NFiP Nasjonal forskerskole i petroleumsfag
Petroleum Research School of Norway

NorTex Petroleum Cluster

Whole Value Chain CCUS Conference Week

CCUS Assessment

ConocoPhillips Chevron The Research Council of Norway Norwegian Consulate General San Francisco COLORADO SCHOOL OF MINES

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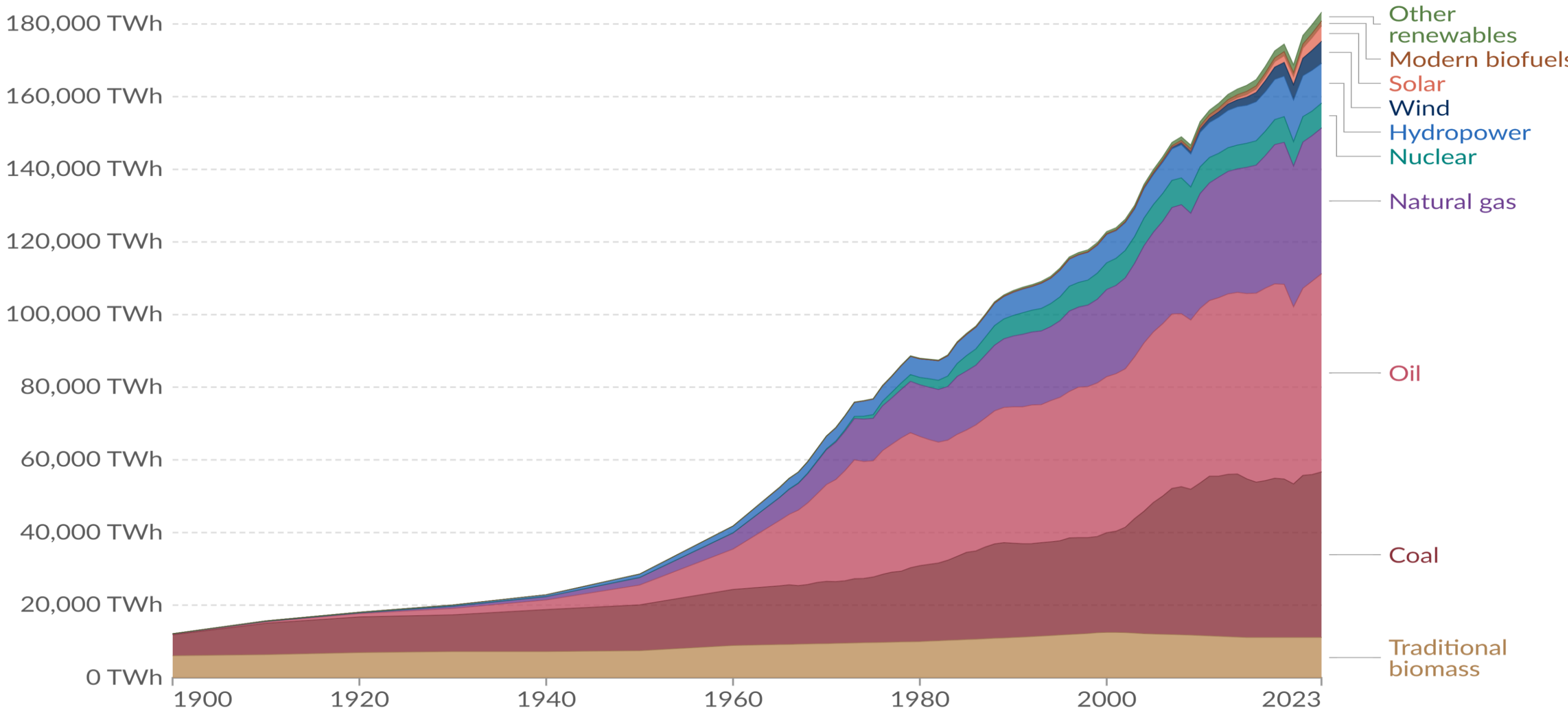
Whole Value Chain CCUS Conference Week, Sept. 22nd–26th, 2025, Golden, CO, USA.

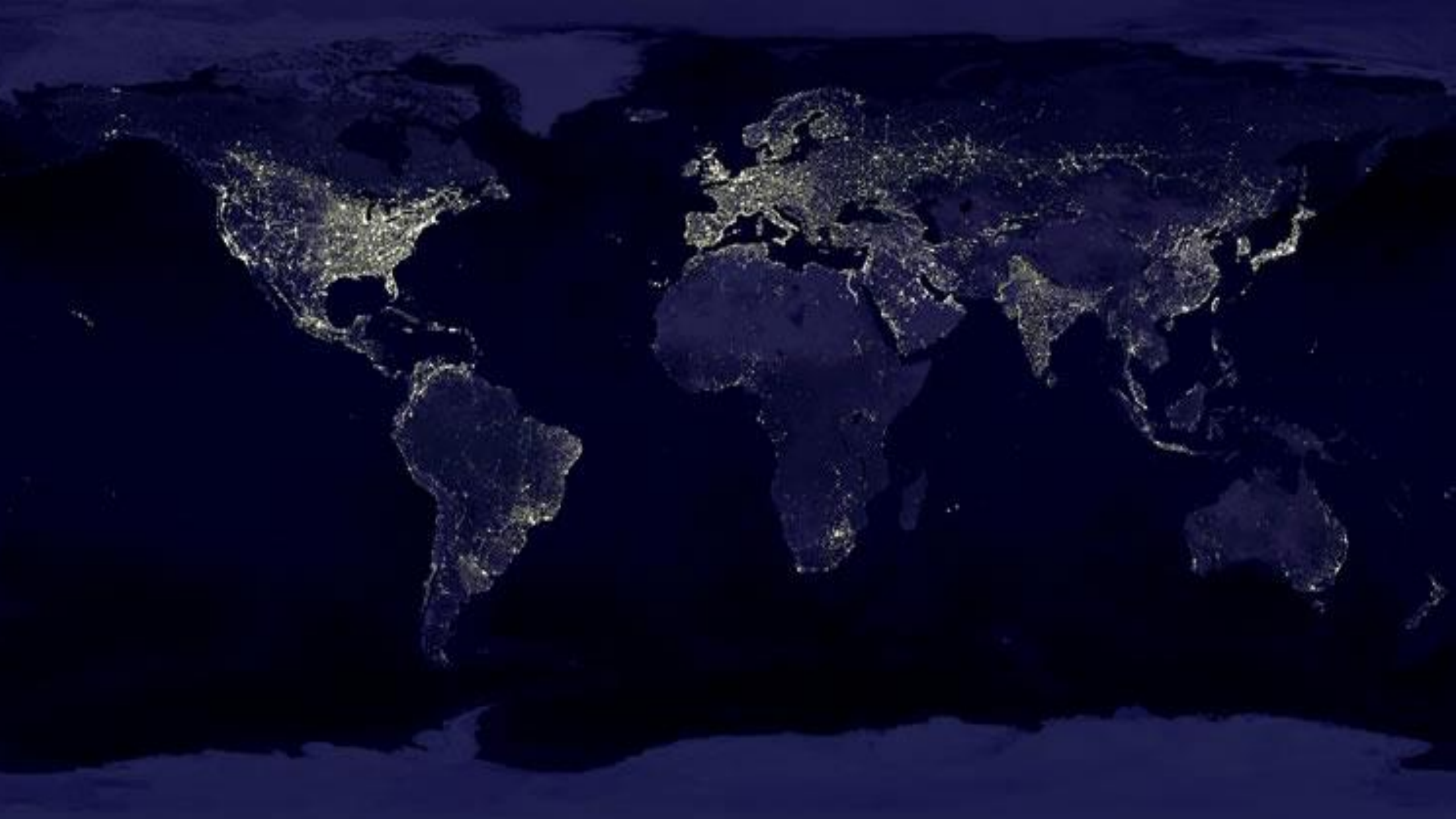
Global primary energy consumption by source

Primary energy[1] is based on the substitution method[2] and measured in terawatt-hours[3].

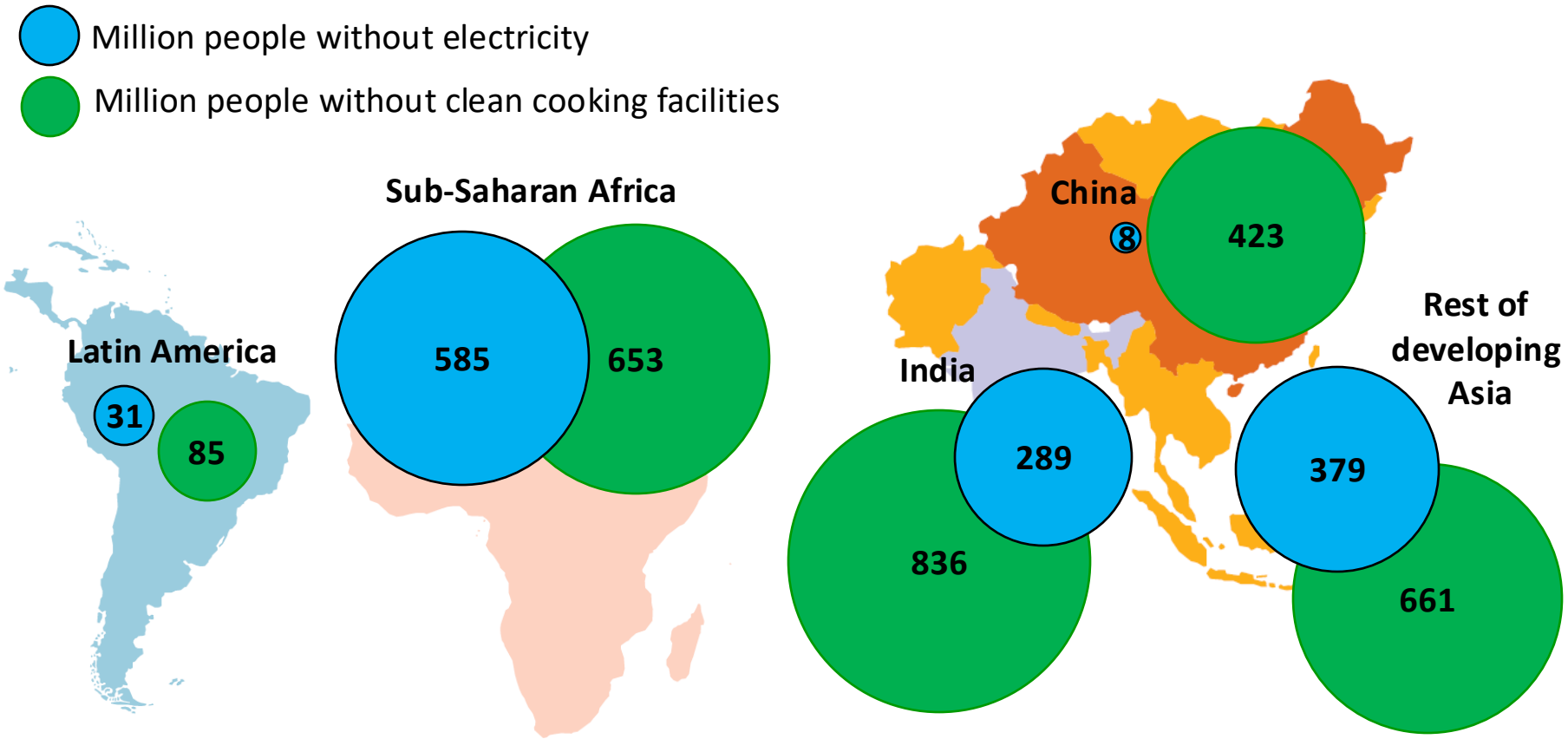


Data source: Energy Institute - Statistical Review of World Energy (2024); Smil (2017)

OurWorldInData.org/energy | CC BY

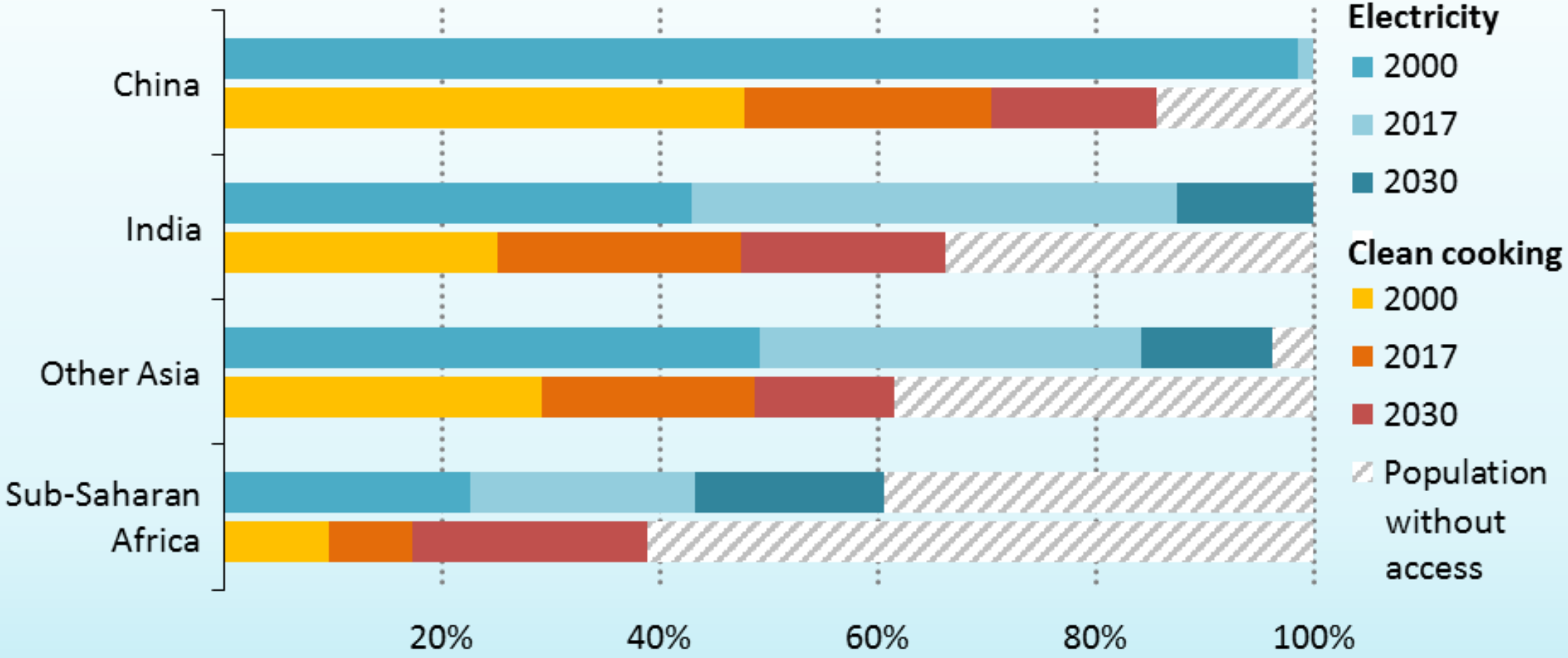


Energy Poverty is Widespread



1 billion people in the world live without electricity & 2.1 billion live without clean cooking facilities

Access to electricity and clean cooking in the New Policies Scenario



International Energy Agency (2018), World Energy Outlook 2018, OECD/IEA, Paris

SUSTAINABLE DEVELOPMENT GOALS

The Global Energy Challenge

- More energy
- Cleaner energy
- Energy security – oil & gas

The Global Energy Challenge

- More energy
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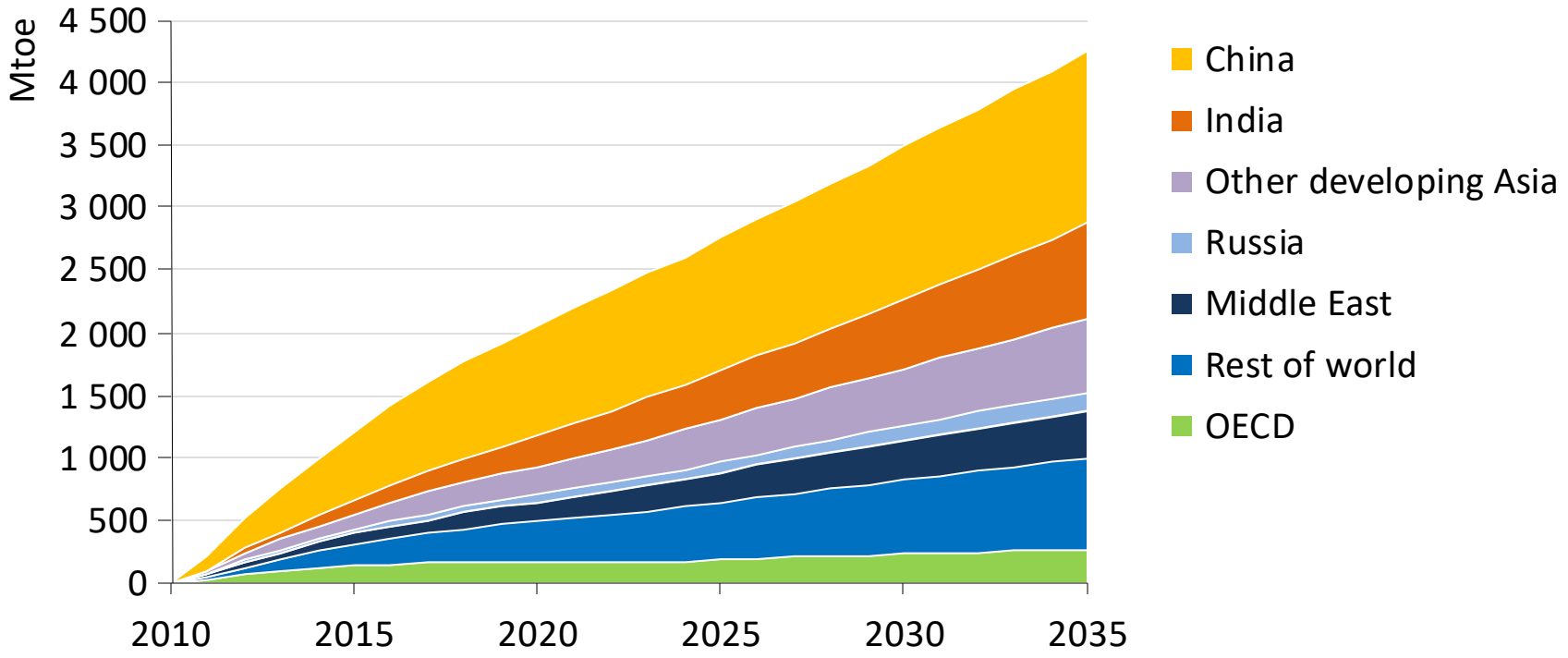
The Global Need for Energy Continues to Rise

Growth in primary energy demand in the IEA's New Policies Scenario



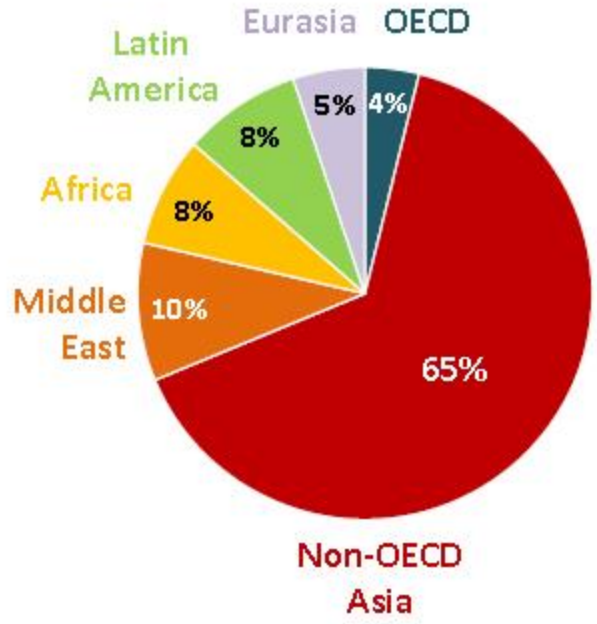
Source: International Energy Agency

The engine of energy demand growth moves to South Asia

WORLD ENERGY OUTLOOK 2013

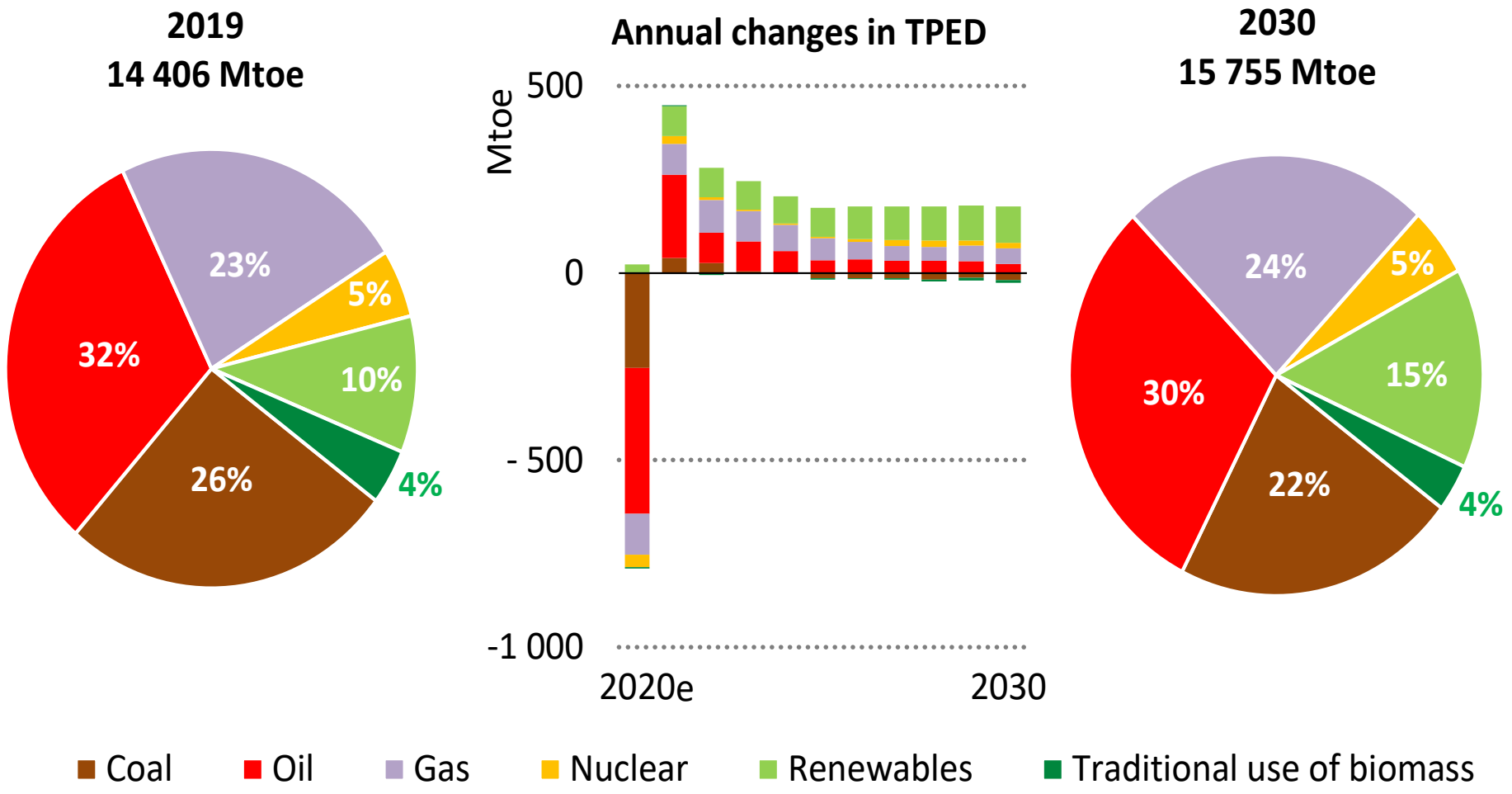
Primary energy demand, 2035 (Mtoe)

Share of global growth 2012-2035



China is the main driver of increasing energy demand in the current decade, but India takes over in the 2020s as the principal source of growth

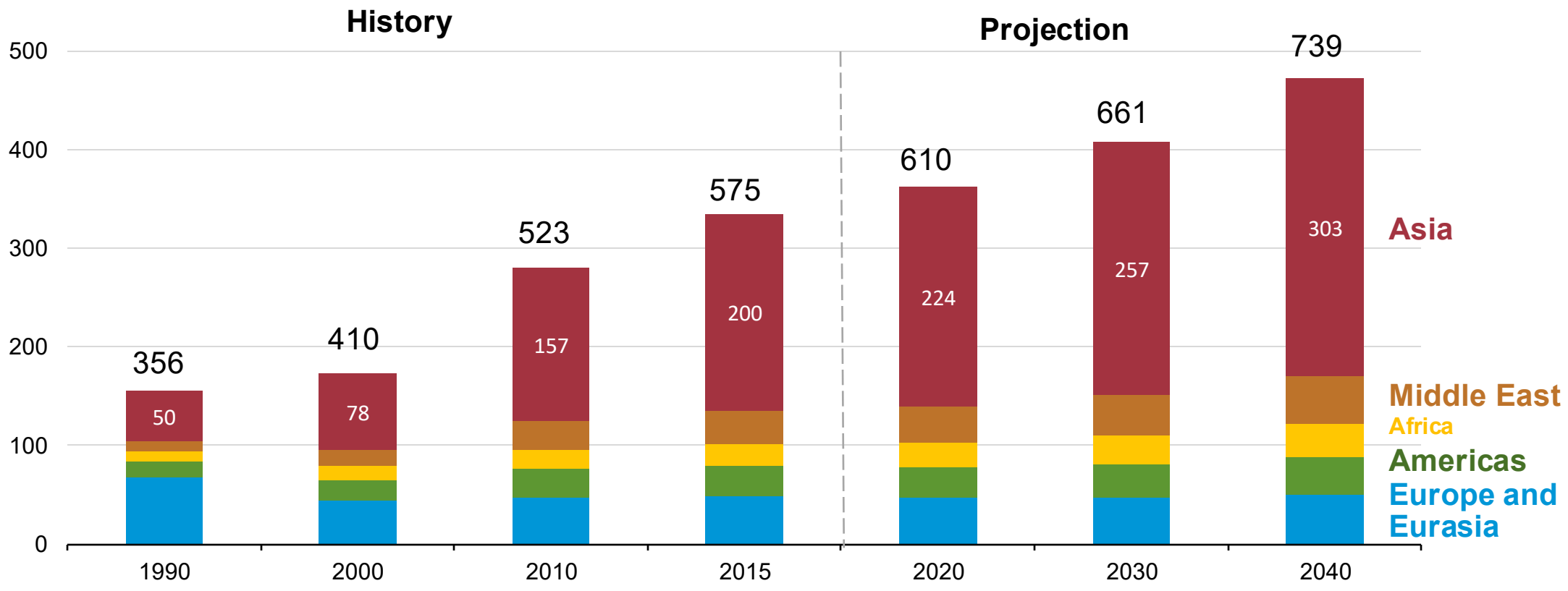
Total primary energy demand in the Stated Policies Scenario, 2019 and 2030



International Energy Agency (2020), World Energy Outlook 2020, IEA, Paris

Asia is projected to have the largest increase in energy use of non-OECD regions

IEO2018 Reference case
non-OECD energy consumption by region
quadrillion Btu



Source: EIA, International Energy Outlook 2018

The Global Energy Challenge

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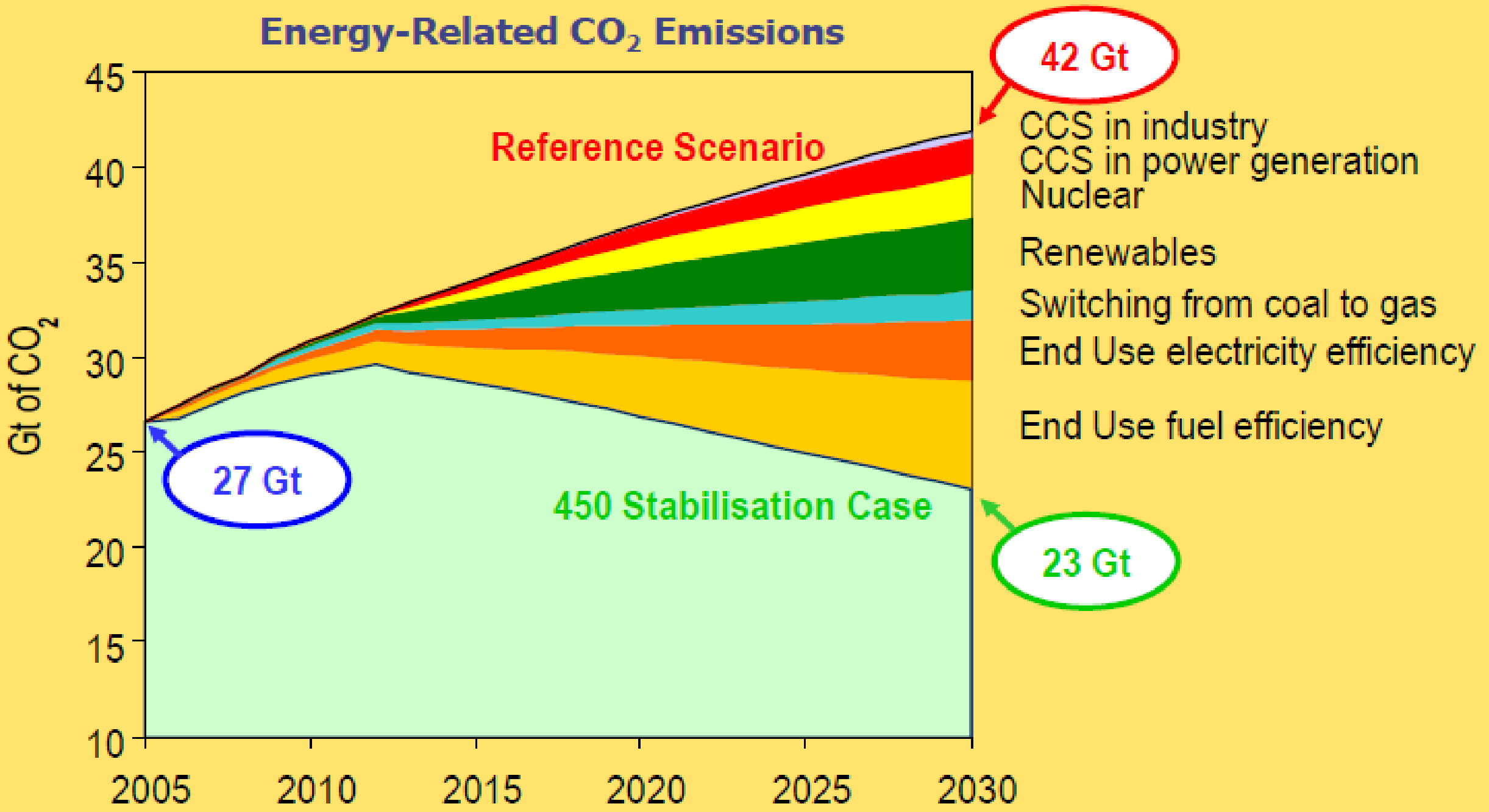
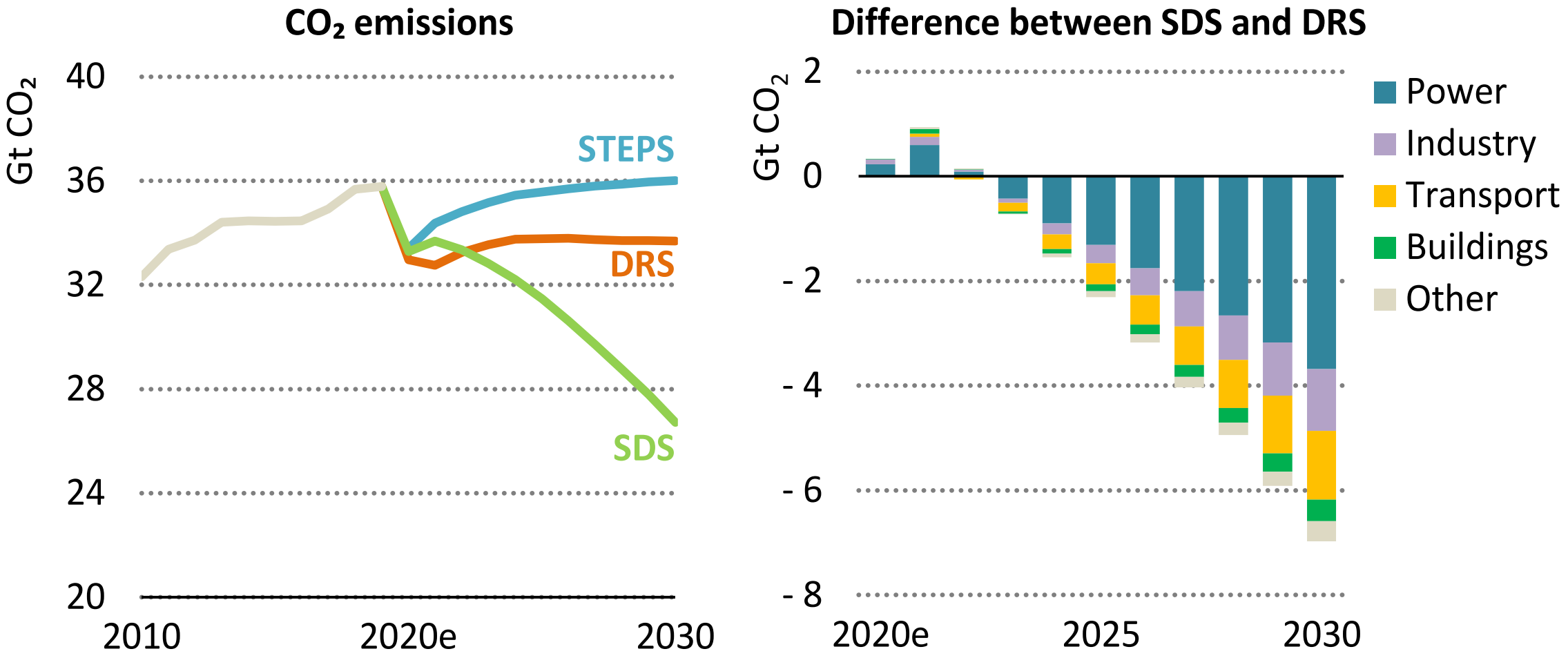
Large methane emissions from oil and gas operations detected by satellite in 2019 and 2020

International Energy Agency (2020), World Energy Outlook 2020, IEA, Paris

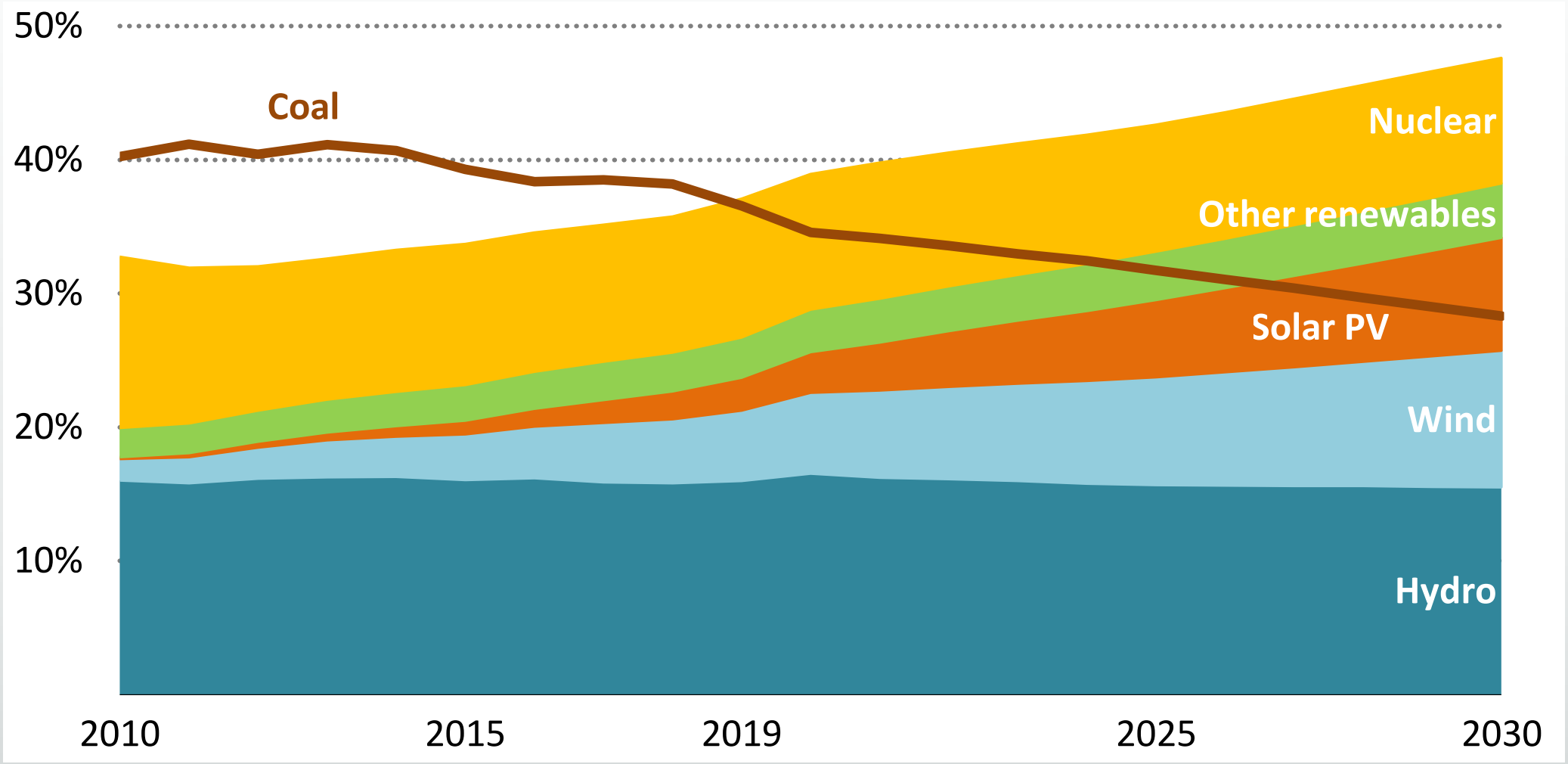

Energy-Related CO_2 Emissions
Gt of CO_2
45
40
35
30
25
20
15
10
2005
2010
2015
2020
2025
2030
Reference Scenario
450 Stabilisation Case
42 Gt
27 Gt
23 Gt
CCS in industry
CCS in power generation
Nuclear
Renewables
Switching from coal to gas
End Use electricity efficiency
End Use fuel efficiency

Energy sector and industrial process CO_2 emissions in the scenarios, 2010-2030



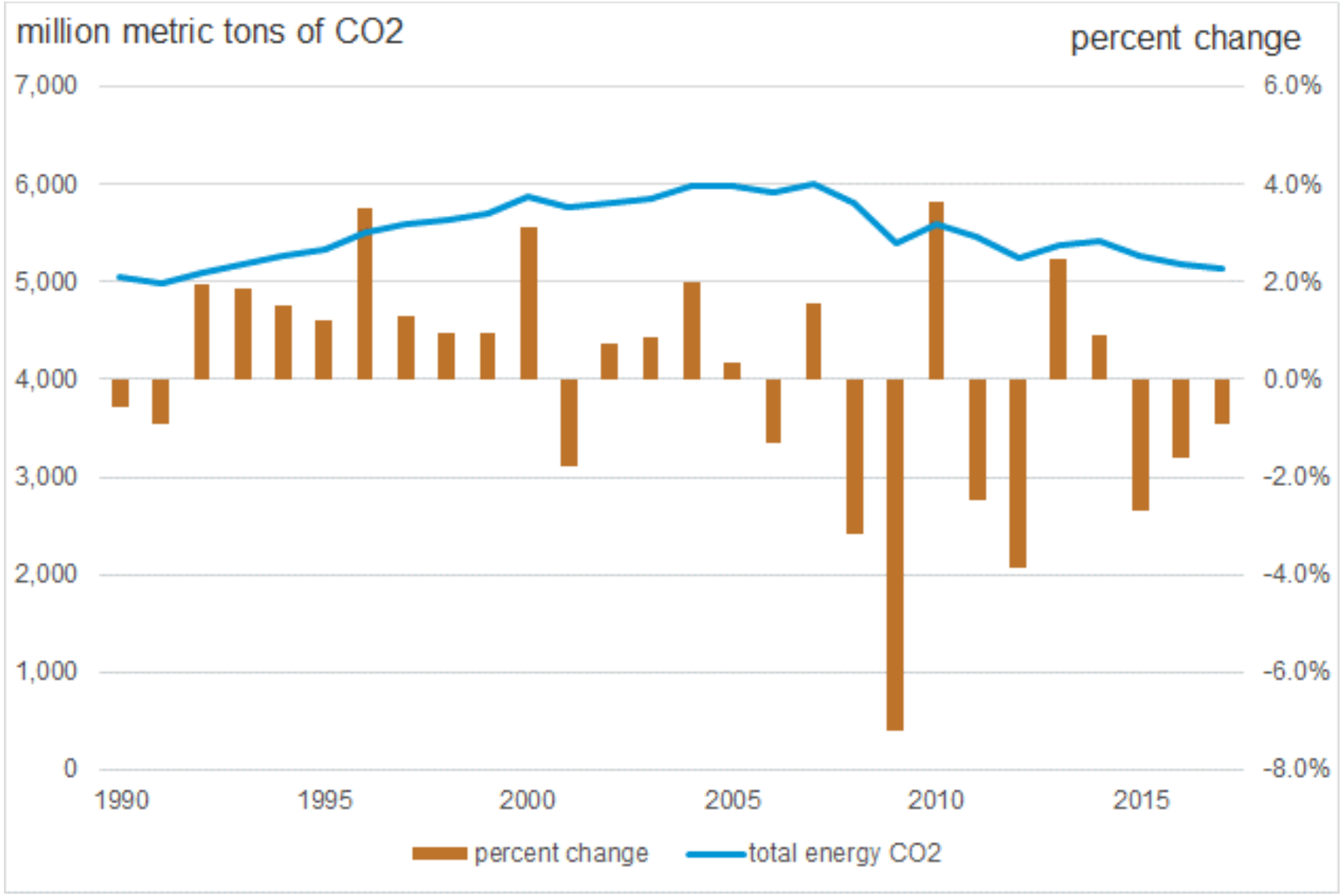
International Energy Agency (2020), World Energy Outlook 2020, IEA, Paris

Renewables, nuclear and coal shares of global electricity supply in the Stated Policies Scenario, 2010-2030



International Energy Agency (2020), World Energy Outlook 2020, IEA, Paris

US energy-related CO2 emissions in 2017 were 849 MMmt (14%) below 2005 levels



U.S. Energy Information Administration, 2017

The Global Energy Challenge

- More energy
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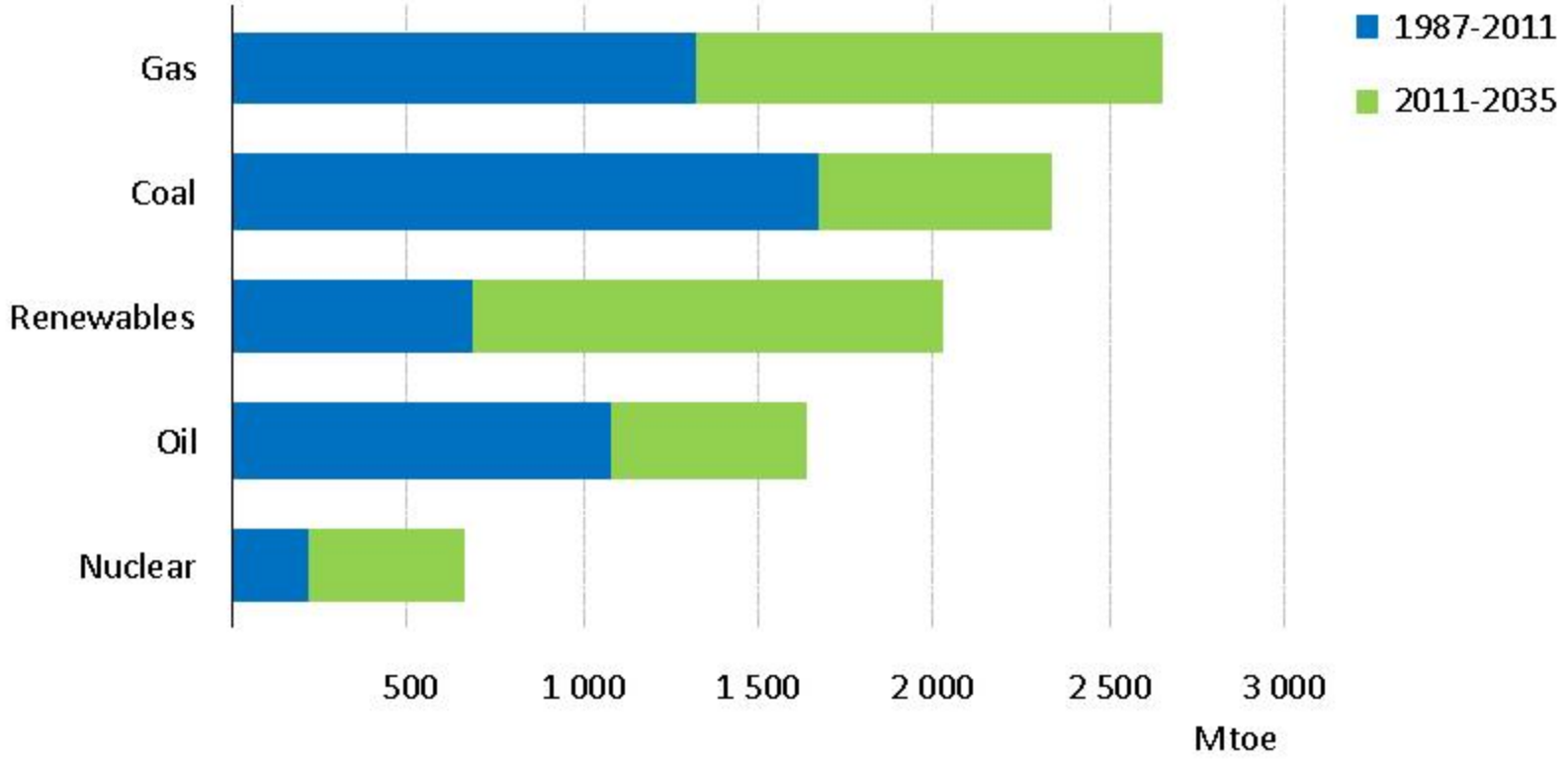
A mix that is slow to change

WORLD ENERGY OUTLOOK 2013

Growth in total primary energy demand

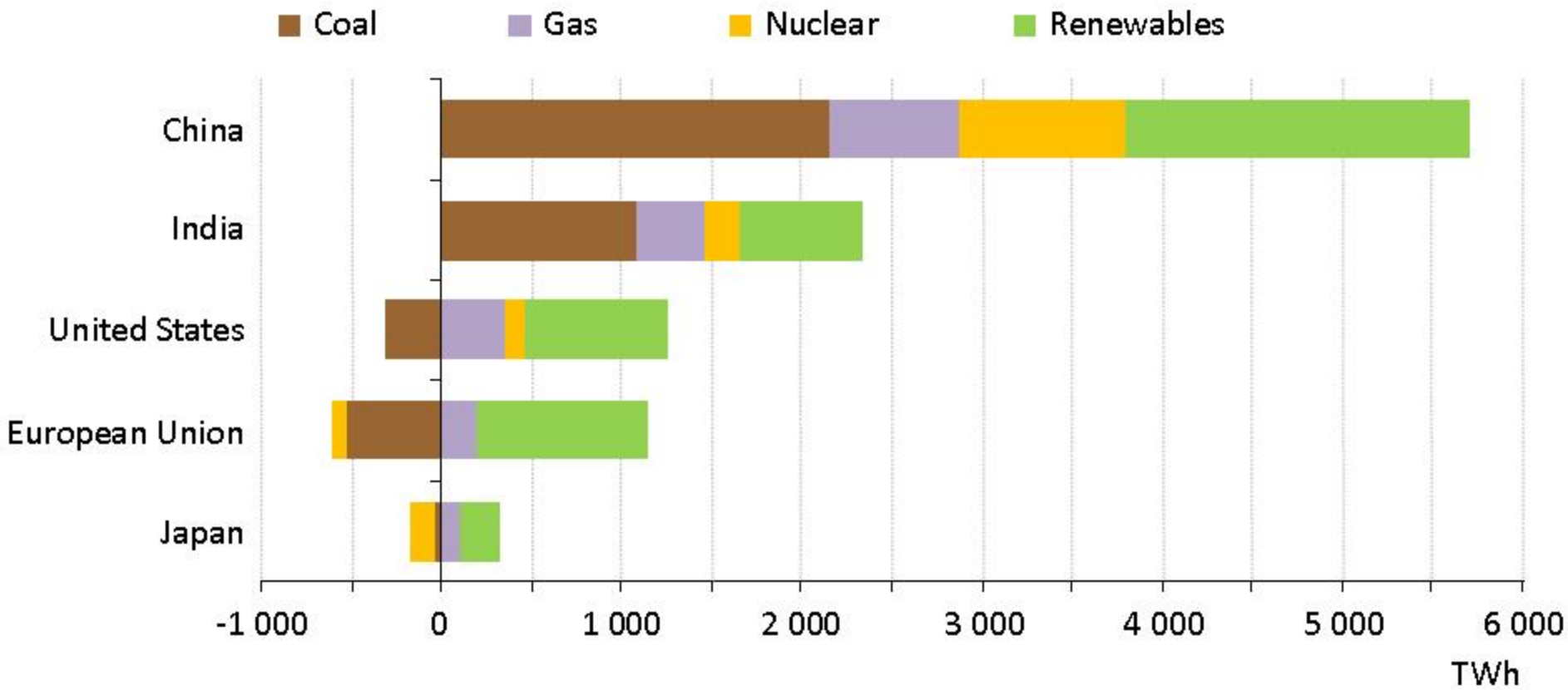


Today's share of fossil fuels in the global mix, at 82%, is the same as it was 25 years ago; the strong rise of renewables only reduces this to around 75% in 2035

A power shift to emerging economies

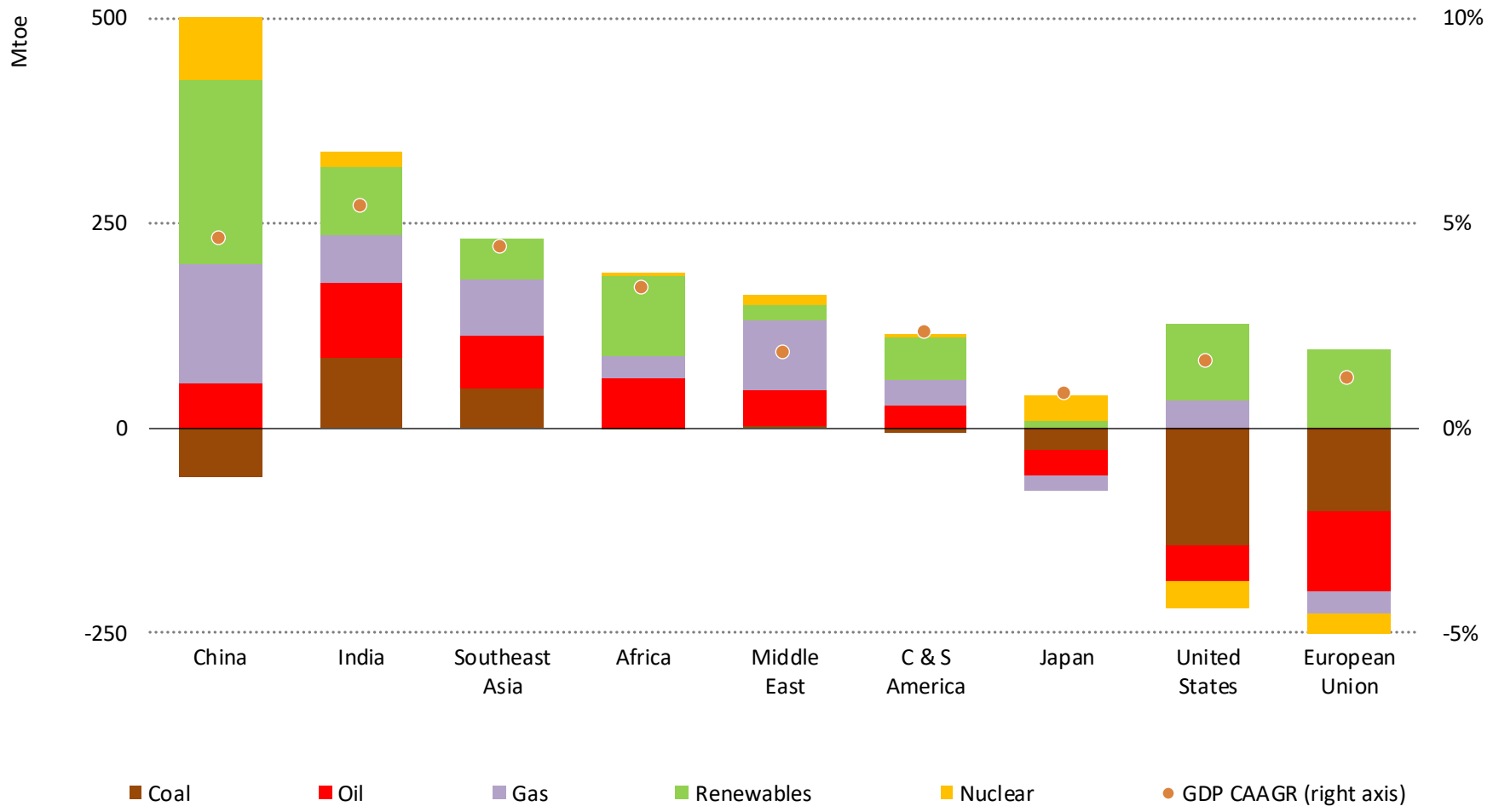
WORLD ENERGY OUTLOOK 2012

Change in power generation, 2010-2035



The need for electricity in emerging economies drives a 70% increase in worldwide demand, with renewables accounting for half of new global capacity

Changes in primary energy demand by fuel and region in the Stated Policies Scenario, 2019-2030



International Energy Agency (2020), World Energy Outlook 2020, IEA, Paris

Norway's Sovereign Wealth Fund Hits $1 Trillion

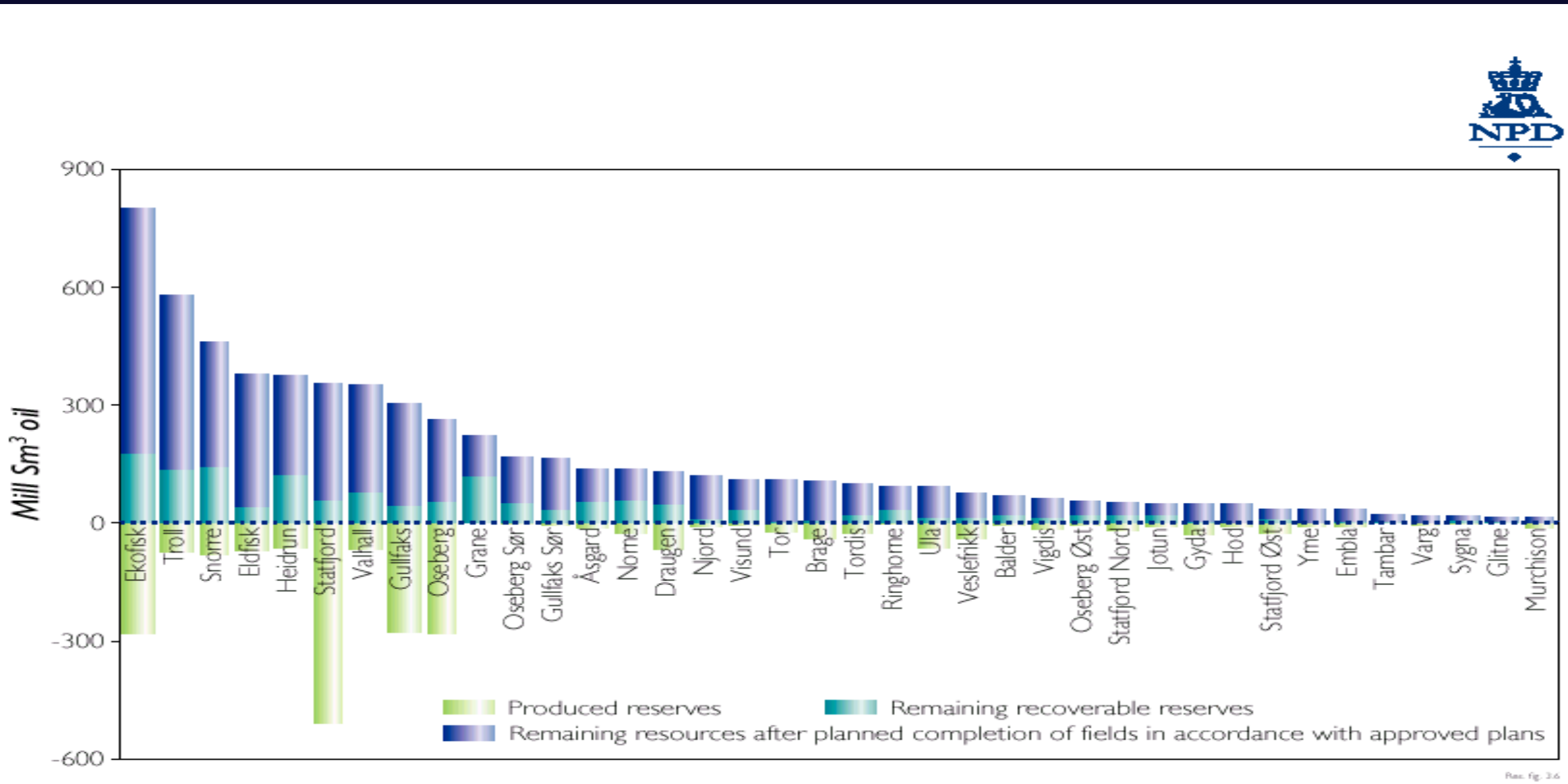
Largest sovereign wealth funds by assets under management in 2017*

* As of September 19, 2017

Source: The Sovereign Wealth Fund Institute

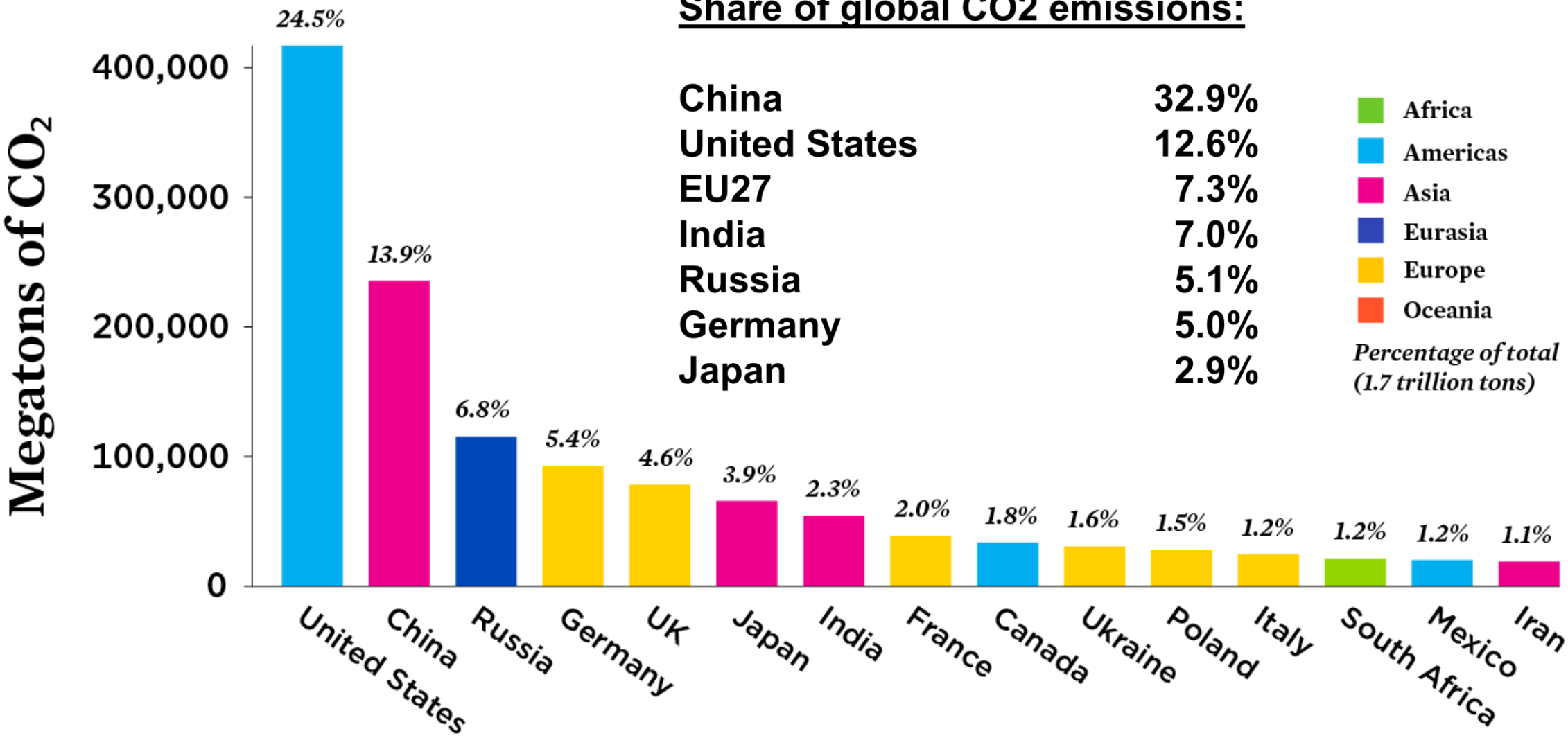
Forbes statista

Petroleum Resources on the Norwegian Continental Shelf



Top CO_2 Emitting Countries, 1750-2020

(from fossil fuels and cement)



CCUS Business Opportunities

Key Factors:

- **Energy Strategies & Commercial Revenues**
- **Disruptive New Technologies & Upscaling**
- **Climate Impacts**
- **License to Operate & Public Perception**
- **Government, Industry & Academia Interactions**

Enabling Global CO_2 Storage

- **Utilize CO2 as a Commodity in Energy Production (CCUS)**
- **Industry Participation & Commercial Revenues**
- **Sustainable Economy; Disruptive Technologies at Low Cost**
- **Carbon Tax Incentives (CCS)**
- **CO_2 EOR/EGR**
- **Social License to Operate & Public Perception**
- **Government, Industry & Academia Interactions**
- **Lab Exp Upscaled to Cost Effective On-Shore Pilots**
- **Offshore Pilots at Relevant Location**
- **Whole Value Chain CCUS**

Success Criteria for Global CO_2 Storage

- Industry participation
  - Sustainable Economy; Disruptive Technologies at Low Cost
    - CO_2 EOR
      - Verification at Field Scale & at Relevant Location
        - Cost Effective On-Shore Analogues
          - Offshore pilots
            - Whole Value Chain Pilots
              - Whole Value Chain Field Wide CCUS

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