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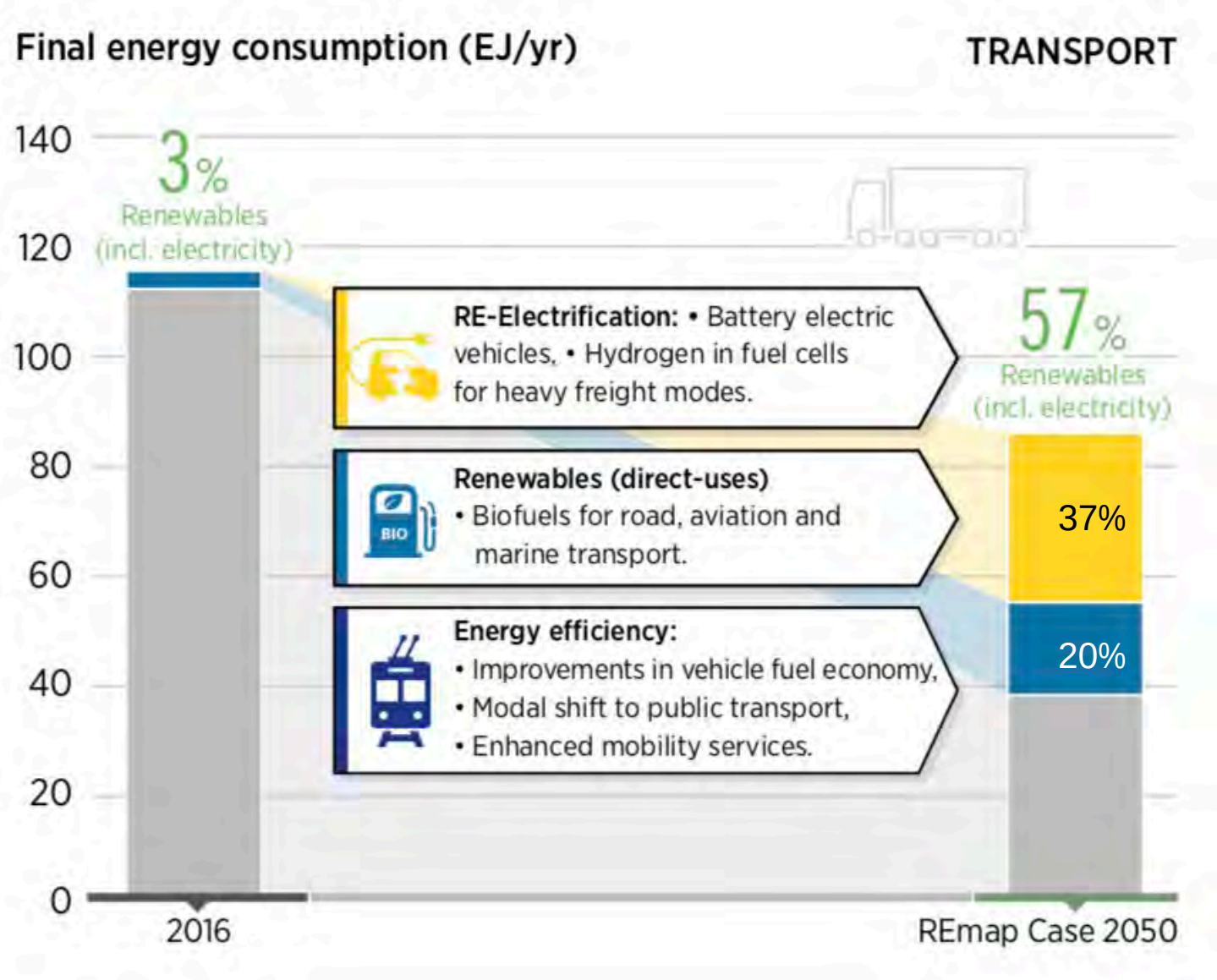
Perspective on biofuel and power demand in the transport sector

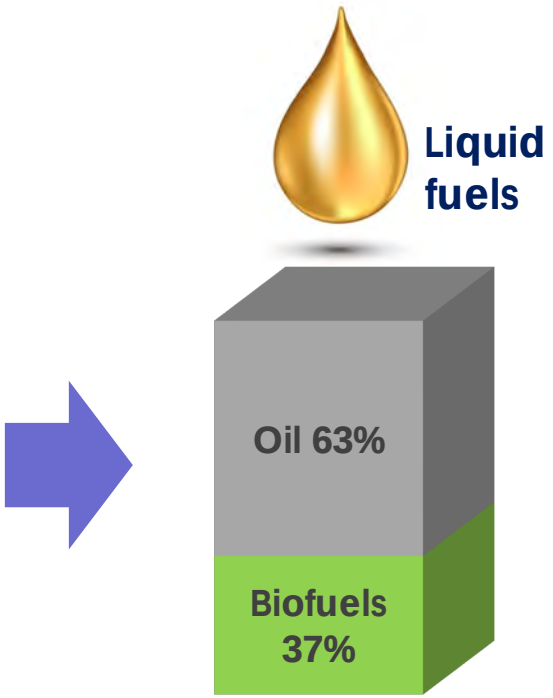
Francesco La Camera
Director General, IRENA
Symposium on Energy Outlooks, Riyadh, 19 February 2020

Transport sector – current situation

- Around **30% of total final energy consumption**
- 92% from oil products, **3% biofuels**, remainder electricity
- Around **25% of energy-related carbon emissions** (8.5 Gt of CO_2 annual emissions)
- **Large source of air pollution,** e.g. nitrogen oxides (NOx), particular matter (PM)
  - Under Remap, transport sector emissions would **decline 75% by 2050,** second largest reduction after the power sector
  - **Renewable electricity and electrification** make up 60% of overall reduction; higher in the transport sector

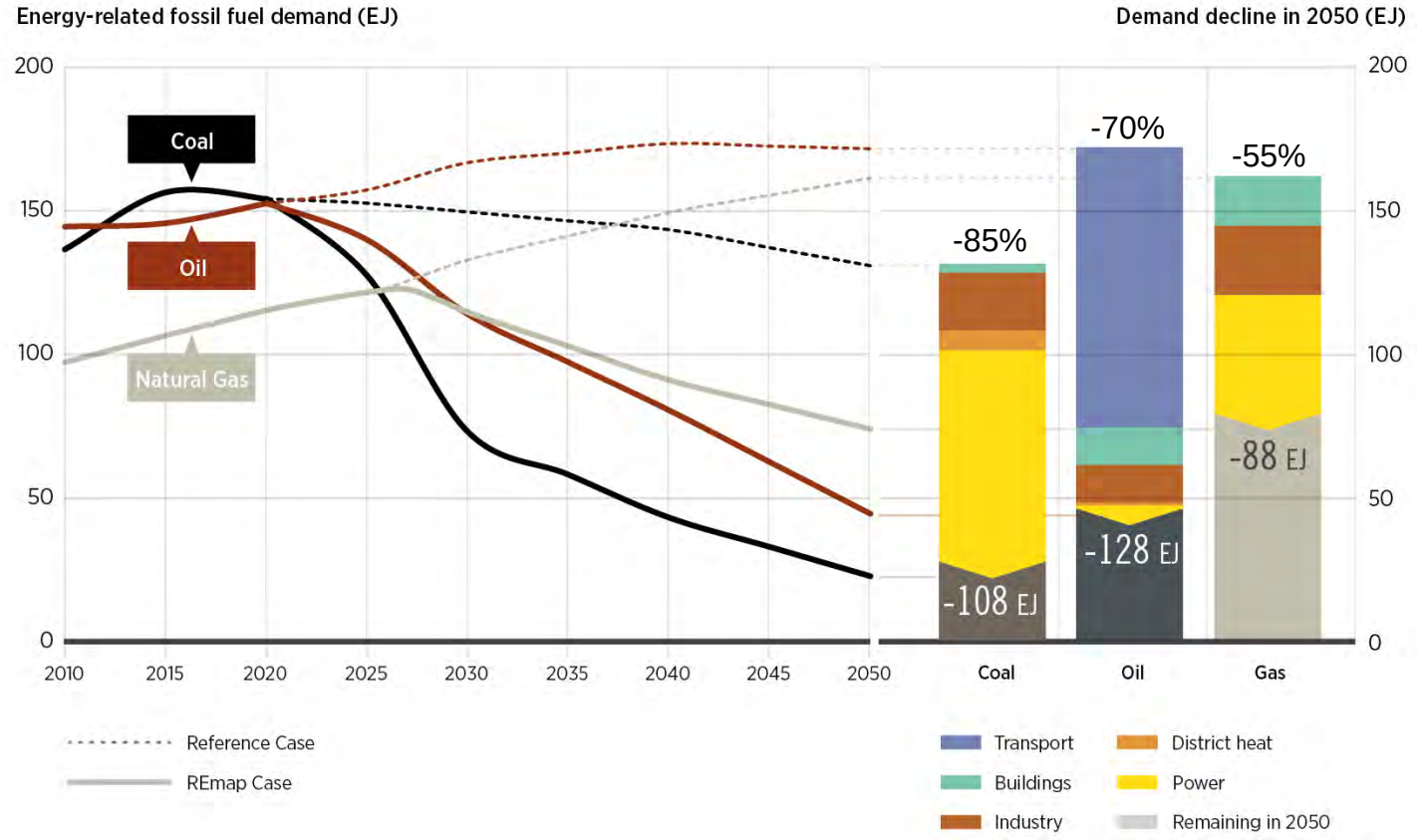
Transport sector decarbonisation pathways (REmap)





Fossil fuel production must decline

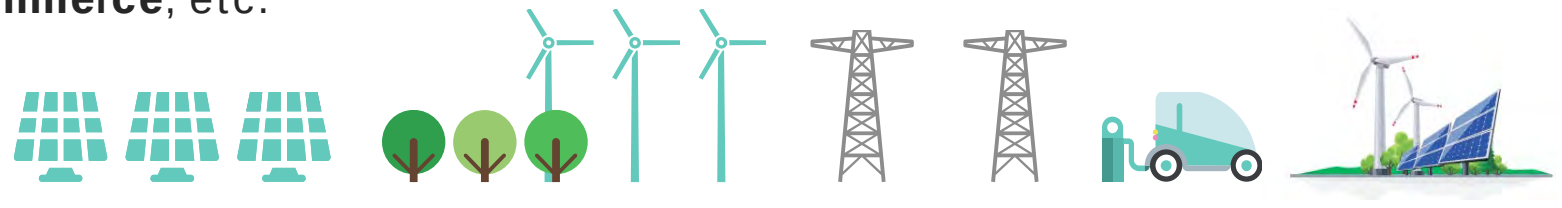
Fossil fuel use (left), 2015-2050; decline in fossil fuel use by sector - REmap Case relative to Reference Case



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.

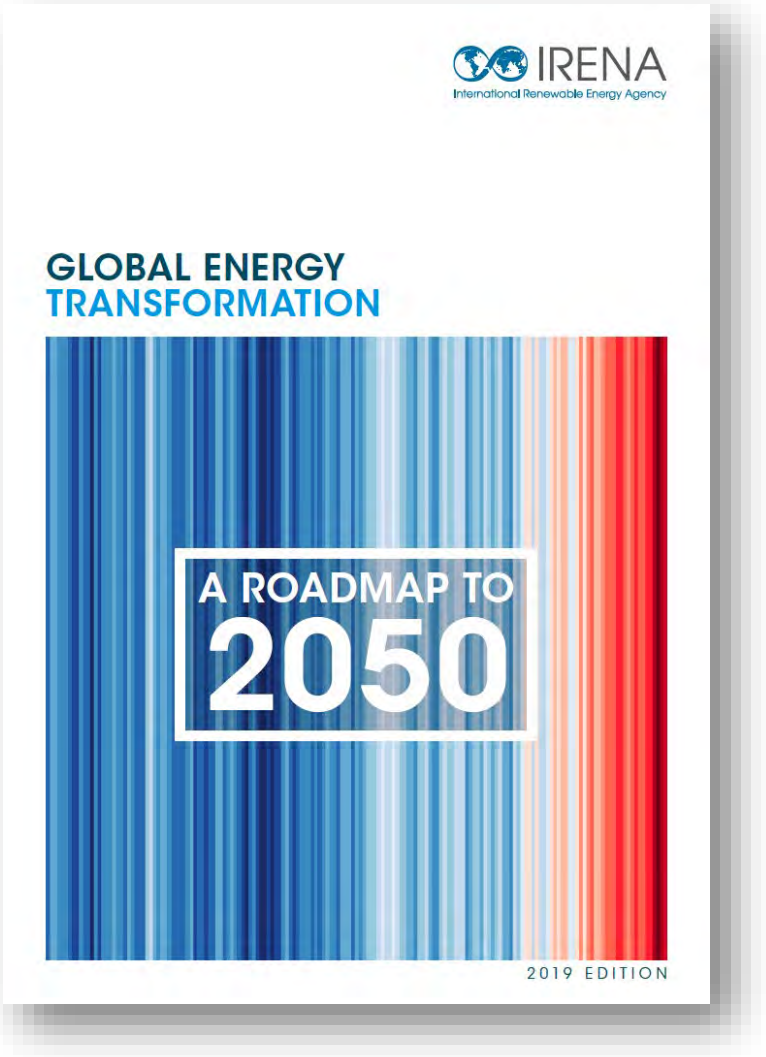
Decarbonising and digitalising

- **DECARBONISATION**
  - **Transport electrification** (i.e. direct electrification) **–** particularly in cars (batteries), but also public systems (trams, buses)
  - **Hydrogen and synthetic fuels, or e-fuels** (i.e. indirect electrification) **–** produced from electricity (needs to be zero-carbon) and uses hydrogen or other synthetic fuels (ammonia, methanol, etc.)
  - **Biofuels** – conventional, advanced, biomethane
  - **Others** – energy efficiency (materials, motors, etc.) and modal shift (cars->trains)
- **DIGITALISATION**
  - **Sharing mobility** – bike/car sharing, carpooling
  - **Mobility as a service** – apps and digital platforms that enable combined travel planning, including ride hailing
  - **Autonomous vehicles**
  - **AI and big data learning** to support optimised planning and operation of transport systems
  - Others including **remote work, e-commerce**, etc.



Role of electrification in transport

- Expanding the use of electricity is the main driver for accelerating the energy transformation
- In particular, the electric mobility revolution is gaining pace
  - At the end of 2019, an estimated 7.5 million EVs were on the roads worldwide
  - To reach our climate goals, around 160 million EVs should be on the roads by 2030 and more than 1 billion by 2050
- Globally, by the end of 2019, there were around 880 000 Public Charing Points (PCP)
- The switch to electricity is not just happening with cars
  - Electric buses are making large in-roads, particularly in China
  - Shenzhen has over 16 000 electric buses in operation



Source: IRENA Global Energy Transformation: A roadmap to 2050 (2019 edition)

Impact of charging EVs on solar PV and wind integration

- Electric vehicles have a **small impact on energy demand** but **larger impact on peak load**
- **Different impact** of EV charging in a **wind or solar PV**-dominated power system
- **Smart charging** cuts **peak load**, reduces **curtailment** and allows higher shares of low-cost PV and wind electricity

International shipping accounts for around 9% of global transport sector emissions

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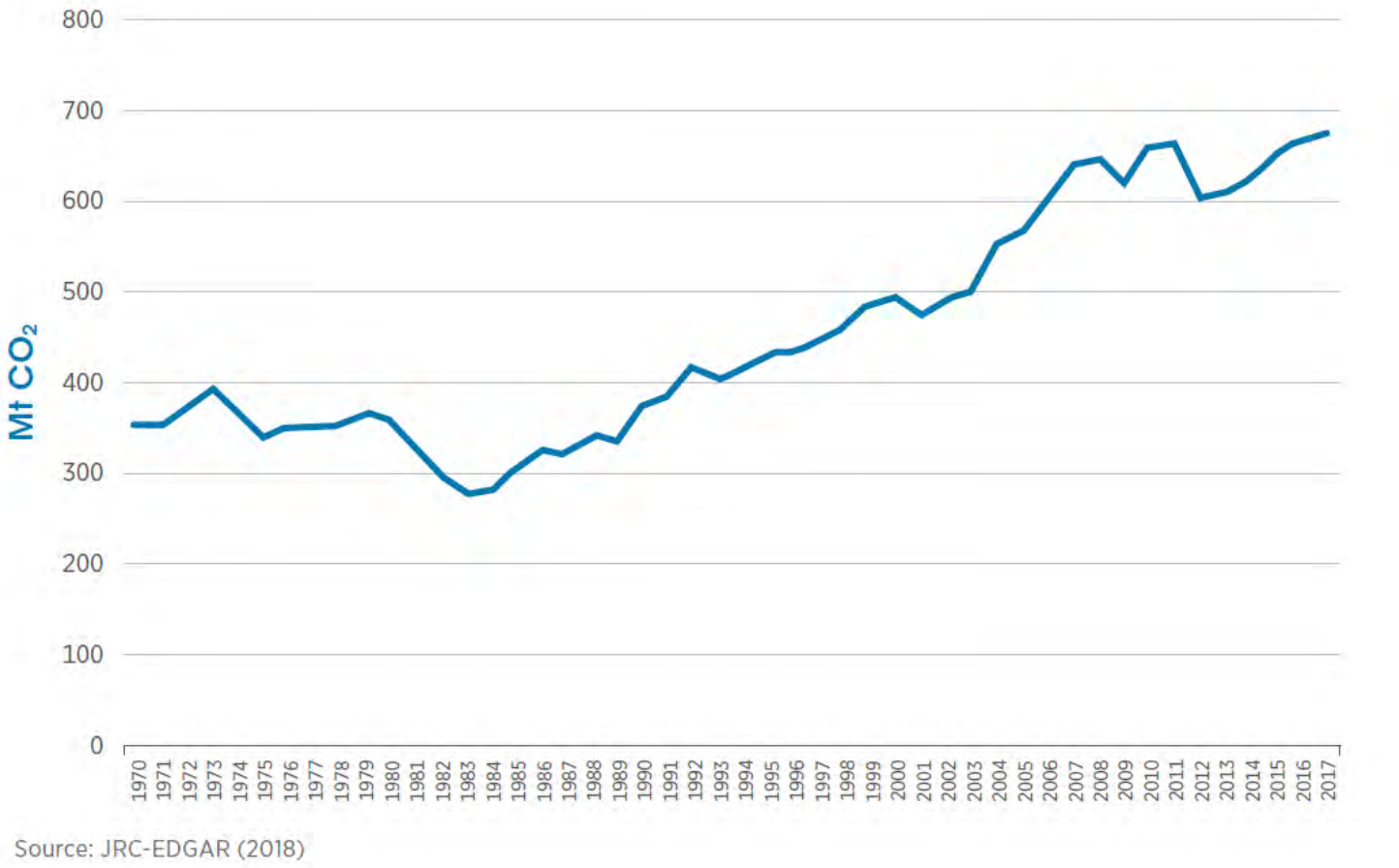
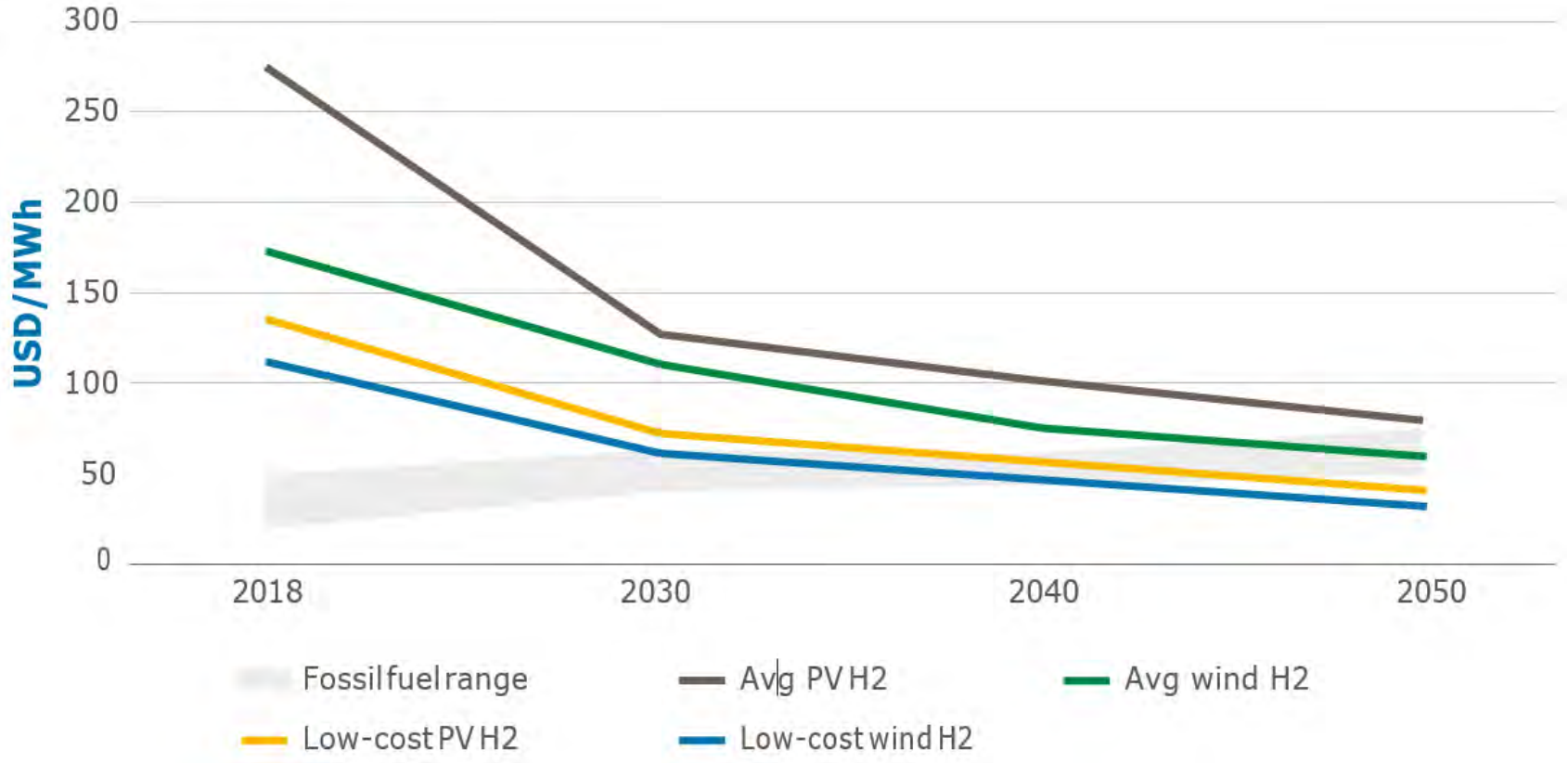


Annual CO_2 emissions associated with international shipping

- The current energy needs of the shipping sector are mostly met by heavy fuel oil (82%), marine gas and diesel oil (18%).
- Global trade volume is estimated to grow at 3.8% per year over the next five years.
- Between 2000 and 2017, the CO_2 emissions associated with the shipping sector grew at an average annual rate of 1.87%.

Hydrogen has an important role to play in the transition to zero-emission shipping

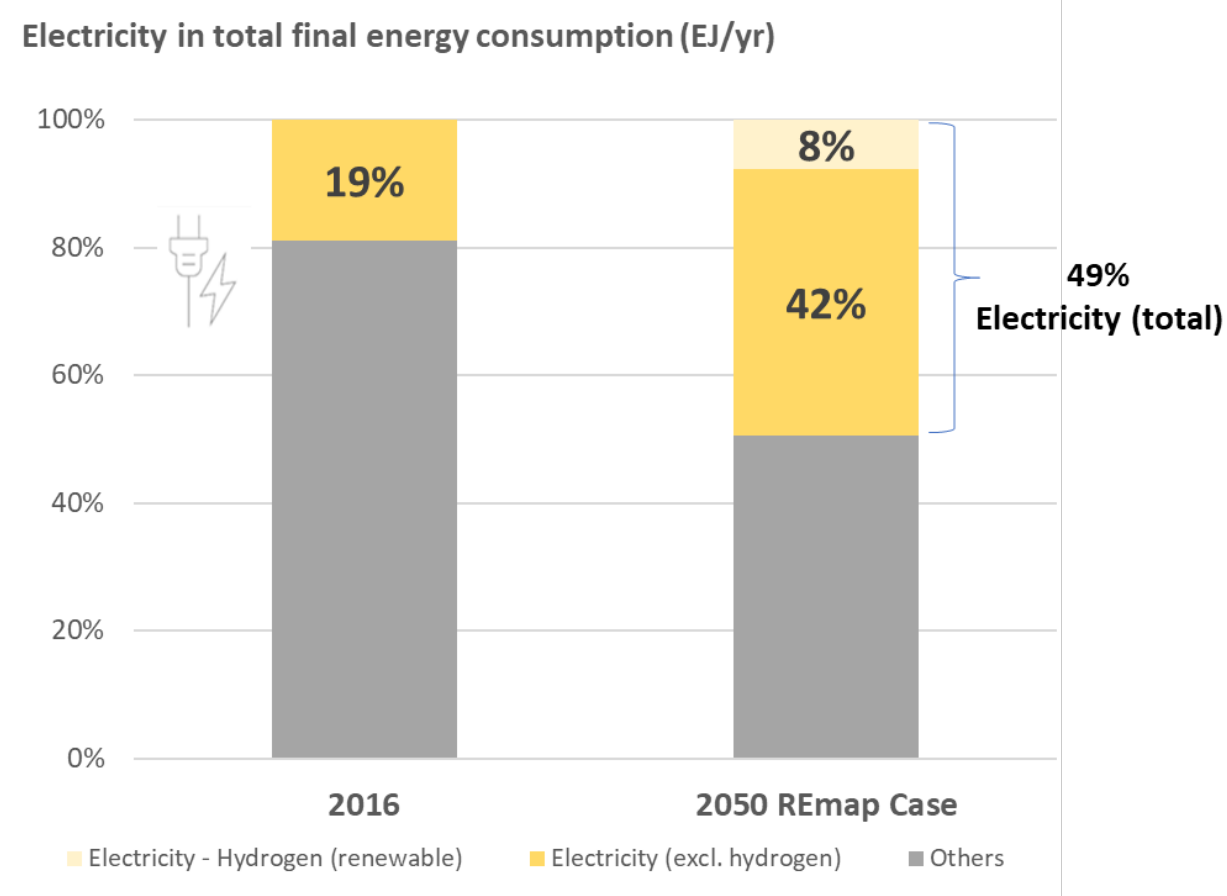
Hydrogen product cost projections



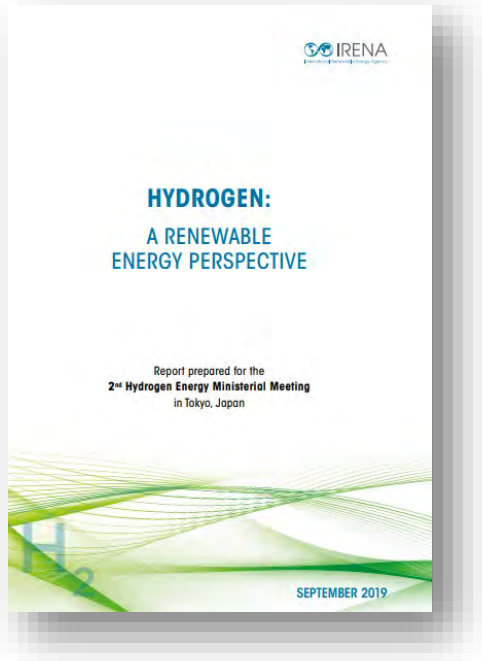
Source: Hydrogen cost projections (IRENA, 2019); fuel cost projections (Lloyd's Register, 2019; Ship & Bunker, 2019)

- Compared to fossil fuel usage, hydrogen would eliminate direct carbon and SOx emissions while reducing NOx emissions to negligible levels.
- The better solution, though, is green hydrogen from renewable sources, as this is the only source of zero carbon hydrogen.

The role of hydrogen in the energy transition



4 TW renewables for hydrogen production

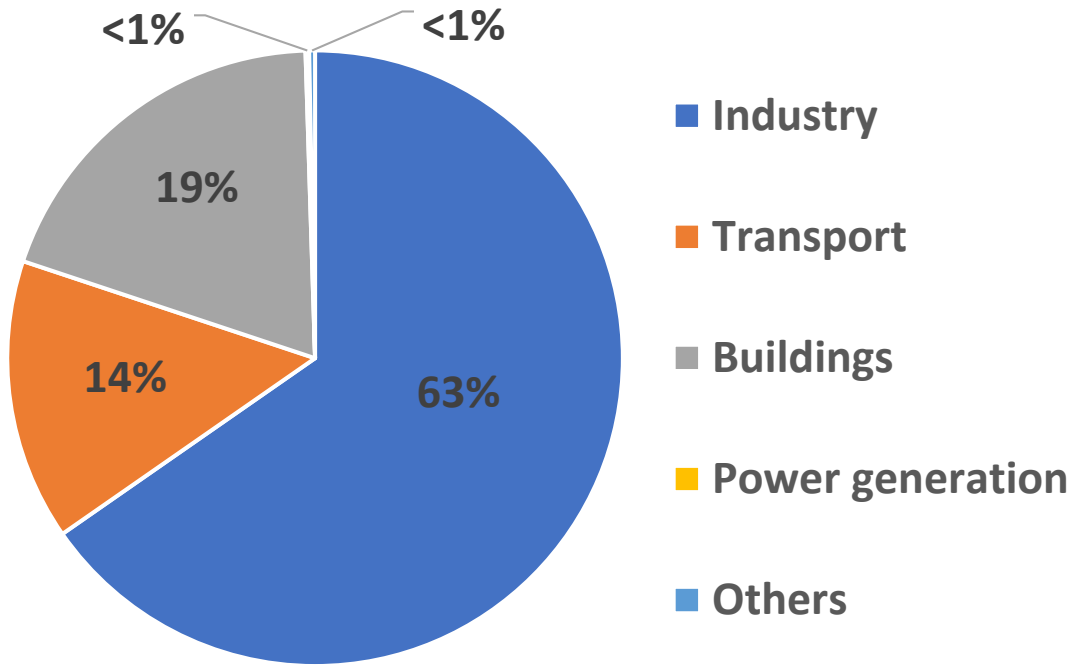


- Hydrogen can be used in the **industry, transport and buildings** sectors for a variety of purposes, i.e. energy vector, feedstock, fuel - **Ensuring a low-carbon, clean hydrogen supply is essential**!
- It offers a way to recycle assets and **potentially transport a renewable, multi-purpose energy carrier** and feedstock over long distances

E-fuels

- From H_2 + CO_2
- Synthetic methane and synthetic liquids
- Technically feasible but at high cost
- Not yet applied on a commercial scale
- Existing gas and liquids infrastructure and equipment can be used – avoid asset stranding
- Biofuels constitute a complementary/competing option
- Advanced biofuels are cheaper today than E-fuels

Hydrogen potential in end-use sectors by 2050



Ranking the barriers to investment in advanced biofuels

Released November 18, 2019

- The most important group of barriers relates to lack of stable regulation, including mandates and subsidies
- This is followed by the difficulty of financing (availability and cost) and cost competitiveness of advanced biofuels production, including conversion efficiency & CAPEX

Summary of key points

- Transport sector emissions need to **decline by 75%,** despite almost a **doubling of passenger and freight activity by 2050**
- Sector's growth shifting from OECD to **non-OECD countries**
- **Energy sector and transport sector transformation** are two sides of the same coin
- **Decarbonisation and digitalisation** are disrupting the transport sector
- Options for decarbonization include sirect and in-direct **electrification**, **biofuels**, **efficiency**
- Electrification increases to **43% of total final energy consumption, USD 13 trillion investment** to 2050

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Global international bunkering for shipping accounts for 8.9 exajoules, this resulted in 677 megatons of CO_2 (2017)

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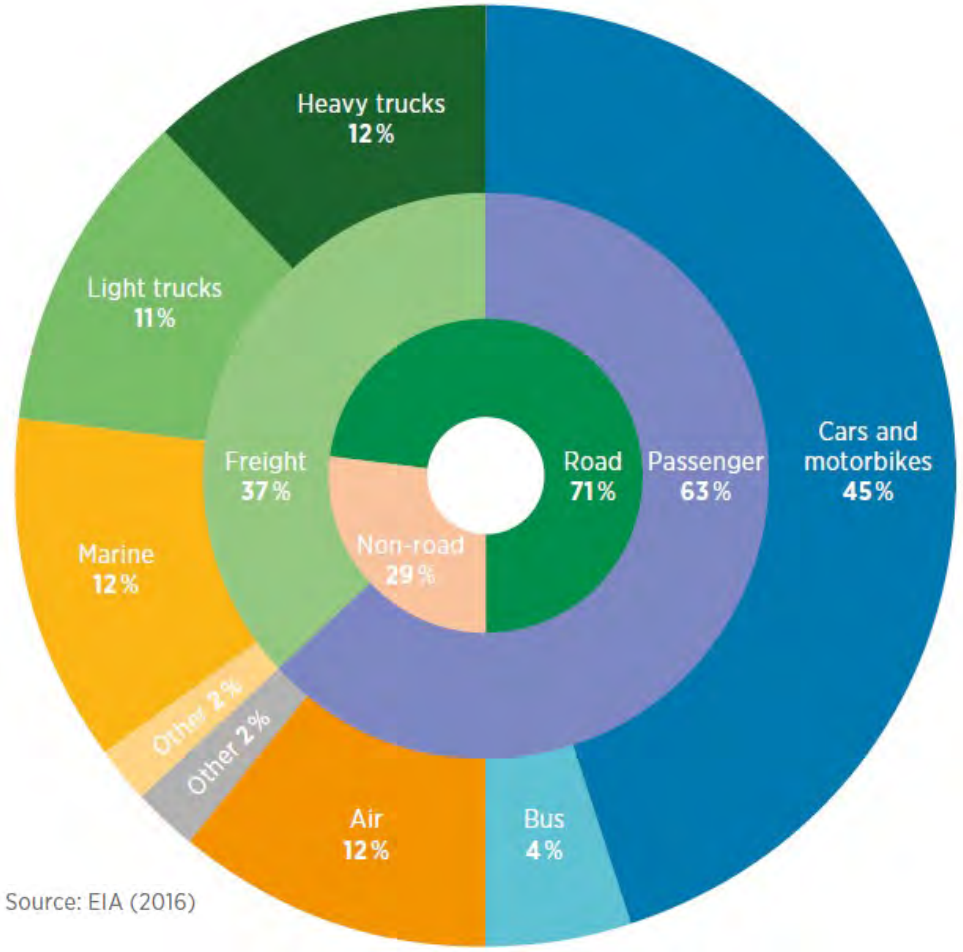
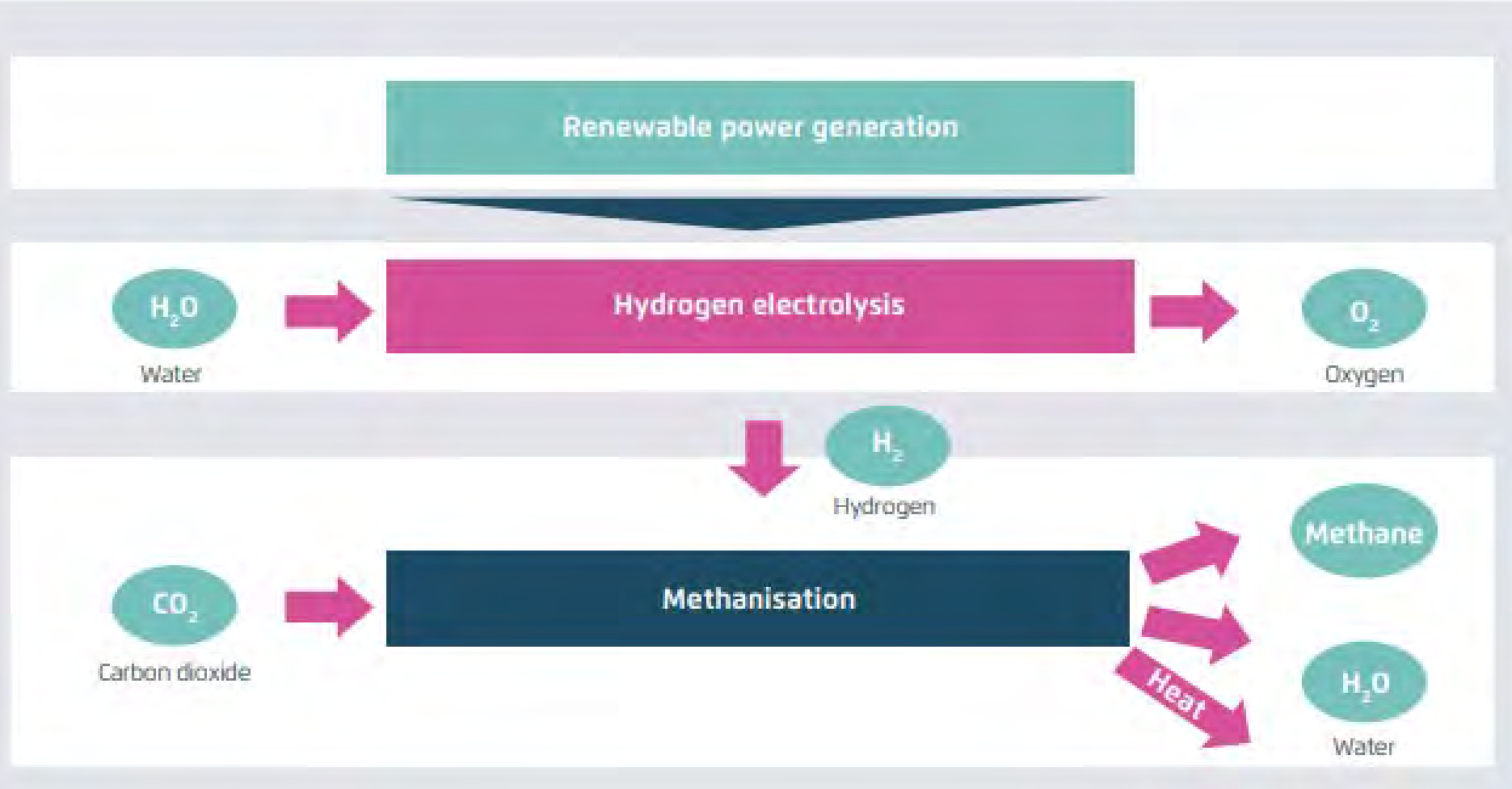
Disaggregation of global energy consumption on the transport sector



Source: EIA (2016)

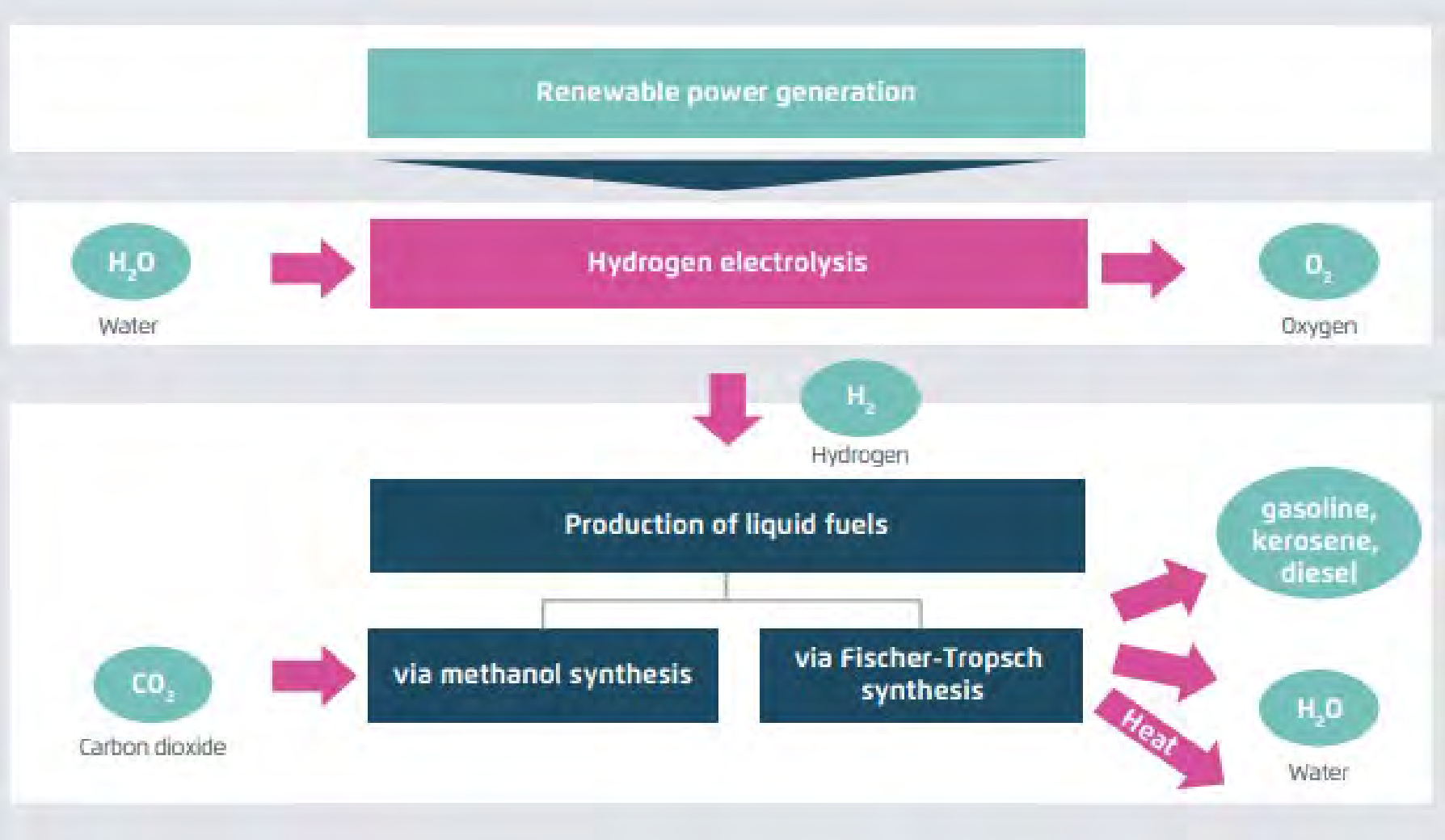
- International shipping alone accounts for around 9% of global emissions associated with the transport sector
- The current energy needs of the shipping sector are mostly met by heavy fuel oil (82%), marine gas and diesel oil (18%)
- Global trade volume is estimated to grow at 3.8% per year over the next five years
- Between 2000 and 2017, the CO_2 emissions associated with the shipping sector grew at an average annual rate of 1.87%

Conversion of electricity to synthetic methane



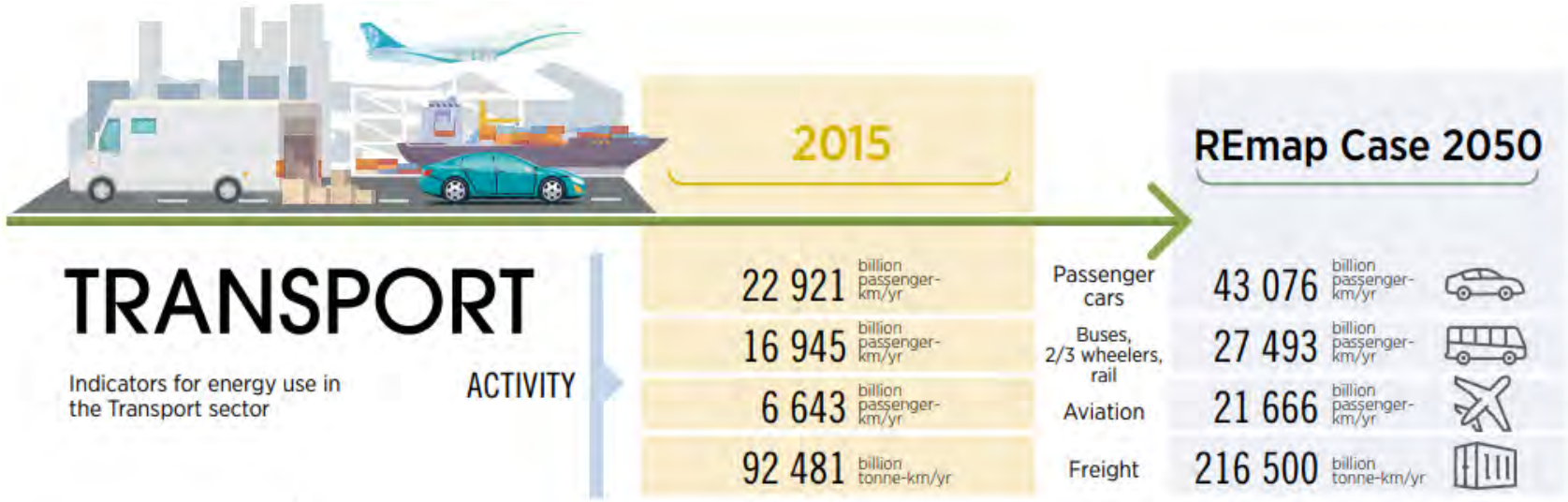
Source: Agora (2017)

Conversion of electricity to synthetic liquid fuels



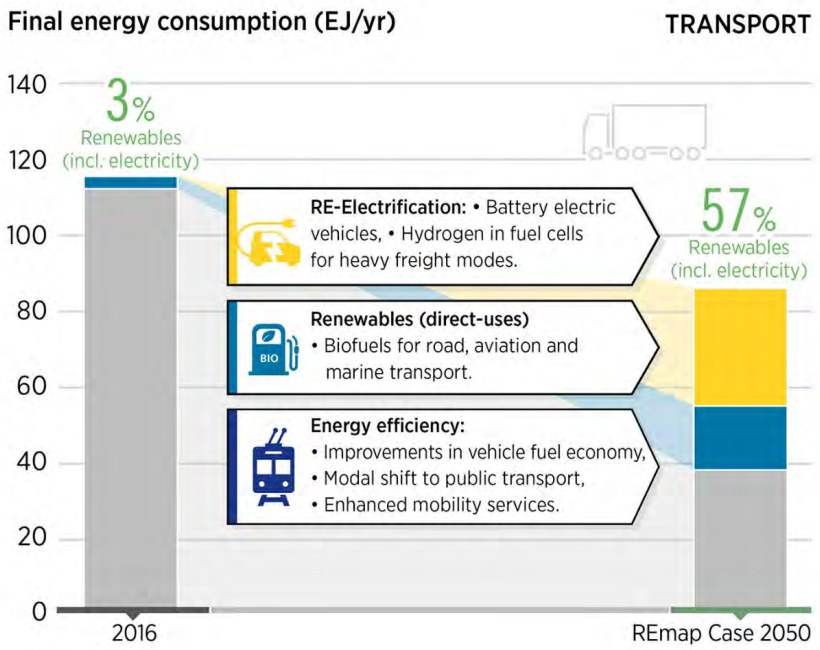
Source: Agora (2017)

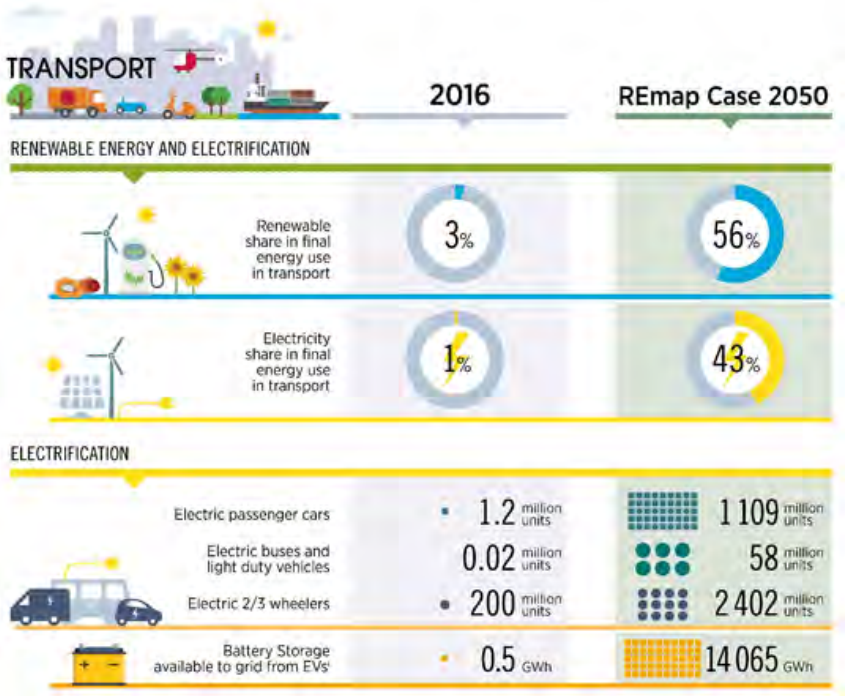
Transport sector – future demand growth



- **Passenger transport activity will increase 75%** even in a climate friendly scenario (REmap), more according to current and planned policies (Reference Case)
- Today's split is **45% OECD, and 55% non-OECD**; by **2050 28% OECD and 72% non-OECD**
- **Freight tonnage will more than double**; shipping will continue to dominate with 75% of tonne/km
- **Energy intensity** differs by mode:
  - Cars 1.0-3.5 MJ/p-km (average 2.1), aviation 1.0-2.9 (average 1.75), bus 0.6, two-three wheeler 0.5, rail 0.3
  - Trucks 0.7-2.0 MJ/t-km, rail 0.4, shipping 0.3

Increasing electrification in the transport sector

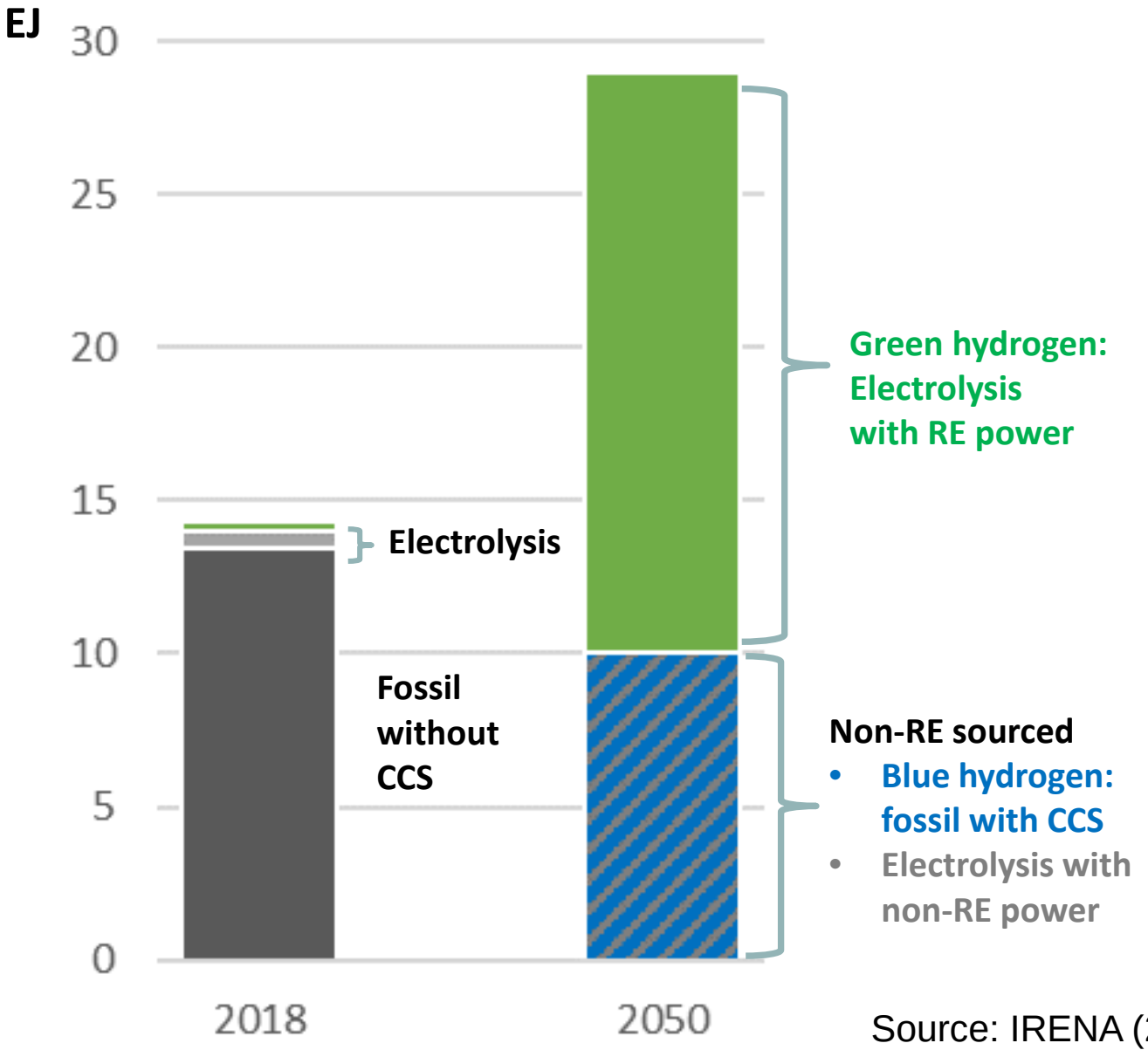




- Electricity providing 43% of total transport energy consumption, and due to higher efficiency, **covering 60% of the overall transport activity**
- Renewables increase to provide **57% of transport TFEC by 2050**
- Overall passenger and freight activity almost doubles (but less than under the Reference Case); but due to energy efficiency and electrification, **TFEC in transport declines**

Source of hydrogen – today and 2050

A shift to clean hydrogen with a key role for green hydrogen



Today:
About 14 EJ hydrogen produced mainly from fossil source - **green and blue hydrogen production is negligible**

2050:
Two-thirds of hydrogen produced could come from green hydrogen

Demonstration projects with electrolysis – with increasingly bigger sizes (> 50 MW)

Source: IRENA (2019)

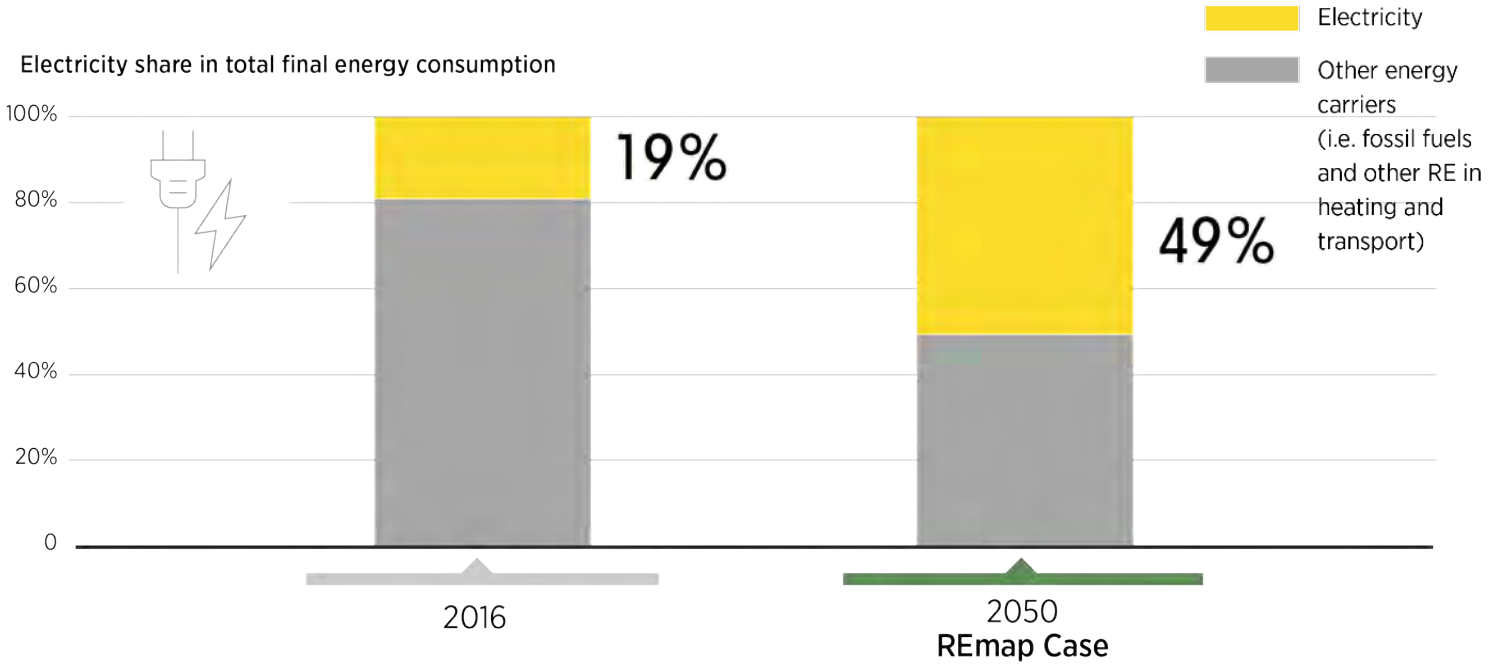
Energy transition has made progress but acceleration is needed – transport is key

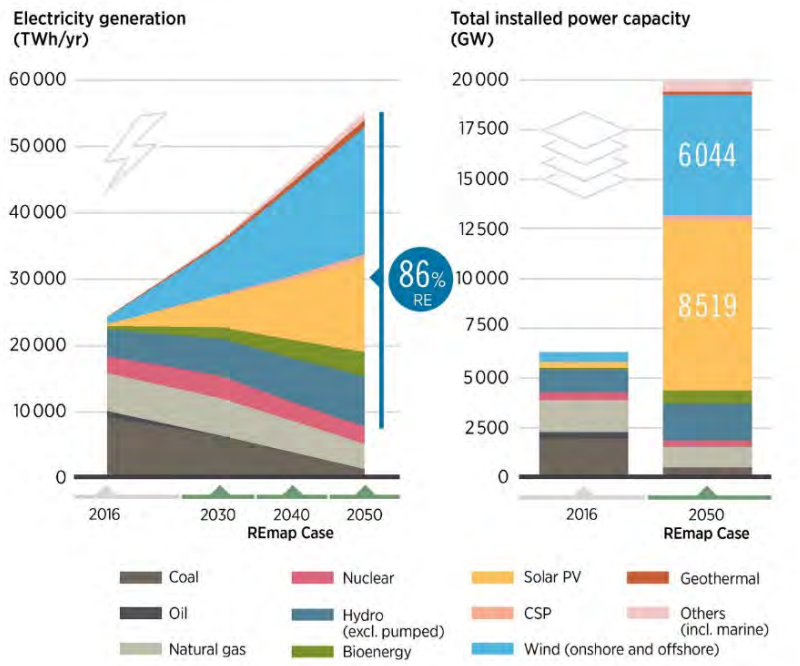
- **Energy transition:**
  - **Costs of renewable energy continue** to decline rapidly with wind and solar leading capacity expansion: 84% of new renewable power capacity added in 2018;
  - **Power is becoming distributed and renewable**; flexibility is key (storage, demand, grids)
  - **Key technologies** with falling costs include PV, wind, batteries, electrolysers

- **Transport transformation:**
  - **Renewable share** remains largely unchanged, efficiency has improved
  - **Expanding electricity use** (direct and indirect) can be a main driver: e.g. EV sales surpassed 2 million units in 2018
  - **Digital platforms** allowing for mobility sharing and multimodality
  - **Sector coupling,** power to vehicle, power to gas, power to grid

→ Two main themes: **Decarbonisation and Digitalisation**

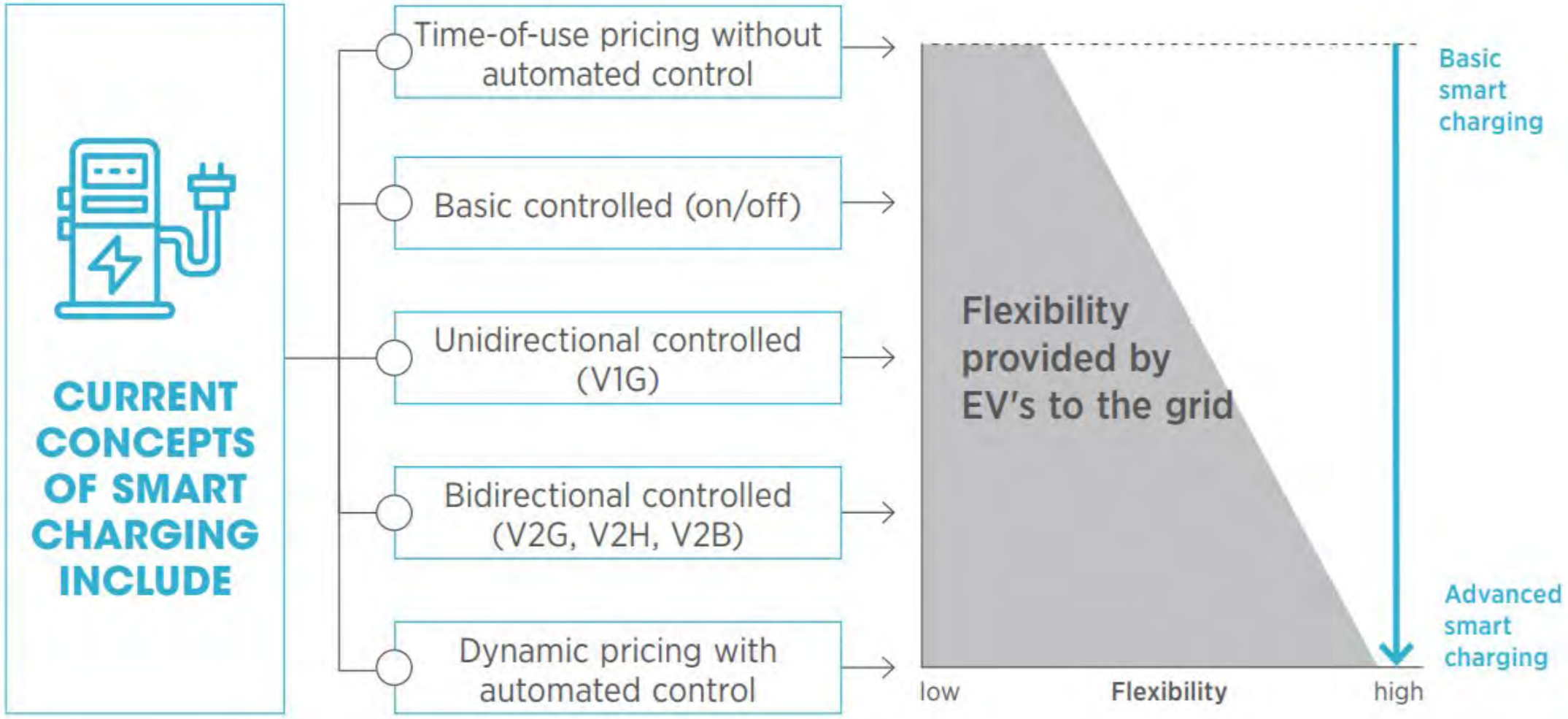
Electrification paired with renewables is a major solution for decarbonisation





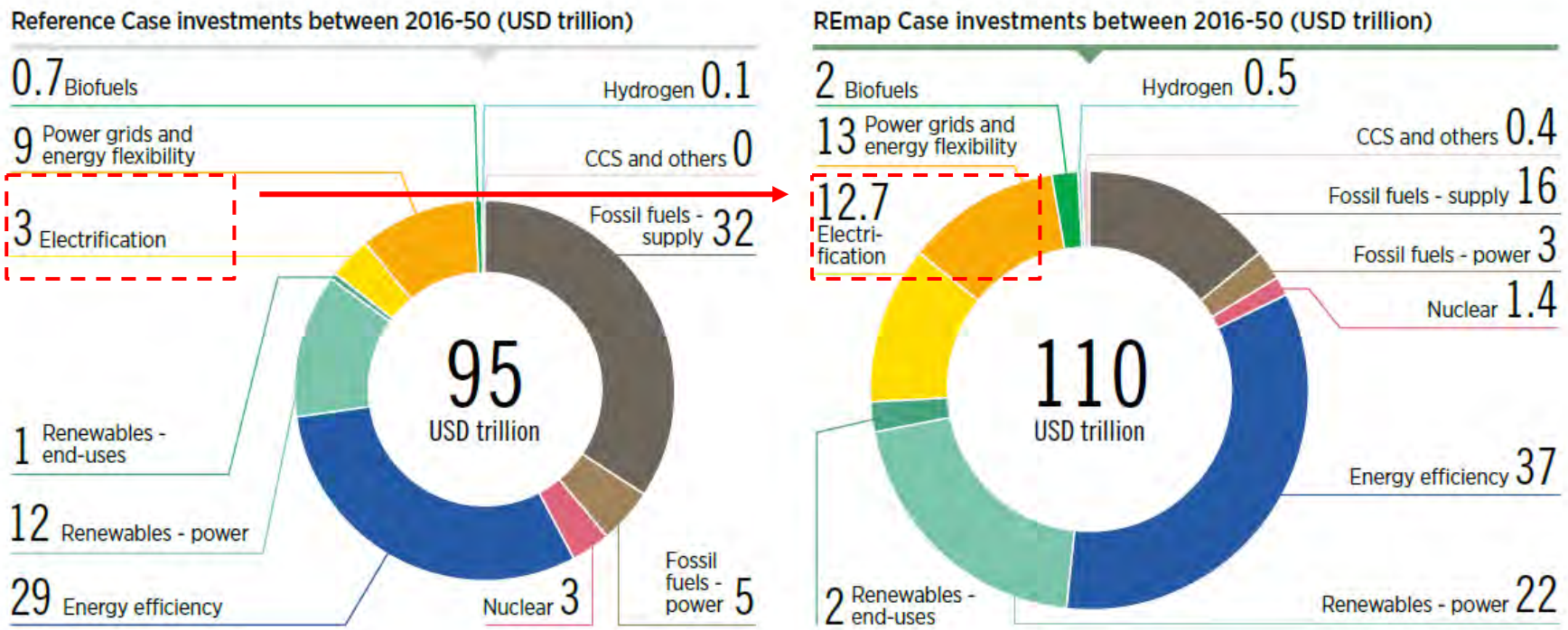
- By 2050, **electricity will provide around 50% of the global final energy mix**
  - Electricity consumption in end-use sectors will more than double from today's level - Electricity consumption includes both direct (e.g. EVs) and indirect (e.g. hydrogen or other e-fuels)
- **86% of electricity generation** will come from renewables in 2050
- **The share of electricity consumed in TFEC** in transport will increase from 1% today to 43% by 2050

Smart charging makes EVs a source of flexibility for power systems - facilitating integration of VRE



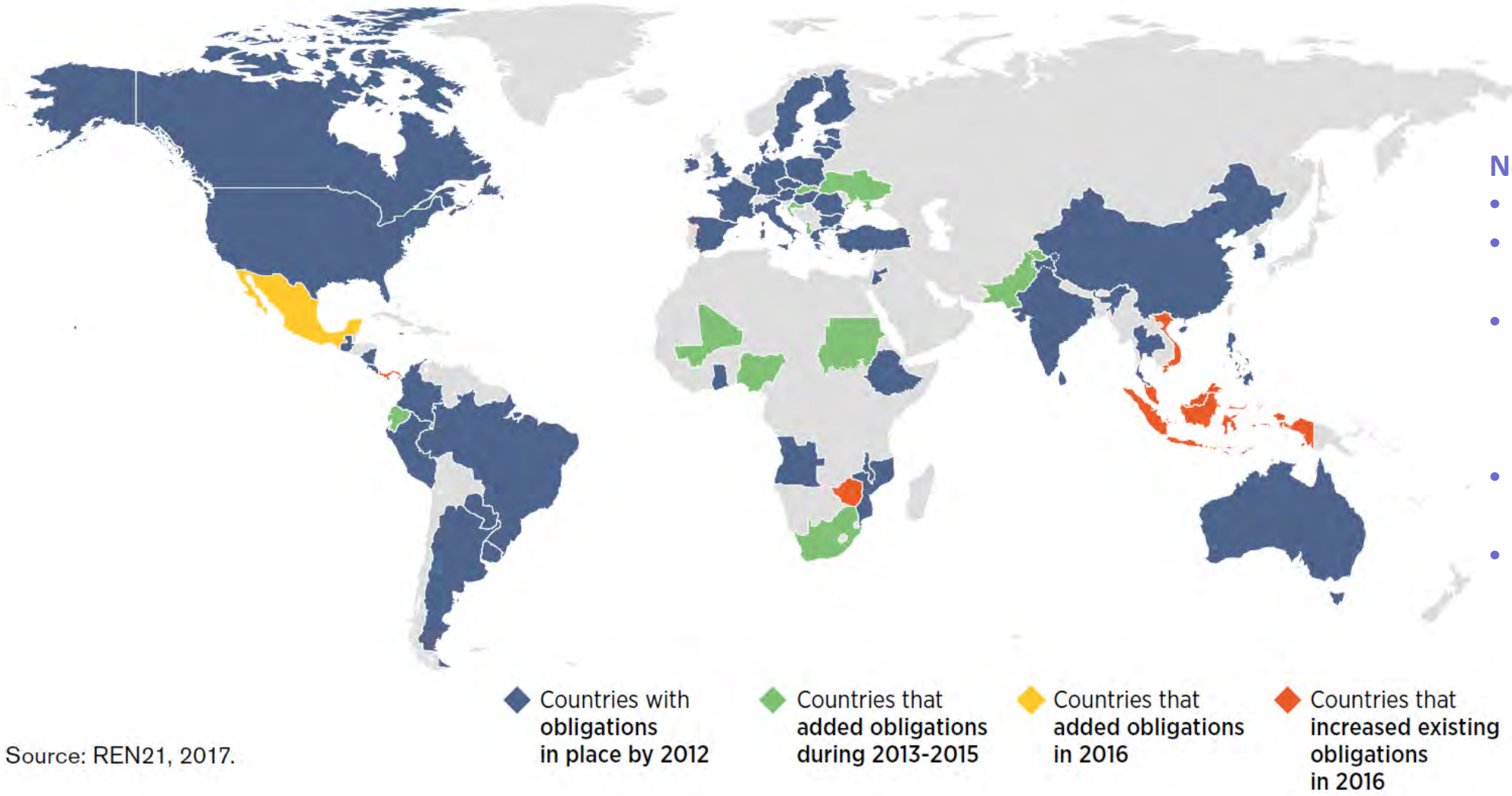
Source: IRENA (2019) Innovation Outlook: Smart charging for Electric Vehicles

Investment will need to shift to EE, RE and electrification of heat and transport applications



- Cumulative investment of USD 110 trillion must be made between 2016-2050 predominantly in low-carbon technologies, **averaging around 2% of global GDP per year over the period**
- **Shifting investments into electrification, renewable energy and energy efficiency technologies,** which together, would make up **four-fifths of the cumulative energy sector investments** over the period to 2050
  - USD 12.7 trillion in electrification technologies in end-uses

Countries with biofuel obligations for transport, 2016

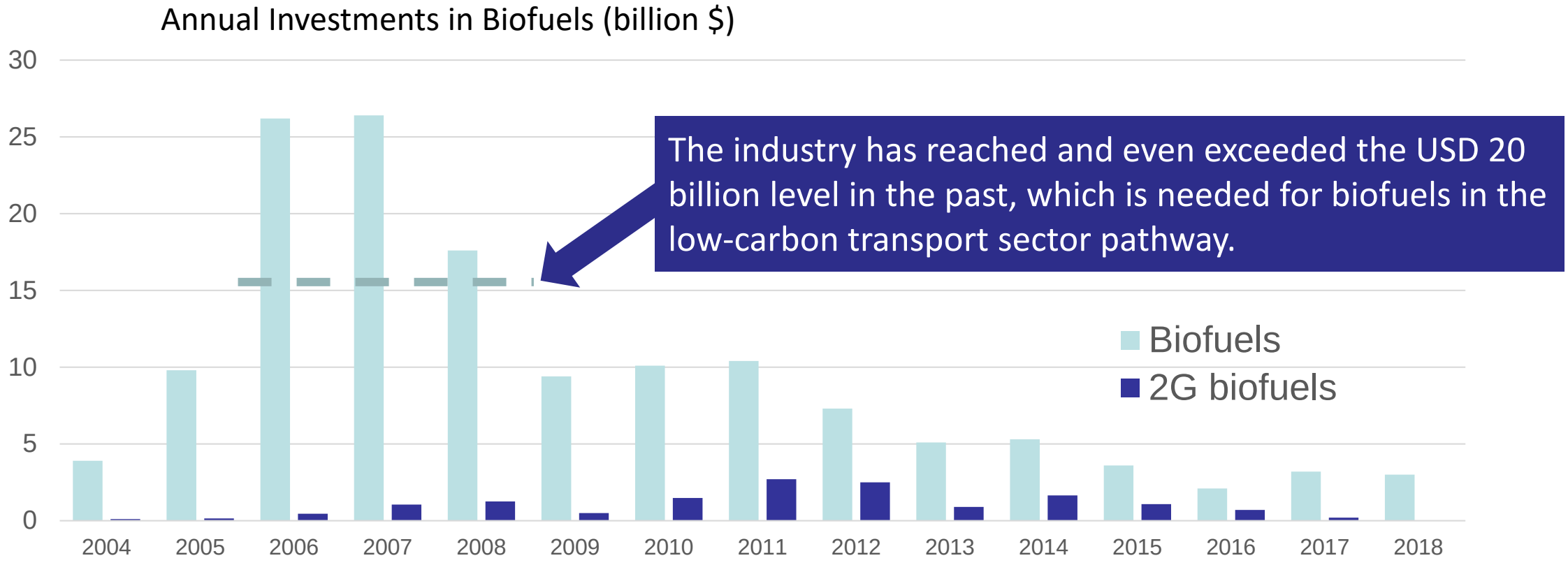


Source: REN21, 2017.

New policies since 2017

- Brazil – RenovaBio
- China – Nationwide E10 by 2020
- Canada – Federal Clean Fuel Standard; Some provinces boost blending
- India – National Biofuel Policy 2018
- Bolivia E25 by 2025

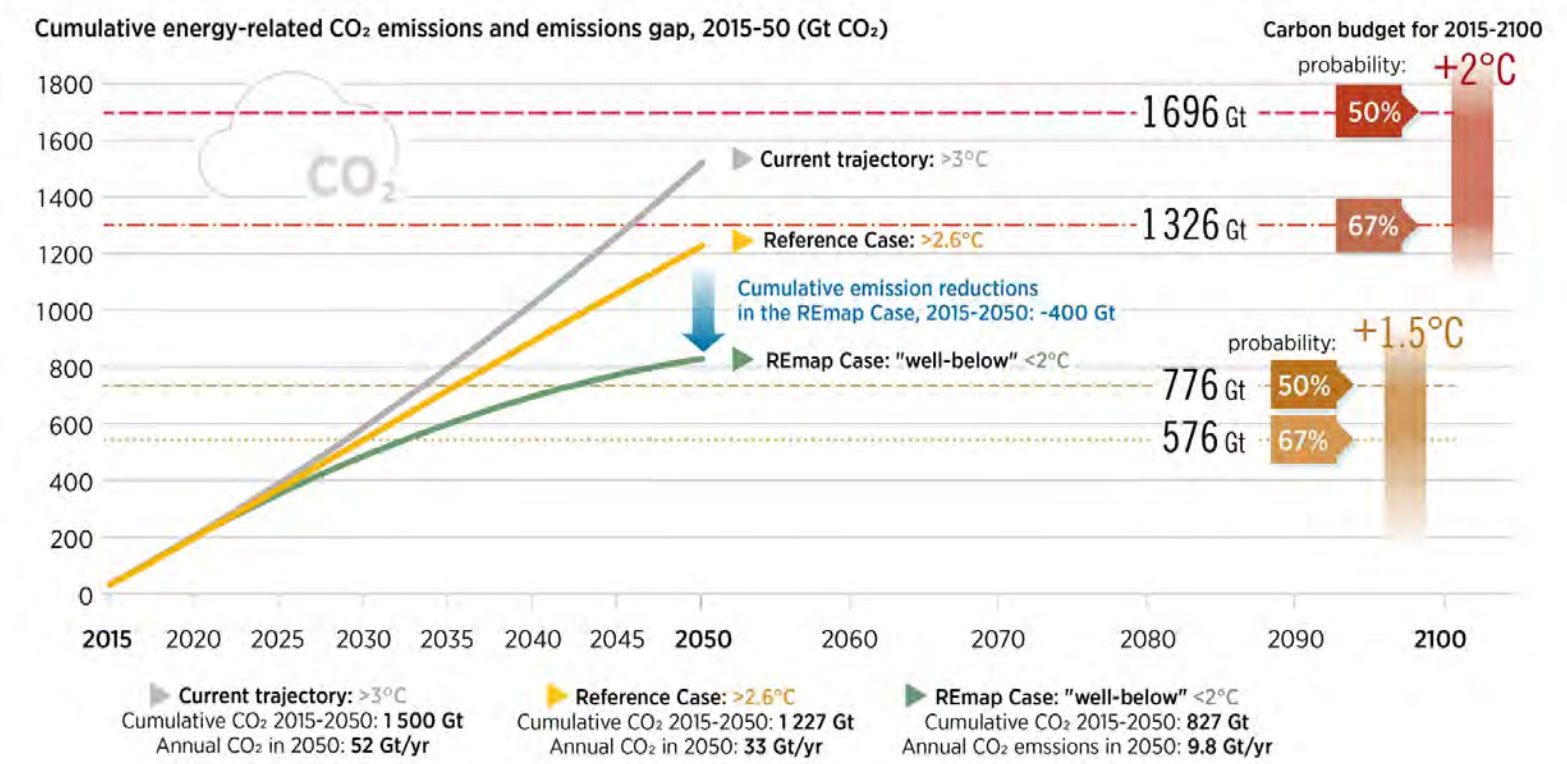
Global biofuel investments are on a declining trend



Source: BNEF

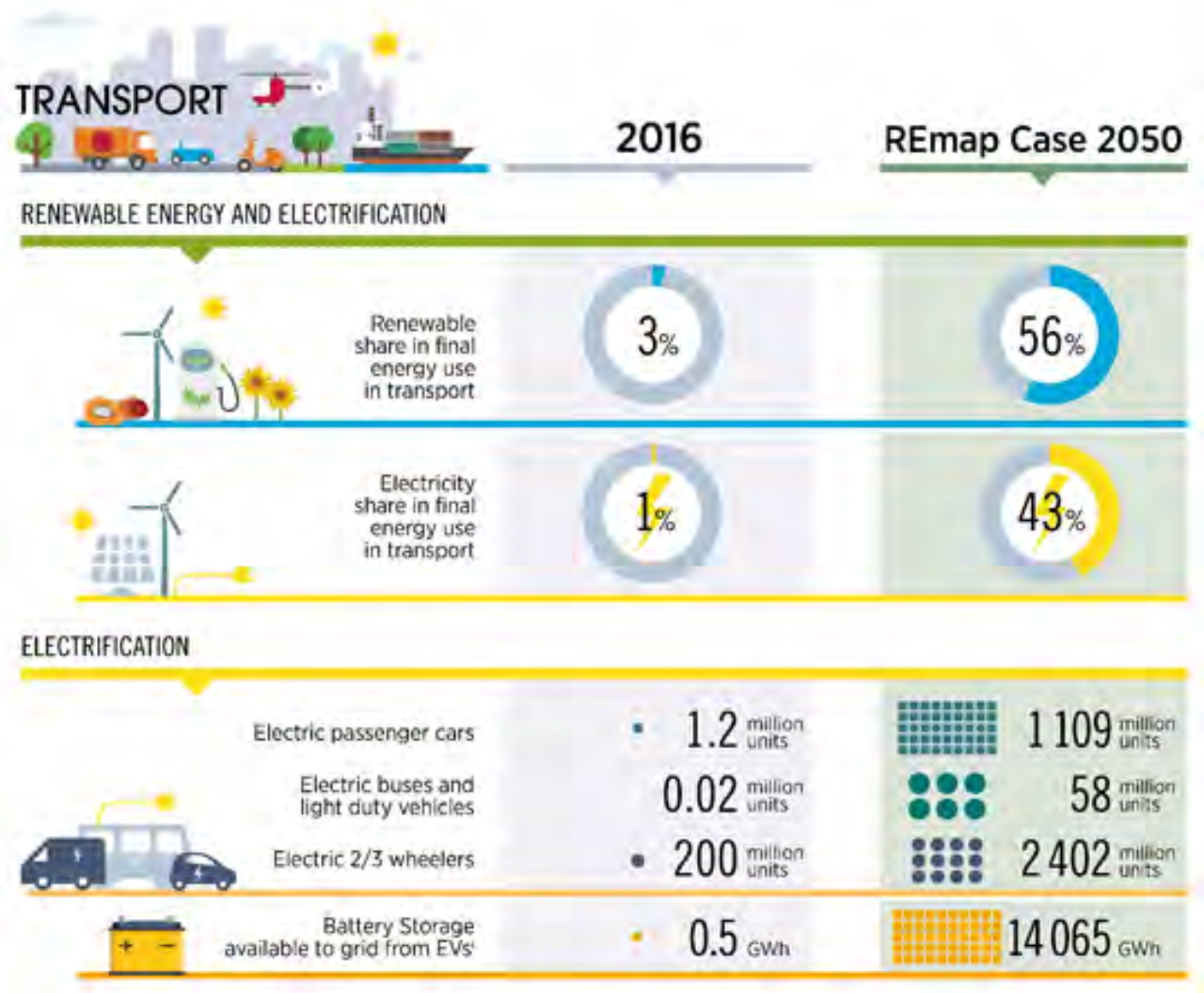
- To achieve the 5-fold increase goal, more than 100 refineries should be developed annually at an investment cost of USD 20+ billion.
- More than 10% of bioliquids should be allocated for aviation but the buildout of biojet refineries is slow.

Bridging the gap: A pathway for a well-below 2°C climate target, towards 1.5°C



- **Energy-related CO2 emissions have grown** by around 1% annually over the last five years.
- The **global carbon budget** is set to **run out by 2030 based on current and planned policies**.
- **Energy-related emissions would need to fall by 3.5% per year** to the world to meet the aims of the **Paris Climate Agreement**.

Electrification of the transport sector



Innovations to integrate solar PV and Wind – EVs smart charging is one of those

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ENABLING TECHNOLOGIES

1 Utility-scale batteries
2 Behind-the-meter batteries
3 Electric-vehicle smart charging
4 Renewable power-to-heat
5 Renewable power-to-hydrogen
6 Internet of things
7 Artificial intelligence and big data
8 Blockchain
9 Renewable mini-grids
10 Supergrids
11 Flexibility in conventional power plants

BUSINESS MODELS

12 Aggregators
13 Peer-to-peer electricity trading
14 Energy-as-a-service
15 Community-ownership models
16 Pay-as-you-go models

MARKET DESIGN

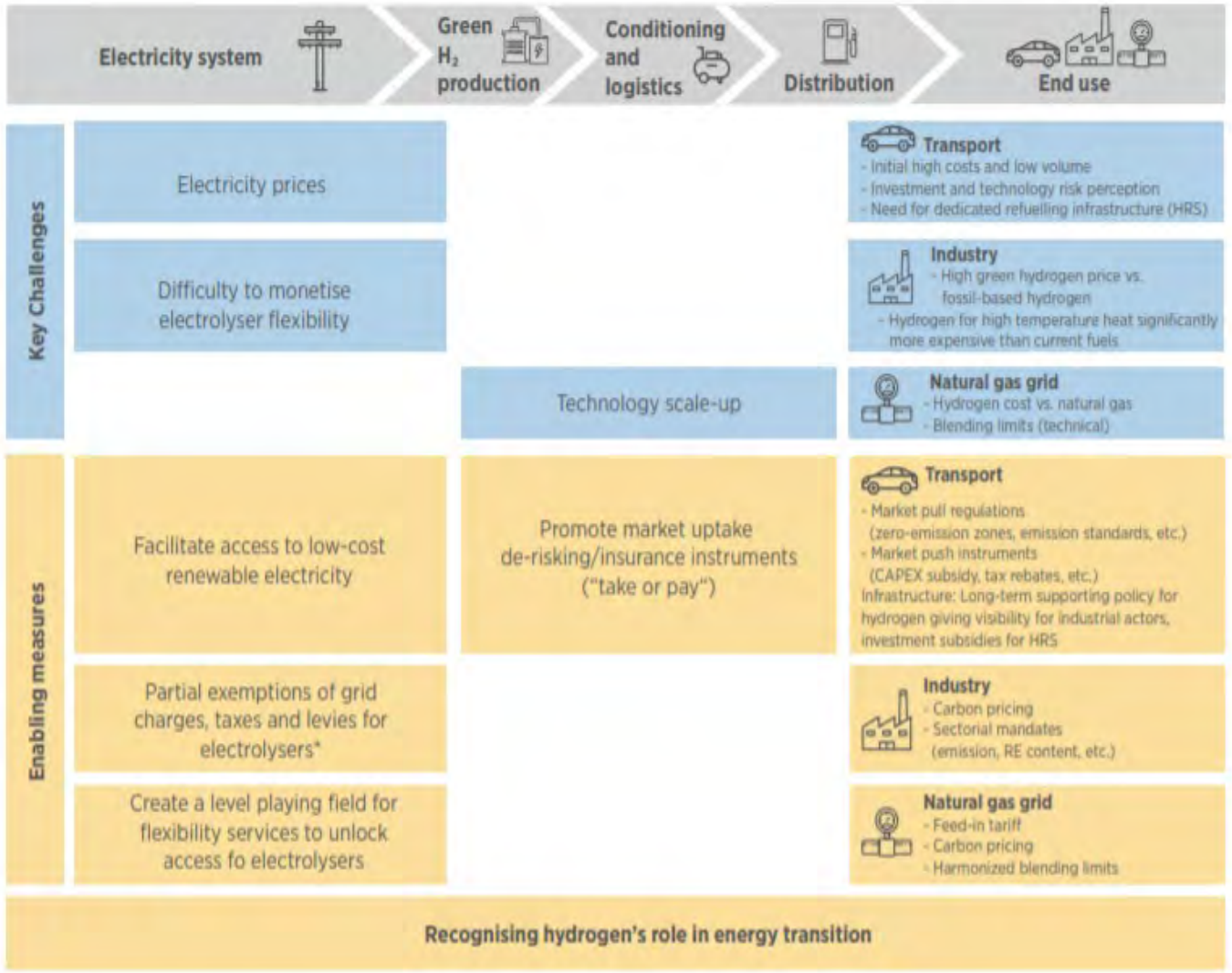
17 Increasing time granularity in electricity markets
18 Increasing space granularity in electricity markets
19 Innovative ancillary services
20 Re-designing capacity markets
21 Regional markets
22 Time-of-use tariffs
23 Market integration of distributed energy resources
24 Net billing schemes

SYSTEM OPERATION

25 Future role of distribution system operators
26 Co-operation between transmission and distribution system operators
27 Advanced forecasting of variable renewable power generation
28 Innovative operation of pumped hydropower storage
29 Virtual power lines
30 Dynamic line rating

Free download of report at:
https://www.irena.org/publications/2019/Feb/Innovation-landscape-for-a-renewable-powered-future

Indirect electrification

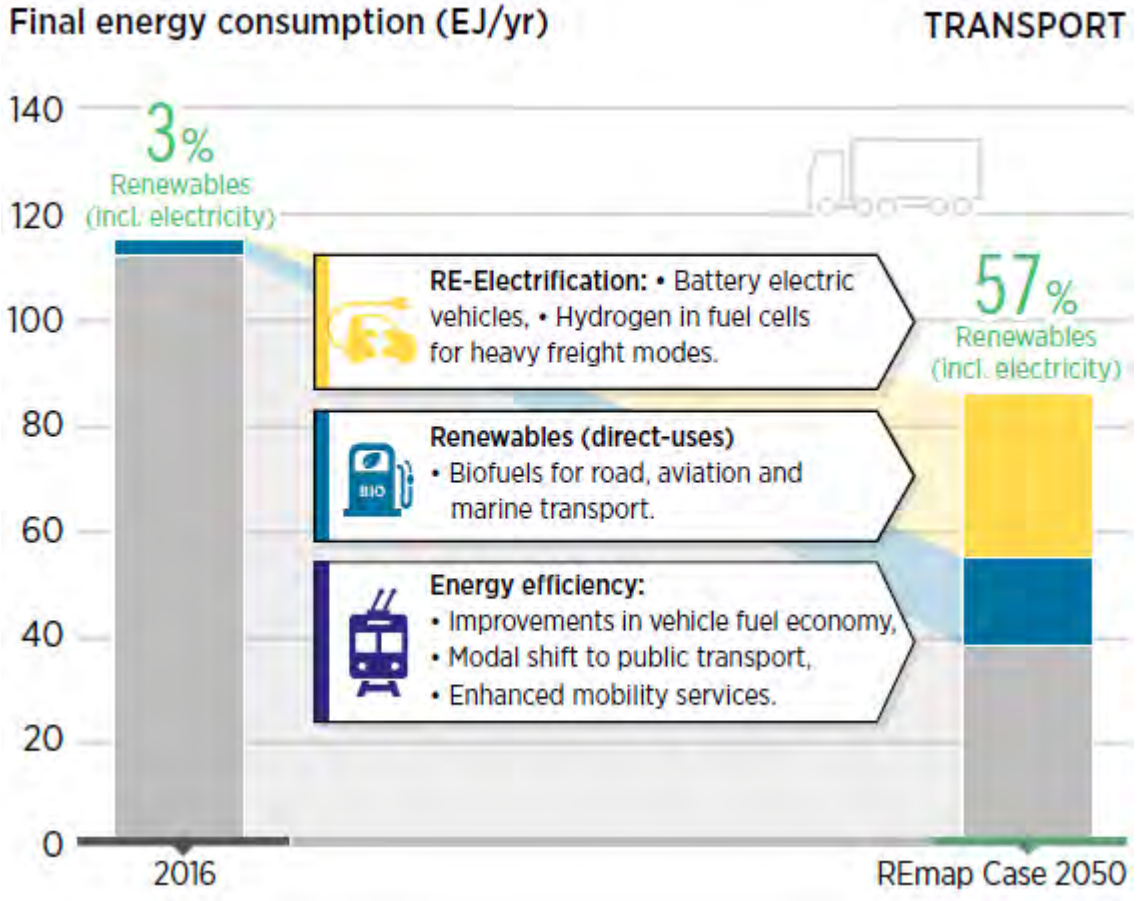


*Provided that they run in system beneficial mode

Sector-level actions essential to effectively transform the global energy system - Transport

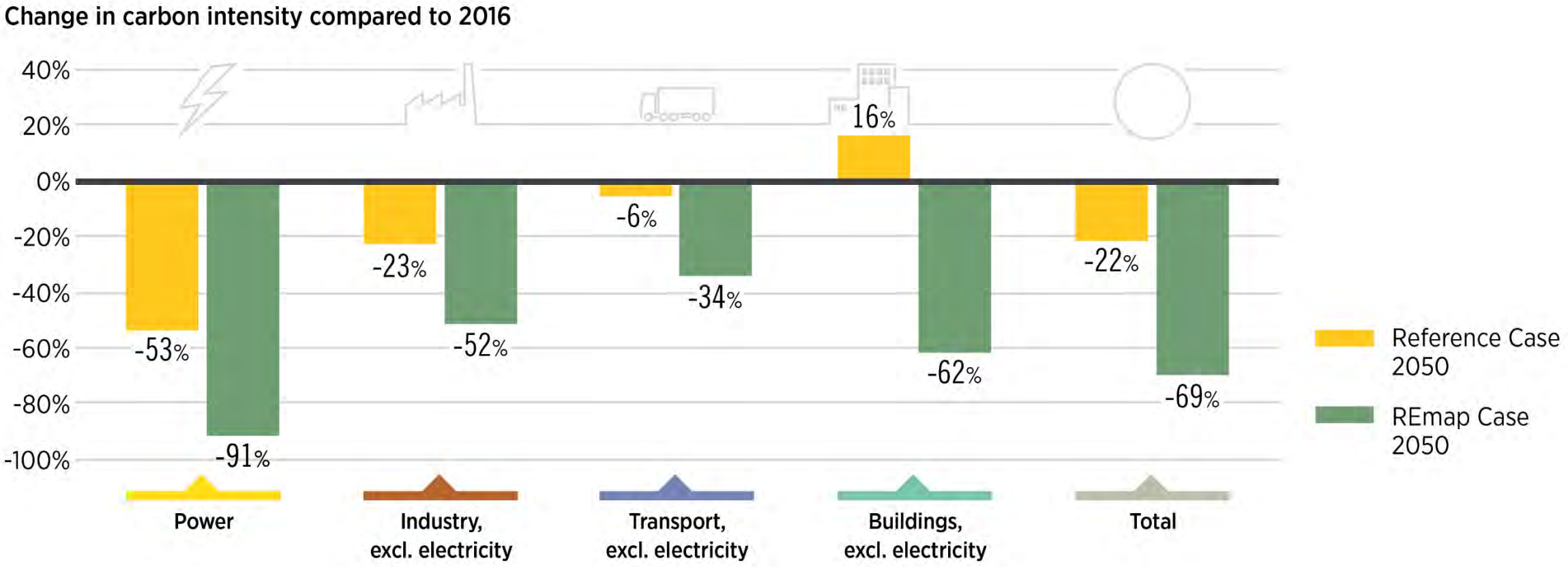
Accelerate the uptake of electric mobility by:

- Establishing minimum standards for vehicle emissions
  - Give EVs priority for city access
- Incentivising charging infrastructure rollout
- Strengthening link between the power and transport sectors for integrated planning and policy designs (vehicle-to-grid services)
- Deploy low-emissions city trucks



Source: IRENA Global Energy Transformation: A roadmap to 2050 (2019 edition)

All sectors need to reduce carbon intensity over time



Renewable energy, energy efficiency and electrification can reduce the carbon intensity of the energy system by 70% by 2050

Transport sector key indicators infographic

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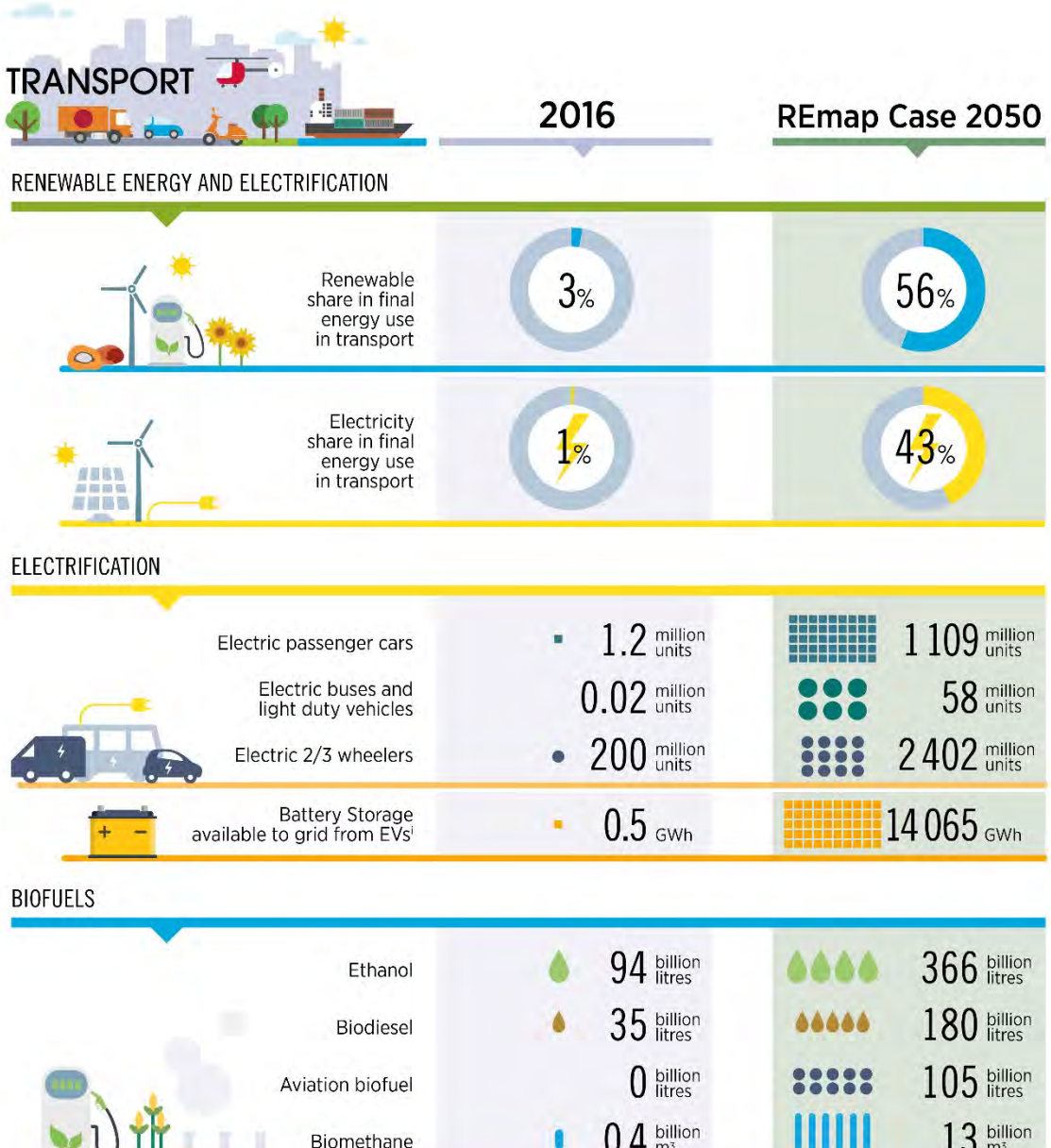
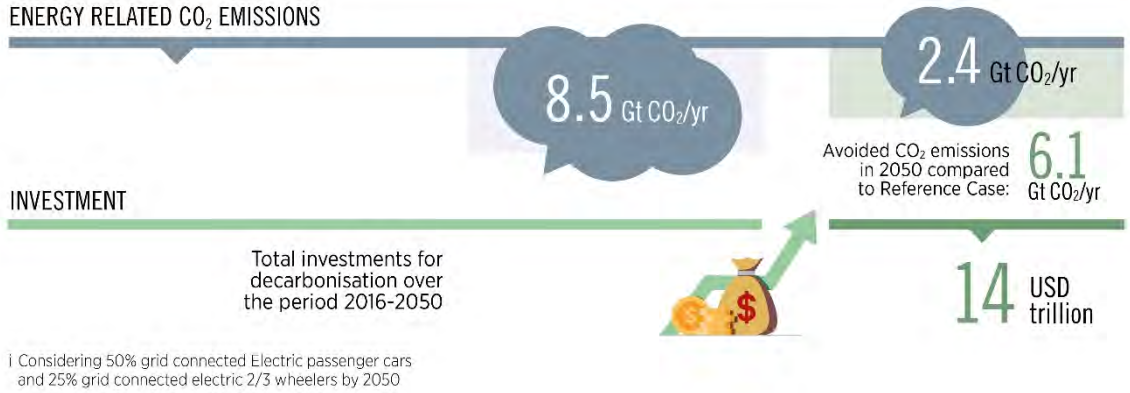
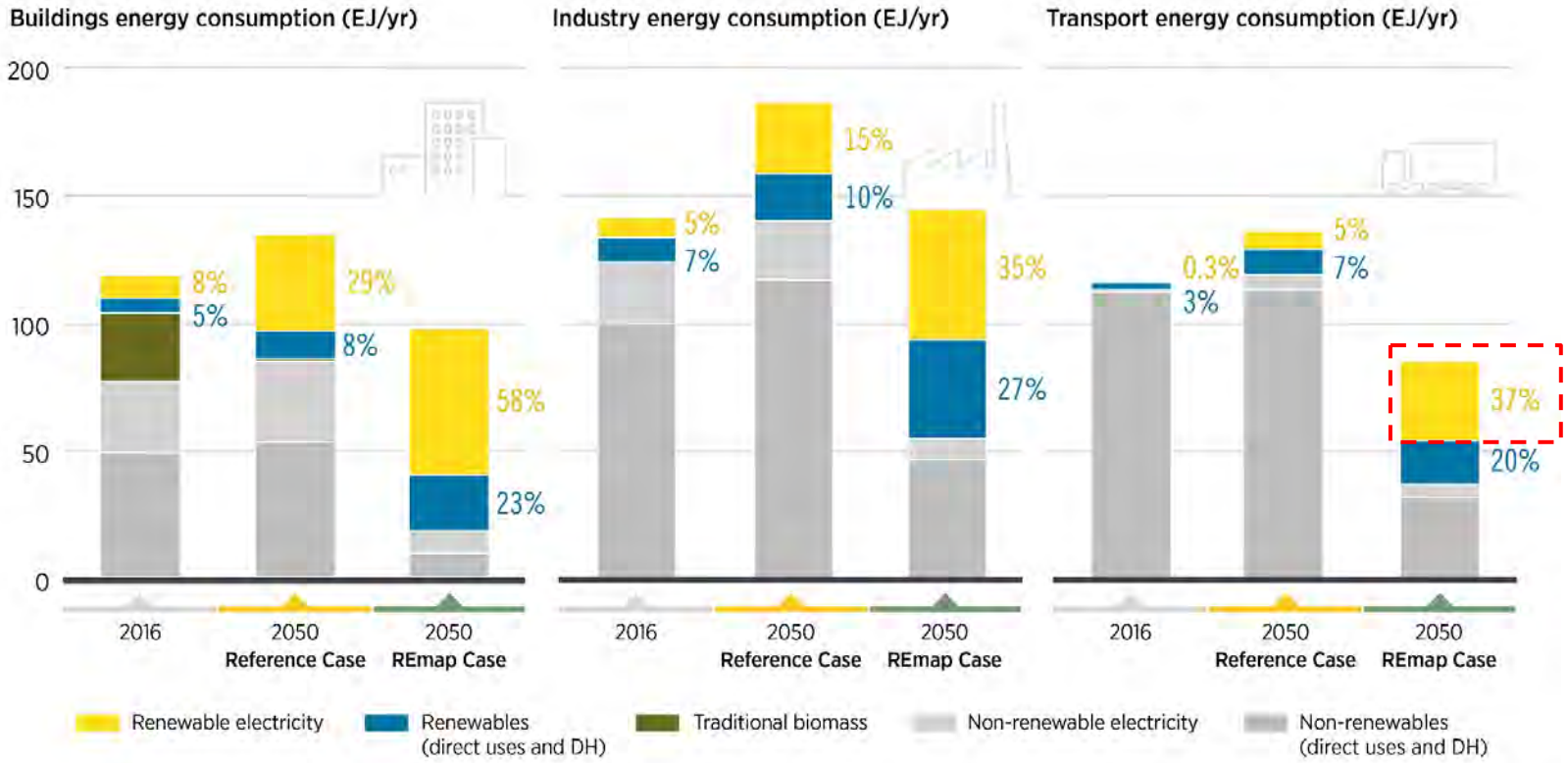




i Considering 50% grid connected Electric passenger cars and 25% grid connected electric 2/3 wheelers by 2050

Renewable energy shares increase in all end-use sectors



- By 2050, **renewables could dominate the transport and buildings sectors reaching 57% and 81% of the sectors' final energy consumption**.
- **Electricity would account for the largest share of renewable energy use**, with over one third of transport final energy source from renewable power

Uptake of EVs - the battery bank of the future

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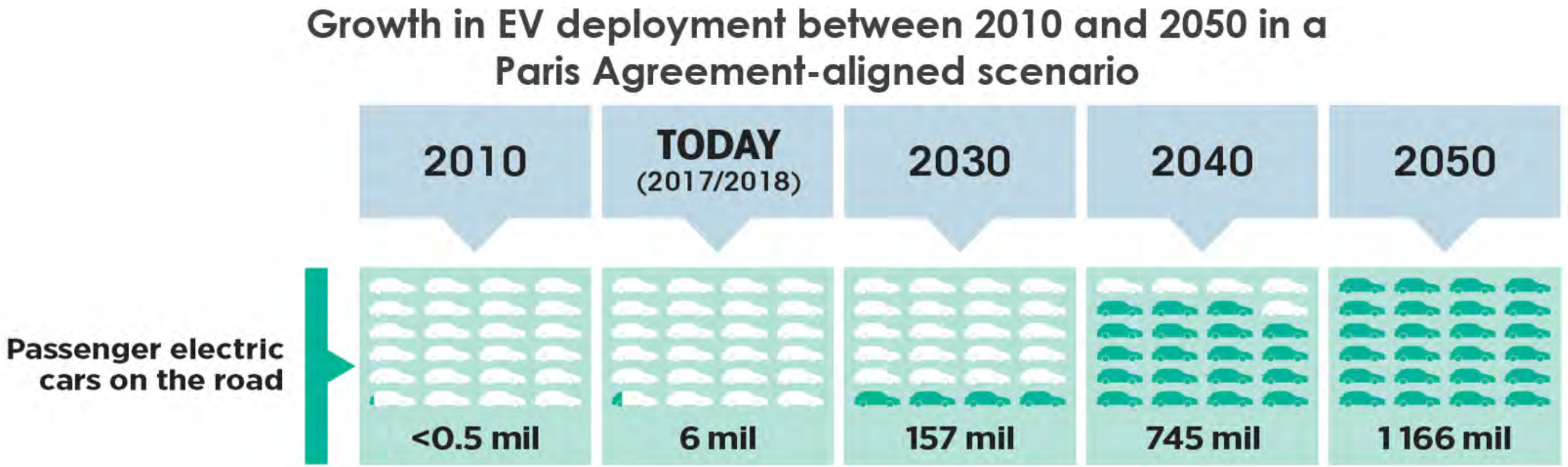
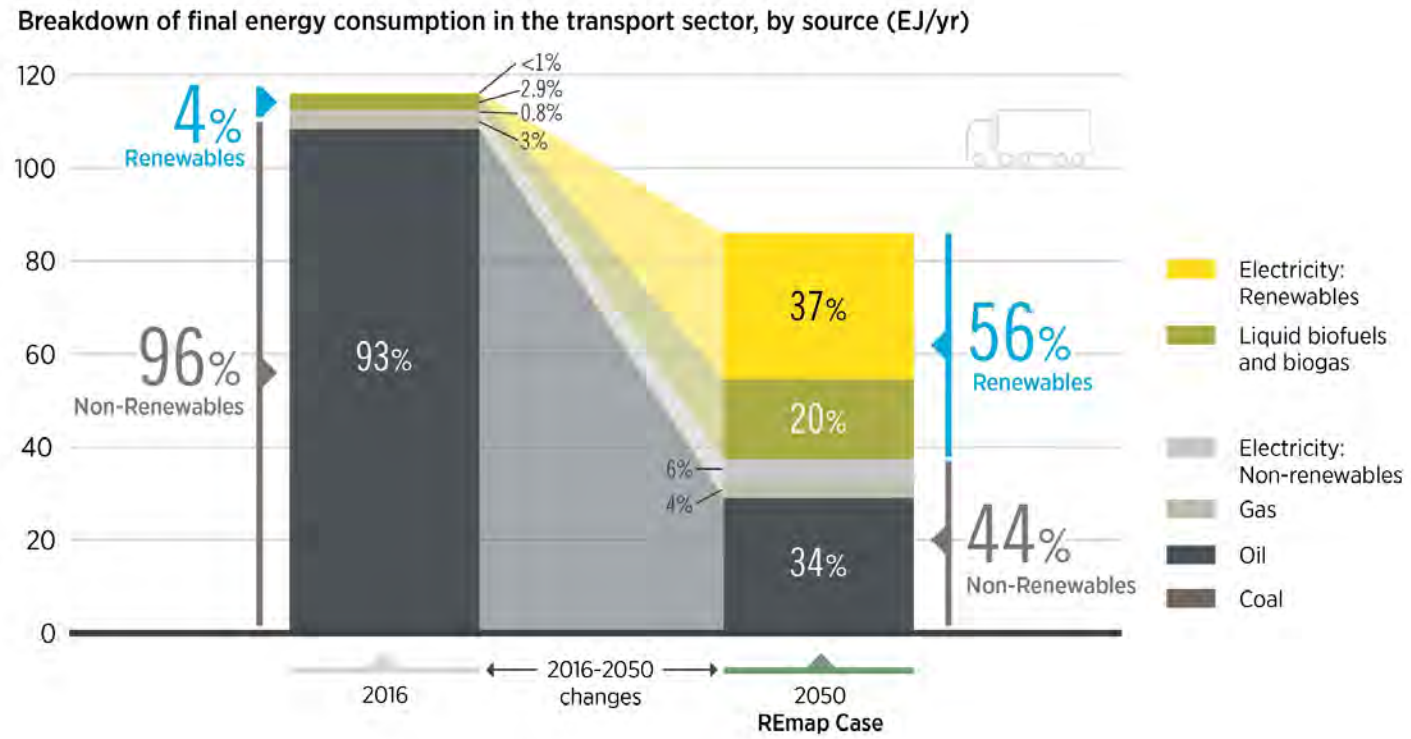


By 2050, potential storage capacity to provide grid services:

~ 14 TWh EV batteries vs ~ 9 TWh stationary batteries
(including second use)

Source: IRENA (2019) Innovation Outlook: Smart charging for Electric Vehicles

Increasing electrification in the transport sector



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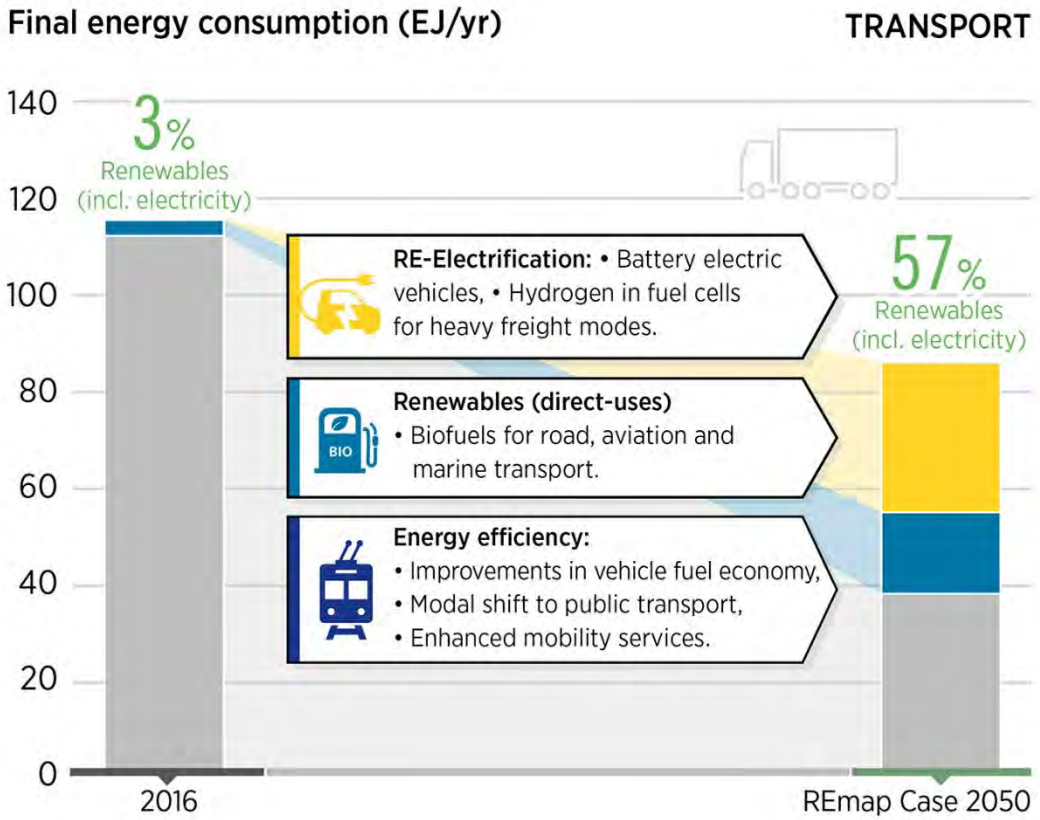
Transport solutions



REDUCE THE ENERGY NEED FOR TRANSPORT:

- Deploy advanced digital communication technologies to reduce the transport needs (eg. teleconferencing over traveling) and to improve efficiency of transport by better utlizing the assets (eg. re-routing due to traffic).
- Promote mobility services: Promote vehicle sharing and autonomous driving.
- Accelerate modal shift from passenger cars to public transport (electric railways or trams or electric buses).

ACCELERATE THE UPTAKE OF ELECTRIC MOBILITY:

- Establish minimum standards for vehicle emissions. Give the priority for electric vehicles for city access.
- Incentivise charging infrastructure rollout.
- Strengthen link between the power and transport sectors for integrated planning and policy designs (vehicle-to-grid services).
- Deploy low-emissions city trucks.

FOSTER BIOFUELS IN ROAD, AVIATION AND SHIPPING:

- Eliminate fossil fuel subsidies and implement carbon pricing to increase the competitiveness of renewable fuels in the shipping and aviation.
- Adopt supporting policies to scale up sustainable production of first- and second-generation biofuels. Introduce specific mandates for advanced biofuels and put in place direct financial incentives along with financial de-risking measures.