INTERNATIONAL LOW-CARBON ENERGY TECHNOLOGY PLATFORM

How2Guide for Bioenergy

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Southern Africa's regional workshop

29-30 April 2014, Durban, South Africa

International Energy Agency

Outline of Session 1

- Introduction
  - The IEA and the Technology Platform
  - *How2Guides*: concept and key elements
  - *How2Guides* vs *Technology Roadmaps*
- *How2Guide for Bioenergy*
  - Authors and scope
  - Content and methodology
- IEA-related work on Bioenergy
  - Technology Roadmaps
  - IEA Implementing Agreement
- FAO-related work on Bioenergy
  - FAO country support toolkit
  - Country work

International Energy Agency

INTERNATIONAL LOW-CARBON ENERGY TECHNOLOGY PLATFORM

International Energy Agency 1974•2014

Secure • Sustainable • Together

Founded in 1974

- **Formed in wake of 1973 oil embargo with mission to promote member country energy security -- autonomous agency of the Organisation for Economic Cooperation and Development (OECD)**

28 member countries

- **Asia Pacific:** Australia, Japan, Republic of Korea and New Zealand
- **North America:** United States, Canada
- **Europe:** Austria, Belgium, Czech Rep, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey and United Kingdom
- **European Commission** also participates in the work of the IEA
- **Chile and Estonia** are in the process of accession to become members of the IEA

Headquarters: Paris

Decision-making body: Governing Board

- Consists of member country representatives
- Under the Governing Board, several committees are focusing on each area

Secretariat:

- **Staff of around 250,** mainly energy experts and statisticians from its member countries

The 3 ‘E’s of Sound Energy Policy

- **Energy security**
- **Economic growth**
- **Environmental sustainability**

And a fourth ‘E’

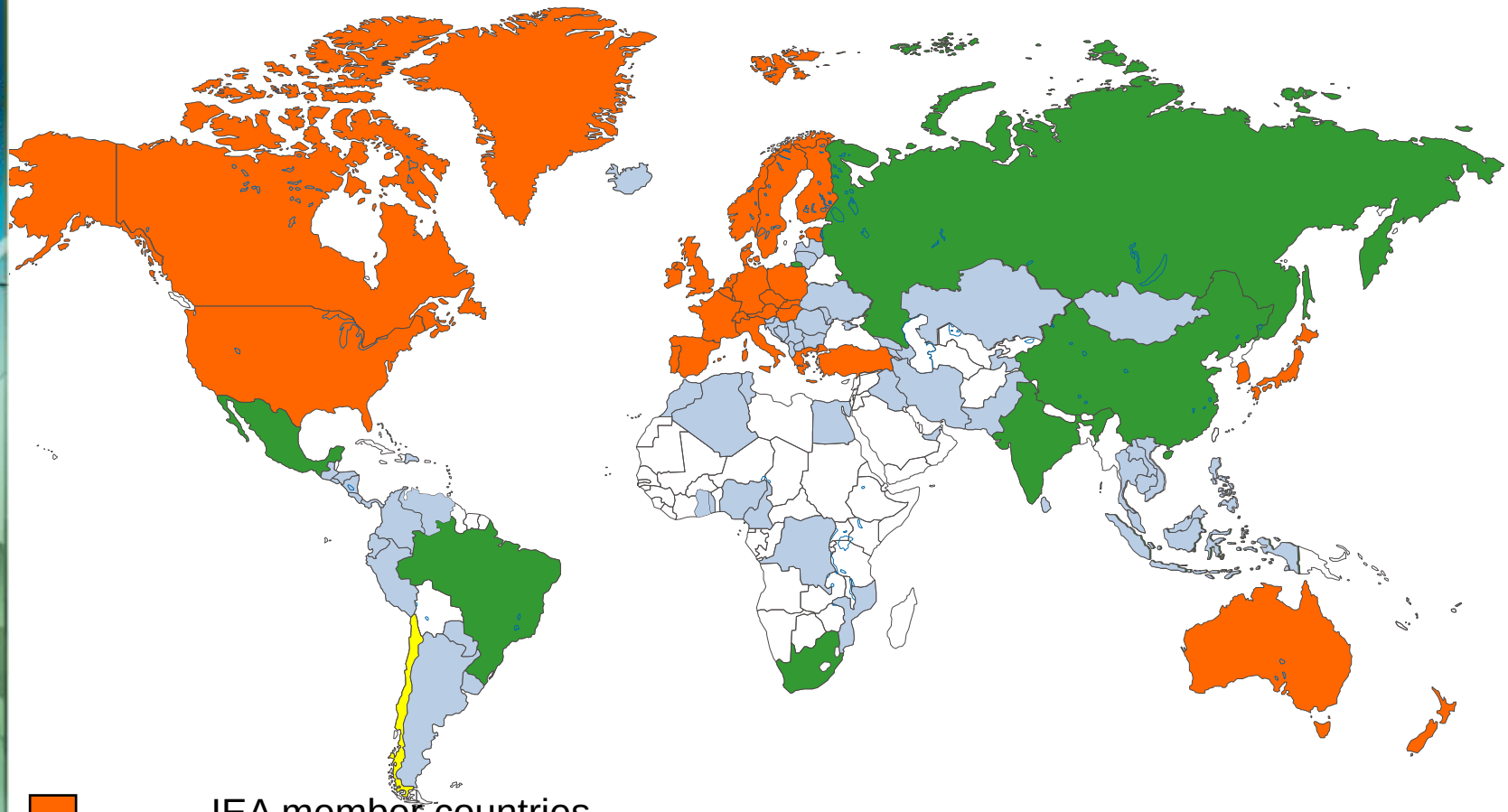
- **Engagement worldwide**

Global co-operation – Why?

- Fundamental global shifts in energy demand
- Common challenges – energy security and climate change
- Sharing and transparency

IEA worldwide engagement

INTERNATIONAL LOW-CARBON ENERGY TECHNOLOGY PLATFORM



- IEA member countries
- Accession countries
- Key Partner countries
- Countries co-operating through IEA programmes

INTERNATIONAL LOW-CARBON ENERGY TECHNOLOGY PLATFORM

International Low-Carbon Energy Technology Platform

The Technology Platform is the chief IEA tool for:

- Engaging with Partner countries and organisations on low-carbon energy technologies
- Adapting IEA global analysis to regional and local contexts

Key information

- Created in 2010 upon mandate of the IEA Ministers to foster international collaboration on low-carbon energy technologies
- Three types of activities:
  1. *How2Guide* manuals for roadmap development at the national and regional levels
  2. Multilateral engagement and partnership building
  3. Selected thematic analysis (cross-cutting)

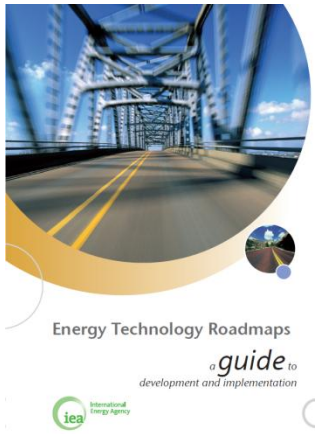
How2Guides: concept

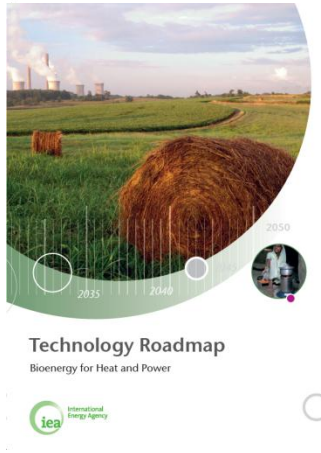
- Building on the IEA global series of technology roadmaps (20+ publications) and IEA established roadmap methodology (updated 2014)

- Growing request for assistance from Partner Countries *IEA-China Wind Roadmap* (2012); *IEA-India Cement Roadmap* (2013); *IEA-South Africa Solar Roadmap* (forthcoming)

- *How2Guides* are a response to this context:

Manuals for policy and decision makers to develop technology roadmaps tailored to national / regional frameworks





INTERNATIONAL LOW-CARBON ENERGY TECHNOLOGY PLATFORM

How2Guides

Why are we doing this?

- To scale-up IEA capabilities to provide support to countries for national roadmap development
- To enhance the impact of the IEA's technology roadmap programme

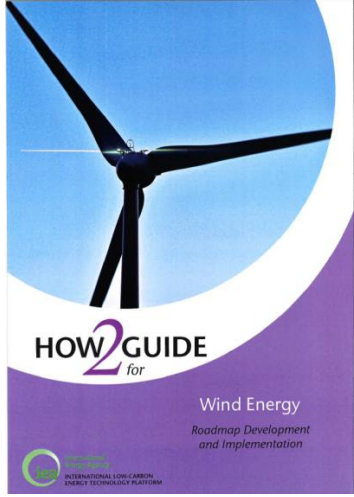
Is this only for IEA Members?

- Not at all – developing countries and emerging economies are a key audience for this initiative
- Countries which already have technology roadmaps can use it as a tool for internal revision, aiming at improvements in the energy mix

Work streams

- *How2Guide for Wind Energy* (released on 10 March 2014)
- ***How2Guide for Bioenergy* (expected Q1 2015)**
- *How2Guide for Smart Grids* (expected in 2015)

How2Guide projects



IEA-ADB H2G workshops for wind and smart grids, Oct 2012, Manila, The Philippines

How2Guide for Wind Energy

- **Published in March 2014**
- Two regional expert workshops in Asia (Oct 2012) and South Africa (Feb 2013)
- IEA Technology Roadmap: Wind Energy (2nd edition, 2013)

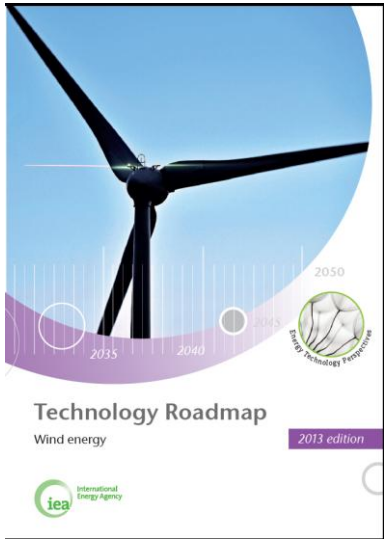
IEA-ISGAN H2G workshop for smart grids, March 2012, Mexico City, Mexico

How2Guide for Smart Grids

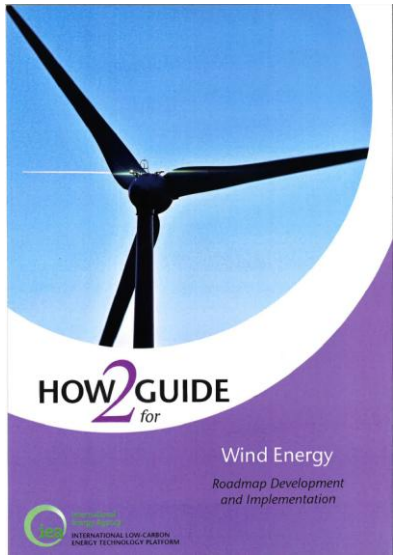
- Expected in 2015
- Four regional expert workshops in Mexico (March 2012), in Ireland (Sept 2012); in Asia (Oct 2012), and in South Africa (Feb 2013)
- Publication in conjunction with the release of the updated IEA Technology Roadmap on Smart Grids (2010)

Technology Roadmap vs How2Guide (1)

- Market, technology and cost evolution
- Medium-term global outlook
- 2050 “Vision” based on global energy context and system optimization
- Actions and time frames

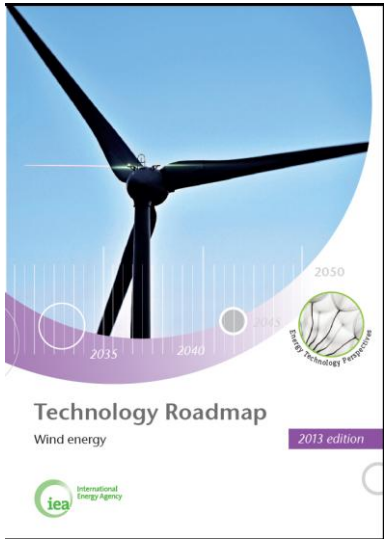


- Short introduction to technology and market
- Process for developing a roadmap
- Step-by-step decision making guidance
- Analysis of drivers, barriers, solutions for wind energy deployment

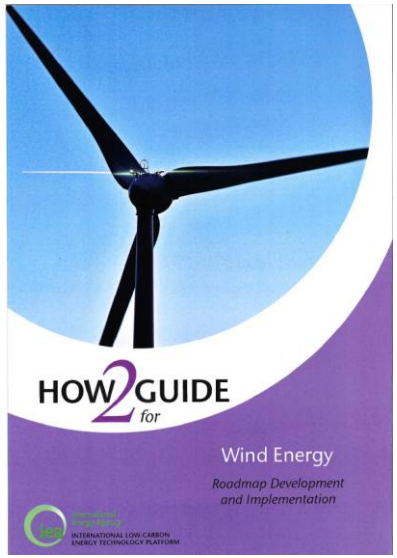


Technology Roadmap vs How2Guide (2)

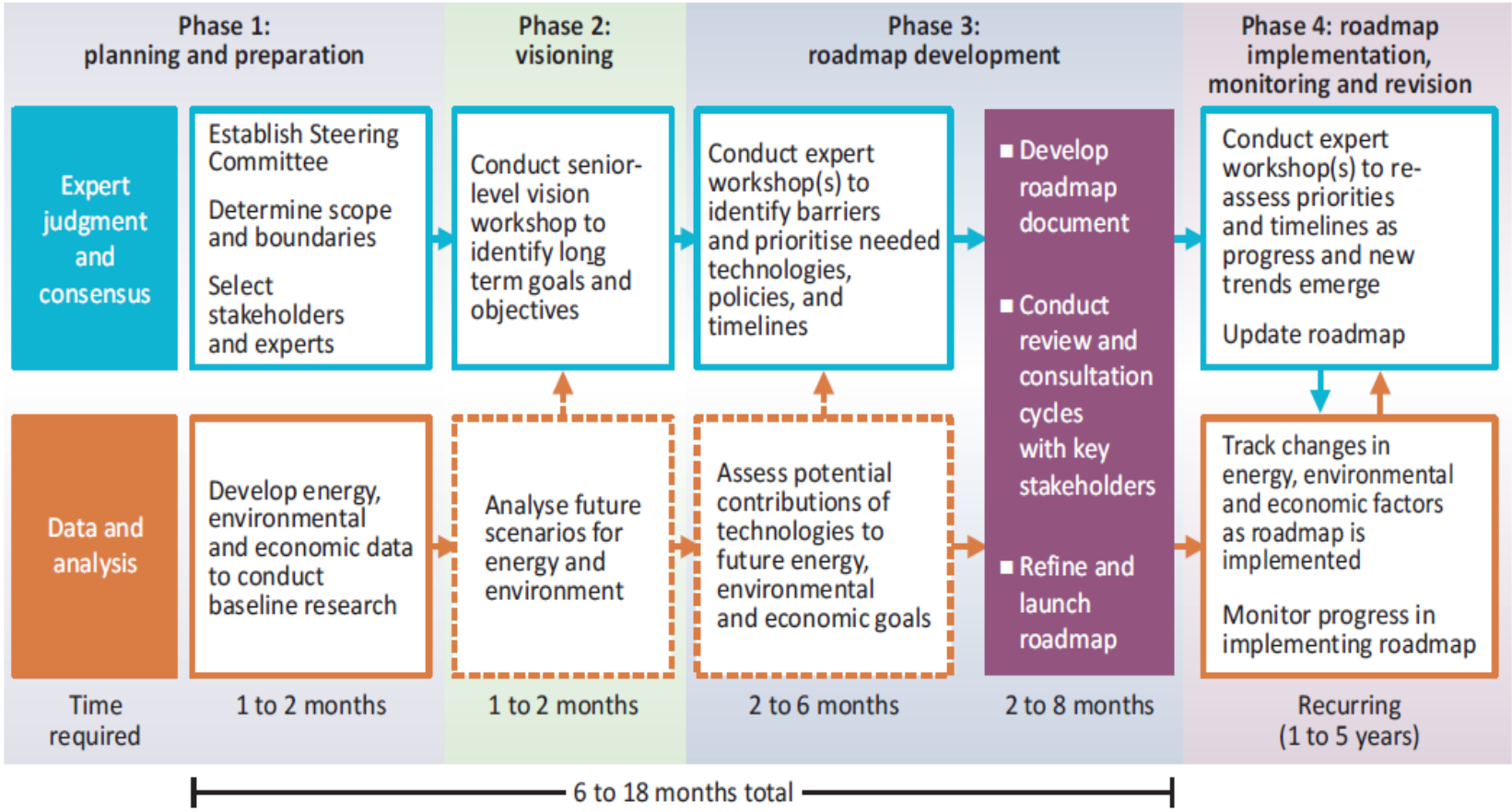
- *Land-based wind represents largest RE capacity addition over 2012-2018*
- *Technology evolution: growth in size, height and capacity. Investment costs for wind power to decrease by 25% on land and 45% off shore by 2050*
- *By 2050 wind power to provide 15% to 18% of global electricity. China, Europe and the USA together account for two thirds of installed capacity*



- *Key aspects of baseline research for wind energy roadmap will likely include the following: (…)*
- *Typical wind energy stakeholders and their categorisation (cf. Table 3)*
- *Barriers encountered in the development phase of WPP mainly concern (…) → 15 "action options"*
- *[indicators] Statistics of production failure will be of particular value in the assessment of progress*



IEA Roadmap process



Source: IEA Roadmap Guide (2014). Note: Timescales are indicative.

Dotted lines indicate optional steps, based on analysis capabilities and resources.

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INTERNATIONAL LOW-CARBON ENERGY TECHNOLOGY PLATFORM

How2Guide for Bioenergy (1)

Key elements :

- **Defines the process of developing and implementing a bioenergy technology roadmap**

- Collaboration between the **IEA** and the **FAO**

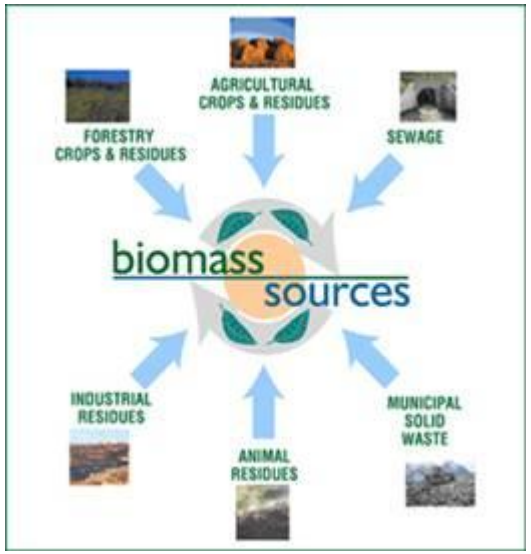
- Roadmap methodology guidance through **four steps**, illustrated by case studies

- **Case studies** from IEA Member and Partner countries (Southern Africa, South East Asia, South America)

- **Comprehensive decision support toolbox**, including and referencing work of other international/regional organisations

How2Guide for Bioenergy (2)

- *How2Guide for Bioenergy* will address all applications and energy demand profiles



Power

Heat

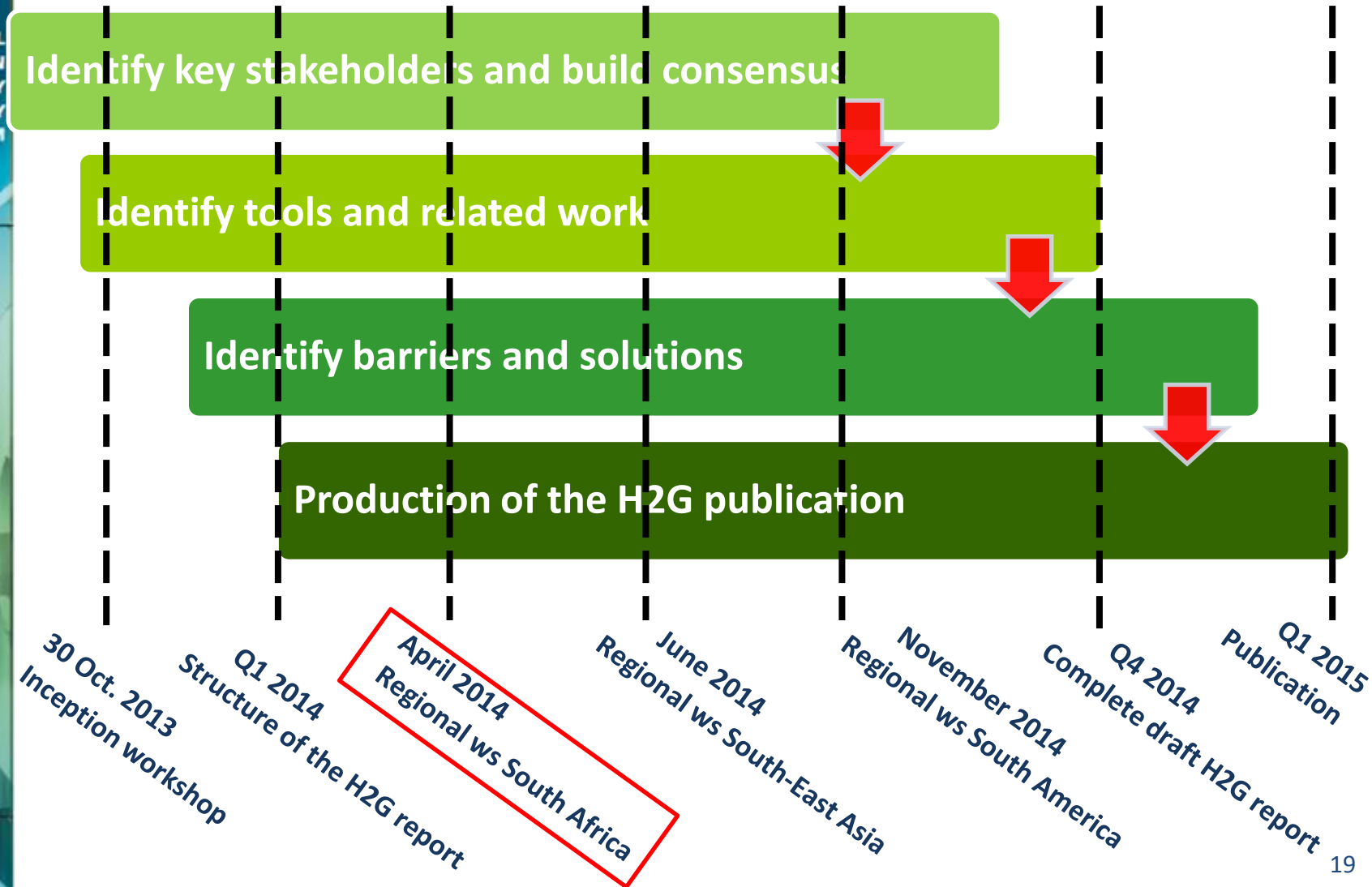
Biofuels

How2Guide for Bioenergy (3)

Process to developing the *How2Guide for Bioenergy*

- Identify key stakeholders and build consensus
- Identify tools and related work
- Identify barriers and solutions
- Production of the H2G publication

How2Guide for Bioenergy (4)



Regional expert workshops

- Objectives:
  - ✓ indentify and share regional best practices as well as less successful experiences
  - ✓ understand regional drivers to bioenergy policy and technology deployment
  - ✓ present resources and tools which can be used in support of bioenergy roadmap planning and implementation

- Thematic focus:
  - ✓ Southern Africa: waste-to-energy and biogas
  - ✓ South East Asia: sustainability of biomass and small scale applications
  - ✓ South America: conventional and advanced biofuels

Key aspects

- Resource availability
- Sustainability of biomass supply and use
- Technology status and cost
- Potential barriers to deployment and action options
  - Technology
  - Policy
  - Market
  - Finance
- Policy options and related costs and effectiveness
- Stakeholders engagement and public acceptance

IEA analysis on bioenergy

- IEA Technology Roadmap: Biofuels for Transport (2011)
- IEA Technology Roadmap: Bioenergy for Heat and Power (2012)
- Medium-Term Renewable Energy Market Report 2013
- Bioenergy Perspectives (upcoming, 2015)

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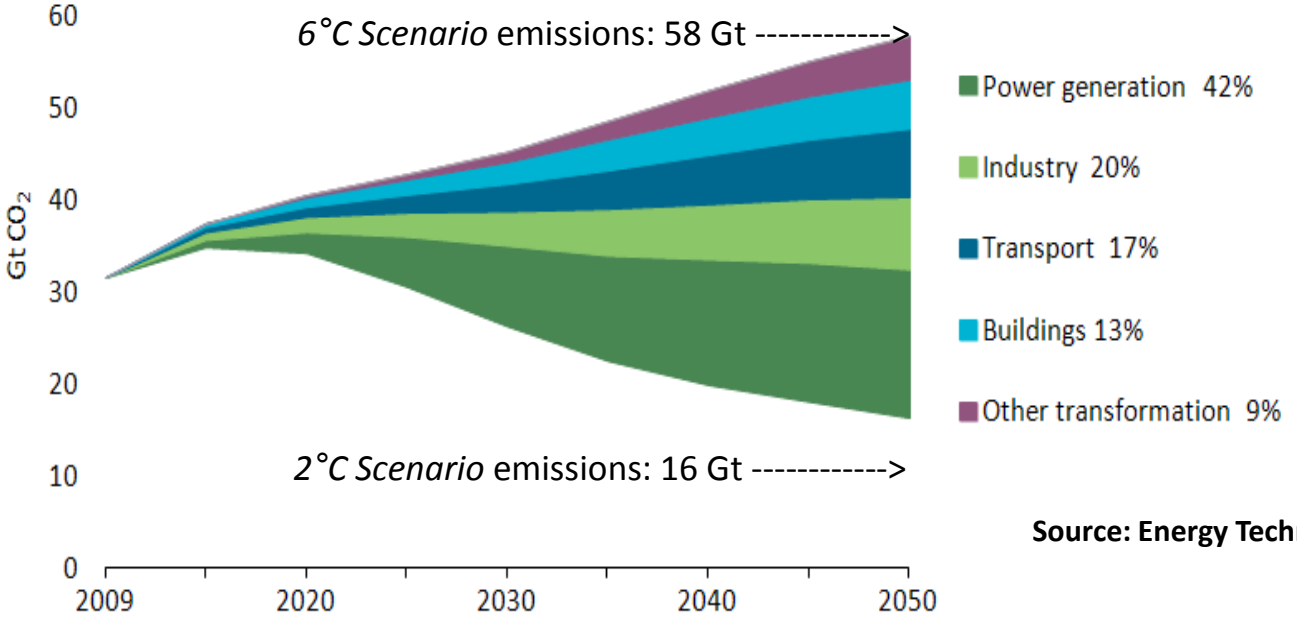
Key role of bioenergy in a low-carbon future



Source: Energy Technology Perspectives 2012

- Reaching the 2DS will require **42 Gt CO_2 annual emissions reduction** by 2050
- Biomass is the only renewable energy source that can make a contribution in all sectors, providing **around 10% of total CO_2 emissions reduction**

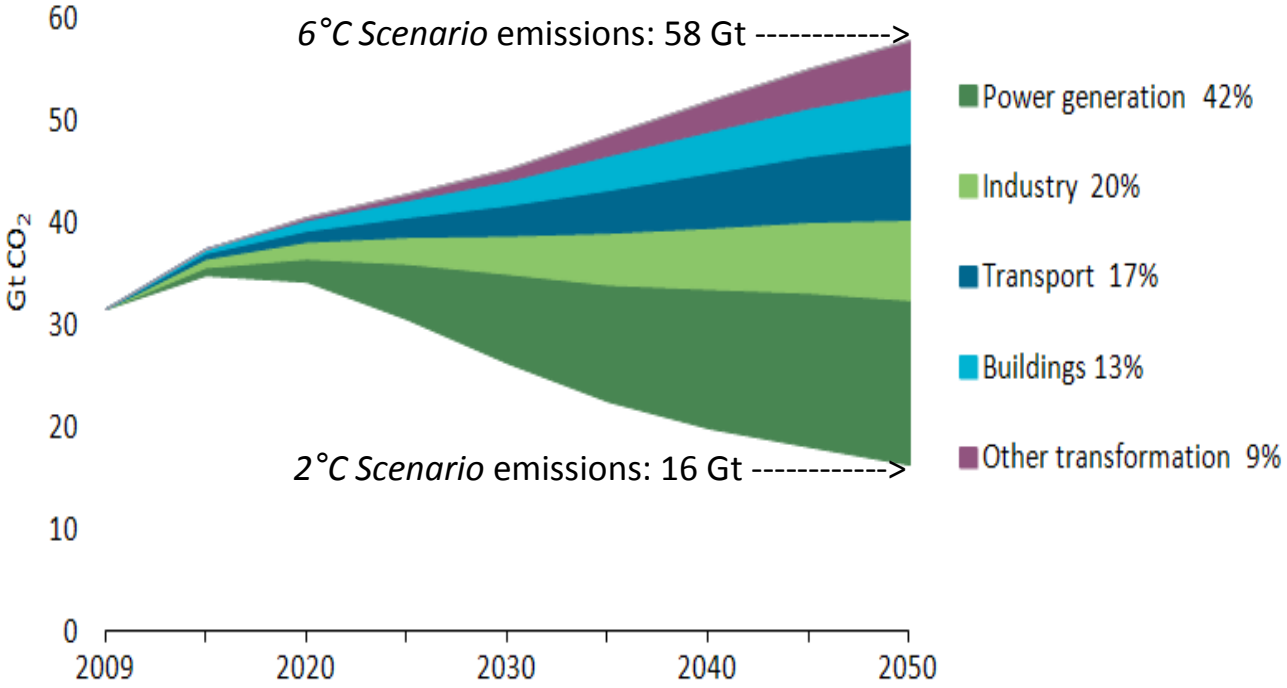
Roadmaps

- **How to Deliver 2DS?**
  - **Vision from ETP**
  - **Opportunities, challenges, actions**
- **23 in total covering range of low carbon options**

Renewables

- Bioenergy for Heat and Power (2012)
- Biofuels for Transport (2011)
- Hydro (2013)
- Geothermal (2012)
- Solar CSP (2011updated 2014)
- Solar Heating and Cooling (2012)
- Solar PV (2011 updated 2014)
- Wind (updated 2013)

Key role of bioenergy in a low-carbon future

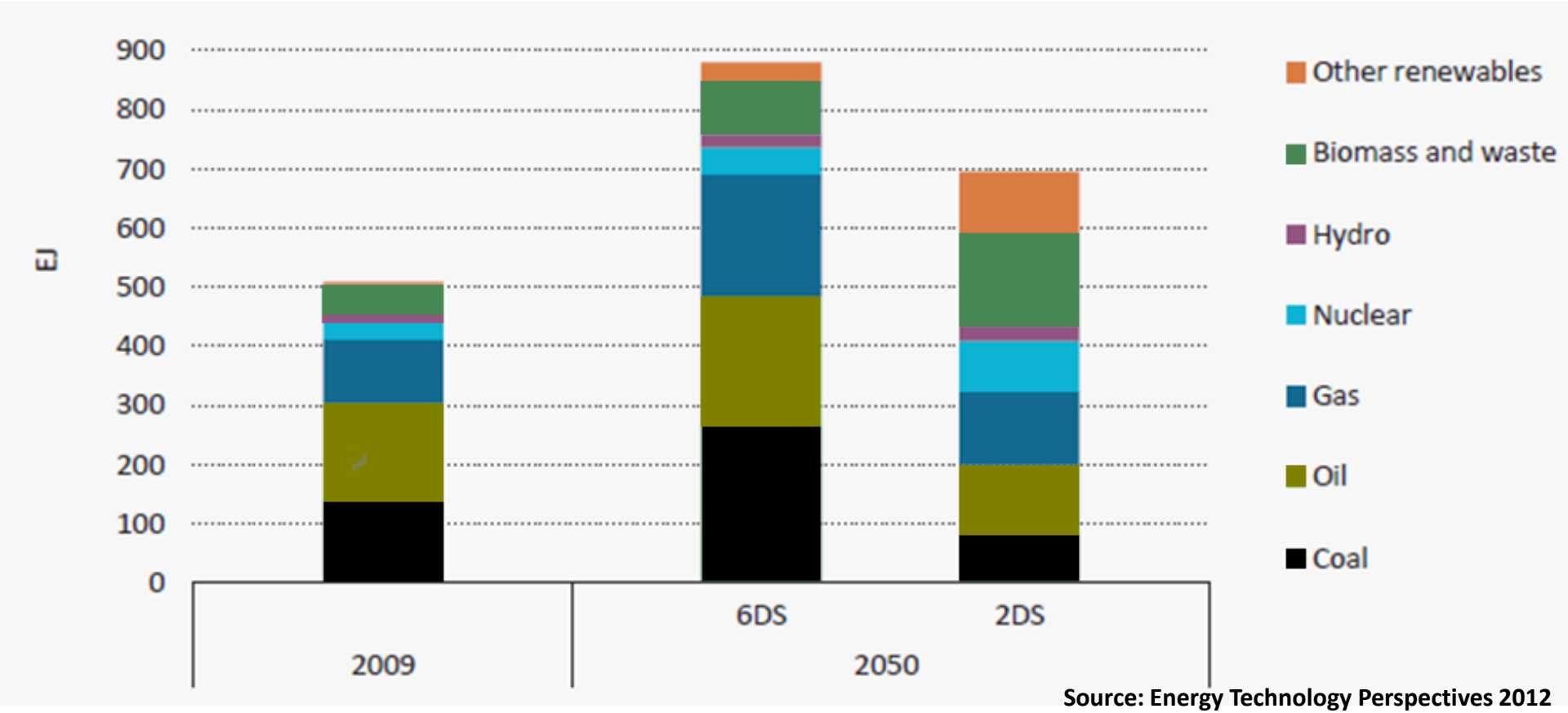


Bioenergy technologies	Emissions reduction in 2050
Bioenergy power	1.0 Gt $CO_{2\text{-eq}}$
Bio-power + CCS	0.3 Gt $CO_{2\text{-eq}}$
Bioenergy heat (industry)	0.5 Gt $CO_{2\text{-eq}}$
Bioenergy heat (buildings)	0.1 Gt $CO_{2\text{-eq}}$
Biofuels	2.1 Gt $CO_{2\text{-eq}}$
Total	**4.1 Gt $CO_{2\text{-eq}}$**

Source: Energy Technology Perspectives 2012

- Reaching the 2DS will require **42 Gt CO_2 annual emissions reduction** by 2050
- Biomass is the only renewable energy source that can make a contribution in all sectors, providing **around 10% of total CO2 emissions reduction**

Total Primary Energy Supply by Fuel Source

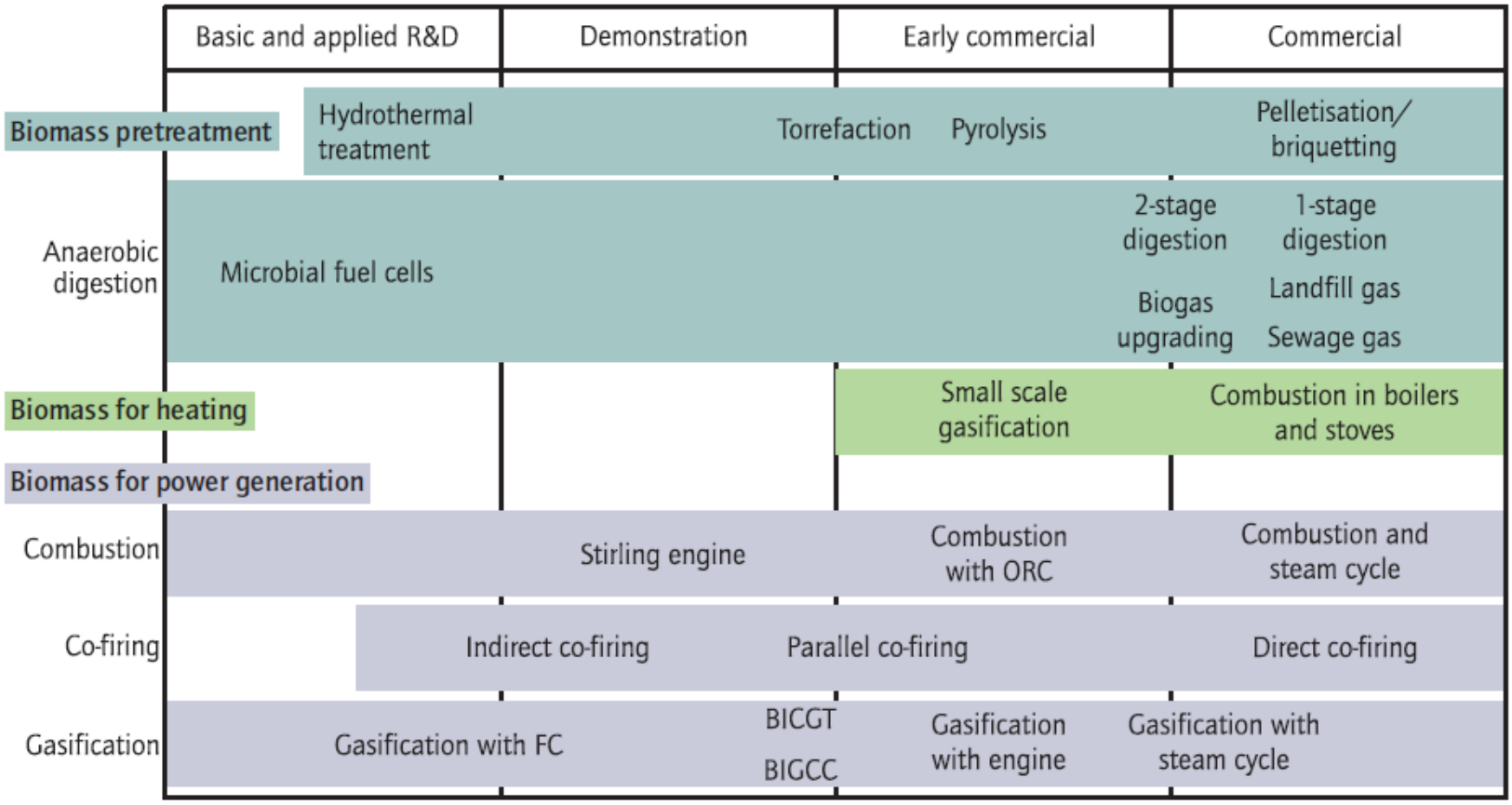


Source: Energy Technology Perspectives 2012

- Bioenergy accounts for 24% of primary energy supply by 2050 in the 2°C Scenario

→ 250-400 Mha of land, *i.e.* 5-8% of total agricultural land today, will be needed in 2050

Overview on Bioenergy Technologies



Note: ORC = Organic Rankine Cycle; FC = fuel cell; BICGT = biomass internal combustion gas turbine; BIGCC = biomass internal gasification combined cycle

Source: Modified from Bauen *et al.*, 2009

- Some promising technologies still need RD&D support to reach commercial-scale

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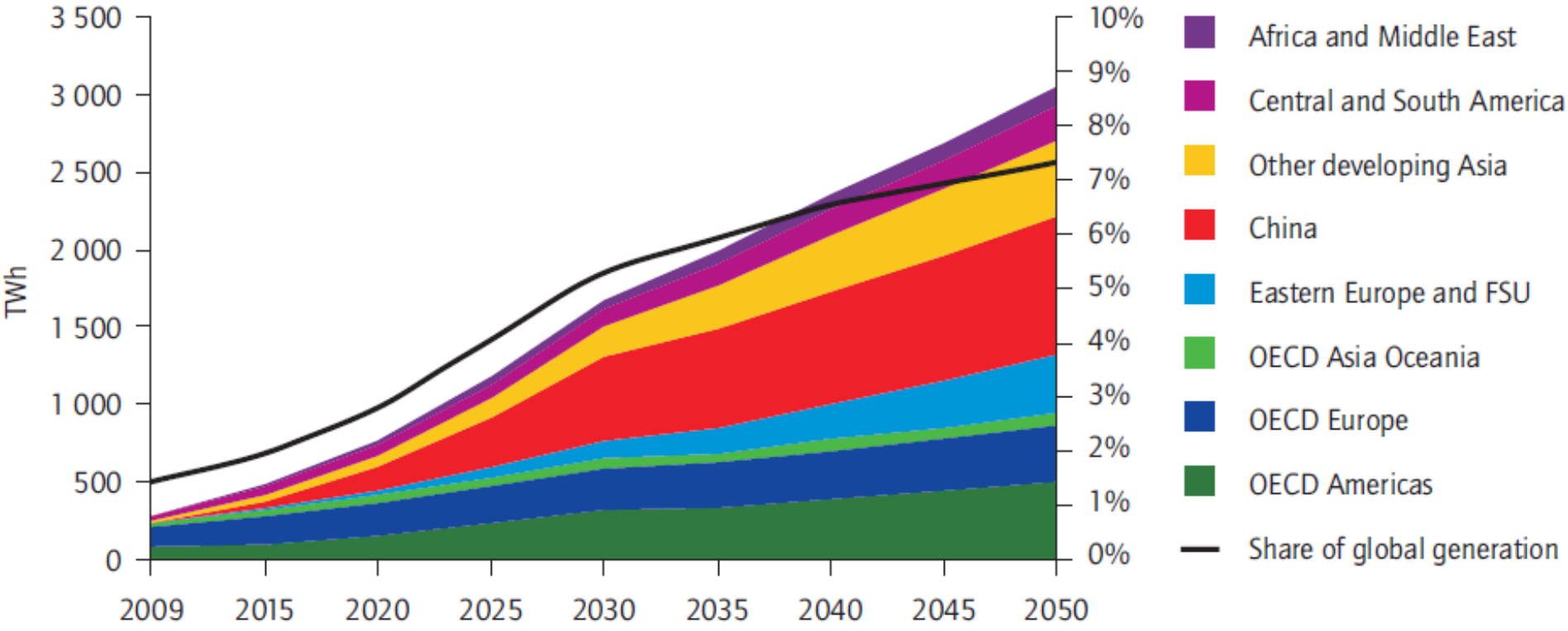
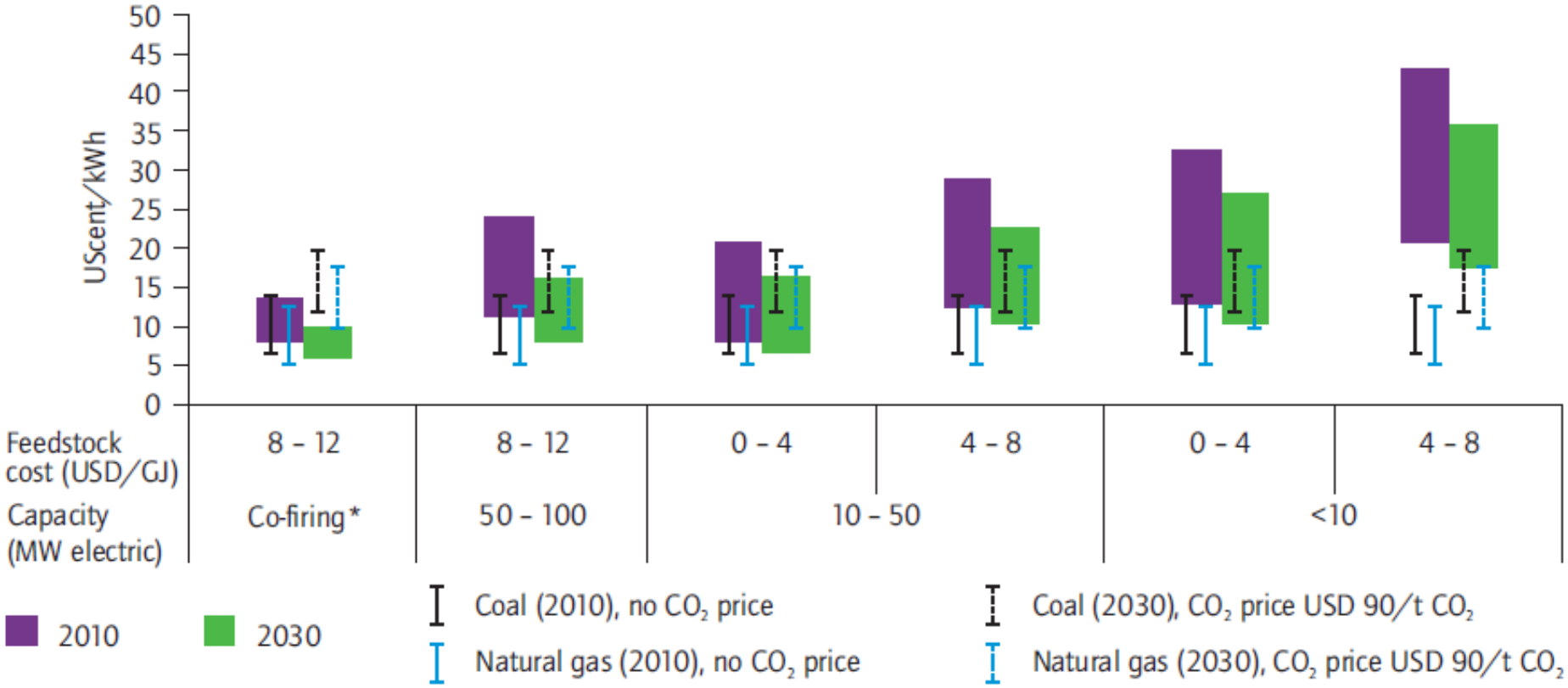
World bioenergy electricity supply to grow more then ten-fold



- **Share in total electricity generation increases from 1.5% today, to 7.5% in 2050**
- **Bioenergy provides firm capacity and dispatchable electricity**

International Energy Agency

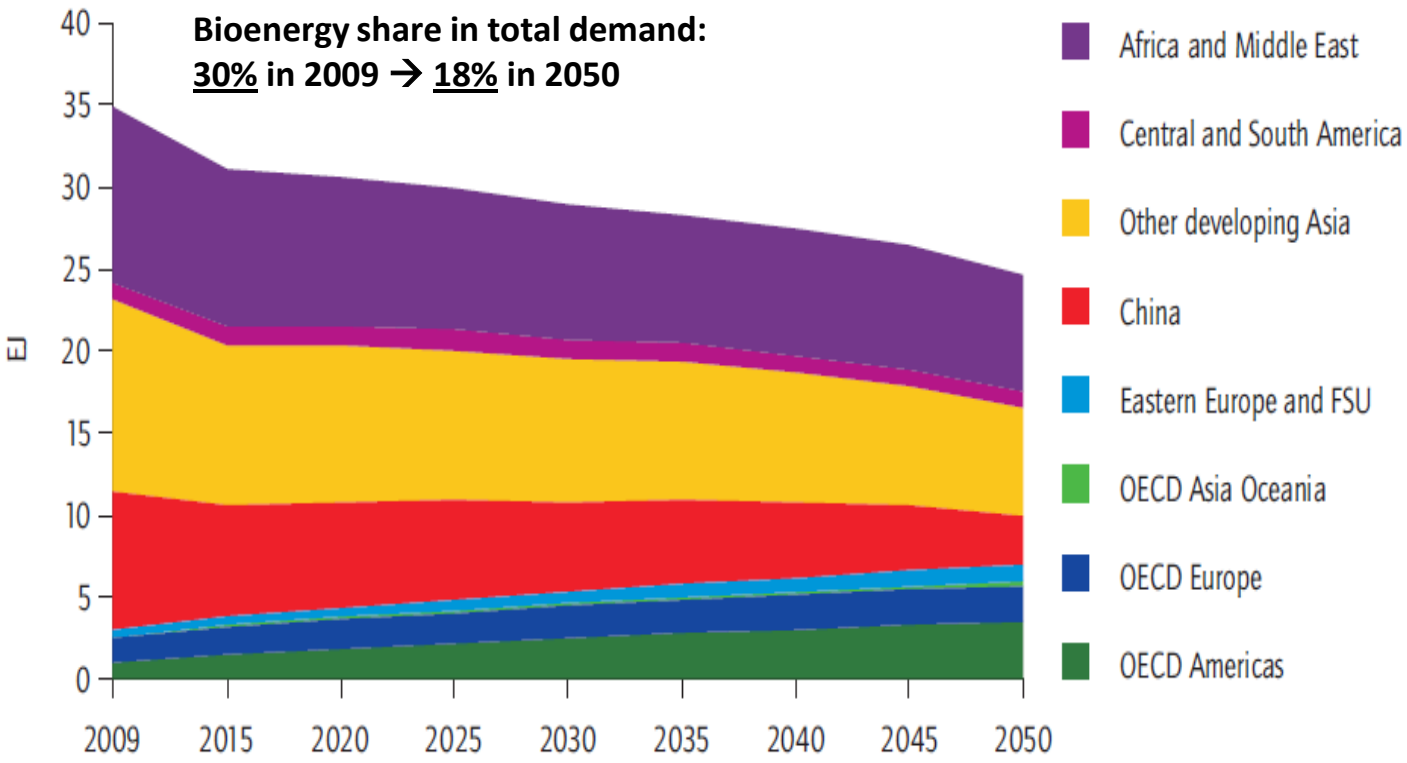
Bioenergy electricity generation costs are strongly scale-dependend

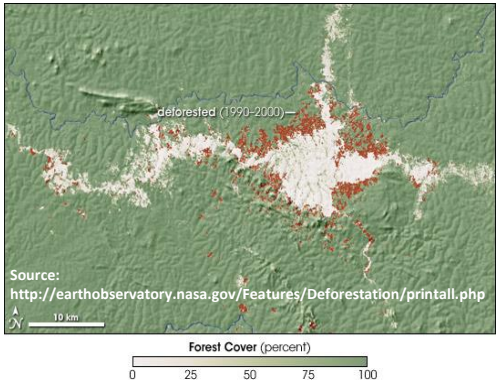


*Co-firing costs relate only to the investment in additional systems needed for handling the biomass fuels, with no contribution to the costs of the coal-fired plant itself. Fossil electricity generation costs are not capacity specific.

Source: IEA analysis based on DECC (2011), IPCC (2011), Mott MacDonald (2011), Uslu *et al.* (2012).

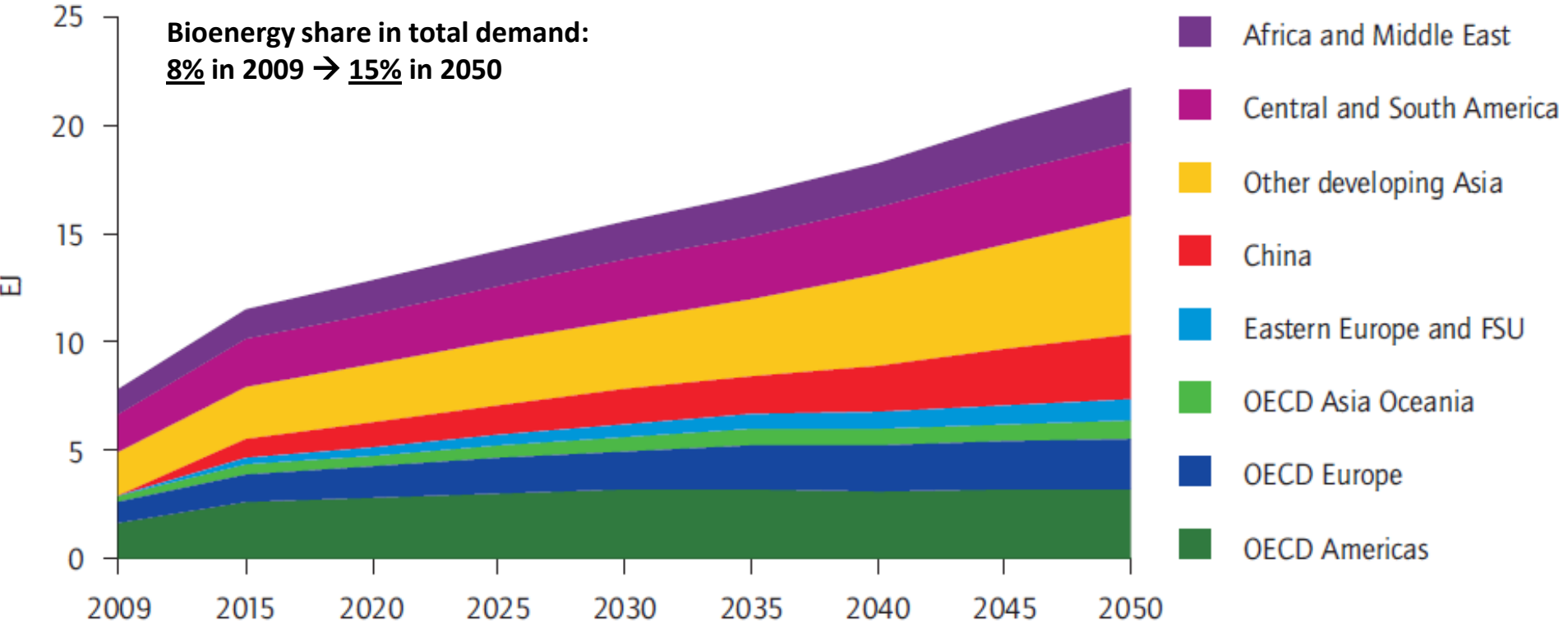
Bioenergy consumption in buildings declines





- **Bioenergy in buildings is pre-dominantly traditional biomass**
  → subject to low efficiency; negative health and environmental impact
- **New stoves, alternative fuels and more energy-efficient buildings key to reduce traditional biomass use**

Industry set to triple consumption of bioenergy



- **Bioenergy is becoming increasingly important for production of high temperature heat**

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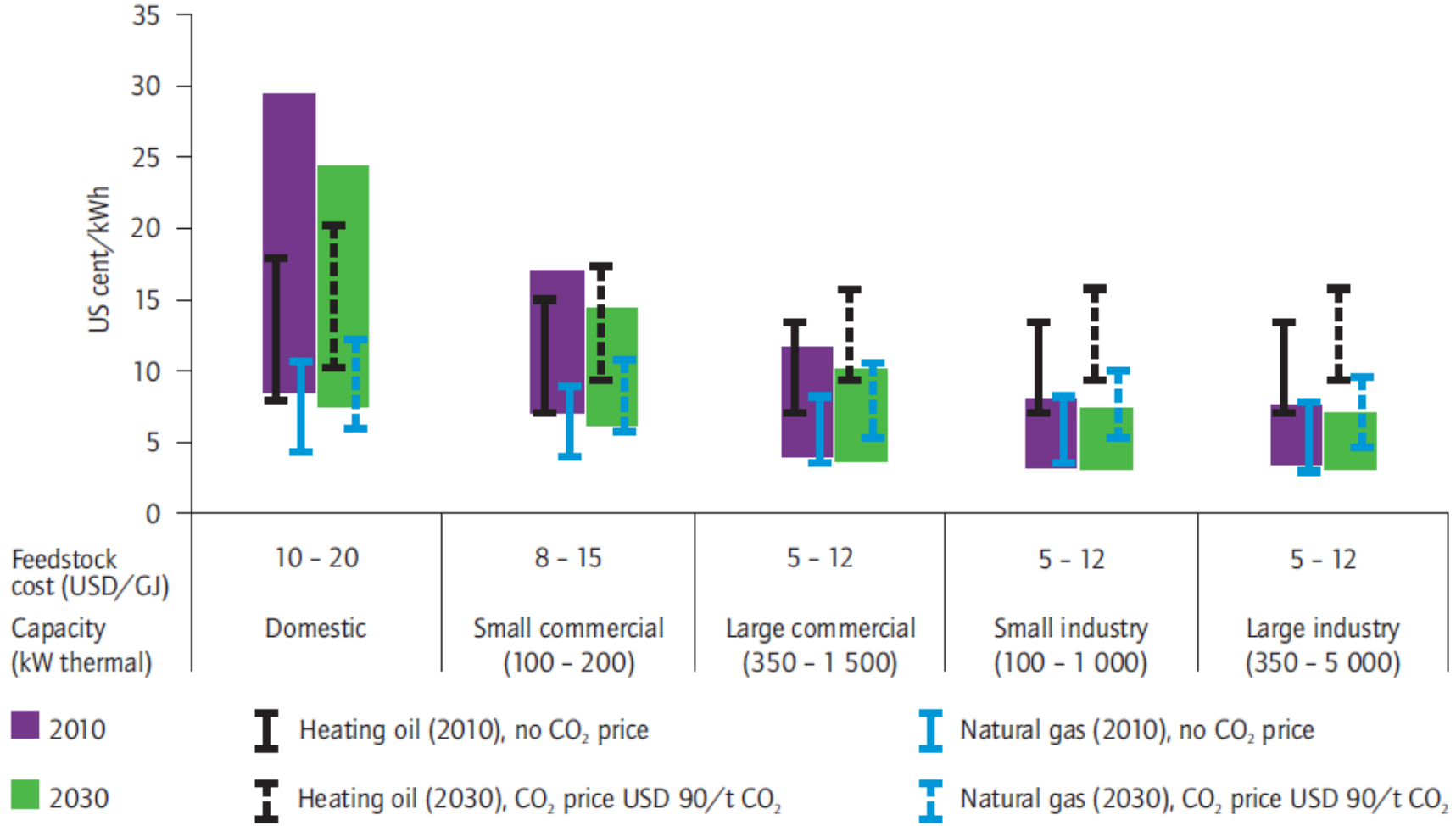
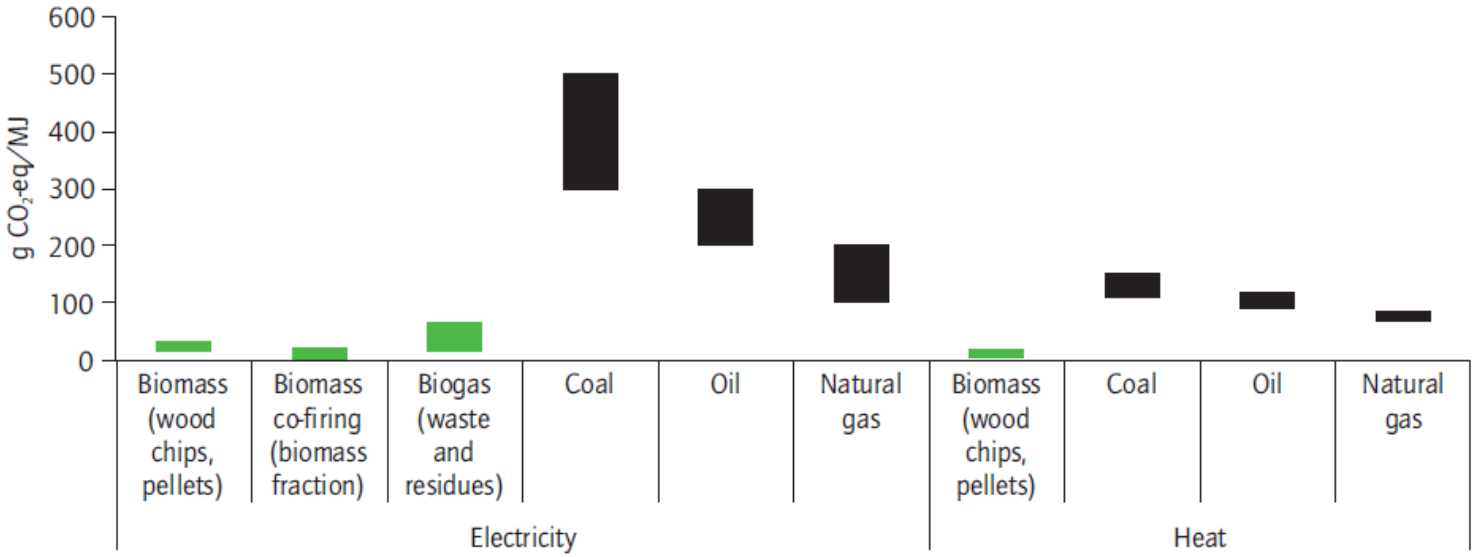
Bioenergy – a competitive heat source in many circumstances



Source: IEA analysis based on AEA (2011), DECC (2011), IPCC (2011), Mott MacDonald (2011), Uslu *et al.* (2012).

GHG Saving Potential of Bioenergy

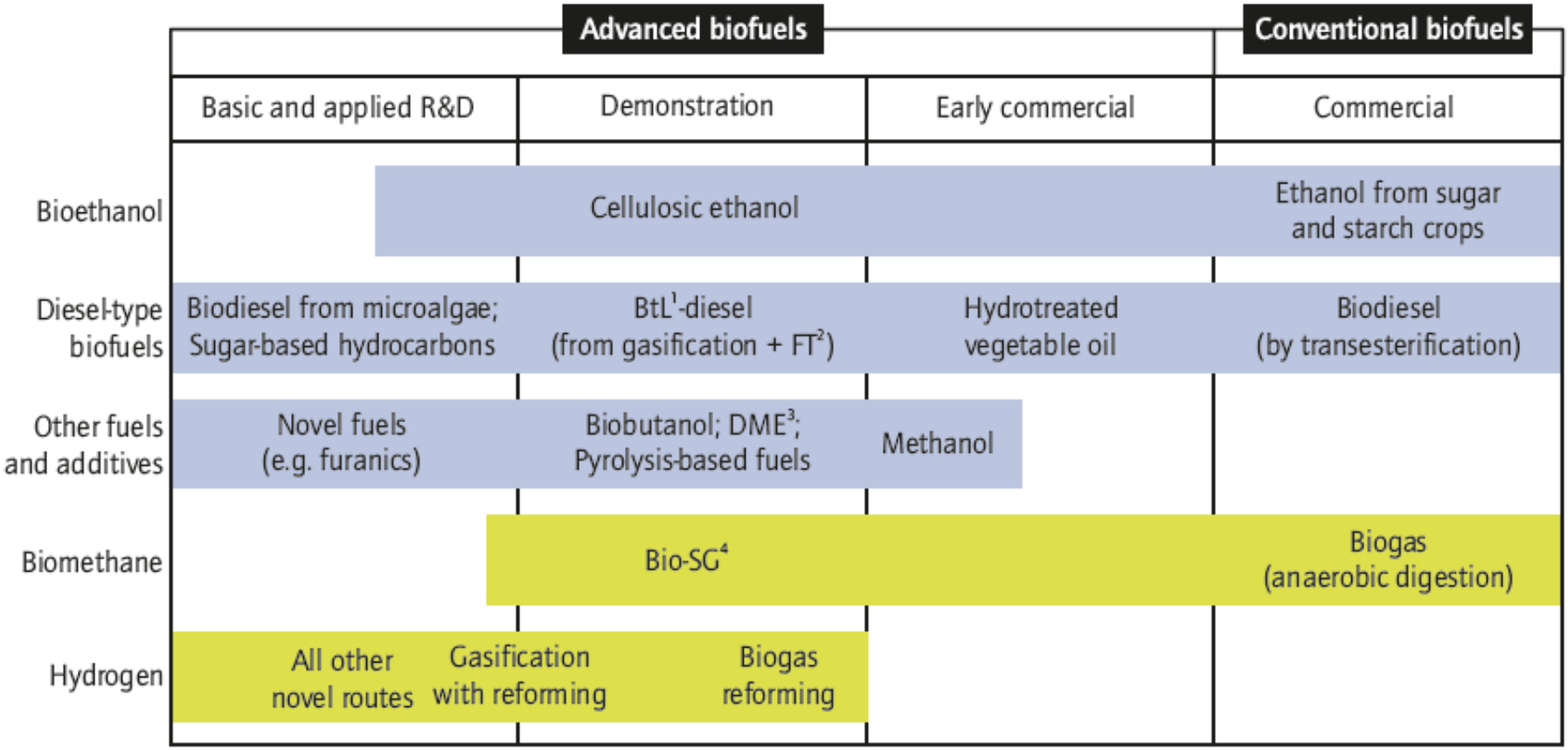


Note: Based on current state of technologies. Ranges reflect variations in performance as reported in literature. Possible emissions from land-use change are not included here.

Source: Based on Cherubini *et al.*, 2009; IPCC, 2011.

- Heat and power from biomass can provide considerable GHG reductions compared to fossil fuels
  - Emissions form land use change are still a big uncertainty
- Key requirement is that biomass is sourced sustainably with very low life-cycle GHG emissions

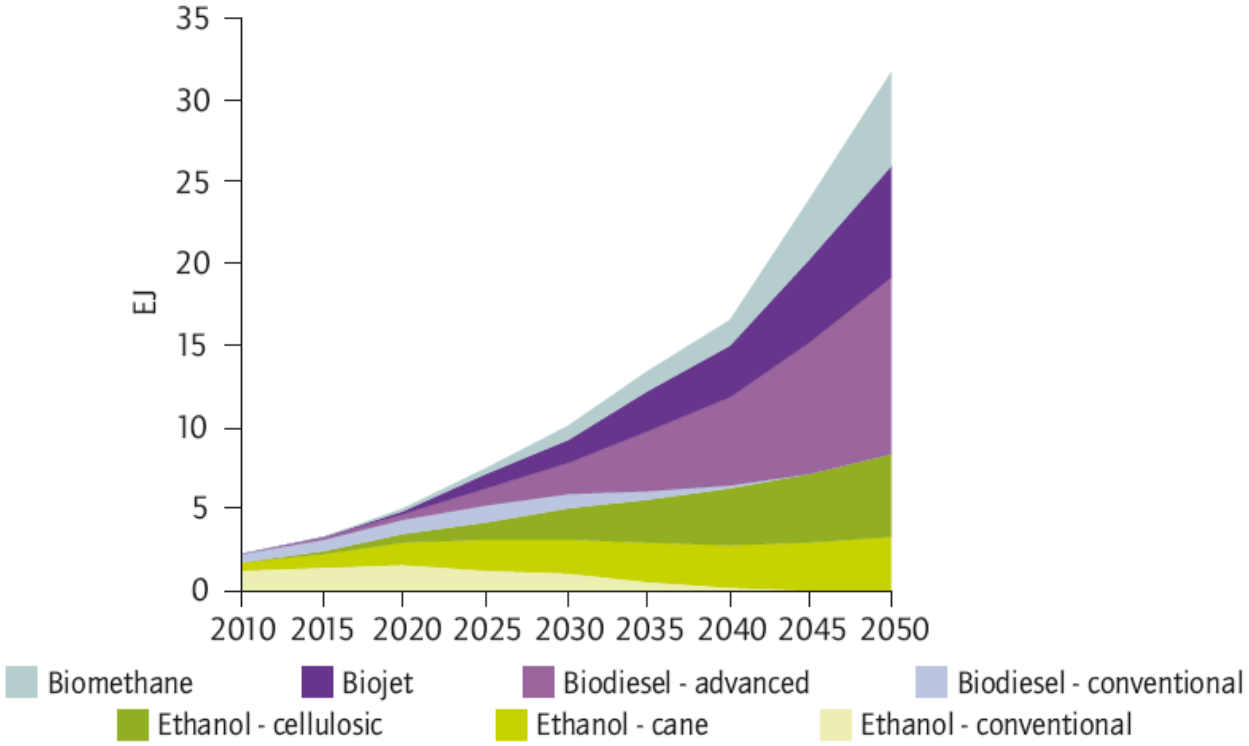
Overview on Biofuel Technologies



Source: Modified from Bauen *et al.,* 2009.

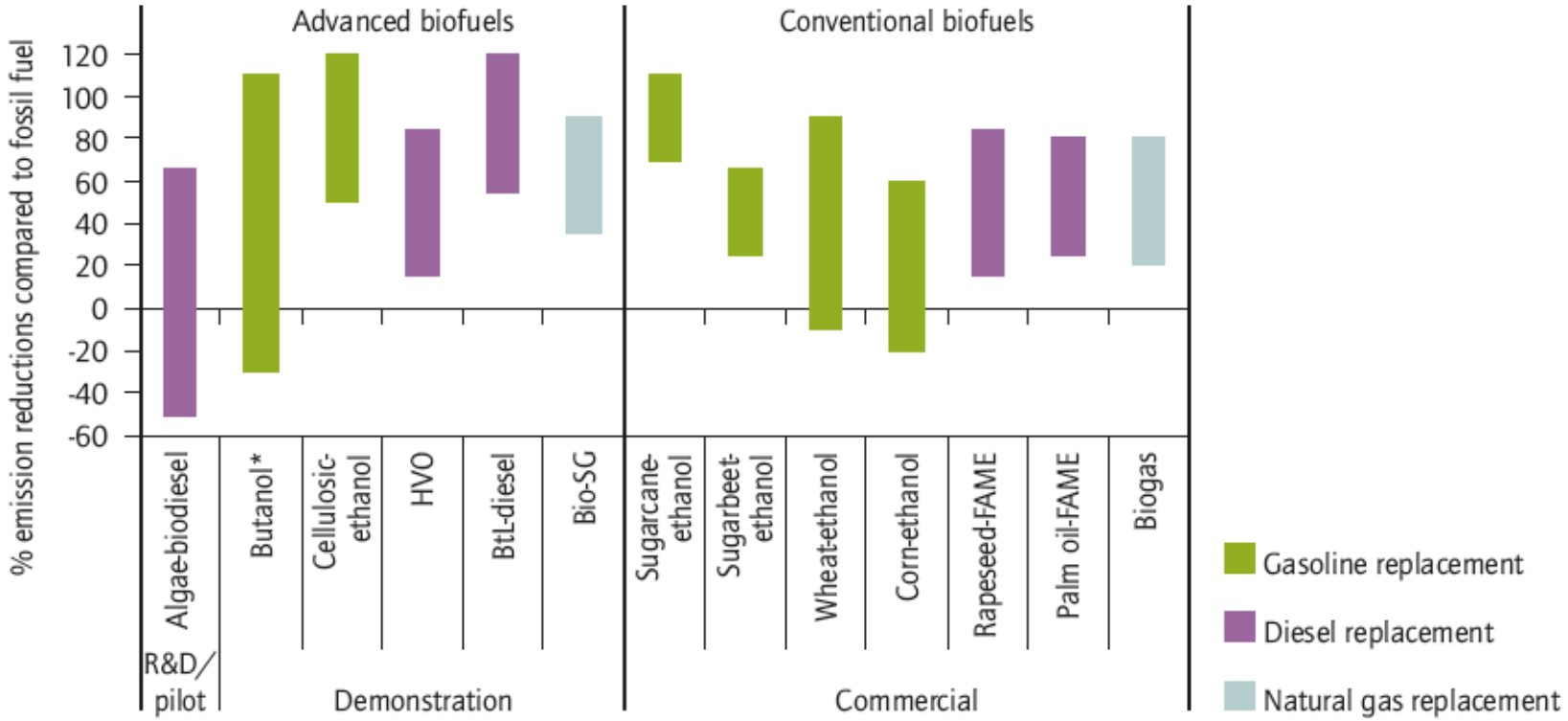
1. Biomass-to-liquids; 2. Fischer-Tropsch; 3. Dimethylether; 4. Bio-synthetic gas.

Advanced biofuels to play a key role in the long-run



- Global biofuel supply grows from **2.5 EJ** today to **32 EJ in 2050**
  - Biofuels share in total transport fuel increases from **2%** today, to **27%** in 2050
- Biofuels are the only low-carbon fuel alternative for heavy, long-distance transport
- Trade will be needed to balance supply and demand for feedstocks and biofuels

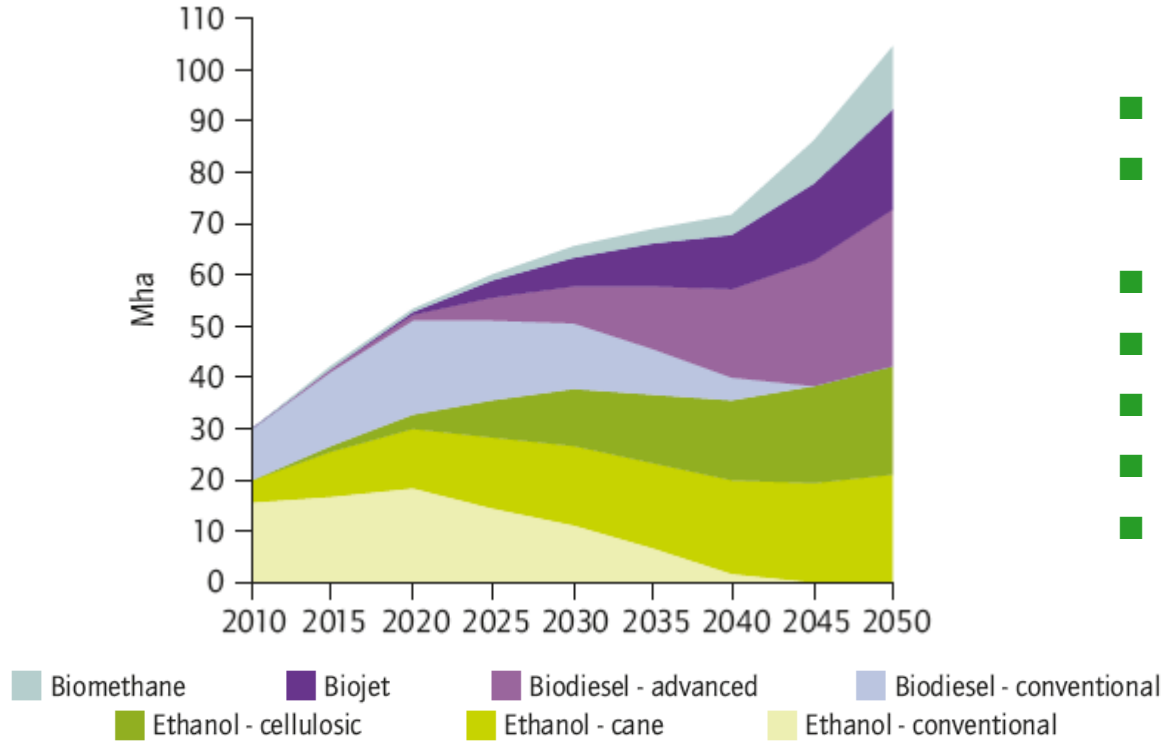
GHG-Reduction Potential of Biofuels



Note: The assessments exclude emissions from indirect land-use change. Emission savings of more than 100% are possible through use of co-products.
Source: IEA analysis based on UNEP and IEA review of 60 LCA studies, published in OECD, 2008; IEA, 2009; DBFZ, 2009.

- **Uncertainty on the impact of land-use change on GHG balance remains**

Land Requirements



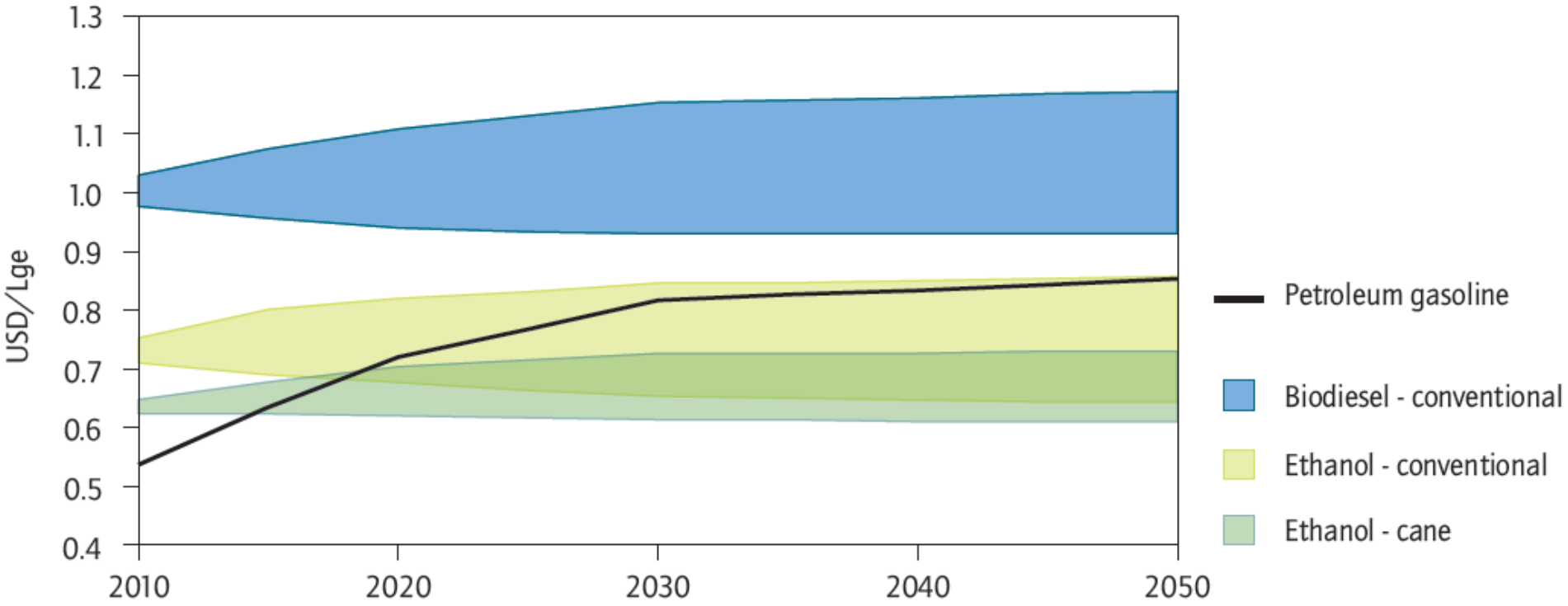
Note: This is gross land demand, excluding land-use reduction potential of co-products

Pressure on agricultural land can be limited and risk of ILUC can be mitigated:

- Productivity improvements
- Efficient use of co-products (biorefinery concept)
- Use of residues and wastes
- Use of pasture/ unused land
- Potential for wood biomass
- Biomass cascading
- Land-use zoning and sustainable land-use management schemes

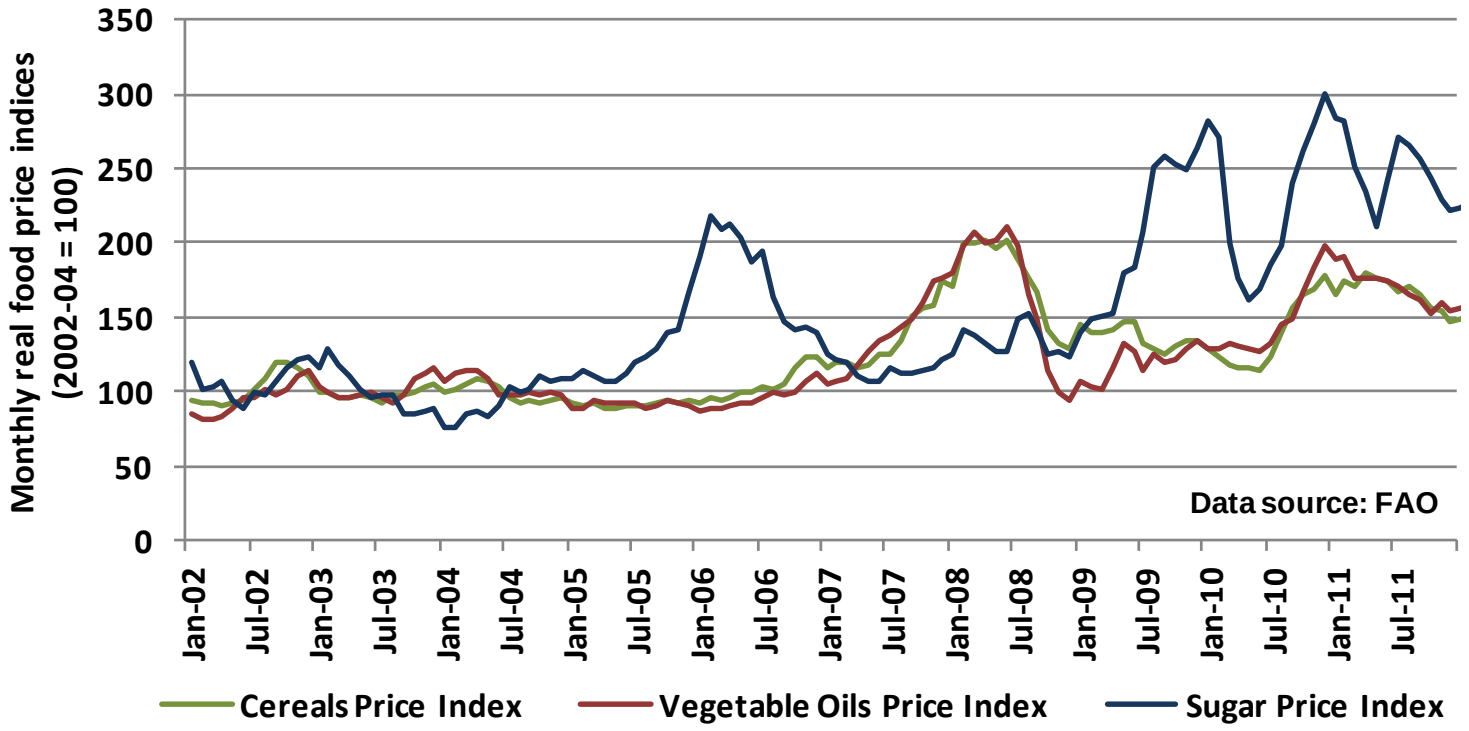
- Land required to produce biofuels increases from **30 Mha** today to **105 Mha** in 2050, in addition to **1 billion tons of residues**
  - Sustainable land expansion will be challenging given increasing demand for food and biomaterial
    → Land-use management is needed (for all agricultural. and forestry land)!

Conventional Biofuels – still some cost-reduction potential…



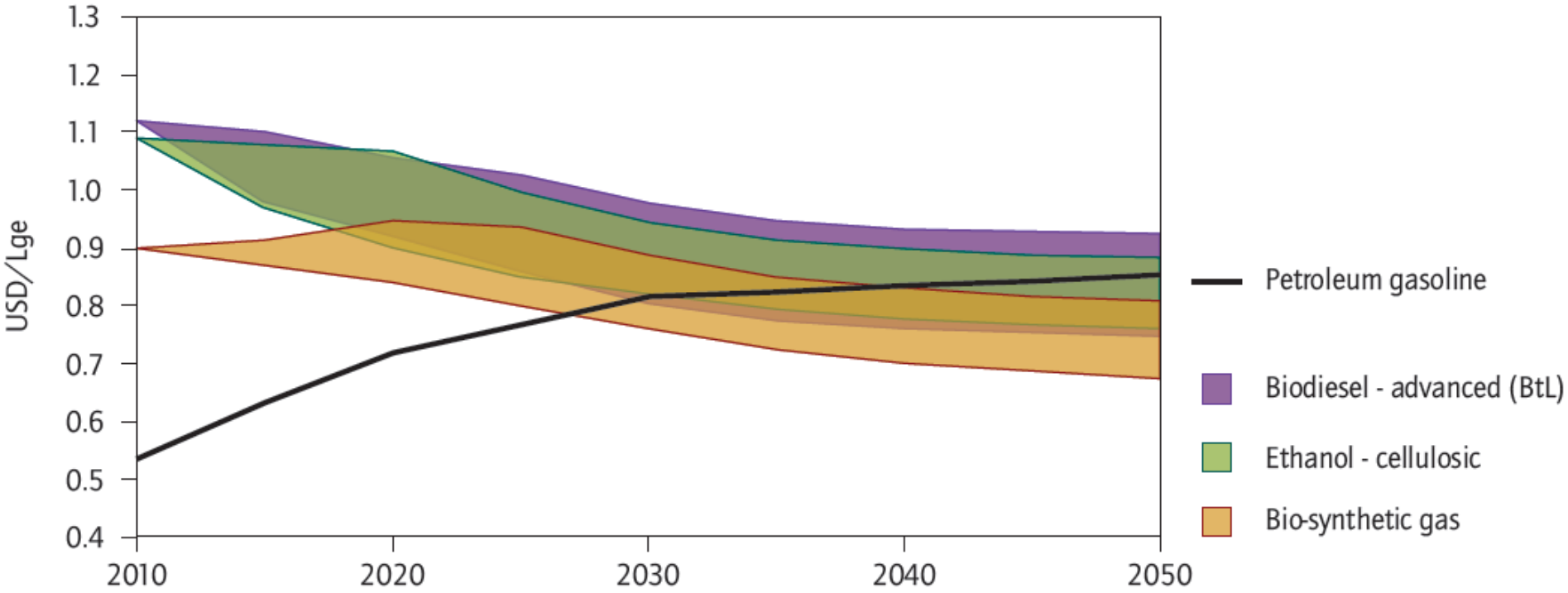
Production costs reflect global average

…but volatile feedstock prices remain a risk.



- Volatility of feedstocks for conventional biofuels continues to put pressure on producers'margins

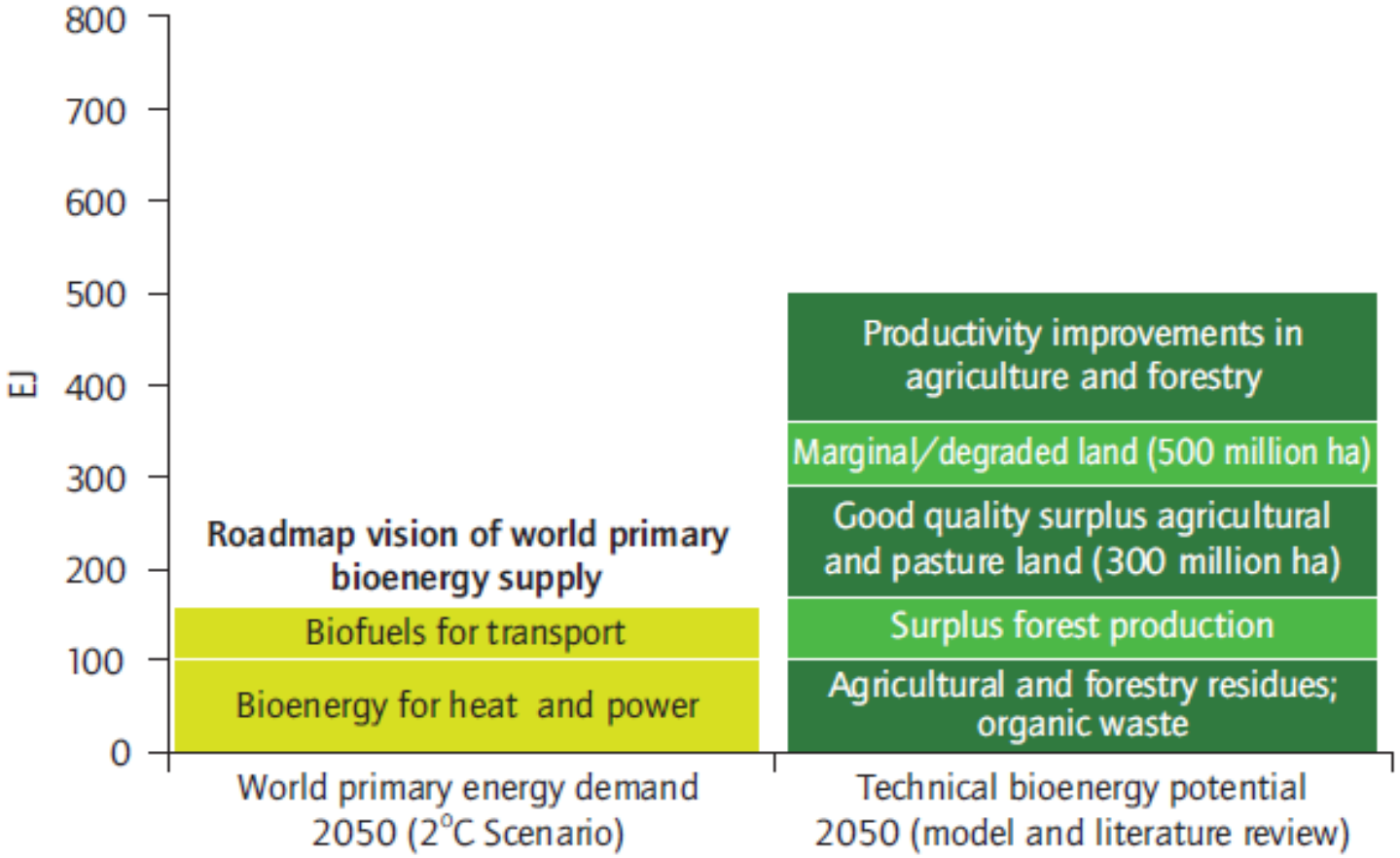
Advanced biofuels production costs set to decline



Production costs reflect global average

- Advanced biofuels could reach cost parity with fossil fuels around 2030

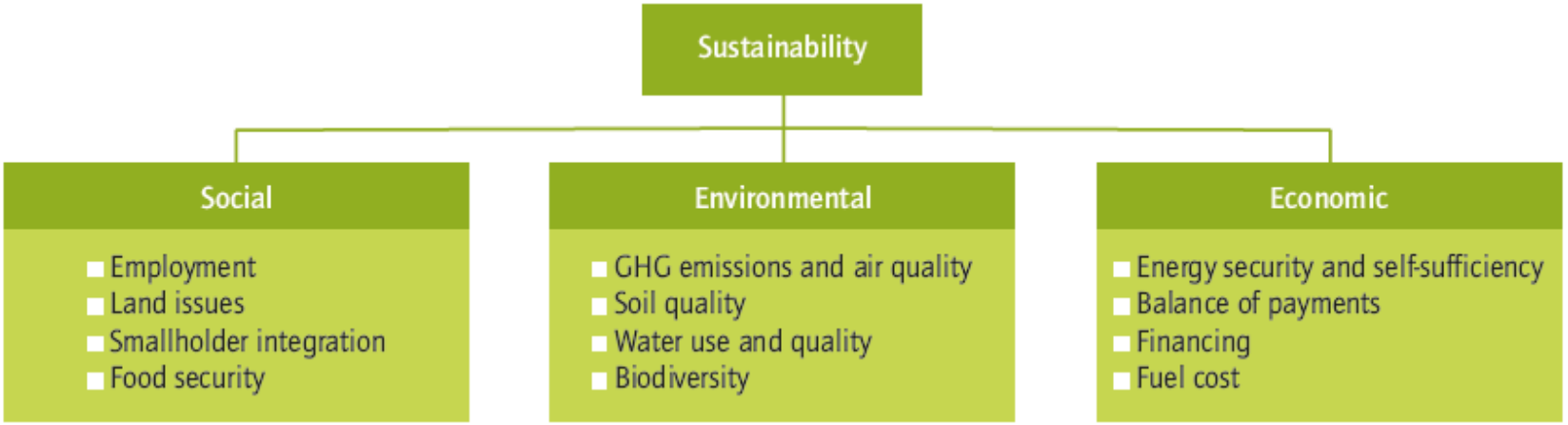
Biomass Supply Prospects – Uncertainties Remain



Source: Based on IPCC SRREN, 2011

- Total biomass demand for heat, power and biofuels reaches 8-11 billion tons in 2050
- Intermediate targets should be adopted to enhance international biomass trade, and assess costs and impact on sustainability

Sustainability of Biofuels



- Sound policies are needed to ensure biofuels are produced sustainably
- Adopt sound, internationally aligned sustainability certification for biofuels
  - Certification schemes should be based on international sustainability criteria (as developed *e.g.* by the Global Bioenergy Partnership, GBEP)
- However, most sustainability issues are relevant to the whole agricultural/ forestry sector
- In the long-term, all agricultural and forestry products should be certified, and an overall sustainable land-use management should be aimed for

Barriers and challenges

- Economic barriers
  - Production costs often not competitive with fossil fuels
    - → Feedstock price volatility is problematic
  - High capital costs
    - → Key challenge for advanced biofuels
  - High risk related to investments in “unproven” technology

- Non-economic barriers
  - Uncertainty about sustainability of biofuels
    - → can discourage investments
  - Infrastructure compatibility of certain fuels
  - Consumer acceptance
  - Trade barriers
  - Lack of capacities

- Economic incentives should be adjusted over time and aim at encouraging the full competitiveness of biofuels!

Best-Practice Policy Principles

Renewable Energy

- **Predictable** RE policy framework, integrated into overall energy strategy
- **Portfolio** of incentives based on technology and market maturity
- **Dynamic** policy approach based on monitoring of national and global market trends
- Tackle **non-economic** barriers
- Address **system integration** issues

Bioenergy and Biofuels

- Medium-term targets for bioenergy need to consider resource availability
- Different incentives for electricity, heat and transport fuels
- Challenging for biomass heat and power due to smaller cost reduction potential compared to other RE technologies
- Sustainability is key requirement (incl. for public acceptance)
- Dispatchable power can balance variable renewables
- Infrastructure compatibility of biofuels

Conclusions

Opportunities:

- **Bioenergy and biofuels have an increasingly important role to play**
  - can provide renewable energy in all sectors
  - can already be competitive with fossil fuels today
  - can provide dispatchable renewable power
  - have the potential to provide substantial emission-reductions

Challenges:

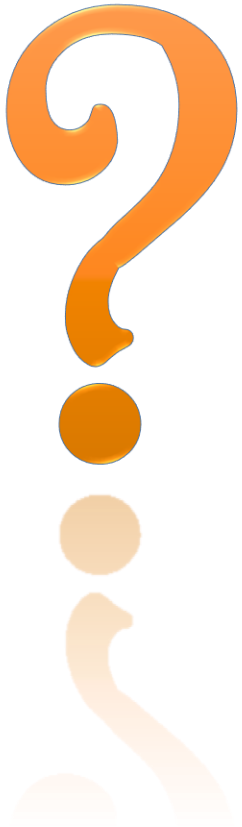
- **Appropriate supply chains supply need to be established**
- **Cost effectiveness depends on fuel costs and scale of operation**
- **Solid sustainability framework is needed to ensure overall positive impact of bioenergy and biofuels development**

Outline of Session 1

- Introduction
  - The IEA and the Technology Platform
  - *How2Guides*: concept and key elements
  - *How2Guides* vs *Technology Roadmaps*
- *How2Guide for Bioenergy*
  - Authors and scope
  - Content and methodology
- IEA-related work on Bioenergy
  - Technology Roadmaps
  - IEA Implementing Agreement
- FAO-related work on Bioenergy
  - FAO country support toolkit
  - Country work

INTERNATIONAL LOW-CARBON ENERGY TECHNOLOGY PLATFORM

Questions



Thank you for your participation!