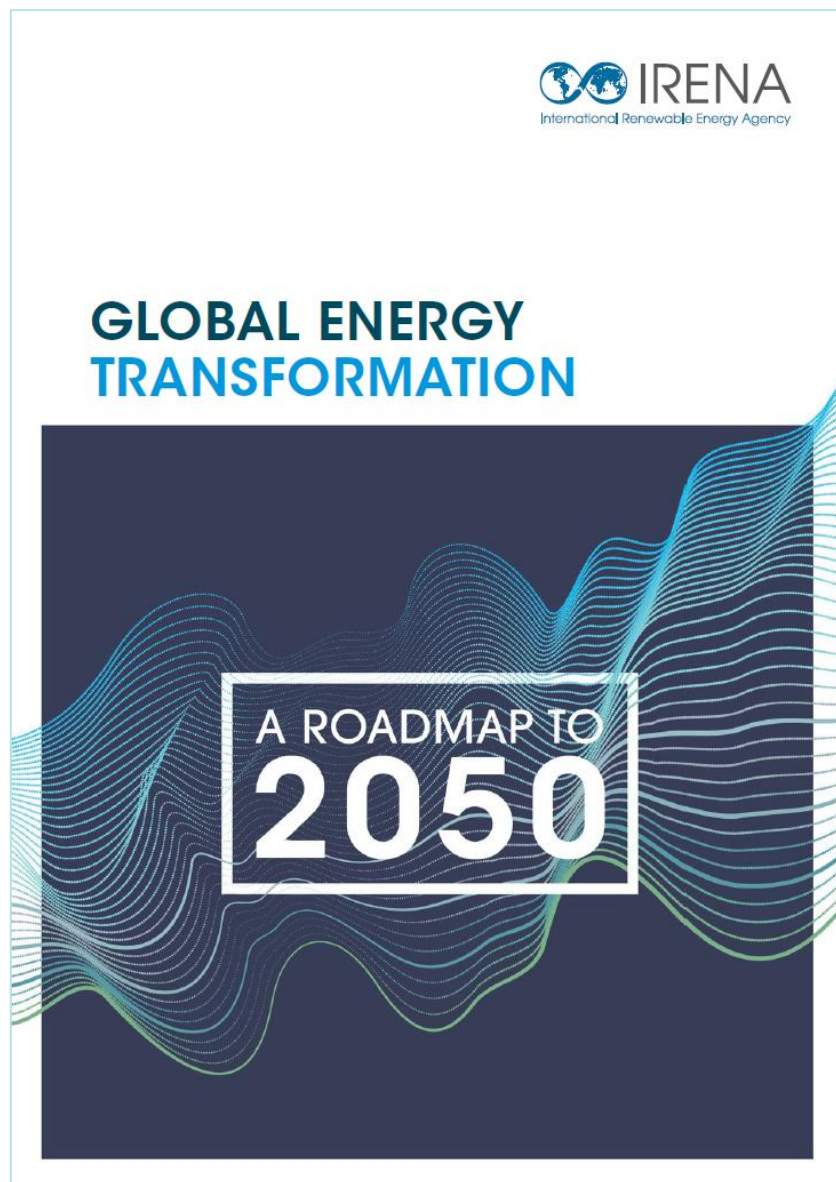


# GLOBAL ENERGY TRANSFORMATION 2050



Nicholas Wagner  
IRENA, Innovation and Technology Centre, Bonn, Germany  
GIZ Event, 4 June 2018



- A long-term pathway to energy system decarbonization:
  - In line with the Paris Agreement goal of keeping global warming below 2C.
  - Based on high energy efficiency and renewable energy.
- Released on April, 2018 at the Berlin Energy Transition Dialogue.
  - Second edition
  - Combines IRENA REmap techno-economic analysis and macroeconomic model analysis
- Available from [www.irena.org](http://www.irena.org)

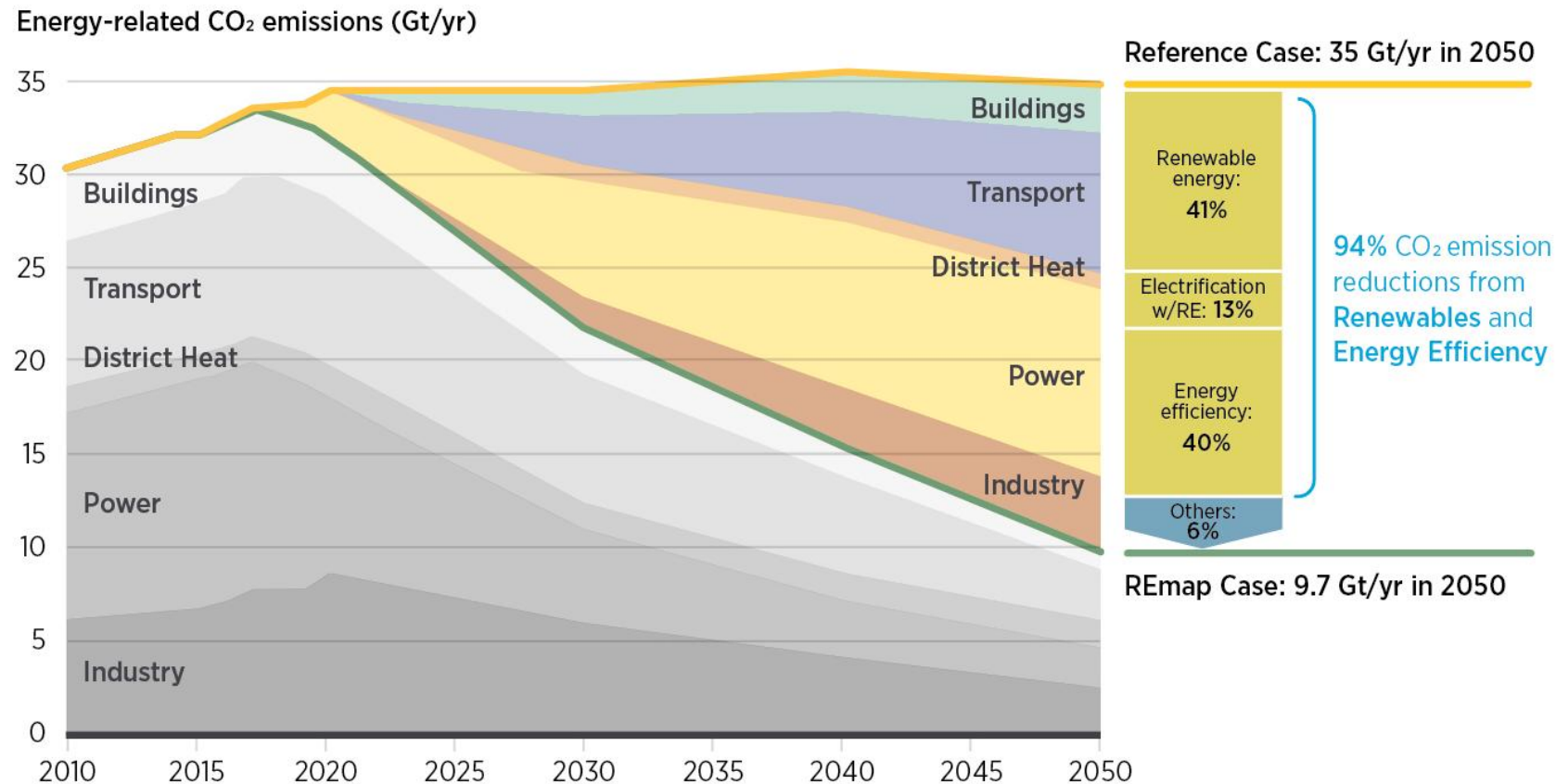
# A pathway for the transformation of the global energy system

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- The acceleration envisaged in the REmap Case would significantly transform the global energy system.
  - » Flat energy demand - the energy intensity of the global economy would need to fall by about two-thirds by 2050, a decline of 2.8% per year.
  - » The total share of renewable energy must rise from around 15% of TPES in 2015 to around 66% in 2050.
  - » A decarbonized power sector - 85% of electricity generation is from renewable sources including 60% variable renewables.
  - » Electrification of end use - the share of electricity rises to 40% of TFEC.
  - » Modern bioenergy can play a vital role in the energy transition if scaled up significantly – doubling of bioenergy use – notably liquid biofuels, feedstock and industrial use .

# Renewable energy and energy efficiency can provide over 90% of the reduction in energy-related CO<sub>2</sub>

## Annual energy-related CO<sub>2</sub> emissions and reductions, 2015-2050



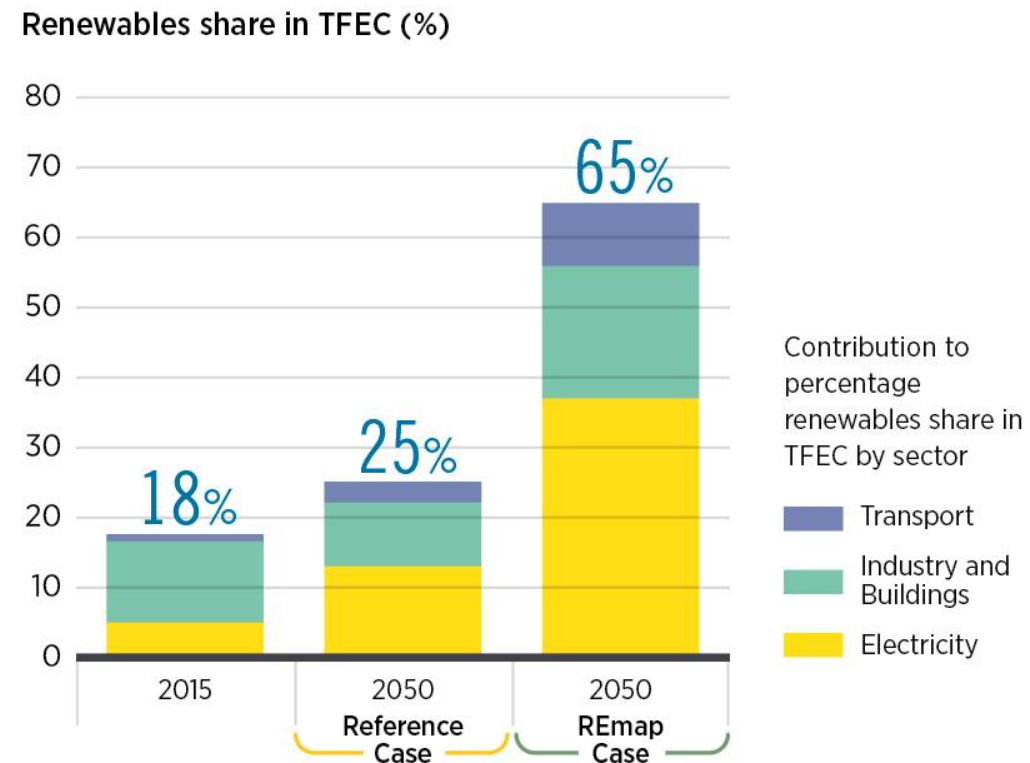
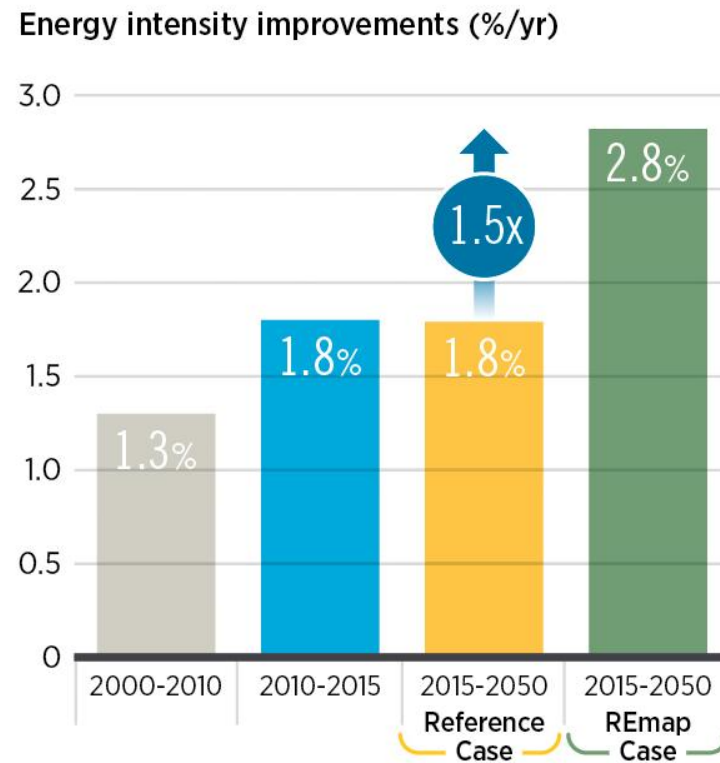
An upper limit of 2 degrees with a 2/3 chance of success:

790 Gt energy CO<sub>2</sub> emissions budget 2015-2100

Annual energy-related emissions are expected to remain flat (under current policies in the Reference Case) but must be reduced by over 70% to bring temperature rise to below the 2° C goal. Renewable energy and energy efficiency measures provide over 90% of the reduction required.

# Significant improvements in energy intensity are needed and the share of renewable energy must rise

## Energy intensity improvement rate and renewable energy share in TFEC, Reference and REmap cases

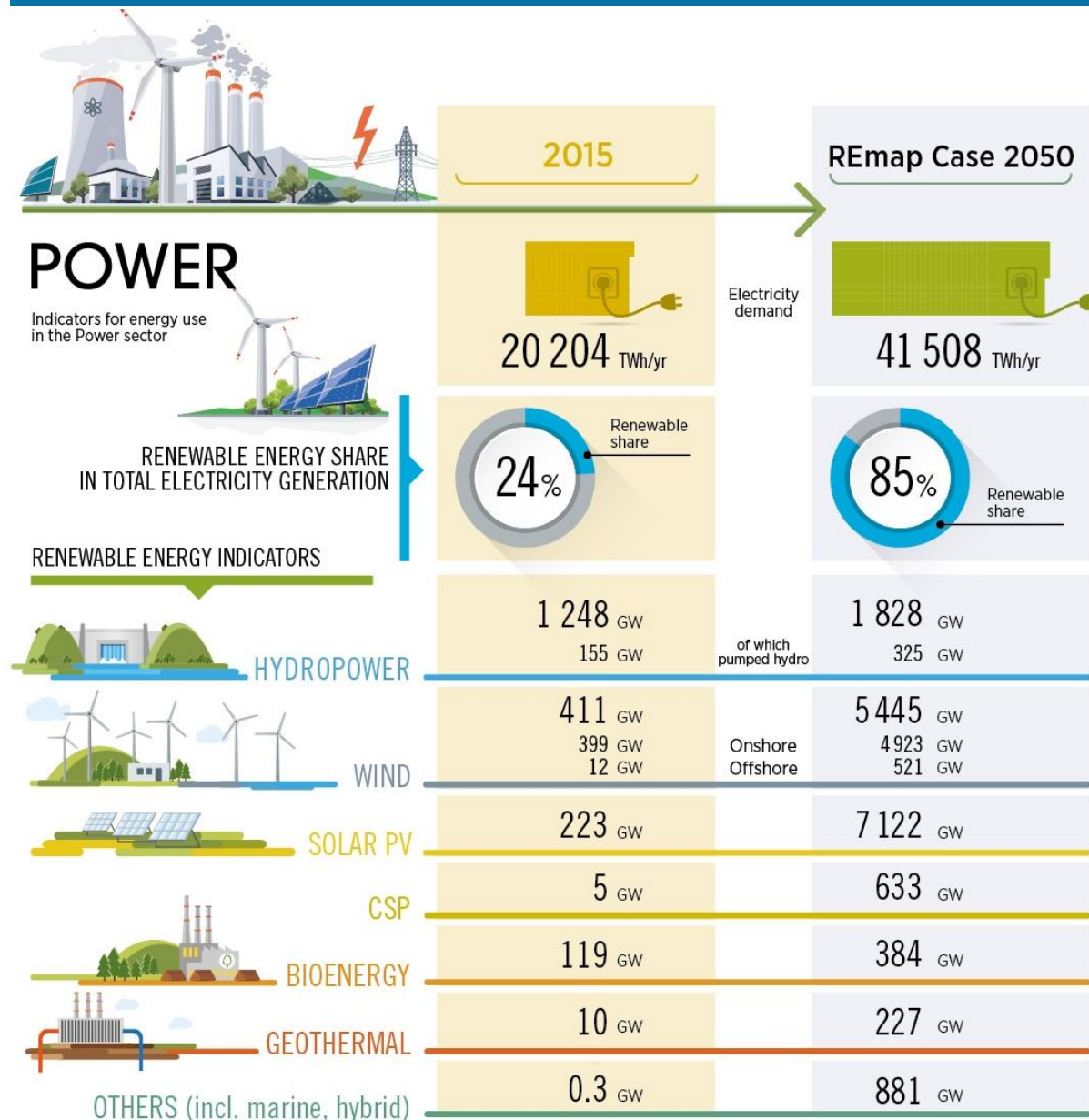


Source: Historical energy intensity improvement values from (SE4ALL, 2016), projections based on IRENA analysis

Both renewable energy and energy efficiency are at the heart of the energy transition and climate goals. By 2050 action in both areas must be scaled up considerably.



# Energy use indicators in Power



## INVESTMENT

Total investments for decarbonisation for the period 2015-2050



→ **POWER GENERATION**  
24.6 USD trillion

→ **POWER SYSTEM FLEXIBILITY AND GRID\***  
18 USD trillion

\* This includes investments needed for transmission and distribution grid expansion, increased generation flexibility, electricity storage.

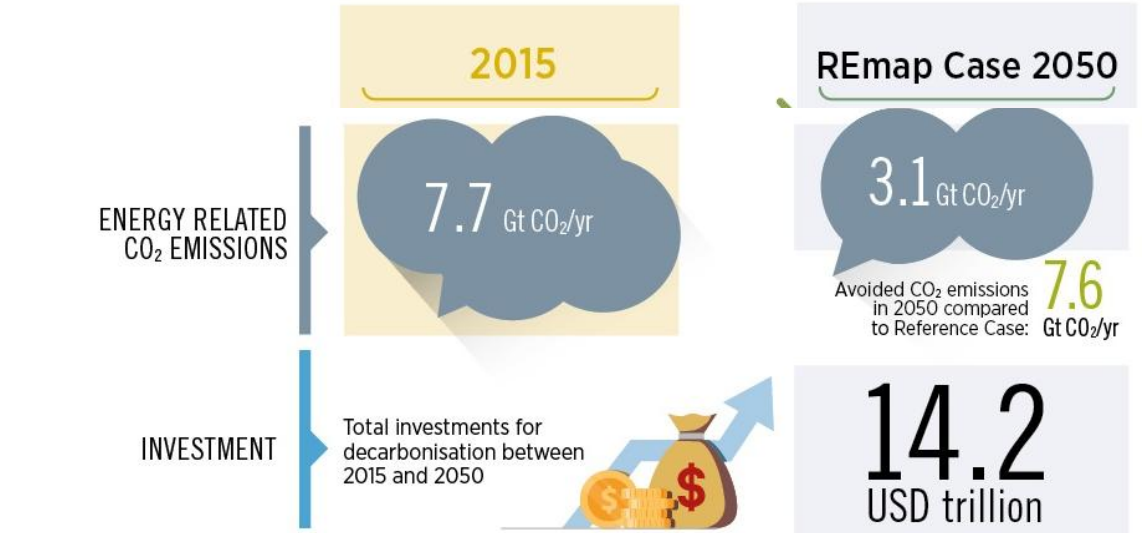
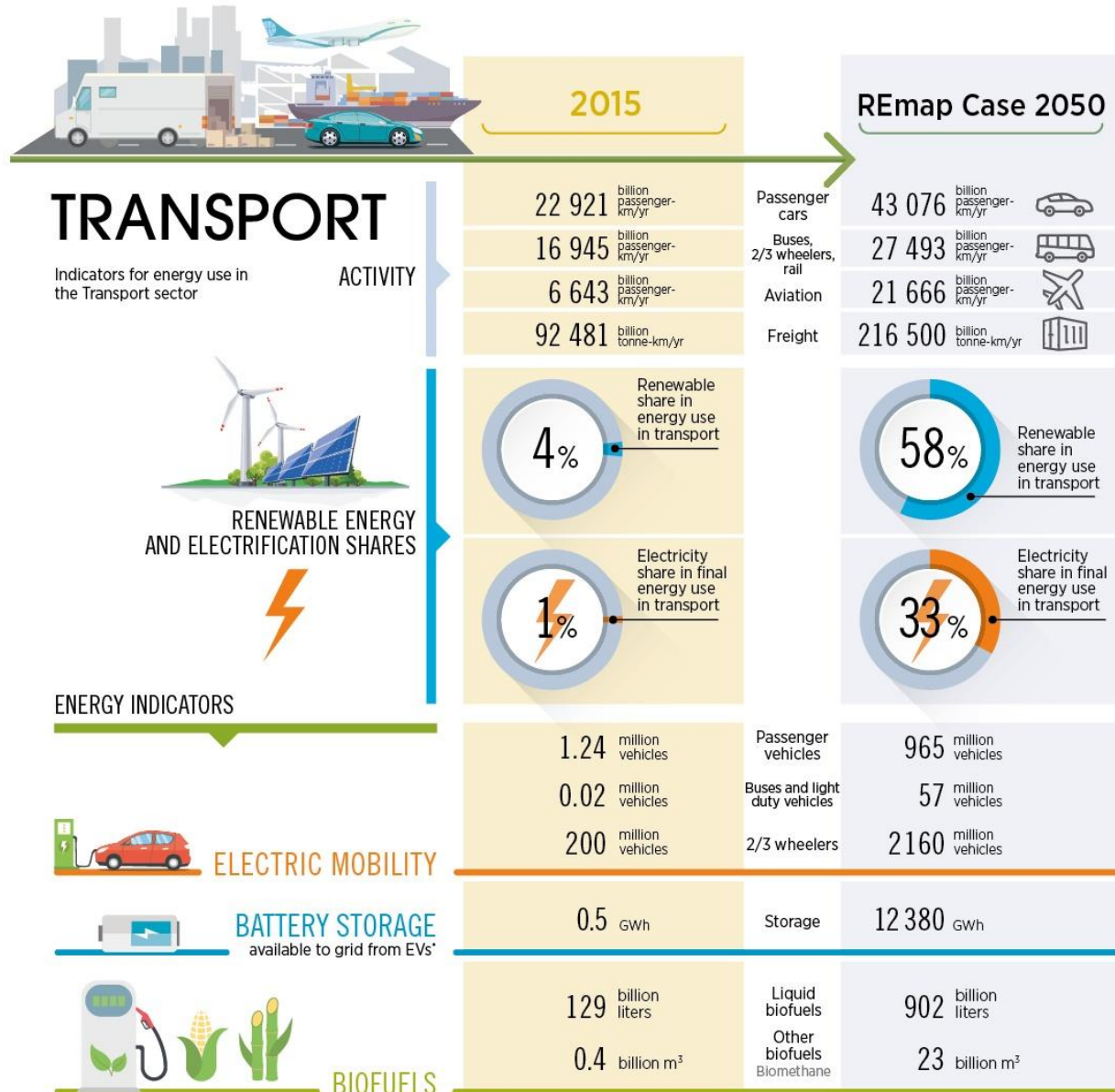
## STRANDED ASSETS

for the period 2015-2050

Delayed Policy Action  
1.4 USD trillion

REmap Case 2050  
1 USD trillion

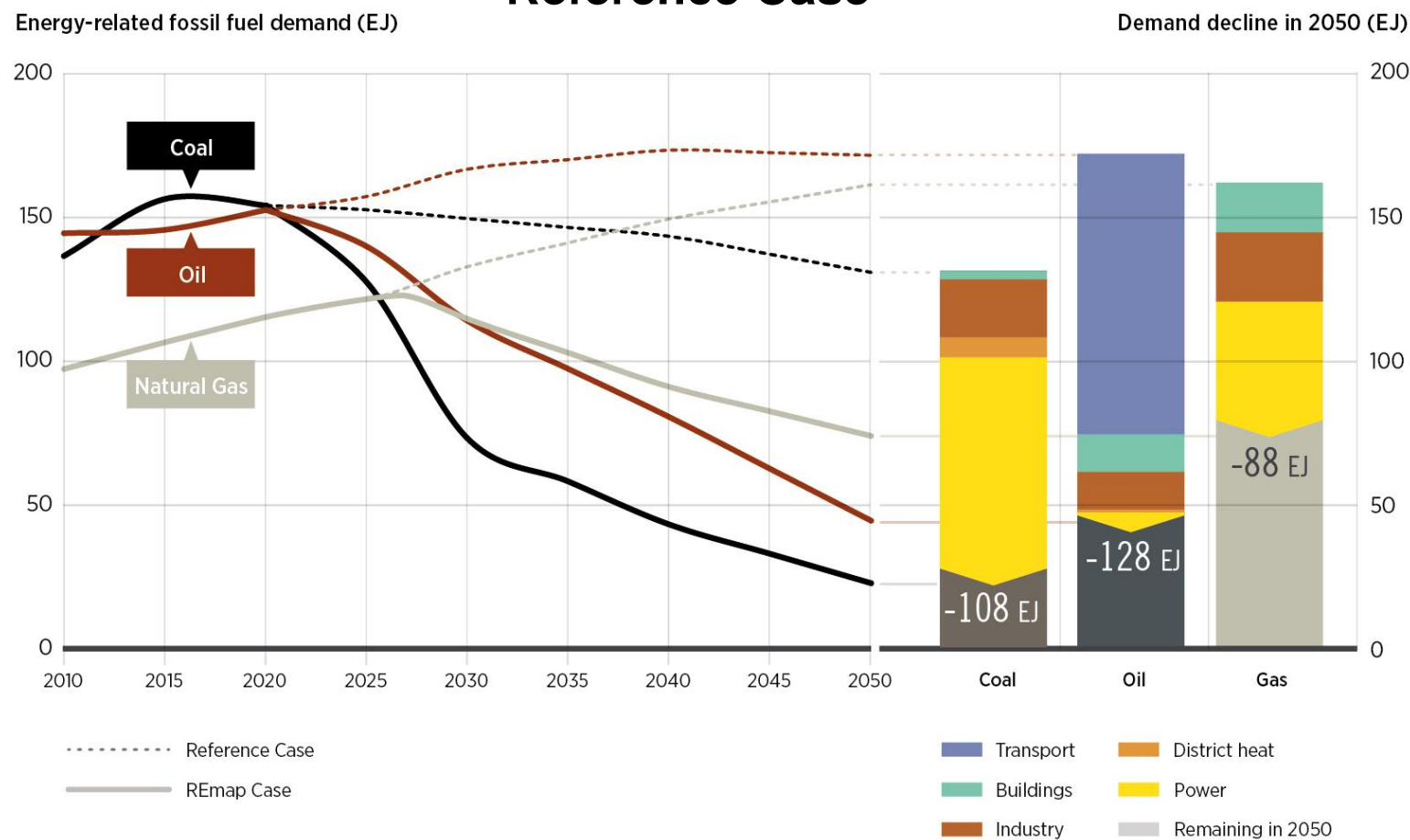
# Energy use indicators in Transport



\* Considering 50% grid connected EVs and 25% grid connected 2/3 wheelers

# Fossil fuel production must decline

## Fossil fuel use (left), 2015-2050; decline in fossil fuel use by sector - REmap Case relative to Reference Case



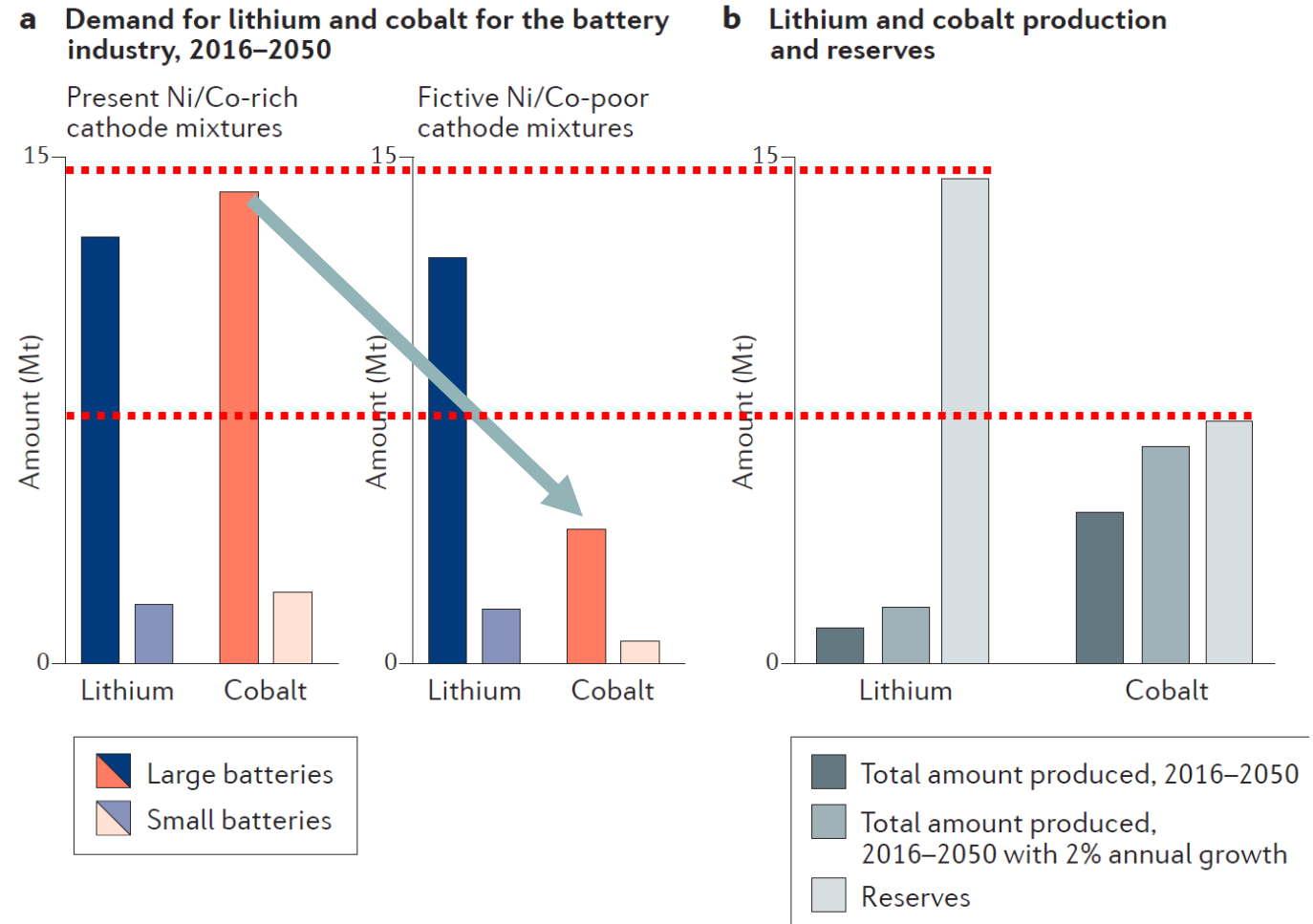
Under the REmap Case, both oil and coal demand decline significantly and continuously, and natural gas demand peaks around 2027. In 2050, natural gas is the largest source of fossil fuel.



- Global Commission established by IRENA
- Established January 2018
- Supported by Germany, Norway, UAE and around 20 members
- Deliverable is a report for the IRENA Assembly January 2019
- Kick-off meeting in Berlin 18-20 April 2018, 3 more meetings planned
- Energy security and new dependencies, economics, sustainability aspects

# Many uncertainties remain, transformation has just started

- Example: Lithium and Cobalt demand depend on battery composition.
- With today's technology, cumulative demand for Lithium may approach reserve levels and Cobalt demand may exceed reserve levels.
- Cobalt is today largely a by-product of Copper and Nickel mining in DRC.
- Copper demand will rise substantially:
  - one study (Elshkaki@Yale) projects energy demand for copper production to rise to 2.4% of global demand by 2050



Source: Vaalma et al., Nature 2018



To know more about the **Global Energy Transformation**, this and other IRENA publications are available for download from [www.irena.org/publications](http://www.irena.org/publications)

For further information or to provide feedback, please contact IRENA at [info@irena.org](mailto:info@irena.org)

For further information or to provide feedback on the socio-economic analysis please contact the Policy team at [policy@irena.org](mailto:policy@irena.org), on the REmap analysis please contact the REmap team at [remap@irena.org](mailto:remap@irena.org).

