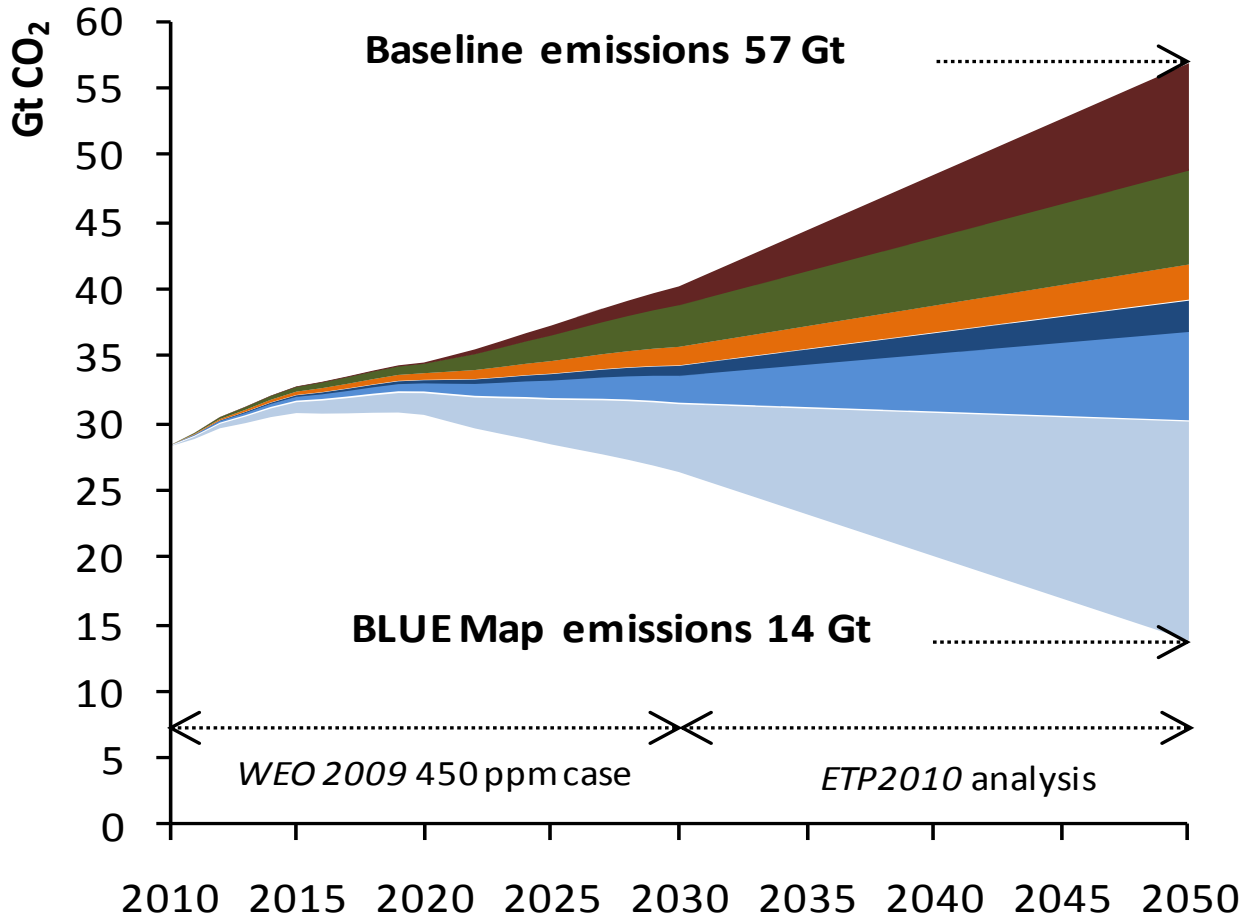
IEA Roadmap Workshop

"Sustainable Biomass Supply for Bioenergy and Biofuels"

15-16 September 2010

Adam Brown
Anselm Eisentraut
Renewable Energy Division

We need a global 50% CO_2 cut by 2050



Source: ETP 2010

- We need a global 50% CO_2 cut by 2050
- A wide range of technologies will be necessary to reduce energy-related CO_2 emissions substantially

The role of roadmaps

- A global price for carbon is necessary
  - …but by itself insufficient to accelerate the needed energy technology advancements in time
- Greater focus on energy technology policies needed
- Technology roadmaps can support GHG goals by:
  - Identifying and addressing technology-specific barriers
  - Highlighting necessary deployment policies and incentives
  - Directing increased RD&D funding for new technologies
  - Supporting technology diffusion, knowledge sharing among countries

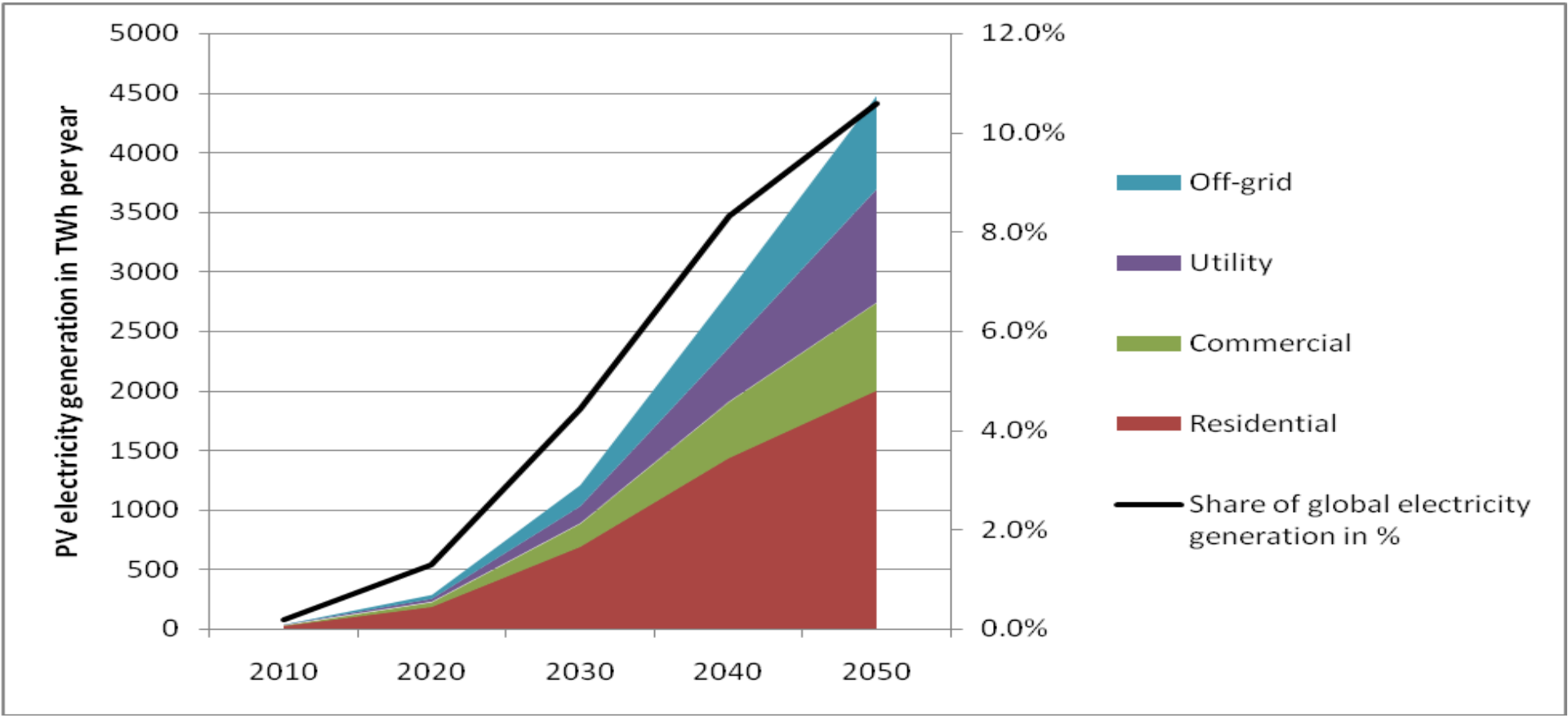
Technology roadmaps provide answers

- Where is technology today?
  - GW installed capacity/kWh of savings
  - Leading countries/regions
  - Cost, efficiency
- What is the deployment pathway needed to achieve 2050 goals?
  - Use IEA Energy Technology Perspectives BLUE Map scenarios
- What are the priority near-term actions?
  - Technology incentives
  - Technology-specific barrier identification and removal
  - RD&D funding
  - Technology diffusion/transfer

Roadmap status

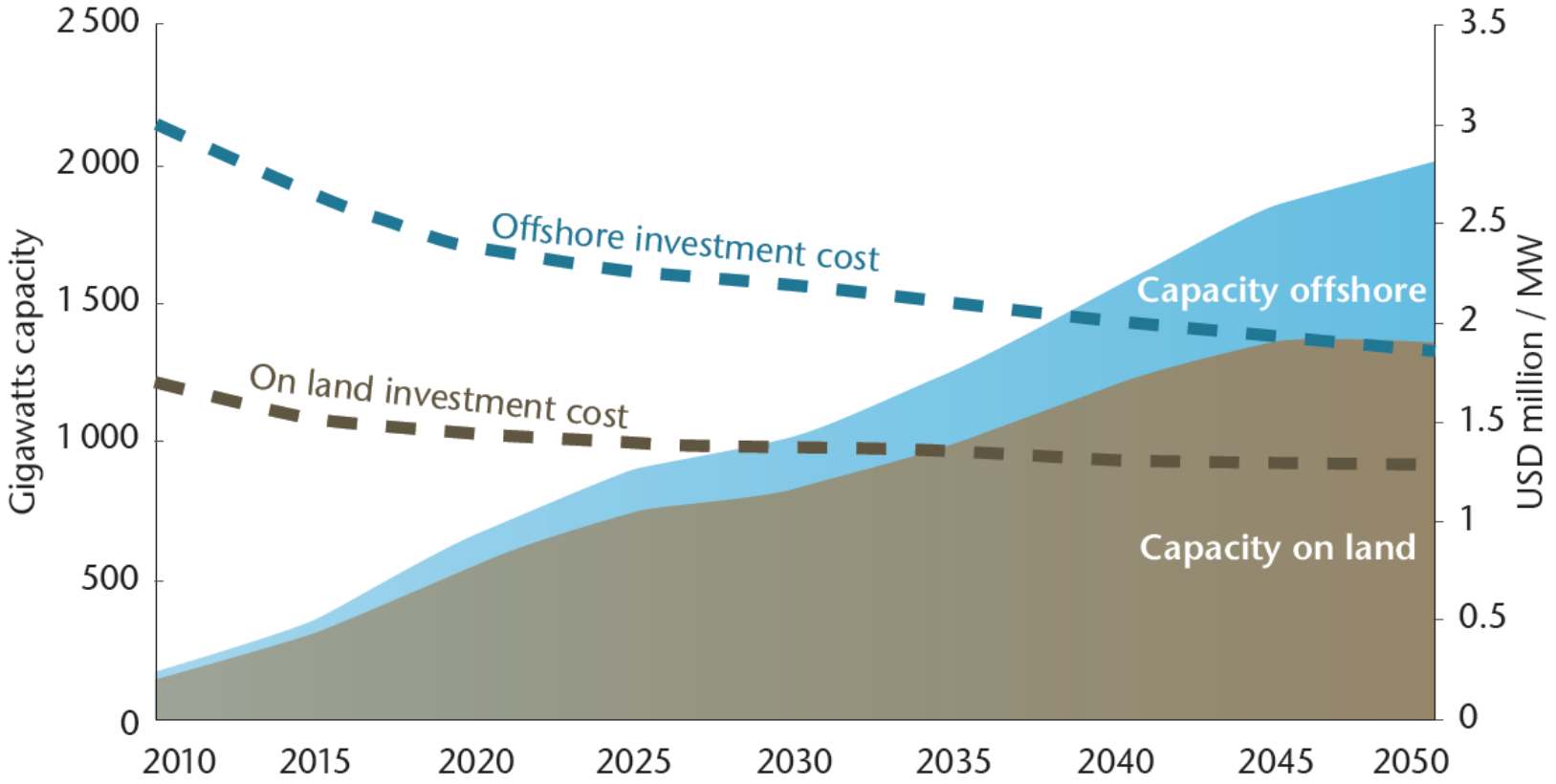
- 2009 releases
  - Carbon capture & storage, Electric vehicles, Cement sector, Wind energy
- 2010 releases
  - Solar PV, Concentrating Solar Power – May
  - Nuclear power – July
  - Energy efficient buildings: heating and cooling – September
  - Smart grids, Vehicle efficiency – December
- 2011 releases
  - **Biofuels**; **Bioenergy for heat & power**; Clean/high-efficiency coal; Energy efficiency in buildings: design & operation; Geothermal power; Hydrogen & fuel cell vehicles

Roadmap example:
Photo Voltaic - an ambitious growth pathway



- PV provides 5% of global electricity generation in 2030, 11% in 2050

Wind roadmap example: cost and deployment targets



- Global wind energy capacity increases to more than 2000 GW in 2050
- Costs decrease to USD 1.3 million/MW (onshore) and USD 1.9 million/MW (offshore) in 2050

Solar PV roadmap example: technology performance milestones

International Energy Agency

Crystalline Silicon Technologies	2010 - 2015	2015 - 2020	2020 - 2030 / 2050
Efficiency targets in %	• Single-crystalline: 21% • Multi-crystalline: 16%	• Single-crystalline: 23% • Multi-crystalline: 18%	• Single-crystalline: 27% • Multi-crystalline: 21%
Industry manufacturing aspects	• Si consumption <5g/Wp	• Si consumption <3g/Wp	• Si consumption <2g/Wp
R&D aspects	• New silicon materials and processing • Cell contacts, emitters and passivation	• Low defect silicon wafers • Improved device structures	• Wafer equivalent technologies • New device structures with novel concepts

Thin Film Technologies	2010 - 2015	2015 - 2020	2020 - 2030
Efficiency targets in %	• Thin film Si: 10% • CIGS: 14% • CdTe: 12%	• Thin film Si: 12% • CIGS: 15% • CdTe: 15%	• Thin film Si: 15% • CIGS: 18% • CdTe: 18%
Industry manufacturing aspects	• High rate deposition • Roll-to-roll manufacturing • Packaging	• Simplified production processes • Low cost packaging	• Large high-efficiency production units
R&D aspects	• Large area deposition processes • Improved substrates and transparent conductive oxides	• Improved cell structures • Improved deposition techniques	• Advances materials and concepts

EV/PHEV roadmap example: policy requirements

International Energy Agency

Vehicle-fuel price related	Not cost-related
• Favourable financing terms – e.g., battery leasing to minimise up-front and monthly cost. • Feebate (vehicle fee/rebate) system at time of vehicle purchase, based on performance (e.g., life-cycle CO_2 emissions). • Differential CO_2-based fuel taxes. • Reductions in highway tolls and other vehicle fees (annual registrations). • Incentives for providing recharging infrastructure in commercial/public areas. • Subsidisation of the cost of recharging infrastructure for households/apartment buildings.	• Differential treatment for EVs/PHEVs in terms of regulations, such as access to otherwise vehicle-restricted zones in city centres, preferential parking spots with charge points. • Guarantees for re-sale values, battery replacements. • Additional credits under regulatory systems (e.g., in EU vehicle CO_2 regulations, EVs/PHEVs are considered zero emissions, so automakers get an advantage for producing them; similar credits exist in the US Corporate Average Fuel Economy (CAFE) law). • Electric-drive vehicles would be favoured by strong regulations addressing pollutants (apart from CO_2). • Initial introduction of EVs by government fleets to help spur manufacture. • Public transport vehicles, two/three-wheeled vehicles – exploit EVs in these segments to promote EVs for individual consumers and increase battery production scales. • Direct provision of recharging infrastructure in public areas.

Roadmap Context

Biofuels for Transport &
Bioenergy for heat and power

- Roadmaps are intended to:
  - Highlight pathway(s) to reach large scale production of sustainable biomass to produce heat, electricity and biofuels, consistent with ETP 2010
  - Focus on the key steps over the next 5-10 years, as well as long-term milestones, including:
    - Identify barriers and obstacles and how to overcome these
    - Identify key conversion pathways
    - Key RDD&D gaps and how to fill them while ensuring sustainability
    - Identify market requirements and policy needs
    - Define international collaboration needs
- Undertake roadmaps in 2 parts
  - Part I – Conversion technologies and end use
  - Part II – Biomass feedstocks and sustainability

Timeline/Tasks

- Workshop on conversion technologies, end-use and markets
  - Workshop on biofuel technologies held in April 2010; WS on bioenergy technologies in early 2011
- Workshop on sustainable feedstock supply
  - Results will be relevant to both roadmaps
- Develop draft roadmap and circulate to a wider stakeholder group (incl. workshop participants) for review
  - Biofuel roadmap draft will be circulated in late October 2010
- Complete missing analysis and refine roadmap
- Roadmaps to be published late 2010/early 2011 (biofuel) and mid 2011 (bioenergy)

Goals for this Workshop

- Identify the potential for bioenergy production
  - Land availability? Potential for yield/ area expansion?
  - Can we meet BLUE Map projections?
- Prospects for international biomass trade
  - Where can it happen? How can it drive/ hinder use of bioenergy?
- Identify the efforts needed to ensure fully sustainable bioenergy production
- Point out key areas and steps for international collaboration
- Identify key policy elements needed to achieve target trajectories in a sustainable fashion
- Agree on next steps, and key issues to tackle in the further roadmap work

Workshop Process

- There will be 3 sessions over the next day and a half

  Session I: Bioenergy Potential

  - state of the art of potential assessment, regional distribution, promising energy crops and key RD&D needs to mobilise the potential

  SessionII: Sustainability and biomass markets

  - Sustainability indicators, sustainable land use management, biomass trade, market barriers and actions needed

  Session III: International collaboration & next steps

  - International collaboration to help meet targets, key roadmap messages, next steps in the process

- Following this workshop, the roadmap will be drafted and circulated for reviewed (by end of October)

Background: ETP projections as a foundation for roadmap development

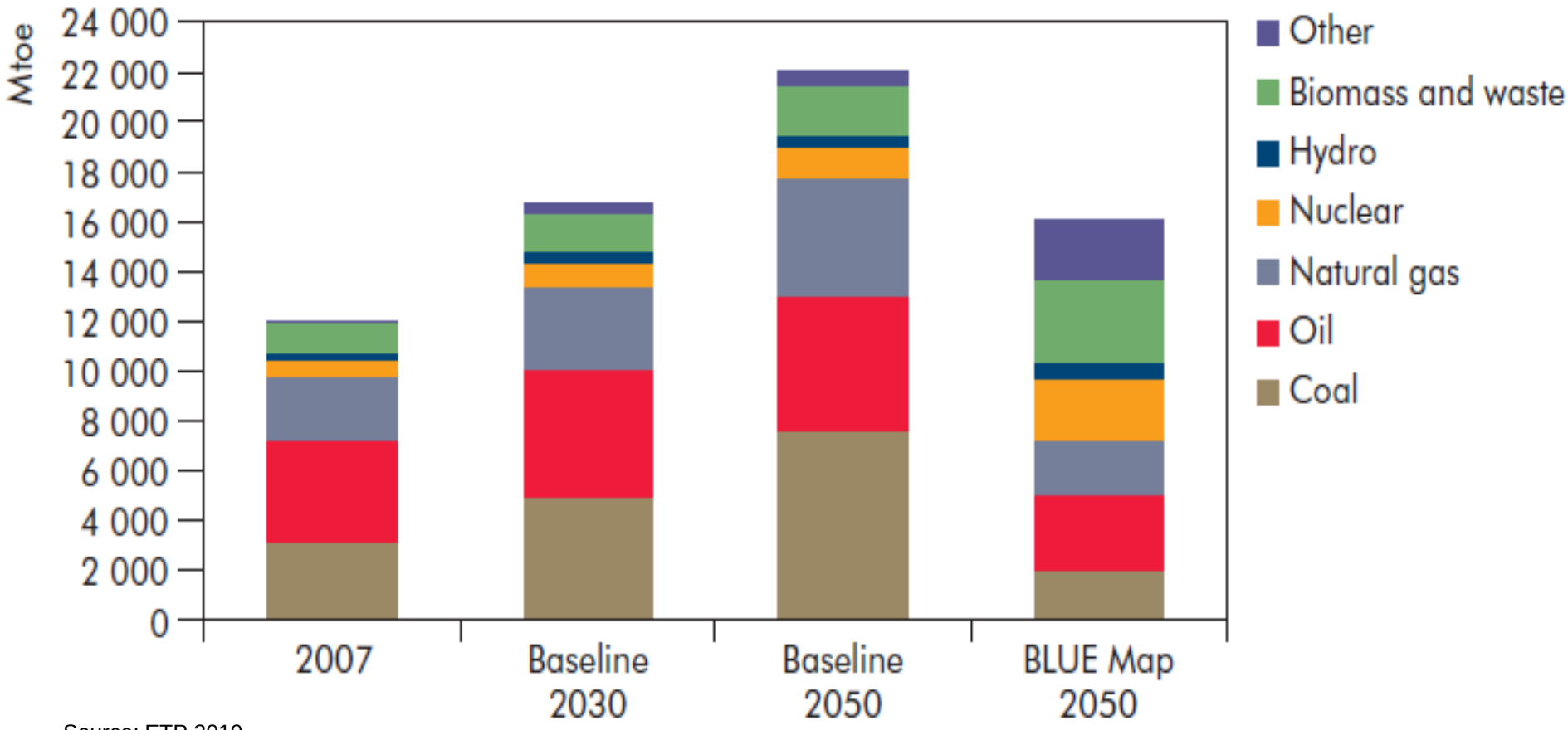
- IEA ETP 2010 provides detailed projections of global energy use to 2050, calibrated to WEO 2009
- ETP BLUE Map scenario depicts a set of pathways to reach a 50% reduction in global energy-related CO_2 by 2050
  - Based on cost-minimization, up to USD 175/ton CO_2 by 2050
  - Uses a back-casting approach to identify pathways and ramp-up rates for different technologies and new fuels
  - Use of bioenergy roughly triples by 2050, biofuels demand in transport increases 10-fold

Biomass use in ETP 2010

- Biomass currently provides around 1100 Mtoe (50 EJ) of primary energy per year
  - 190 Mtoe (8 EJ)/yr of commercial heat and power and 40 Mtoe (1.7 EJ)/yr of liquid transport fuels
  - Traditional biomass accounts for over 800 Mtoe (35 EJ) /yr
- In BLUE Map scenario biomass use increases to around 3400 Mtoe (140 EJ)/yr in 2050.
  - This will require roughly 7 000 Mt dry biomass
  - between 375-750 Mha* of land needed, if 50% come from crop and forest residues and the rest from purpose grown energy crops

*assuming average yield of 5-10 tons (dry)/ha

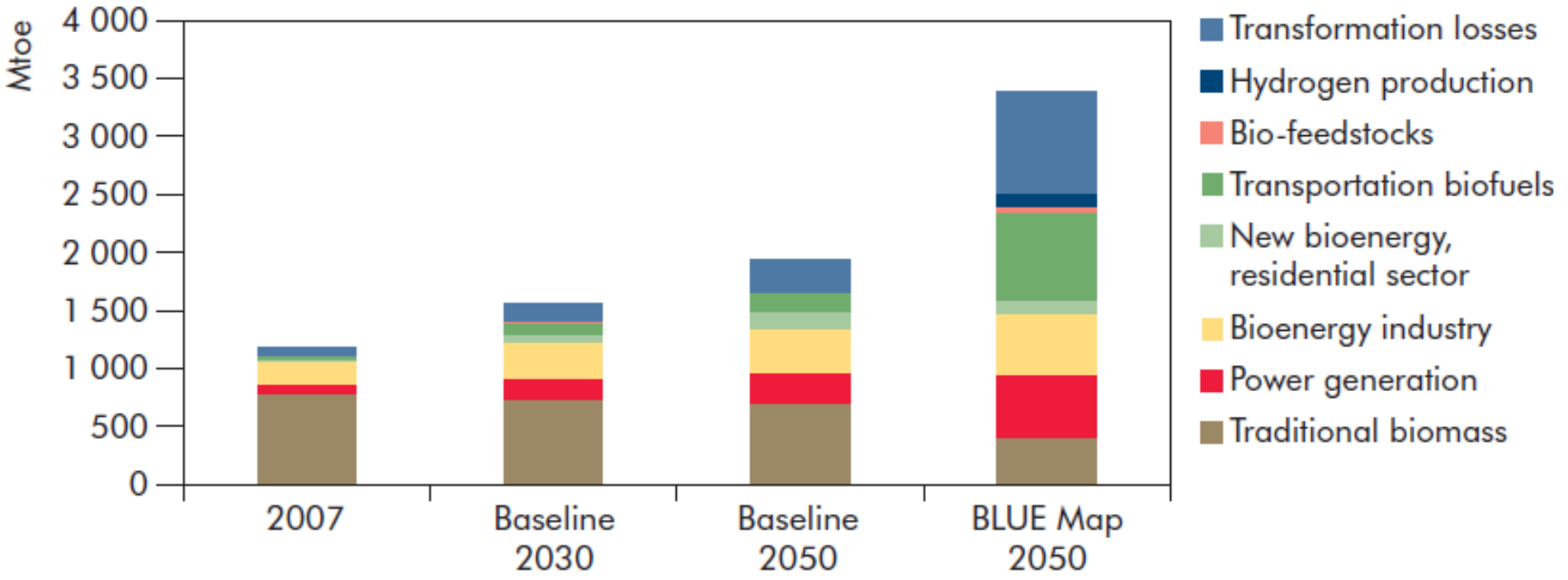
World TPES in ETP 2010



Source: ETP 2010

- Use of biomass increases 3-fold in the BLUE Map scenario, and provides 20% of TPES (140 EJ) in 2050
- Bioenergy accounts for roughly 10% of energy related CO_2 emission reductions in 2050

Biomass use in ETP 2010



Note: The chart includes transformation losses in the production of liquid biofuels from solid biomass.

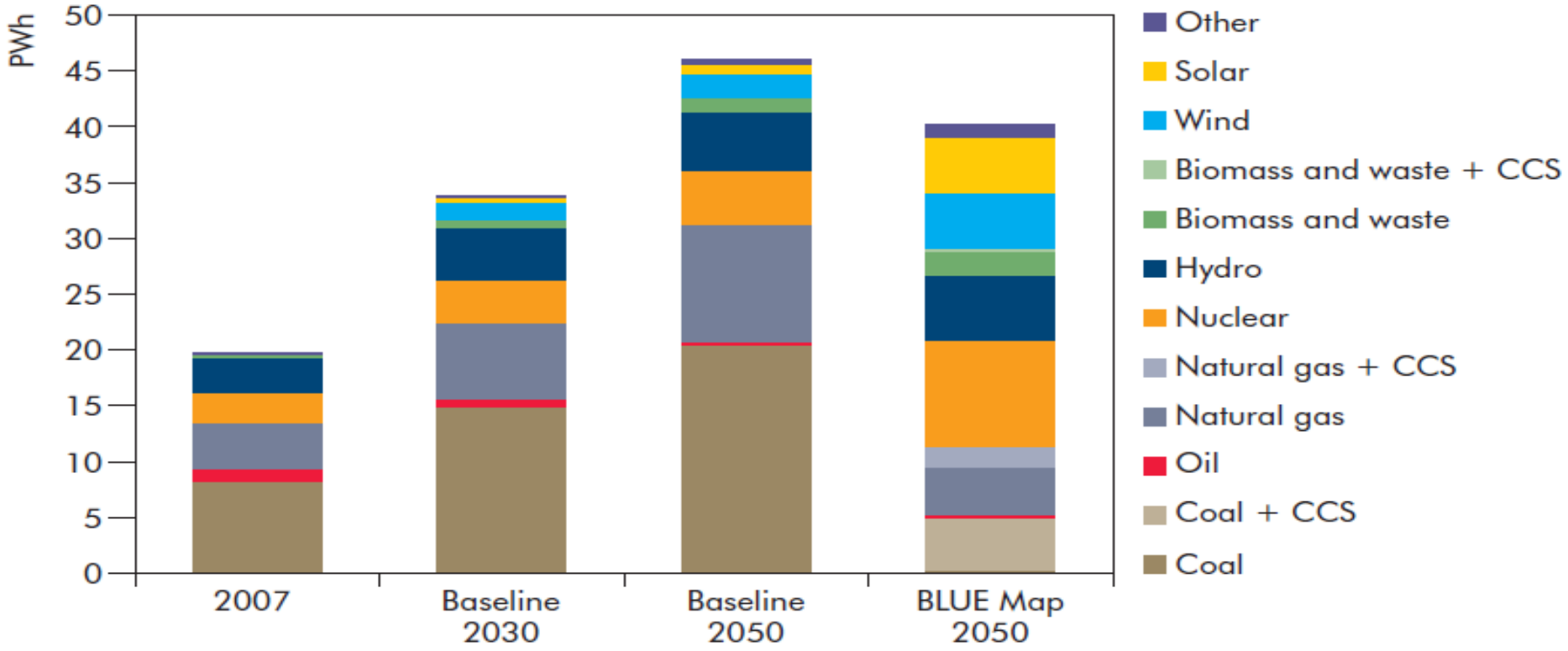
Source: ETP 2010

- Modern bioenergy production increases significantly in Blue Map, whereas traditional biomass use is reduced by 2050
- Around 50% of biomass demand in the BLUE Map scenario is for production of biofuels for transport

Biomass use in ETP 2010

Electricity sector

Global electricity production by energy source and scenario



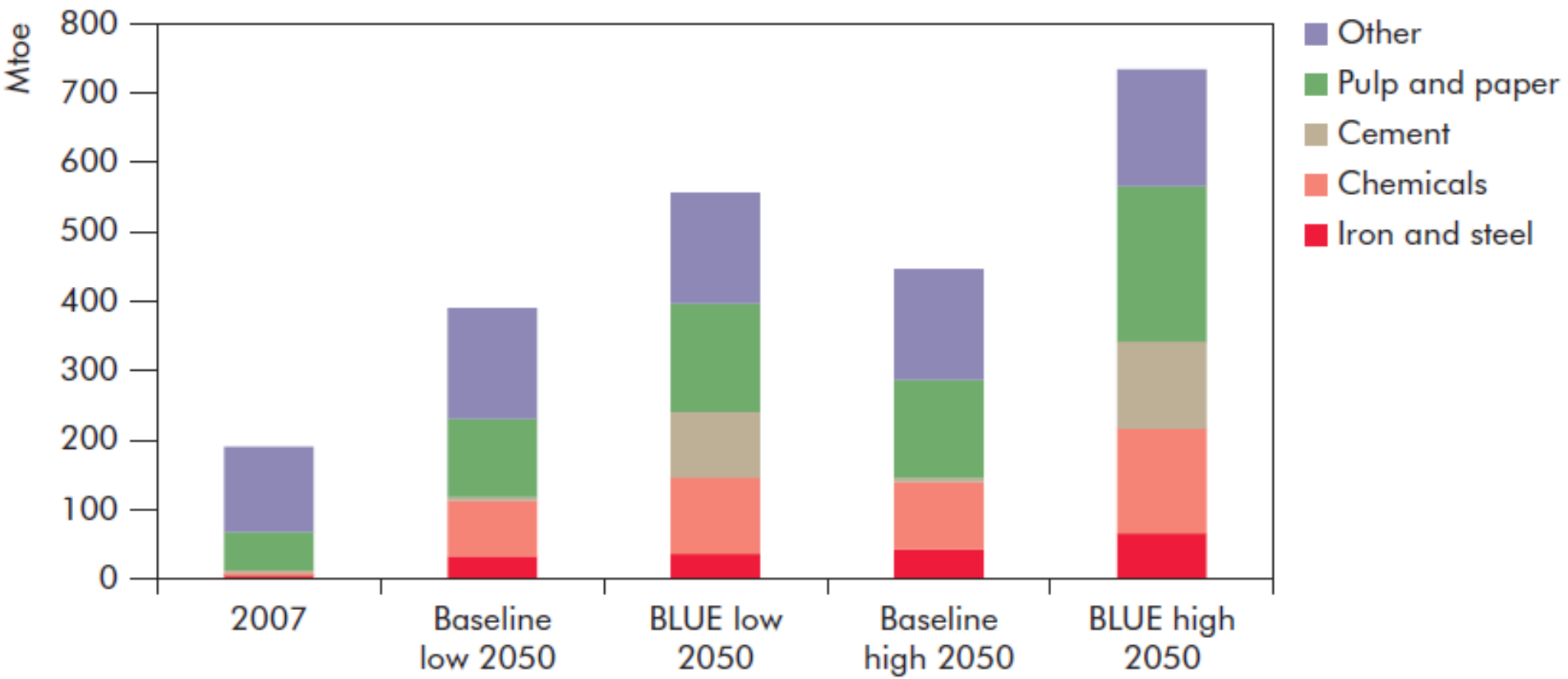
Source: ETP 2010

Note: Other includes electricity generation from geothermal and ocean technologies.

- Biomass electricity generation increases significantly and provides 6% (2460 TWh) of total electricity in BLUE Map in 2050
- By 2050, all regions produce at least 50% of their electricity from renewables

Biomass use in ETP 2010

Industry

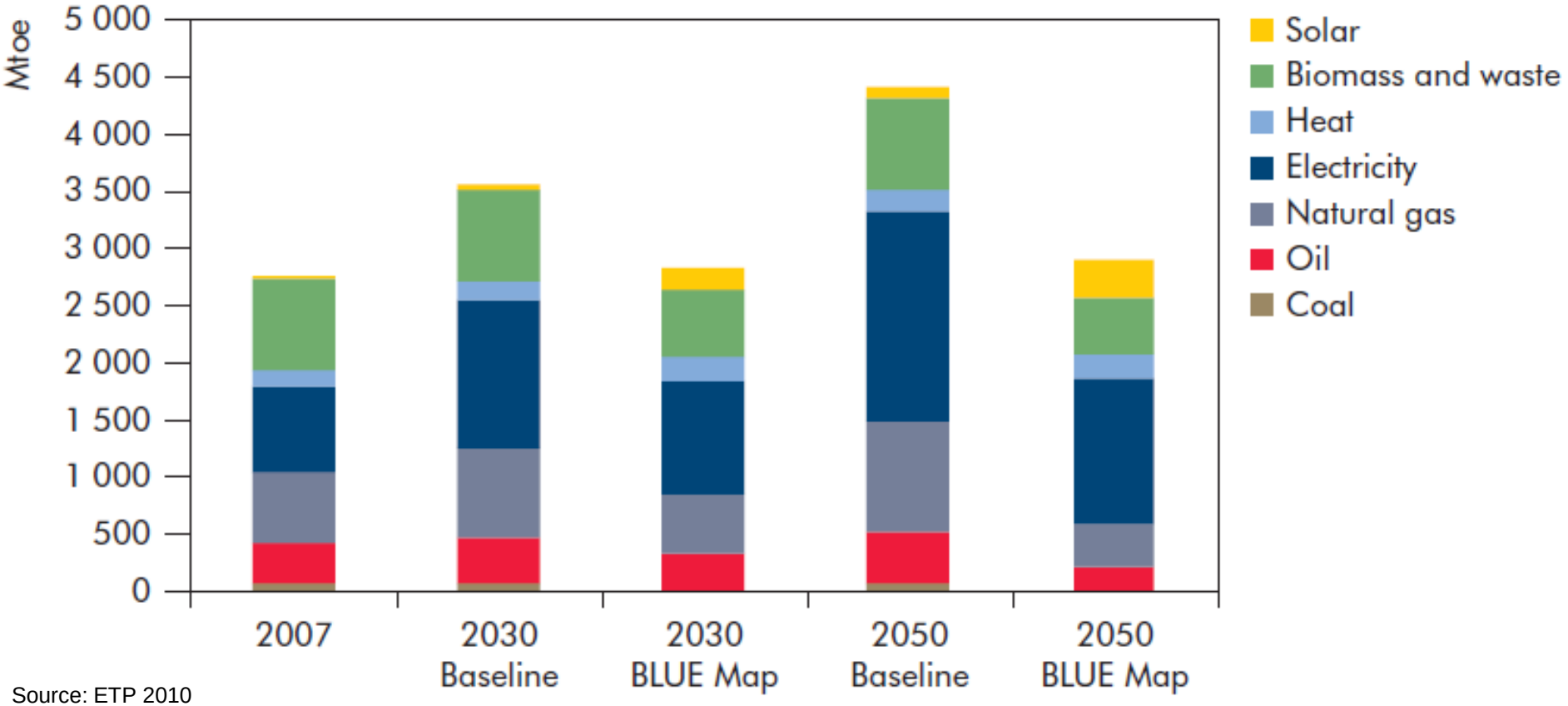


Source: ETP 2010

- By 2050, biomass use in industry reaches between 560 - 730 Mtoe (23-31 EJ), accounting for 12-14% of total industrial energy use in BLUE Map
- Strongest demand growth comes from the chemical industry, followed by cement and iron/steel sector

Biomass use in ETP 2010

Buildings

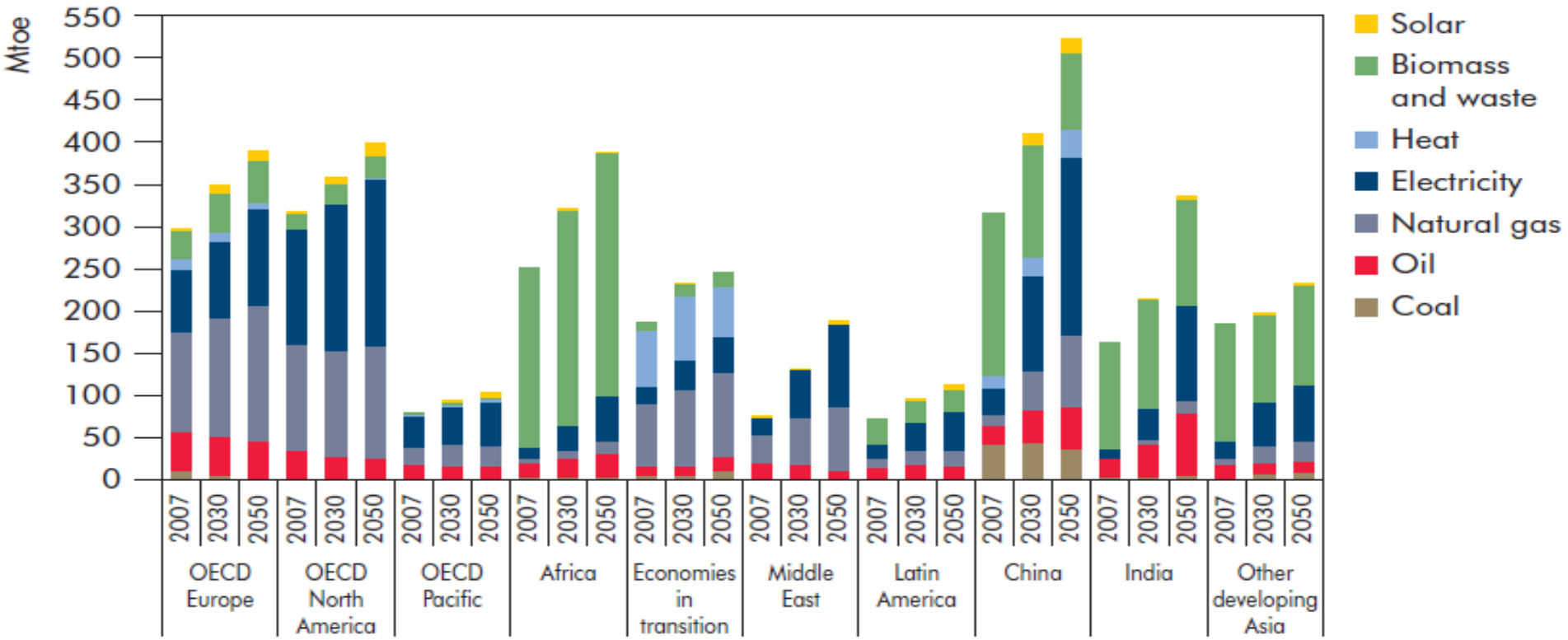


Source: ETP 2010

- Total biomass use in the buildings sector decreases from 805 Mtoe (34 EJ) in 2007 to 491 Mtoe (21 EJ) in 2050 in the BLUE Map Scenario
- Modern biomass fuels and increased efficiency reduce use of traditional, low-efficient biomass for heating and cooking

Biomass use in ETP 2010

Buildings – Residential sector



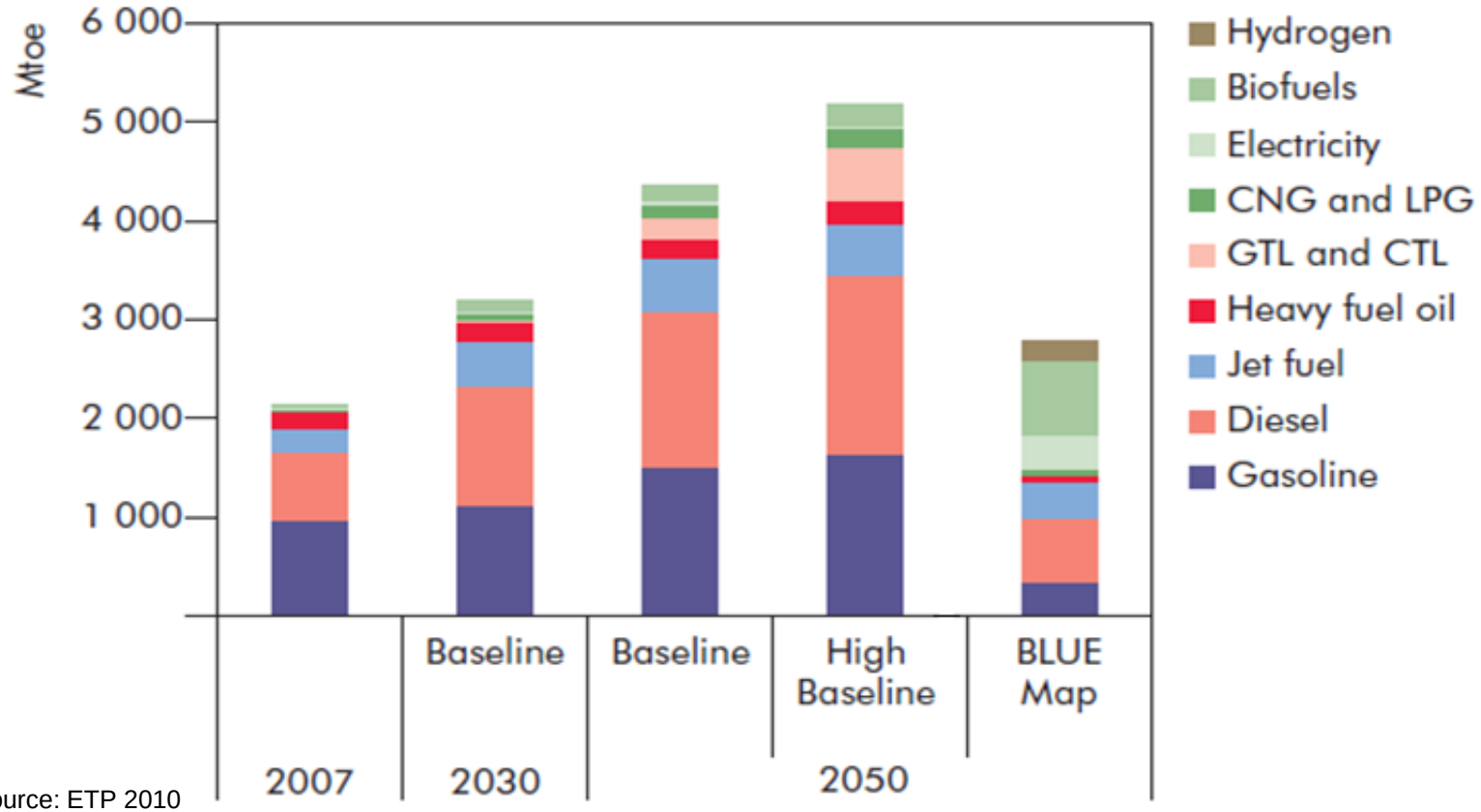
Source: ETP 2010

- Biomass continues to play a major role in the residential sector outside the OECD, even in BLUE Map

  → mainly used in the residential sector in Africa, India and other developing Asia

Biomass use in ETP 2010

Transport sector



Source: ETP 2010

- In BLUE Map, transport energy use returns nearly to 2007 level, with more than 50% very low CO_2 fuels
- Total biofuel use in BLUE Map reaches 760 Mtoe (32 EJ) in 2050, with the major share coming from advanced technologies
- Biofuels will be particularly important to decarbonise planes, marine vessels and trucks

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Key Questions for Discussion 1

- What are the key roadmap elements that need to be included?
- Where do we set the boundaries for what the roadmap process will consider?
- What assessment/evaluation criteria should be used in the process?
- What additional questions should the meeting and the roadmaps address?