Decarbonisation pathways to 2050
CONTEXT AND SCOPE
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

The G20 Toolkit

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)

- Global temperatures have risen by 0.9 °C and continue to rise by 0.03 °C/yr
- By 2045, 2 °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 °C

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

At this rate, by 2050 2 °C will be reached

Source: NASA (2016)
IRENA’s carbon emission budget (DRAFT)

Energy emissions pathways for 2 degrees/66%

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$_2$
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 CO₂ emissions of 40% in 2015-2050

Emissions must decline by 85% to remain in the proposed carbon budget
Energy-related CO₂ emissions (Gt/yr)

- **Power and district heat**: Largest effort required in power, RE progress well
- **Transport & industry**: Largest emitting end-users, but large tech challenges
- **Buildings**: Small emitter, but large investment implications

Legend:
- Yellow: Power and district heat
- Green: Transport
- Red: Industry
- Purple: Buildings
- Gray: Non-G20
- Black: Other

Year:
- 2014
- 2030
- 2050
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
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)

**Global building stock evolution**

- **Existing buildings - no retrofit**
- **Existing buildings - mild retrofit (-20%)**
- **Existing buildings - strong retrofit (-30%)**
- **New built - efficient (-50%)**
- **New built - very efficient (-80%)**
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

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

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)

- 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 CO₂ emission reduction objective
- New infrastructure over the next 2 decades that is incompatible with deep CO₂ 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 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**

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<tr>
<th>Country</th>
<th>USD bn in 2050</th>
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<tr>
<td>Rest of World</td>
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**Stranded power generation assets - Reference Case 2030 - REmap 2050**

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Stranded assets – preliminary findings (power) (DRAFT)
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)

![Germany building stock evolution graph]

- New buildings - not consuming fossil fuels
- New buildings - consuming fossil fuels
- Existing stock - not consuming fossil fuels
- Existing stock - consuming fossil fuels
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)

• 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
THANK YOU!
WWW.IRENA.ORG/REMAP