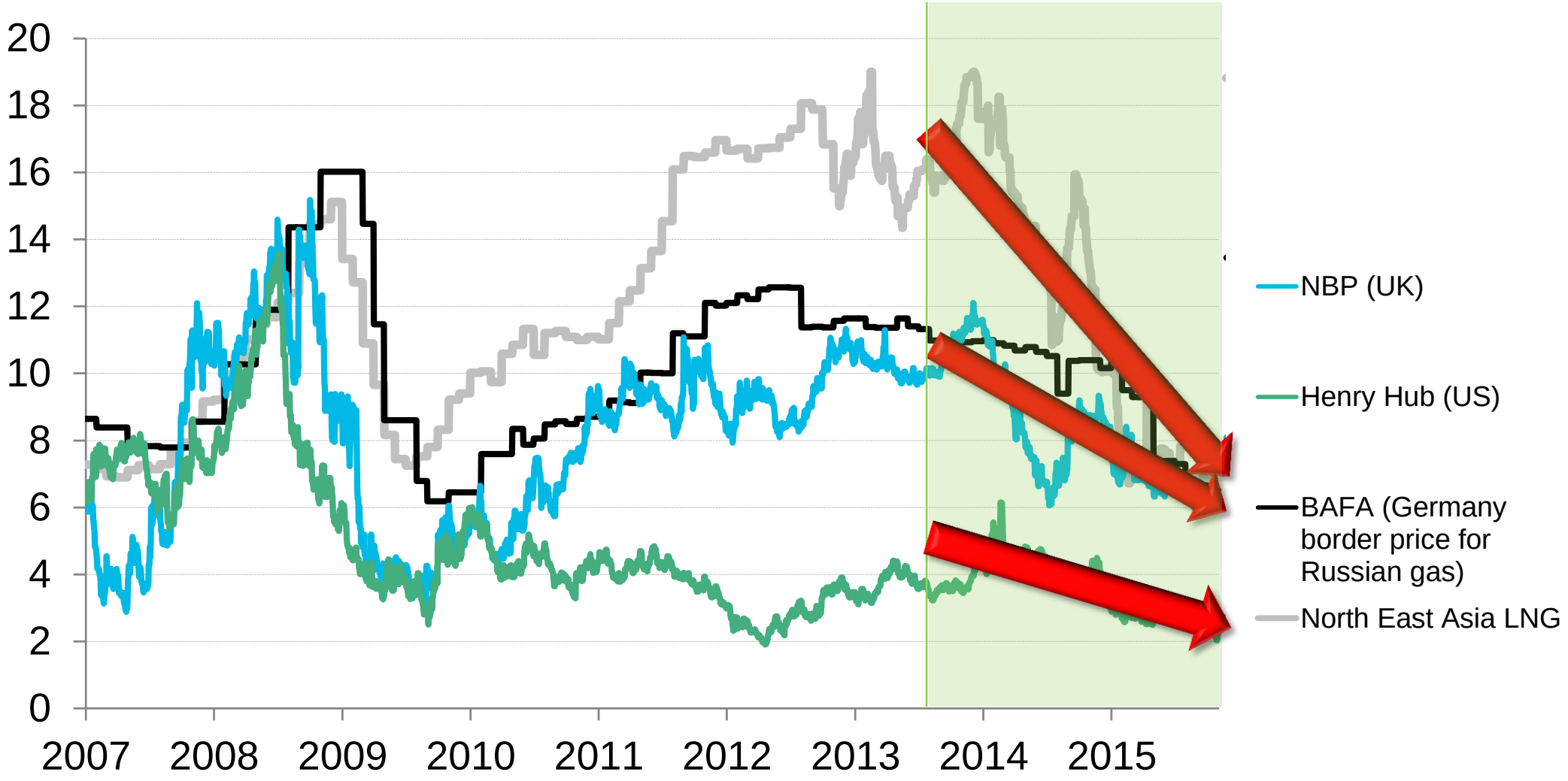


Source: Bloomberg New Energy Finance, EIA

OIL AND GAS PRICES: HENRY HUB, NBP, BAFA, AND NE LNG, 2004–15 (US$/MMBTU)

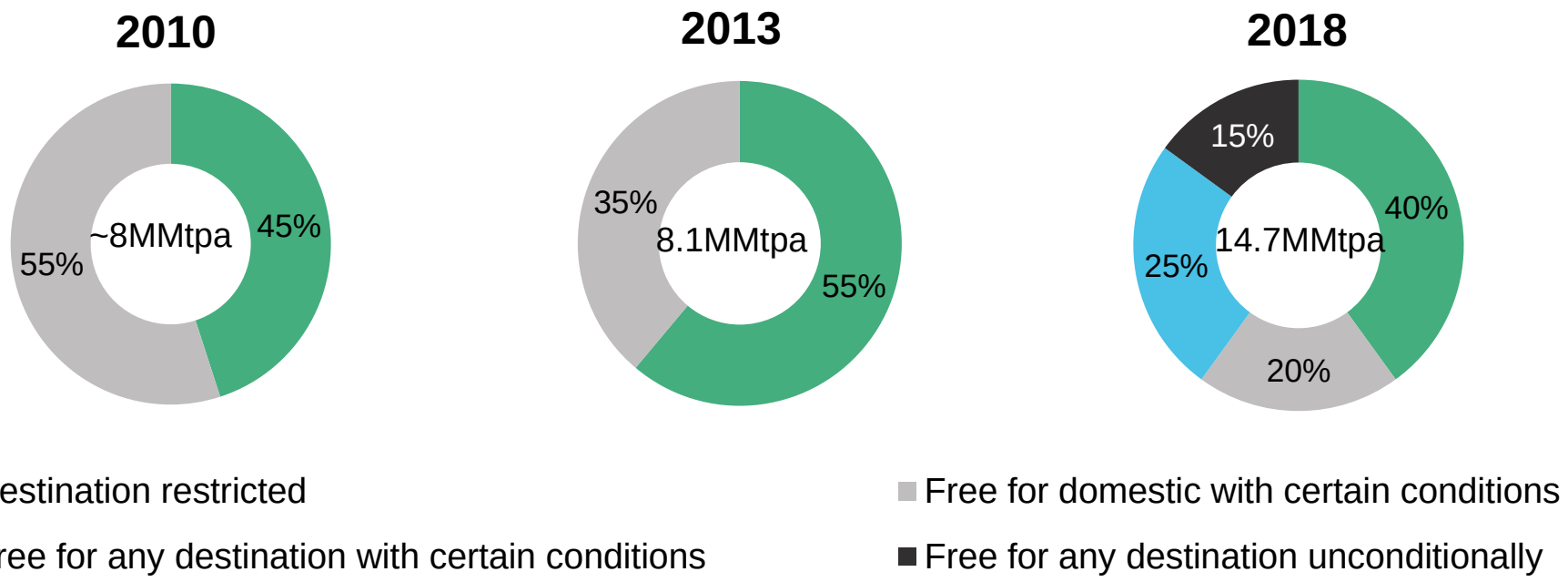
Bloomberg NEW ENERGY FINANCE



Note: Japan-Korea Marker is based on broker assessments of the spot price of un-contracted LNG cargoes delivered into the Northeast Asia market.

Source: Bloomberg New Energy Finance, ICAP, Platts

DESTINATION FLEXIBILITY IN CHUBU ELECTRIC'S LNG PURCHASES (%, MMTPA)



- Destination flexibility opens up new possibilities
  - Portfolio optimisation by teaming up with other buyers (minimise take-or-pay charges)
  - Reselling/allocation to trading teams

Note: Note: 2018 numbers are estimates provided by Chubu Electric.

Source: Chubu Electric (Singapore, October 2014), Bloomberg New Energy Finance

AFRICAN PROVERB

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"The gazelle does not have to outrun the cheetah
It has to outrun the slowest gazelle"

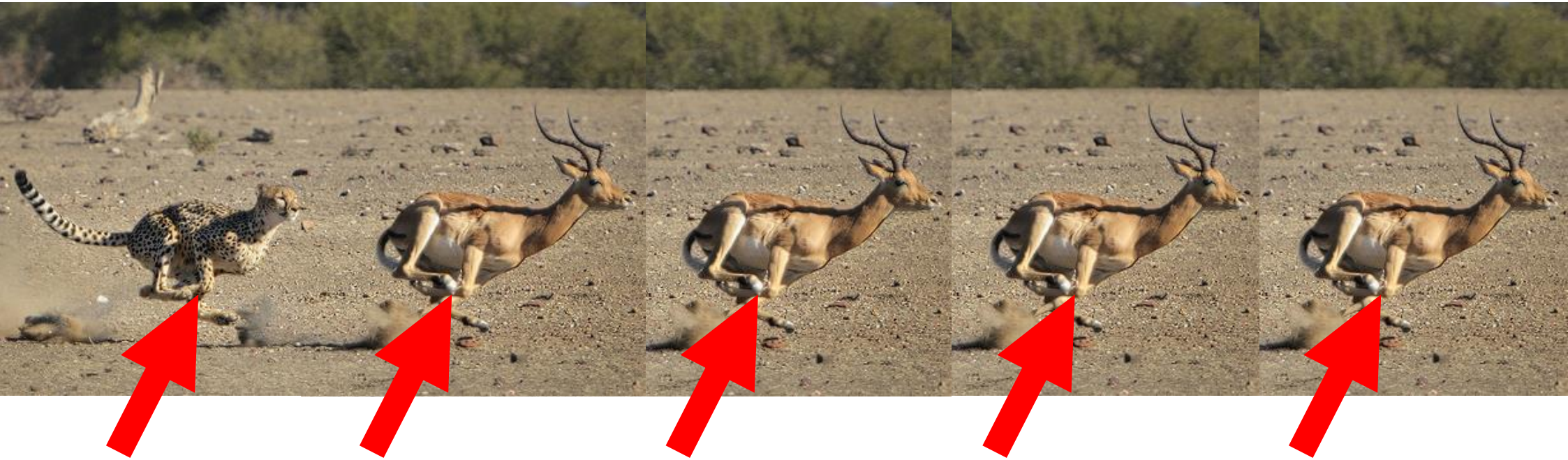

Image: Denis Donohue / Shutterstock

CLEAN ENERGY AUCTIONS

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GLOBAL OVERVIEW OF RENEWABLE ENERGY AUCTIONS, Q2 2015

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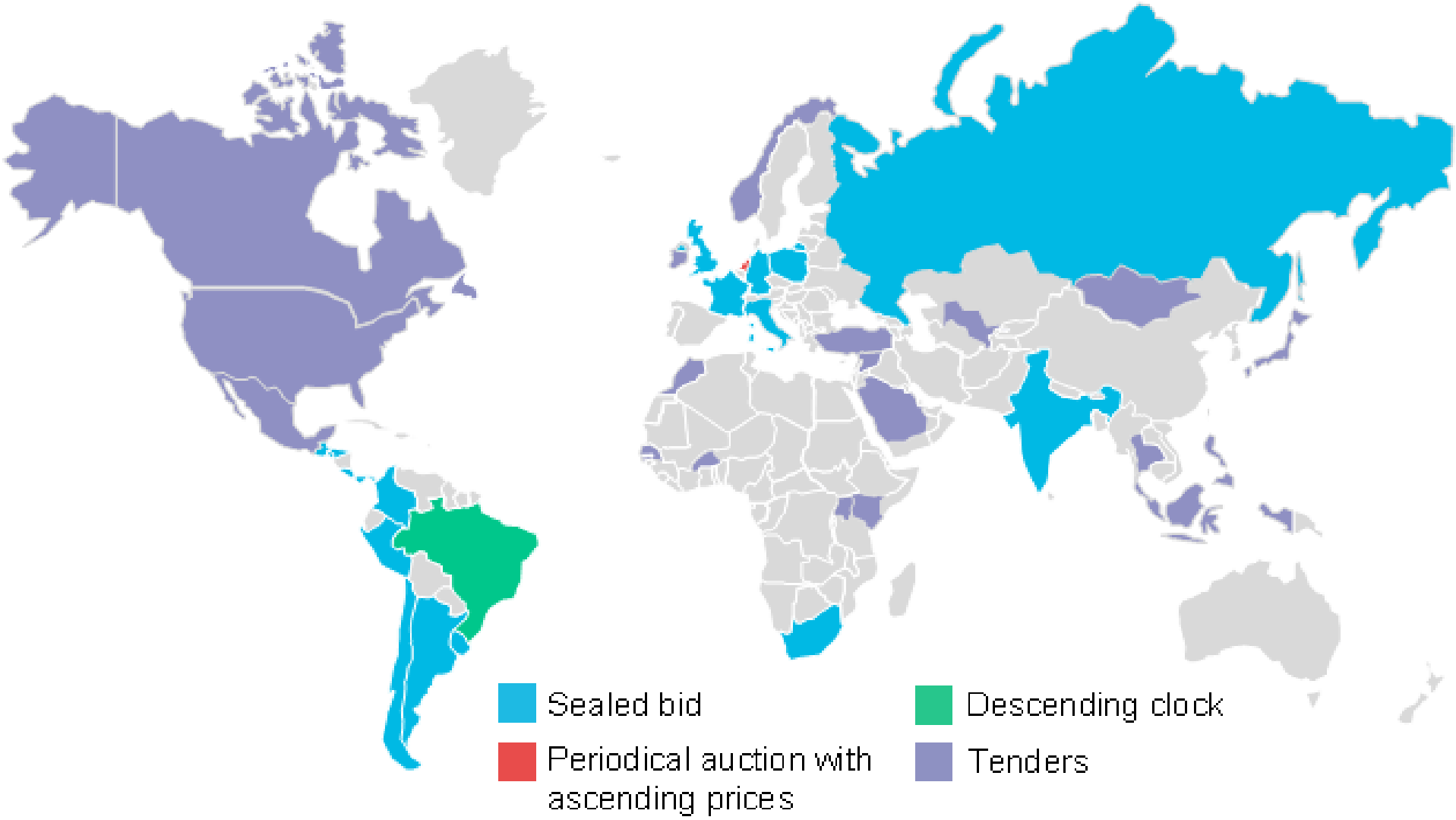
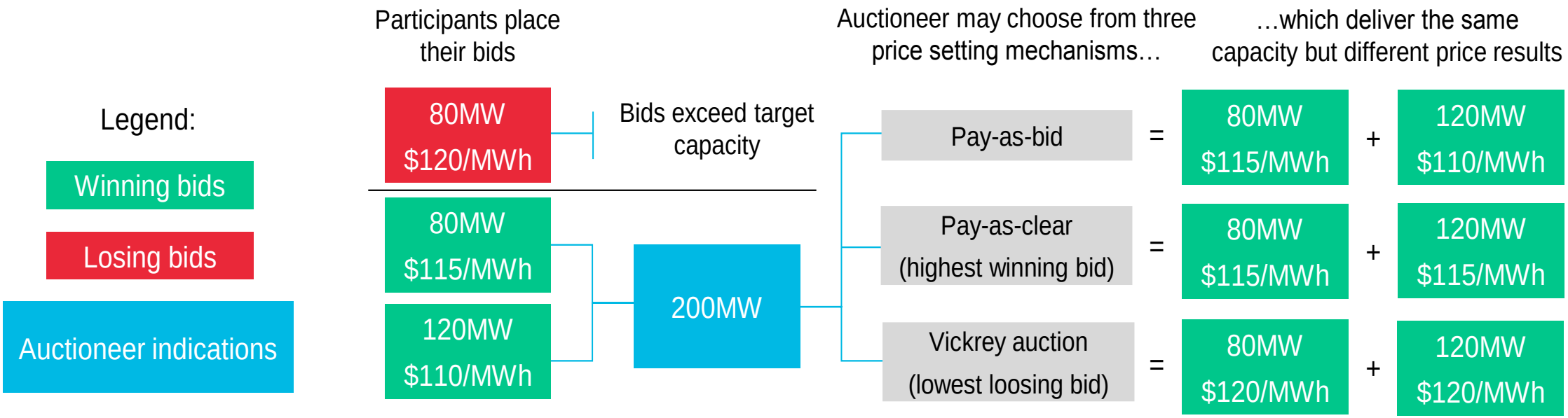
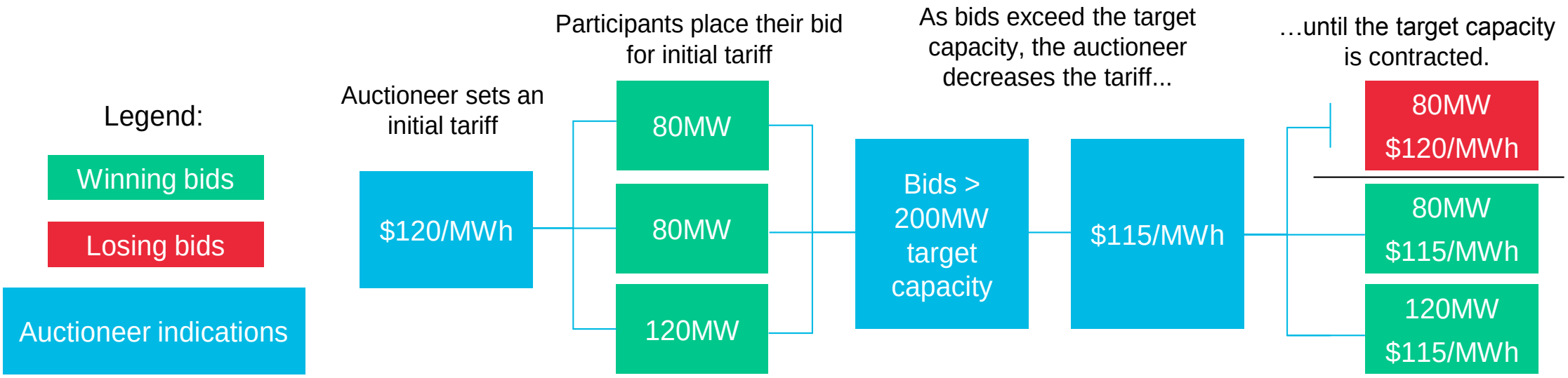


SEALED BID AUCTION



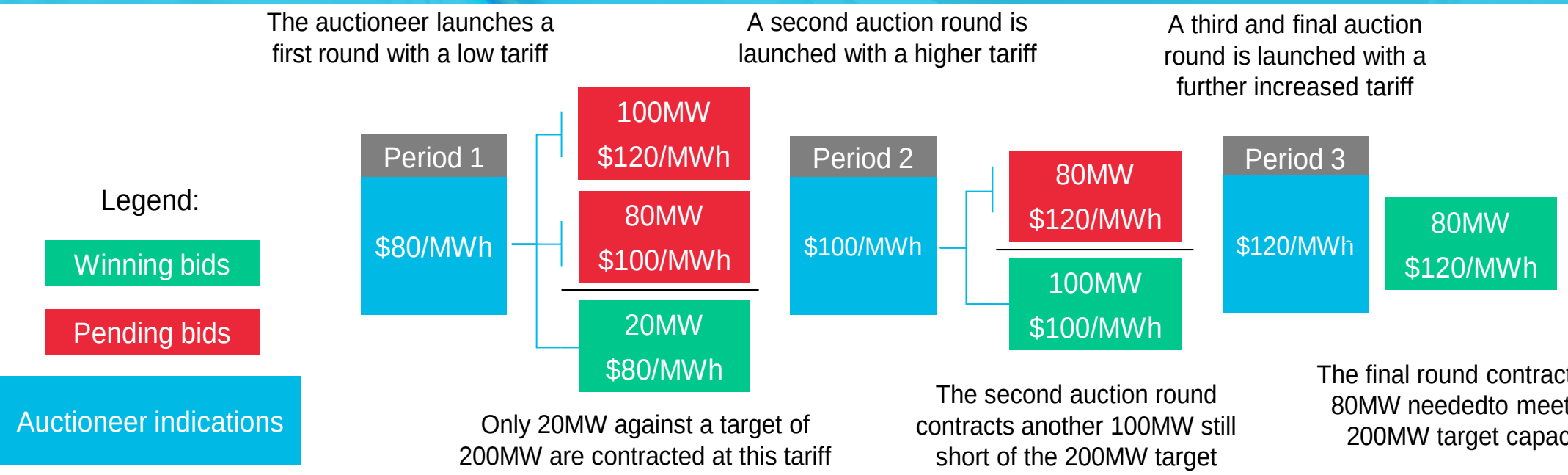
- Bidders submit a capacity offer (in MW) and the tariff ($/MWh) they require to deliver a project.
- All bids are then ordered by price, starting with the cheapest bid. The auctioneer selects the most price-competitive offers – in this case starting with 120MW at $110/MWh – until the cumulative amount of bid capacity reaches the target total of 200MW – in this case with the 80MW at $115/MWh. The auctioneer then has three main price-setting options:
  - The **'pay-as-bid'** design gives each successful bidder the tariff offer they submitted.
  - The **'pay-as-clear'** design gives all successful bidders the tariff offer submitted by the last successful bidder, also known as the clearing price.
  - The **'Vickrey auction'** design pays all successful bidders the tariff offer submitted by the first unsuccessful bidder.

DESCENDING CLOCK AUCTION



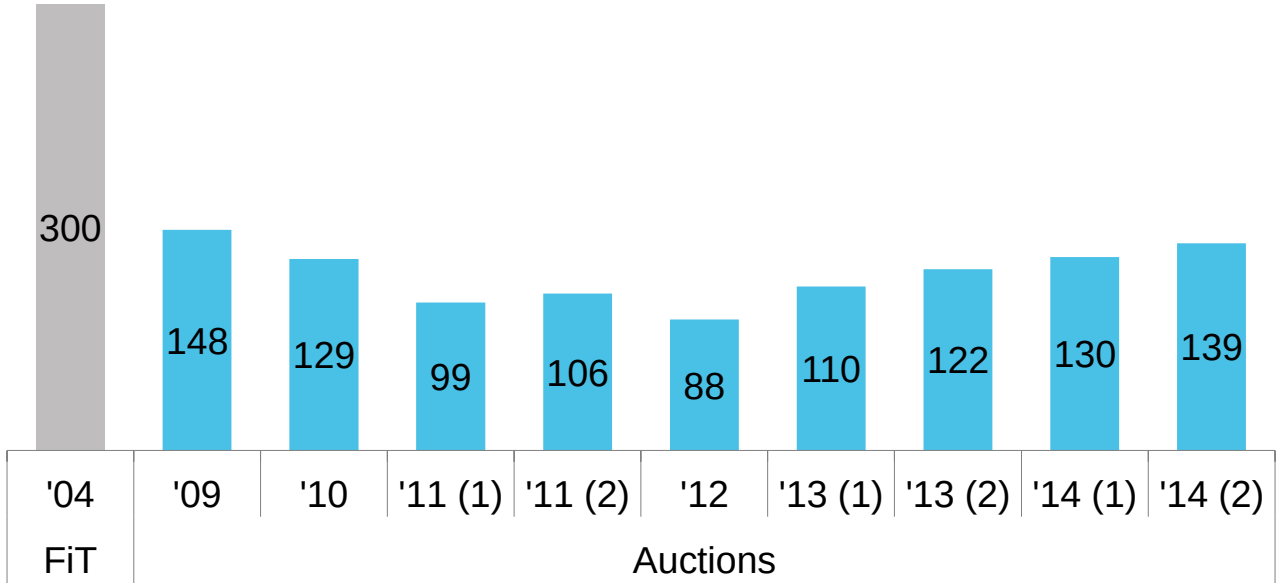
- In the descending clock auction model (also called Dutch auction), the auctioneer announces an initial tariff – in this case $120/MWh.
- Bidders respond with the capacity they can deliver at that price – in this case a cumulative amount of 280MW.
- The tariff is lowered as long as the cumulative capacity of all the bids exceeds the auctioneer's 200MW target – in this case to $115/MWh.

PERIODICAL AUCTION



- The periodical auction with ascending prices is the least common of the main auction models in the renewable energy sector.
- The model consists of a series of descending clock auctions with ascending prices.
- The fact that bidders know that there will be several tariff periods but that winning bids are capped by the capacity target affects their bidding behaviour.
- A bidder might want to hold back to place his bid in the highest tariff period – in this case $120/MWh – but faces the risk of losing out completely if the 200MW target capacity is reached in the lower tariff periods – in this case $80/MWh and $100/MWh.

BRAZIL ONSHORE WIND SUBSIDY (BRL/MWH, NOMINAL)

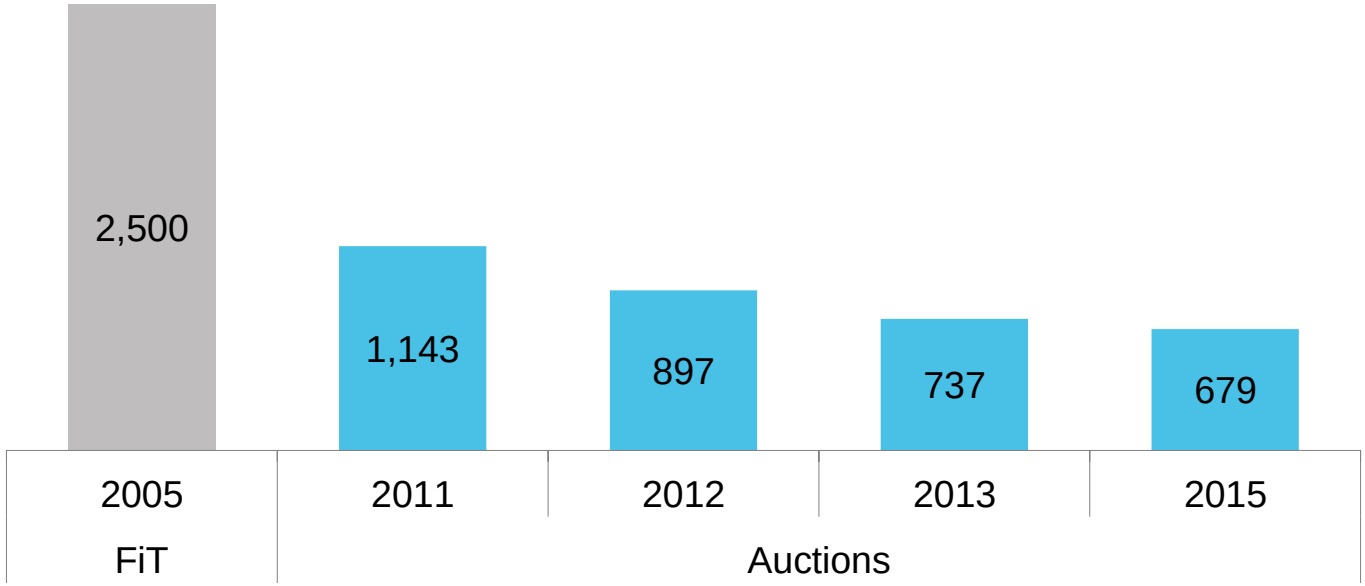


- In 2004, the Proinfa feed-in tariff was granted to 1.4GW of onshore wind developed over 2004-11.
- The introduction of auctions as an allocation mechanism prompted tariffs to be cut in half in 2009.
- Thereafter, auctions have acted as a price discovery mechanism and have led to the award of tariffs to around 13GW of onshore wind.
- Prices have moved in both directions reflecting, for example, the impact of movements in the foreign exchange rate, turbine shortages and local content rules.

Note: read all you need to know on Brazil's latest auction round in our in our Analyst Reaction (26 August 2015).

Source: Bloomberg New Energy Finance, CCEE

SOUTH AFRICA ONSHORE WIND (ZAR/MWH, NOMINAL)



- South Africa only had a single commercial grade onshore wind project (5MW), commissioned in 2008, before launching its first auction.
- Unsurprisingly, the first auction round awarded 634MW of onshore wind projects a tariff that was half as costly as that on the original project.
- A more remarkable achievement came from future rounds. As the renewables sector responded to the stability provided by the auction programme with increased competition and higher participation, tariffs in 2015 were 40% lower than in 2011.
- In total, South Africa's auctions have awarded tariffs to 7GW of onshore wind.

Note: read all you need to know on South Africa's latest auction round in our in our Analyst Reaction (21 April 2015). Source: Bloomberg New Energy Finance

CHILE 2015/02 AUCTION OVERVIEW

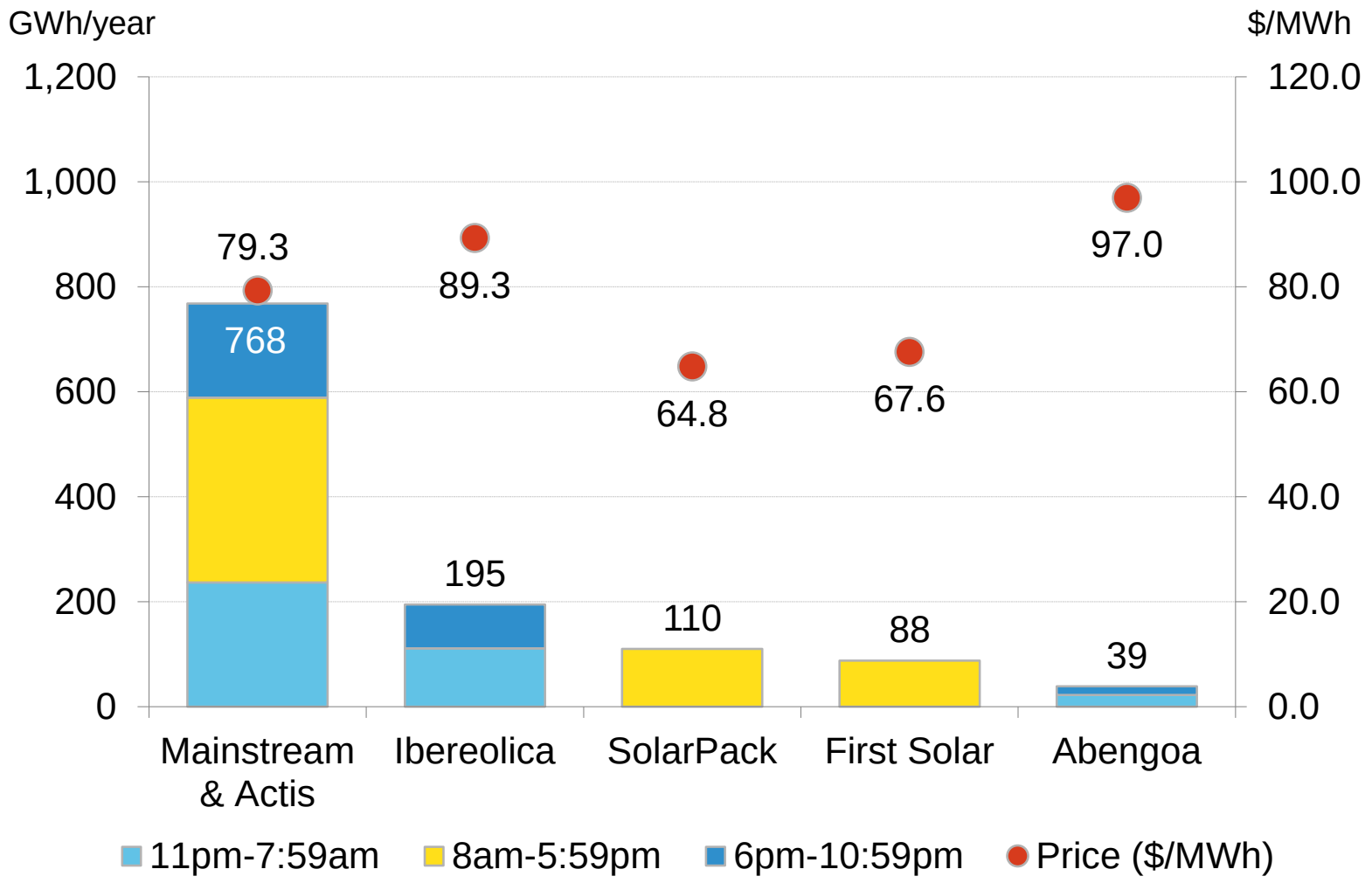
- On 15 June 2015, Chile's National Energy Commission (CNE) published resolution 311, which sets the rules for Auction 2015/02 to contract electricity from generators for delivery starting 1 January 2017.
- **This tender falls within Chile's new auction guidelines under which generators must supply power during blocks of time during the day under 20-year power purchase agreements (PPAs).** The auction offered contracts for three portions of the day as listed below.
- Tender contracts mandate that generators supply a given base demand and a variable demand (10% of base demand) curve at a determined time block. For example, in Block A, generators must supply 336GWh from 11pm to 7:59am with a possible variation of 10%.
- All power contracted must be delivered at the Polpaico (220kV) node located in the Central Interconnected System (Sistema Interconectado Central, SIC). The offtakers will be 26 distribution companies located in the SIC and the SING system.

Chile Power Tender 2015/02 – Demand (GWh/year) per time block

Demand (GWh/year)	A – 11pm-7:59am	B – 8am-5:59pm	C – 6pm-10:59pm
Base	336	500	255
Variable	34	50	25
Total	370	550	280

Source: CNE

CHILE POWER TENDER 2015/02 – WINNERS BY VOLUME CONTRACTED (GWH/YEAR) AND PPA ($/MWH)



Source: Bloomberg New Energy Finance, CNE

CORPORATE PROCUREMENT

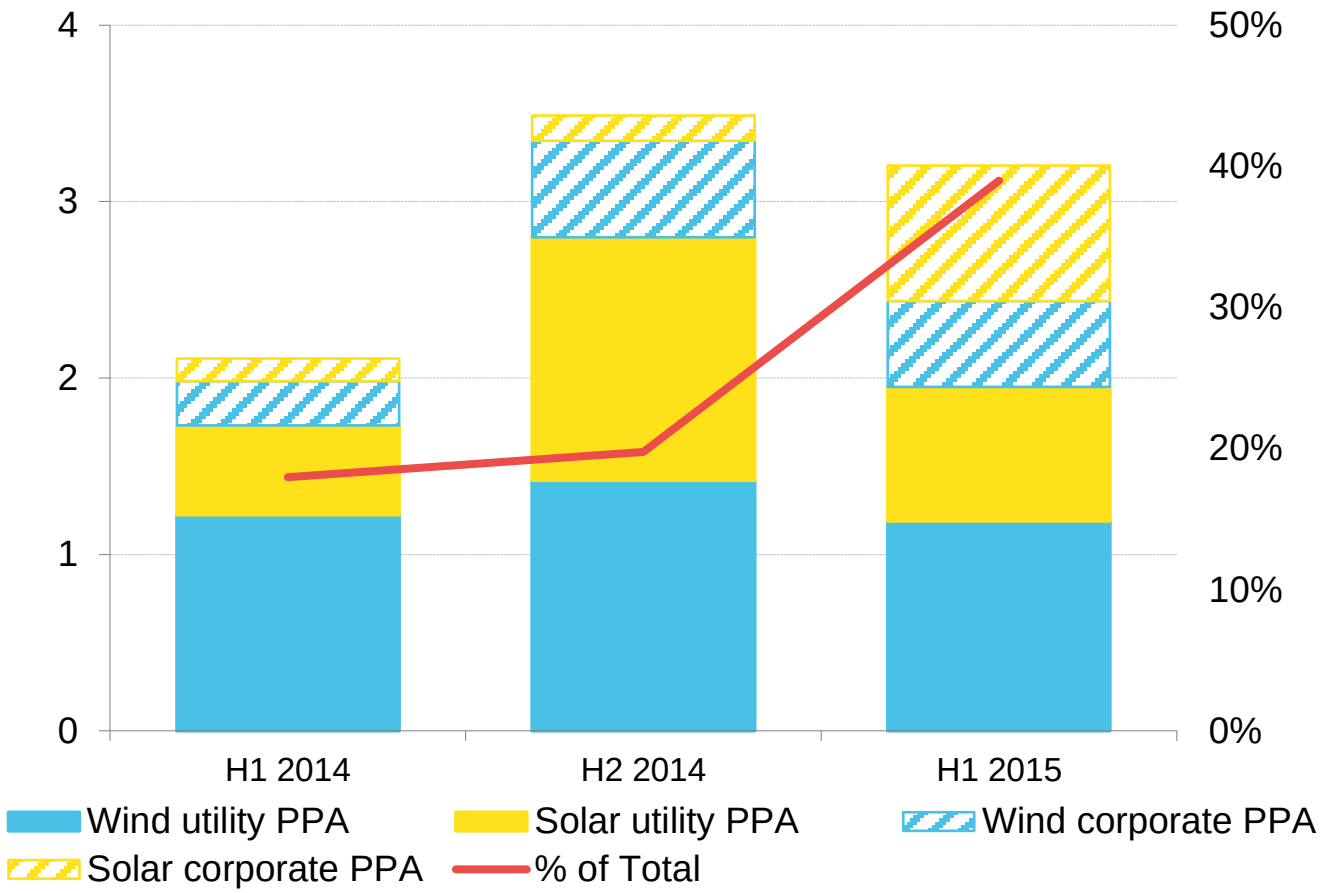
Bloomberg
NEW ENERGY FINANCE

KEY NON-TRADITIONAL PPA OFFTAKERS BY INDUSTRY

Bloomberg NEW ENERGY FINANCE

Source: Bloomberg New Energy Finance

PPA CAPACITY BY CONTRACT SIGNING DATE (LEFT AXIS – GW) AND CORPORATE PPAS AS A PERCENTAGE OF TOTAL RENEWABLE PPAS (RIGHT AXIS), H1 2014-H1 2015



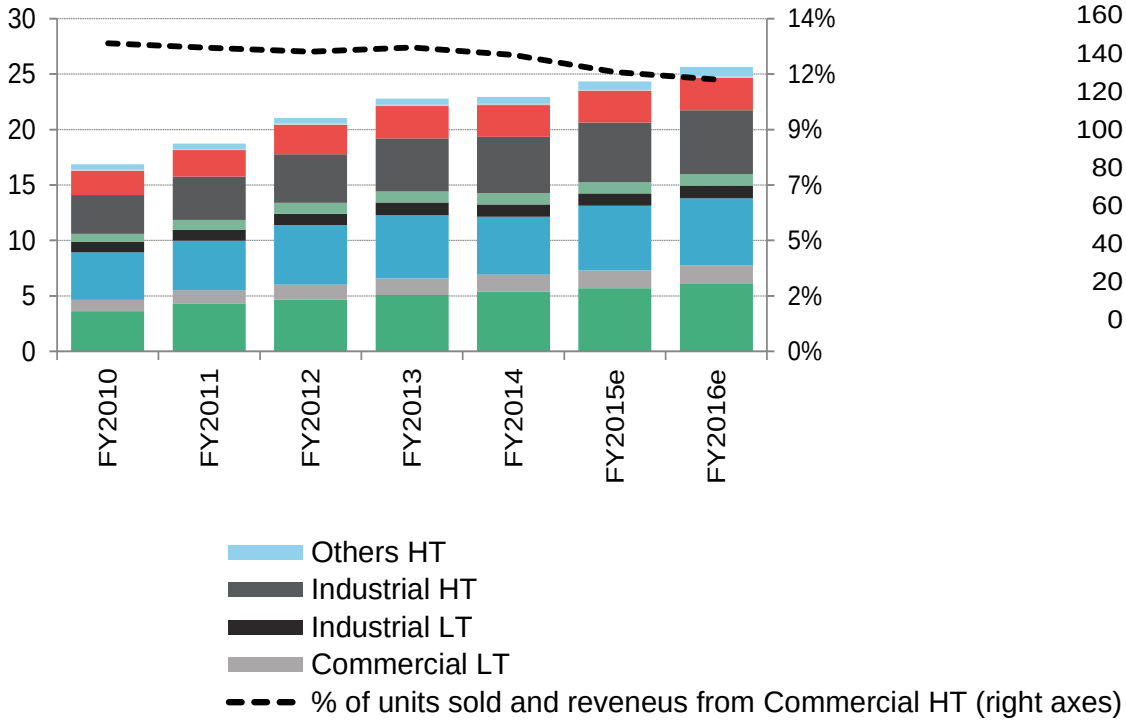
Note: capacity for both corporate and utility PPAs is estimated based on known contracts.

Source: Bloomberg New Energy Finance.

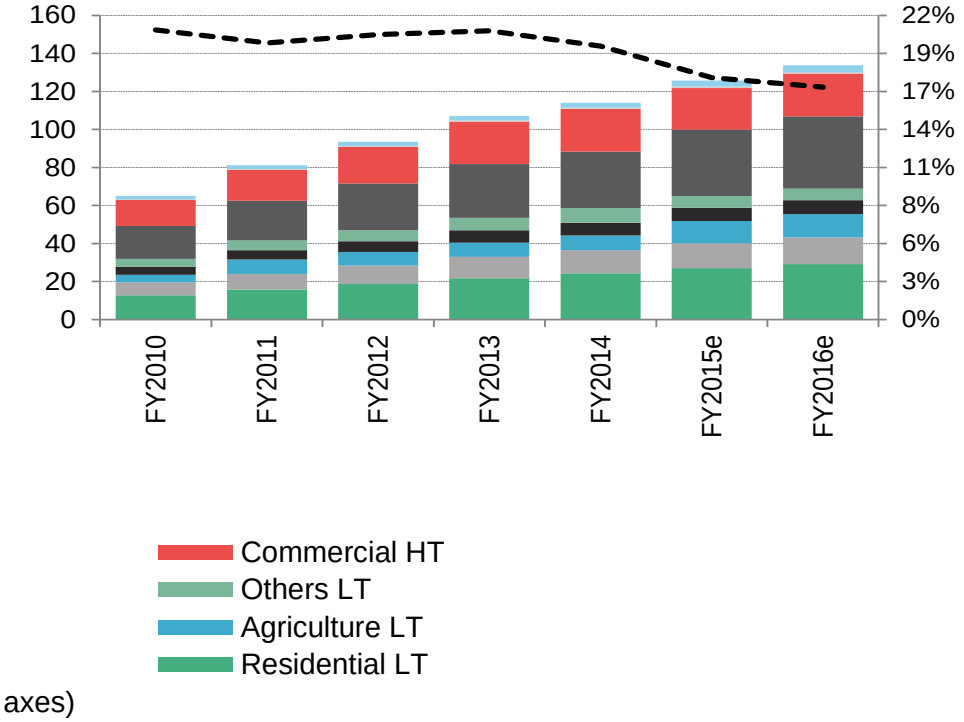
UNITS SOLD AND REVENUES BY CUSTOMER CATEGORY

Bloomberg NEW ENERGY FINANCE

Units sold to different customer segments (TWh)



Revenues by customer category (INR bn)



Note: FY2015 and FY2016 numbers are estimates from BESCOM

Source: Bloomberg New Energy Finance, Bangalore Electricity Supply Company

CUSTOMERS WHO HAVE PARTIALLY/FULLY OPTED-OUT FROM BUYING POWER FROM BESCOM

Bloomberg NEW ENERGY FINANCE

Information technology and communications

Energy

Industrials and Healthcare

Food & Beverages and Hospitality

Note: this is a sample list

Source: Bloomberg New Energy Finance

KEY PLAYERS SUPPLYING POWER FOR OPTED-OUT CUSTOMERS IN APRIL 2014

Bloomberg NEW ENERGY FINANCE

Renewable independent power producer

ReNew POWER

GREEN INFRA empowering naturally!

Greenko

IL&FS Energy

Key investor

Goldman Sachs

IDFC PRIVATE EQUITY

IFC

Standard Chartered

GLOBAL ENVIRONMENT FUND

BLACKROCK®

IL&FS

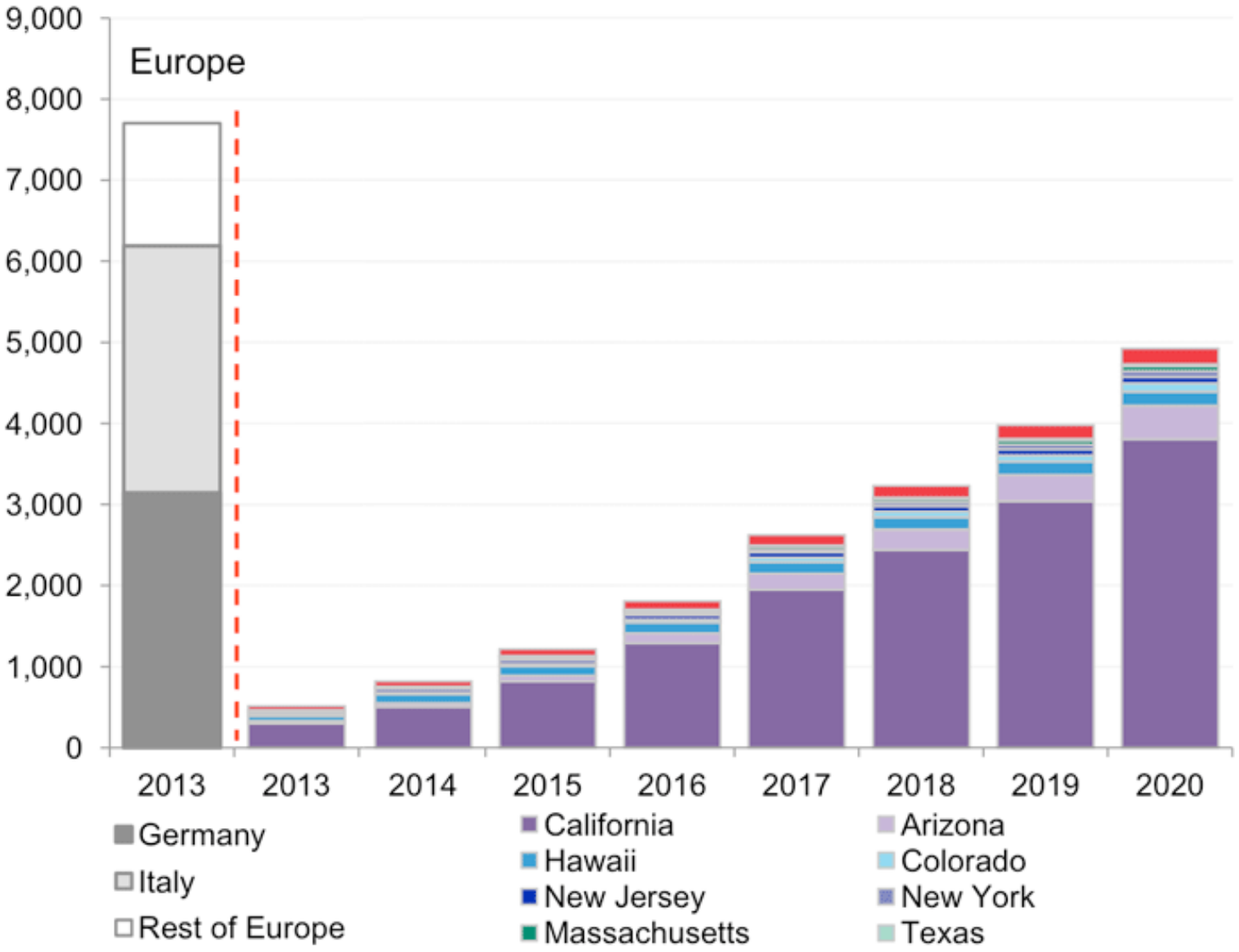
Source: Bloomberg New Energy Finance, Bangalore Electricity Supply Company

UTILITY BUSINESS STRATEGY

Bloomberg
NEW ENERGY FINANCE

ESTIMATED GROSS REVENUE LOSS TO UTILITIES FROM RESIDENTIAL PV ($M)

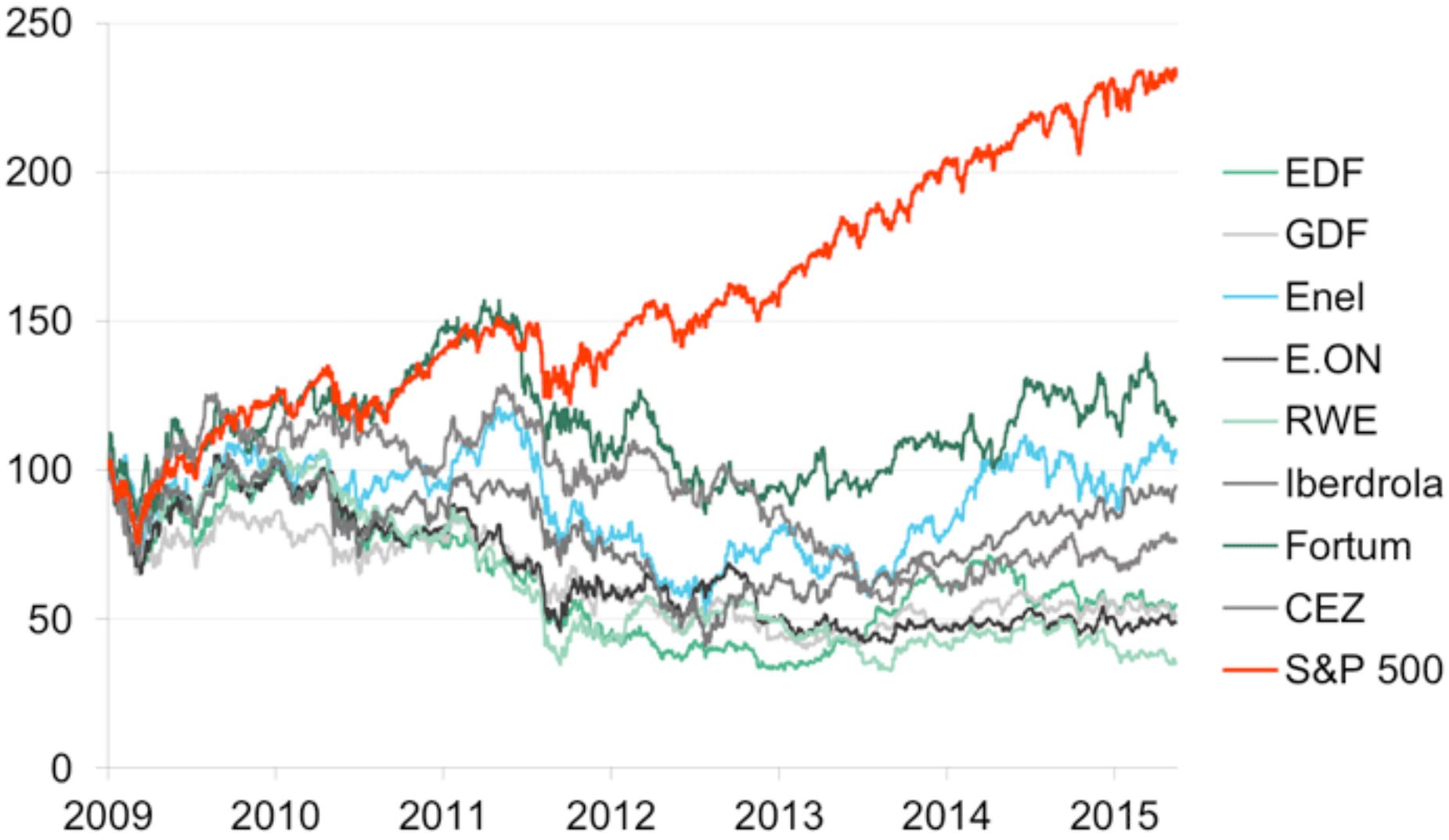
Bloomberg NEW ENERGY FINANCE



Source: Bloomberg New Energy Finance

EUROPEAN UTILITY STOCK PRICE DEVELOPMENTS (NORMALISED TO DECEMBER 2008)

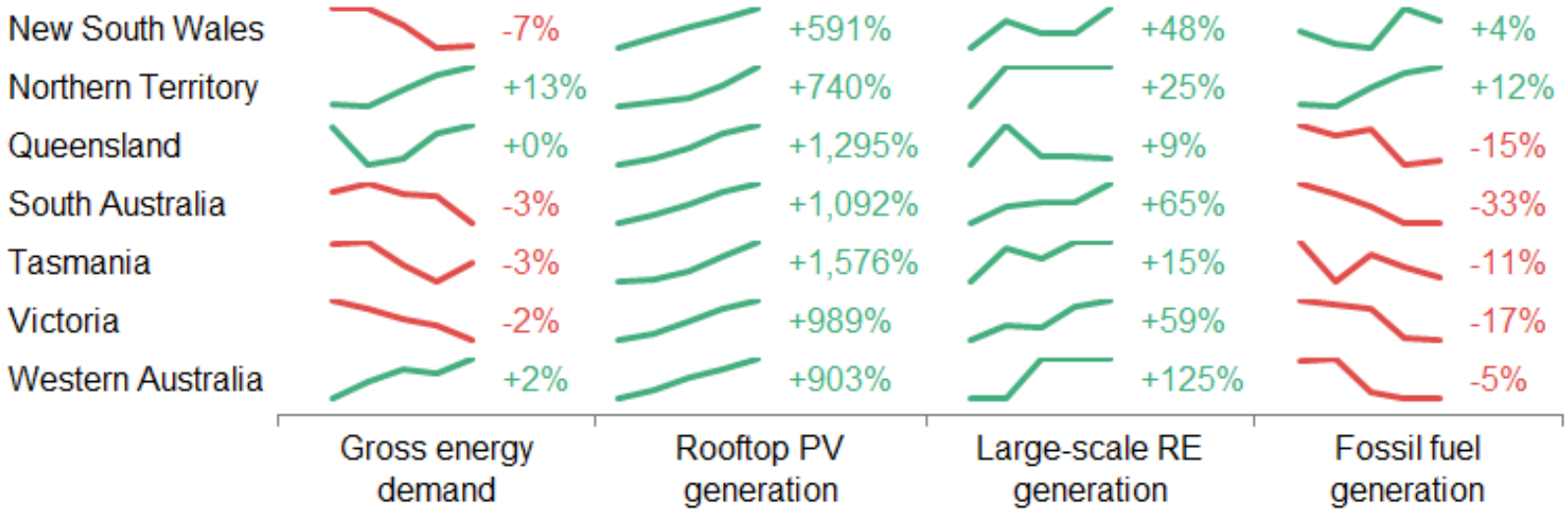
Bloomberg NEW ENERGY FINANCE



Source: Bloomberg New Energy Finance

HISTORICAL DEMAND AND GENERATION INDICATORS, FY2010-14 (% CHANGE - CUMULATIVE)

Bloomberg NEW ENERGY FINANCE

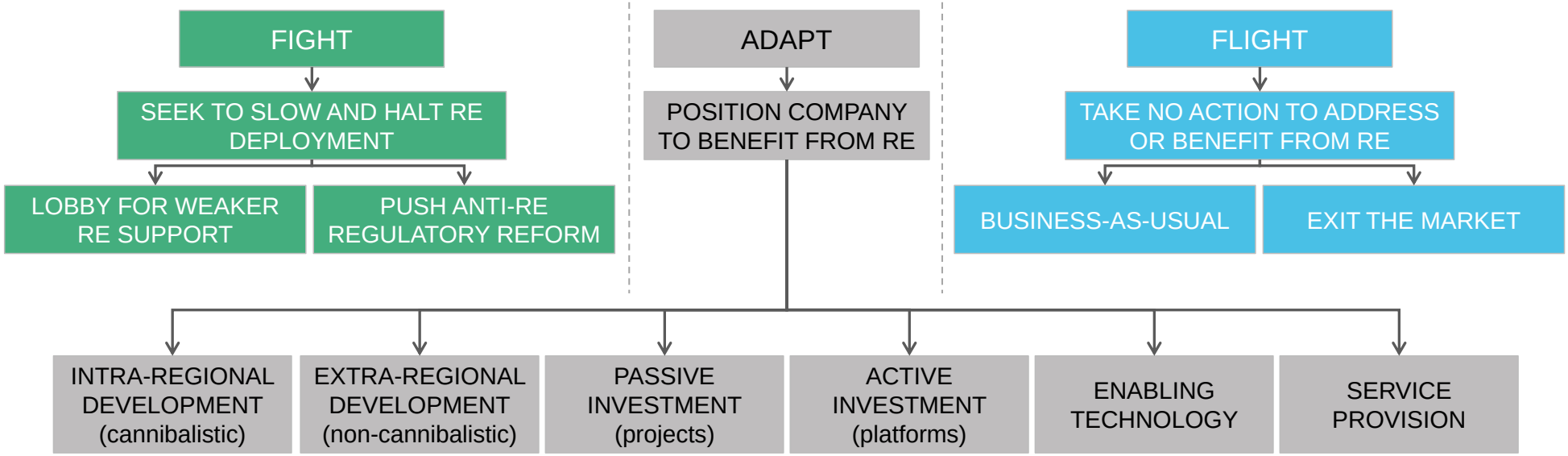


Note: New South Wales includes Australian Capital Territory

Source: Bloomberg New Energy Finance

E.ON SPLIT

UTILITY STRATEGY DECISION TREE



Source: Bloomberg New Energy Finance

A POTENTIAL DEATH SPIRAL FOR INDIAN DISTRIBUTION UTILITIES

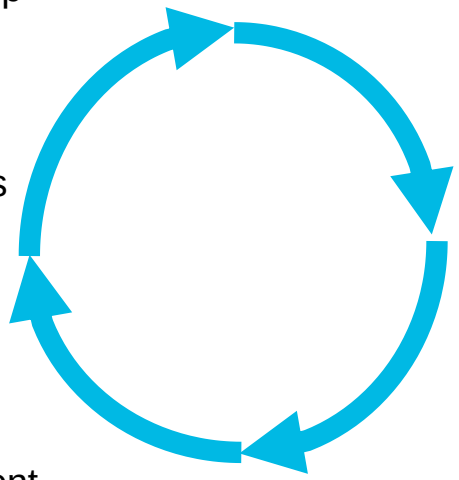
Bloomberg NEW ENERGY FINANCE

Causing

- increased interest in rooftop solar/net metering
- smaller consumers to opt-out
- further capex requirements for grid management

Leading to

- reduced grid reliability
- deteriorating services
- stranded assets/investment programmes



Big customers paying high tariffs opt-out due to:

- increasing retail tariffs and poor service
- falling costs of renewables/socket parity
- supportive regulation for grid access
- cash availability
- environmental concerns

Creating problems in

- capital availability for grid augmentation/management
- increasing retail tariffs for all customers (highest rise in households and agriculture due to lack of cross subsidy)

Source: Bloomberg New Energy Finance

POTENTIAL *ADAPT* STRATEGIES FOR INDIAN DISCOMS

Bloomberg NEW ENERGY FINANCE

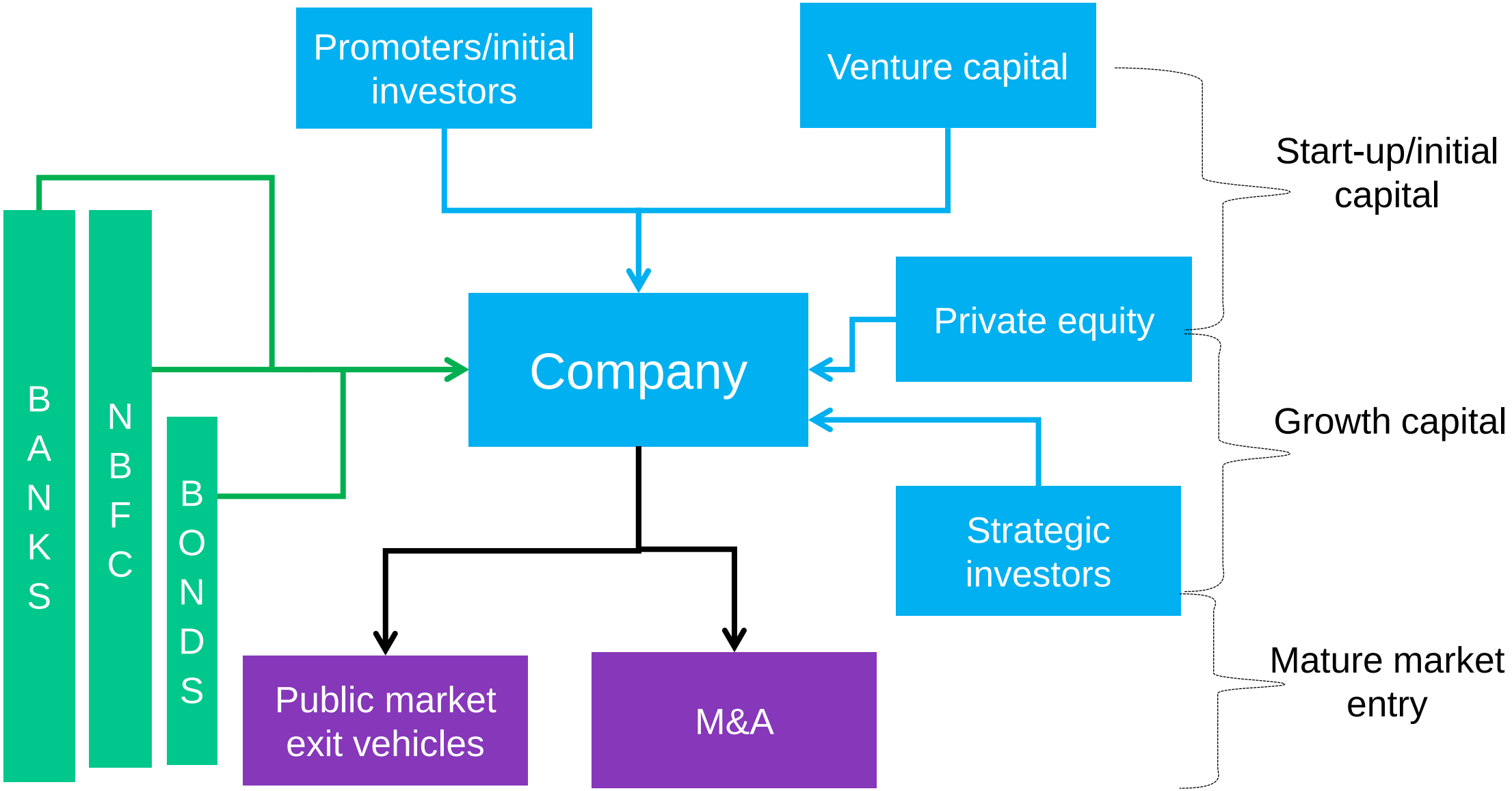
Strategy	Description	Pros	Cons
Service provision for large consumers	Provide the option to large commercial and industrial consumers to consume clean energy through tie-ups with renewable power producers	• Low capital investment option • Avoid fuel price escalations on consumer bills as clean energy producers agree to a long-term $/MWh rate • Existing billing and customer relationship systems can be modified to meet the needs	• Utility may still not be the lowest cost provider • Staff training needed
Investments in enabling technology	Discom invests in assets or companies that enhances the grid's ability to absorb higher penetration of renewable energy	• Benefit from growth of renewable energy • Can be viewed as favourable by the regulators who can allow specific return on equity on such investments	• Higher growth in renewable energy can further cannibalise core business of power sales • Increase in power prices due to capital investments may aggravate consumer relationship (particularly with non-PV/renewables consuming ones)
Service provision for small consumers	Partner with PV system providers to increase use of rooftop solar	• Low capital investment option • Leverages discoms's core competence in dealing with end consumers	• Can cannibalise core business of power sales • Requires training of staff • Partner's performance effects reputation

Source: Bloomberg New Energy Finance

FINANCIAL INNOVATION IN CLEAN ENERGY

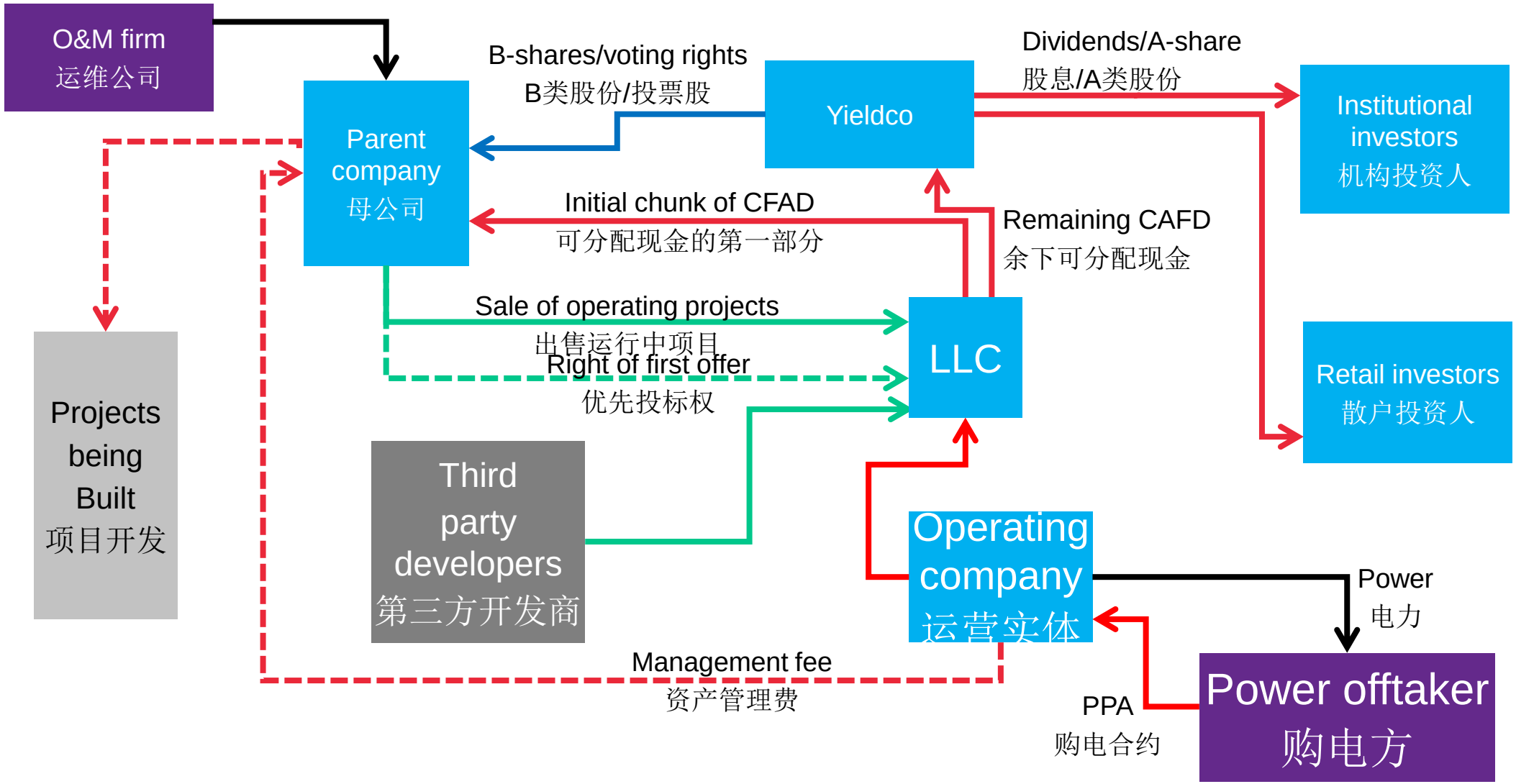
Bloomberg
NEW ENERGY FINANCE

FUNDING TIMELINE



Source: Bloomberg New Energy Finance

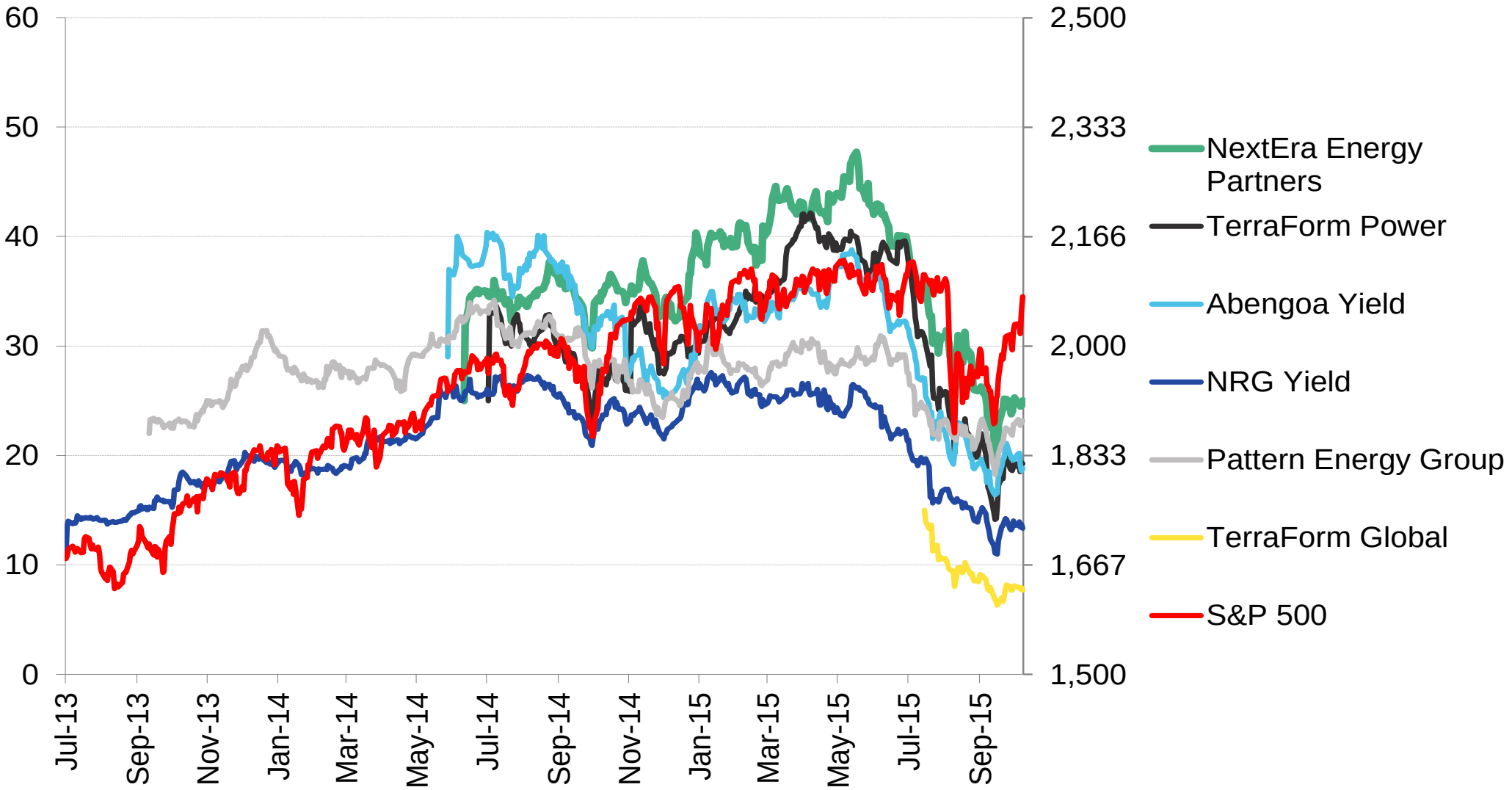
YIELDCO: OPERATING MODEL



Note: CFAD is cash flow available for distribution. PPA is power purchase agreement. LLC is limited liability company.

US YIELDCOS' STOCK PRICE PERFORMANCE SINCE RESPECTIVE IPOS ($, INDEX)

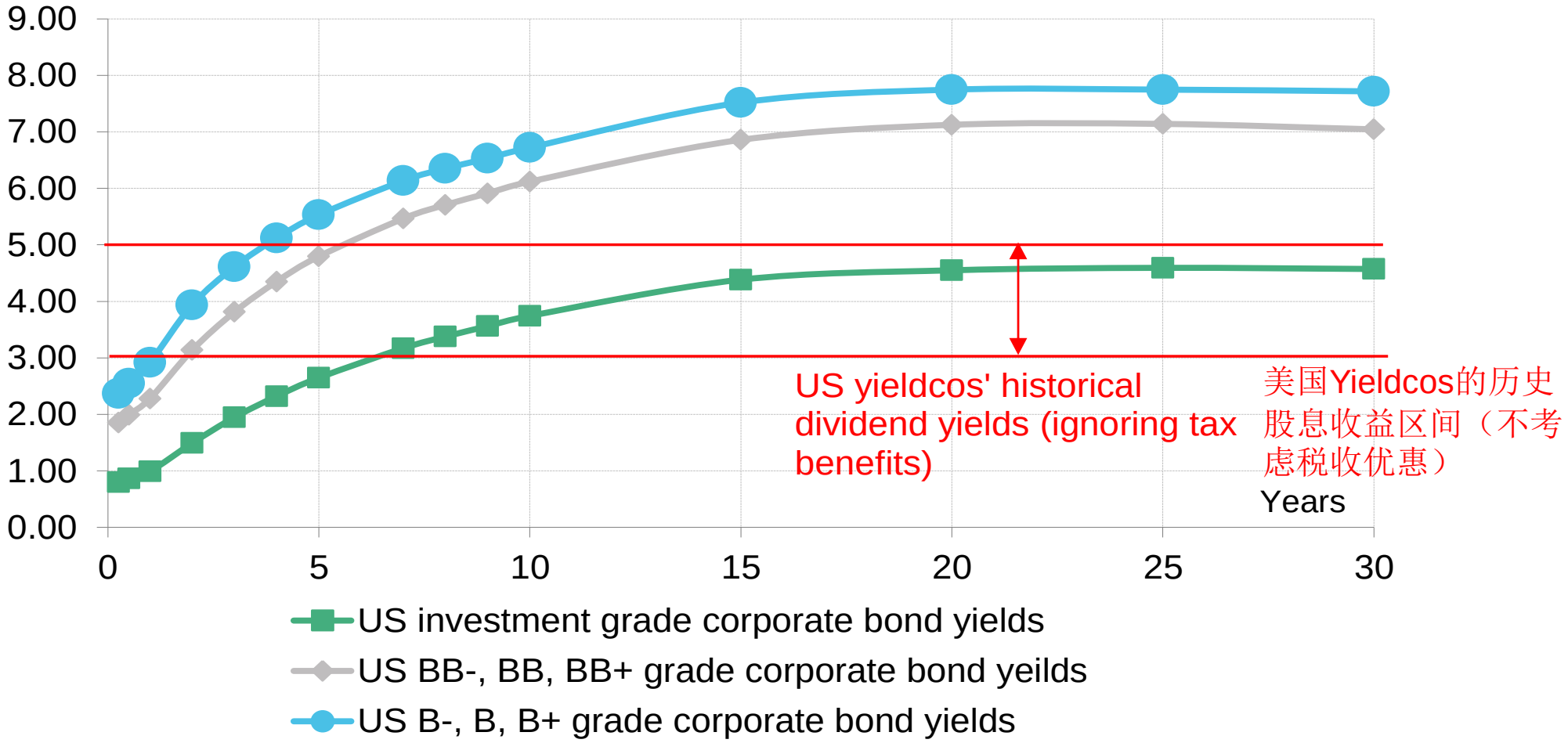
Bloomberg NEW ENERGY FINANCE



LISTING STRATEGY

Strategy 策略	Location of assets 资产位置	Location of listing 上市地点
An **offshore** yieldco with **overseas assets** **海外资产海外上市**	Overseas 海外	Overseas 海外
An **offshore** yieldco with **domestic assets** **境内资产海外上市**	Local 境内	Overseas 海外
A **near-shore** yieldco 近岸市场上市	Local 境内	HK/Singapore 香港/新加坡
An **onshore** (local) yieldco 境内上市	Local 境内	Local 境内

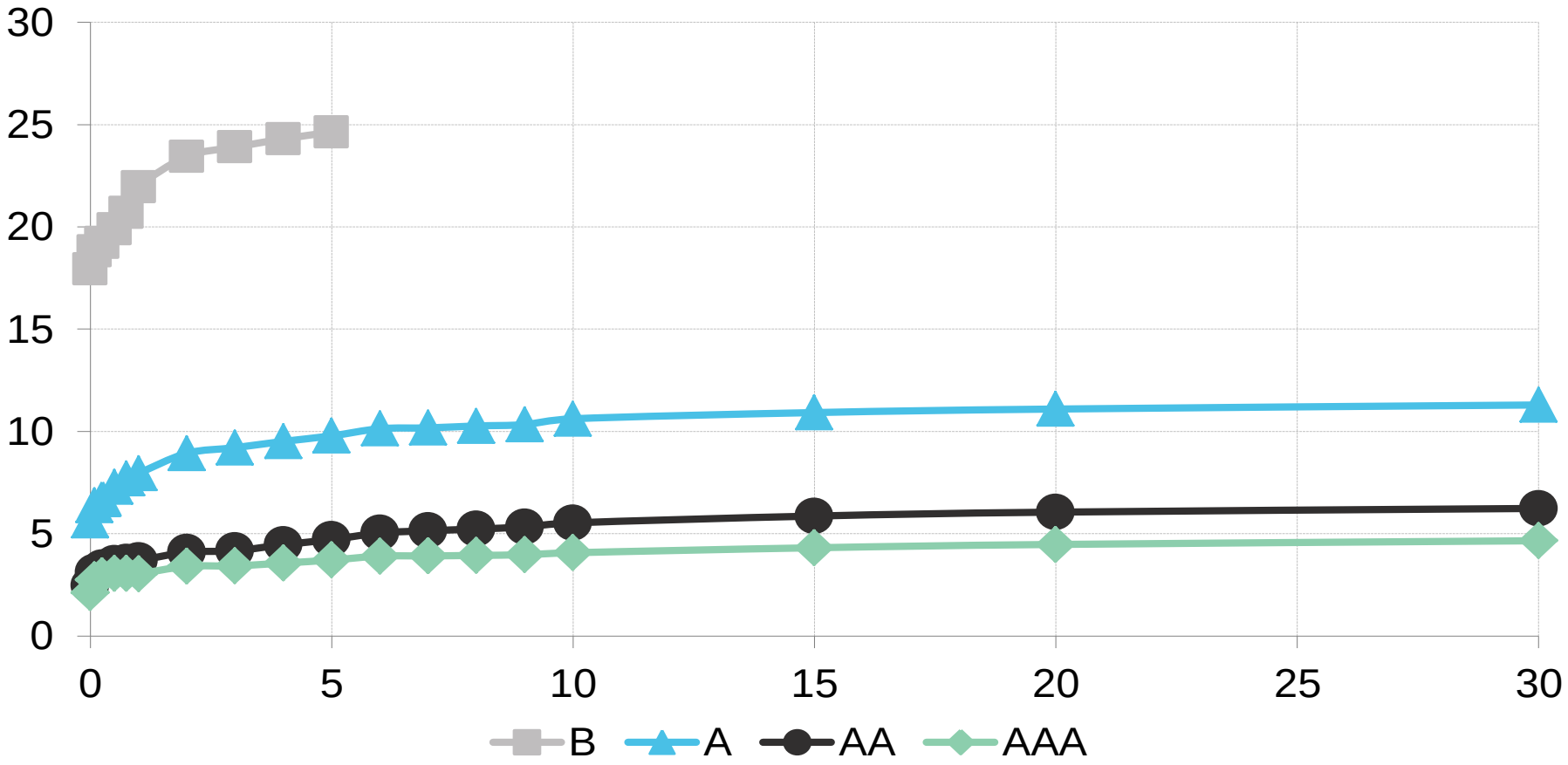
COMPARING YIELDS BETWEEN YIELDCOS AND BONDS IN THE US



Note: yields as of as of 28 October 2015.

Source: Bloomberg New Energy Finance

CHINA'S CORPORATE BOND YIELDS (%)

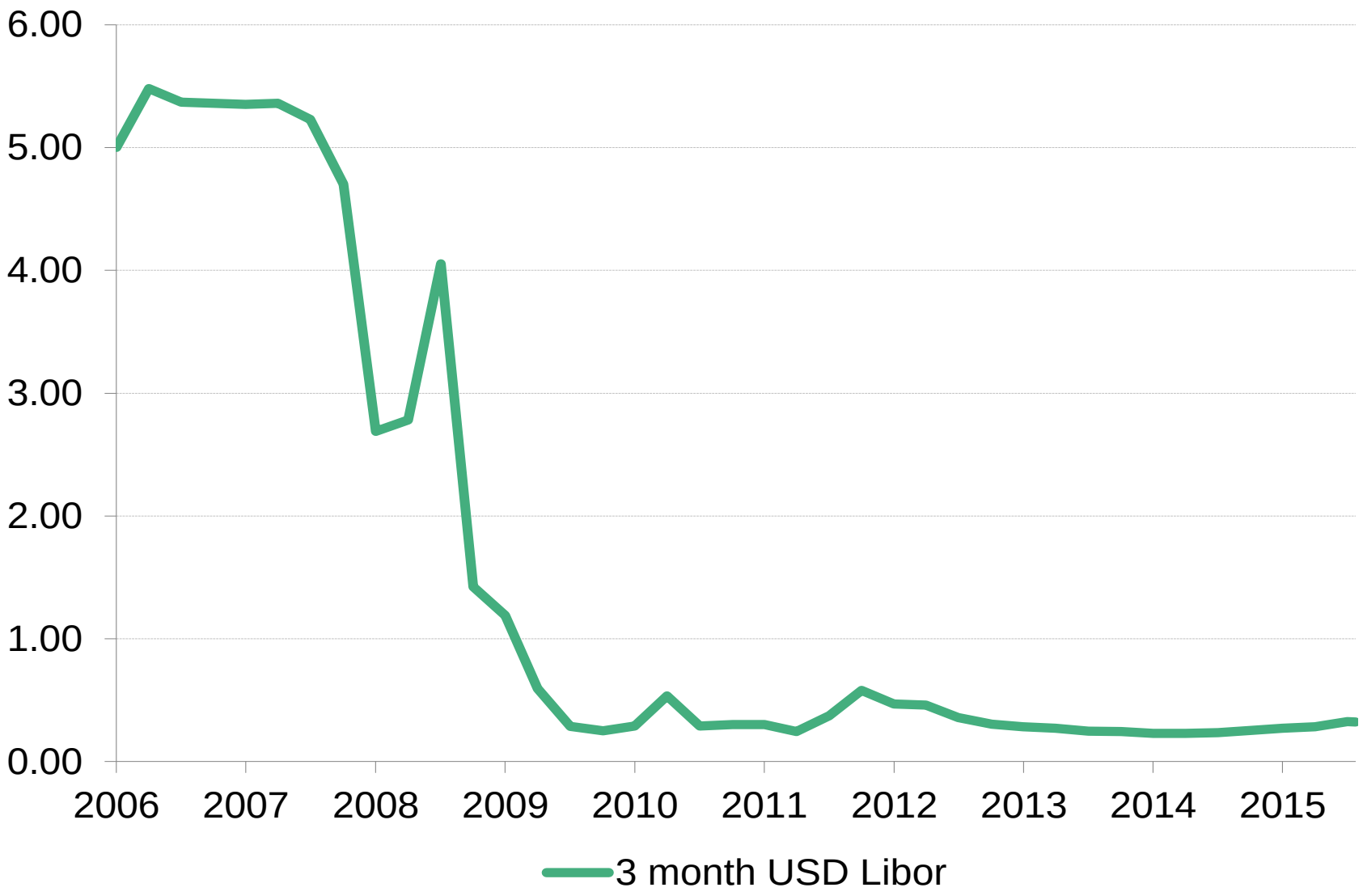


Note: yields as of as of 29 October 2015.

Source: Bloomberg New Energy Finance

DECLINING INTEREST RATES OF USD SINCE 2009, JAN 2006 - MAY 2015 (%)

Bloomberg NEW ENERGY FINANCE



Source: Bloomberg

WHAT IS A GREEN BOND

Green Bonds are like any other infrastructure bonds but with a condition that the proceeds of these bonds would be used as per the "Green Bond" definition that one follows. There is no standard definition of Green Bonds as of now and many people/organizations define it differently and include activities such as clean energy, energy efficiency, carbon reduction activities and more.

Type	Definition
Labelled green bonds	A labelled green bond is a bond issued with a clear intent to use proceeds for green initiatives.
Unlabelled green bonds	Bonds that are issued by companies promoting green initiatives but have chosen not to market their issuances as green are called unlabeled bonds. These bonds may not be branded as green as the issuer may find no additional benefit of doing so or because a part of the proceeds would be used for activities which may not be strictly considered as green.

Source: Bloomberg New Energy Finance

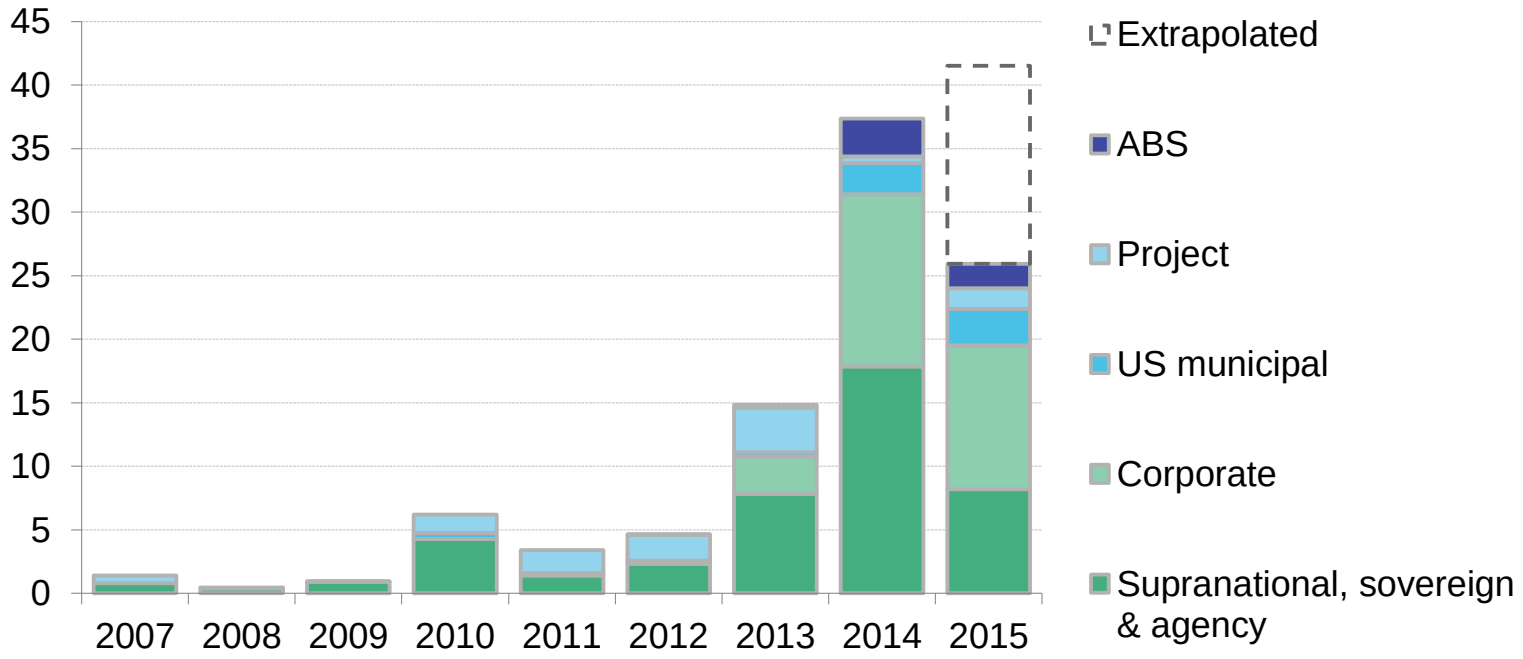
CLASSIFICATION OF GREEN BONDS BASED ON ISSUER

Bloomberg NEW ENERGY FINANCE

Type	Definition
Corporate self-labelled	Bonds issued by corporations and explicitly labelled as green
Green ABS	Asset-backed securities whose cashflows come from a portfolio of underlying receivables such as loans, leases and PPAs. The receivables are associated with green (eg, renewable energy, energy efficiency) projects.
Project bonds	Bonds backed by the cashflows of an underlying renewable energy project or portfolio of projects
Sovereign & supranational	Bonds issued by multilateral banks, development finance institutions and export credit agencies to finance green projects. This includes bonds issued by national development banks.
State & municipal	Bonds issued by state, municipal and provincial (ie, sub-sovereign public sector) entities to finance green projects

Source: Bloomberg New Energy Finance

GREEN BOND ISSUANCE BY TYPE, BY YEAR, 2007-2015 ($BN)



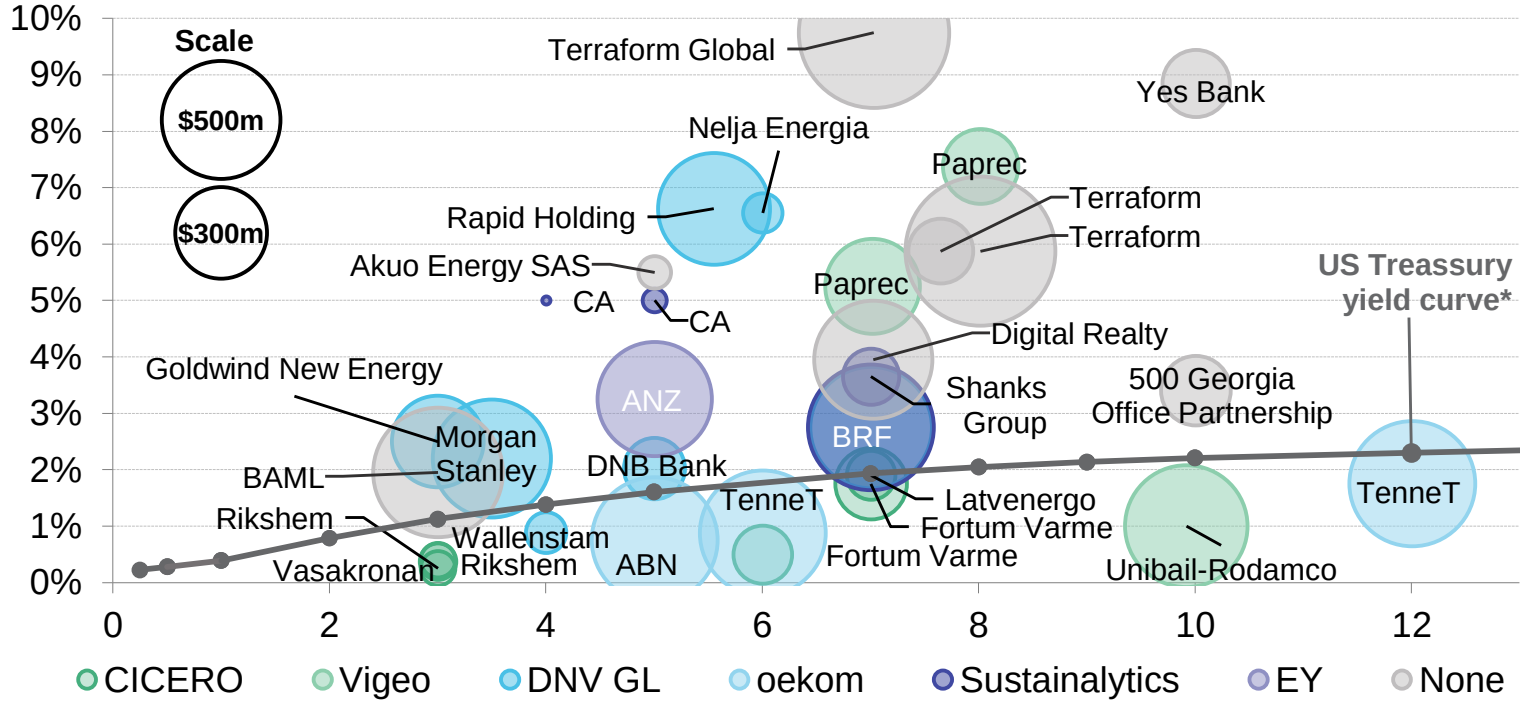
Notes: See Section 2 of the accompanying report for methodology and sources.

Source: Bloomberg New Energy Finance, Bloomberg Terminal

SELECT CORPORATE GREEN BONDS, JANUARY-AUGUST 2015

Bloomberg NEW ENERGY FINANCE

How to interpret: Coupon on y-axis, tenor on x-axis, bubble size based on issuance size, bubble colour based on second opinion provider



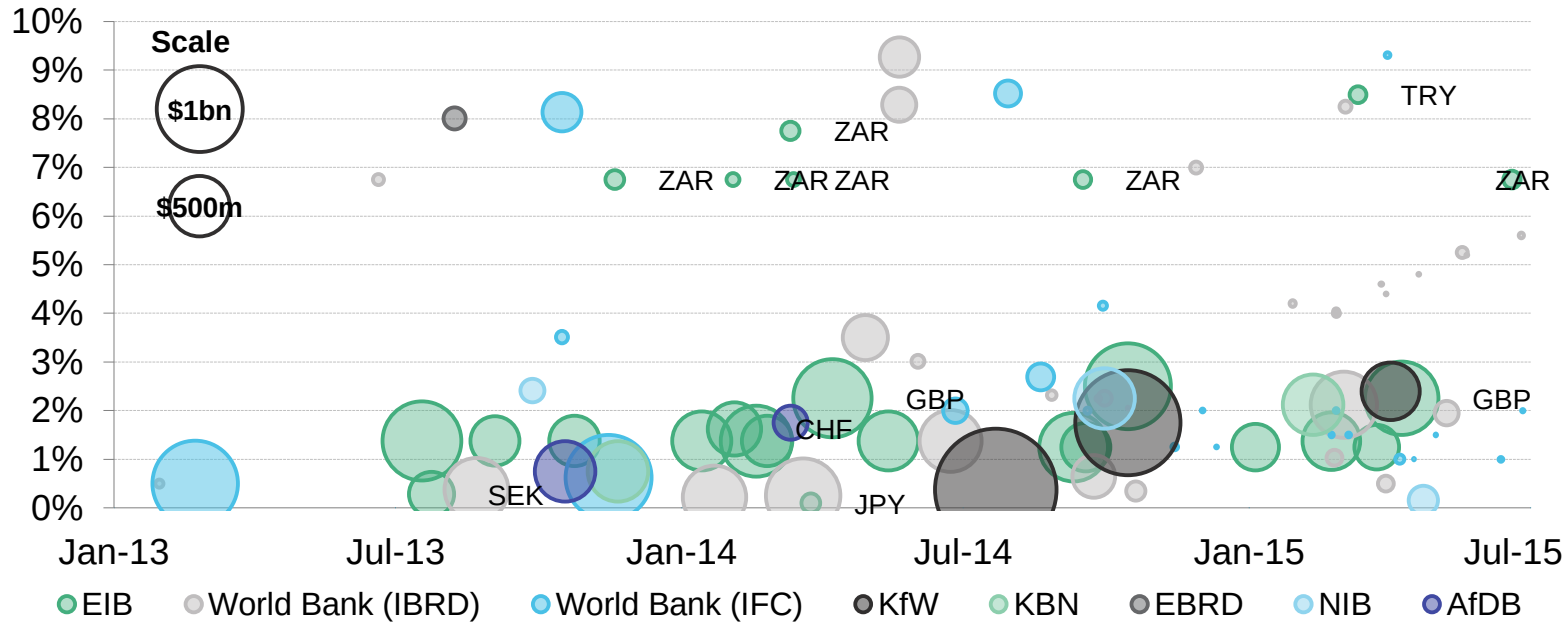
Notes: (*) Yield curve as of 17 August 2015. Section 2 for methodology and sources.

Source: Bloomberg New Energy Finance, Bloomberg Terminal

DEVELOPMENT BANK GREEN BONDS, JANUARY 2013-JULY 2015

Bloomberg NEW ENERGY FINANCE

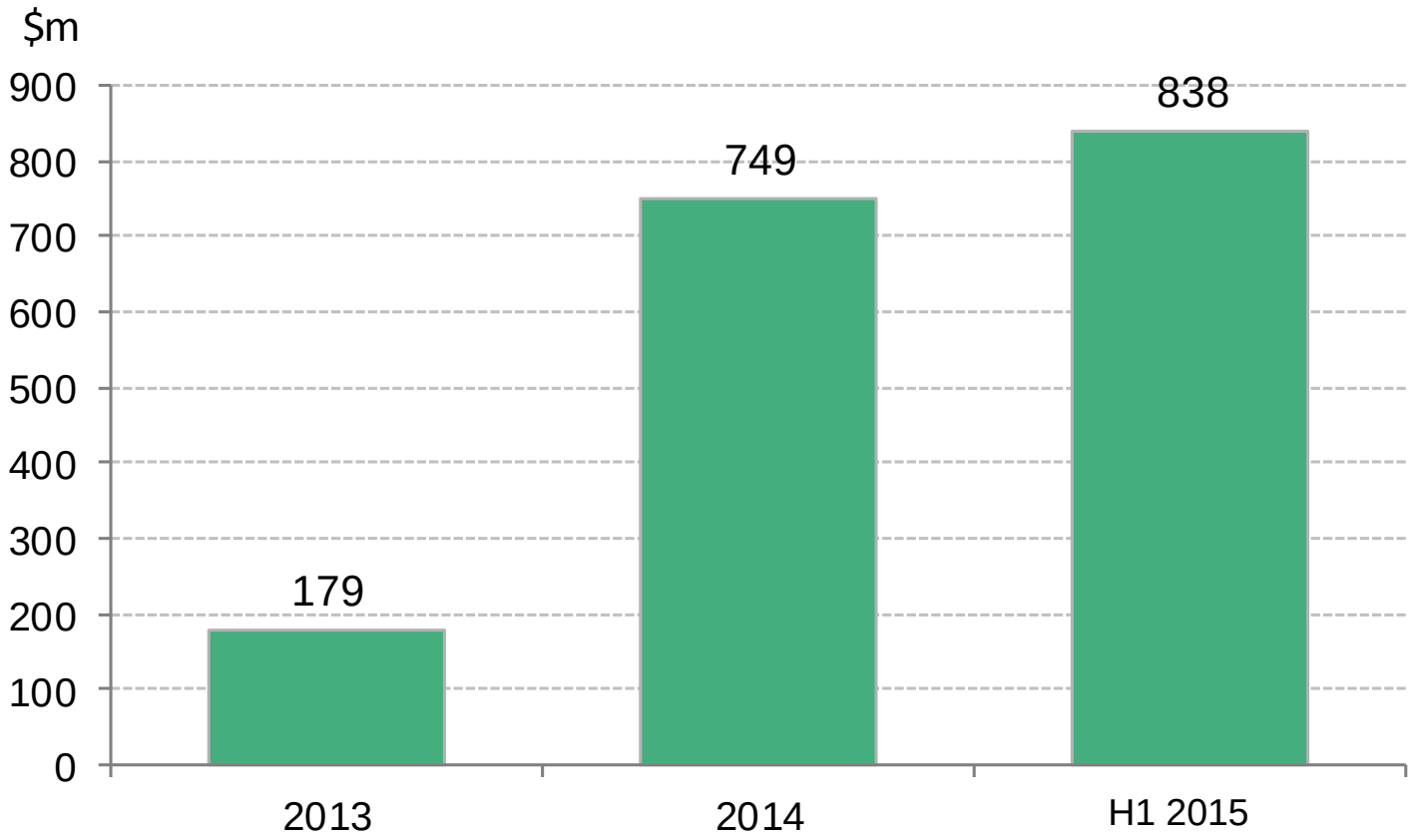
How to interpret: Coupon on y-axis, tenor on x-axis, bubble size based on issuance size, bubble colour based on second opinion provider



Notes: Currencies labelled only where issuance was not in USD or EUR. (The currency is relevant as most of these non-USD issues are either Uridashi or dual currency issues.) EIB: European Investment Bank; IBRD: International Bank for Reconstruction and Development; IFC: International Finance Corporation; KfW: Kreditanstalt für Wiederaufbau; KBN: Kommunalbanken; EBRD: European Bank for Reconstruction and Development; NIB: Nordic Investment Bank; AfDB: African Development Bank.

Source: Bloomberg New Energy Finance, Bloomberg Terminal

LABELLED AND UNLABELLED GREEN BOND ISSUANCES IN INDIA



Source: Bloomberg New Energy Finance

GREEN BONDS ISSUED IN INDIA, H1 2015

Bloomberg NEW ENERGY FINANCE

Issuer	Date	Value (INR m)	Currency	Value (USD m)	Coupon	Tenor
Yes Bank Ltd	2/24/15	10000	INR	161	8.85	10
Export-Import Bank of India	4/1/15		USD	500	2.75	5
TOTAL				**661**		
ReNew Power Ventures Pvt Ltd	3/23/15	1000	INR	16	12.29	5
ReNew Power Ventures Pvt Ltd	3/23/15	1000	INR	16	12.29	5
ReNew Power Ventures Pvt Ltd	3/23/15	500	INR	8	12.00	5
ReNew Power Ventures Pvt Ltd	3/23/15	1000	INR	16	12.00	5
ReNew Power Ventures Pvt Ltd	3/24/15	500	INR	8	13.07	5
ReNew Power Ventures Pvt Ltd	3/24/15	1000	INR	16	13.07	5
ReNew Power Ventures Pvt Ltd	3/24/15	500	INR	8	12.68	5
ReNew Power Ventures Pvt Ltd	3/24/15	1000	INR	16	12.68	5
Mytrah Energy India Ltd	3/31/15	3447	INR	55	12.00	5
Tata Cleantech Capital Ltd	4/22/15	500	INR	8	9.05	3
Tata Cleantech Capital Ltd	5/20/15	600	INR	9	9.15	3
TOTAL				**176**		

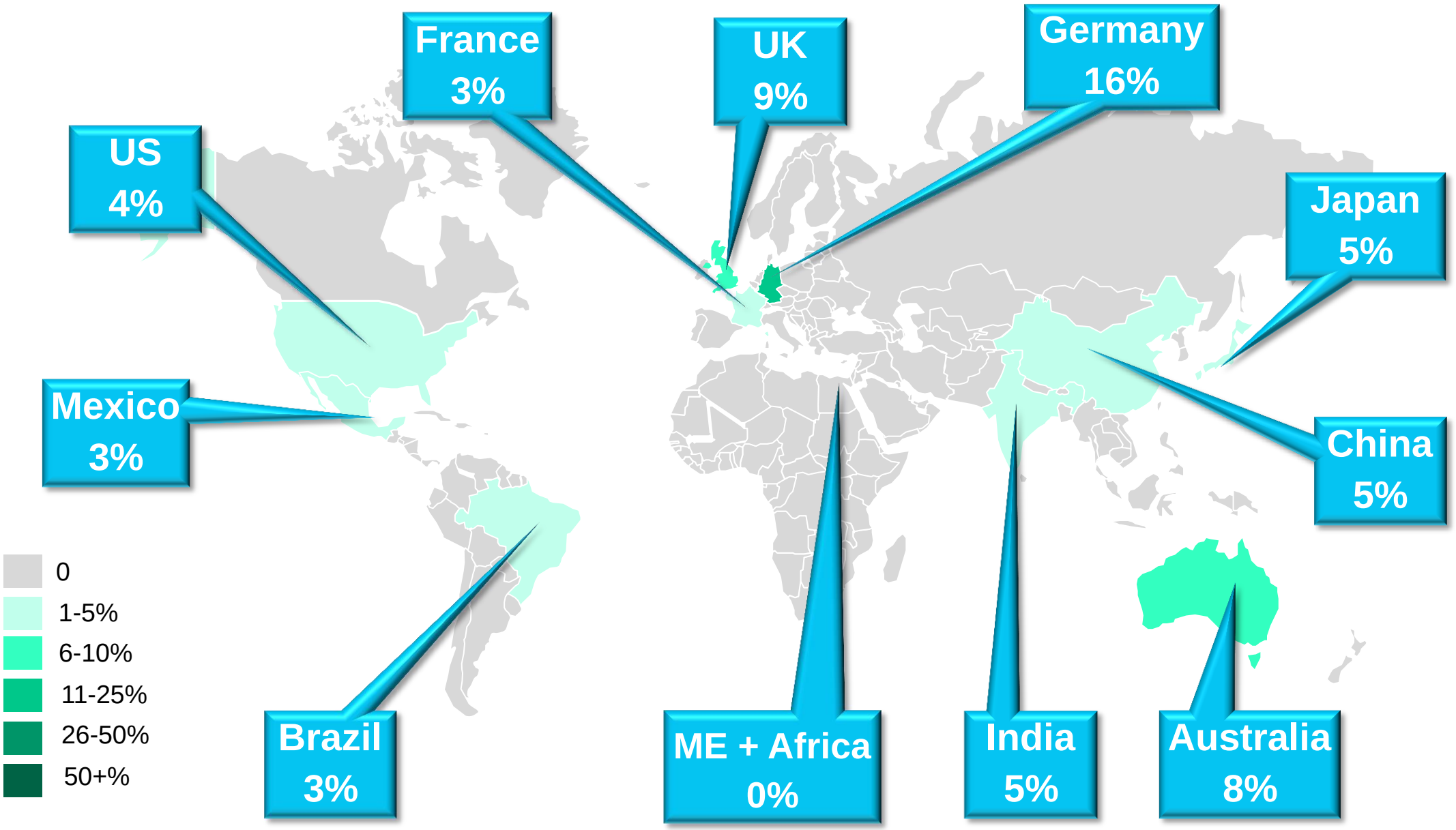
Source: Bloomberg New Energy Finance

STORAGE: GRID BALANCING & ELECTRIC VEHICLES

Bloomberg
NEW ENERGY FINANCE

RENEWABLE ENERGY PROPORTION OF POWER GENERATION- INTERMITTENT ENERGY (WIND & SOLAR), 2014 (%)

Bloomberg NEW ENERGY FINANCE

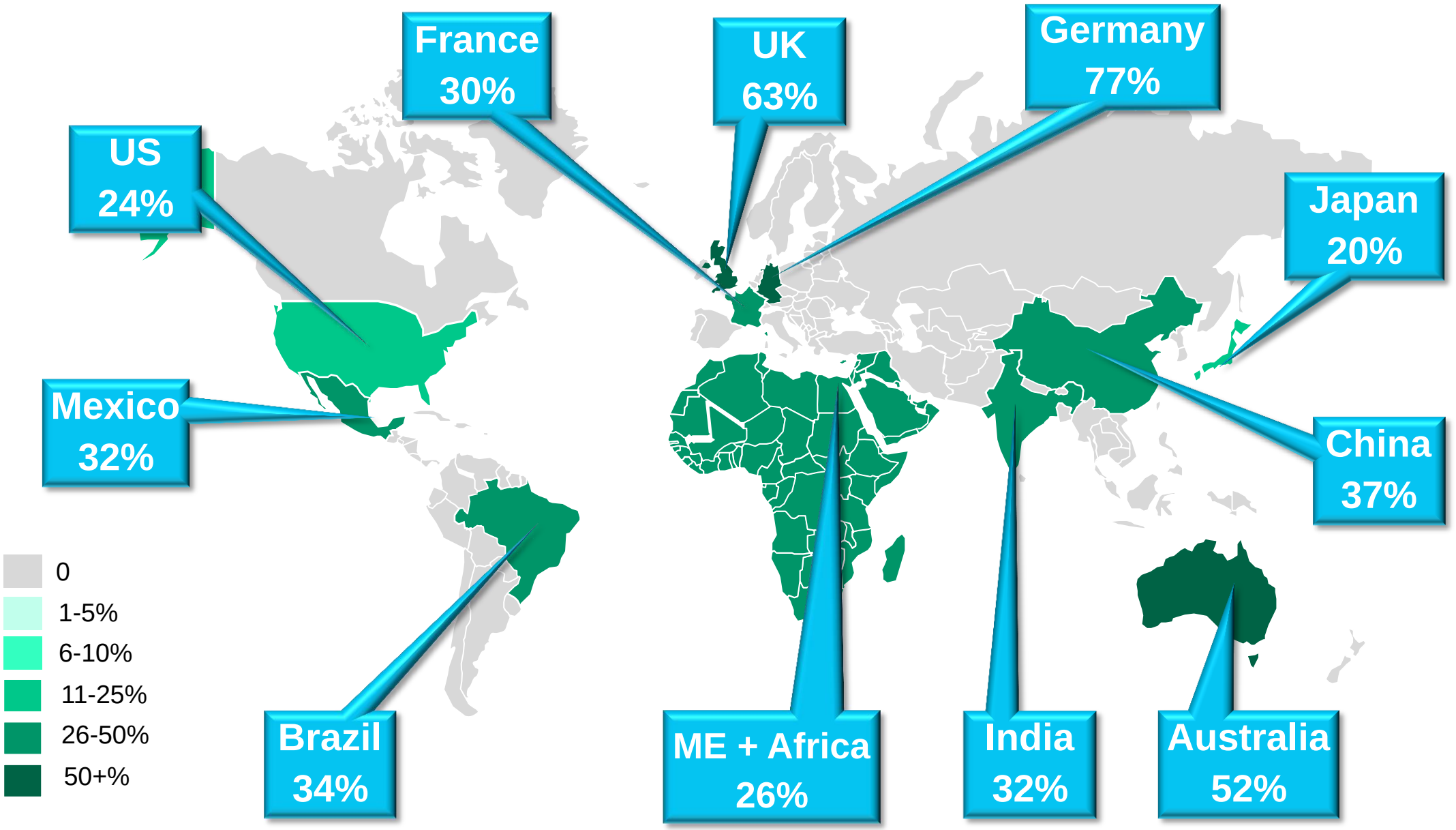


Note: This only shows the combination of wind and solar energy generation. All numbers come from BNEF's New Energy Outlook 2015

Source: Bloomberg New Energy Finance

RENEWABLE ENERGY PROPORTION OF POWER GENERATION- INTERMITTENT ENERGY (WIND & SOLAR) , 2040 (%)

Bloomberg NEW ENERGY FINANCE



Note: This only shows the combination of wind and solar energy generation. All numbers come from BNEF's New Energy Outlook 2015

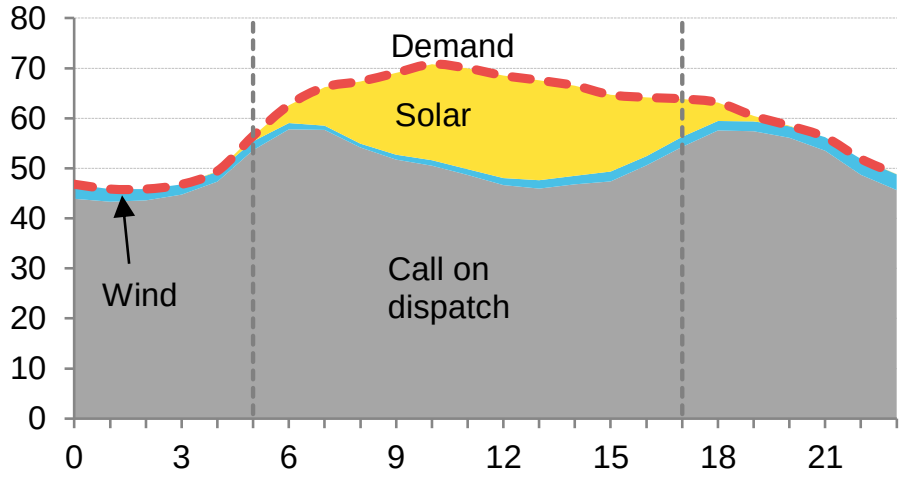
Source: Bloomberg New Energy Finance

ALTHOUGH SOLAR ASSISTS WITH THE MORNING PEAK, ITS DROP OFF AT NIGHT WILL CAUSE RECORD RAMPING.

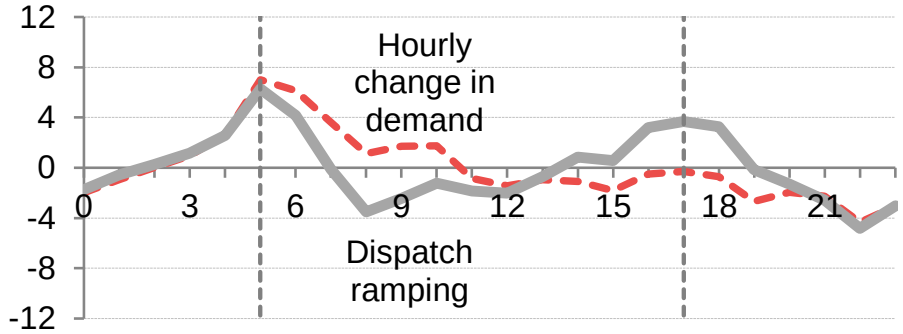
Bloomberg NEW ENERGY FINANCE

2013

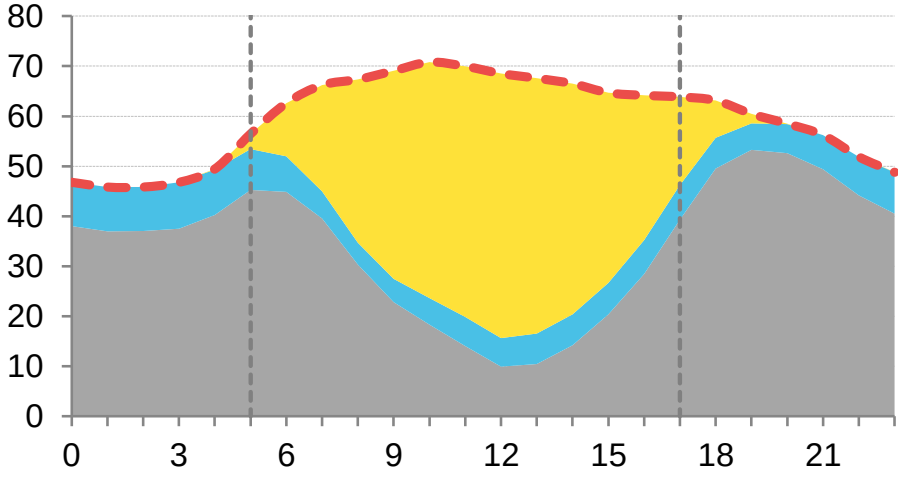
July median German generation profile (GW)

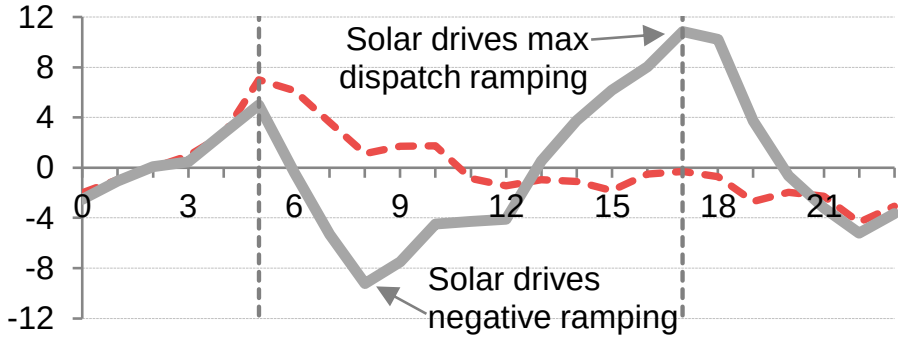


July median hourly dispatch ramping



2033



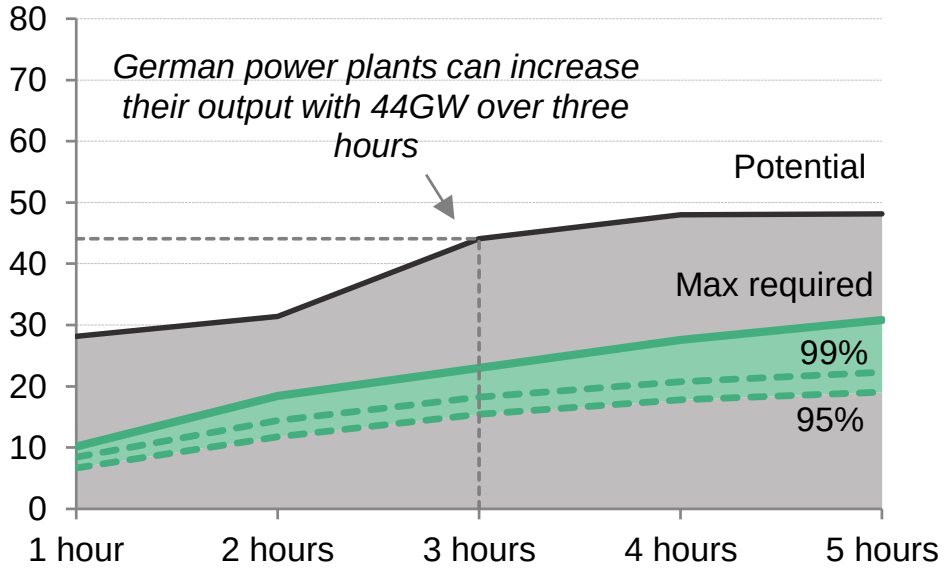


Source: Bloomberg New Energy Finance, EEX, Bnetza, Destatis Note: assumes equal demand profiles in 2013 and 2033.

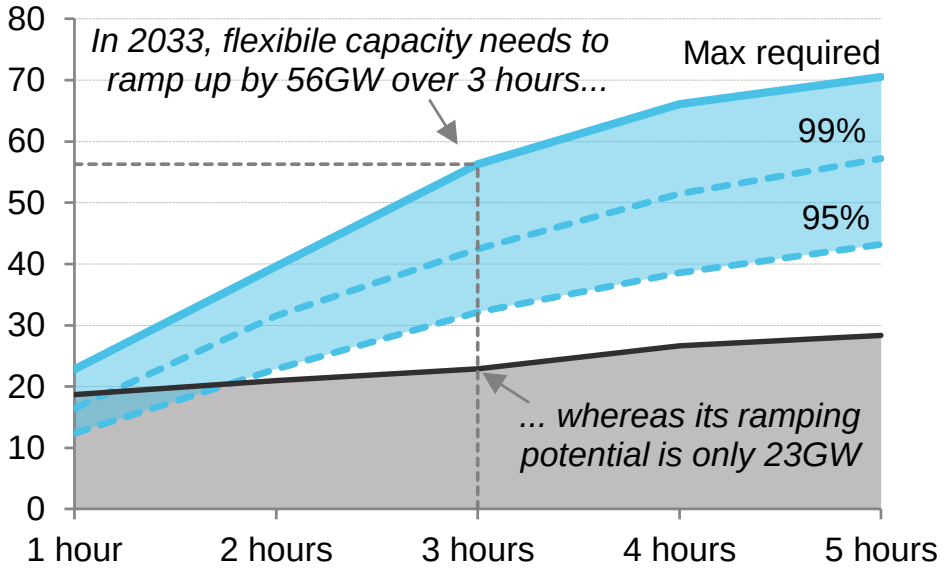
BY 2033, GERMAN POWER PLANTS ALONE WILL NOT BE ABLE TO RESPOND QUICKLY ENOUGH TO RECORD DROPS IN RENEWABLE OUTPUT

Bloomberg NEW ENERGY FINANCE

2013 dispatch maximum cumulative ramping requirements compared to ramping potential (GW)



2033 dispatch maximum cumulative ramping requirements compared to ramping potential (GW)

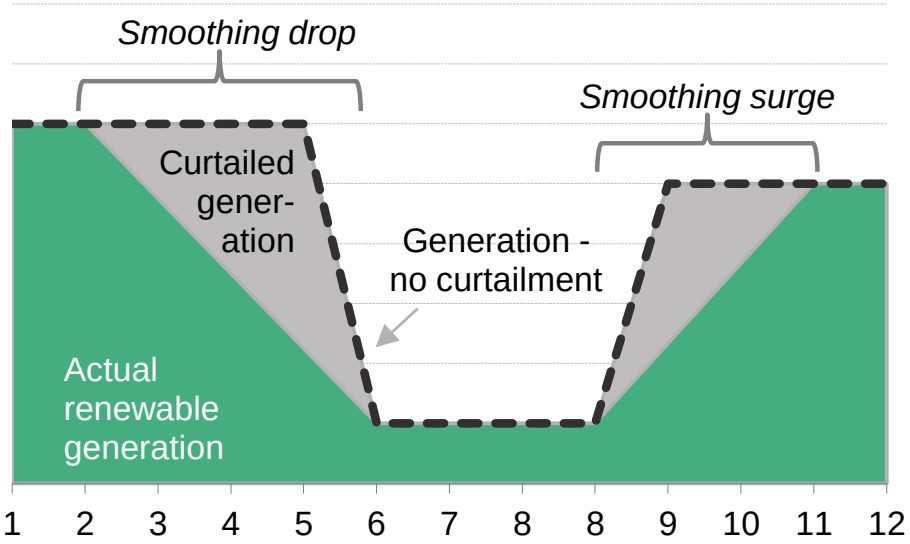


Source: Bloomberg New Energy Finance, EEX, Destatis, Bnetza
Note: 99% and 95% are confidence intervals and should be read as: ramp requirements do not exceed y GW in 99% or 95% of the hours in the year.

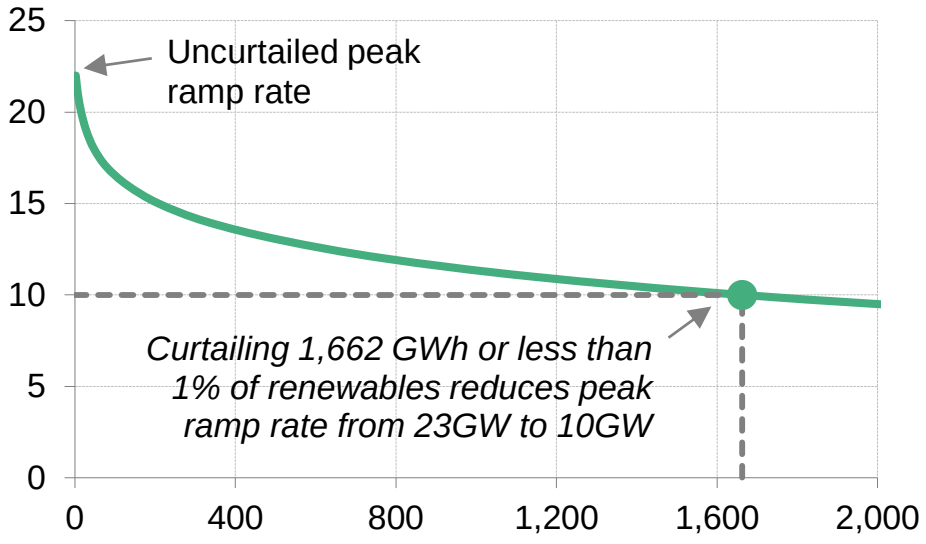
CURTAILING LESS THAN 1% OF RENEWABLES MIGHT CUT MAXIMUM RAMP RATES BY 57%

Bloomberg NEW ENERGY FINANCE

Smoothing steep drops or surges in renewable output through curtailment (x-axis = hours)



2033 maximum projected ramp up rates (y axis, GW/hour) for different levels of curtailment (x axis, GWh)



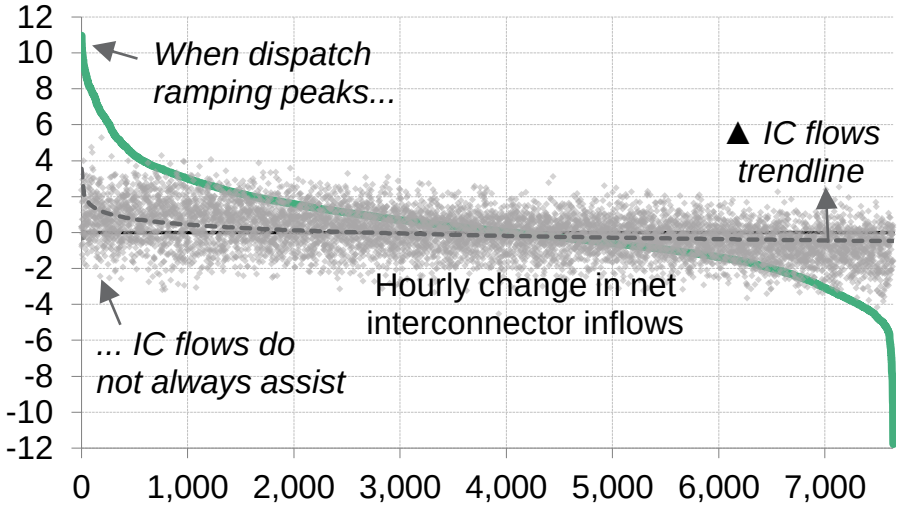
Source: Bloomberg New Energy Finance
Note: illustrative example, not based on actual data.

Source: Bloomberg New Energy Finance, EEX, Destatis, Bnetza

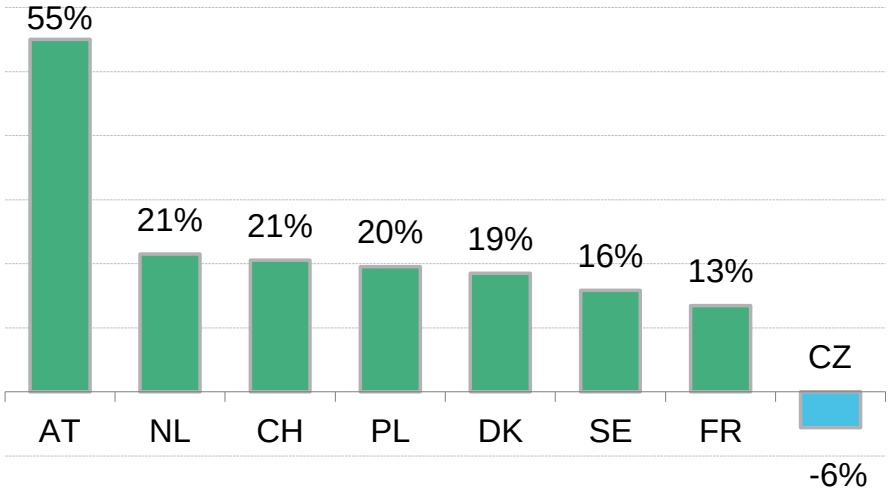
INTERCONNECTORS ARE A SOURCE OF FLEXIBILITY BUT MIGHT BE UNRELIABLE TO COVER PEAK RAMPING.

Bloomberg NEW ENERGY FINANCE

2012 hourly dispatch ramping duration curve and associated change in total interconnector inflows (GW/hr)



Contribution of interconnector flows to dispatchable capacity ramping (correlation)



Source: Bloomberg New Energy Finance, EEX, Destatis, Bnetza
Notes: The ramping duration curve should be read as: x-axis value is the number of hours in 2012 where dispatch ramping exceeded the associated y-axis value. Dataset based on 7643 hours in 2012.

Source: Bloomberg New Energy Finance, EEX, Entso-e

LAUDATO SI – INTEGRATION

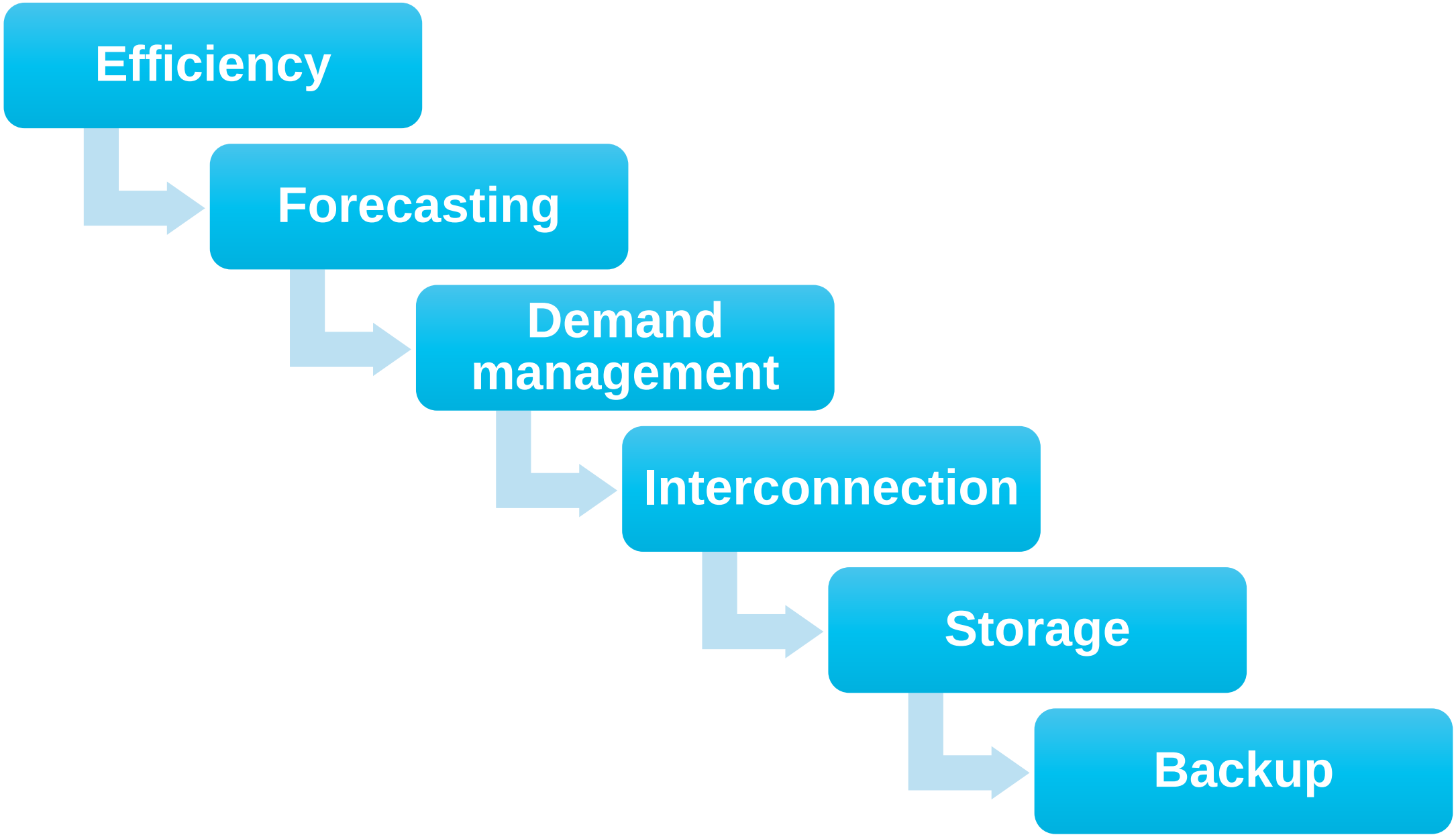
Bloomberg NEW ENERGY FINANCE

> There is still a need to develop adequate storage technologies.

Pope Francis

Picture: Wikimedia

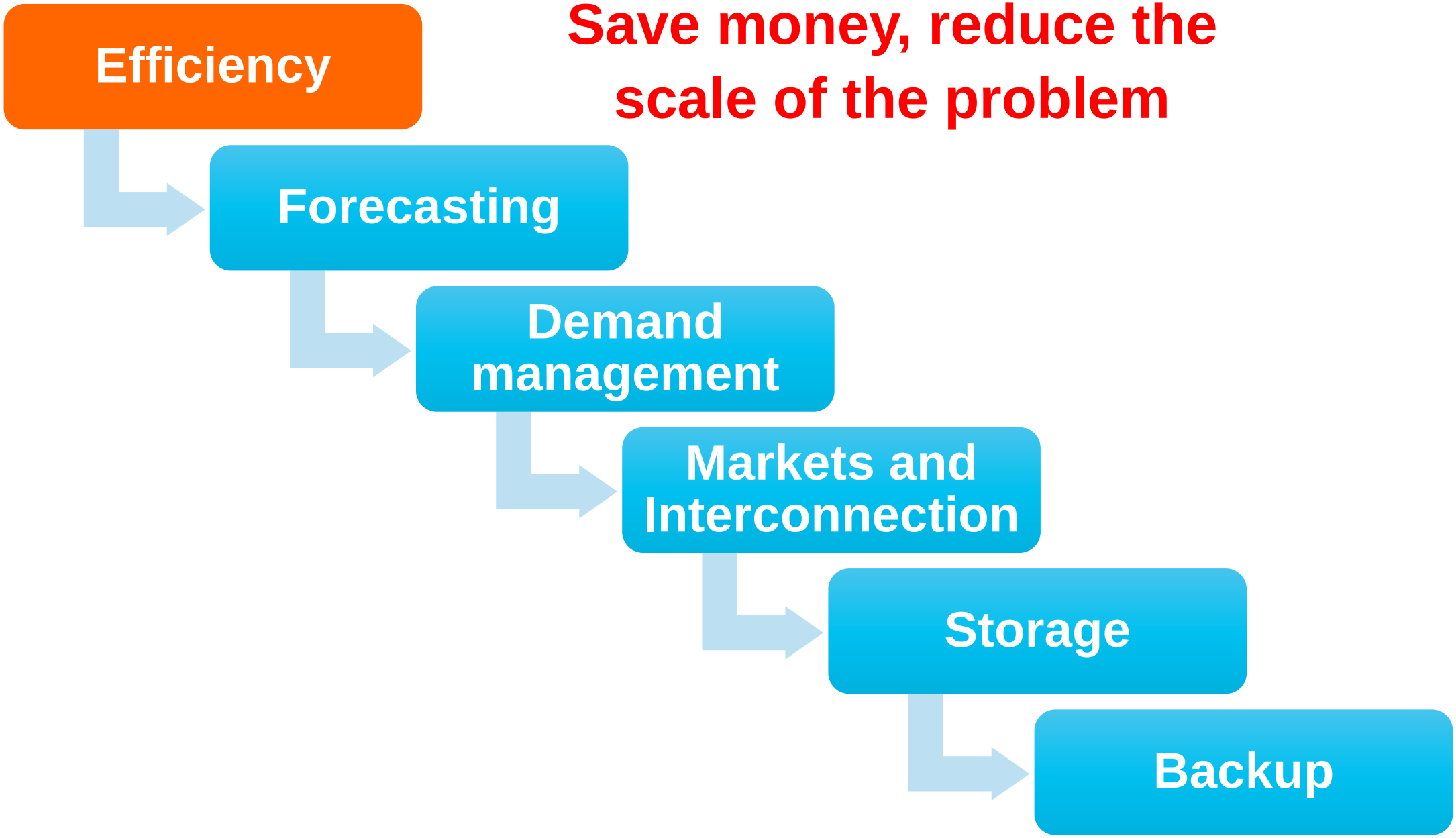
MANAGING INTERMITTENCY



MANAGING INTERMITTENCY

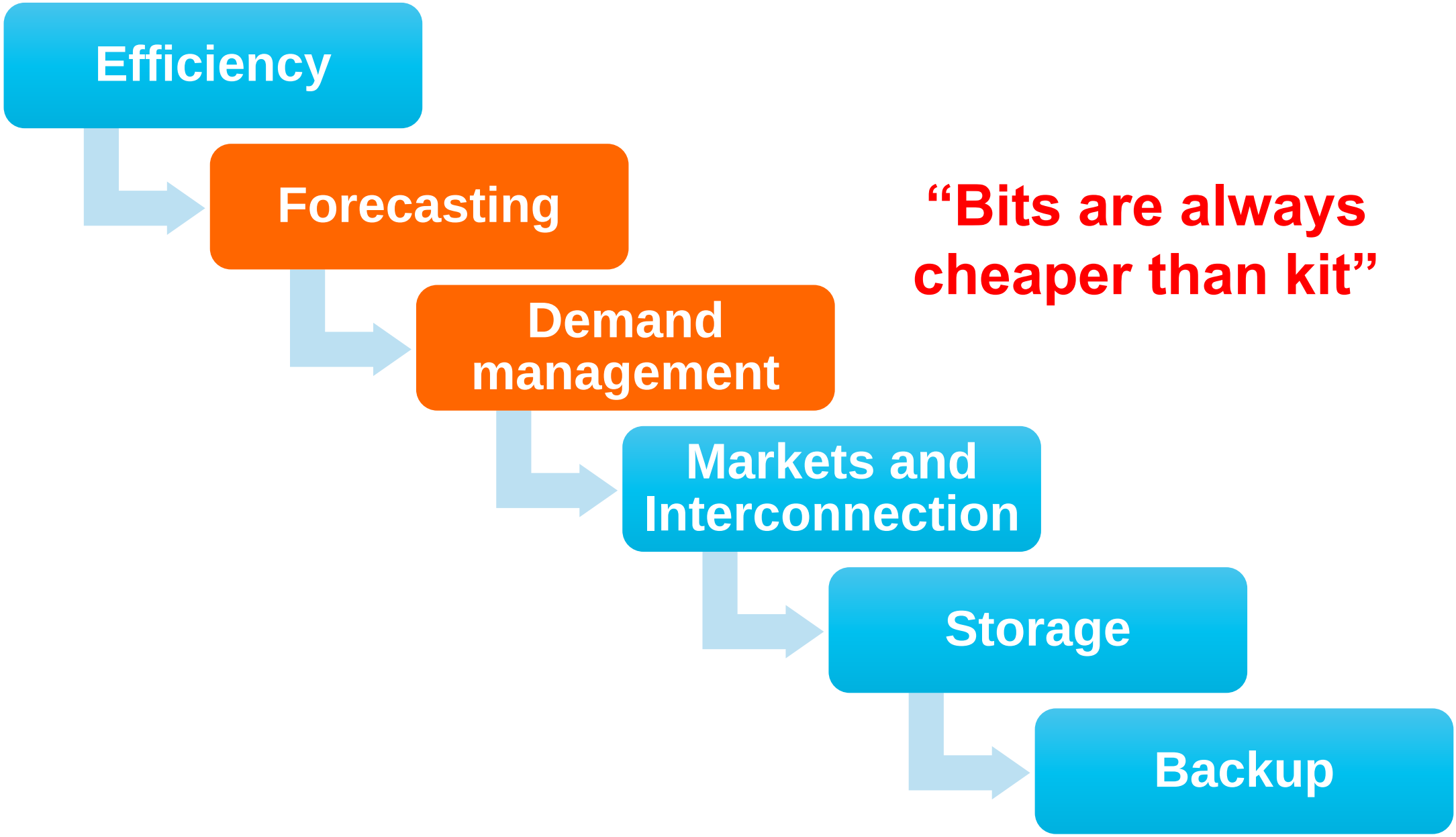
Bloomberg NEW ENERGY FINANCE

Save money, reduce the scale of the problem



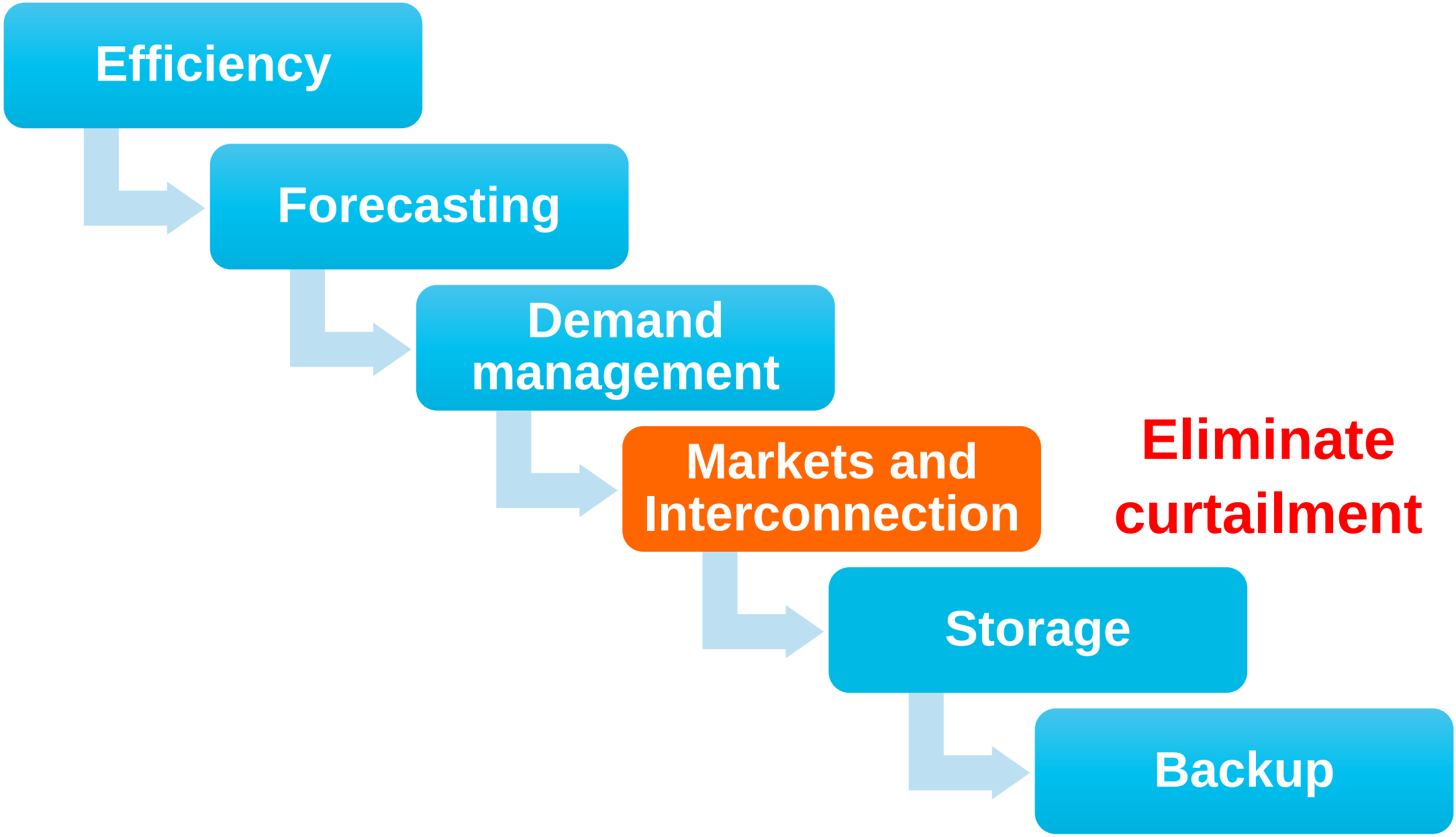
MANAGING INTERMITTENCY

Bloomberg NEW ENERGY FINANCE



"Bits are always cheaper than kit"

MANAGING INTERMITTENCY



INTERMITTENCY MANAGEMENT MERIT ORDER

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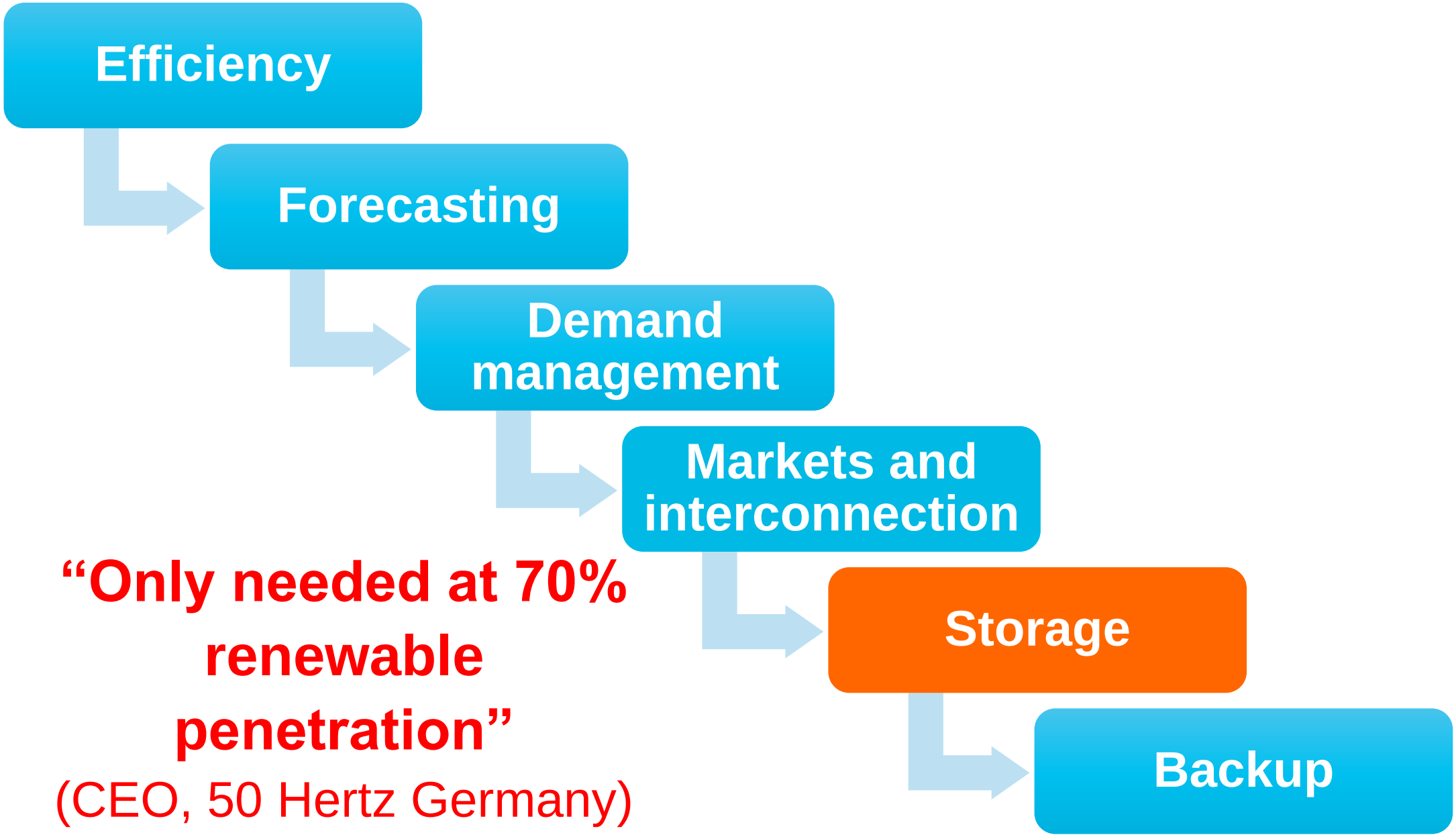
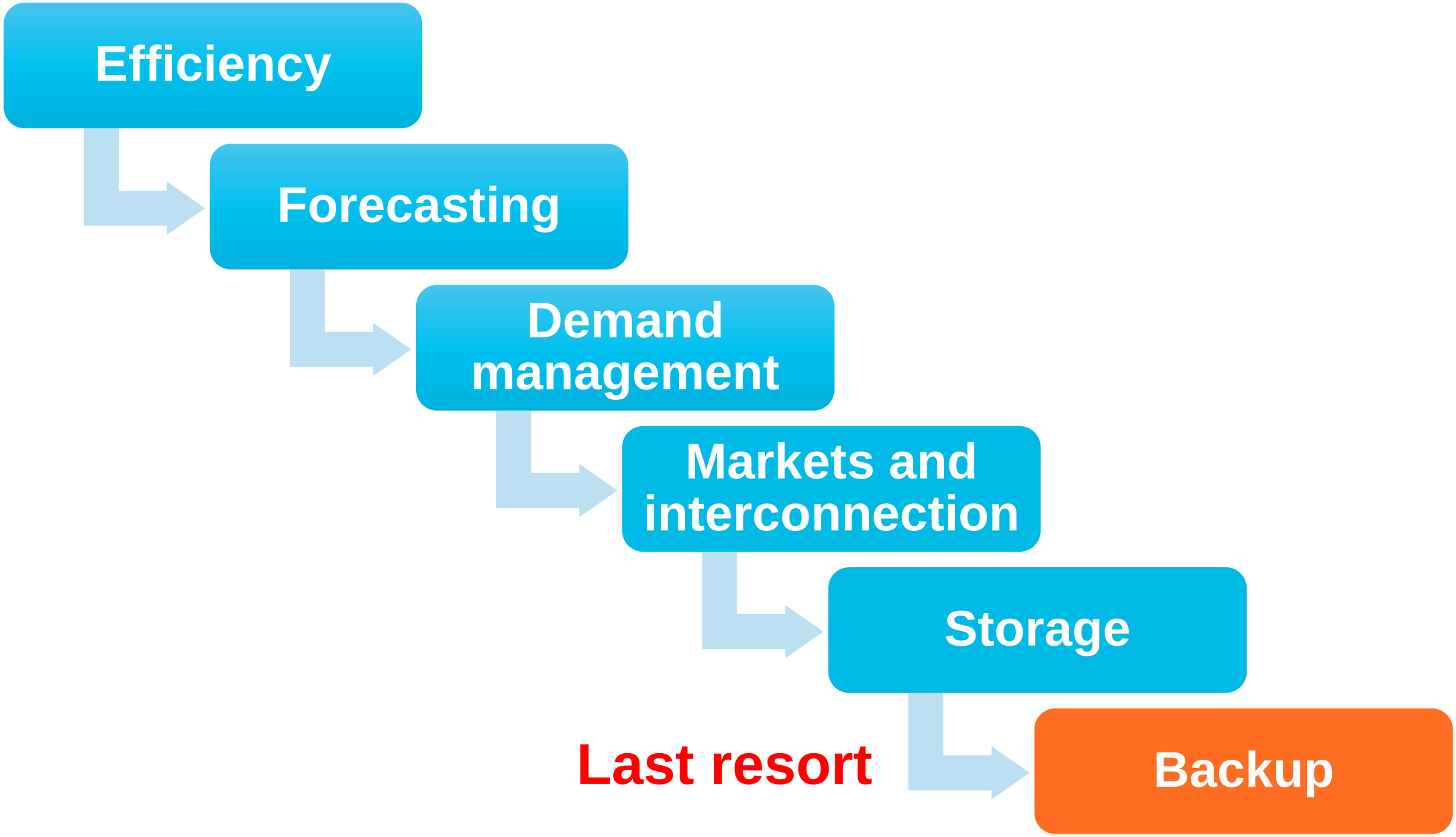


"Only needed at 70% renewable penetration"

(CEO, 50 Hertz Germany)

MANAGING INTERMITTENCY



EV LITHIUM-ION BATTERY PACKS & CRYSTYALLINE SI PV MODULES: HISTORICAL COST REDUCTIONS

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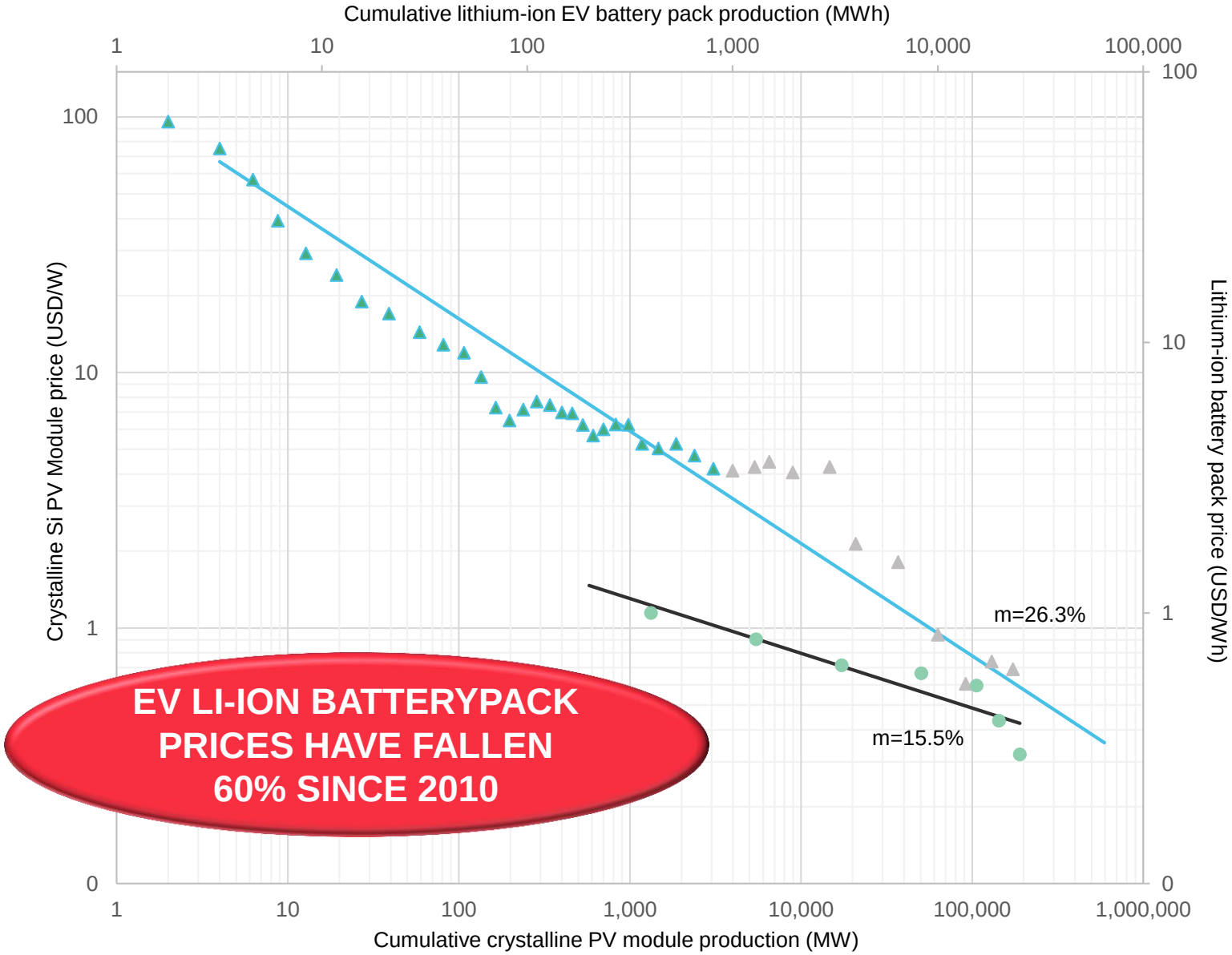

Note: Values from 2010-2014 are based on BNEF's annual battery price index, *2015 based on H1 data. For more see here: https://www.bnef.com/Insight/10299. Cumulative production is based on total EVs sold and their respective battery pack size.

Source: Bloomberg New Energy Finance

PV AND LITHIUM-ION SUPPLY CHAINS

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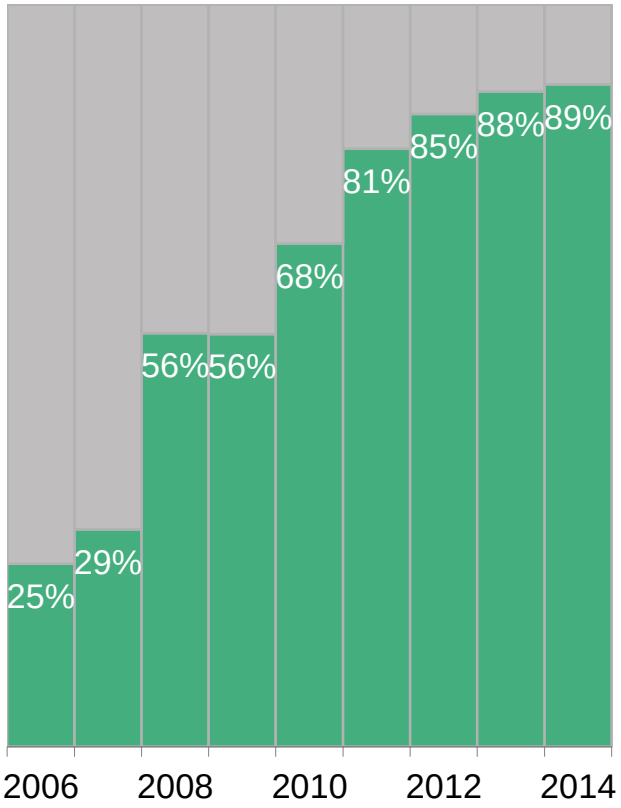
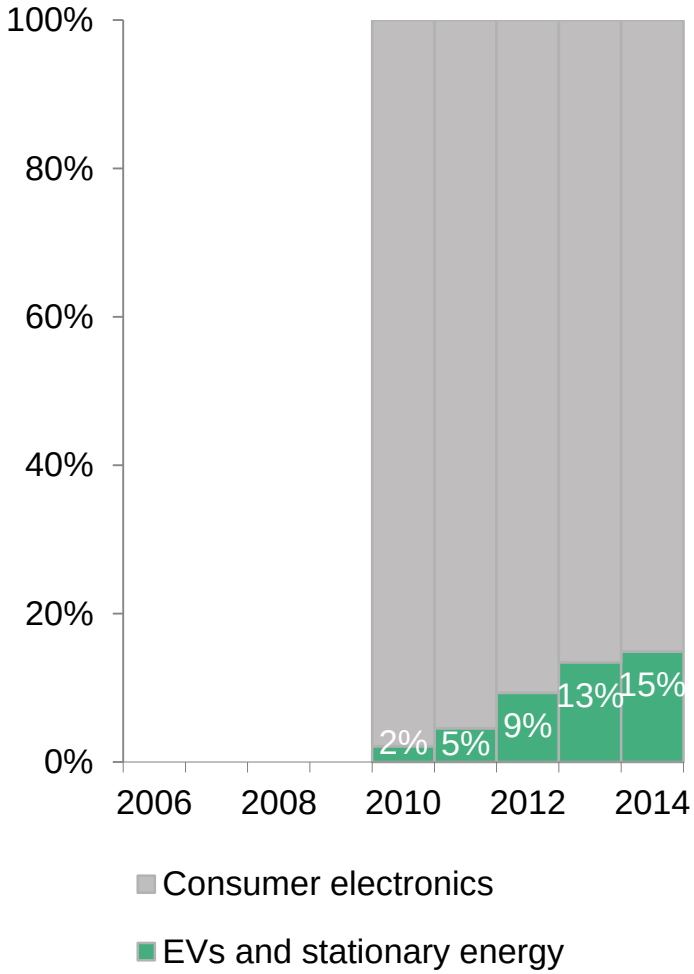
SILICON CONSUMPTION BY SECTOR

% of production



LITHIUM-ION BATTERY SALES BY SECTOR

% of capacity sold

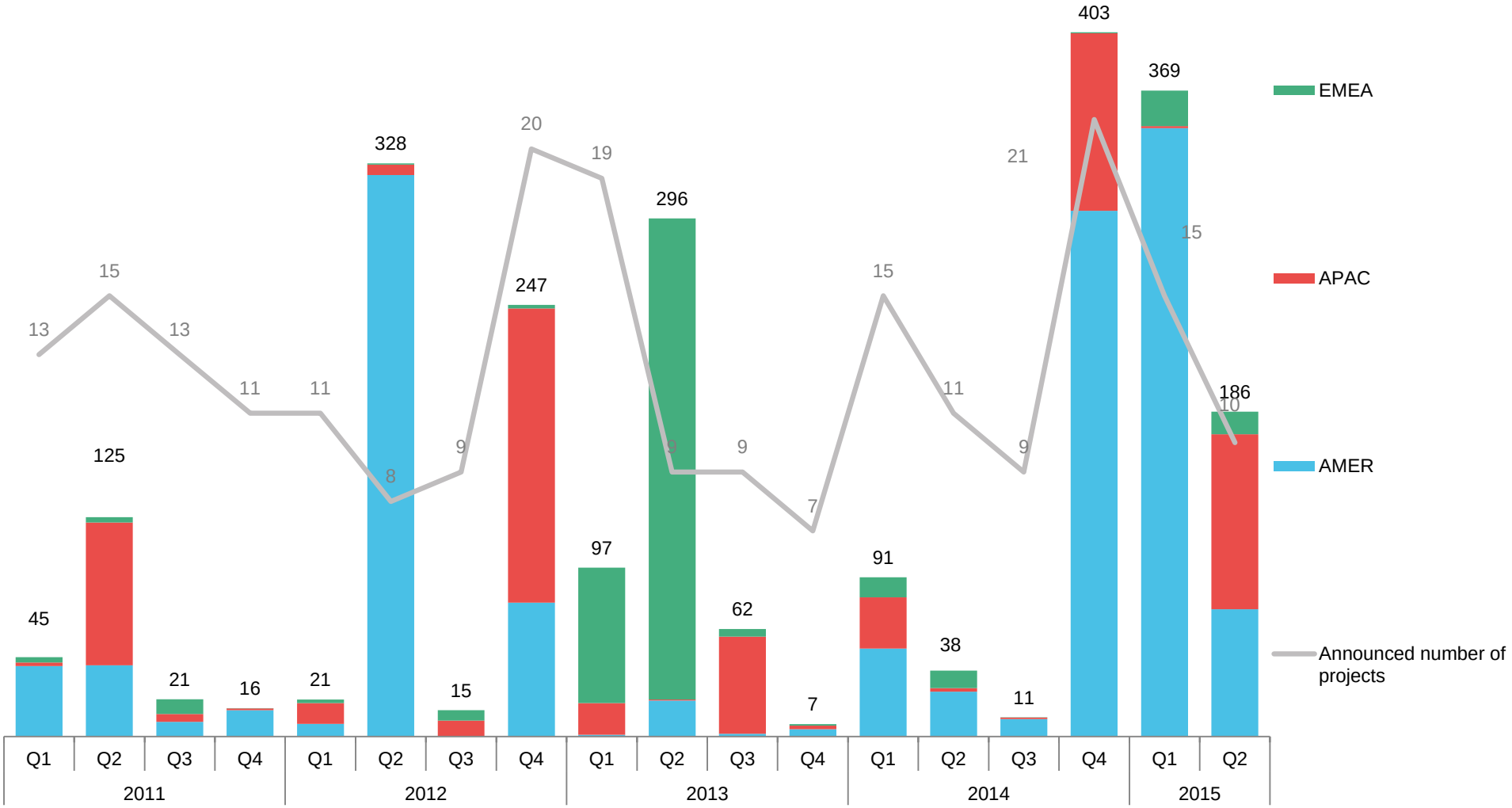


Note: Electric vehicles includes hybrid, plug-in-hybrid and fully electrified.

Source: Bloomberg New Energy Finance.

ANNOUNCED ENERGY STORAGE PROJECTS WORLDWIDE (MW AND NUMBER OF PROJECTS)

Bloomberg NEW ENERGY FINANCE



Note: Q2 2015 numbers are provisional since this Market Outlook is published mid quarter. For underlying data, including 2009 – 2010, click here.

Source: Bloomberg New Energy Finance

TECHNOLOGY MIX OF ANNOUNCED ENERGY STORAGE PROJECTS (% BY MW)

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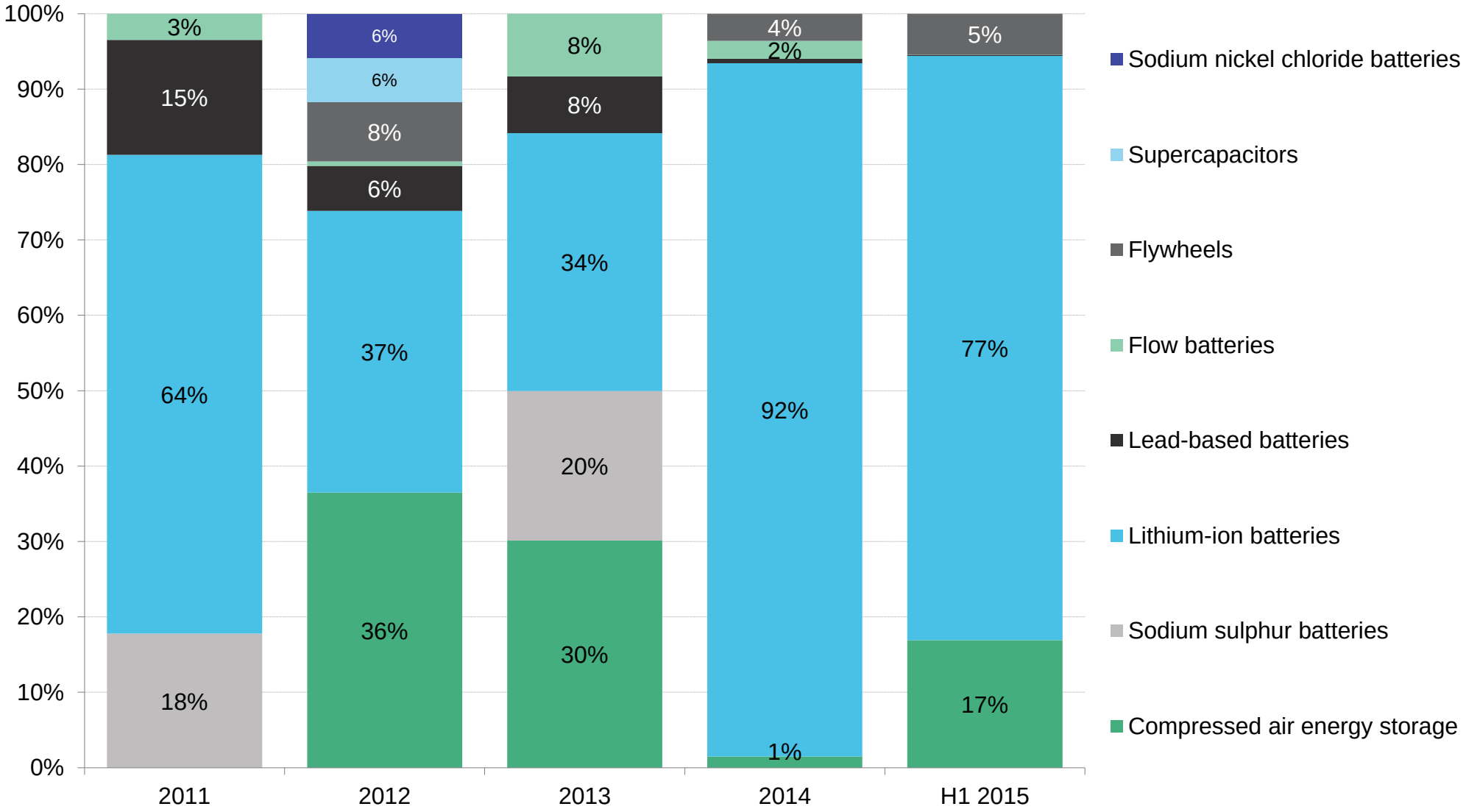
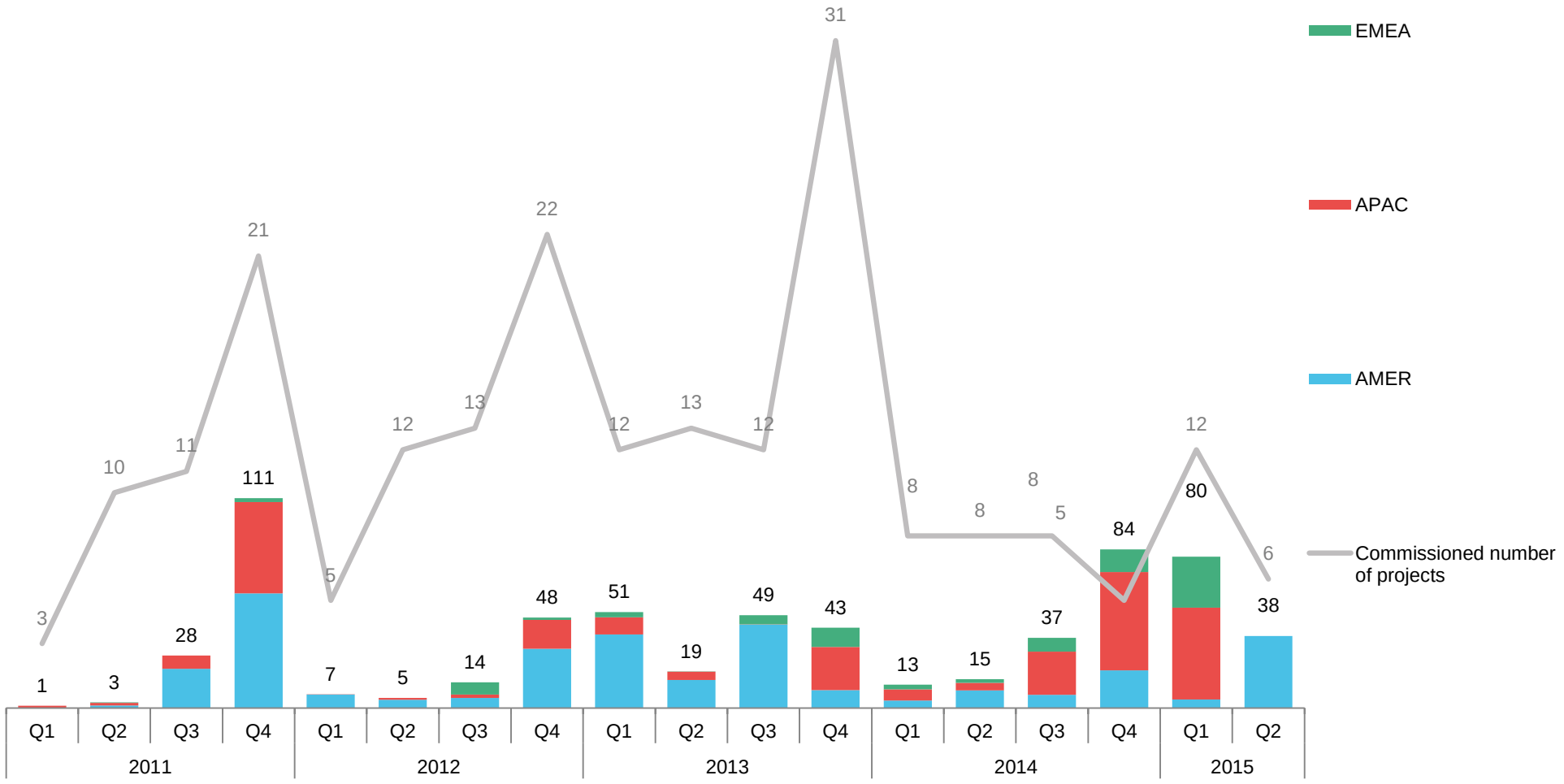


Note: Q2 2015 numbers are provisional since this Market Outlook is published mid quarter. For underlying data, including 2009 – 2010, click here.

Source: Bloomberg New Energy Finance

COMMISSIONED ENERGY STORAGE PROJECTS WORLDWIDE (MW AND NUMBER OF PROJECTS)

Bloomberg NEW ENERGY FINANCE



Note: Q2 2015 numbers are provisional since this Market Outlook is published mid quarter. For underlying data, including 2009 – 2010, click here.

Source: Bloomberg New Energy Finance

ELECTRIC VEHICLES – THE PROMISE

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> Prices on electric cars will continue to drop until they're within reach of the average family.

The Washington Post, 1915

Images: BMW, Detroit Electric, 2015, courtesy of EVASD

ELECTRIC VEHICLE – THE UPTAKE SO FAR

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CARS AND TRUCKS IN USE WORLDWIDE, 2013

1.2 billion

ELECTRIC VEHICLES IN USE WORLDWIDE, 2014

0.75 million (to scale)

Source: Bloomberg New Energy Finance, International Organization of Motor Vehicle Manufacturers

GLOBAL EV SALES, BY REGION 2011- H1 2015 (THOUSAND UNITS)

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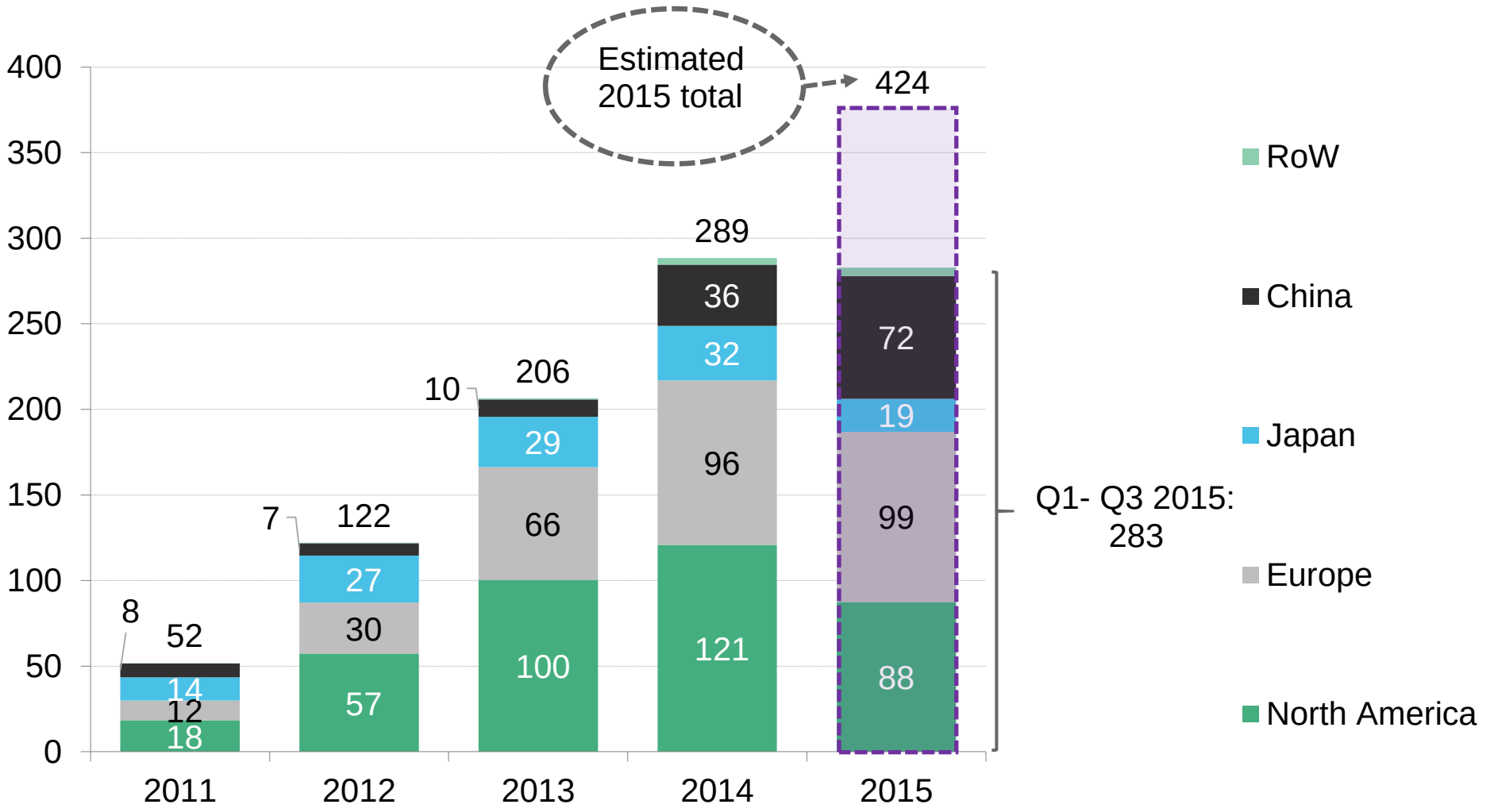
Thousand vehicle sales



The EV penetration rate of total new car sales in Q1-Q3 2015 was 0.63% - up from 0.49% at the end of 2014

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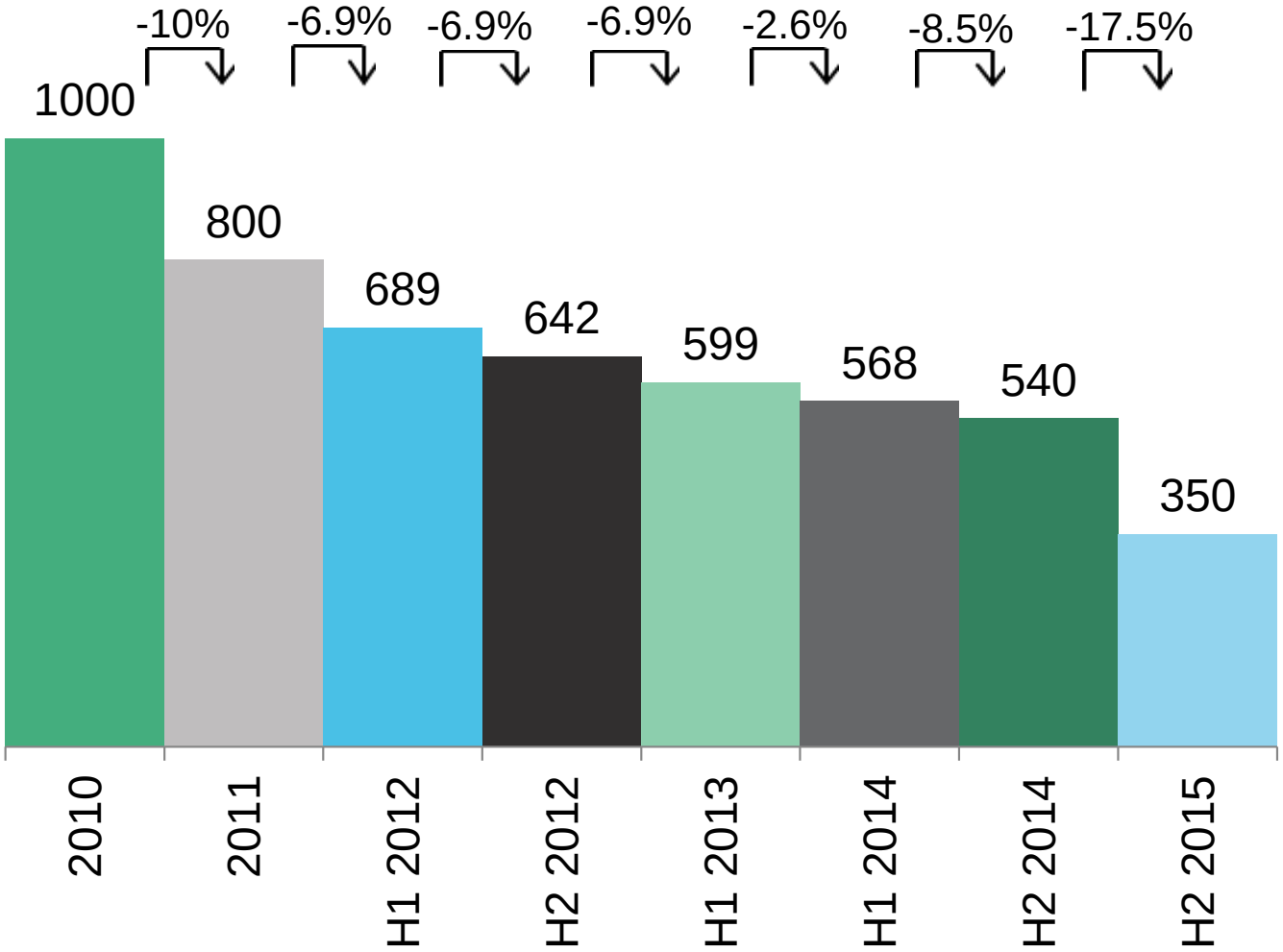
BNEF BATTERY PRICE SURVEY, 2010-15 ($/KWH)



Battery prices are falling faster than battery production costs, as a result of significant overcapacity and the predatory pricing tactics of the largest five battery suppliers

Source: Bloomberg New Energy Finance

THE MAJORITY OF TOP 10 BATTERY COMPANIES HAVE CAPACITY IN ONLY ONE REGION

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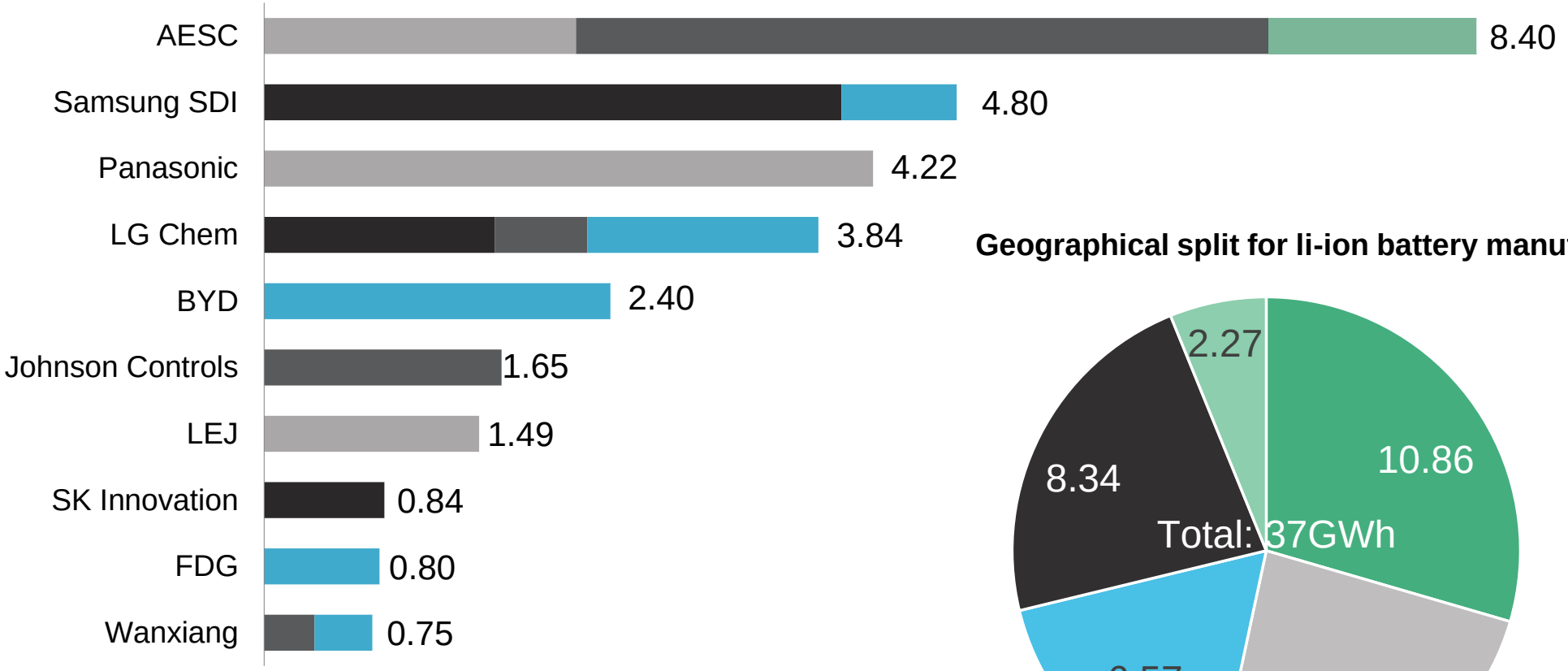
10 largest li-ion battery manufacturers globally, showing geographical location, 2015 (GWh)



Geographical split for li-ion battery manufacturers

Source: Bloomberg New Energy Finance. Notes: See the notes slides for further details.

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