Accelerating the Global Energy Transition

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IRENA Innovation and Technology Centre

Bonn University/IRENA lecture series - Renewable Future
12 October, 2017

Renewable Future lecture series – 7 Sessions

- October 12: Accelerating the Global Energy Transition
- October 26: Planning for the Transformation of Power Systems
- November 9: Island Energy Transitions
- November 23: Approaches to Sustainable Bioenergy
- December 7: Innovation Driving the Energy Sector Transformation
- December 21: Improving Energy Access with Renewable Energy Project Facilitation
- January 25: The True Costs of Renewables

This lecture

- **Decarbonisation of the energy sector** requires urgent action on a global scale. While a **global energy transition** is under way, further action is needed to **reduce carbon emissions** and mitigate the effects of climate change. The energy transition is a pathway toward **transformation of the global energy sector from fossil-based to zero-carbon** by the second half of this century.

- There are many routes facilitated by the introduction of different technologies and supporting policies. **Government strategies can streamline the transition**, maximizing economic and social benefits, wealth creation and the inclusion of all stakeholders. **Accelerated deployment of energy efficiency and renewable energy technologies** play a central role. The energy transition will be enabled by information technology, smart technology, policy frameworks and market instruments.

- The lecture will elaborate the **latest IRENA findings on energy transition** including technology and sector **roadmaps**, **economics** of energy transition and **enabling frameworks**.

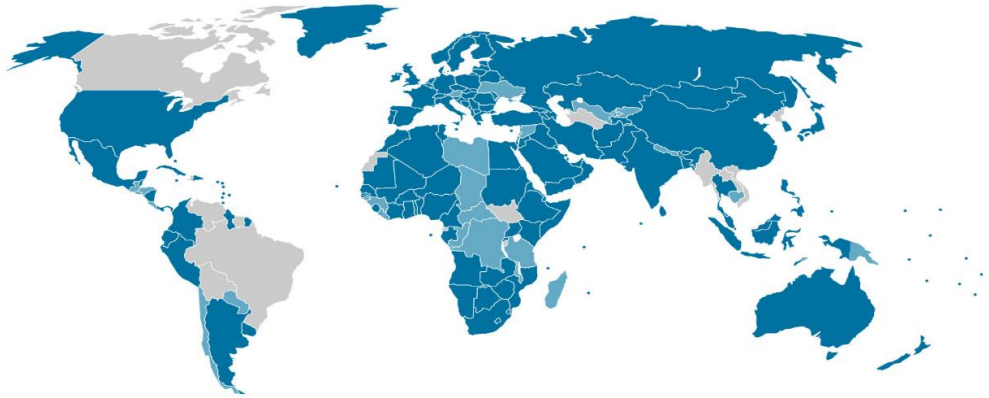
PART 1: IRENA

IRENA: Introduction & Overview

- Established in 2011
- Headquarters in Abu Dhabi, UAE
- IRENA Innovation and Technology Centre – Bonn, Germany
- Permanent Observer to the United Nations – New York

152 Members

28 States in Accession

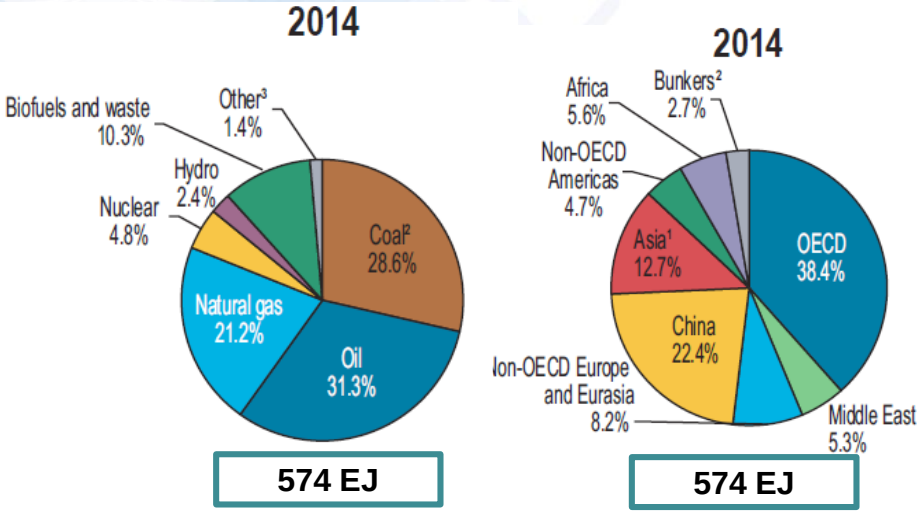


Mandate: Assist countries to accelerate RE deployment

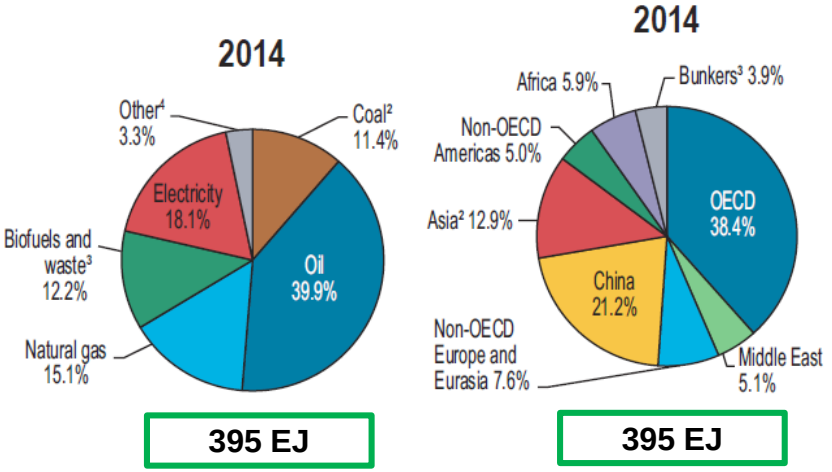
PART 2: ENERGY STATUS AND TRENDS

How is energy used today?

Primary Supply



Total Final Consumption

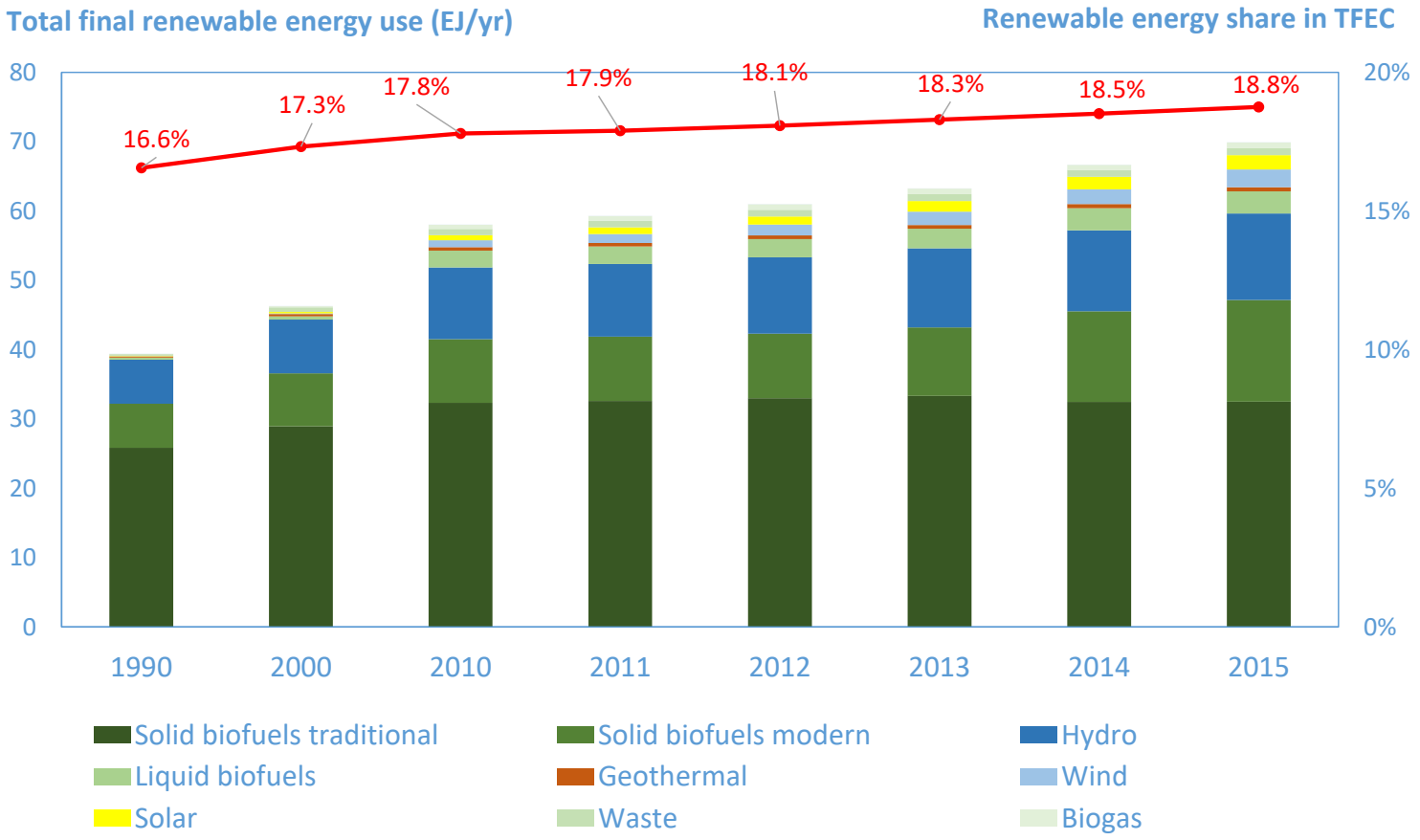


Source: IEA

14.2% Renewables → 18.3% Renewables

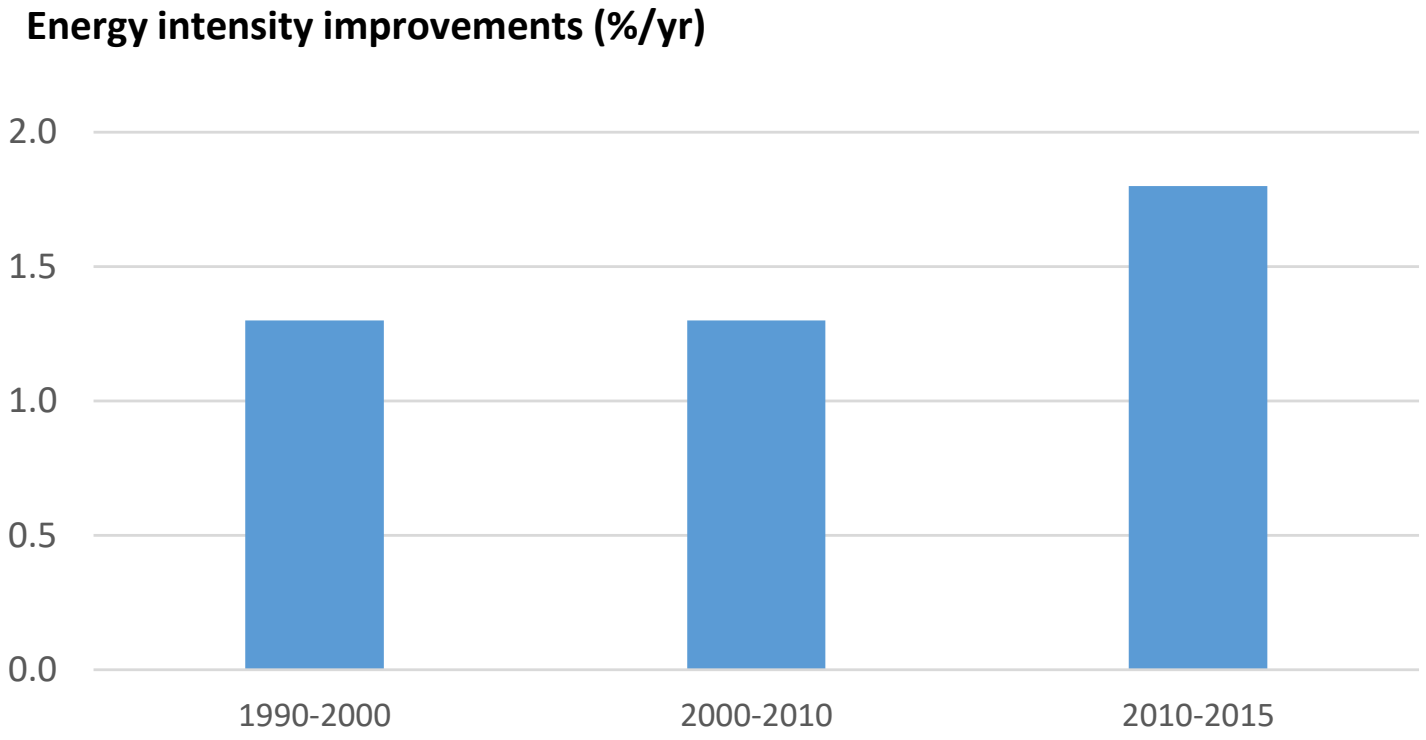
- 130 EJ losses/own consumption electricity sector
- 1/3 Buildings, 1/3 Transport, 1/3 Industry

Progress in energy intensity improvements



During 2010-2015, renewable energy share grew from **17.8% to 18.8%** in total final energy consumption – **0.17%/yr** growth.

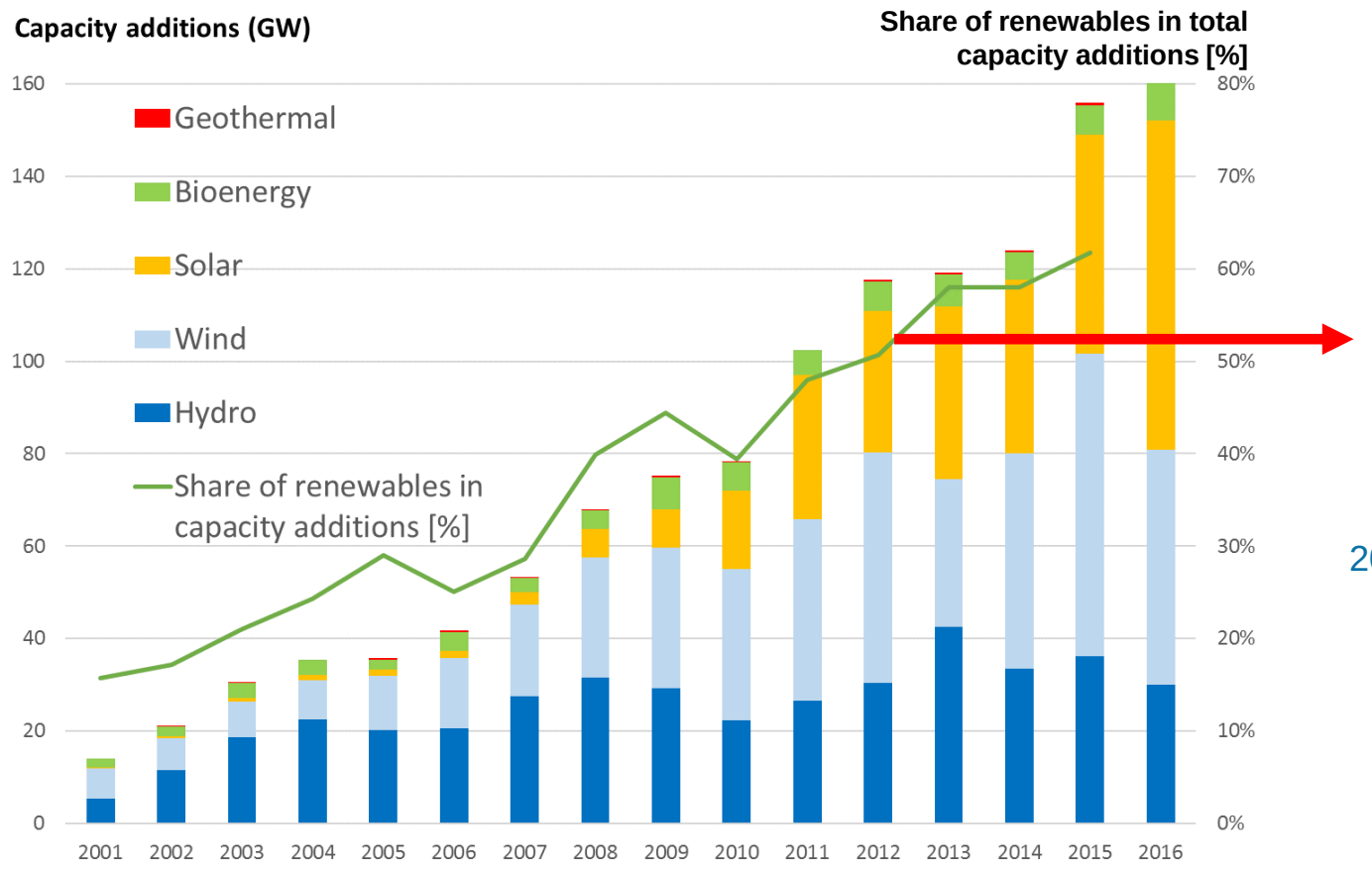
Progress in energy intensity improvements



Energy intensity = total primary energy supply per unit of GDP in PPP

The annual energy intensity improvement rate has increased from **1.3%** in **1990-2010** to **1.8%** in **2010-2015**.

On-going power sector transformation



Since 2012 >50% of total capacity additions

Source: IRENA statistics

2016

2006 GW RE power generation capacity in place

Annual RE capacity addition 161 GW (+8%/yr) of which:

- 71 GW solar
- 51 GW wind
- 30 GW hydropower
- 9 GW biomass

- Around **25%** renewable power generation share worldwide
- Growing by **0.7 percentage** per year

PART 3: A GLOBAL PERSPECTIVE

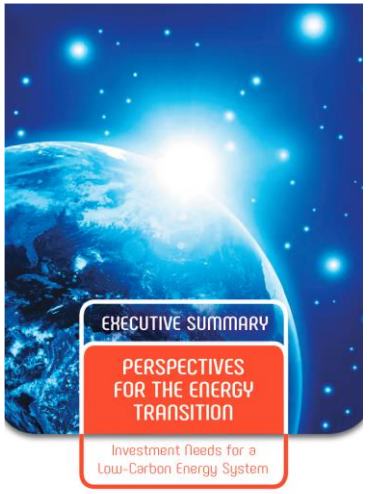
REmap – Roadmap for a Renewable Energy future

- IRENA's **Global Renewable Energy Roadmap**
- Shows feasible, cost-effective ways to **increase renewable energy deployment** in world's energy mix by 2030 **in line with SDG7**
- **Support the G20** in determining pathways for operationalising Paris Agreement with decarbonisation scenarios analysis to 2050, report released in March 2017
- **REmap 3.0 report** coming in early 2018

- Identifies concrete **technology options** for countries and sectors
- Assesses policy and investment **implications**
- Outlines **benefits** (economic, social, environmental)
- In cooperation with **70 countries**
- **30 publications to date and datasets**
- **12 country reports for major economies**

Perspectives for the energy transition – Investment needs for a low carbon energy system

- Joint IRENA and IEA report
- Prepared at the request of German G20 Presidency
- Issued at the time of the Berlin Energy Transition Dialogue April 2017
- Informed G20 Energy And Climate Working Group Discussions
- Resulted in G20 Energy and Climate Action Agenda
- Follow-up work ongoing

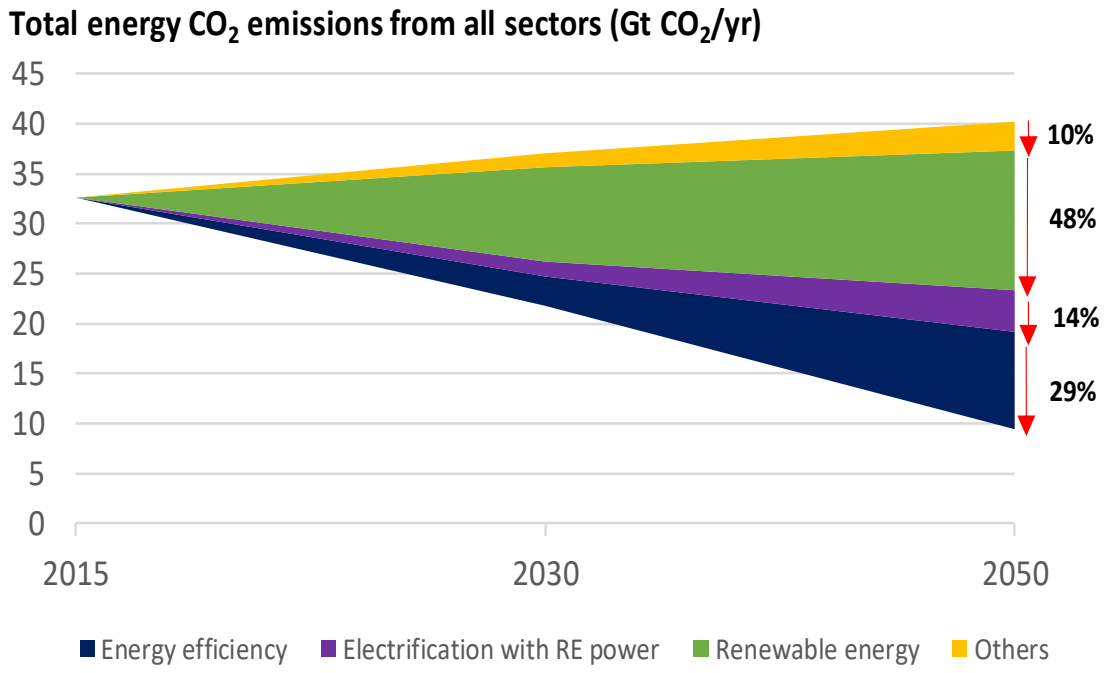


IRENA/IEA, 2017

A global view to 2050 – Energy Transition

To meet 2°C climate target set at COP 23 in Paris 2015

- Carbon intensity of energy:
  - needs to fall by 85% in 2015-2050
- Energy-emission budget:
  - 790 Gt CO_2 from 2015 till 2100



Renewable energy and energy efficiency can account for more than 90% of emission mitigation

- Renewables acceleration:

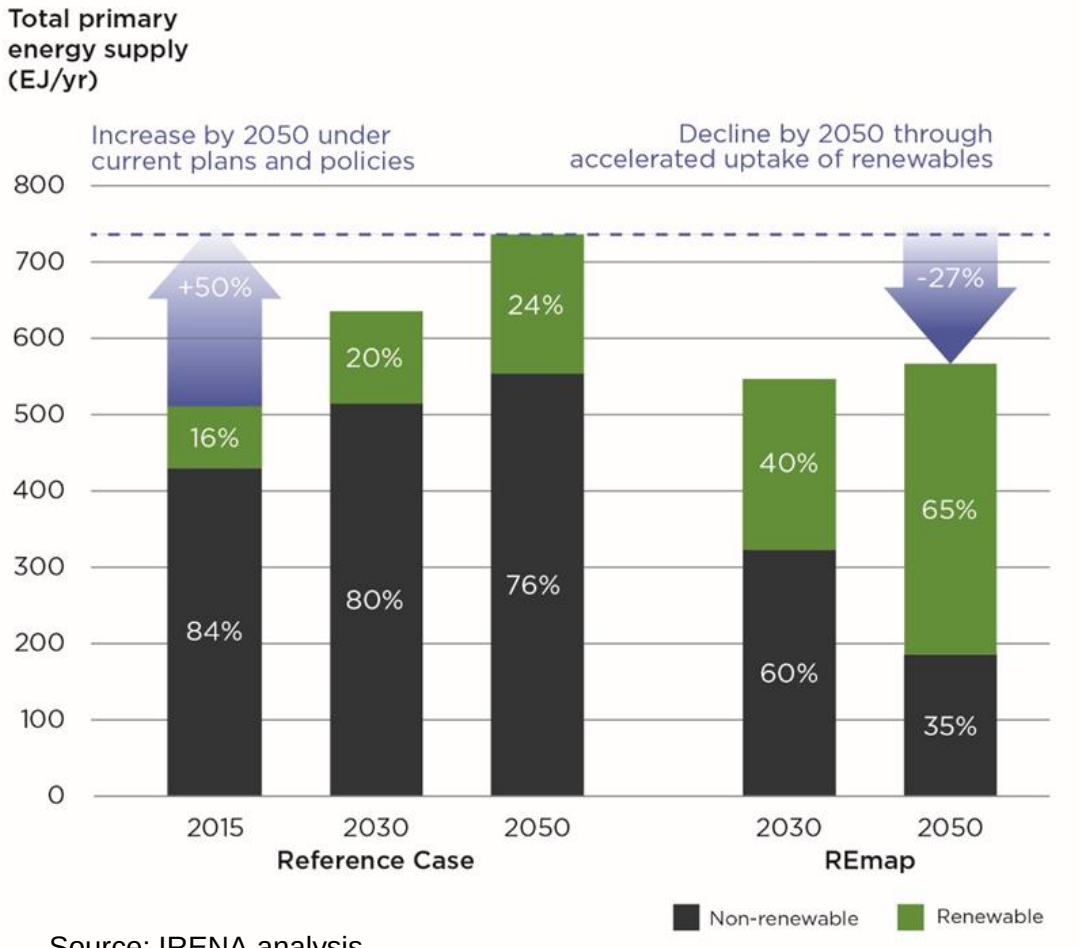
  needs an 8-fold increase compared to recent years

- Renewables in 2050:

  represent 2/3 of the energy supply

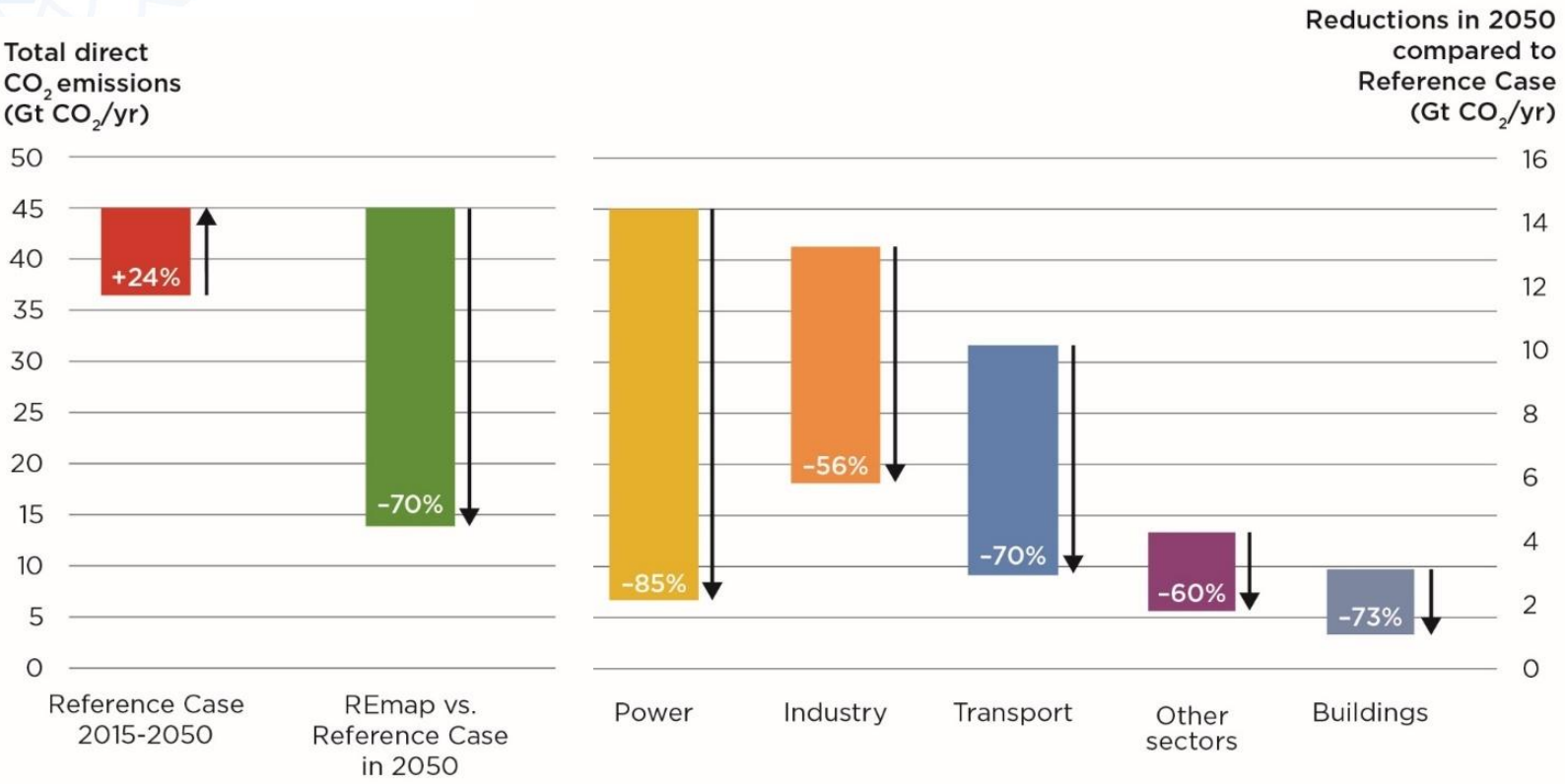
- Efficiency gains:

  need to rise to 2.5% per year in 2015-2050 (from 1.8%/yr in 2015)



Source: IRENA analysis

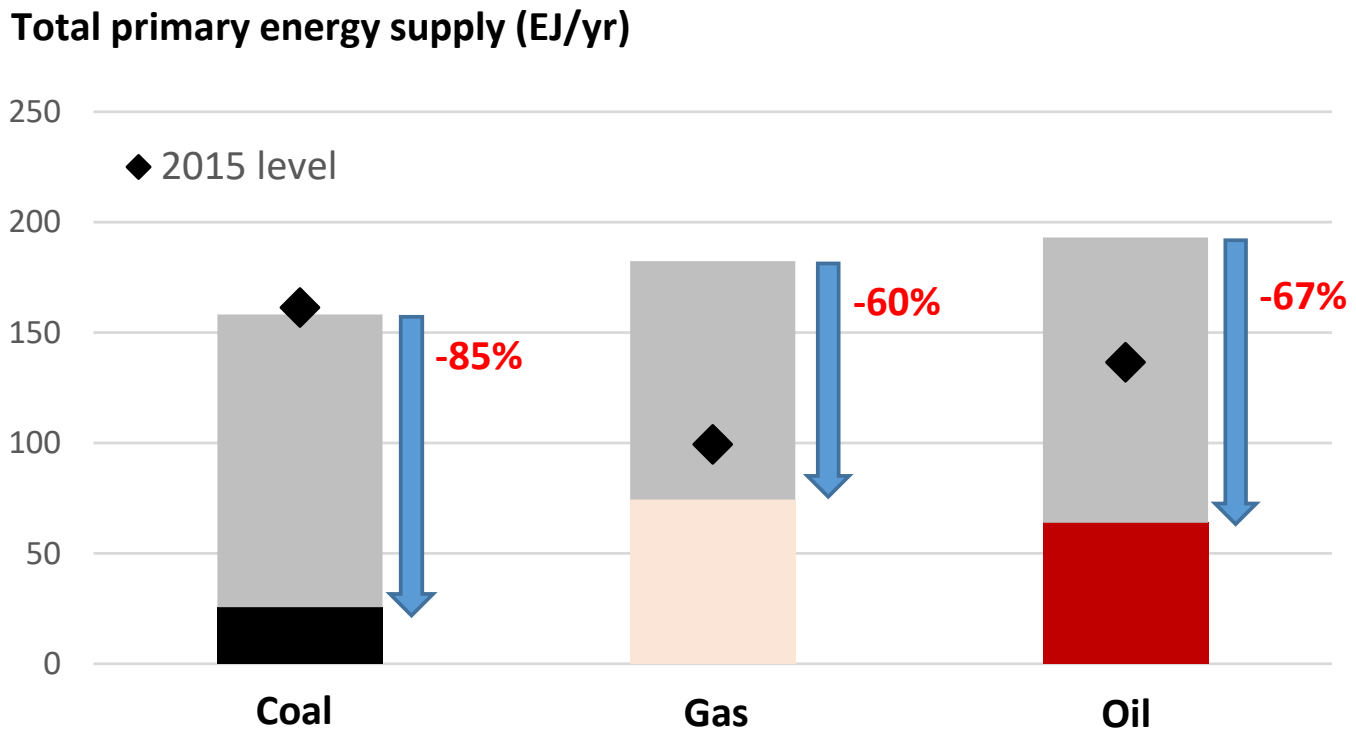
CO_2 emissions by sector in REmap relative to the Reference Case



By **2050**, total energy-related **CO_2 emissions** will need to decrease to **below 10 Gt**.

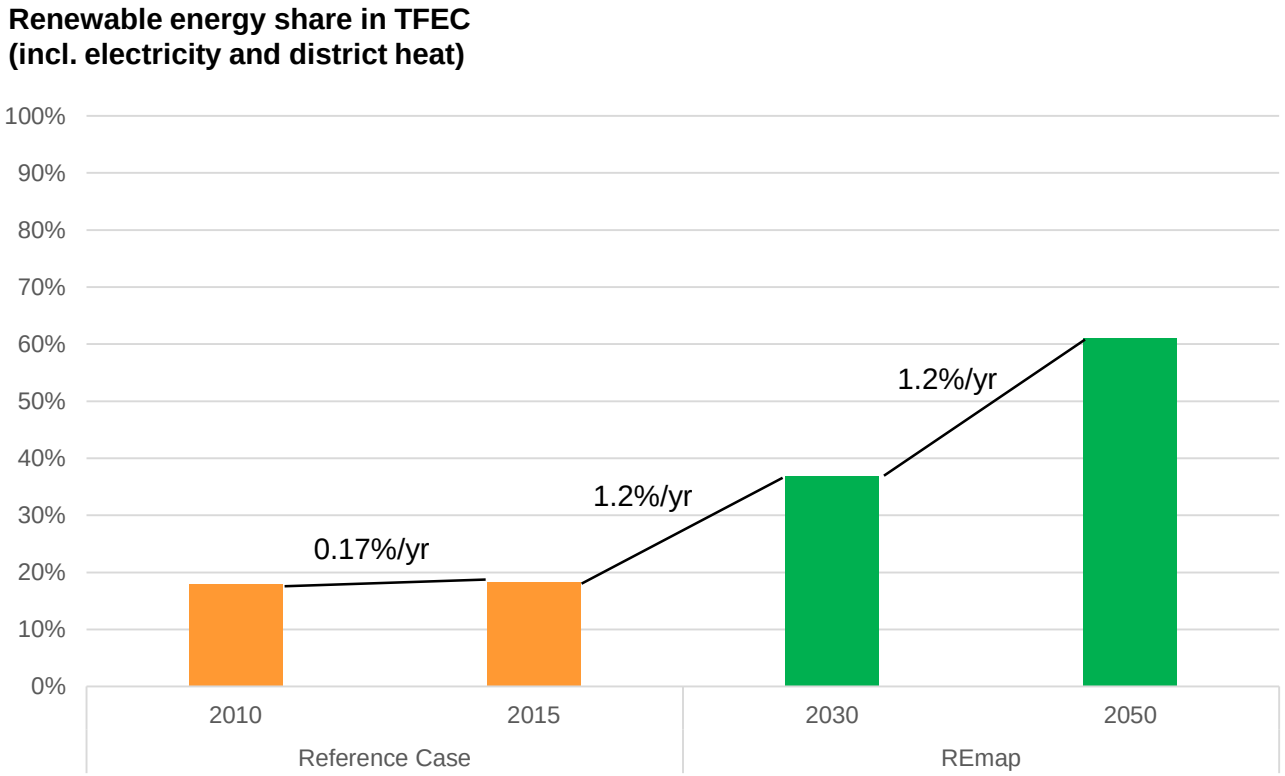
- CO_2 emissions from the power and buildings sectors will be almost eliminated.
- **Industry and transport** would be the **main sources of emissions** in **2050.**

Global change in primary energy supply in REmap



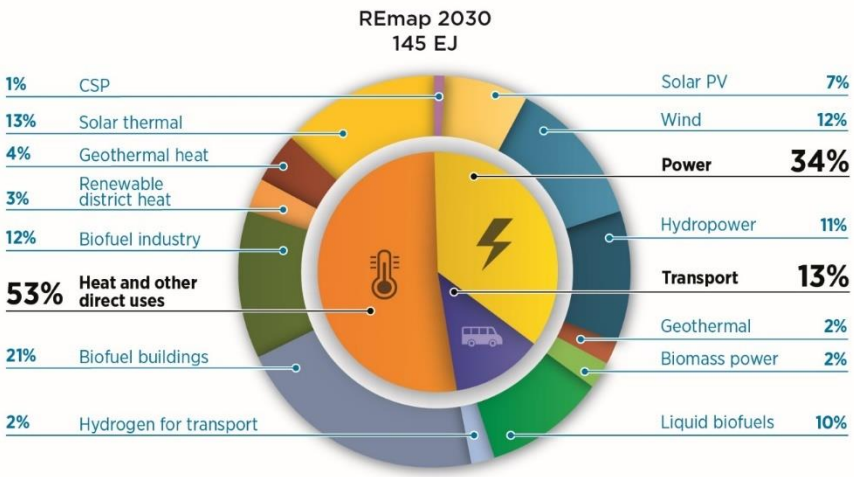
- **Fossil fuel use** would be **reduced by 60%-85%** in REmap compared to the Reference Case in 2050.
- Gas demand stays at today's level.

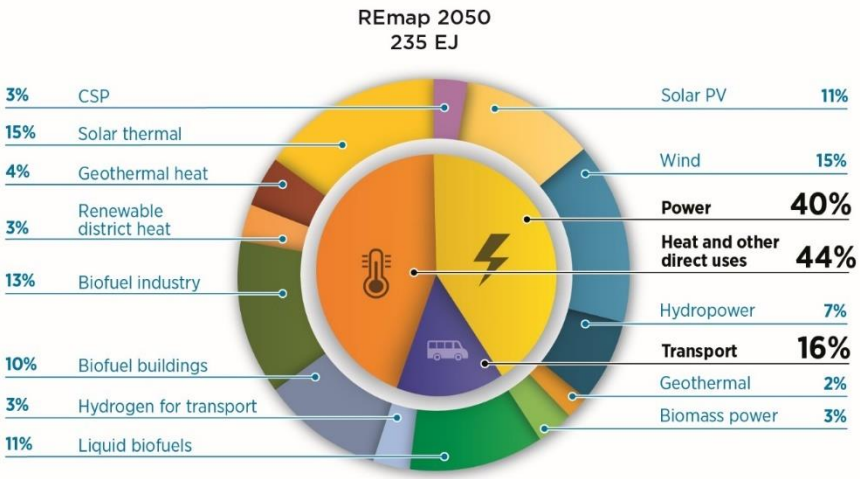
Renewable energy share in total final energy consumption



- Under REmap, the **renewable share** of total final energy consumption will rise from **19% to over 60% by 2050**, a **three-fold increase**.
- The growth rate in terms of renewable share per year will need to **increase seven-fold** over past rates.

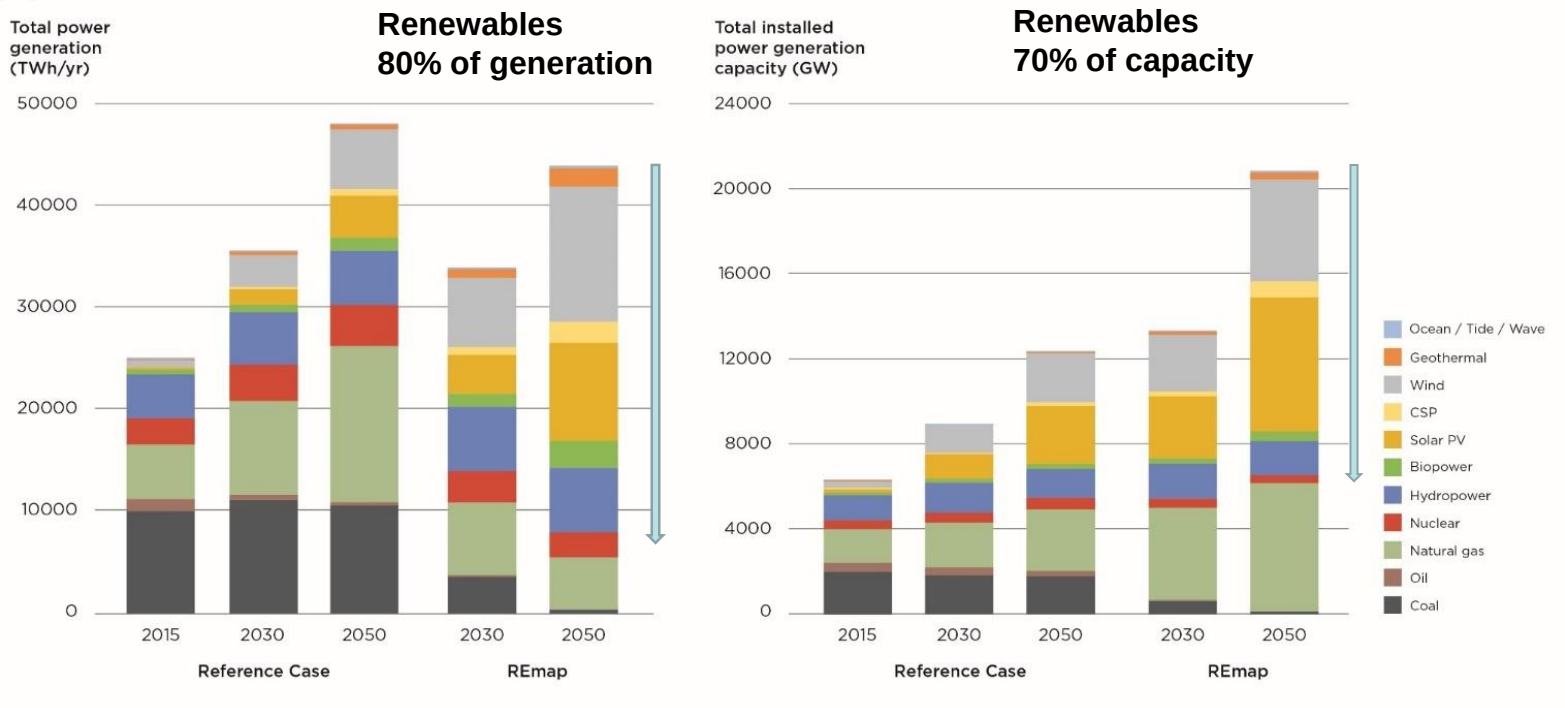
Final renewable energy use by sector and technology in REmap





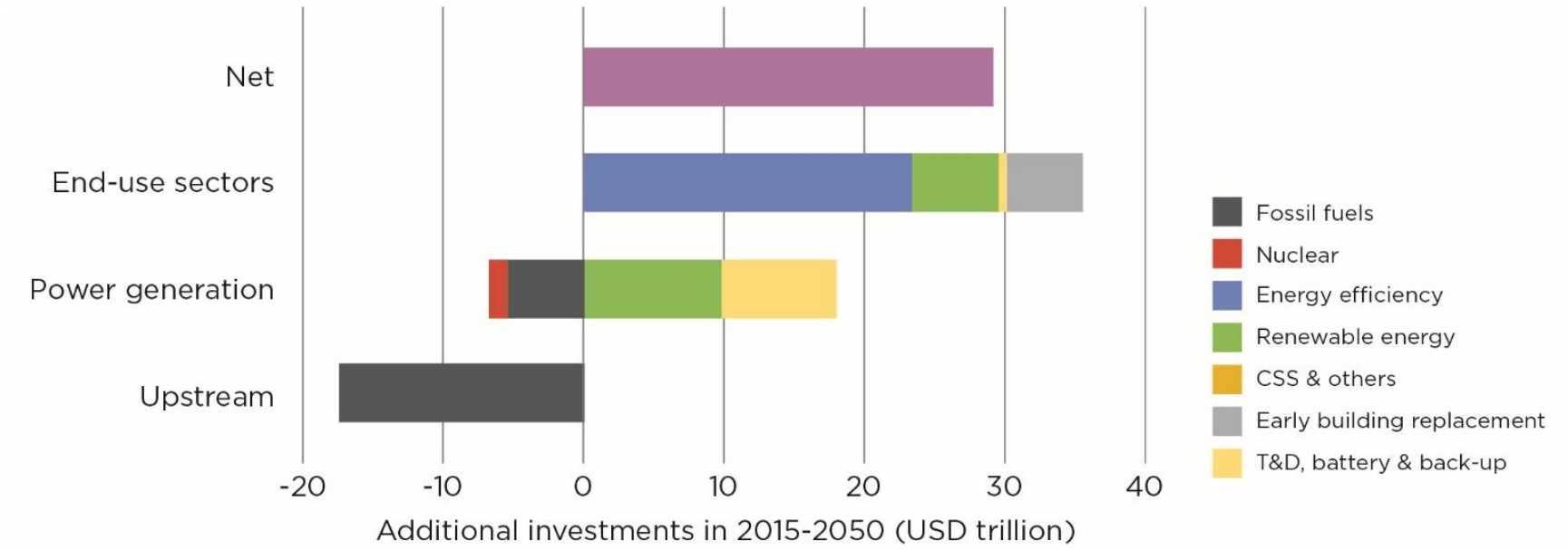
- Under REmap, **final renewable energy use is four-times higher in 2050** than it is today.
- Power and heat consume about 40% and 44% of the total renewable energy respectively, while transport uses about 16%.

Power generation capacity and total electricity generation by technology in the Reference Case and REmap



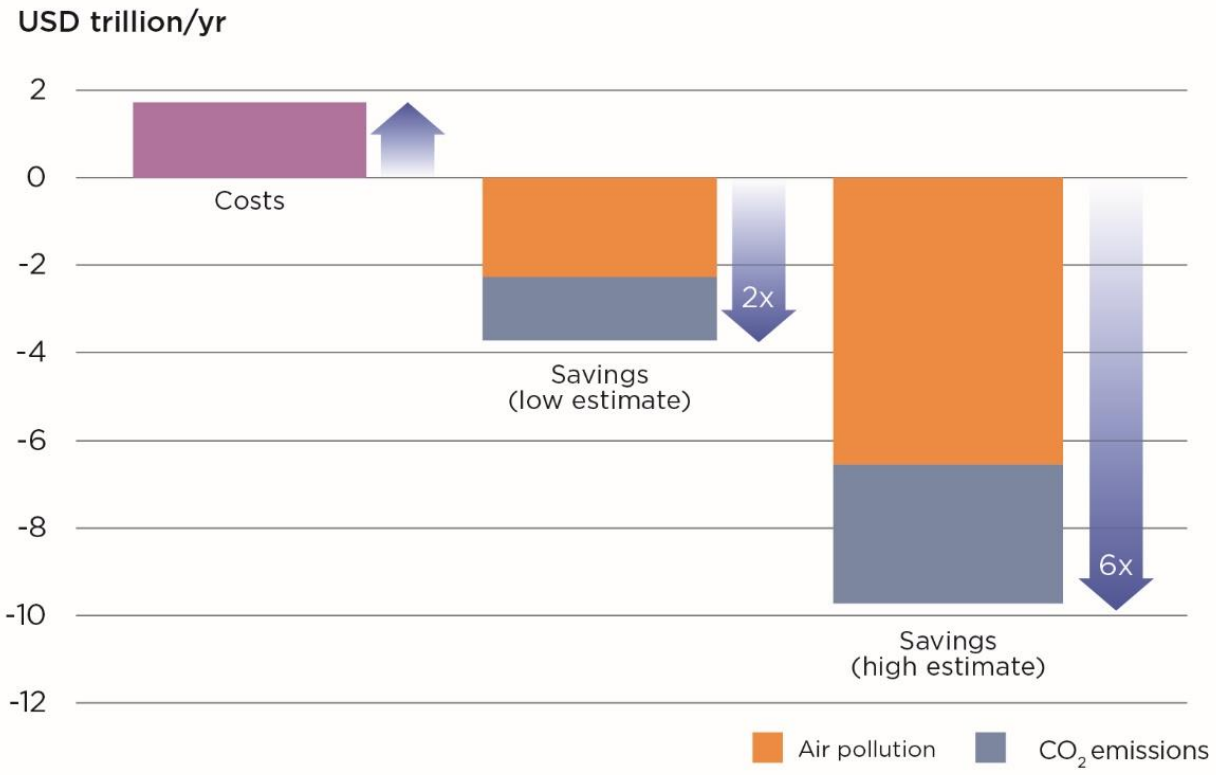
- The **power sector** will see the **highest share of renewables**.
- In REmap by 2050, a diverse mix of renewables will provide more than 80% of electricity, with wind and solar providing the largest shares.
- Coal and oil in power generation will be eliminated.

Additional investment needs by sector and technology in REmap relative to the Reference Case



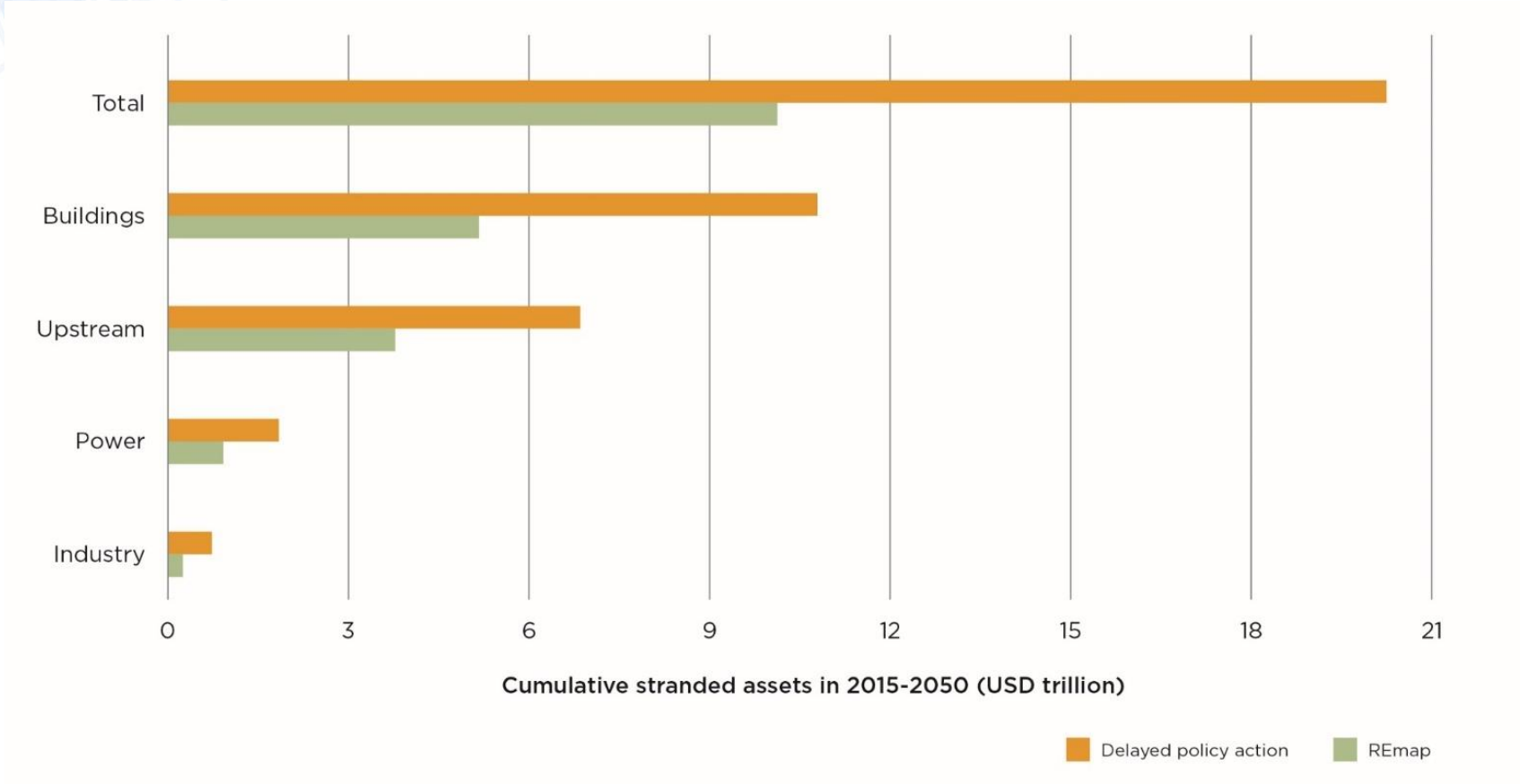
- Meeting the 2°C target requires investing an additional **USD 29 trillion between 2015 and 2050** compared to the Reference Case.
- The largest additional investment needs are in **energy efficiency, followed by renewables**.
- The total investment cost, however, is reduced by the **avoided investments in the upstream sector and in fossil-fuelled power generation**.

Costs and reduced externalities of decarbonisation – important health benefits



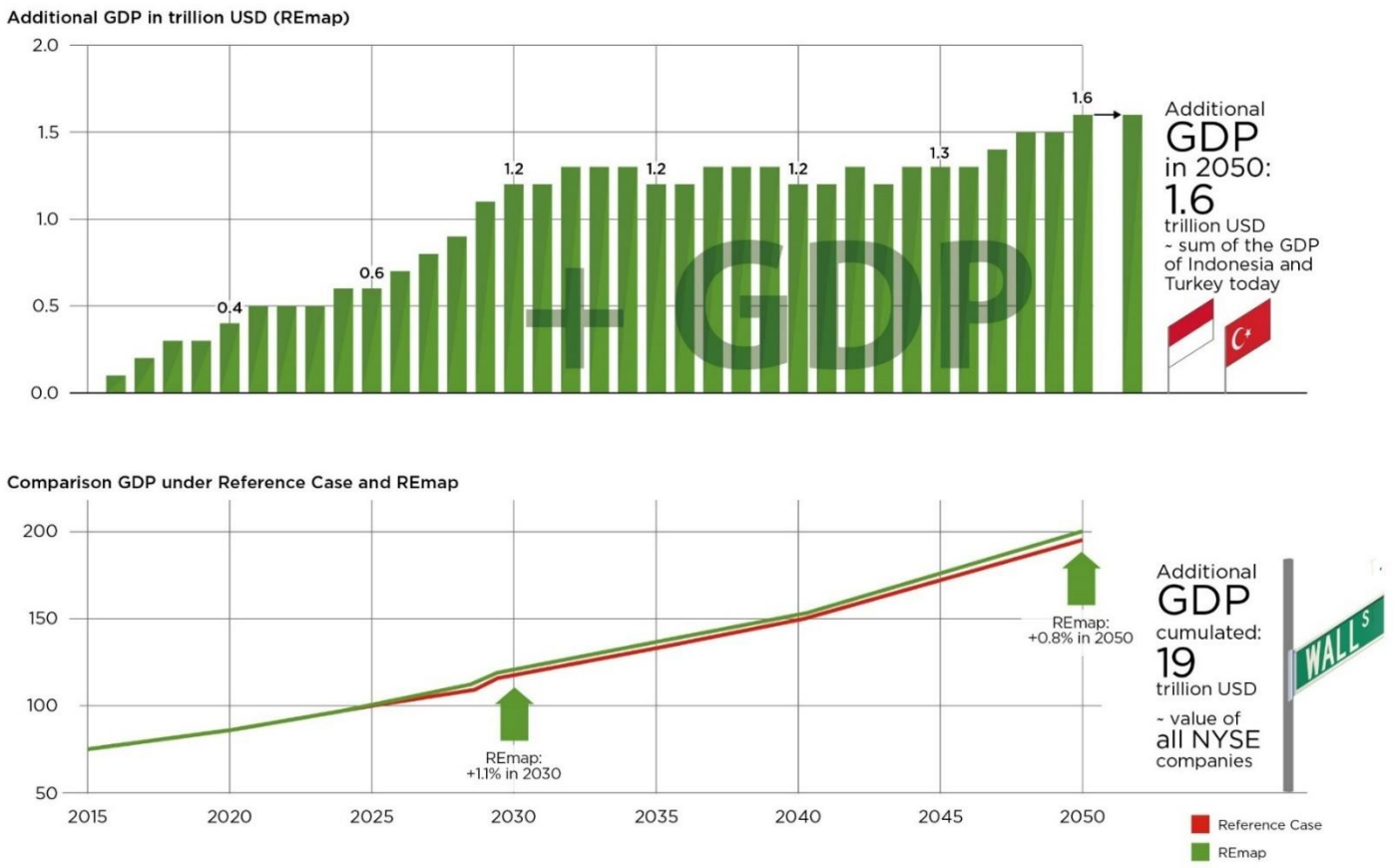
- Benef**its from reduced externalities** exceed the costs of decarbonisation by a factor of between **two and six in 2050**.
- Health benefits from reduced air pollution health alone exceed the costs.

Stranded assets by sector in REmap and Delayed Action cases



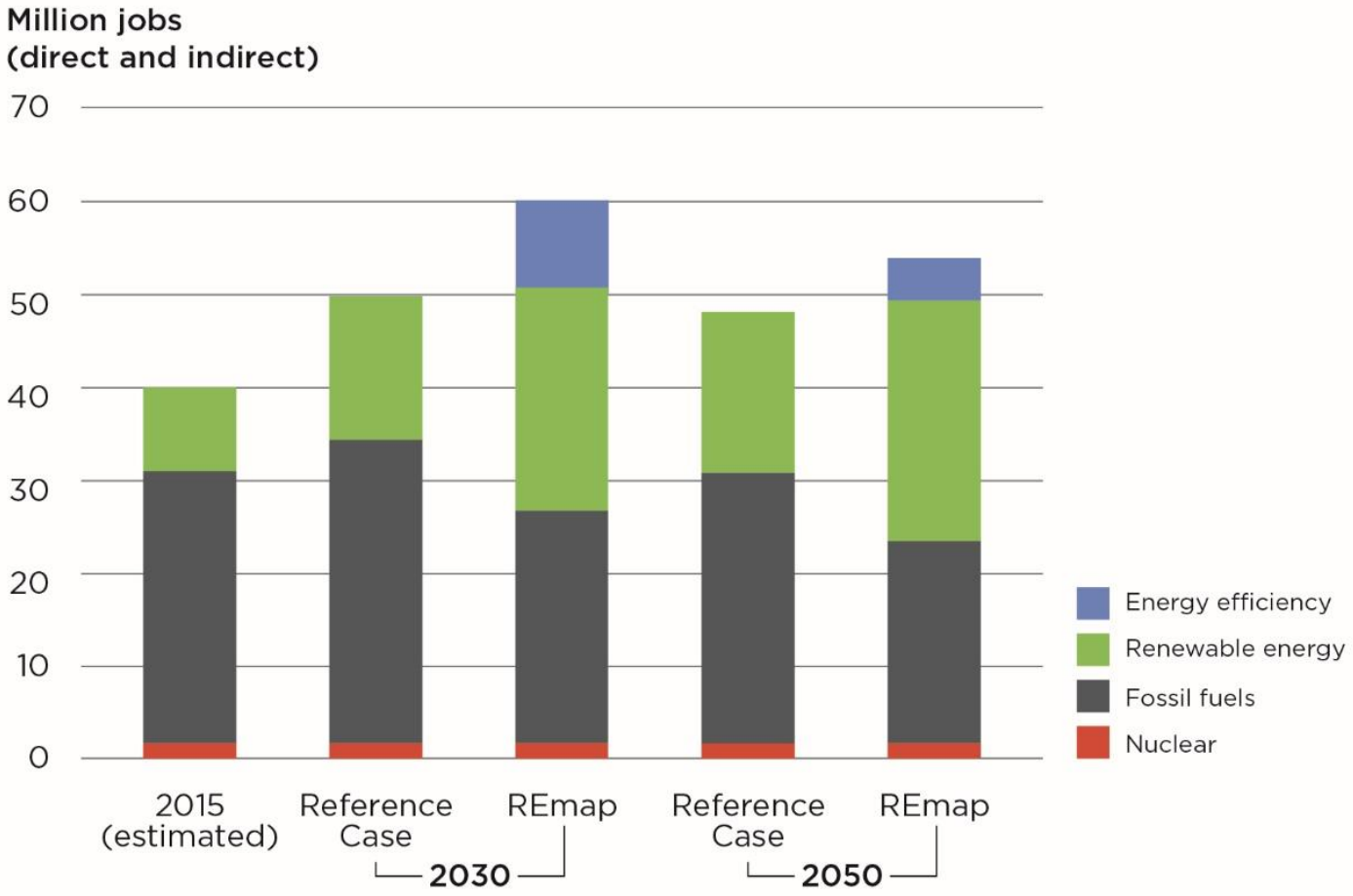
- REmap scenario results in USD 10 trillion of stranded assets
- Delaying action will result in an additional **USD 10 trillion in stranded assets**.

Increase in global GDP



- Decarbonising the energy sector in line with REmap **increases global GDP by around 0.8%** by 2050 compared to the Reference Case.
- That is the equivalent of almost **19 trillion USD in increased economic activity** between today and 2050.

Energy transition results in jobs growth



- New jobs in renewables and energy efficiency more than offset job losses in fossil fuel sectors.

PART 4: A EUROPEAN PERSPECTIVE

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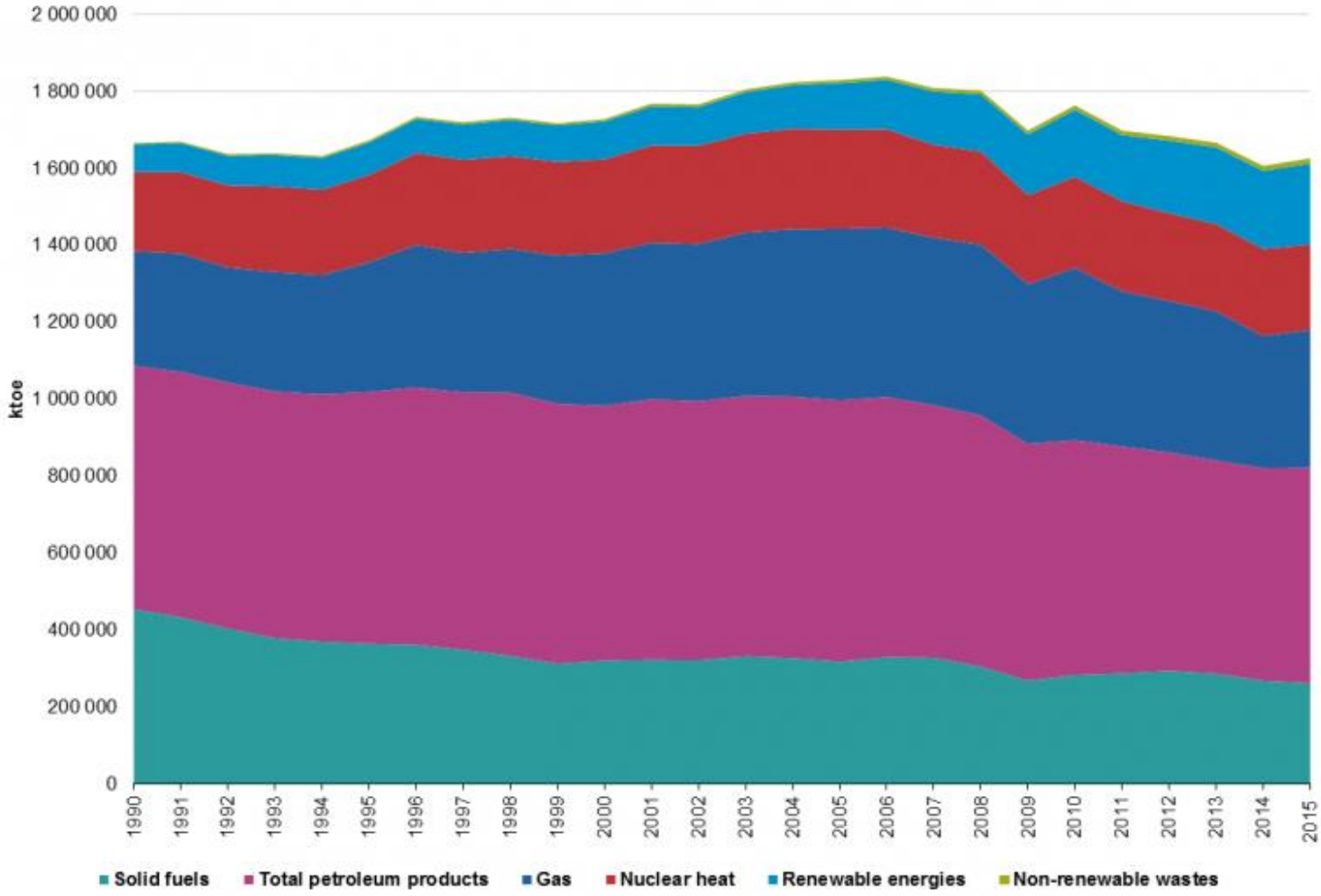
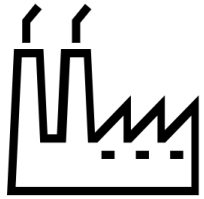
Evolution of energy consumption in Europe

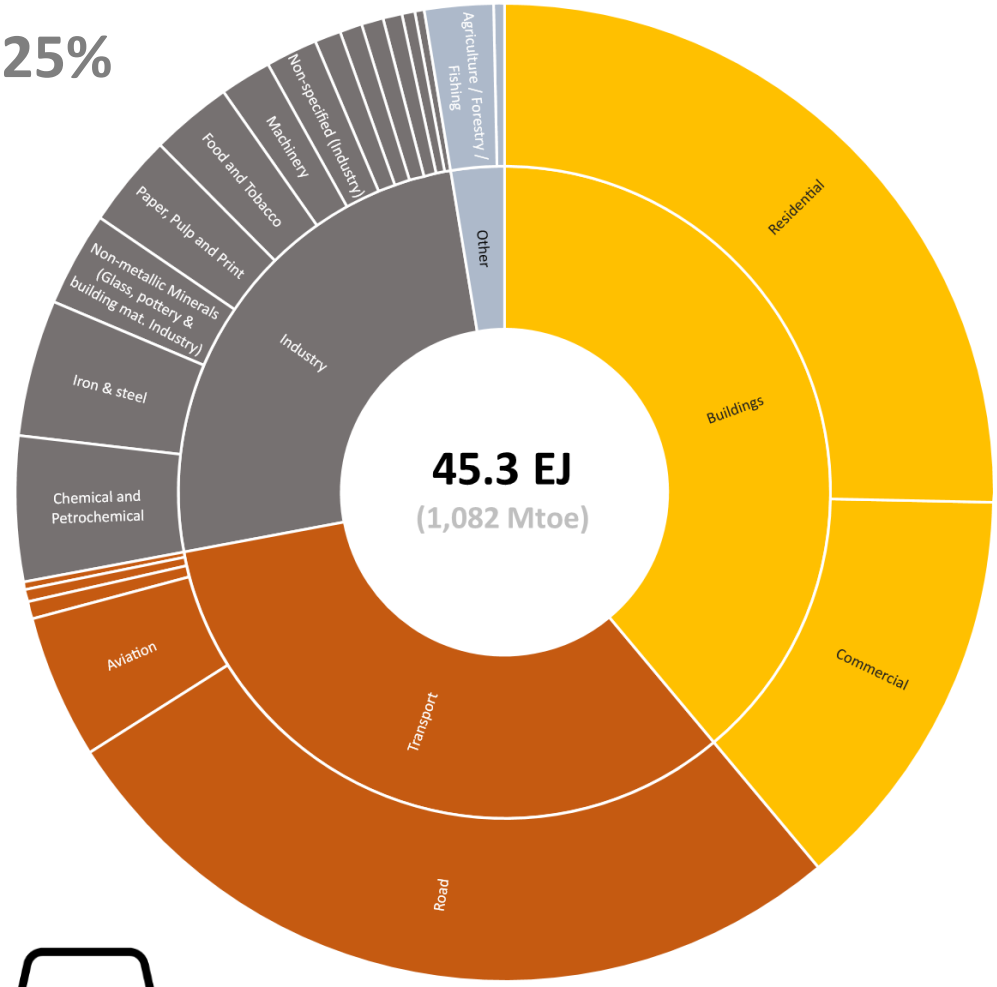


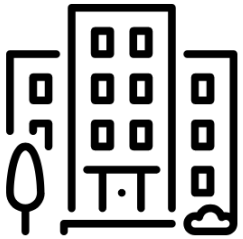
Source: EUROSTAT (Gross inland energy consumption of the EU. Dataset: nrg_100a)

European consumption of energy per end-use sectors



25%



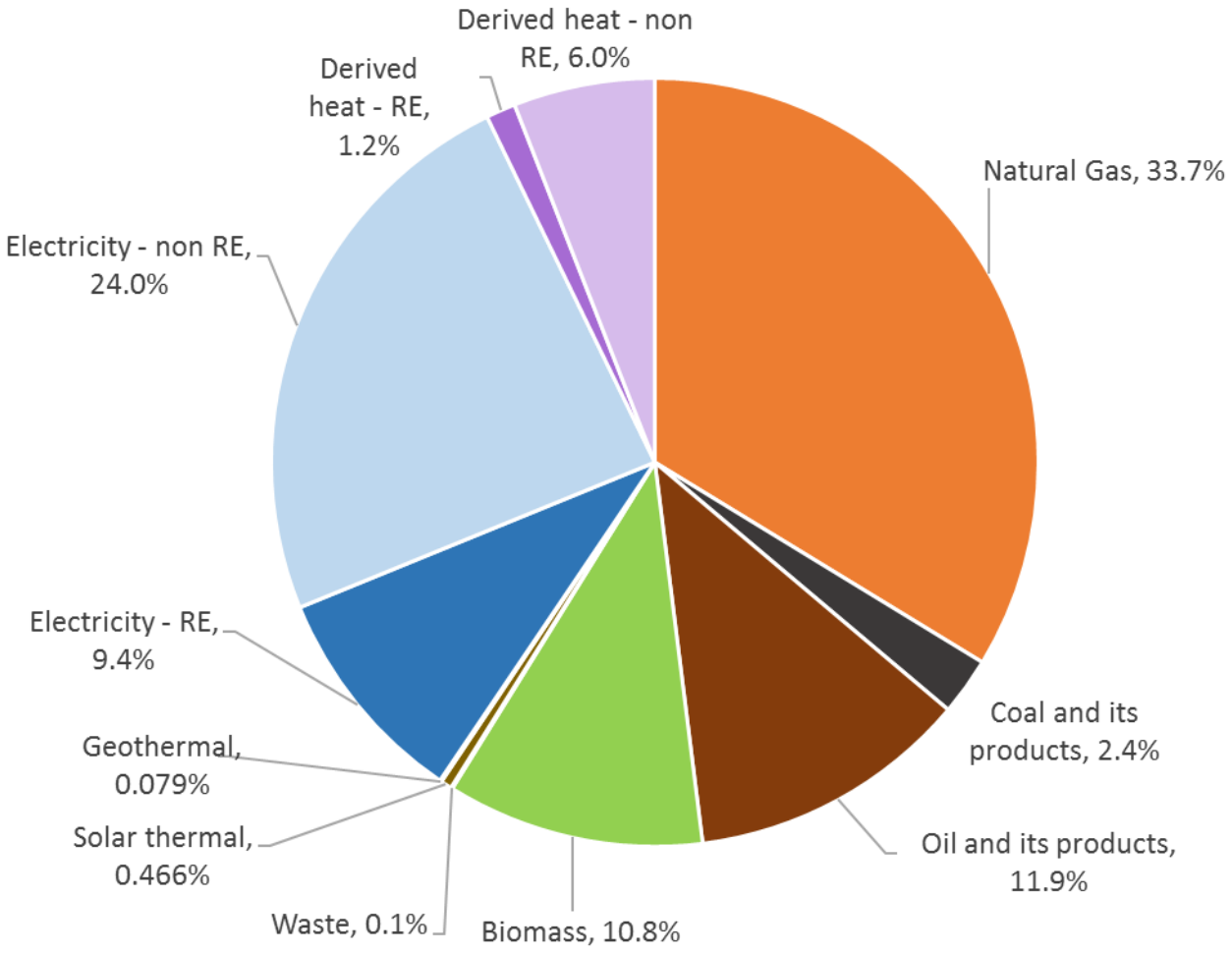


39%

33%

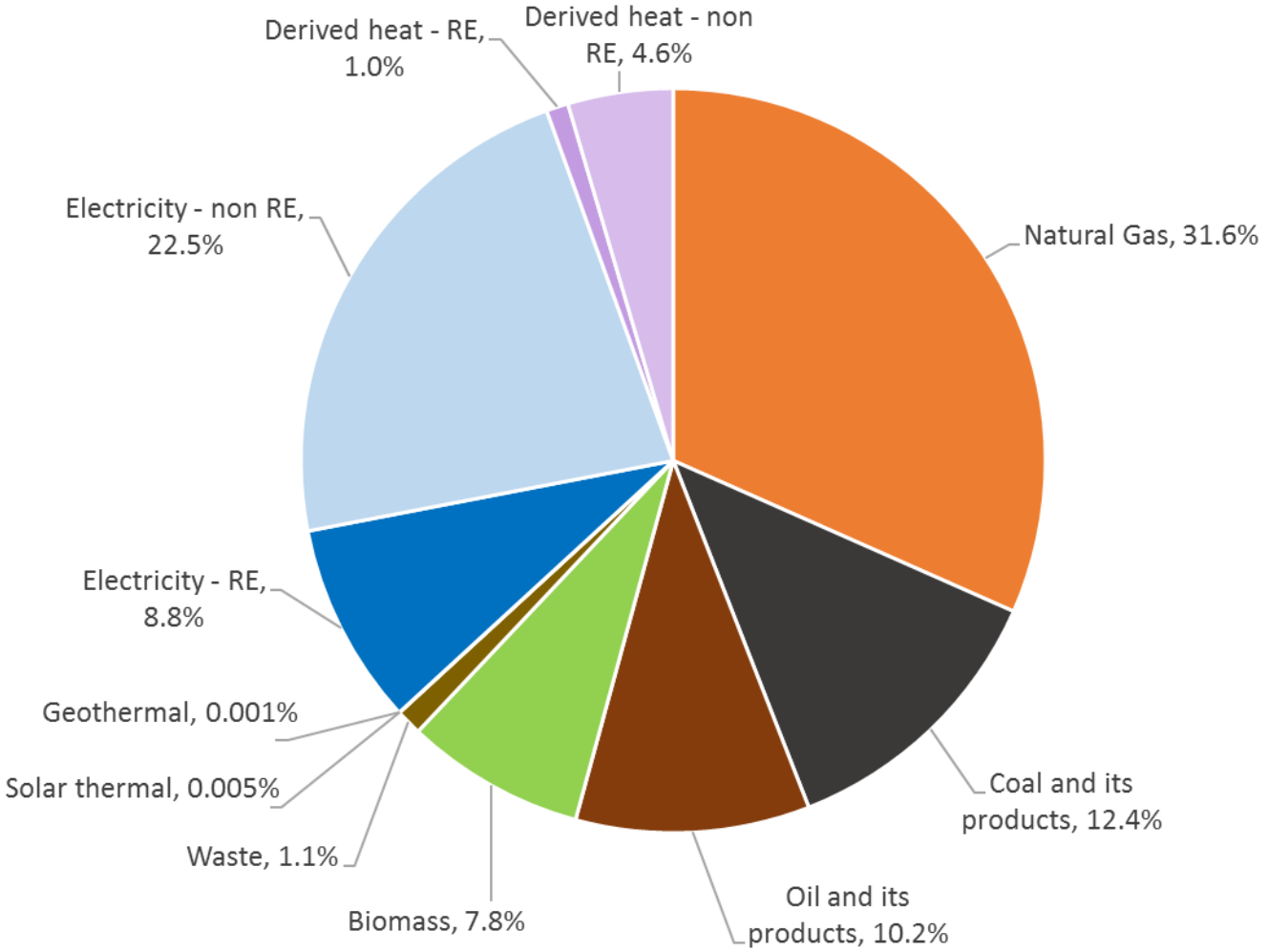
European consumption per source - Buildings

39%



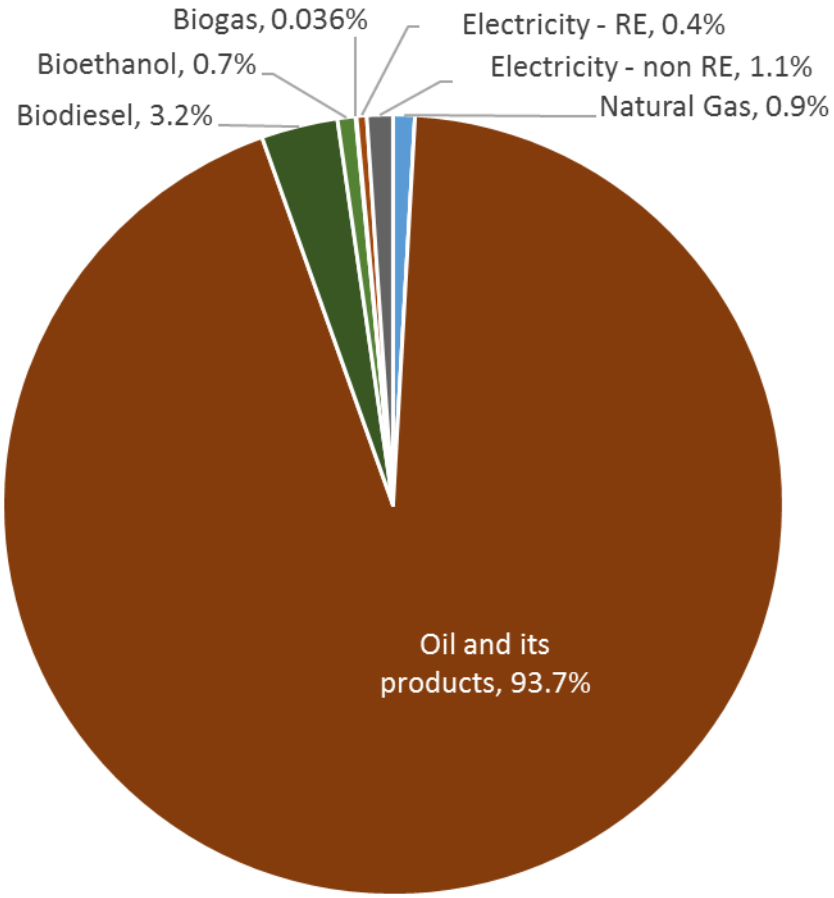
European consumption per source - Industry

25%



European consumption per source - Transport

33%



What are the issues with this energy system?

- **Environmental**
  - Global warming
  - Other environmental impacts

- **Human**
  - Health impacts from pollution

- **Strategic and economic**
  - Security of supply concerns (dependency)
  - Balance of trade

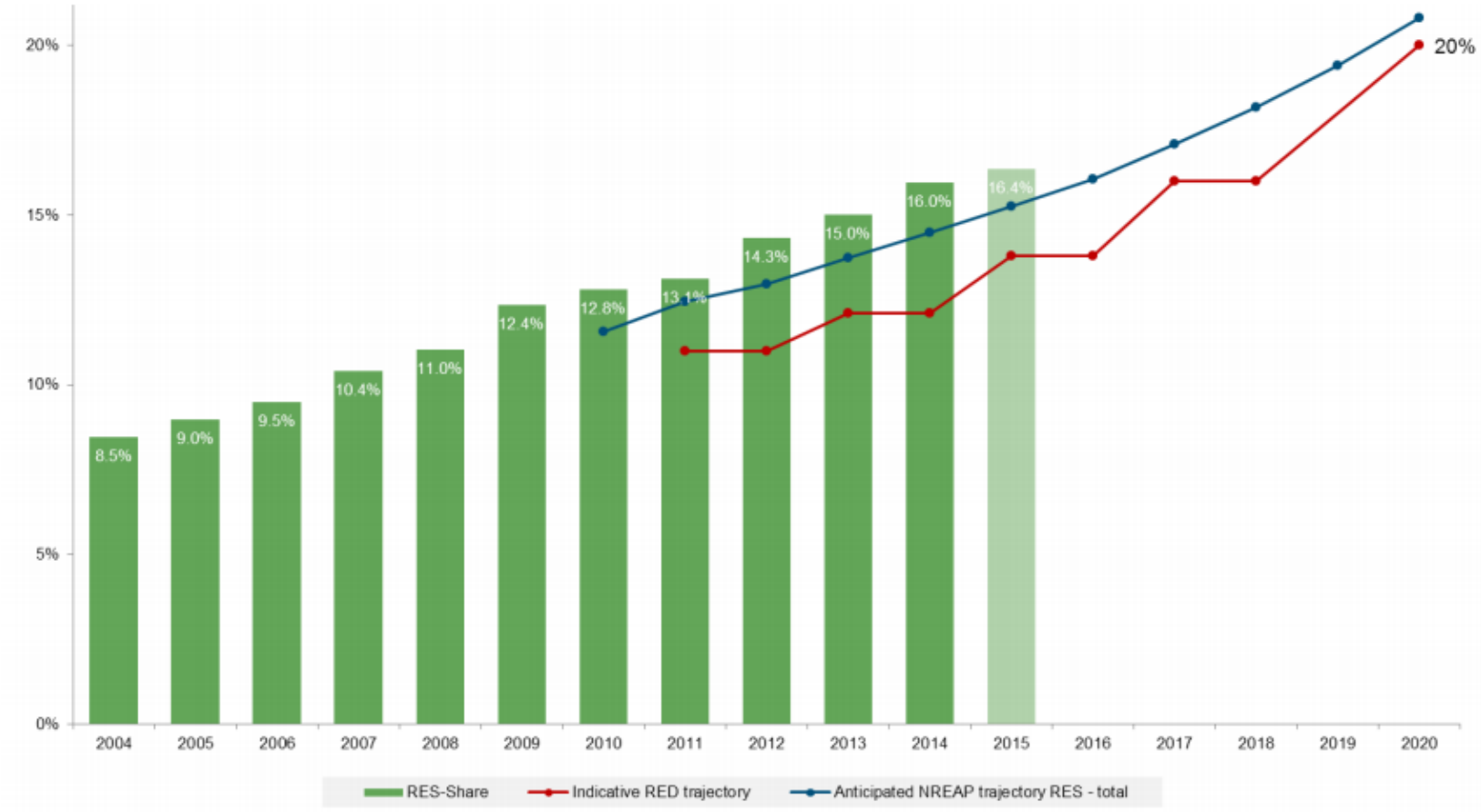
European policy for renewables today

Renewable Energy Directive (2009)

- EU wide target of **20% renewable energy by 2020**
  - 10% renewable energy in the transport sector

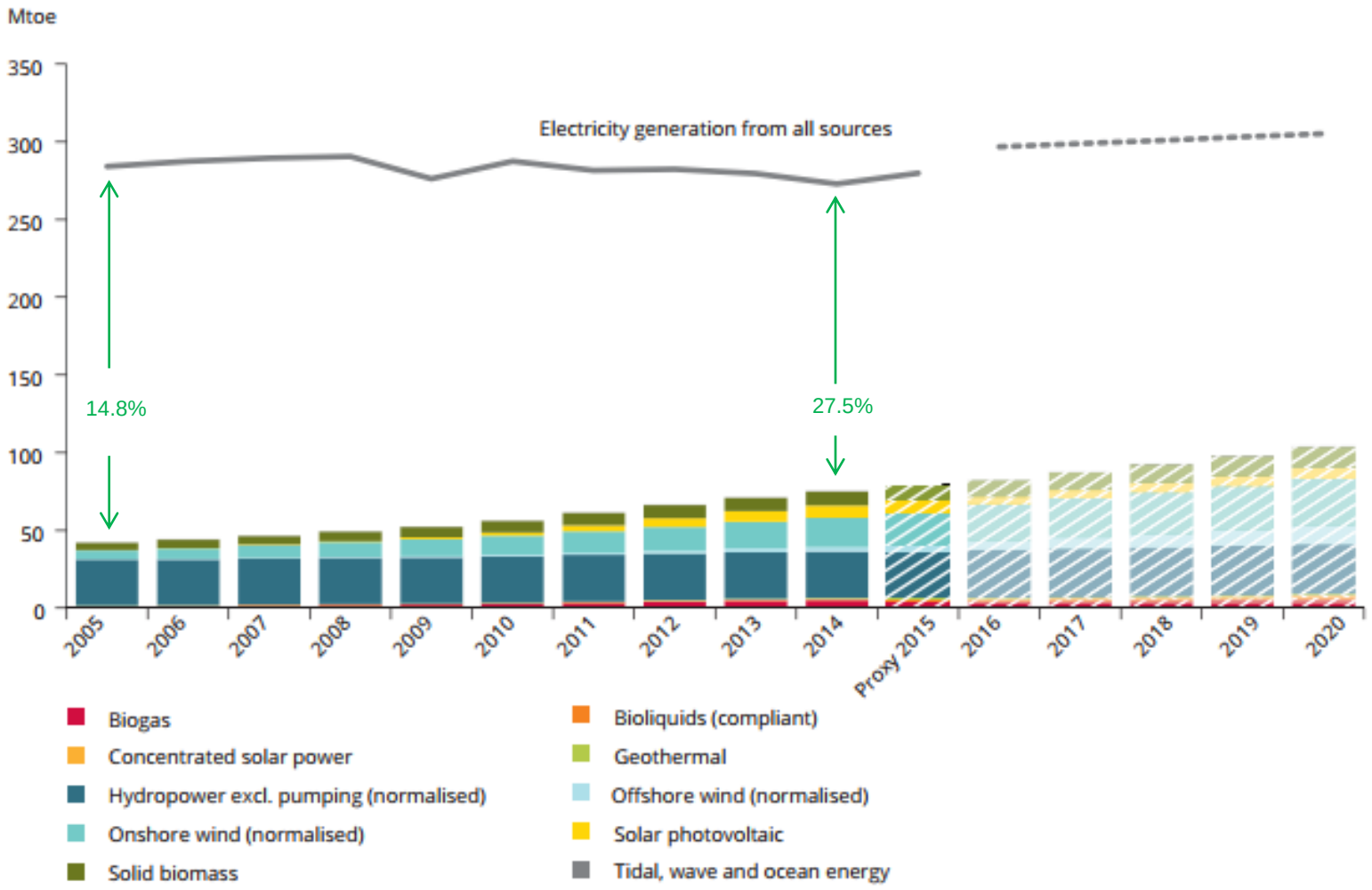
- Establishes targets for each Member State
  - Mandates adoption of policy measures (support schemes)
  - National renewable energy action plans (NREAPs)
  - National progress reports (every 2 years)

EU-28 progress on renewable energy so far



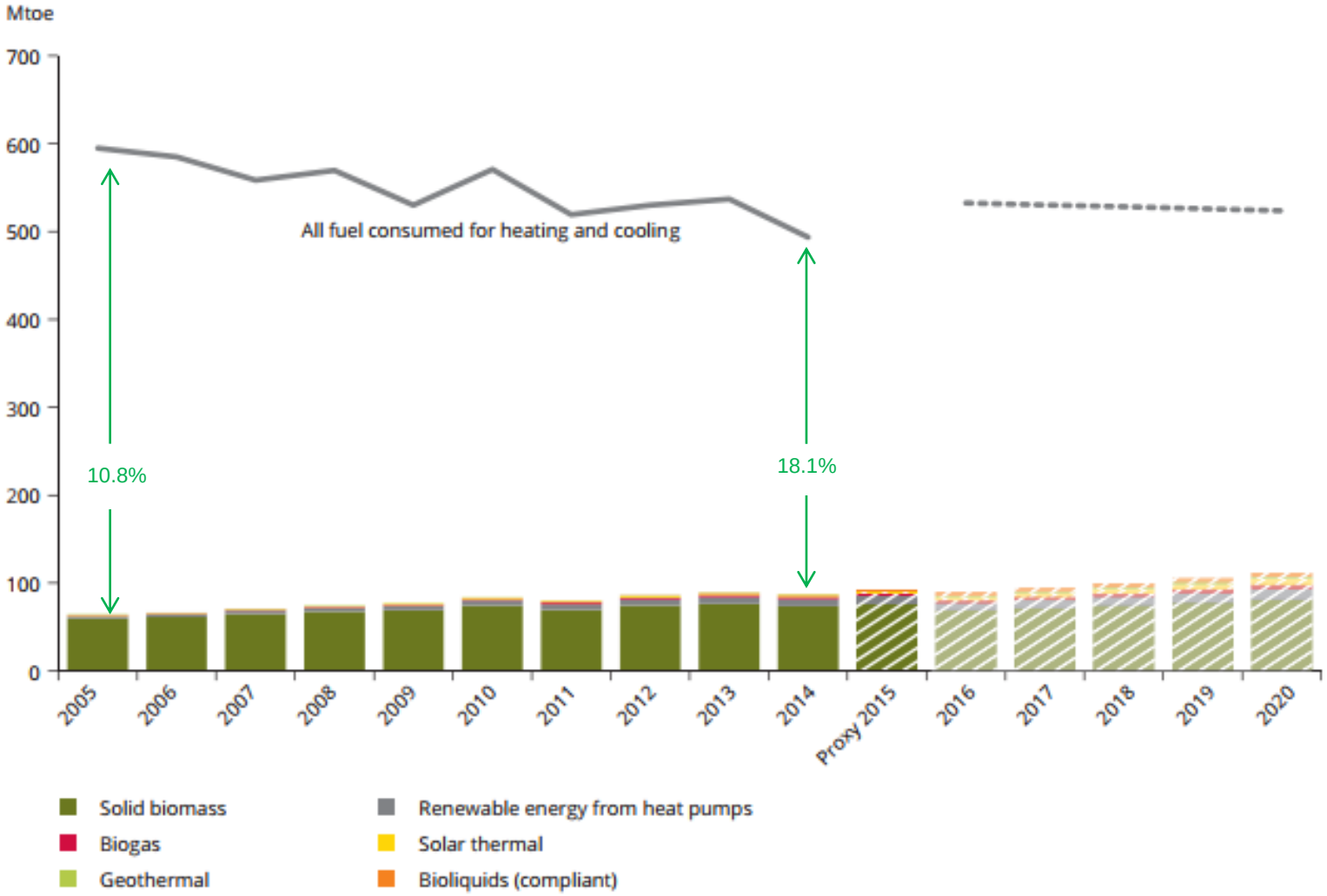
Source: European Commission, 2017. Renewable Energy Progress Report (COM(2017) 57 final)

Evolution of renewable electricity in power sector



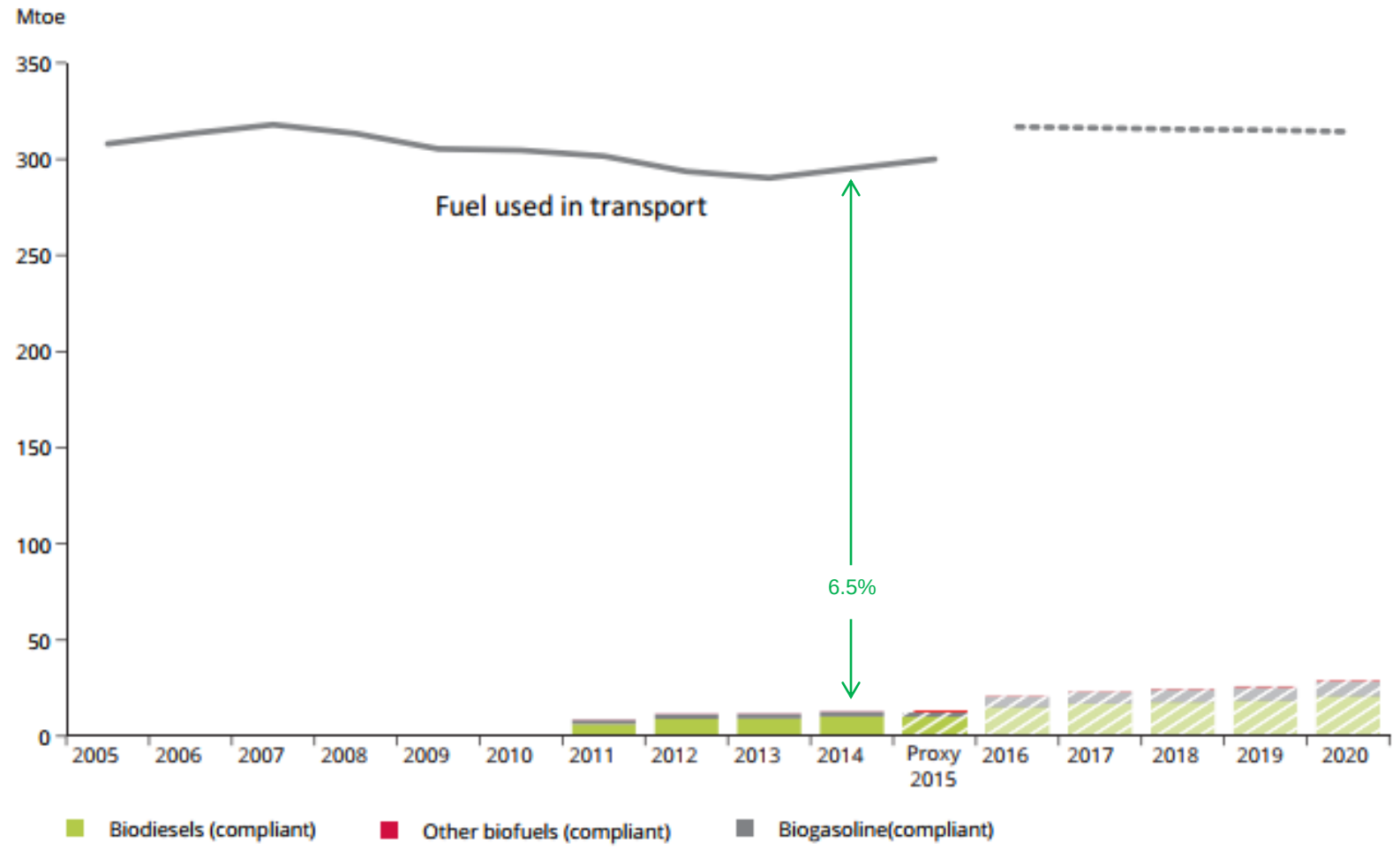
Source (Graph): EEA,2017 Renewable energy in Europe 2017. Recent growth and knock-on effects; Source (shares): EUROSTAT, 2017 RES Shares Database

Evolution of renewables for heating and cooling



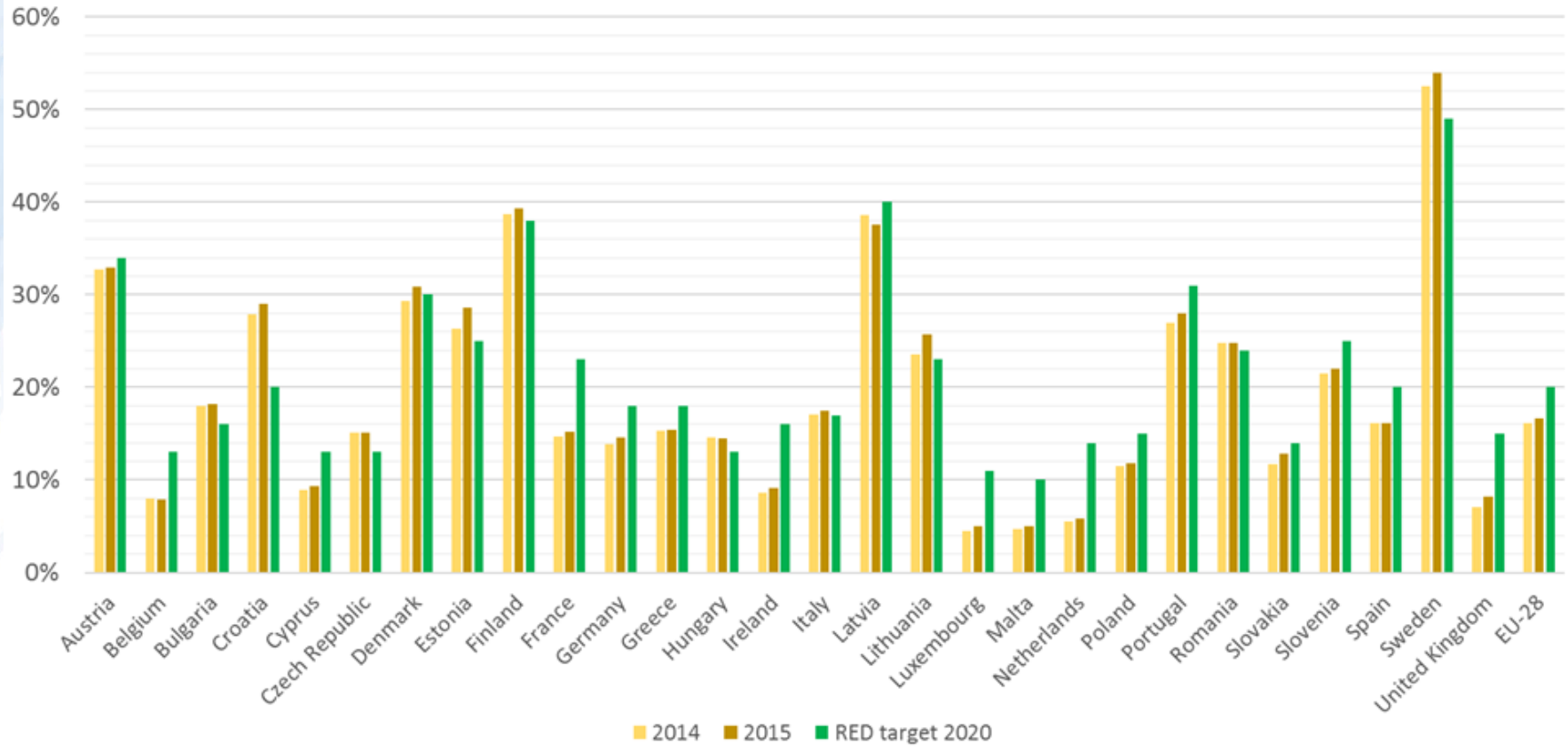
Source (Graph): EEA,2017 Renewable energy in Europe 2017. Recent growth and knock-on effects; Source (shares): EUROSTAT, 2017 RES Shares Database

Evolution of renewables in transport



Source (Graph): EEA,2017 Renewable energy in Europe 2017. Recent growth and knock-on effects; Source (shares): EUROSTAT, 2017 RES Shares Database

Progress on renewable energy by Member State



Source: EUROSTAT, 2017. RES Shares database. http://ec.europa.eu/eurostat/web/energy/data/shares

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European objectives for 2030 – ongoing discussion

> 2014, the EU Council agreed on a target of **at least 27%** renewable energy by 2030

> 2016, the European Commission proposed legislation (a new RE Directive) to meet the **27% target**

> 2017: Draft report from ITRE Committee at the EU Parliament on the proposed directive **considers appropriate a target of at least 35%**

?

The EU energy system in 2030: Will it be in line with the Paris Agreement?

- The Paris Agreement established a global warming goal of ***"well below 2C"*** compared to pre-industrial levels.

- Global emissions in the energy sector **need to fall to net zero by 2060** and stay there for the rest of the century.

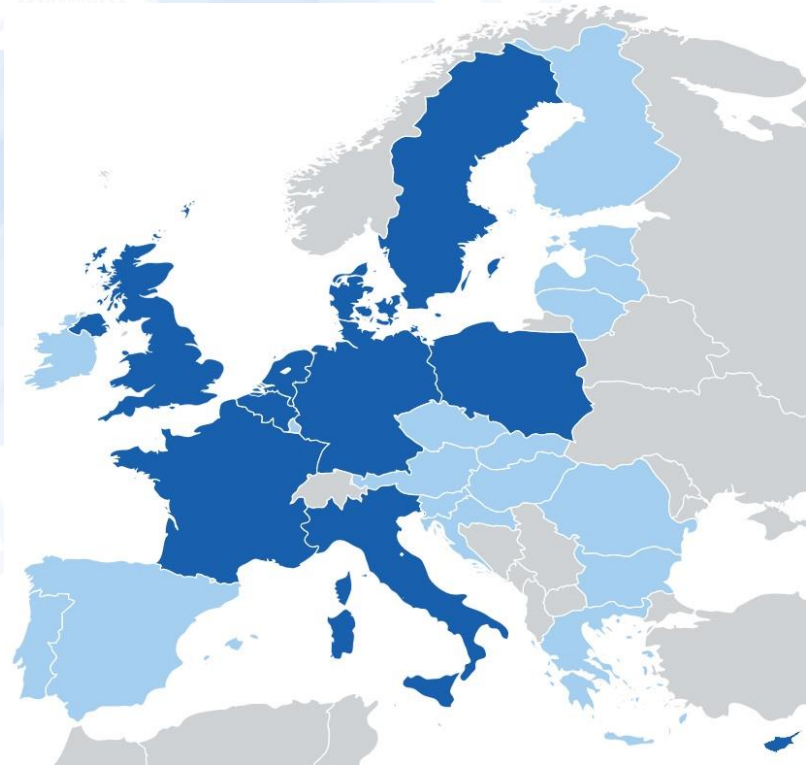
- EU GHG reduction target for 2030: **-40% by 2030**

- Much deeper reductions will be needed between 2030 and 2050 to be in line with Paris Agreement

Contents

1. Energy in Europe today
2. Where will/should Europe be in 2030?
3. **Options to accelerate renewable energy transition**
4. Conclusions and challenges ahead

IRENA's 2030 renewable energy roadmap for the EU (REmap)



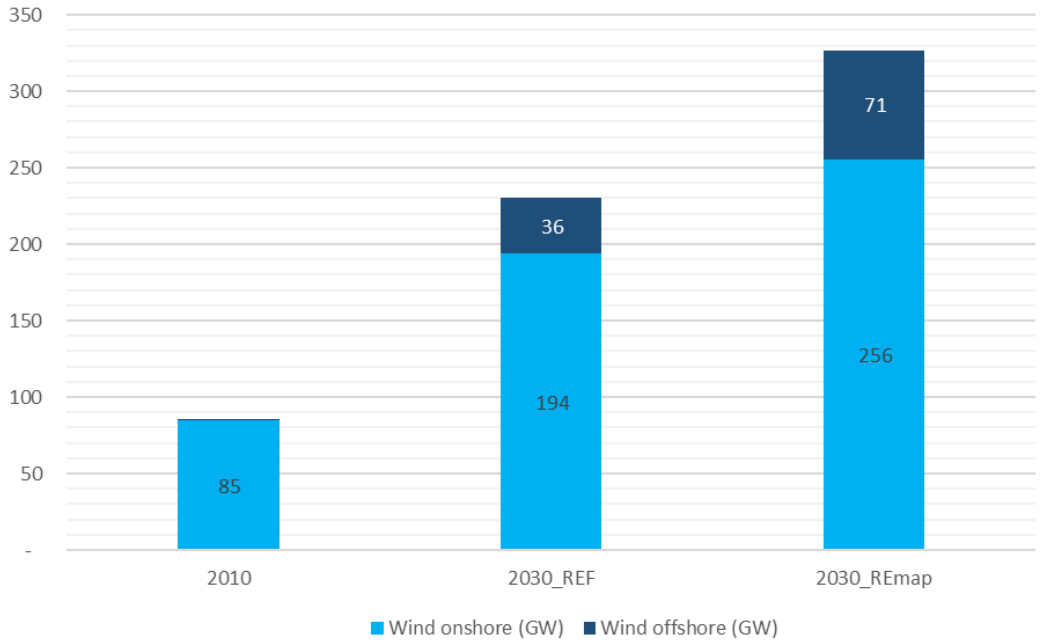
- 10 in-depth REmap analyses (73% of EU energy use)
  - With national experts nominated by each Member State to work with IRENA staff
- Streamlined RE quick-scans for the remaining 18 members
  - Based on indicators analysis (e.g. share of SWH use in roof area, total heating demand) and review of literature available.

Renewable energy options for power generation (i)

Wind onshore and offshore

- Potential for almost 4-fold increase in installed capacity by 2030 compared to 2010
- Wind power could account for ~ 21% of total power generation in the EU-28 by 2030.

- Highly cost-competitive already today.
- Technology improvements enable capturing more renewable resource
  - Larger machines
  - Deeper waters (offshore)



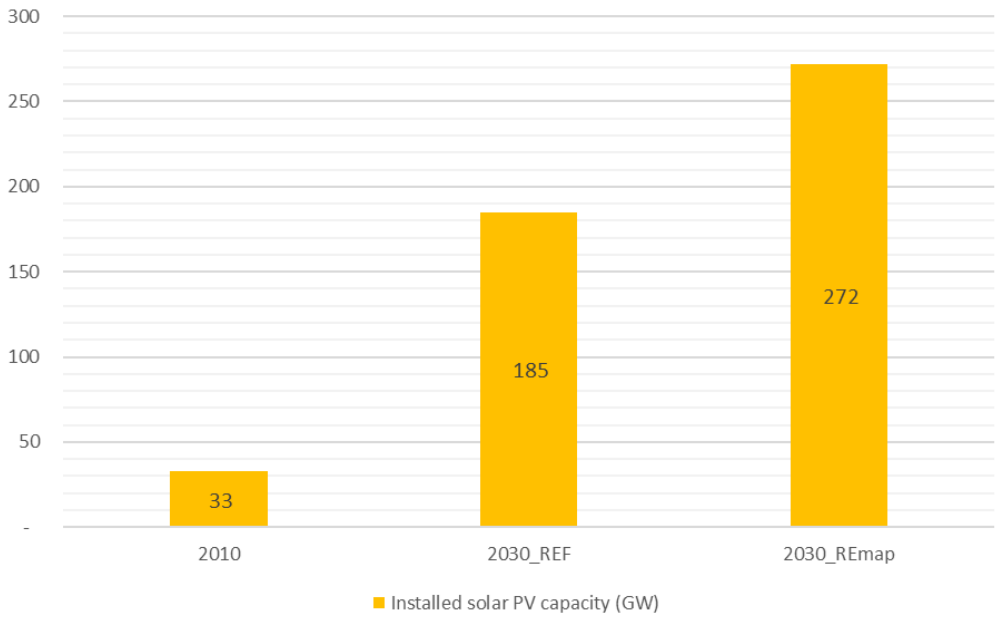
Source: IRENA REmap analysis for the EU-28 Draft results. October 2017.

Renewable energy options for power generation (ii)

Solar photovoltaics

- PV panels cost 80% less now than in 2010
- Highly cost-competitive already today.
- Room for deeper cost reductions until 2030

- Potential for almost 9-fold increase in installed capacity by 2030 compared to 2010
- Solar PV could account for ~ 8% of total power generation in the EU by 2030.



Source: IRENA REmap analysis for the EU-28 Draft results. October 2017.

Renewable energy options for heating

Solar thermal

https://www.cleanenergyresourceteams.org

- Mostly for hot water, although they can also contribute to space heating or process heat in industry.
- Limited to low and medium temperatures

Heat Pumps

https://energy.gov/energysaver/heat-pump-systems

- 3 to 4 x energy delivered vs energy input
- Enable efficient use of electricity for space heating
- Large potential for growth in residential and commercial buildings
- Limited to low and medium temperatures

Biomass

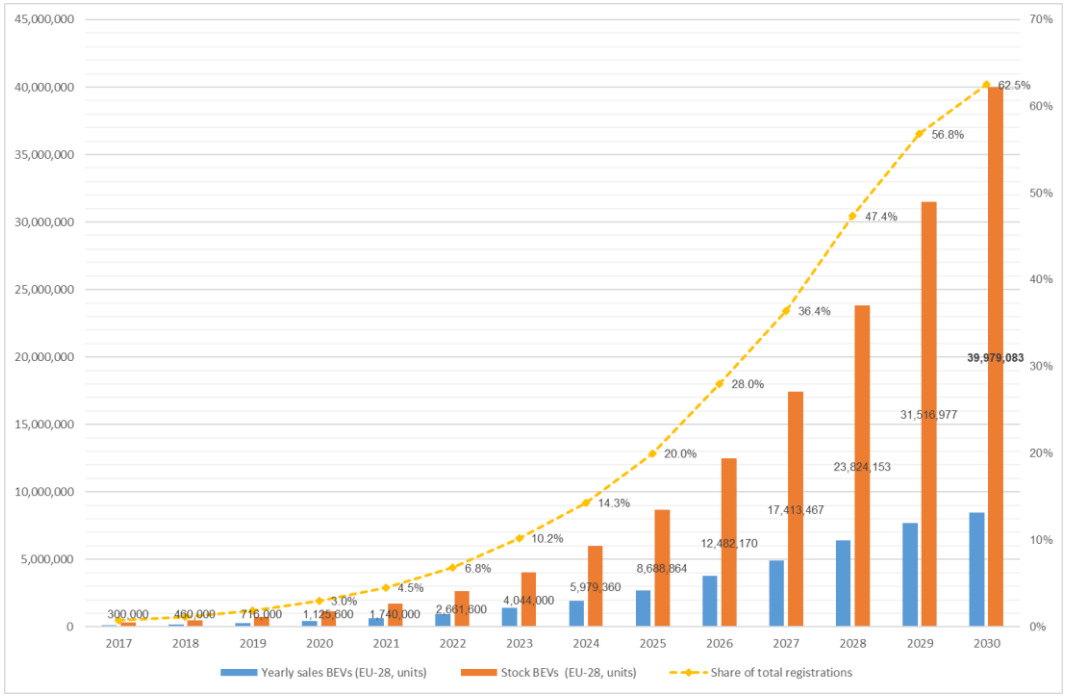
- Needed for high temperature applications in industrial processes
- Can also be used for space heating in commercial and residential buildings

Renewable energy options for transport (i)

Electric vehicles

- Less than half the final energy consumption of internal combustion engines
- Can be powered with renewable electricity
- Can help integrate renewables in the power sector

- Market growing exponentially: June 2016 - June 2017 -> 46%
- Sales of EVs in the EU could outpace those of conventional cars by 2030.
- By 2030, the stock of EVs in the EU could reach 40 million (16% of the total stock of vehicles)



Source: IRENA REmap analysis for the EU-28 Draft results. October 2017.

Renewable energy options for transport (ii)

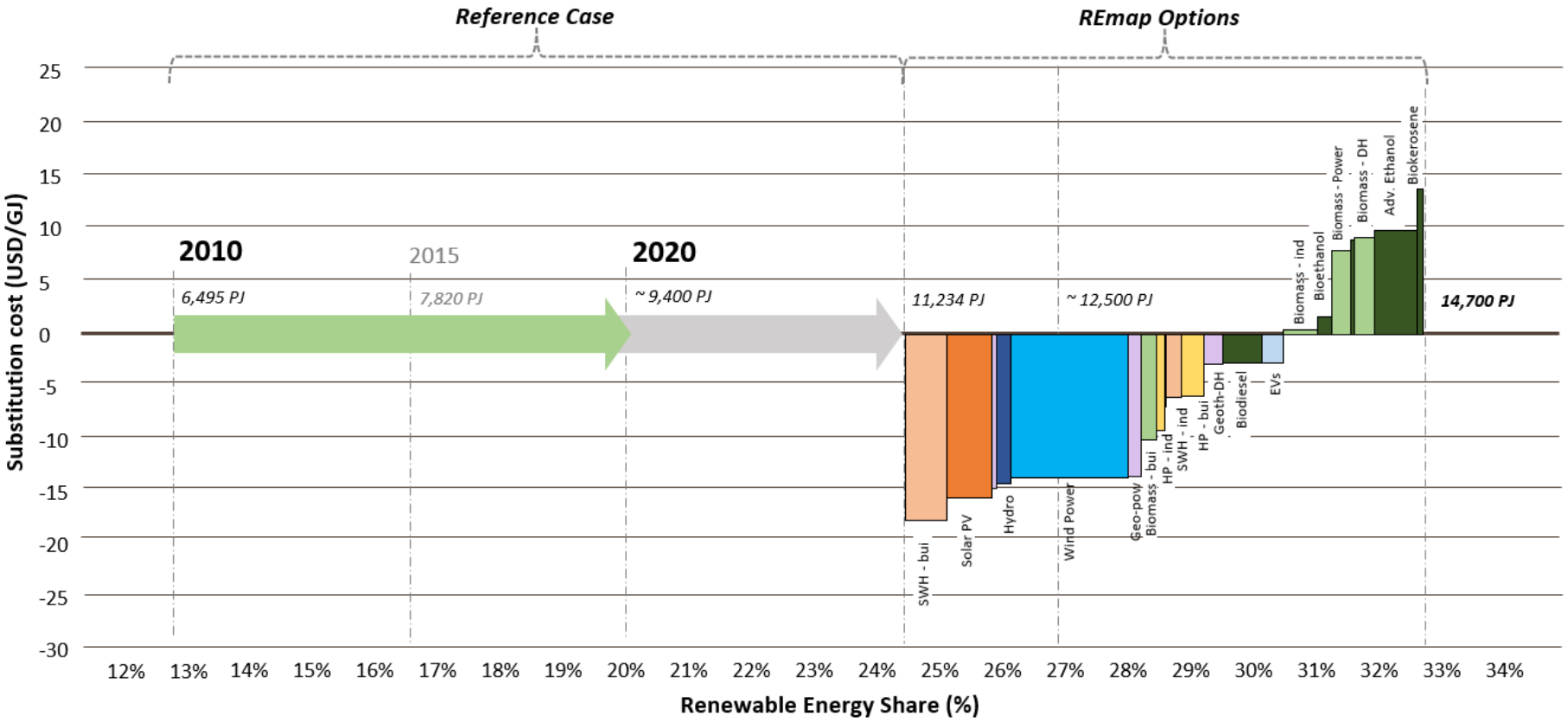
Liquid biofuels

- In the short/medium term, needed to fuel existing stock of internal combustion engines with renewable energy.
- In the longer term, needed for transport applications that cannot be ‘electrified’ e.g. aviation, shipping.

- **First generation biofuels** (bioethanol and biodiesel) are technologically mature; however, they face supply limitations and sustainability concerns.
- **Second generation biofuels** (e.g. lignocellulosic ethanol) are reaching commercial maturity, have less biomass supply restrictions and avoid some sustainability concerns e.g. food vs fuel debate;

Renewable energy potential for the EU by 2030

DRAFT



Source: IRENA REmap analysis for the EU-28 Draft results. September 2017.

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1. Energy in Europe today
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Conclusions

- Accelerating the adoption of renewables in EU-28 by 2030:
  - Is technically possible with existing technologies
  - Is key for Europe to meet its Paris Agreement commitments
  - Is cheaper than the conventional alternatives
  - Would bring substantial additional social benefits
    - Investments & jobs
    - Avoided pollution & health damages

Open challenges for long-term renewable deployment

- Many open questions to work on in the near future:
  - Effective integration of variable renewables in power systems?
  - Renewables in industrial processes?
  - Aviation and shipping with renewables?
  - Long-term (seasonal) storage of renewable energy?
  - New / improved / cheaper renewable technologies?

IRENA
International Renewable Energy Agency

Thank you!

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