

# SEVENTH CLEAN ENERGY MINISTERIAL

San Francisco  
2 May 2016

Michael Liebreich

Chairman of the Advisory  
Board

Twitter: @mliebreich

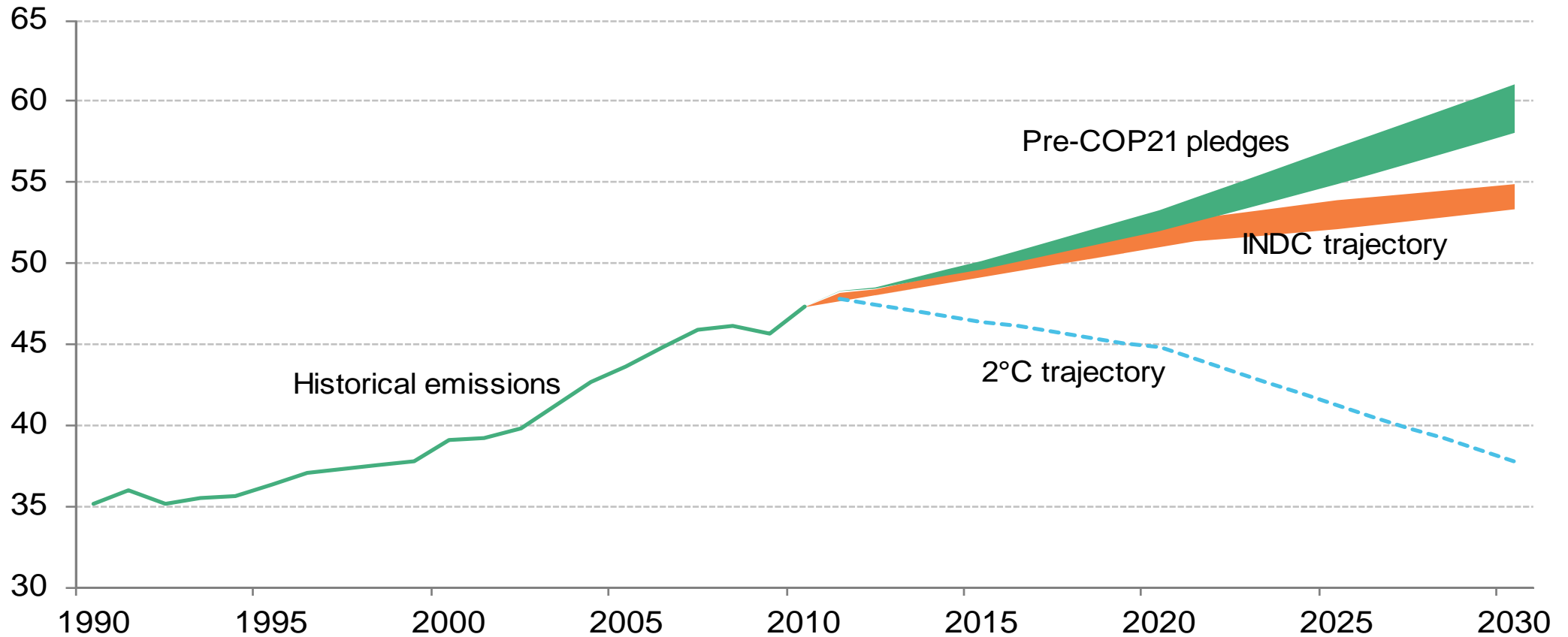
**Bloomberg**  
NEW ENERGY FINANCE

A graphic on the left side of the slide features a large, stylized number '1' with a gradient from yellow to green. Inside the lower curve of the '1', there is a white silhouette of the Eiffel Tower. To the right of this graphic, the text 'PARIS 2015' is written in a large, bold, sans-serif font, with 'PARIS' in dark blue and '2015' in green. Below this, the text 'UN CLIMATE CHANGE CONFERENCE' is written in a smaller, dark blue, sans-serif font. At the bottom, 'COP21·CMP11' is written in a large, dark blue, sans-serif font.

**PARIS 2015**  
UN CLIMATE CHANGE CONFERENCE  
**COP21·CMP11**

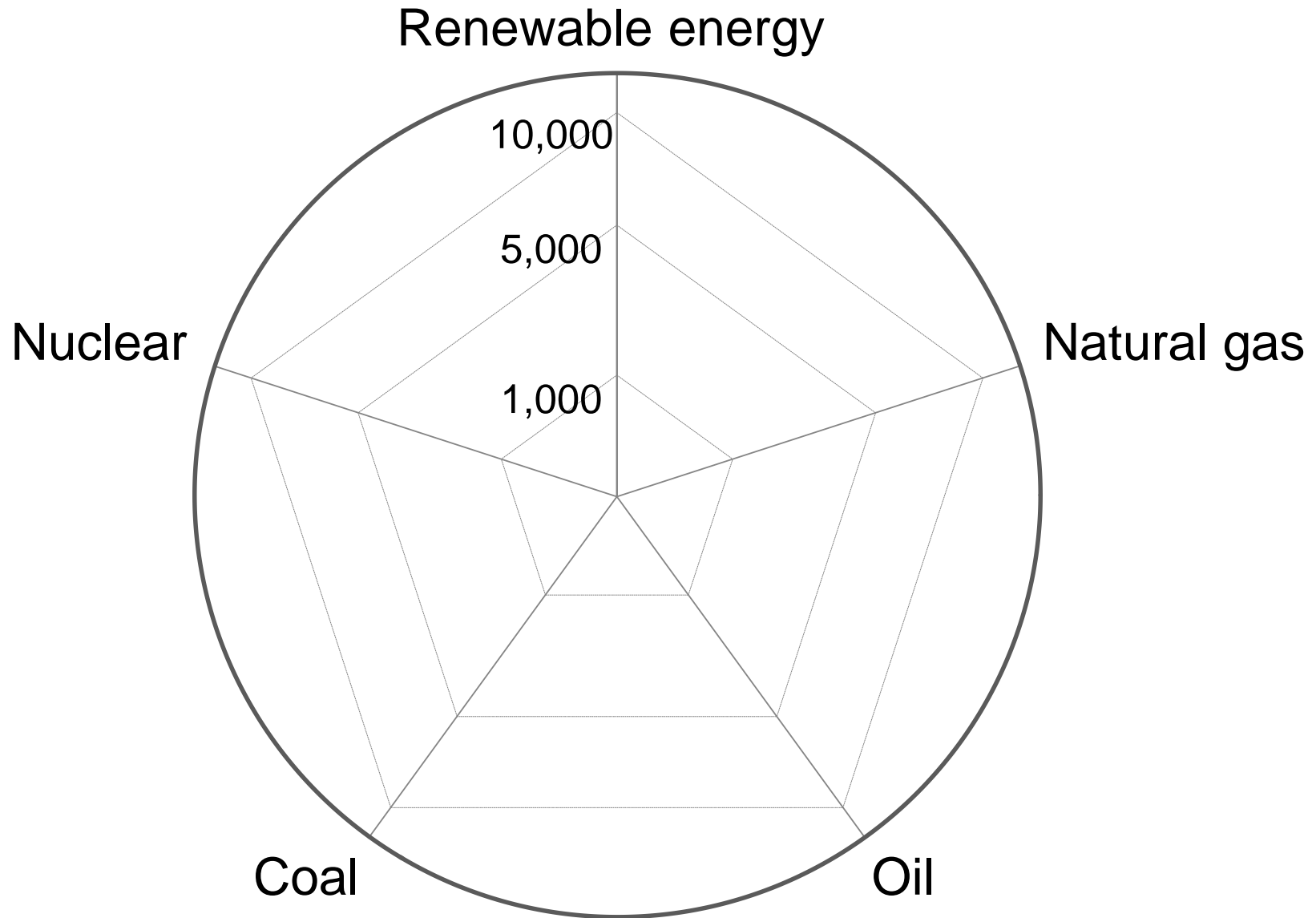
Image: UNFCCC

# GLOBAL GREENHOUSE GAS EMISSIONS (GTCO2)

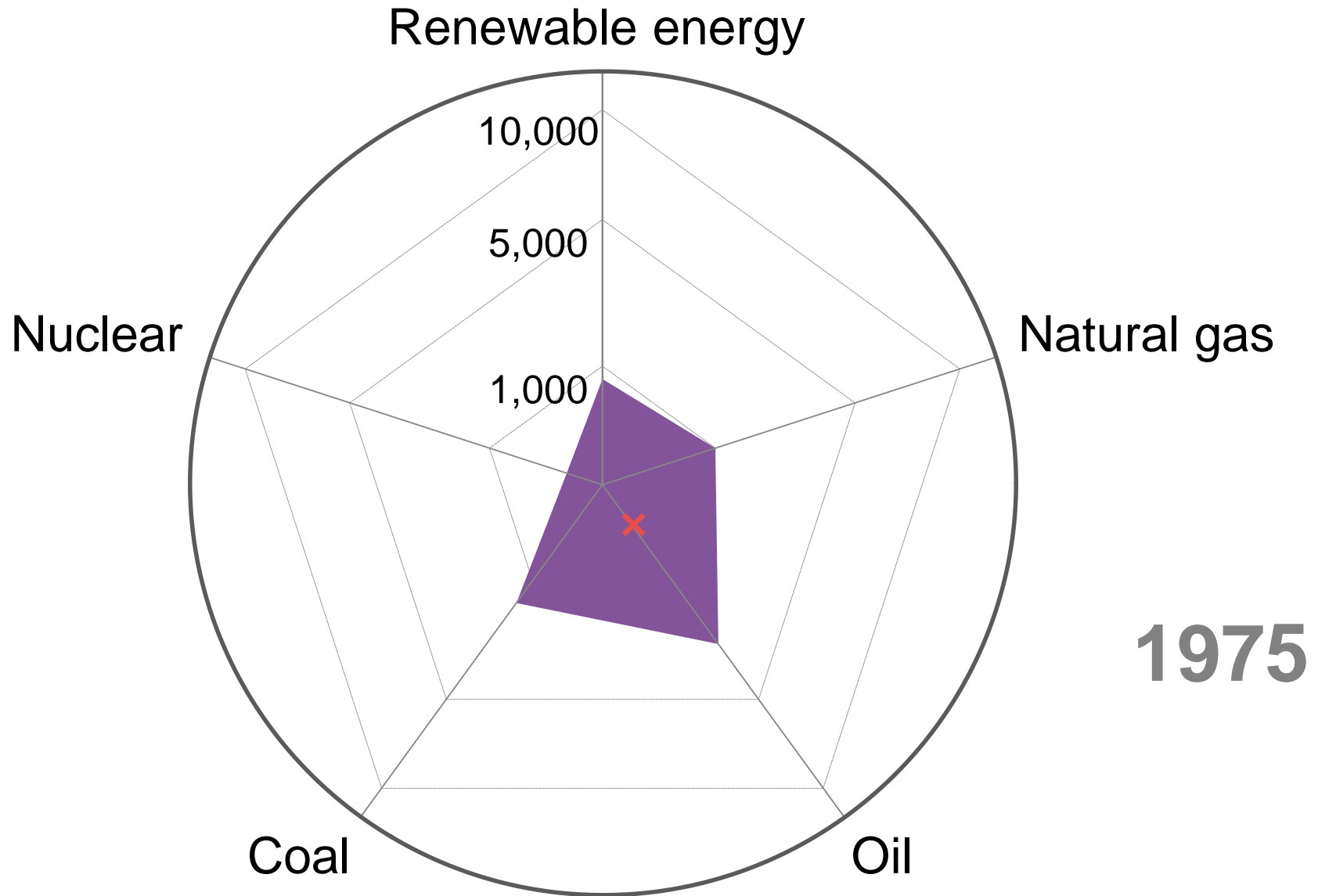


Source: UNFCCC, UNEP, Climate Action Tracker  
Bloomberg New Energy Finance

# GLOBAL PRIMARY ENERGY SUPPLY (MTOE)



Source: Bloomberg New Energy Finance

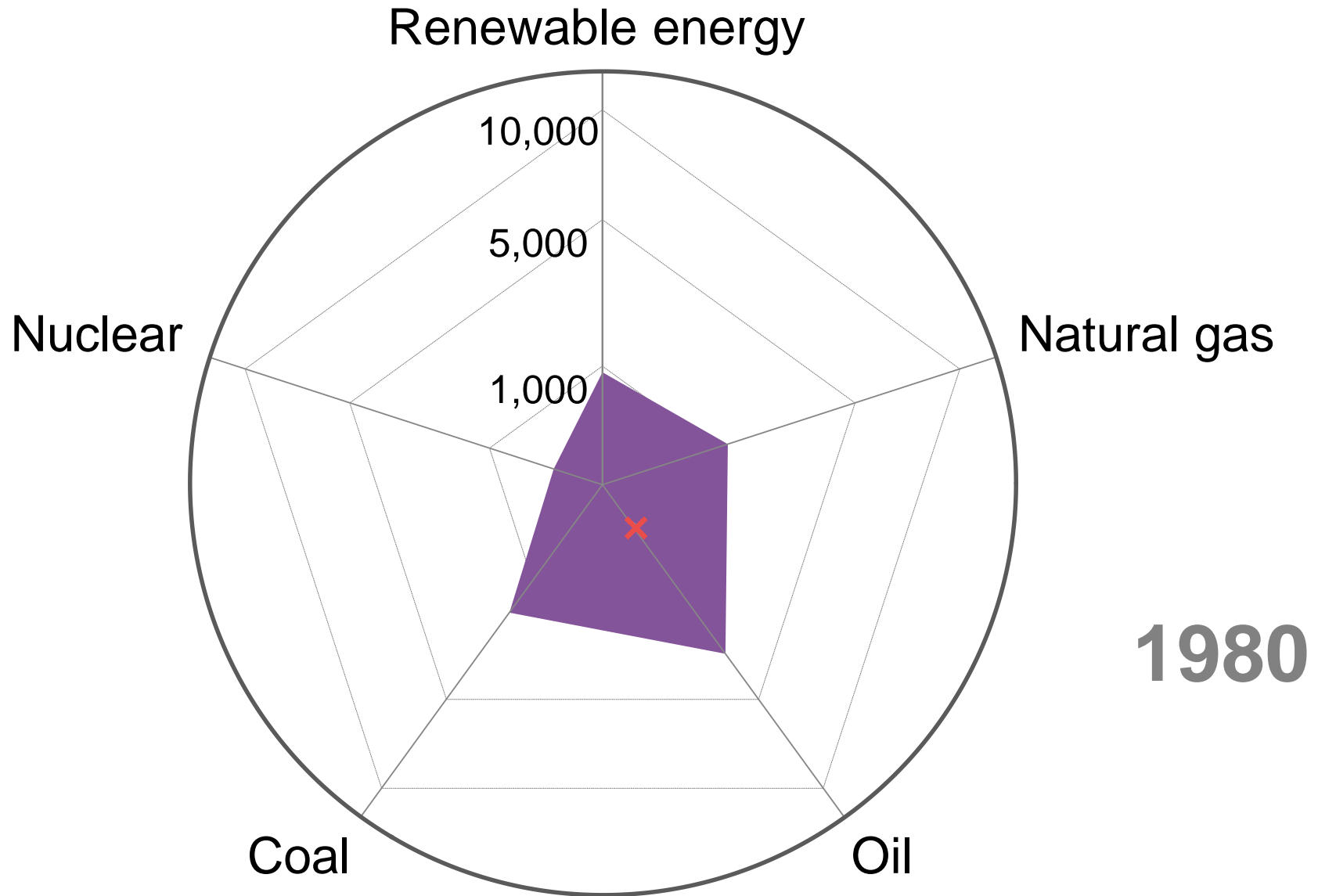


1975

Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

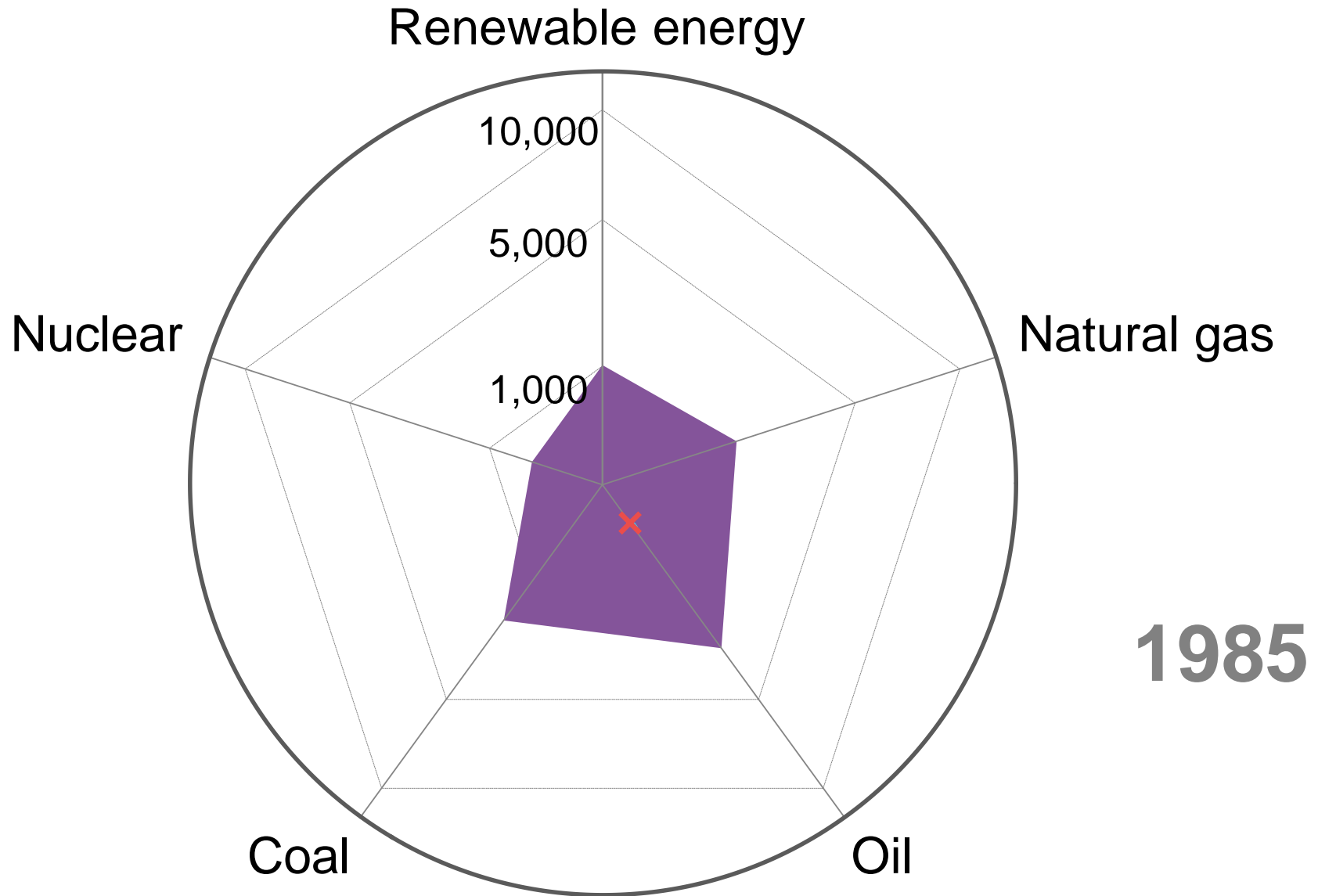
Source: Bloomberg New Energy Finance, IEA

# GLOBAL PRIMARY ENERGY SUPPLY, 1980 (MTOE)



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA

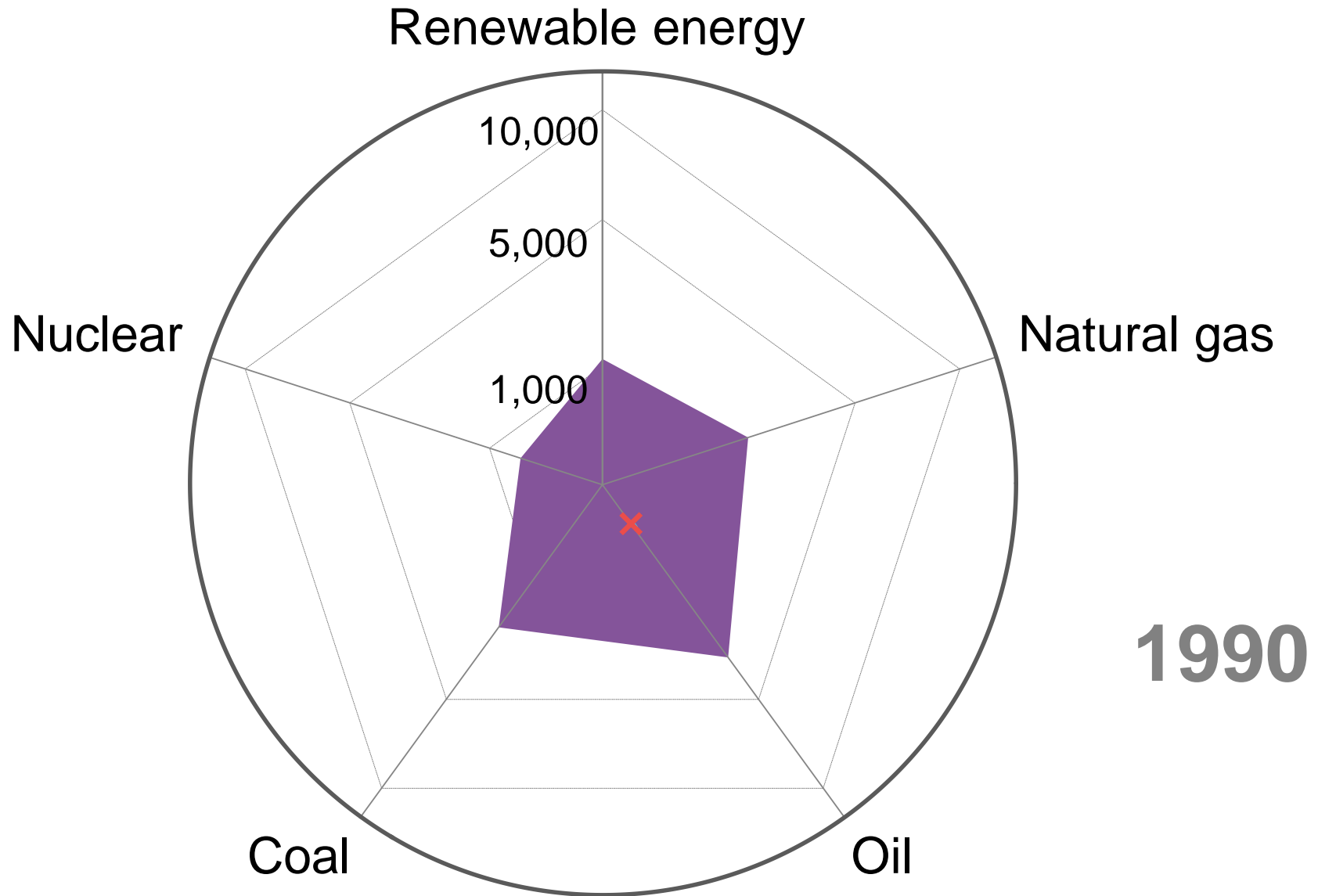


**1985**

Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA

# GLOBAL PRIMARY ENERGY SUPPLY, 1990 (MTOE)



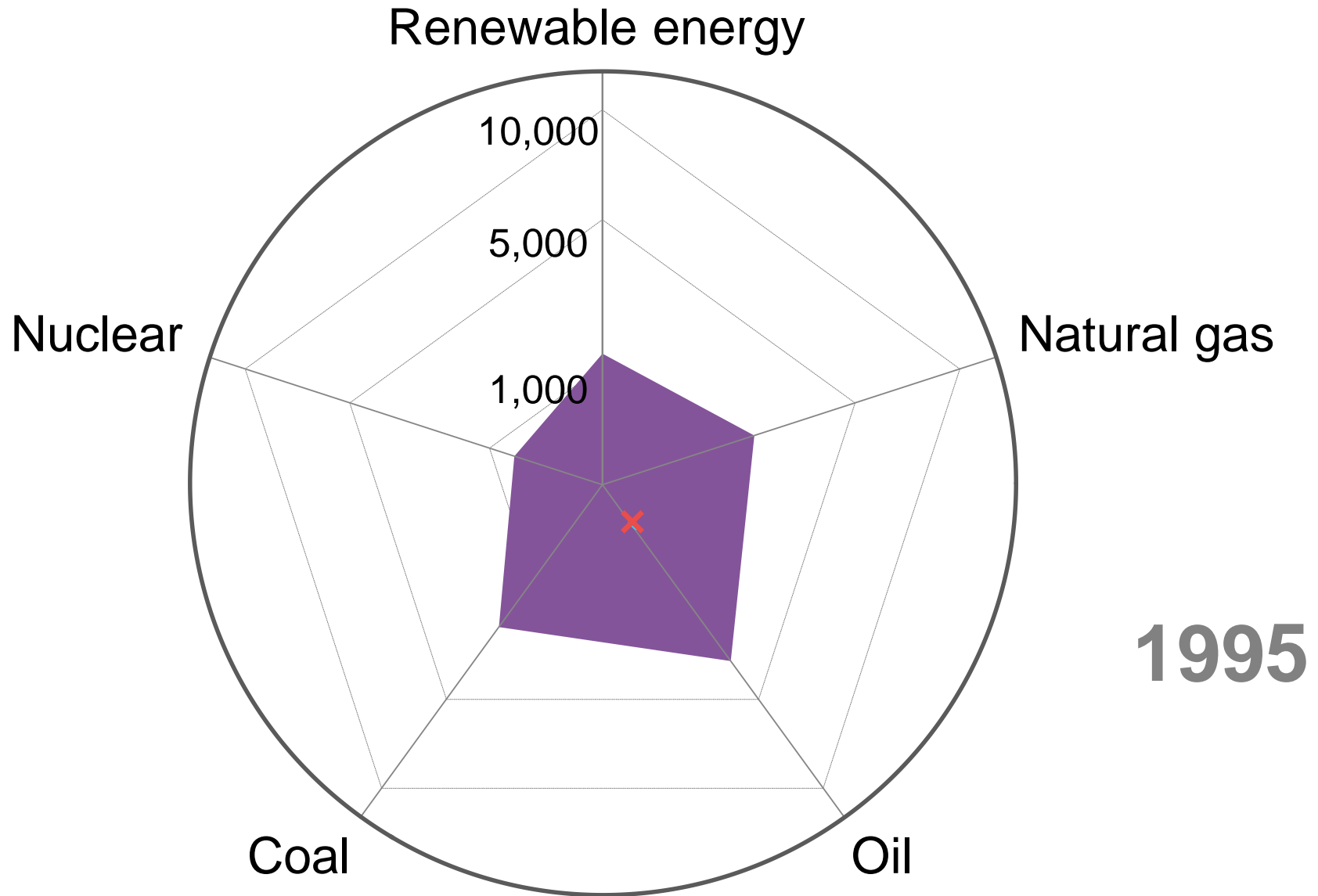
1990

Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA



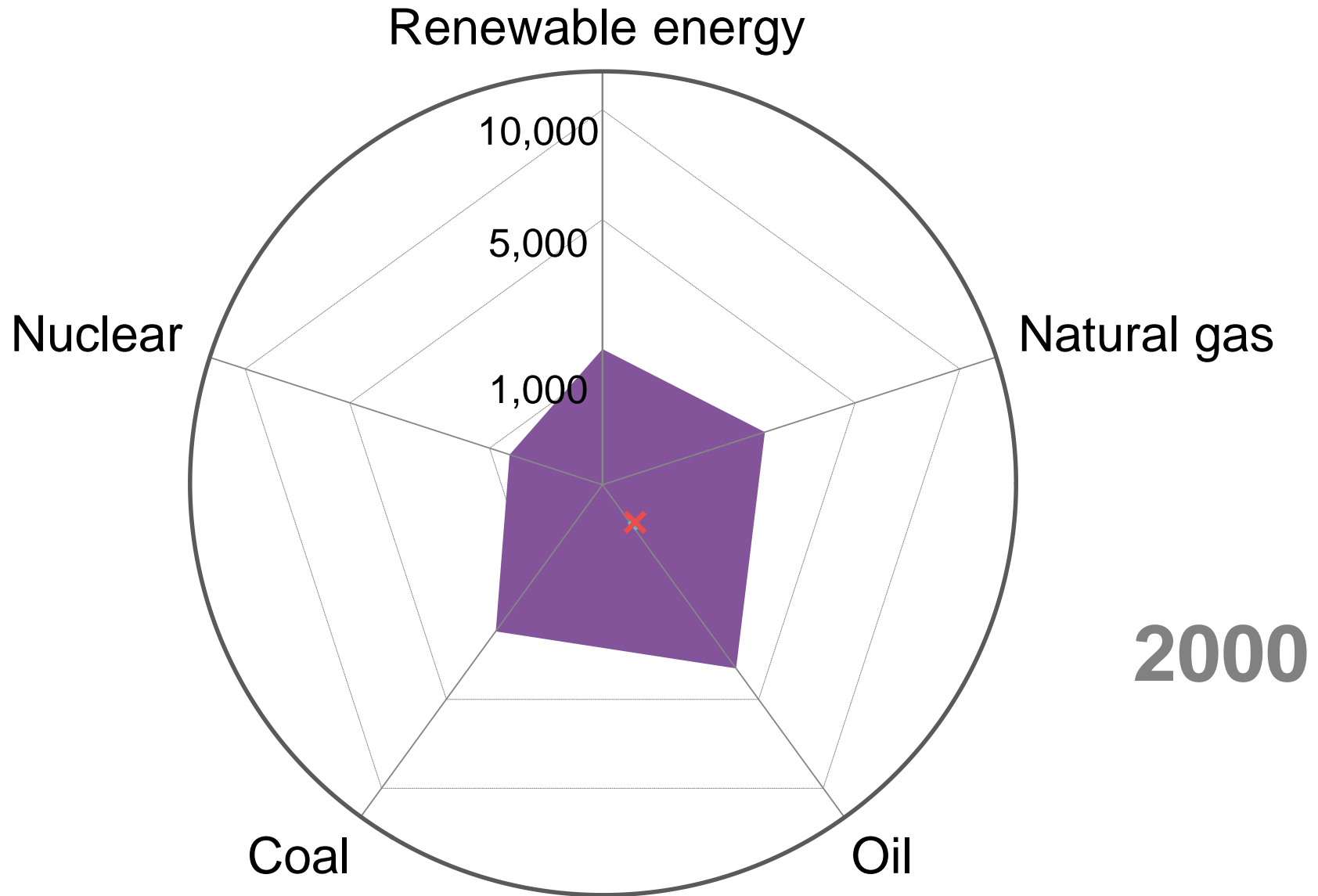
# GLOBAL PRIMARY ENERGY SUPPLY, 1995 (MTOE)



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA

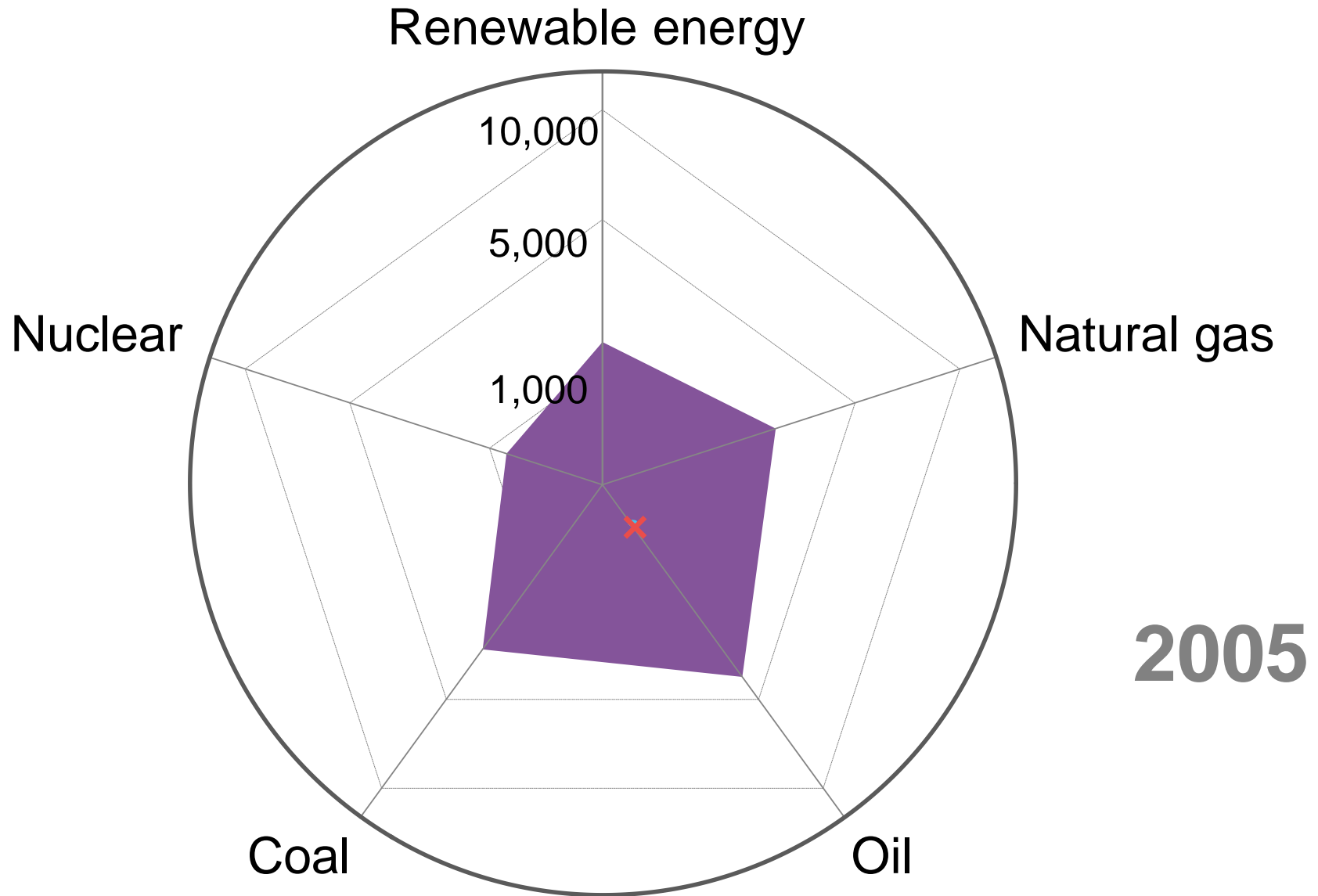
# GLOBAL PRIMARY ENERGY SUPPLY, 2000 (MTOE)



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA

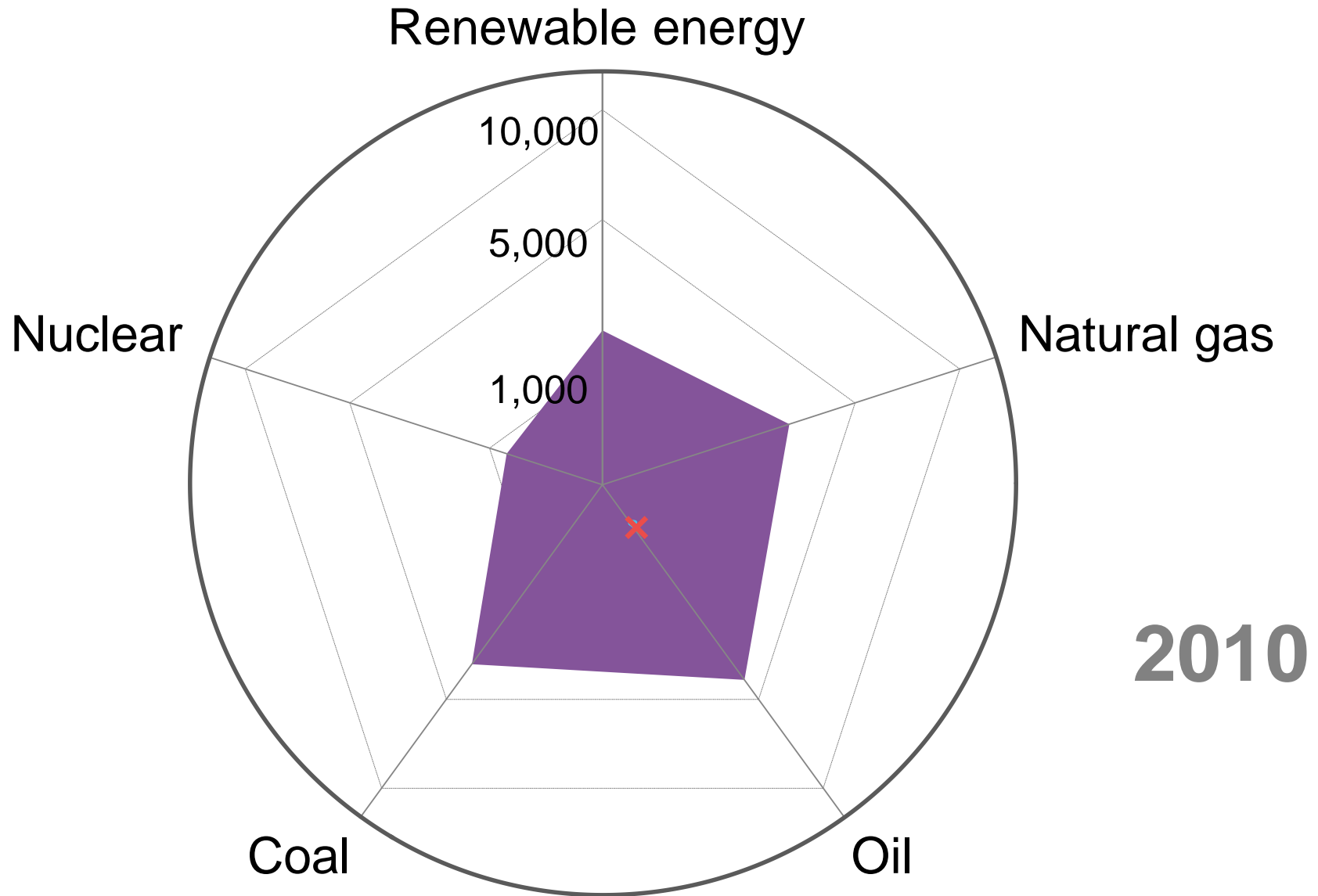
# GLOBAL PRIMARY ENERGY SUPPLY, 2005 (MTOE)



2005

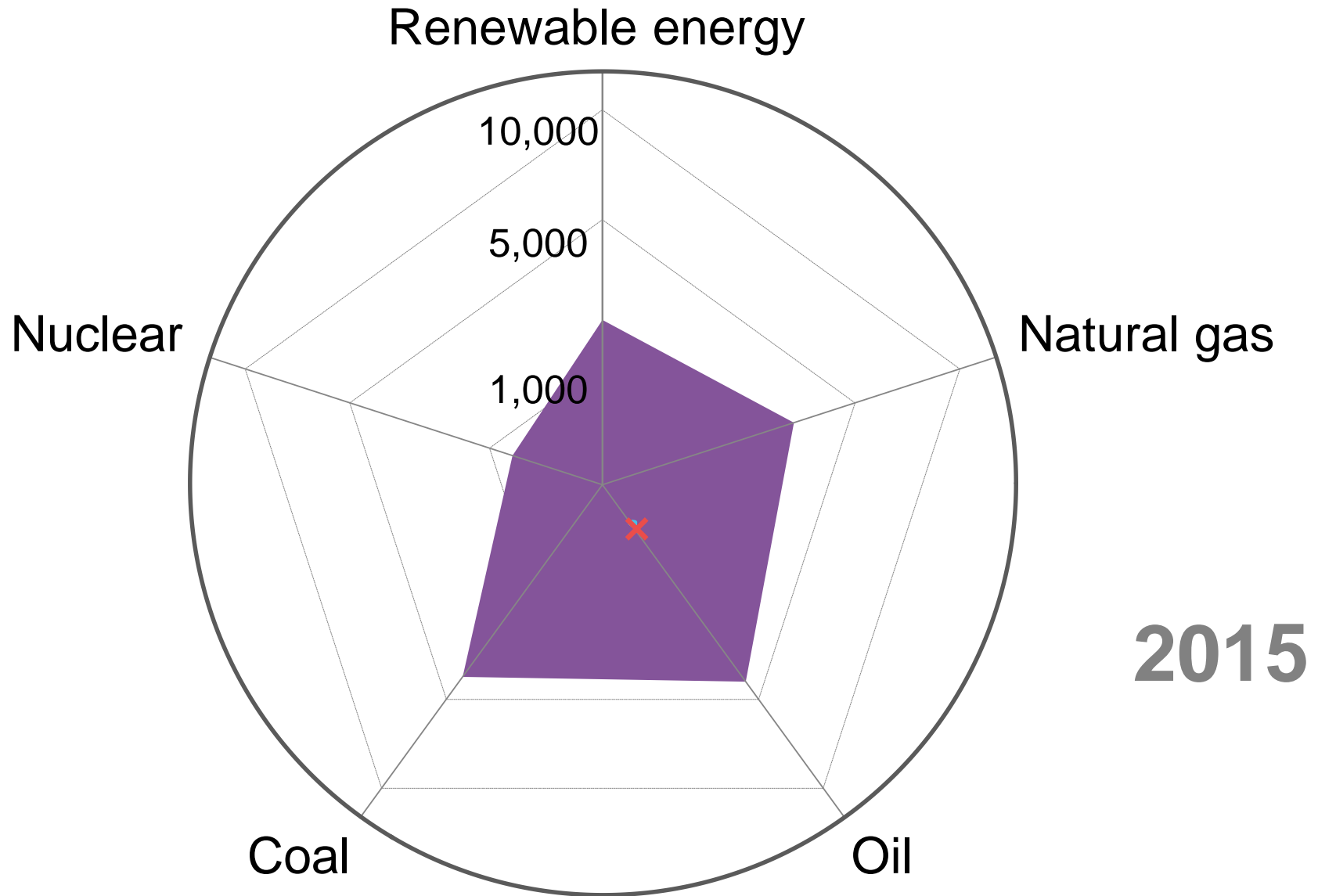
Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA



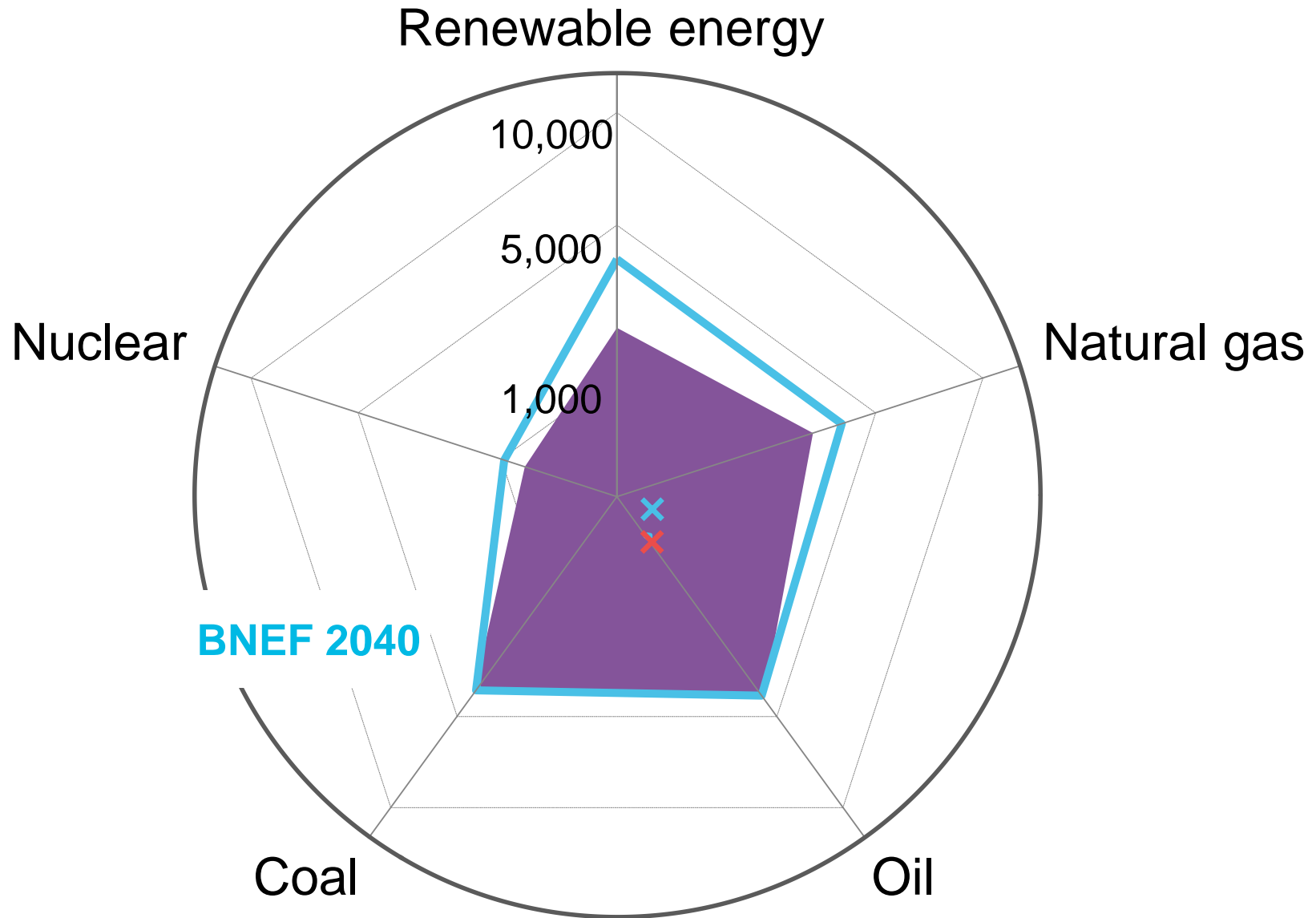
Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA



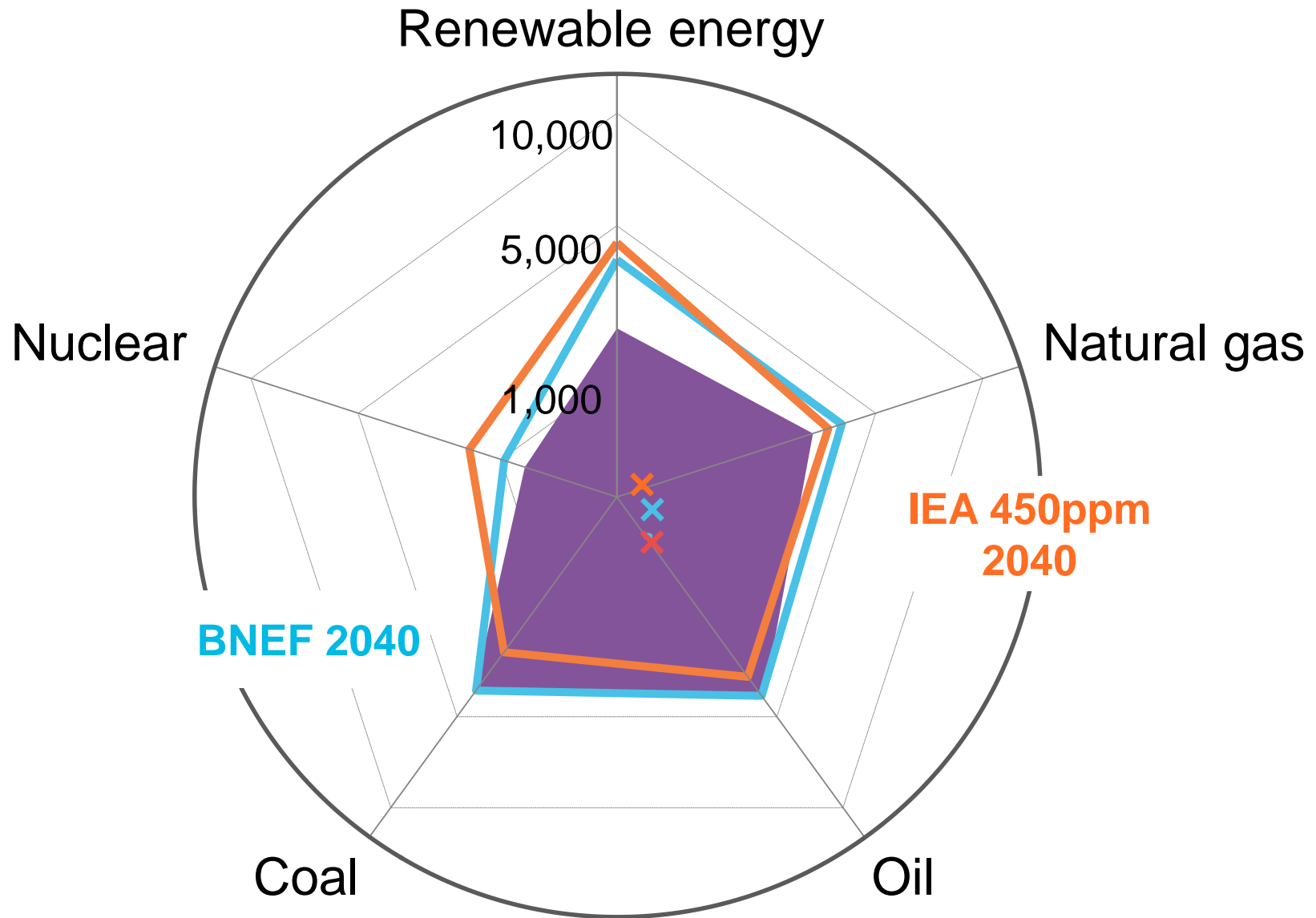
Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA



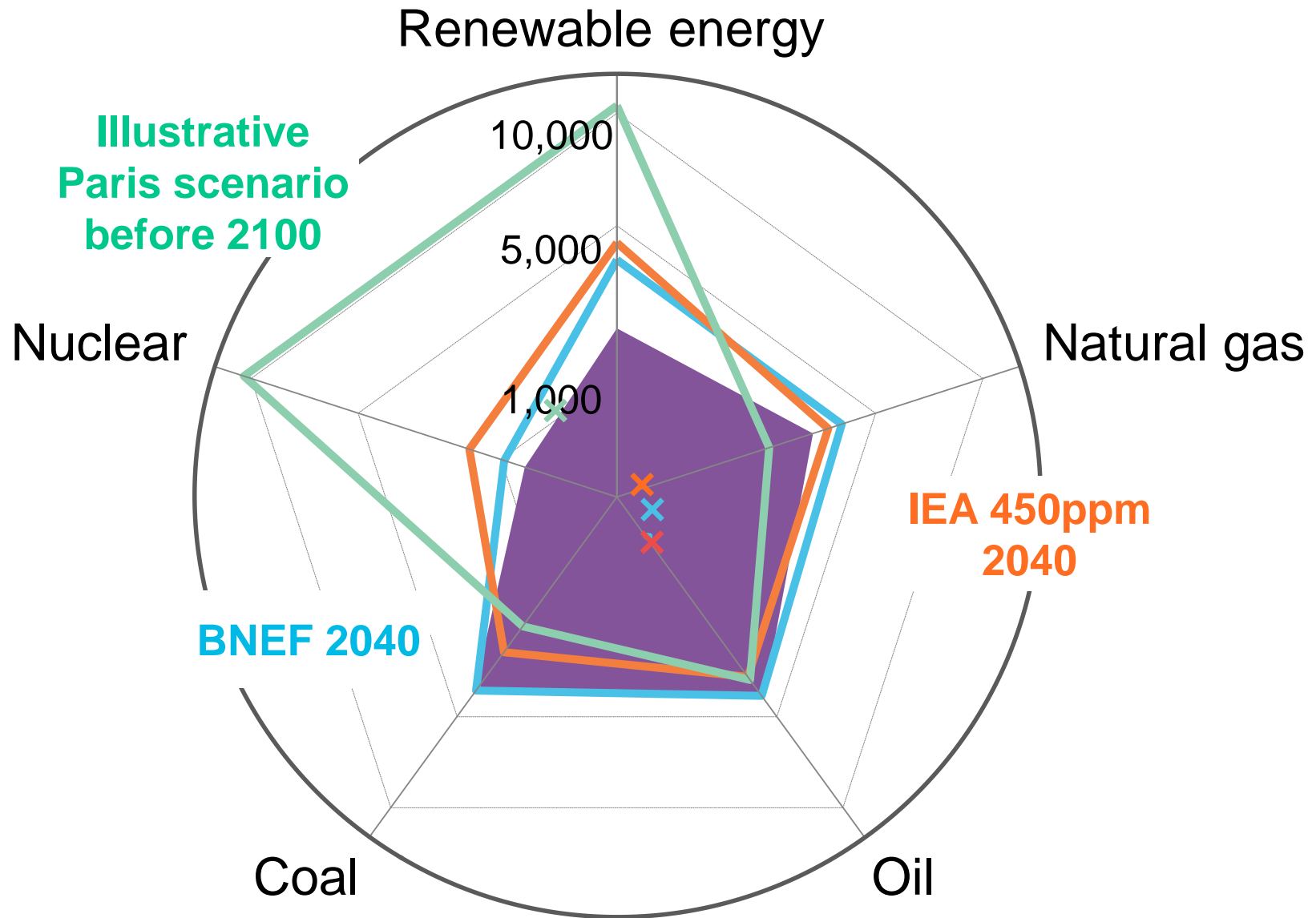
Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro.

Source: Bloomberg New Energy Finance, IEA



Note: BNEF adjusted IEA NPS forecast using its own electricity generation and EV demand forecast. Renewables total includes bioenergy and hydro. Paris illustrative scenario assumes some carbon capture.

Source: Bloomberg New Energy Finance, IEA



“

We need an  
energy miracle

”

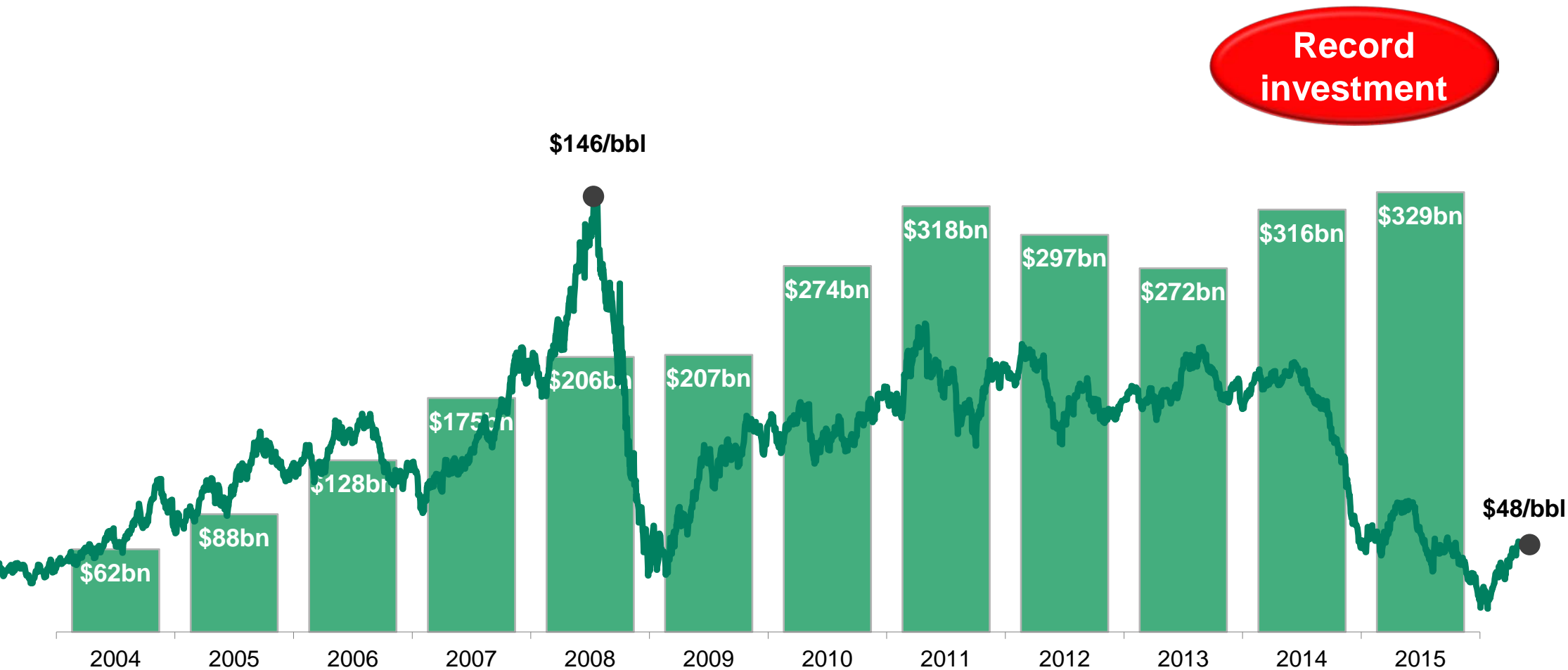
*Bill Gates*  
*February 2016*



Picture: Bloomberg

# CLEAN ENERGY INVESTMENT ROSE WHILE OIL PLUMMETED

GLOBAL CLEAN ENERGY INVESTMENT VS WTI CRUDE SPOT 2004-15

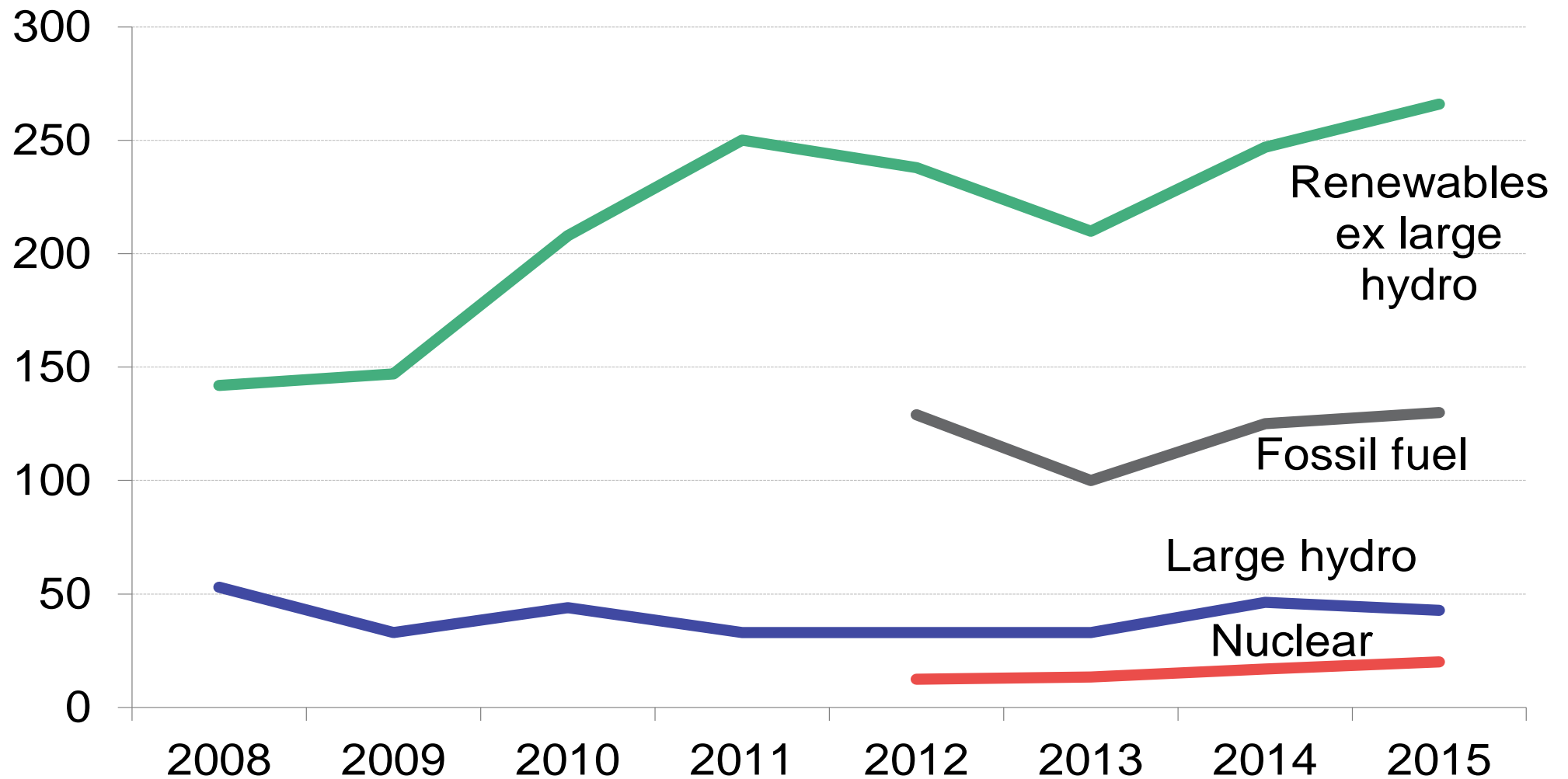


Note: Total values include estimates for undisclosed deals. Includes corporate and government R&D, and spending for digital energy and energy storage projects (not reported in quarterly statistics). Excludes large hydro.

Source: Bloomberg Intelligence, Bloomberg New Energy Finance

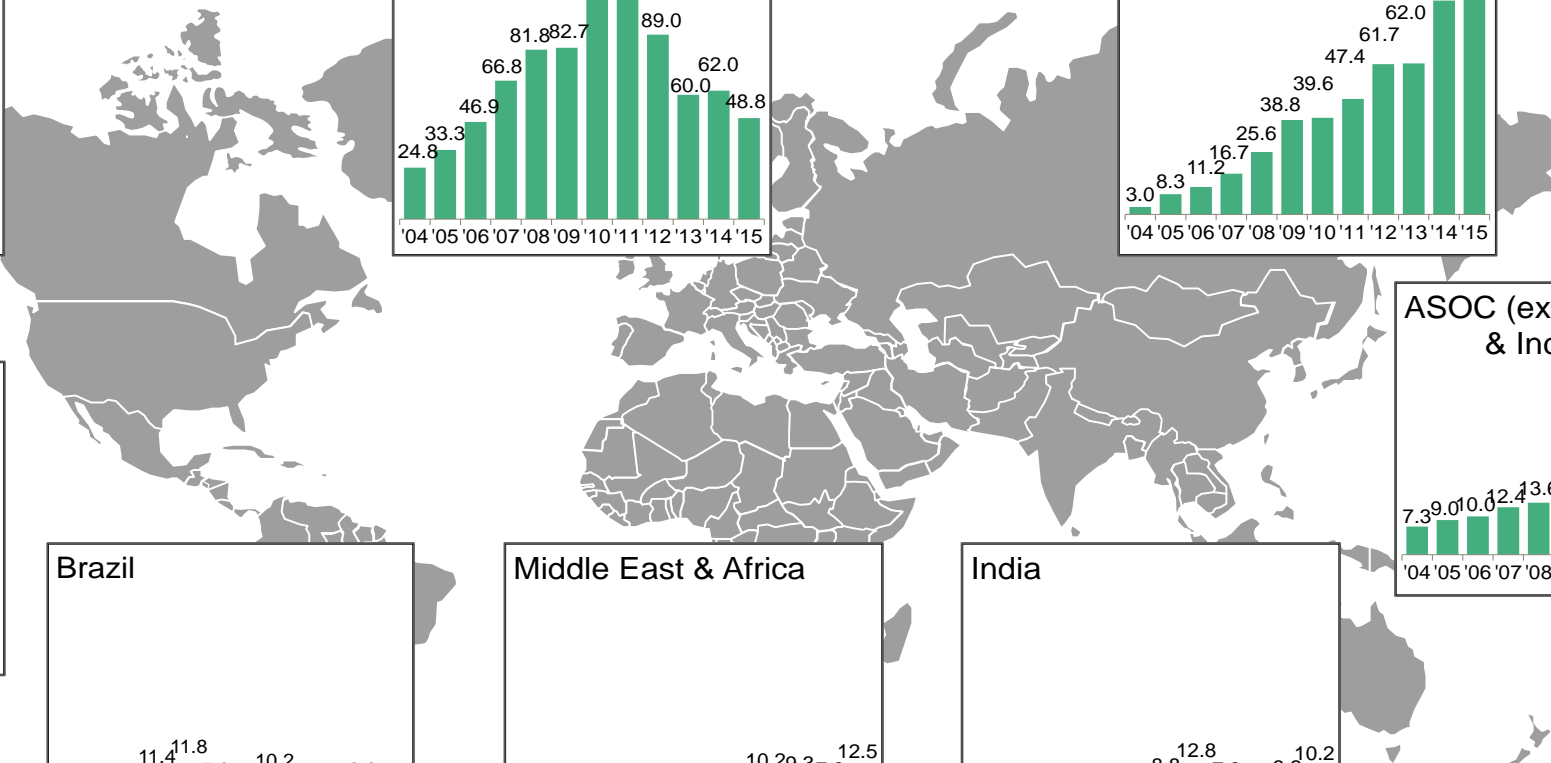
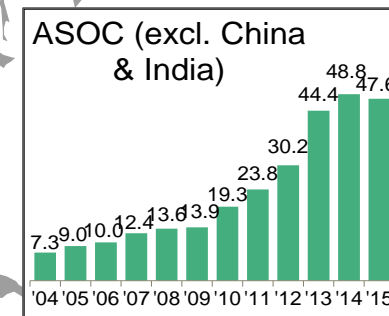
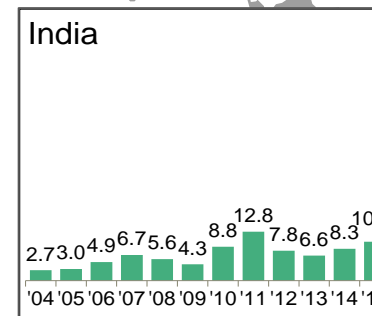
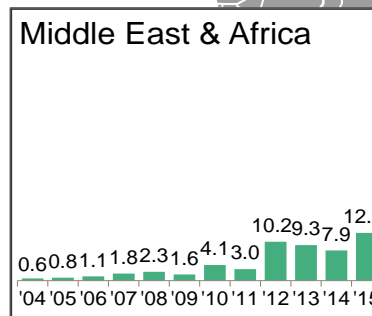
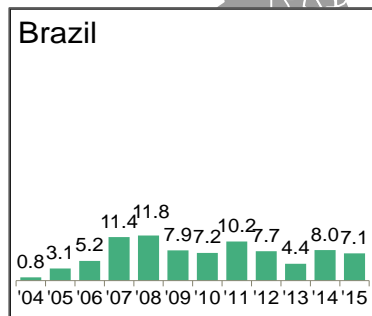
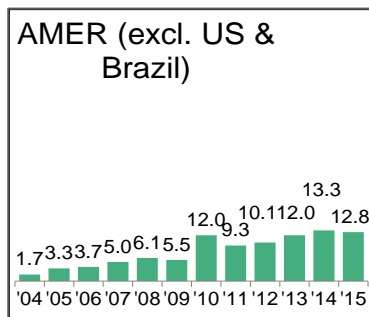
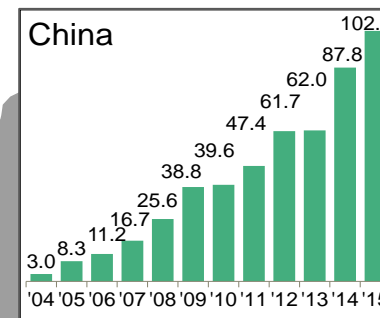
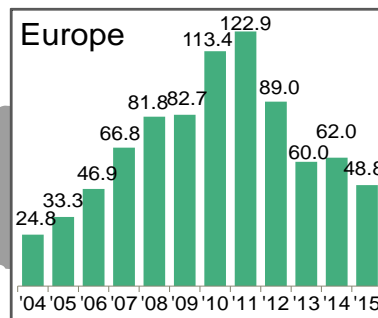
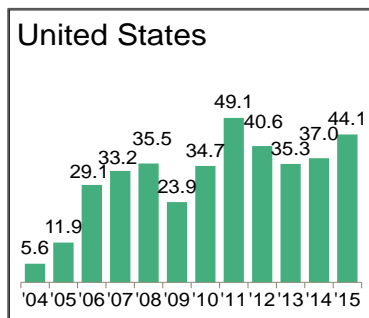
# INVESTMENT IN POWER CAPACITY, 2008–15

(\$BN)



Source: UNEP, Bloomberg New Energy Finance

# RENEWABLE ENERGY INVESTMENT, 2004–15 BY REGION (\$BN NOMINAL)



Note: New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals. Source: Bloomberg New Energy Finance

# 2011 UNSUBSIDISED CLEAN ENERGY WORLD RECORDS

## ONSHORE WIND



**US\$ 6.2 cents/kWh**

## SOLAR PV



**US\$ 17 cents/kWh**

Source: Bloomberg New Energy Finance; ImagesSiemens; Wikimedia Commons

## ONSHORE WIND



Location: Morocco  
Bidder: Enel Green Power  
Signed: January 2016  
Construction: 2018  
**Price: US\$ 3.0 c/kWh**

## SOLAR PV



Location: Peru  
Bidder: Enel Green Power  
Signed: February 2016  
Construction: 2017  
**Price: US\$ 4.8 c/kWh**

Source: Bloomberg New Energy Finance; ImagesSiemens; Wikimedia Commons

## ONSHORE WIND



Location: Morocco  
Bidder: Enel Green Power  
Signed: January 2016  
Construction: 2018  
Price: **US\$ 3.0 c/kWh**

## SOLAR PV



Location: Coahuila, Mexico  
Bidder: Enel Green Power  
Signed: March 2016  
Construction: 2018  
Price: **US\$ 3.6 c/kWh**

Source: Bloomberg New Energy Finance; ImagesSiemens; Wikimedia Commons

## ONSHORE WIND



Location: Morocco  
Bidder: Enel Green Power  
Signed: January 2016  
Construction: 2018  
**Price: US\$ 3.0 c/kWh**

## SOLAR PV



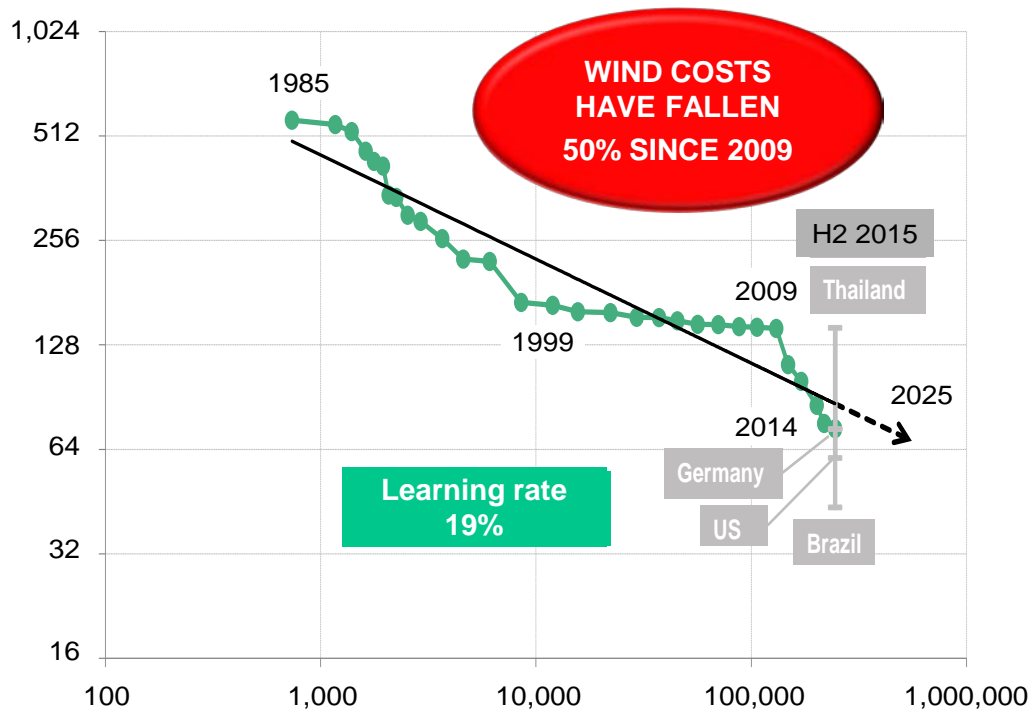
Location: Dubai  
Bidder: Masdar Consortium  
Signed: May 2016  
Construction: 2019  
**Price: US\$ 2.99 c/kWh**

Source: Bloomberg New Energy Finance; ImagesSiemens; Wikimedia Commons



# WIND AND SOLAR EXPERIENCE CURVES

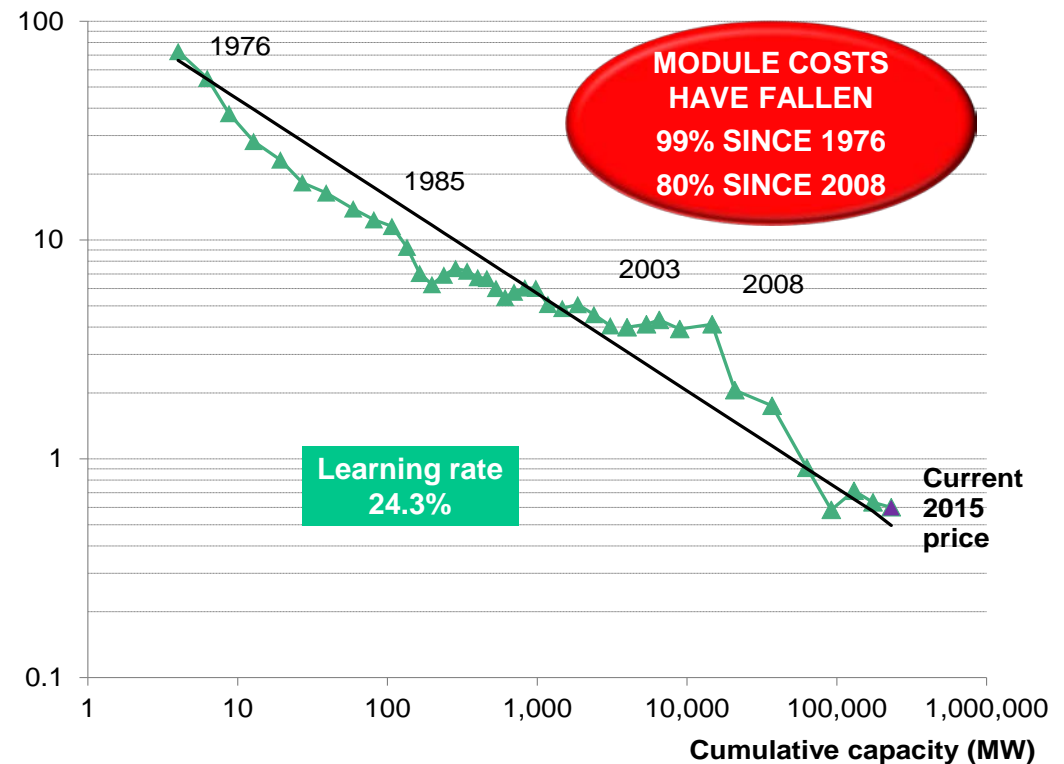
## ONSHORE WIND LEVELISED COST (\$/MWh)



Note: Pricing data has been inflation corrected to 2014. We assume the debt ratio of 70%, cost of debt (bps to LIBOR) of 175, cost of equity of 8%

Source: Bloomberg New Energy Finance

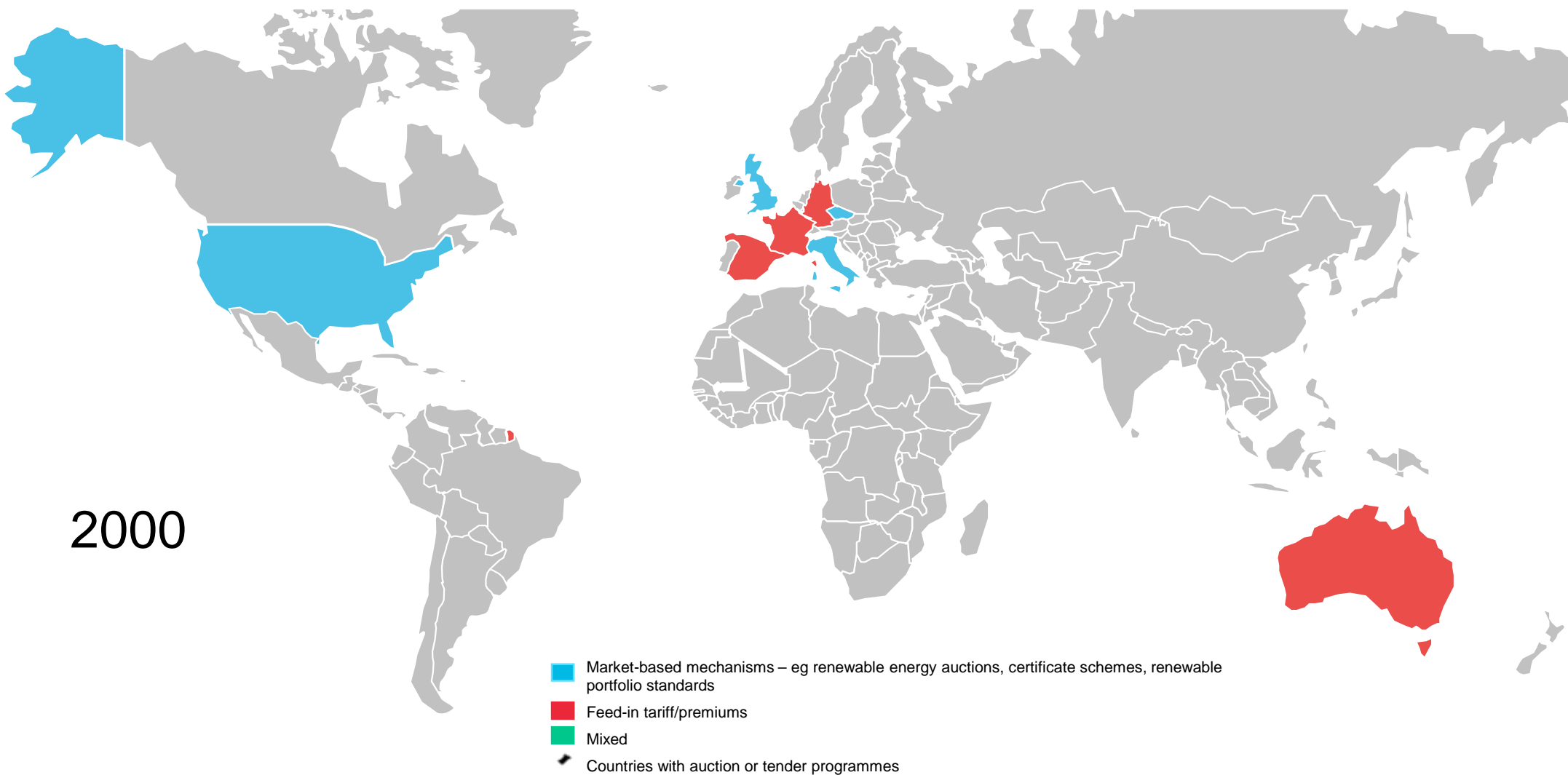
## SOLAR PV MODULE COST (\$/W)



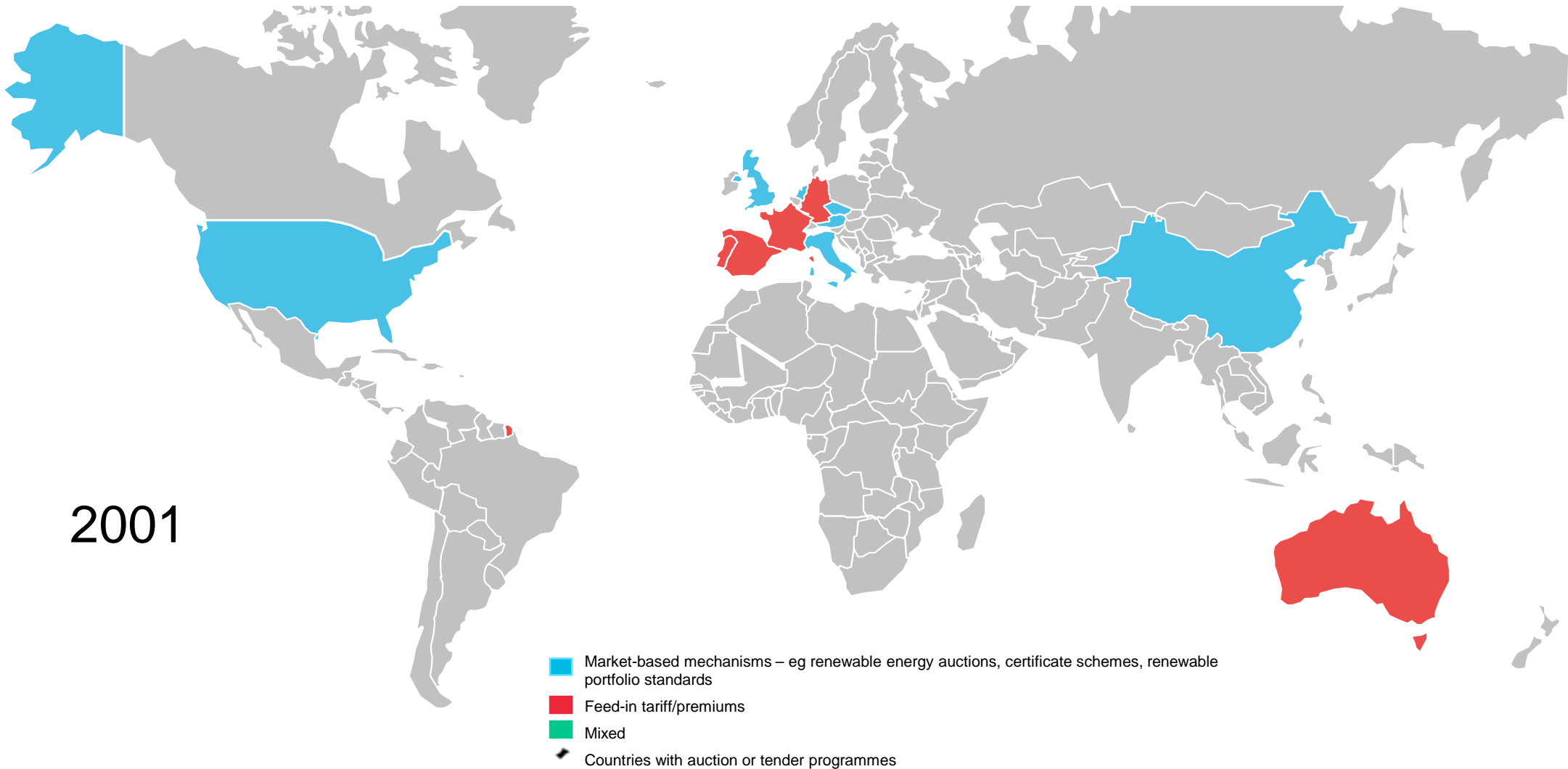
Note: Prices are in real (2015) USD. 'Current price' is \$0.61/W

Source: Bloomberg New Energy Finance, Maycock

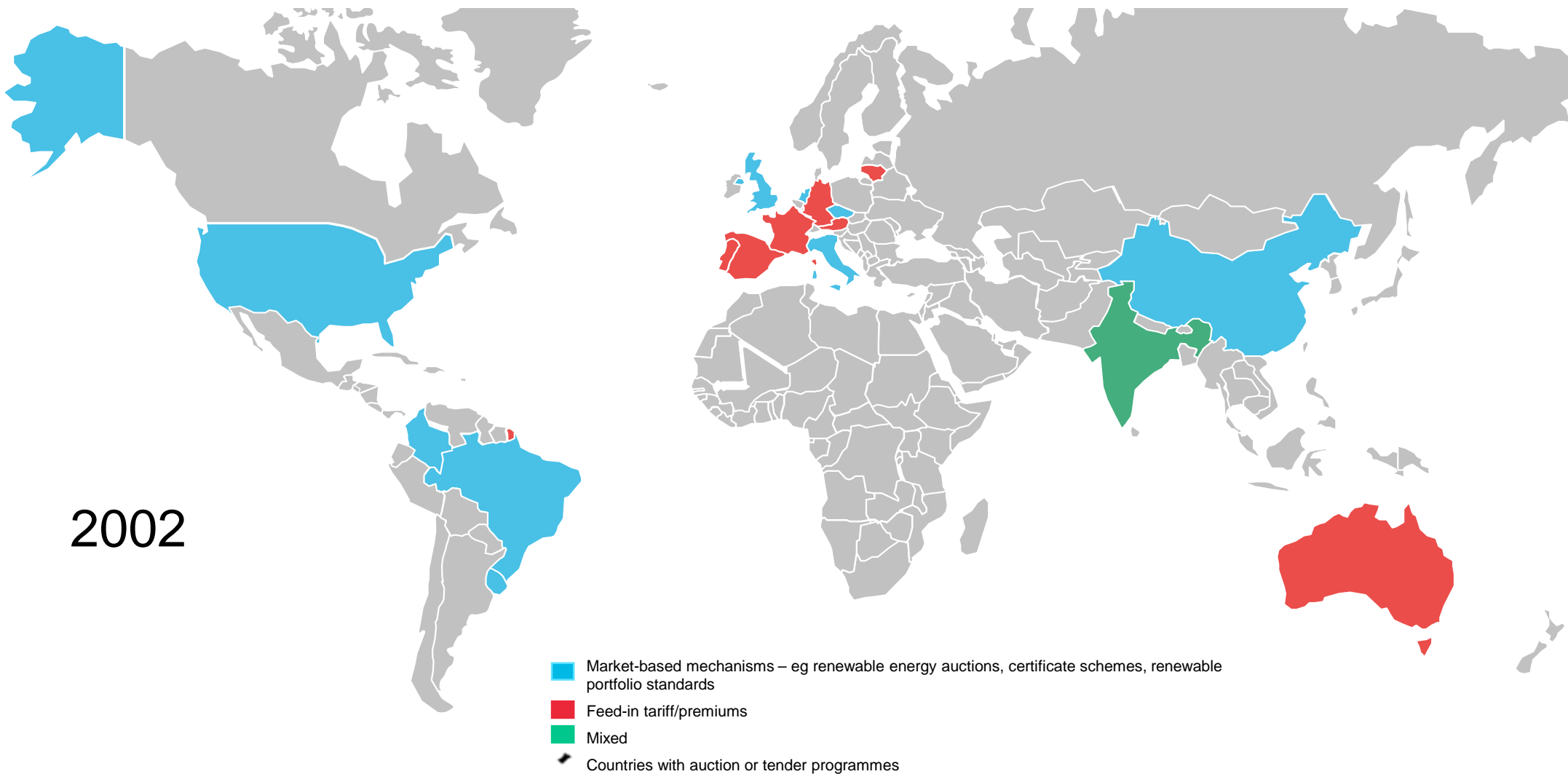
# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL



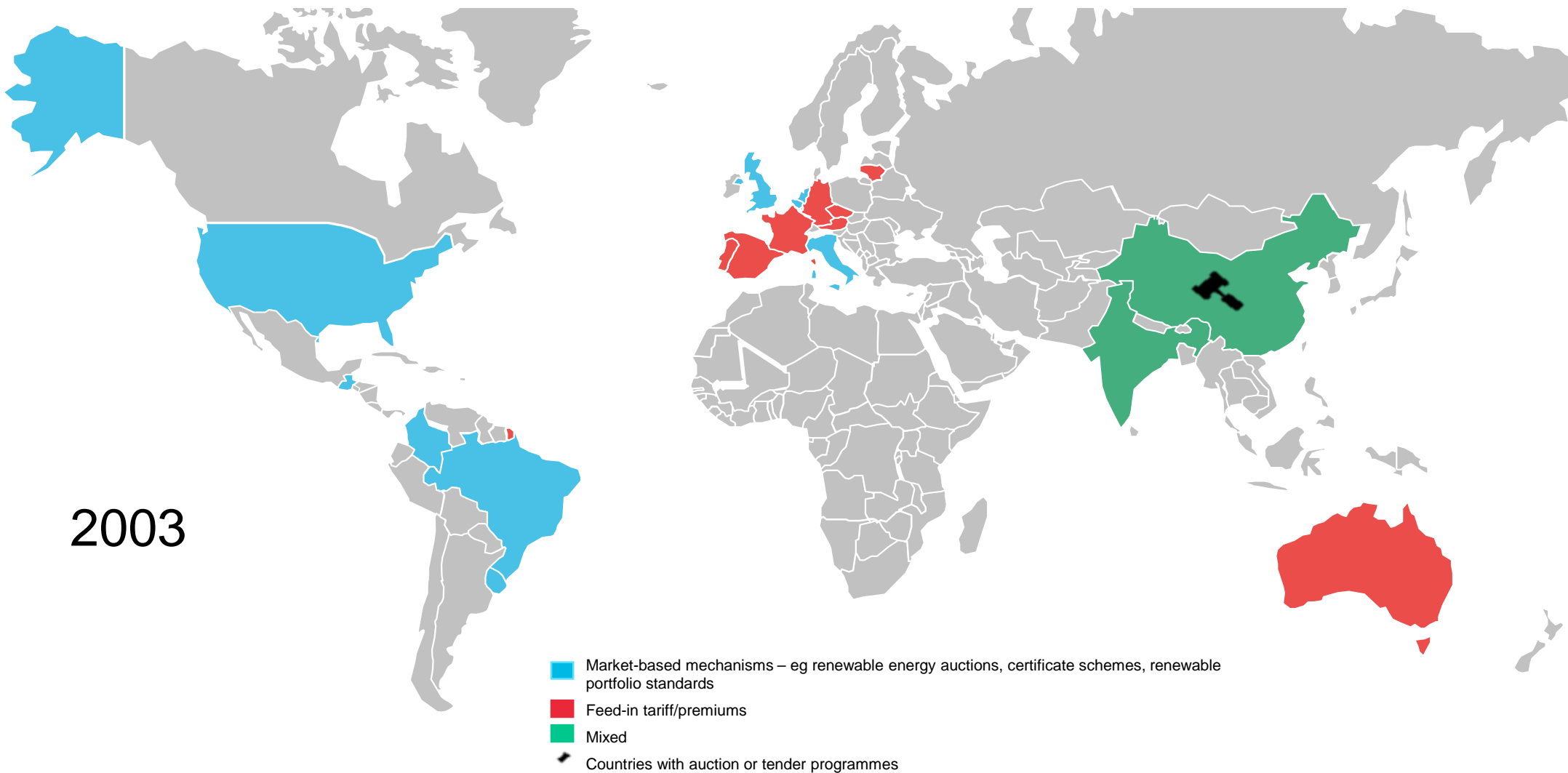
# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL



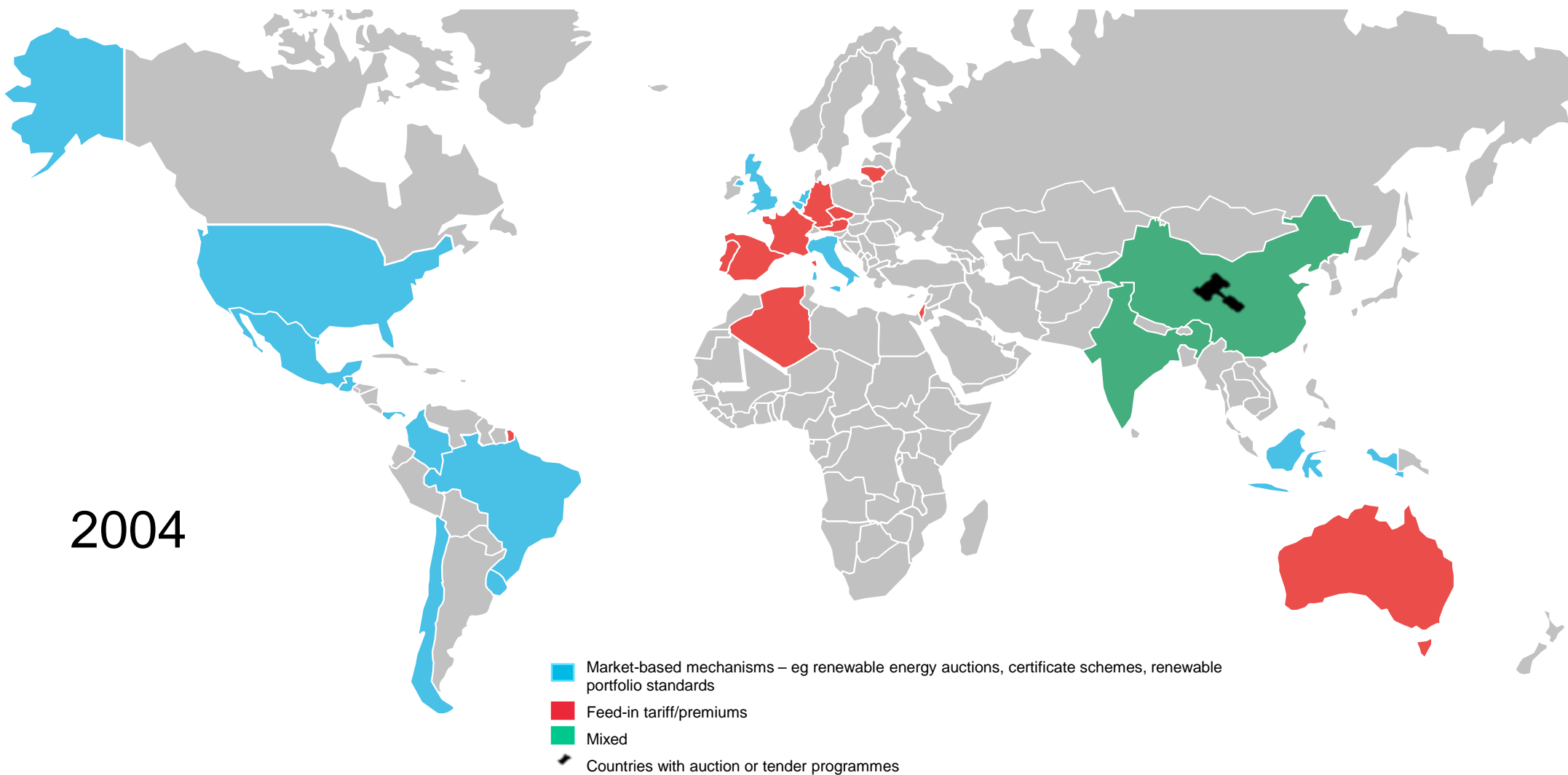
# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL



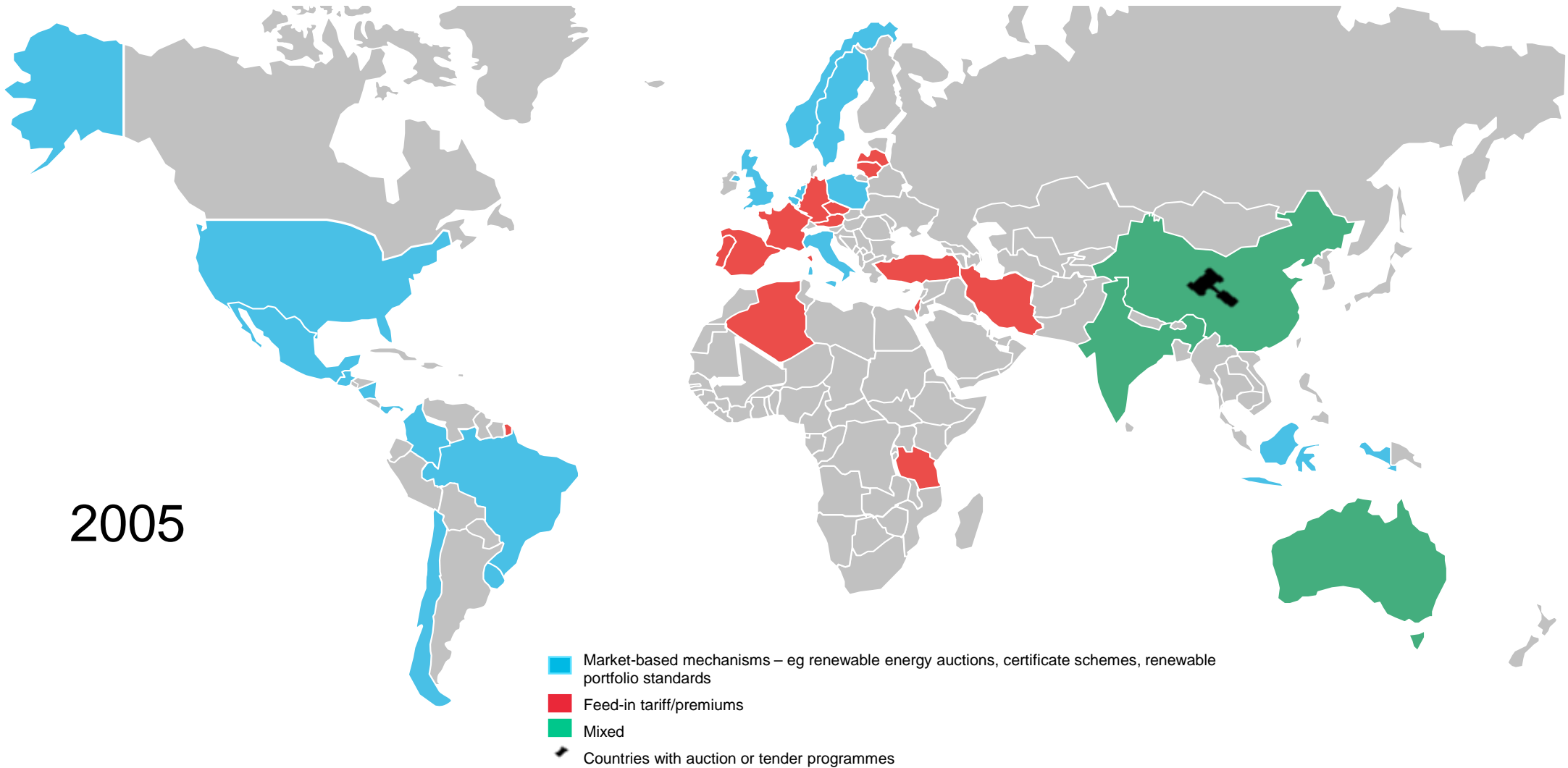
# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL



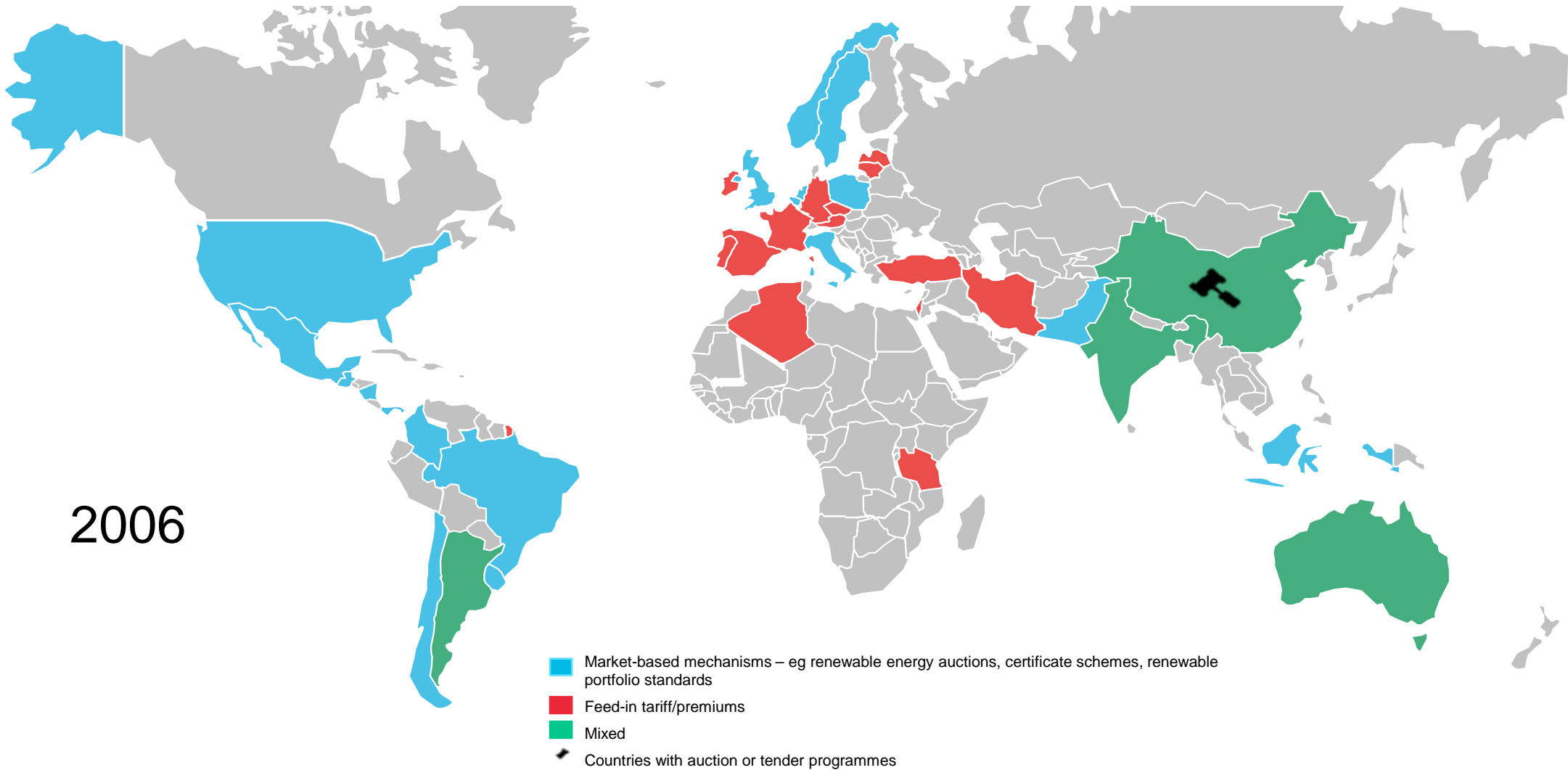
# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL



# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL

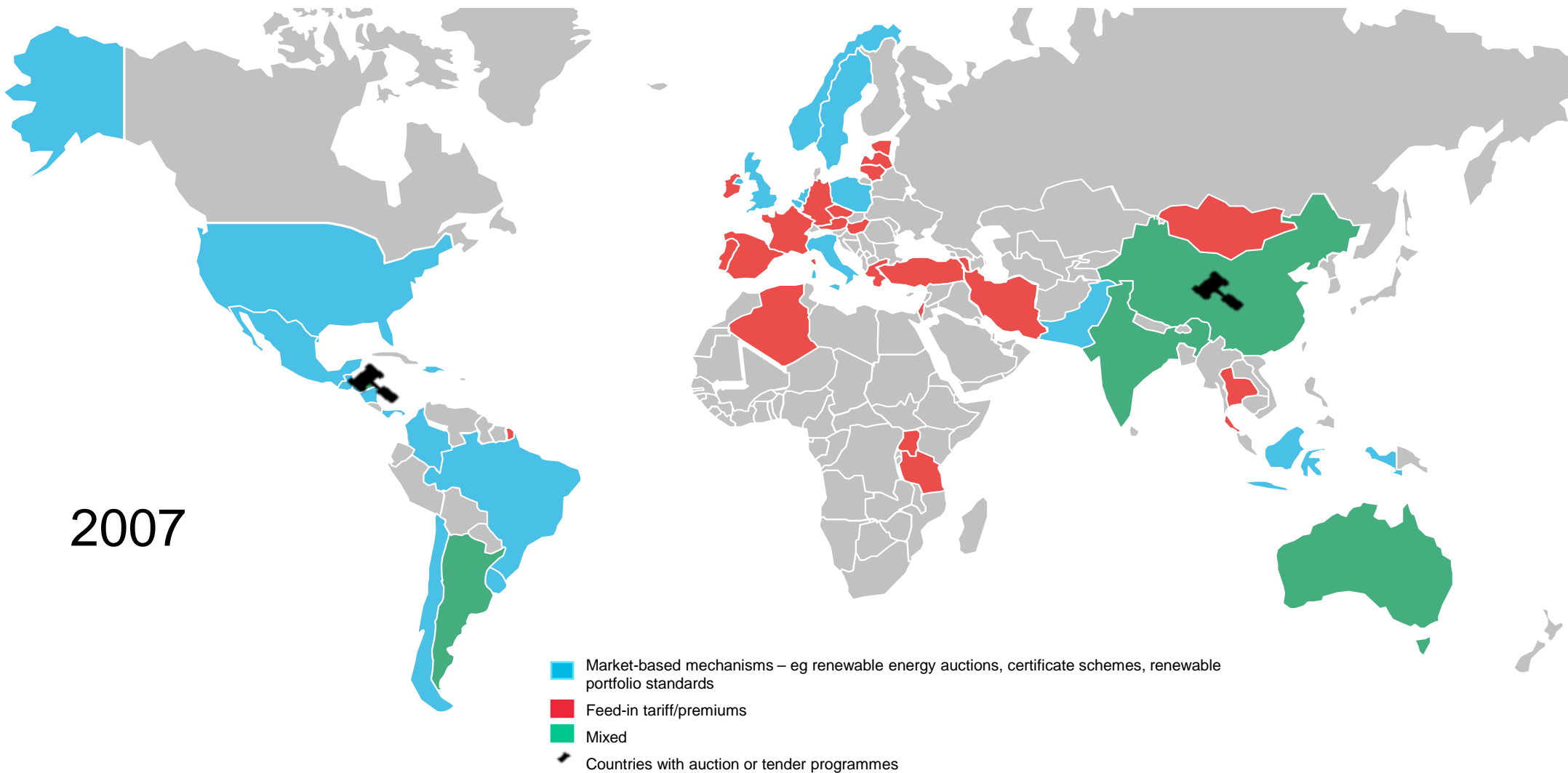


# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL

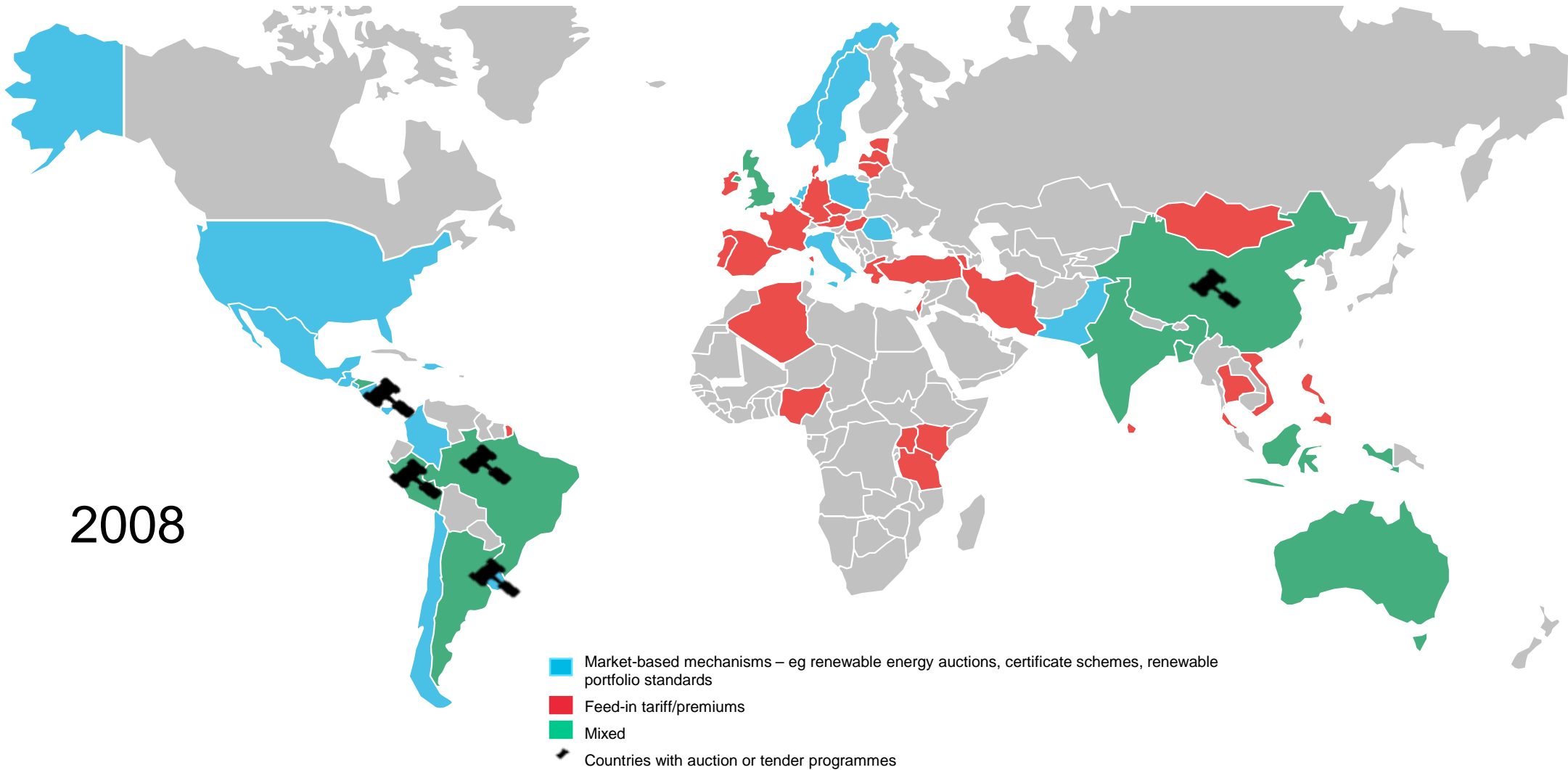




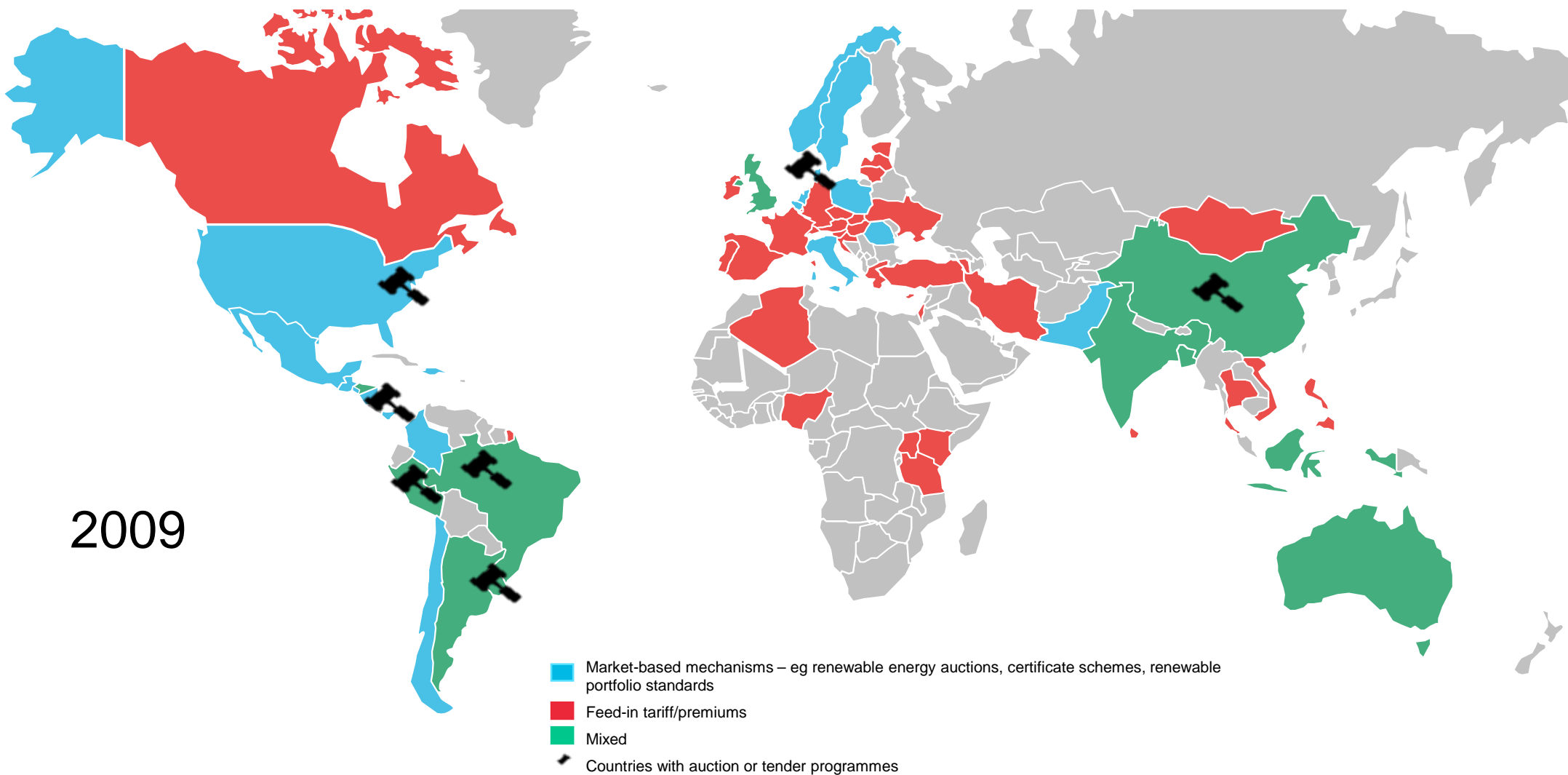
# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL



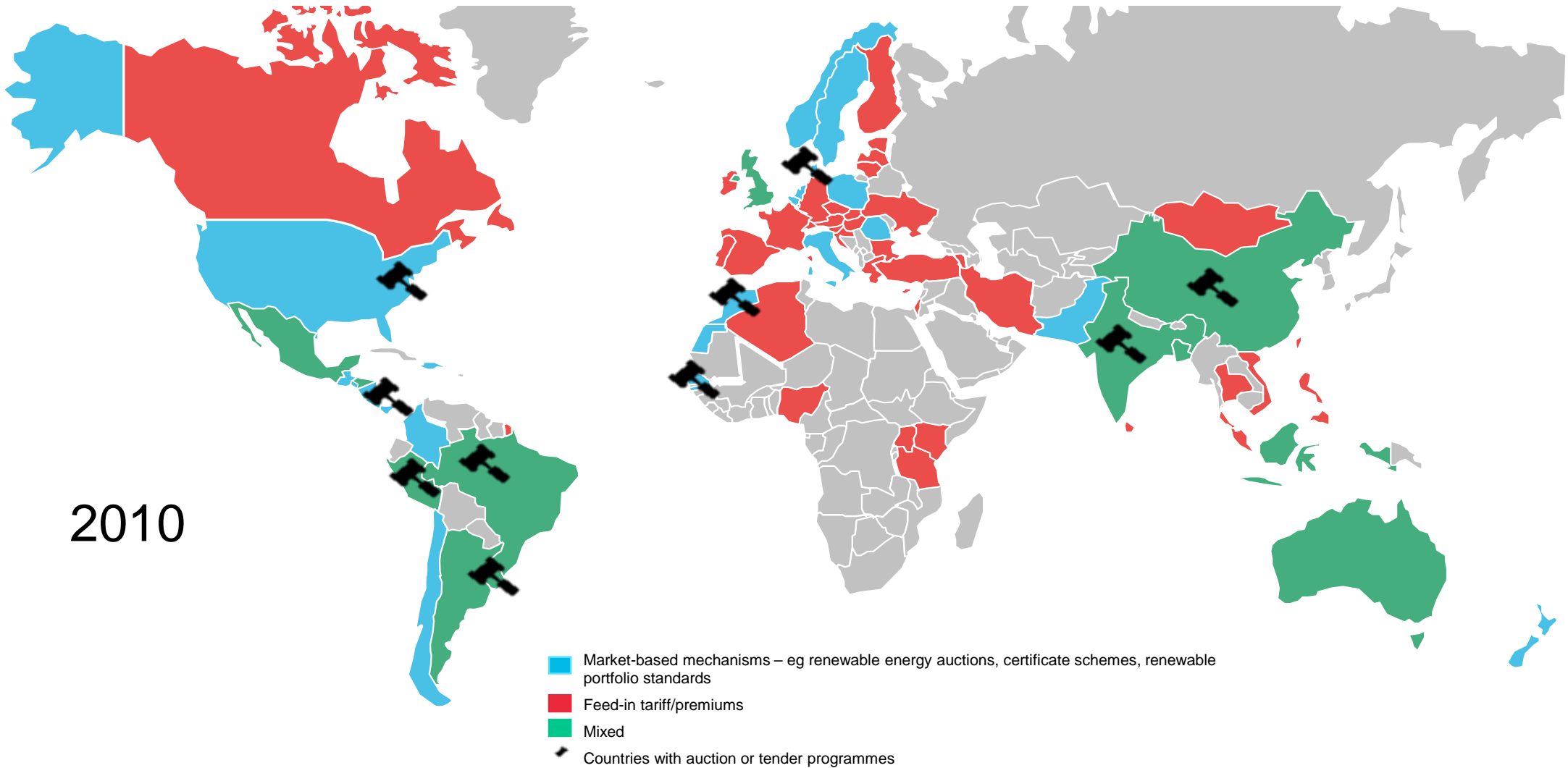
# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL



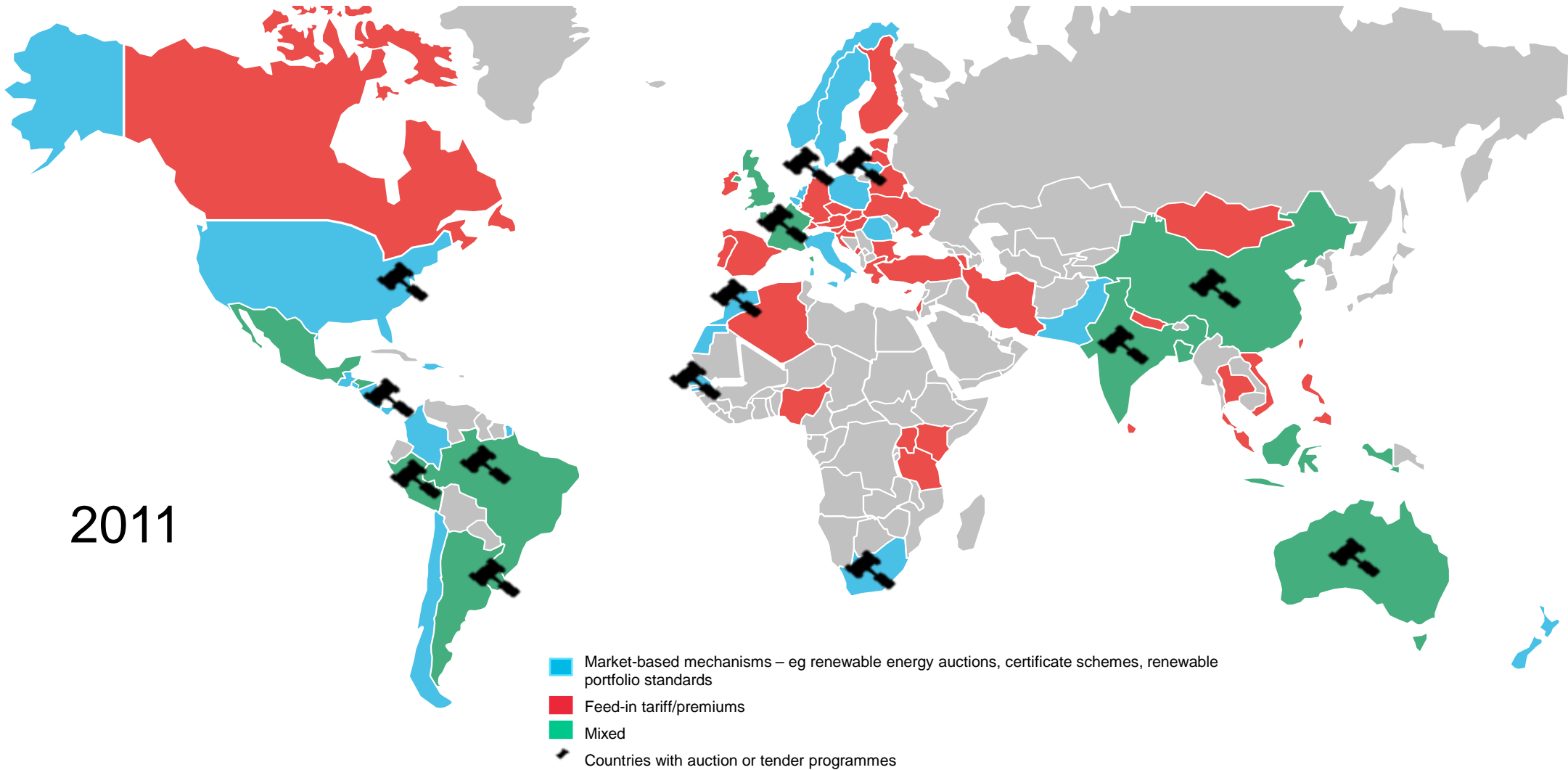
# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL



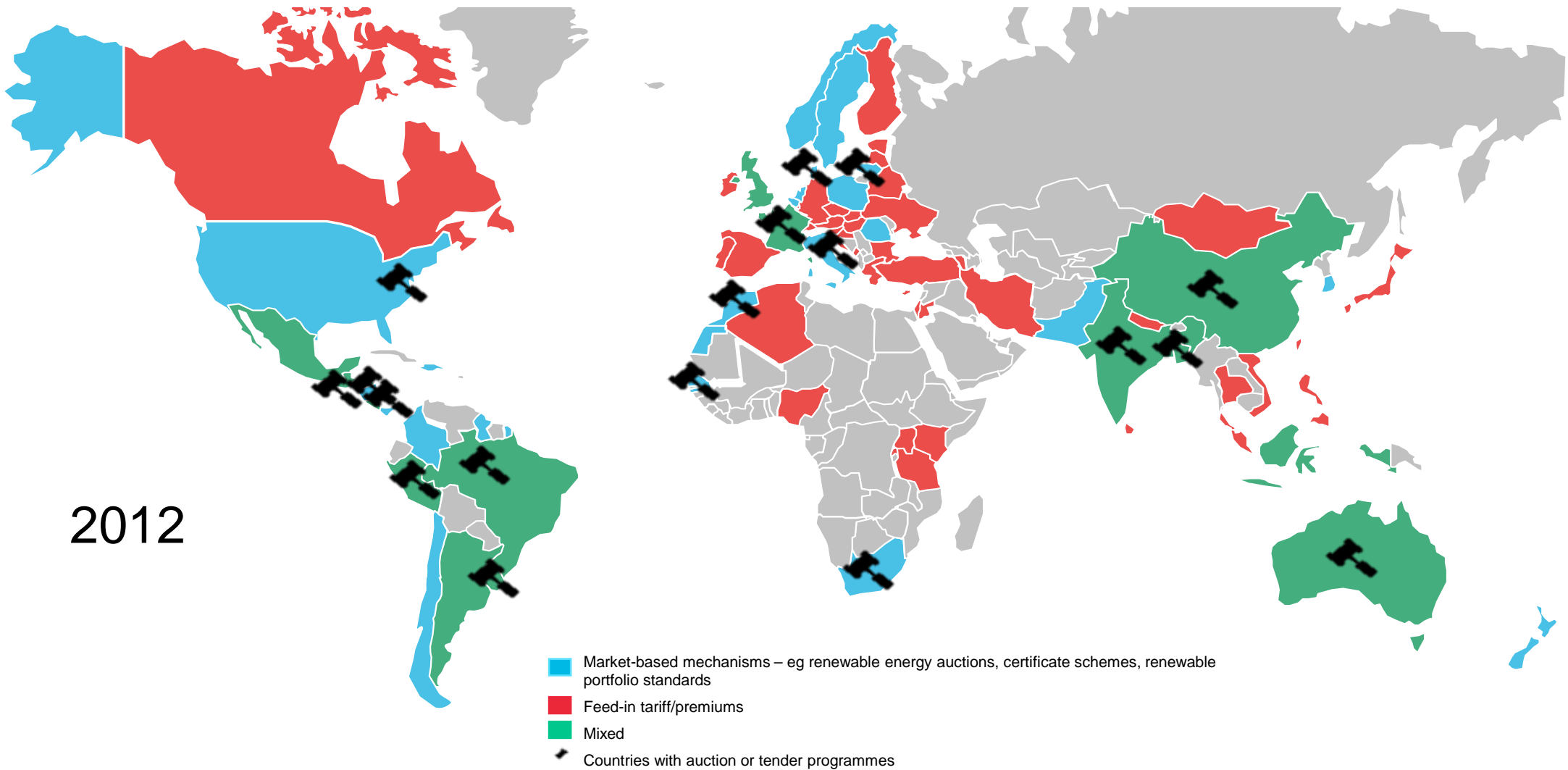
# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL



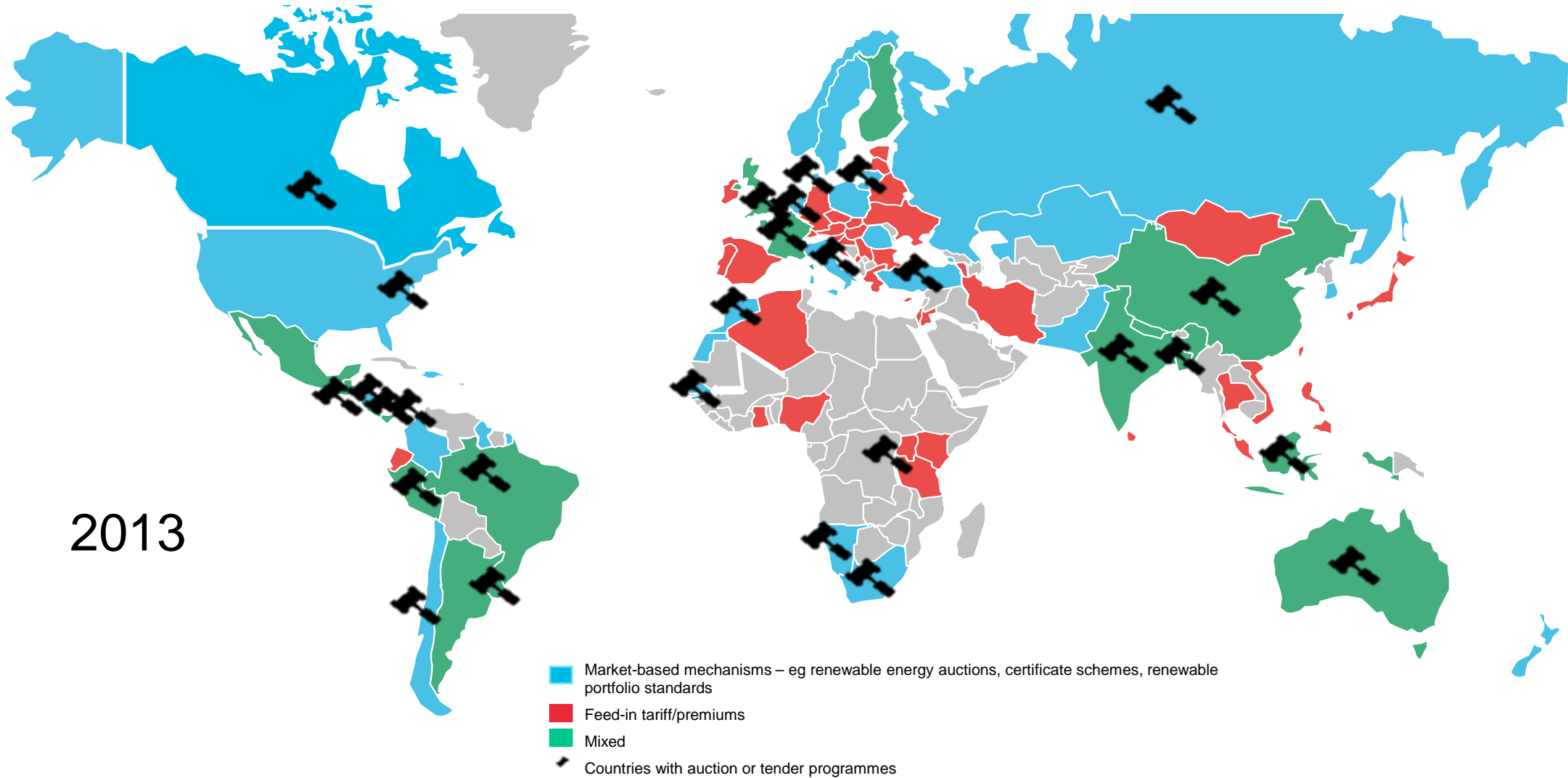
# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL



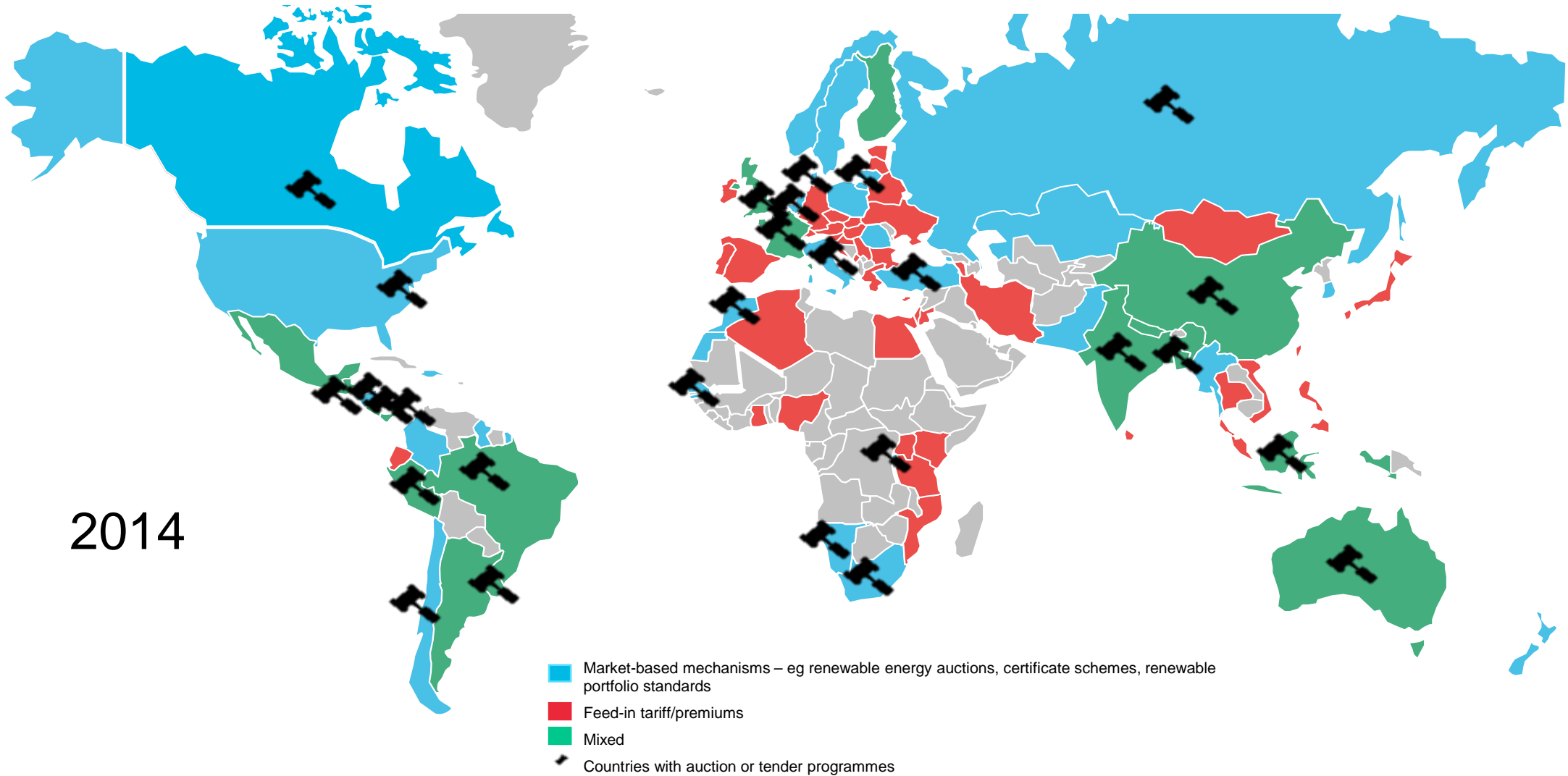
# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL



# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL

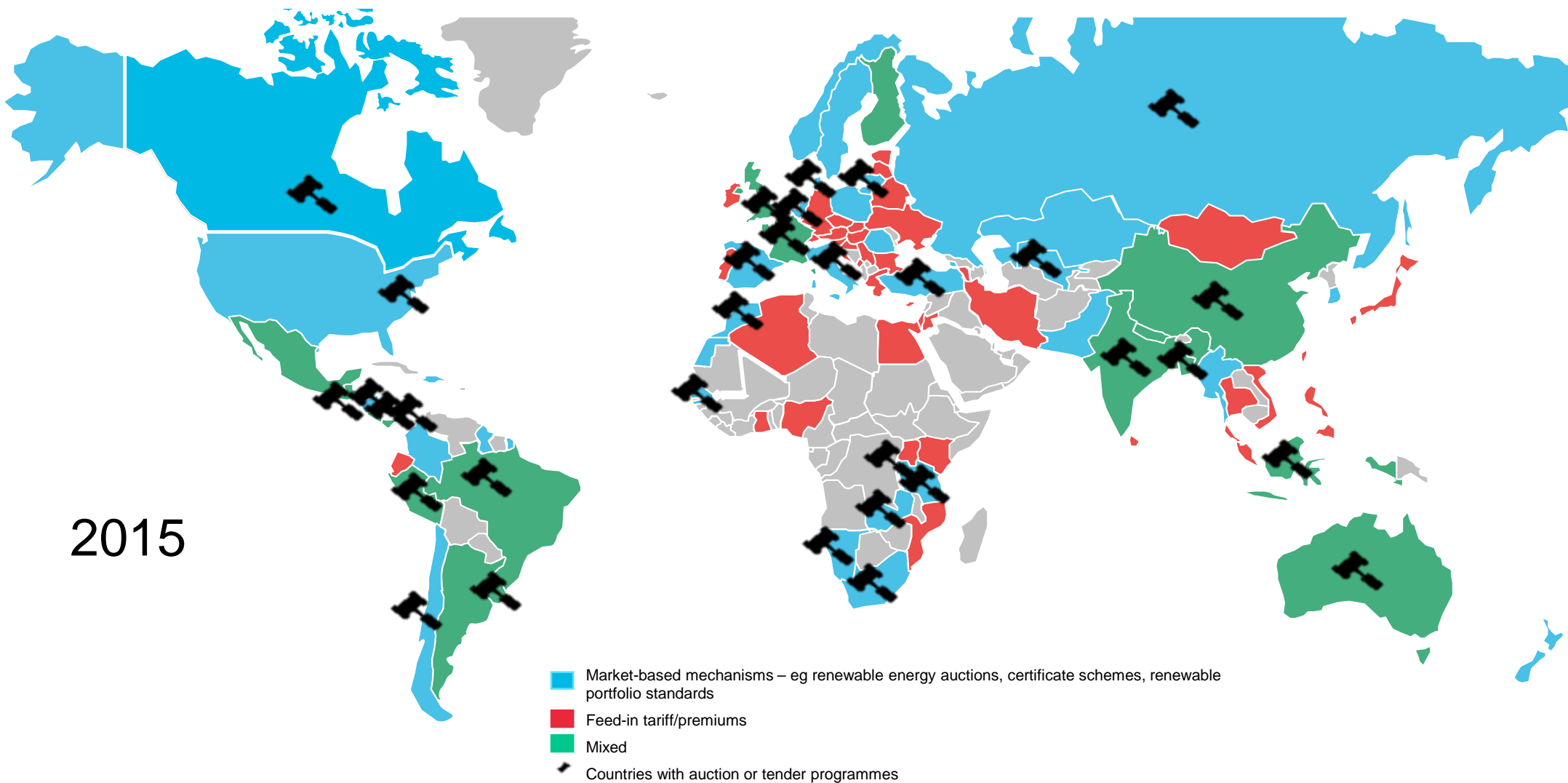


# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL

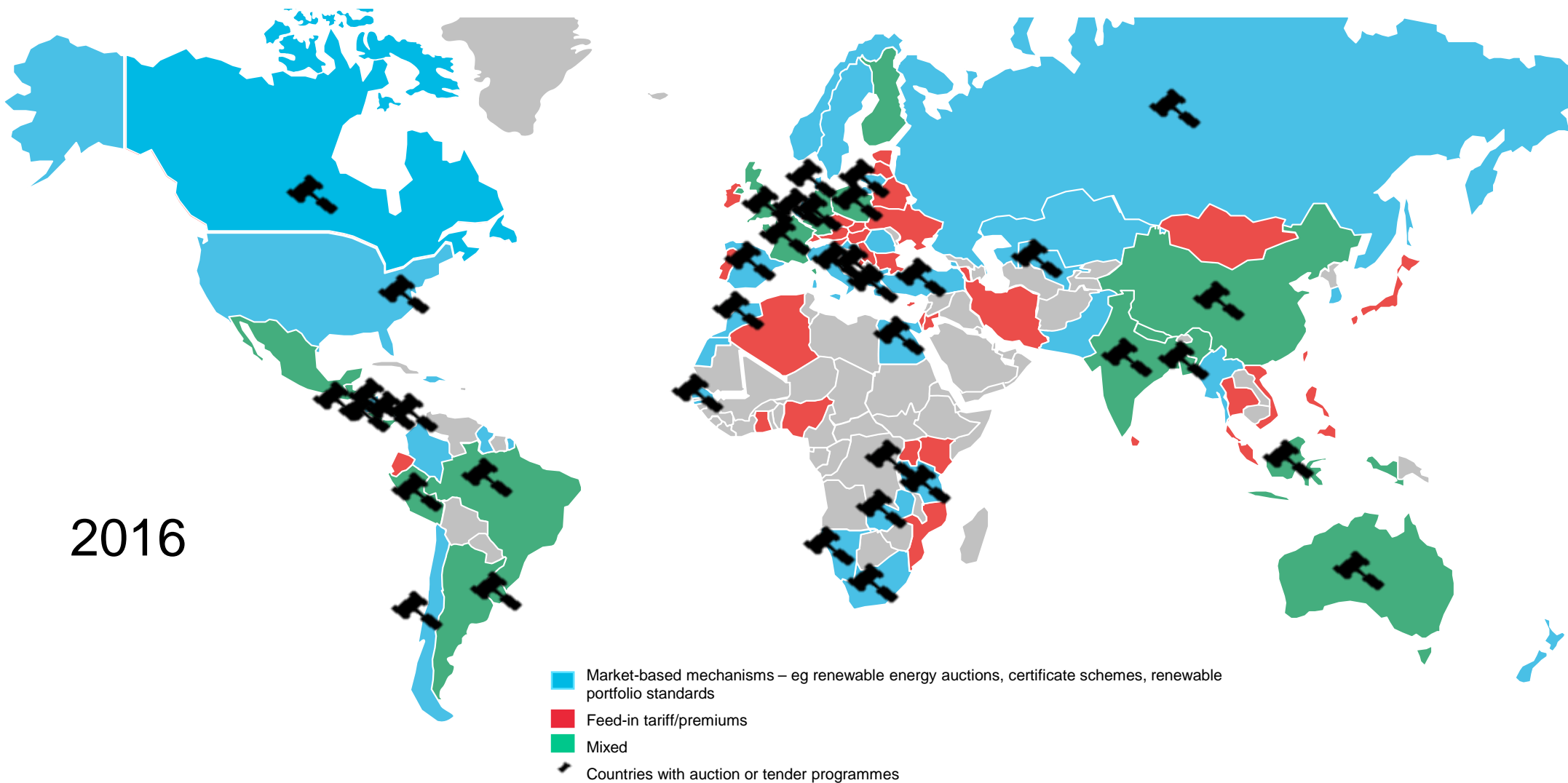




# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL

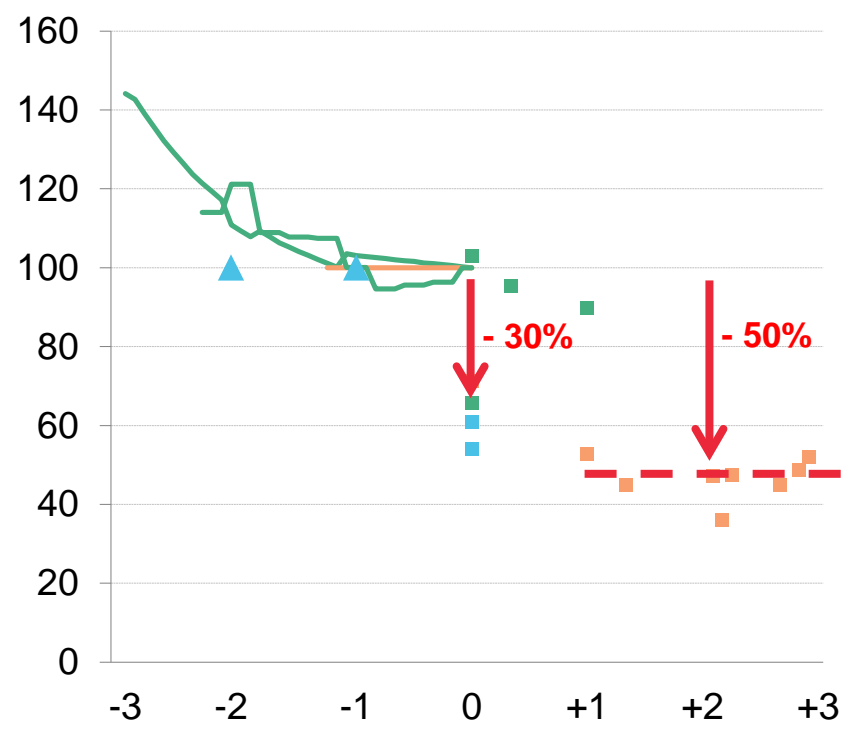


# RENEWABLE ENERGY - THE MARCH OF THE PRICE SIGNAL

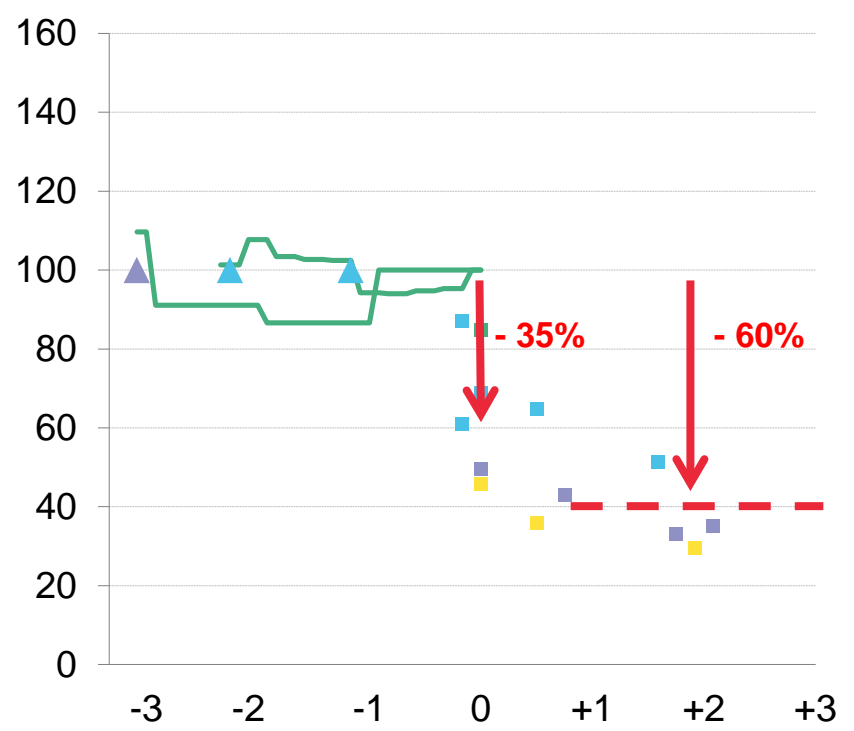


# PRICE IMPACT OF SWITCH FROM FIT TO AUCTIONS, SELECTED COUNTRIES (NORMALISED)

**Solar PV**  
(unit price normalised to 100 at date of first auction)



**Onshore Wind**  
(unit price normalised to 100 at date of first auction)



**KEY**

- : tariffs
- : non-tariff price signals
- : auctions
- EMEA
- Other LatAm
- Brazil
- India
- South Africa

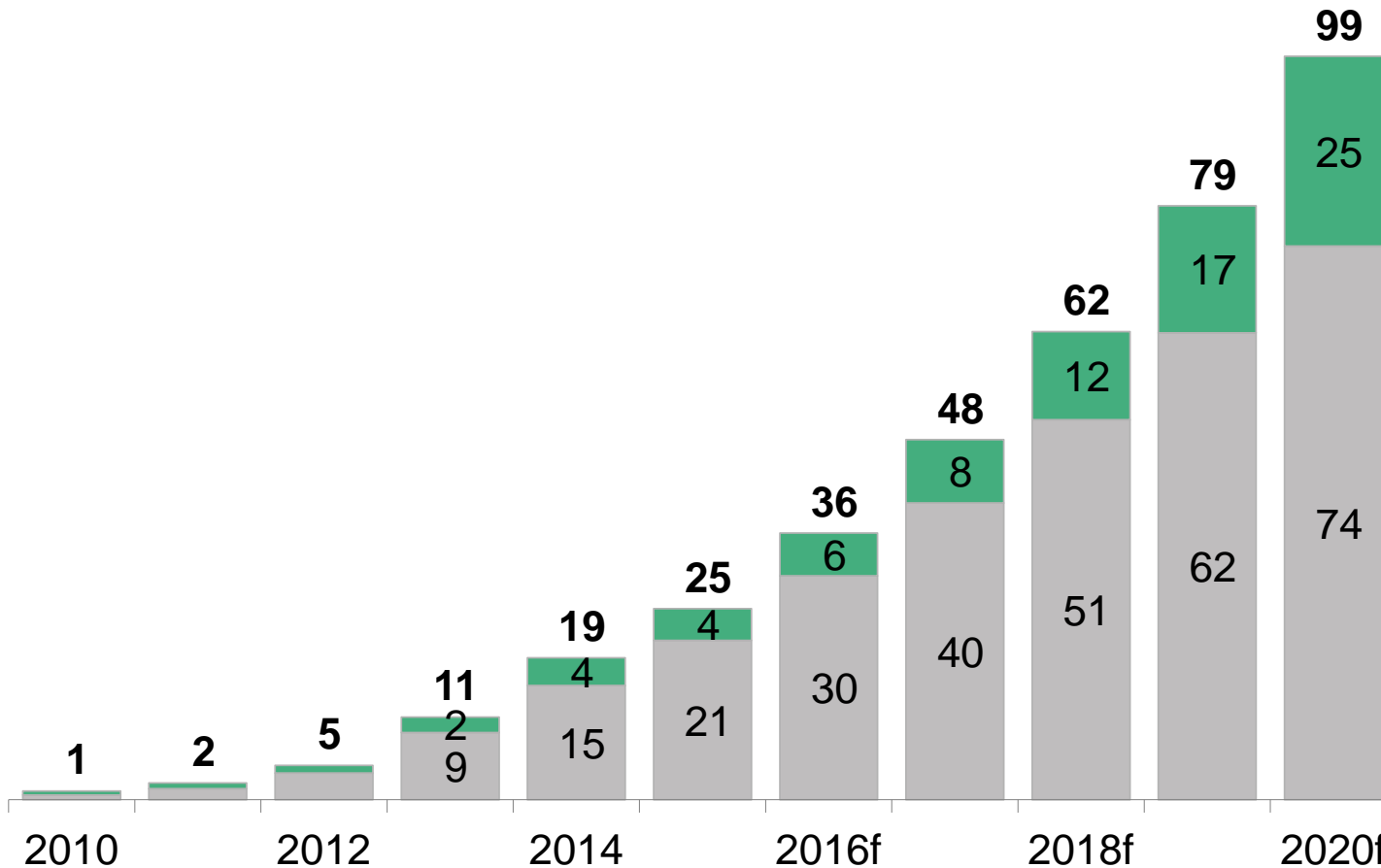
Source: Bloomberg New Energy Finance

# ENERGY MIRACLE – SOLAR?



Images: Gatesnotes.com, D-Light; Source Bloomberg New Energy Finance

# OFF-GRID SOLAR USERS (MILLION HOUSEHOLDS)



## Large solar home systems



## Portable solar lanterns and small home systems



Note: Large solar home systems are defined as larger than 10W solar panels. Historical data is based on Lighting Global and GOGLA data and Bloomberg New Energy Finance estimates.

Source: Bloomberg New Energy Finance, Lighting Global, GOGLA

# EV MASS MARKET \$30,000 + 200 MILES RANGE



Tesla Model 3



BMW i3



VW e-Golf



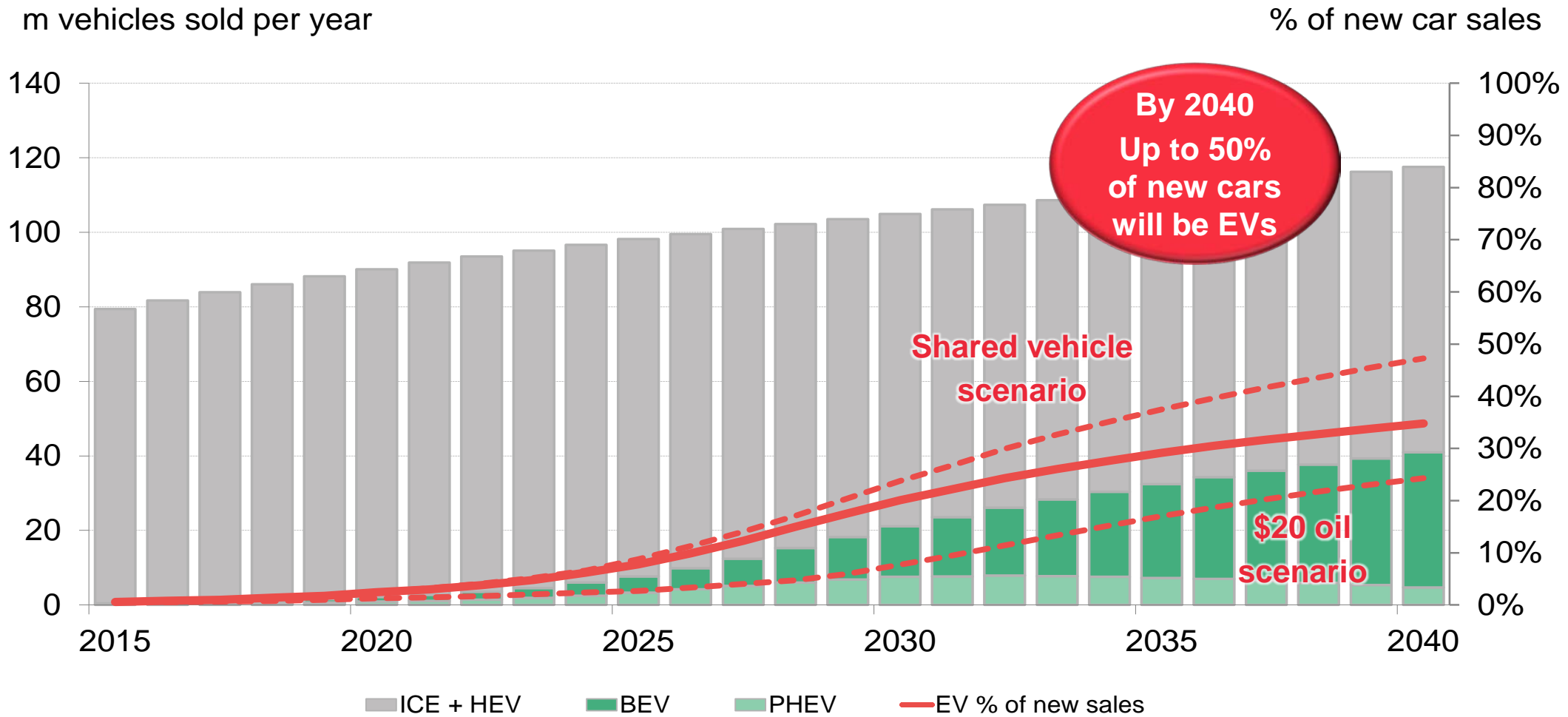
Chevy Bolt



Nissan Leaf

Images: Tesla, BMW, VW, GM, Nissan

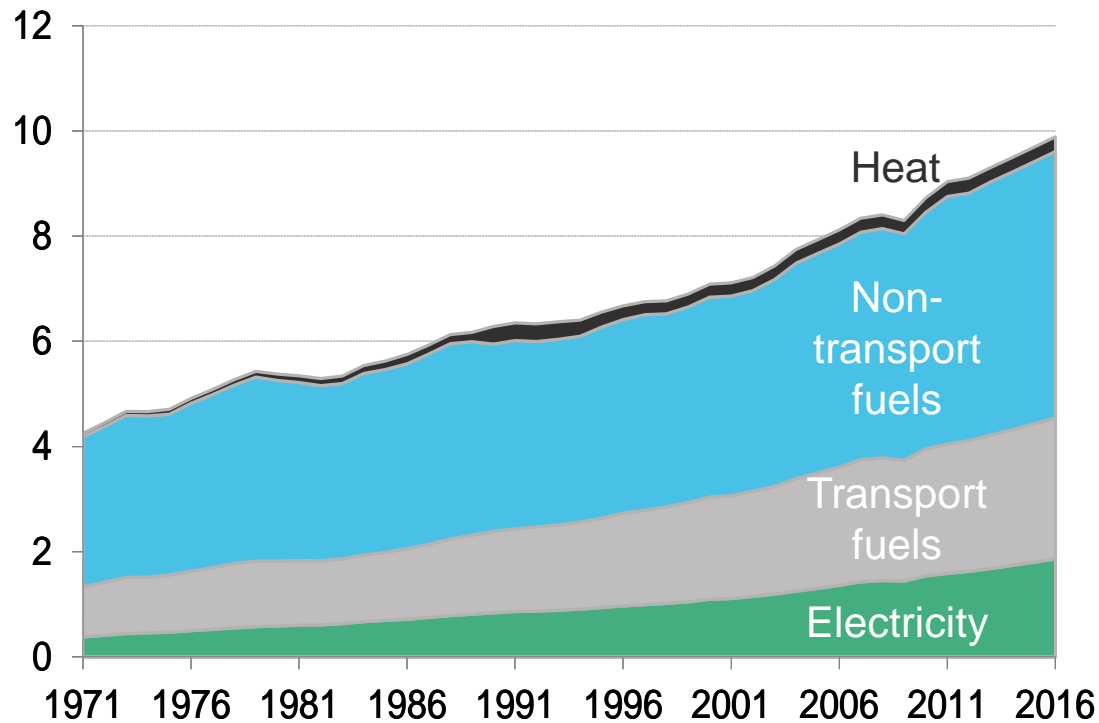
# GLOBAL LIGHT DUTY VEHICLE AND EV ANNUAL SALES, 2015–40 (M VEHICLES SOLD PER YEAR, %)



Note: forecast uses Gasoline and electricity prices from EIA's 2015 Annual Energy Outlook 'Low Oil Price' scenario (ranging from \$50 to \$65 per barrel between 2015 and 2025). High scenario assumes greater vehicle utilisation. Low scenario assumes \$20 per barrel oil price

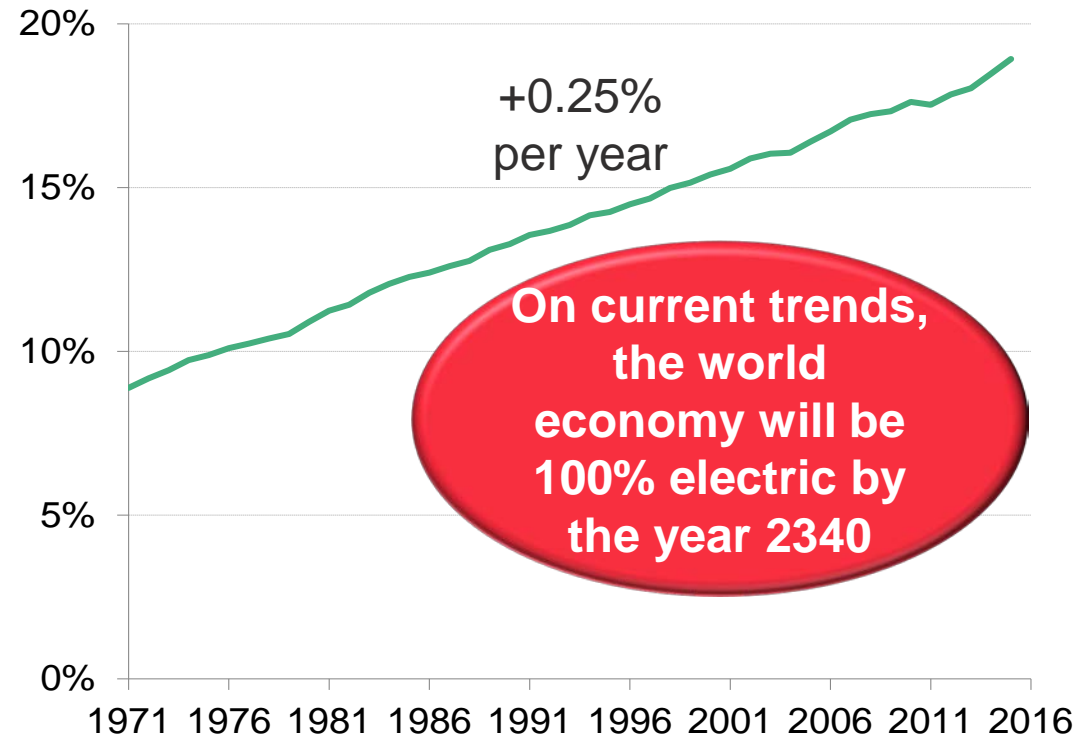
Source: Bloomberg New Energy Finance

## STRUCTURE OF FINAL ENERGY (BN TOE)



Note: TOE is tonnes of oil equivalent

## ELECTRICITY SHARE OF FINAL ENERGY CONSUMPTION (%)



Source: Bloomberg New Energy Finance, IEA



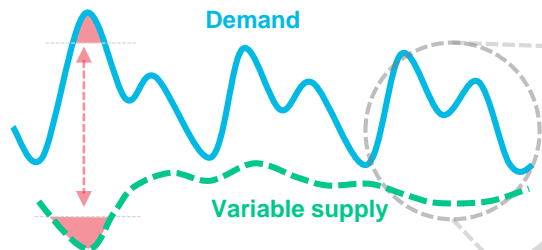
# MANAGING INTERMITTENCY THE BIG CHALLENGE – THE BIG OPPORTUNITY

Years to Months

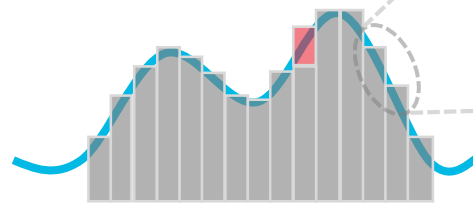
Days to minutes

Seconds to minutes

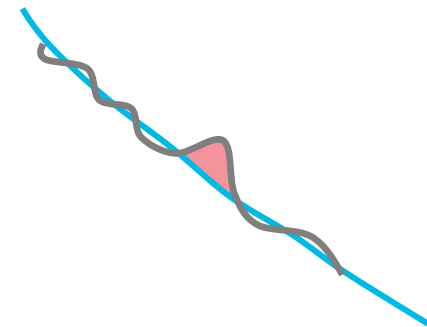
## I. PLANNING FOR EXTREMES



## II. CONTINUOUS BALANCING



## III. CONTROLLING FREQUENCY

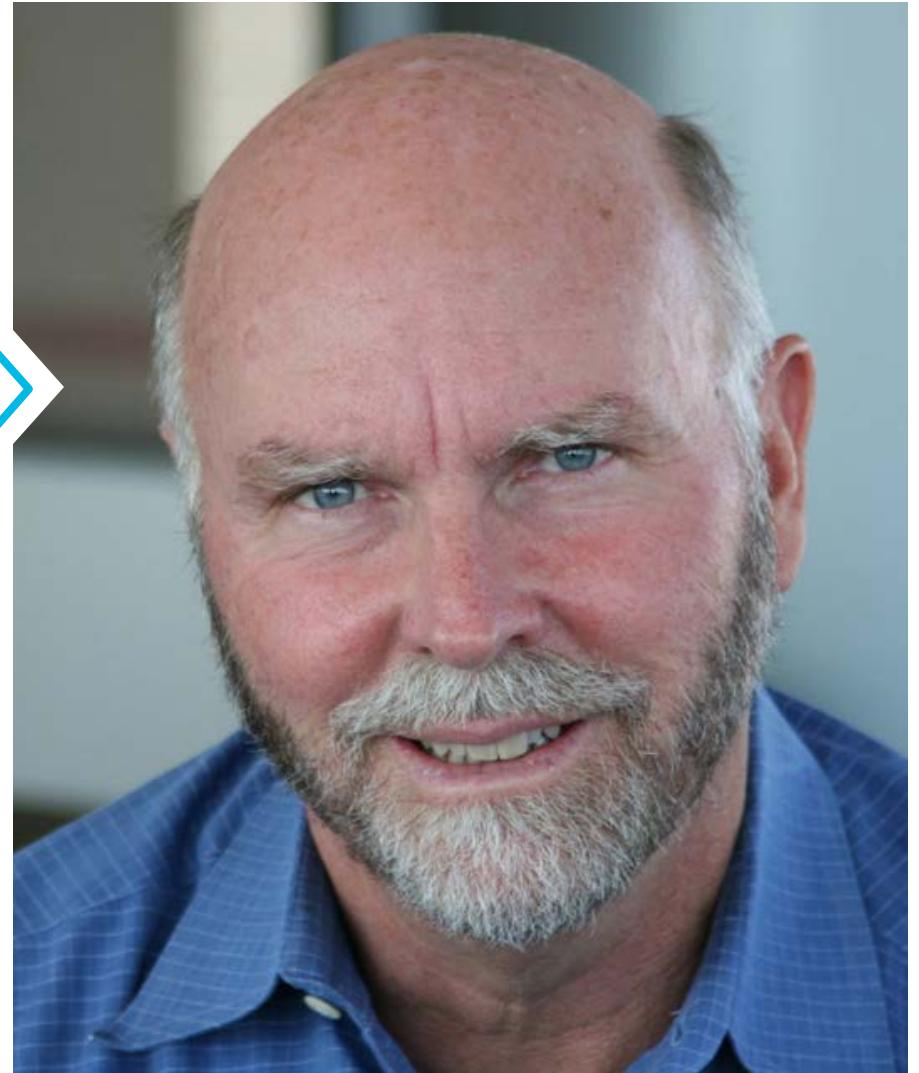


Source: Bloomberg New Energy Finance

“

I'm not sure whether the optimists or the pessimists are right, but I do know this: it is the optimists who will get something done.

”



# Thanks!

## **MARKETS**

Renewable Energy  
Energy Smart Technologies  
Advanced Transport  
Gas  
Carbon and RECs

## **SERVICES**

Americas Service  
Asia Pacific Service  
EMEA Service  
Applied Research  
Events and Workshops

Unique analysis, tools and data for decision-makers  
driving change in the energy system

[sales.bnef@bloomberg.net](mailto:sales.bnef@bloomberg.net)

Michael Liebreich  
Twitter: @MLiebreich

**Bloomberg**  
NEW ENERGY FINANCE