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Decarbonisation pathways to 2050

Abu Dhabi, 1 November 2016

CONTEXT AND SCOPE

The G20 Toolkit

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Five Actions on a voluntary opt-in basis

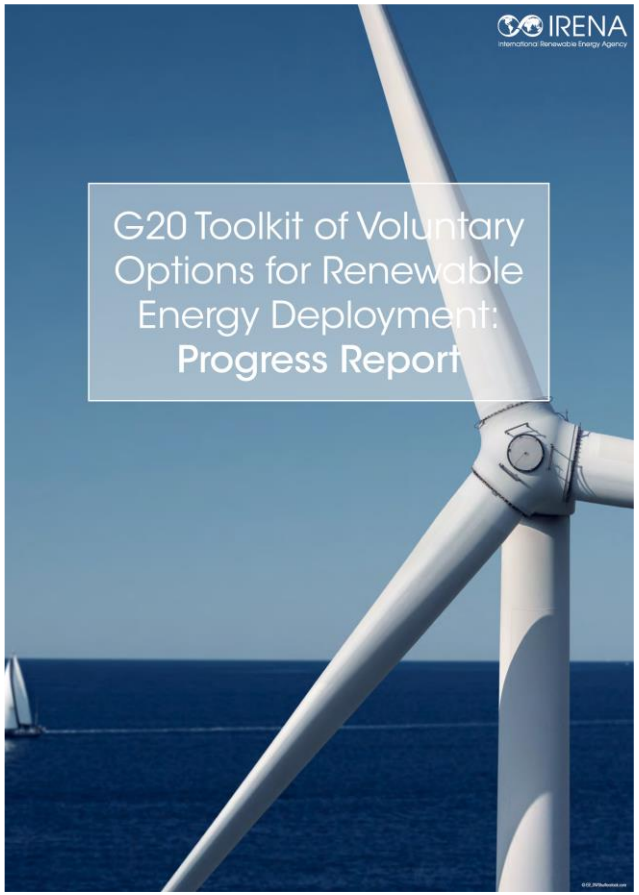
1. Analysis of RE costs, cost reduction potentials and best practice exchange

2. Best practice exchanges on
   (i) enabling policy framework
   (ii) integration of high shares of variable renewables

3. Development of a renewable energy specific risk mitigation facility

4. Assessment of country renewable energy technology potentials and development of roadmaps

5. Accelerate deployment of modern bioenergy



September 2016

Decarbonisation study

- **New study:** “Global Energy Transition: Shifting Investments for Decarbonisation”
- **Objective:** identify investments in low-carbon technologies in the areas of power generation, transport, buildings and industry to enable energy sector decarbonisation, whilst supporting security of energy supply, sustainable development and poverty alleviation
- Commissioned by Germany as input to the G20 discussions
- Closely coordinated with the International Energy Agency (IEA)
- Feeding to final OECD study of decarbonisation of the global economy

IRENA decarbonisation study content

- Builds on IRENA's REmap 2030 analysis, and expand to 2040/50 with national plans & credible third-party sources
- Assess renewable energy, energy efficiency technology potential (CCS & nuclear, if needed) by G20 country and sector
- Combine options into scenarios that meet the climate objective
- Assess the economics of scenarios: investments, stranded assets
- Macro-economic assessment: welfare, GDP, trade, jobs - E3ME model
- REmap country expert group for review
- With support and consultation of academia:
  - Institute for Sustainable Futures (University of Technology Sydney),
  - Smith School of Enterprise and Environment (Oxford University)
  - Numerous globally acknowledged climate experts (IPCC; IDDRI/DDPP; Global Carbon Project; PBL; Climate Analytics; IIASA)

Initial observations from IRENA's 2050 decarbonisation analysis (DRAFT)

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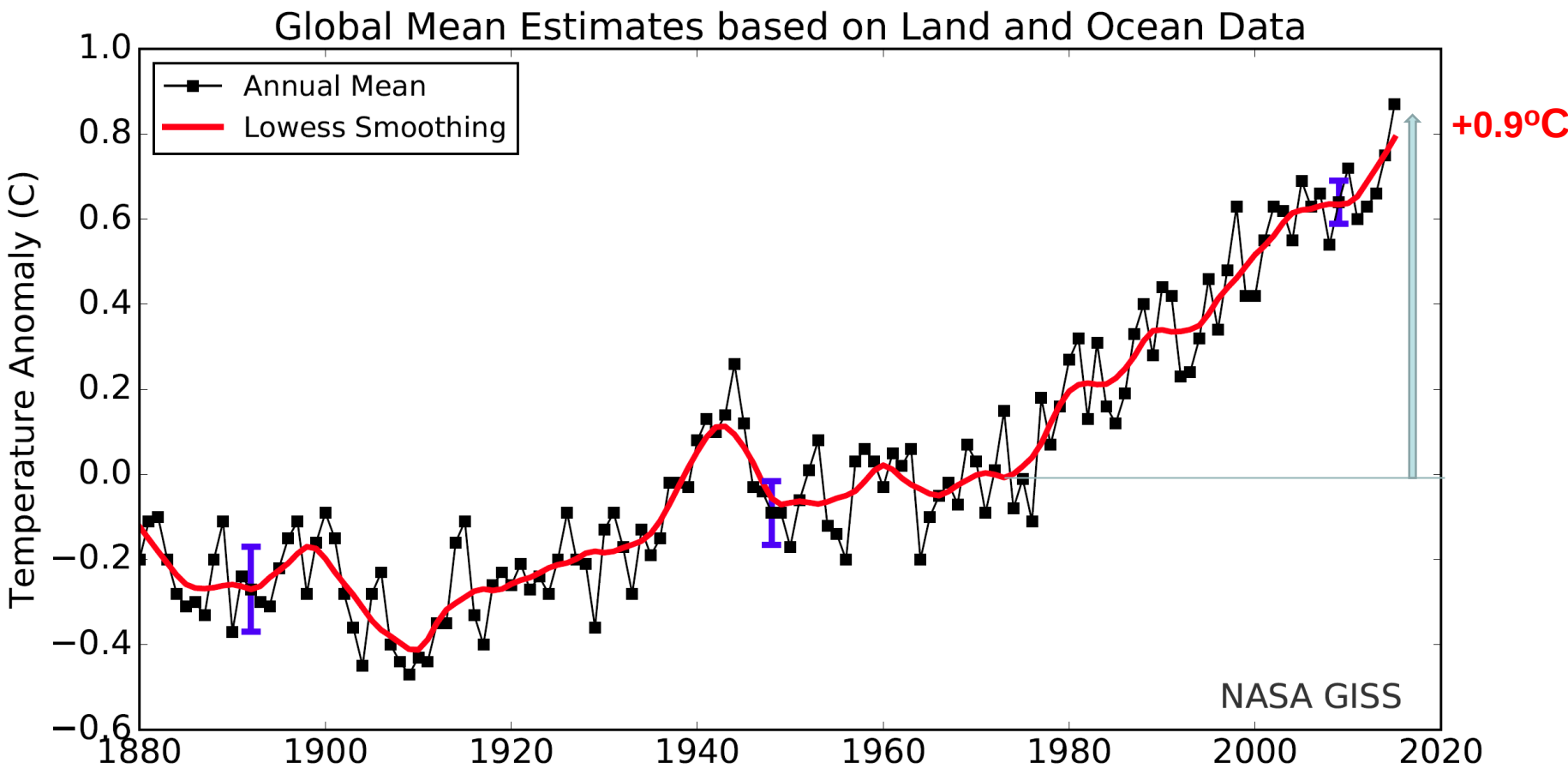
- Global temperatures have risen by 0.9 ^{o}C and continue to rise by 0.03 ^{o}C/yr
- By 2045, 2 ^{o}C will be reached – need to stop concentration rise by 2050
- Large uncertainty remains what this means for carbon budget
- IRENA study energy emission budget: **640 Gt** (2015-2050)
- Very little room to delay, and delayed action means failure
- Renewables and efficiency can account for more than 85% of energy emission mitigation
- **RE share in TPES needs to reach >70% by 2050.** Uncertainties remain:
  - Development of country energy use patterns
  - Costs, maturity and availability of low-carbon technologies
- Efficiency, electrification and bioenergy as major end-use sector solutions
- Average annual investments needs to 2050 **USD 840 bln/yr**, efficiency uncertain
- First estimates of stranded assets show significant impact of delayed policy action – buildings are key, especially in cold climates
- Air pollution, climate and GDP benefits outweigh the costs

DETAILED DRAFT FINDINGS

Global temperature change – 0.9 ºC

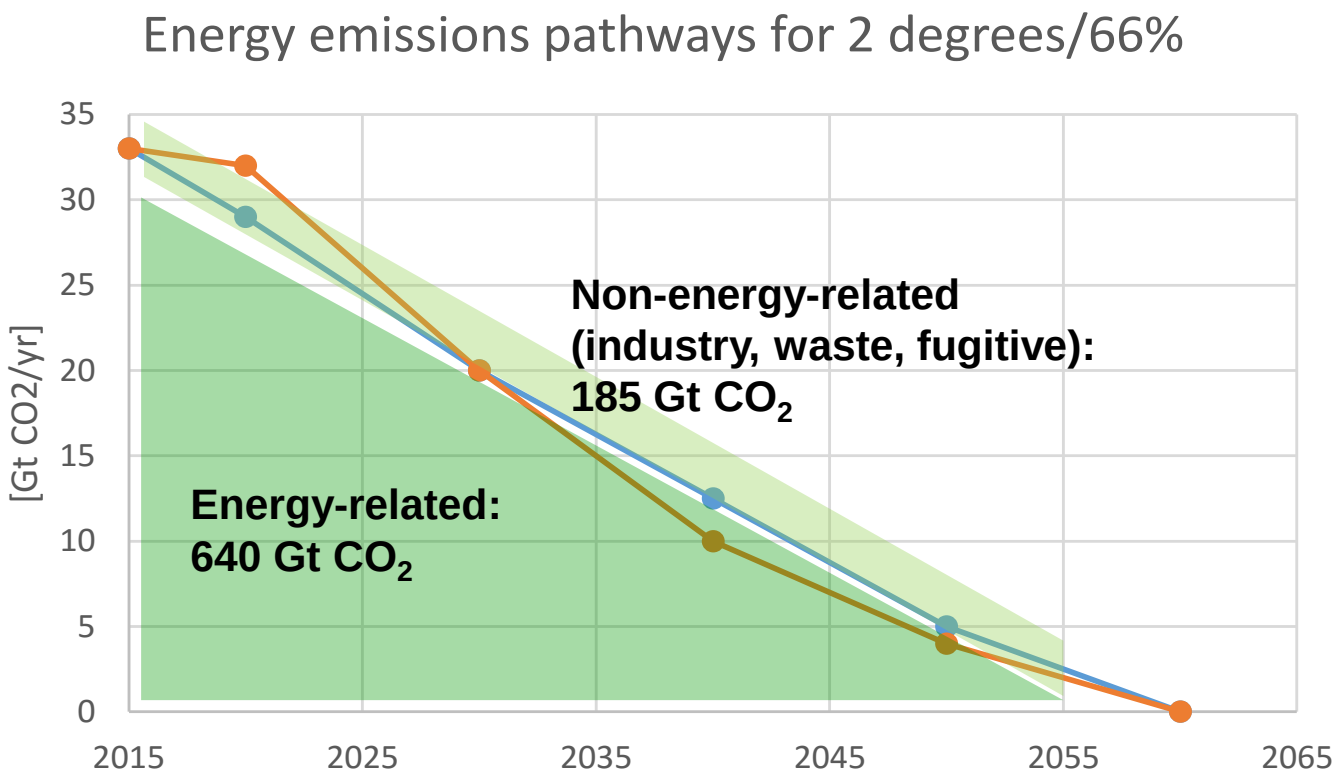


~0.03 ºC/year fairly linear increase over the past 25 – 30 years

At this rate, by 2050 2 ºC will be reached

Source: NASA (2016)

IRENA's carbon emission budget (DRAFT)

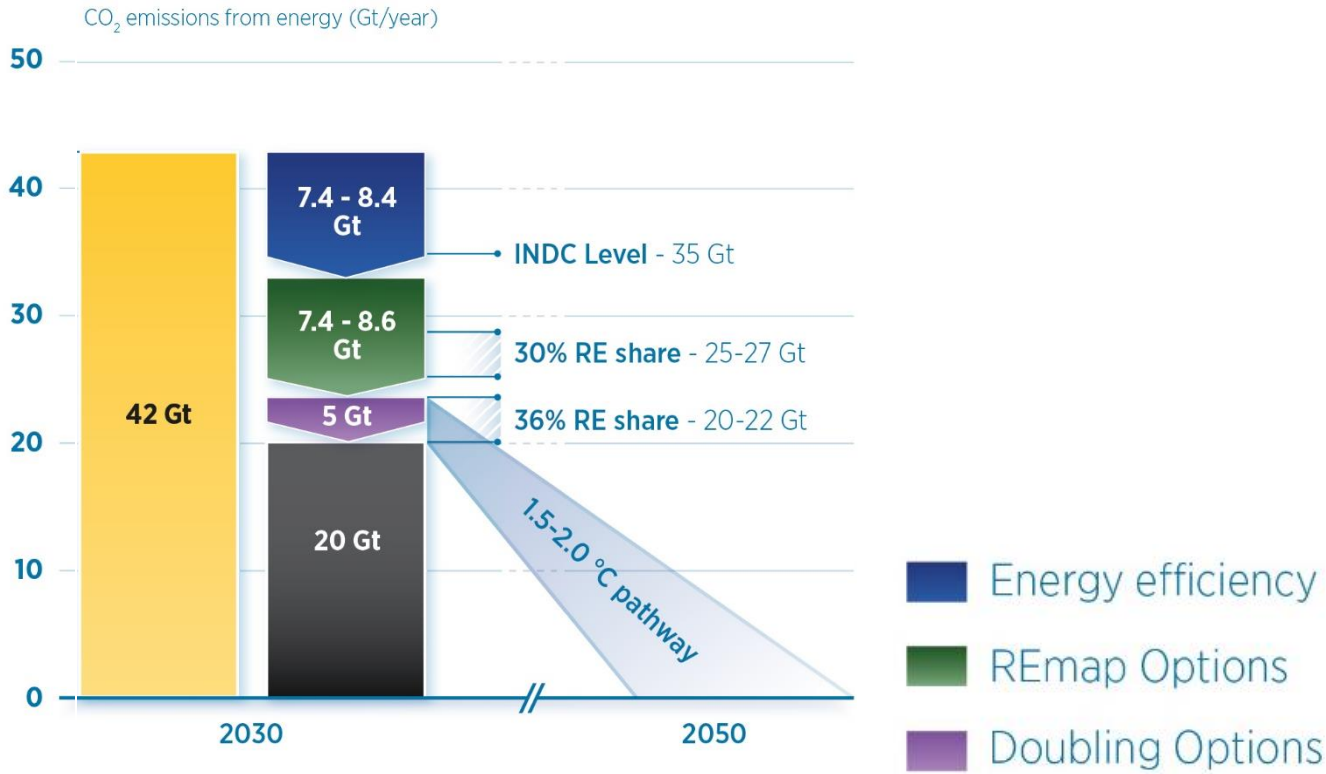


Total CO_2 emission budget for 2015-2050: 825 Gt CO_2

Max level emissions for decarbonisation: 2030 20 Gt & 2050 5 Gt

On average 25 Gt per year in 2015-2050, and annual decline of 0.7 Gt CO_2

Role of renewable energy and energy efficiency

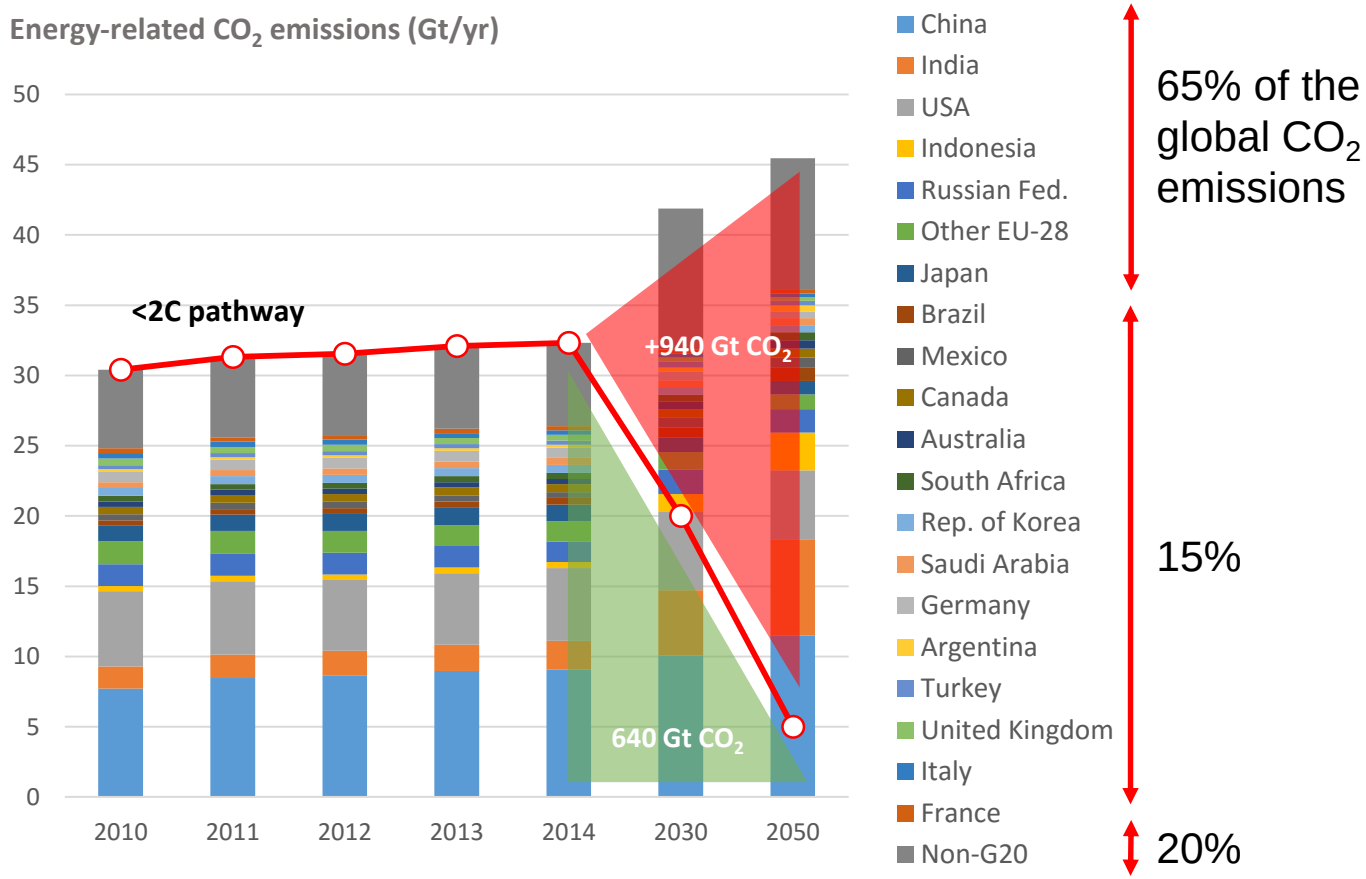


Doubling the share of renewables by 2030 would put the world on a pathway to limiting global warming to 1.5-2.0 degrees

Renewable energy reduction potential on par with efficiency potential

Source: IRENA (2016)

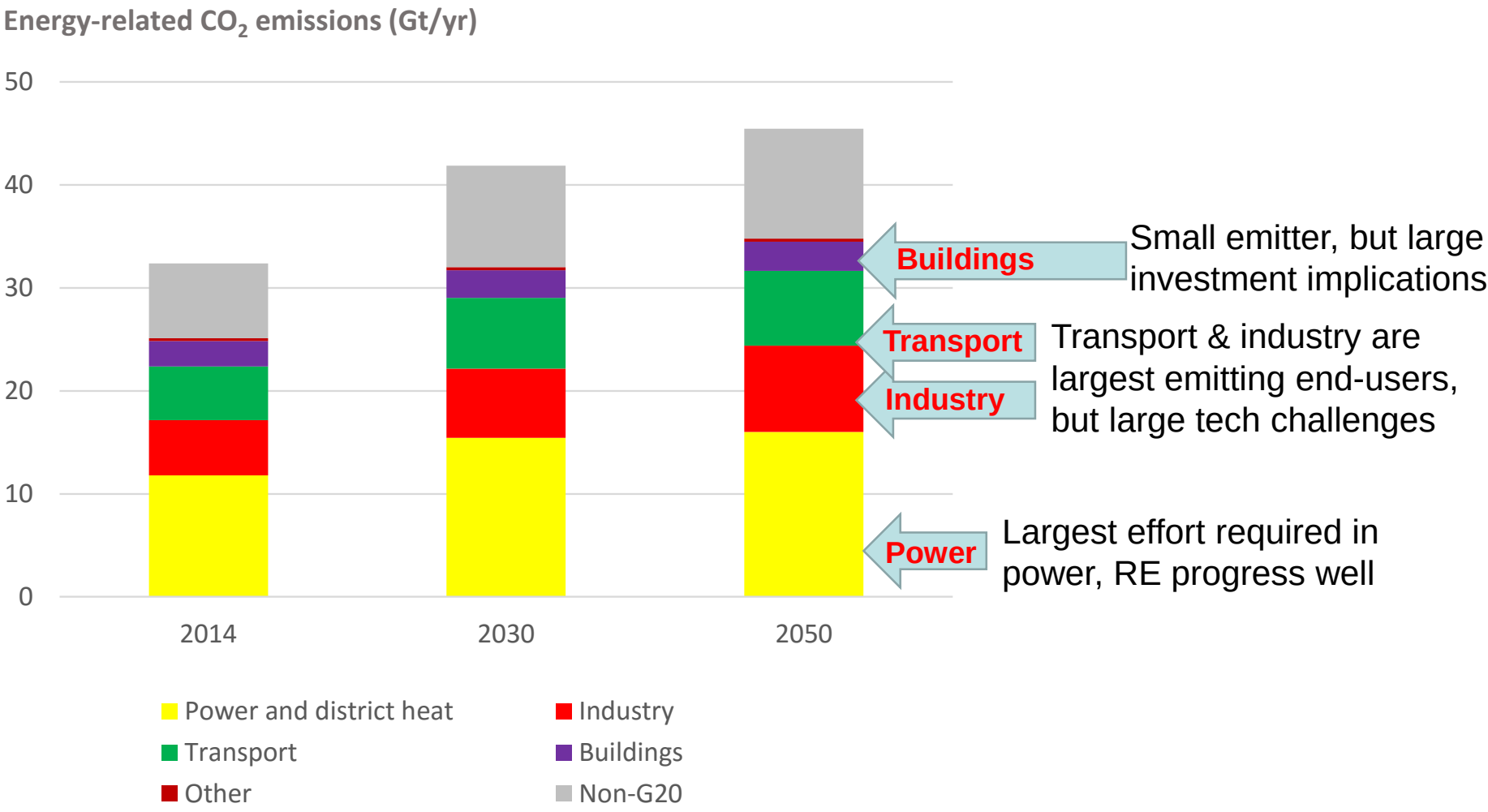
Country Reference Cases (DRAFT)



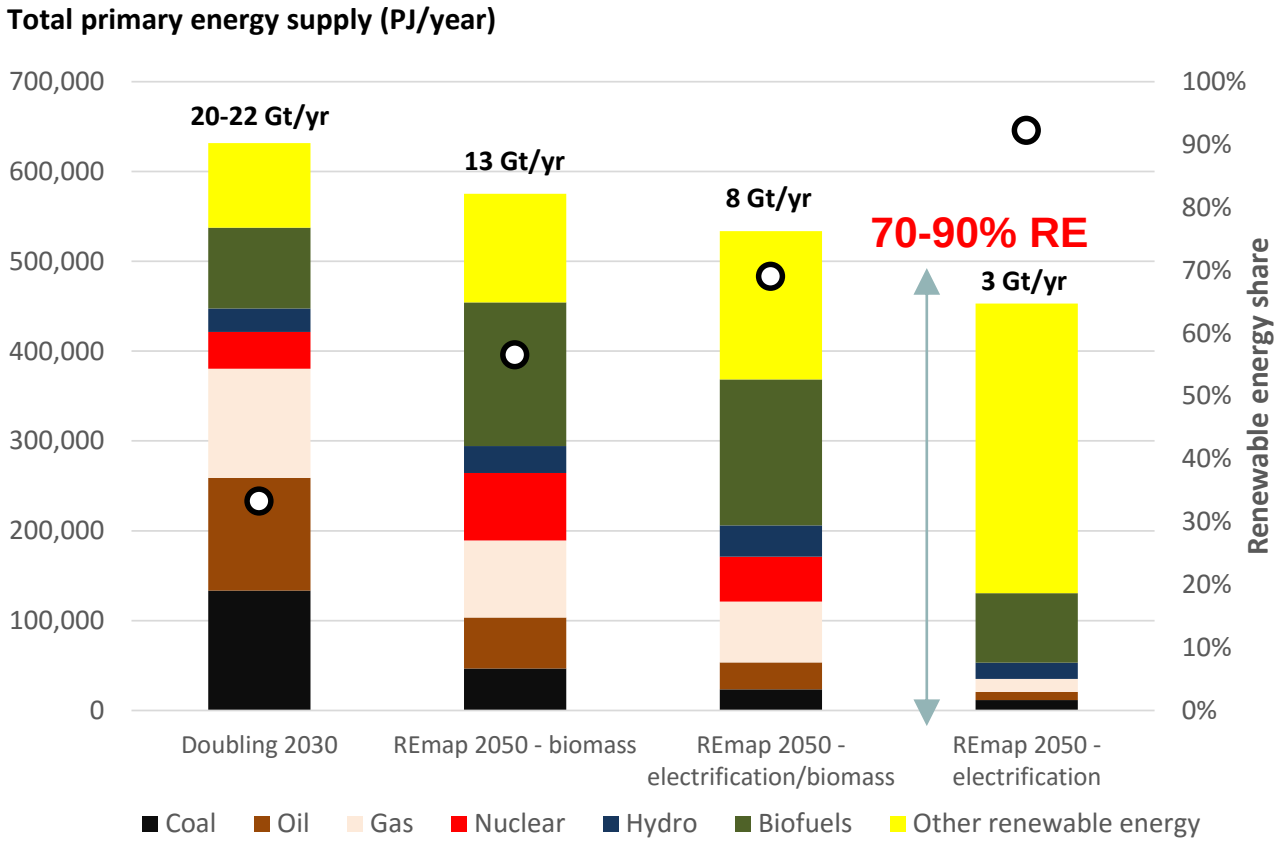
Reference Case growth in total energy-related CO_2 emissions of 40% in 2015-2050

Emissions must decline by 85% to remain in the proposed carbon budget

Sector Reference Cases (DRAFT)



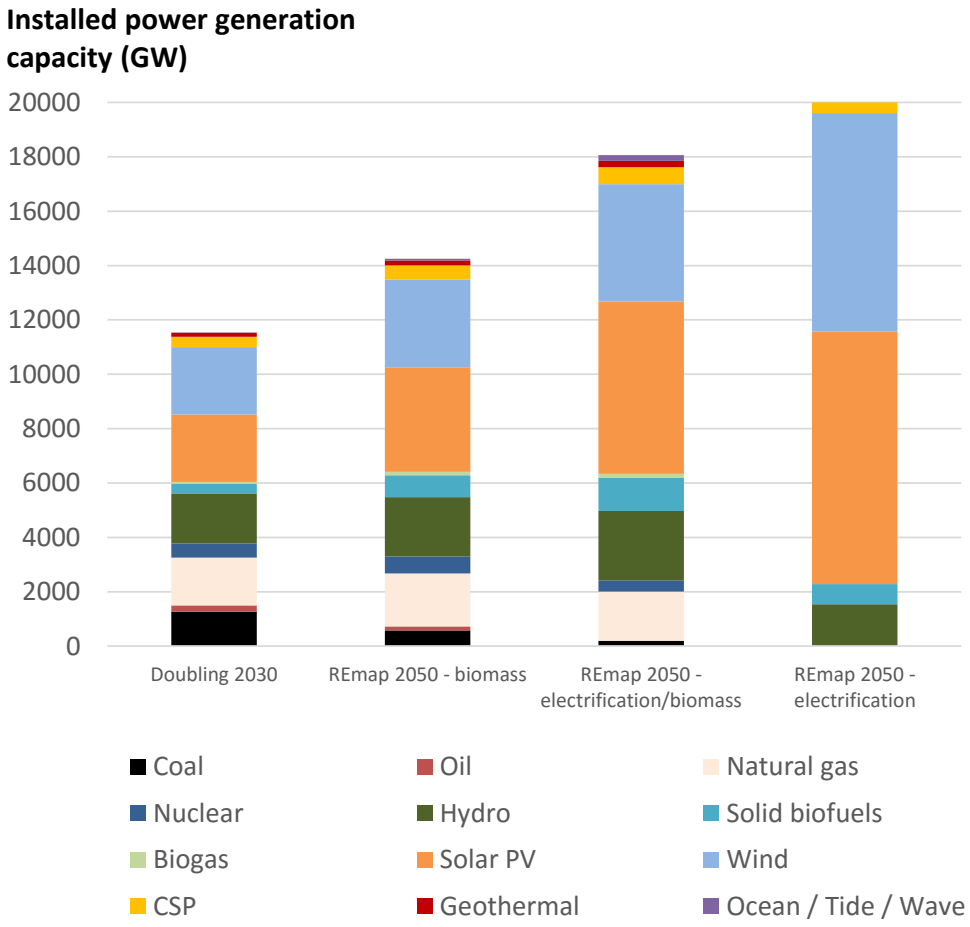
Developments in energy sector to 2050 (DRAFT)



Realising RE share of 70-90% in TPES by 2050, from 30% in 2030

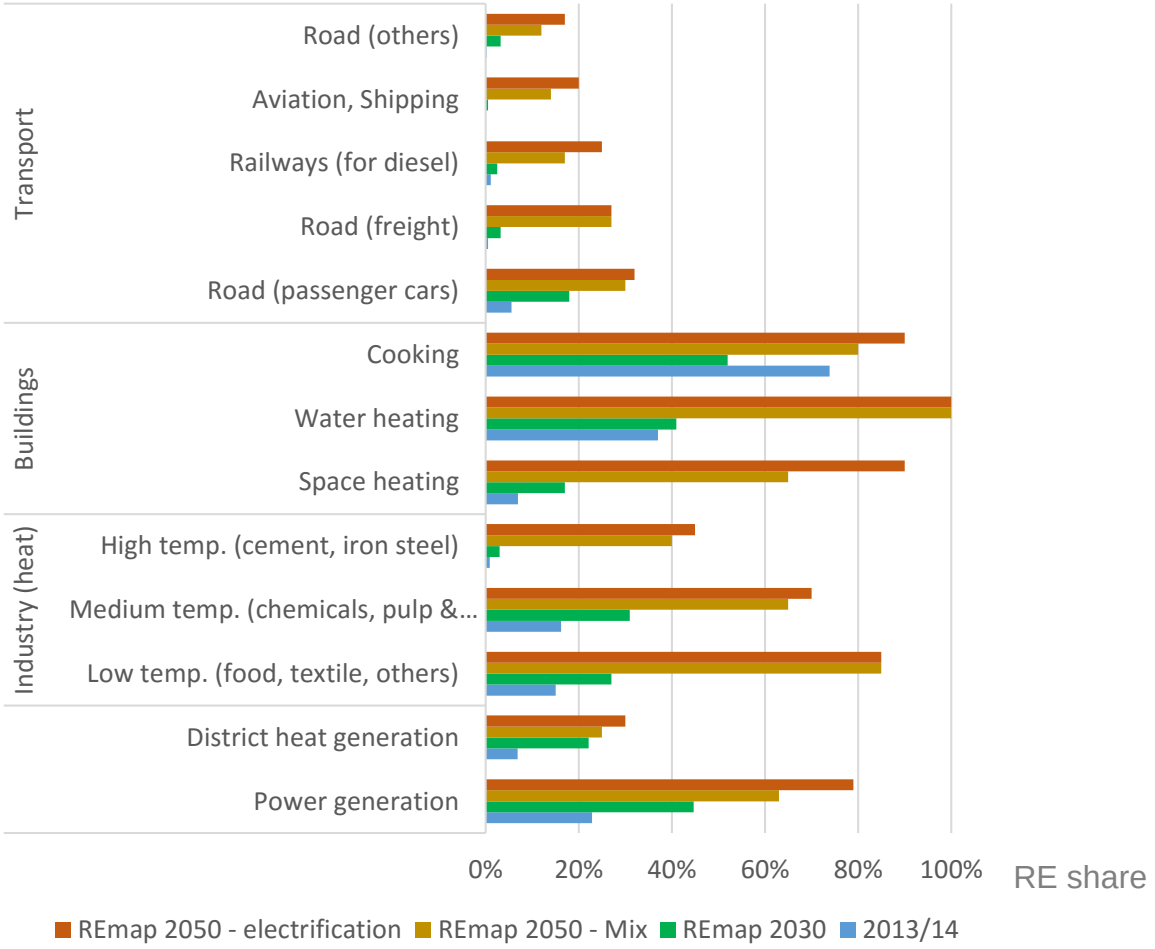
GHG policy implies 1.5-2 percent point per year growth in RE share
About 10x growth from current progress

Developments in the power sector (DRAFT)



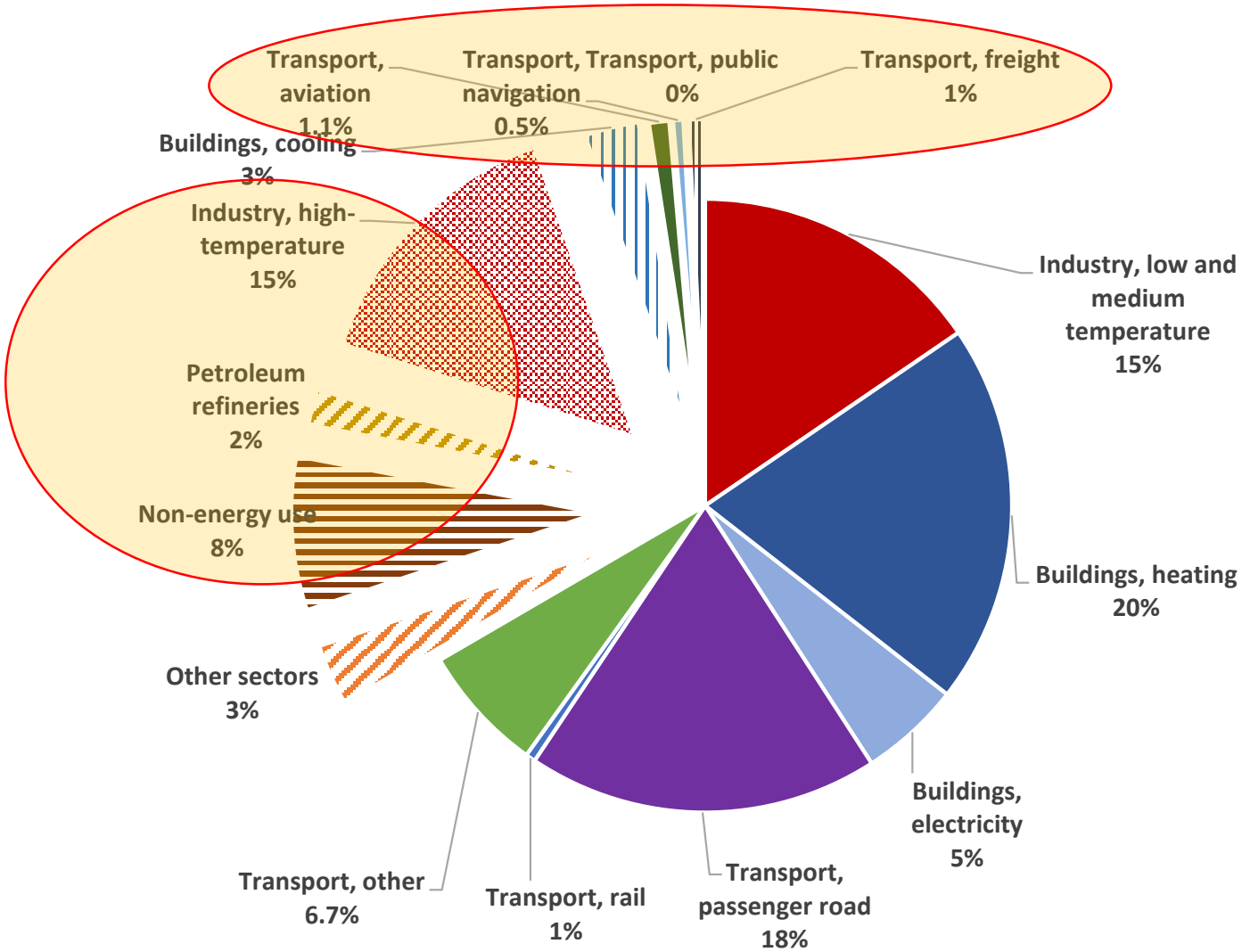
Electrification will be key. With limited biomass available it implies even more ambitious electricity end-use coupled with RE power

Renewable energy by sector & application (DRAFT)



Largest challenges in industry and transport sectors

Renewable energy by sector & application (DRAFT)

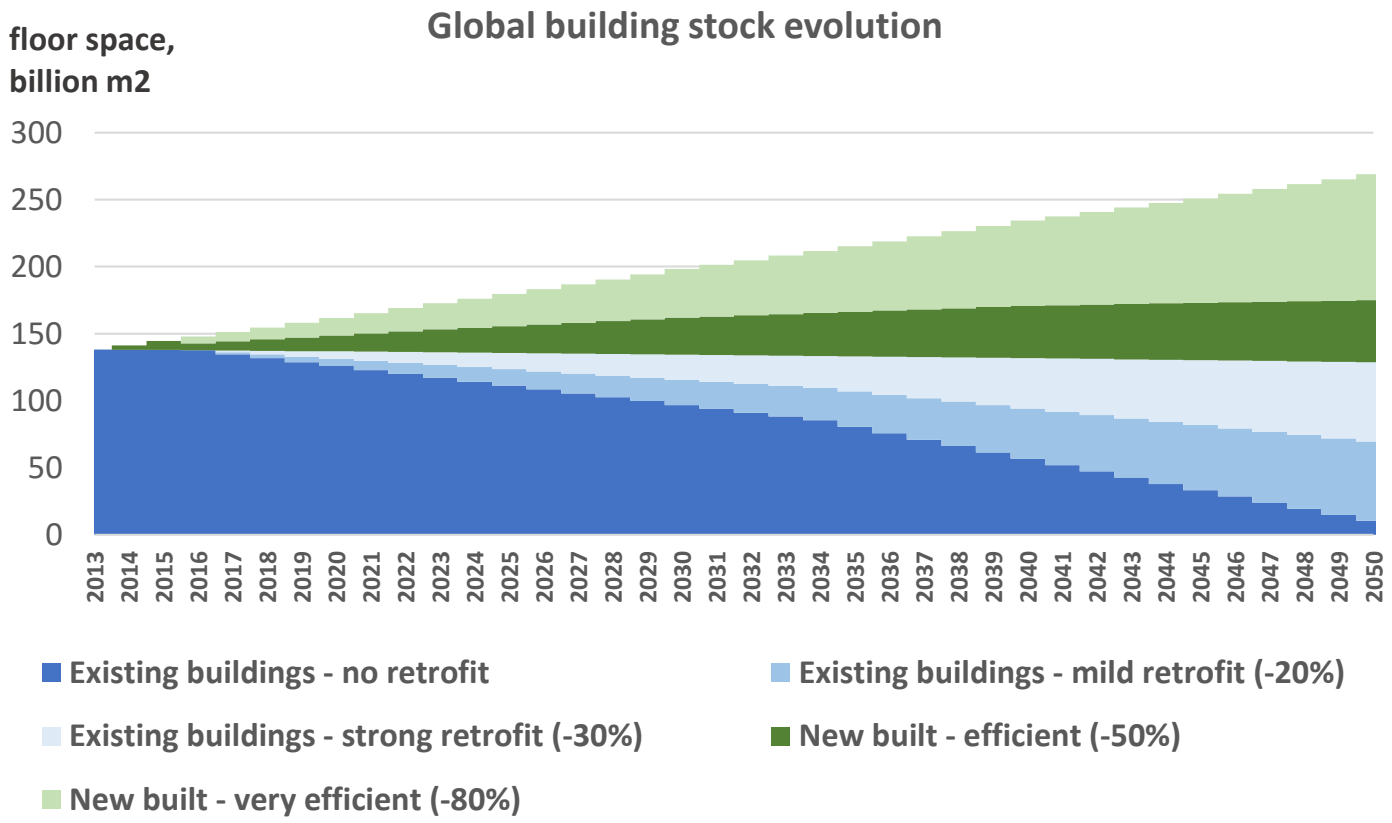


Focus so far on 1/3 of the global energy use of sectors RE knowledge limited

Building stock developments (DRAFT)

- About 80% growth in building stock between now and 2050
  - About 85% of the global growth will be in China and India

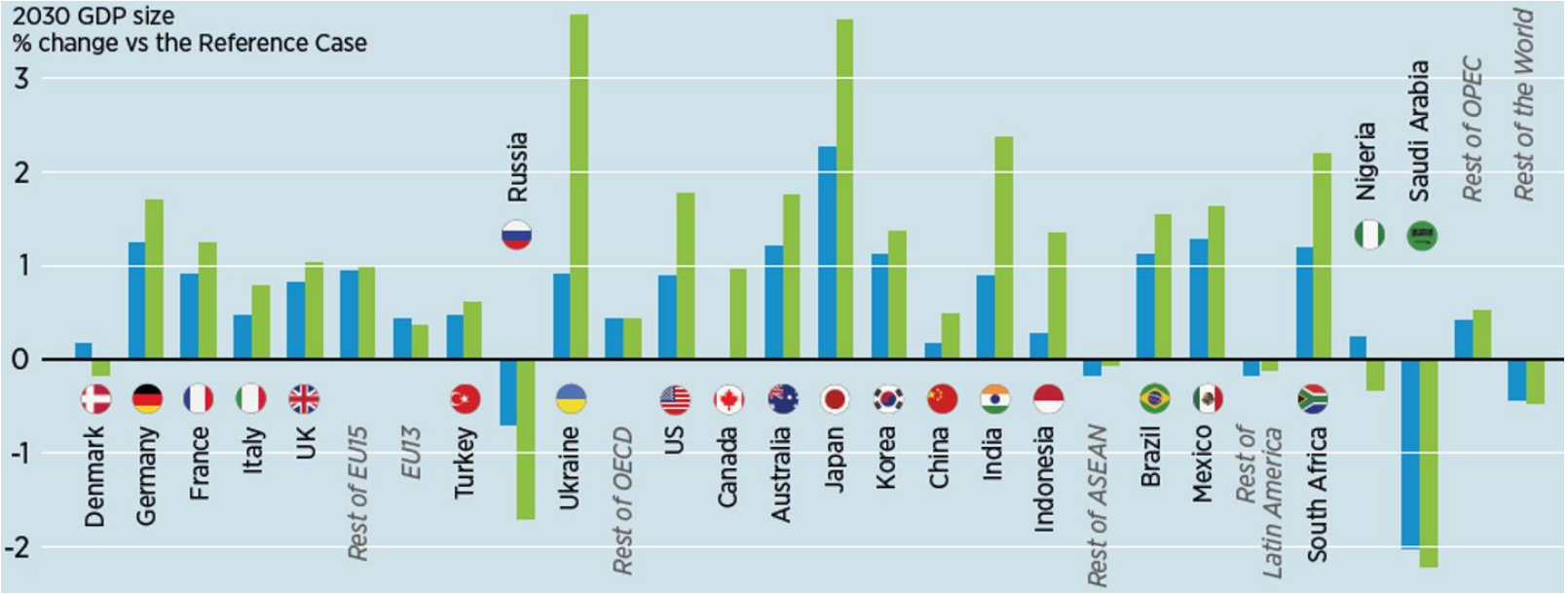
- To achieve 2050 targets, >90% of existing building stock needs to be retrofitted and 2/3 of new buildings to 2050 need to be built very efficient (-80% energy use)



MACRO-ECONOMIC IMPACTS

Renewable energy boost global GDP

- Doubling the share of renewables by 2030 would increase **global GDP by up to 1.1% or USD 1.3 trillion**
- The increased investment in renewable energy deployment triggers ripple effects throughout the economy



Source: IRENA (2016)

Renewable energy will create more jobs

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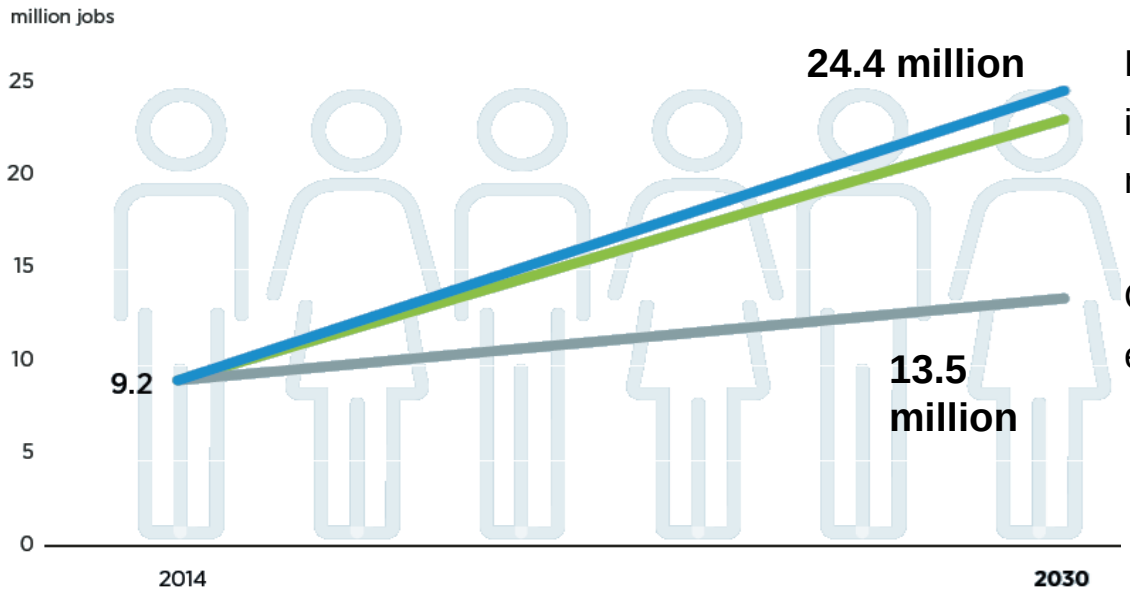

From 9 million today, to 24 million jobs in renewable energy in 2030 (13 million in the Reference Case)

Overall energy sector employment effects are slightly positive

	Reference	Doubling RE
China	3.5	5.9
India	1.5	3.5
Brazil	1.1	2.2
United States	0.4	1.4
Indonesia	0.2	1.3
Japan	0.5	1.1
Russia	0.6	1.1
Mexico	0.1	0.3
Germany	0.2	0.3
Rest of the World	5.4	7.3
World total	13.5	24.4

As could be expected, all large employers are G20 countries

Source: IRENA (2016)

ECONOMIC COST INDICATORS & STRANDED ASSETS

A number of economic cost indicators will be assessed

- Annualized **system cost increase** in addition to the Reference Case
  - Annualized incremental RE+EE cost – FF cost savings + stranded assets
- **Investment support for renewable energy** – net cost of all options with incremental cost
- **Investment volume** of RE and EE options (absolute, incremental)
- **Stranded assets**
- **Net investment impact** (Incremental RE+EE – reduced fossil fuel investments)
- **Welfare effect** – cost minus savings

What are stranded assets?

- Possible definitions in the energy context
  - Loss in valuation of fossil fuel reserves (e.g. Exxon this week)
  - Remaining value of assets (e.g. power plants, industrial equipment) that is depreciated
  - Lost value of supporting physical infrastructure (e.g. gas stations), human resources (e.g. oil sector expertise), etc.?
  - Definitions for stranded assets vary significantly, risking its under-estimation

- IRENA's proposed approach to stranded assets
  - Stranded asset definition used in this case:

Remaining book value of upstream, power generation and end-use sector assets that would be substituted - before the end of their economic lifetime and without recuperation of any remaining value - to achieve 2050 decarbonisation targets

Estimating stranded assets (DRAFT)

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- Preliminary findings:
  - **Upstream:** - up to USD 5.1 trillion, 85% oil
    - based on current market valuation of upstream producers, adjusted by a reduced outlook for production levels
  - **Power:** - up to USD 2.4 trillion, 60-70% coal
  - **Buildings:** - up to USD 1.3 trillion in Germany; for other countries work in progress, but **greatly exceeds stranded assets in other sectors**

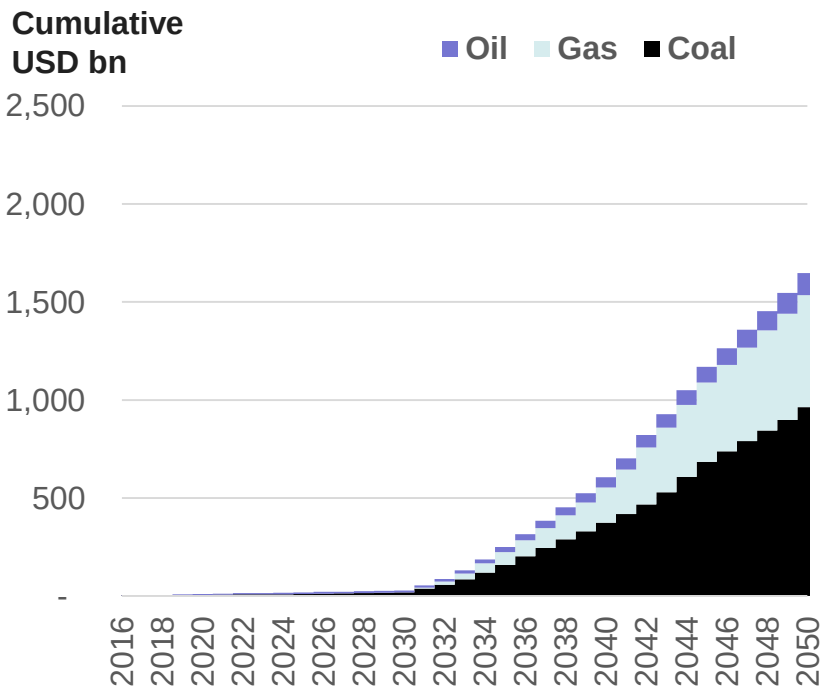
- Stranded assets between two pathways compared:
  - **REmap:** accelerated renewables deployment as per REmap up to 2030 and 2050
  - **Delayed policy action:** business as usual up to 2030, accelerated path afterwards to reach same outcomes by 2050

- Industry, other infrastructure TBD but probably of secondary importance
- Stranded assets depend critically on CO_2 emission reduction objective
- New infrastructure over the next 2 decades that is incompatible with deep CO_2 emission reduction will result in additional stranded assets

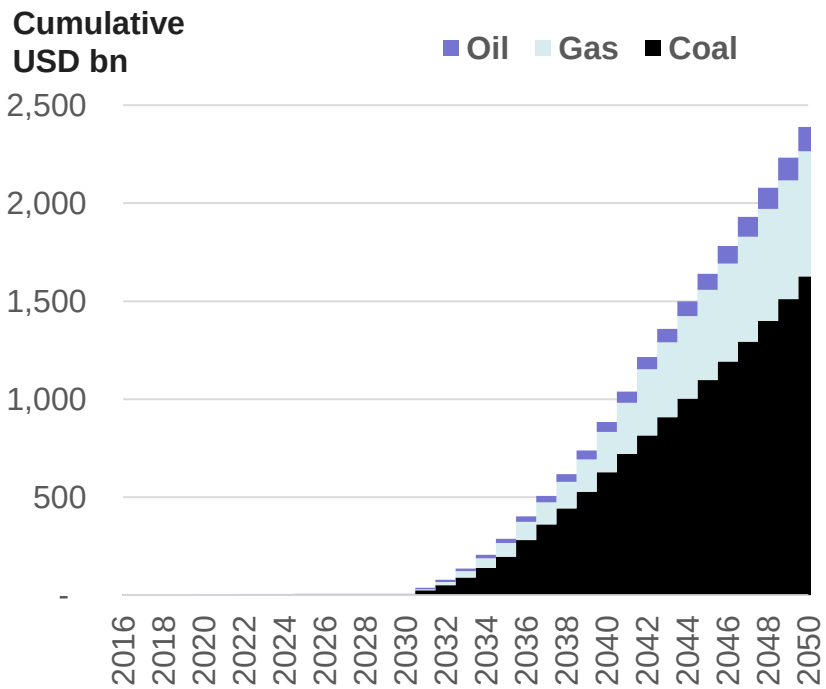
Stranded assets – preliminary findings (power) (DRAFT)

- Stranded assets increase significantly if policy action is delayed:
  - USD 1 650 billion with REmap, ~60% of which coal
  - USD 2 390 billion (+45%) with delayed policy action, ~70% of which coal
- Assumed full decarbonisation of power sector by 2050 (0 GW coal, gas, oil)
  - With gas still online in 2050, stranded assets reduce by c. USD 600 billion

Stranded power generation assets
REmap 2030 - REmap 2050



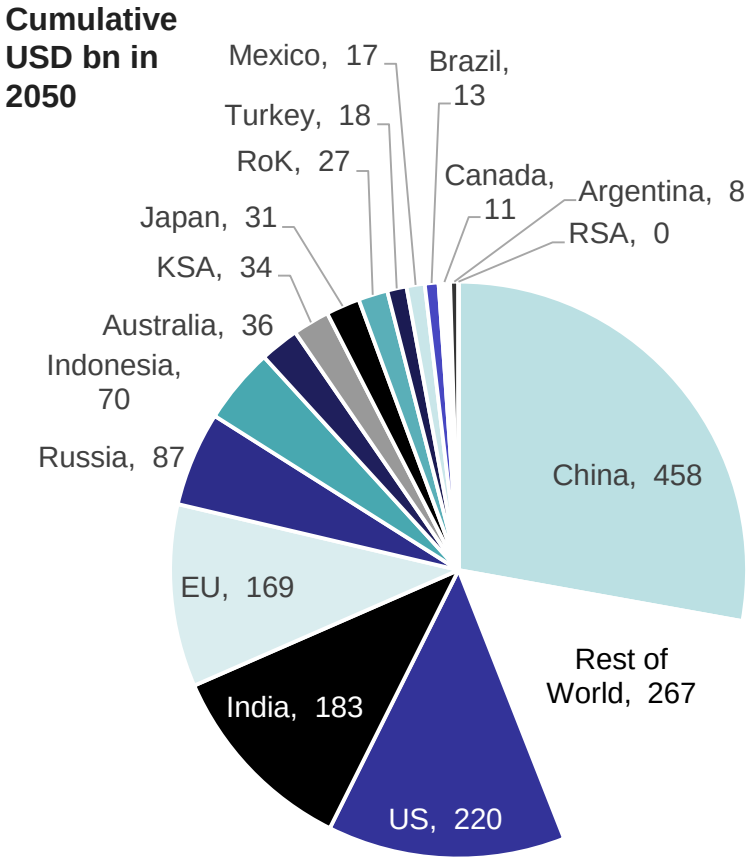
Stranded power generation assets
Reference Case 2030 - REmap 2050



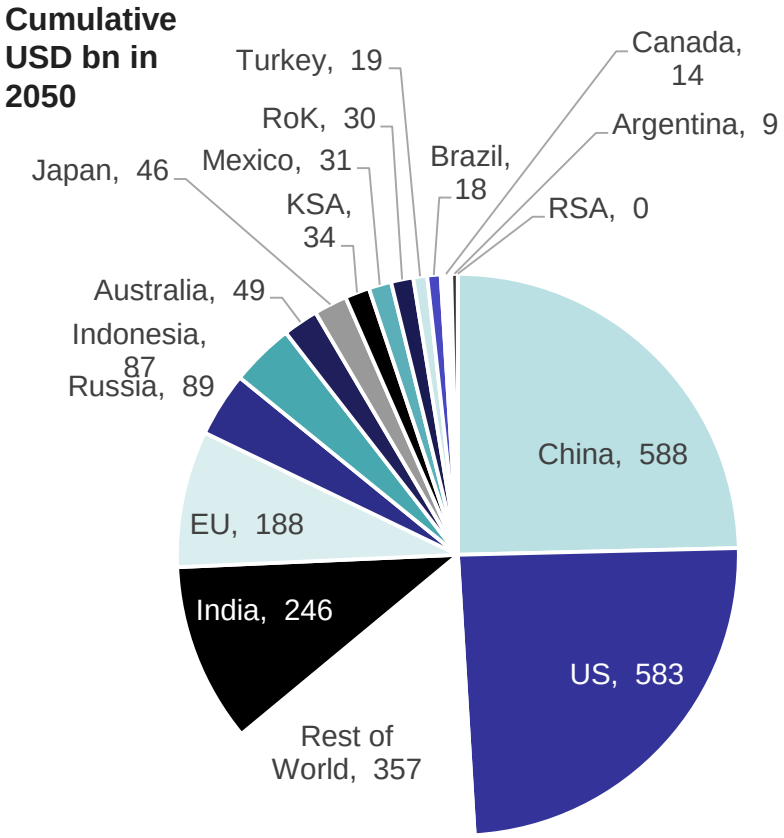
Stranded assets – preliminary findings (power) (DRAFT)

- With delayed policy action, 2/3 of stranded assets in US, EU, China, India
  - China and India account for more than half of all coal stranded assets
  - US, EU, Russia account for nearly half of all gas stranded assets

Stranded power generation assets -
REmap 2030-2050

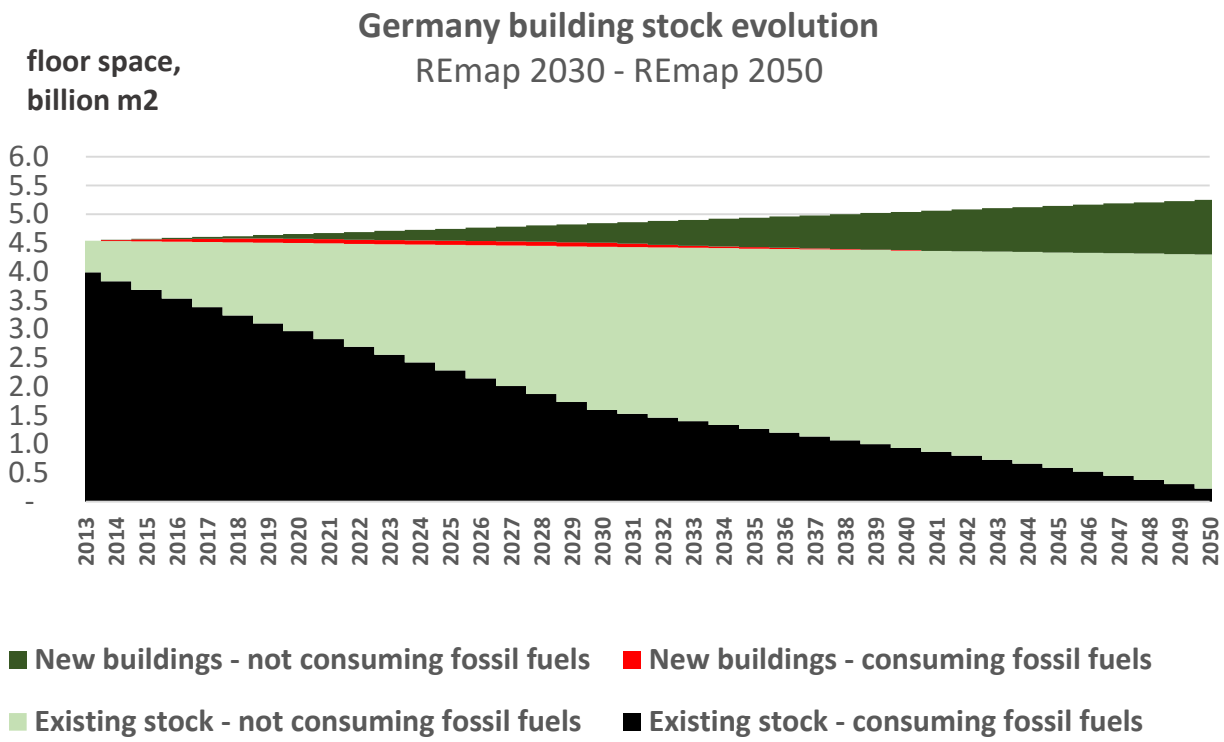


Stranded power generation assets -
Reference Case 2030 - REmap 2050



Building stock evolution (Germany) (DRAFT)

- With **REmap**:
  - Reduction in direct use of fossil fuels of **58%** by 2030: 90% by 2050
  - 100% of new buildings from **2020** without direct fossil fuel use
  - Both retrofits and new buildings not consuming fossil fuels include EE/RE measures (insulation, efficient doors/windows, heat pumps)



Stranded assets – preliminary findings (buildings) (DRAFT)

- Estimating buildings stranded assets:
  - Construction value lost when undertaking a deep retrofit:
    - Estimated as difference between:
      1. % of construction value for retrofit to achieve zero fossil fuel use, and
         - *Estimated at ~20% of construction value for residential buildings*
      2. premium to construction value to achieve zero fossil fuel use in new building
         - *Estimated at ~10% of construction value for residential buildings*
    - Intuition: e.g. difference between cost of installing double-glazed windows vs. first installing single-glazed windows, and then replacing by double-glazed windows:
      - Stranded asset: value of single-glazed windows

- Estimated for Germany at:
  - REmap: **USD 540 billion** over 2016-2050 (undiscounted)
  - Delayed policy action: **USD 560 billion** over 2016-2050 (undiscounted)
    - Higher than REmap because more buildings are constructed (until 2030) that consume fossil fuels, which later have to be retrofitted

Stranded assets – preliminary findings (buildings) (DRAFT)

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- For a 100% reduction of direct fossil fuel use in buildings, the construction value of the remaining building stock is unsuitable for retrofit (~10% of building stock today) would need to be added to this:
  - Estimated for Germany at **~USD 750 billion** (present value)

- **Up to ~USD 1.3 trillion** in total stranded assets in Germany for full decarbonisation of building sector by 2050;
  - Germany only **3%** of global building stock today, so worldwide can reach up to USD 100 trillion

- Analysis for other countries in progress;
  - Rest of EU: similar dynamics to Germany
  - US: faster building stock turnover, more opportunities to avoid stranded assets
  - Asia, RoW: most parts direct use of fossil fuels in buildings is lower, higher share of electricity due to lower demand for space heating and fewer

IRENA PUBLICATIONS

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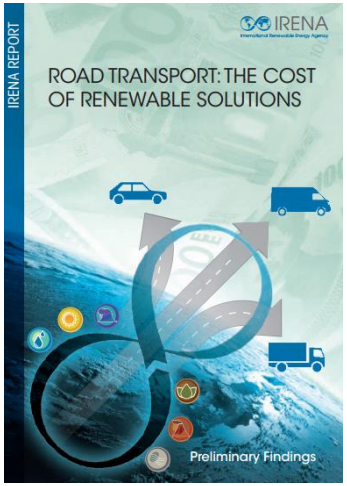

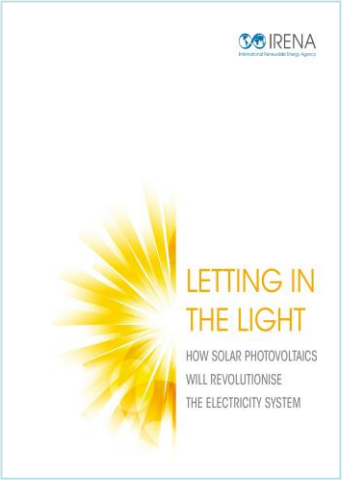

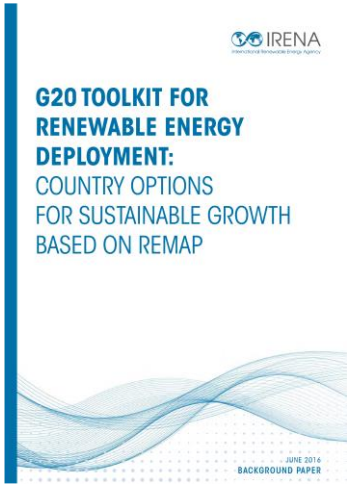

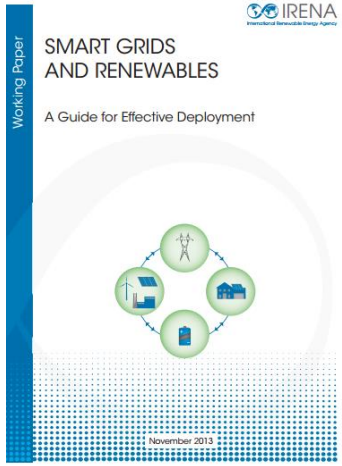

THANK YOU!

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