Bioenergy and Energy Security

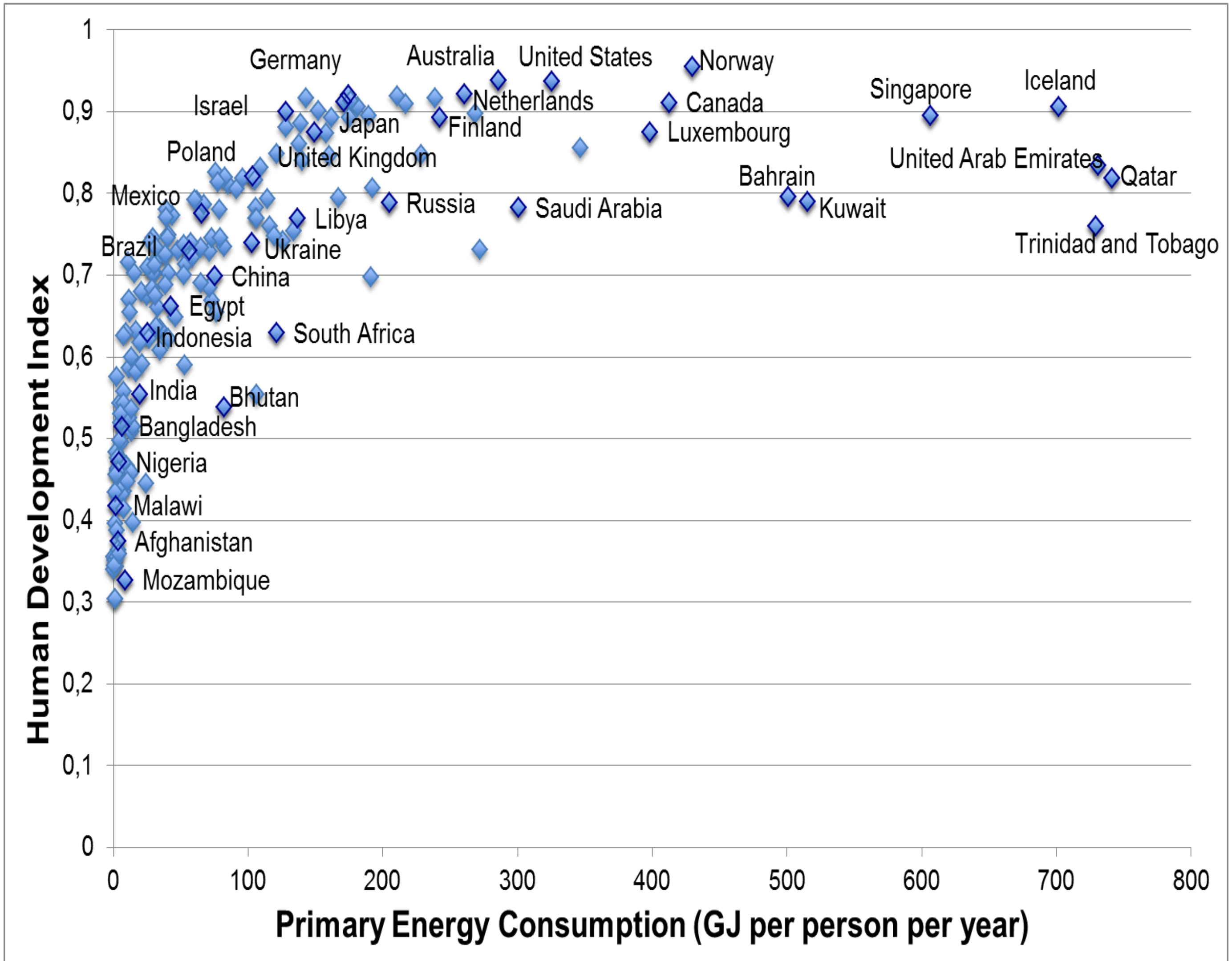
The role of bioenergy for a sustainable energy matrix, meeting societal needs in the face of climate change

Summary

- Energy security is seen today within a broader environment that includes food and water security, development, economic productivity, and multiple foreign policy aspects.
- What are the conditions under which bioenergy contributes positively to energy security?

→ ***Sustainable* bioenergy is expected to play an increasingly important role for climate change mitigation, energy access and other energy security aspects.**

Bioenergy provides (10-18%) of human energy use; it is expected to grow .Sustainable bioenergy can enable positive synergies, supporting energy access, economic growth and stability, and environmental goals.


Human Development Index
Primary Energy Consumption (GJ per person per year)
0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1
0
100
200
300
400
500
600
700
800
Germany
Australia
United States
Norway
Israel
Netherlands
Canada
Singapore
Iceland
Japan
Finland
Luxembourg
Poland
United Kingdom
United Arab Emirates
Qatar
Bahrain
Mexico
Russia
Saudi Arabia
Kuwait
Libya
Brazil
Ukraine
Trinidad and Tobago
China
Egypt
South Africa
Indonesia
India
Bhutan
Bangladesh
Nigeria
Malawi
Afghanistan
Mozambique

Understanding Energy Security and Bioenergy

- Energy security applies to nations (geopolitical security of energy supply), but also for their communities and households (accessible, reliable, sustainable, economically viable energy supply).
- Bioenergy provides a high percentage of the energy for many nations using < 100 GJ/person/year; climate stabilization requires that bioenergy provide ~ 25% of the energy for the nations with much higher per capita consumption (Ch 9).

Questions:

how can the biomass resources for *traditional bioenergy* improve productivity and environmental performance (Ch 6)?

how much can *sustainable, modern bioenergy* expand, to supply electricity and transportation fuels (Ch 9, 10, 12)?

Understanding ES and Bioenergy -2

Availability & markets issues

For energy security the immediate challenge is not global supply; it is local supply and equitable distribution. Cellulosic biofuels may have a large positive impact (Ch 12). Issues for the expansion of bioenergy:

Traditional biomass: needs more efficient use (technologies and policies), (Ch 10, 12).

Modern bioenergy:

Countries with large biomass resources: cost (paths & policies to compete with fossil based energy)

Countries with small biomass resources: global trade of biofuels

Understanding ES and Bioenergy -3

Bioenergy and access to energy

Developing and deploying the needed *infrastructure* to achieve energy security requires effective planning and policies, as well as stable governments.

In developing nations *public investment and sustained policies* are essential for bioenergy expansion; in market driven economies, large scale adoption depends on *cost.*

Usability and processing

Higher value bioenergy (fuels: high energy density, easy storage and transportation) needs more processing, but it is amenable for high value uses such as transportation and high efficiency conversion.

Understanding ES and Bioenergy -4

Bioenergy Technologies and Energy Security issues

Biomass is more equitably distributed than fossil fuels. It is *flexible* as end use is concerned (and increasingly so, with new technologies); and *it can be stored* to avoid the intermittency of solar, wind or hydro energy (Ch 12,11).

Advanced production / conversion technologies may substantially enhance bioenergy utilization (Ch 10,12)

There is a rapid growth in biomass/*biofuels* trade, but it seems that most biomass will be used close to its source.

Understanding ES and Bioenergy -5

Bioenergy Geopolitics and Energy Security

Climate change mitigation (a global problem) may lead to much larger bioenergy utilization.

Technology advances, from cellulose based fuels to advanced cooking stoves, increase the resource base globally and *alter the geopolitical landscape*, while increasing energy security. A major expansion of lignocellulosic biofuels may begin after 2020, worldwide (Ch 12).

As international trade expands, bioenergy may play a larger role in the geopolitical dialogue, including the complexities across multiple energy segments and the *interconnectivity with other geopolitical issues (food, water, trade, and conflict).*

Interconnectivity with key goals and policies

Access to modern energy services drives global *economic activity* and *social development*. Availability and affordability of energy determine how economies are structured as well as whether and how they grow.

Today's global energy economy was built with relatively inexpensive and abundant energy supplies (lower economic, environmental and security challenges); now energy security must consider a broader context (*resources, national priorities, food security, the ecosystem*) (Ch 20,21).

The geopolitical, economic and environmental dynamics of this increasingly challenging future can be reshaped and, in the process, ensure continued economic growth and sustainable development.

Interconnectivity with key goals and policies -2

In some developing regions the advanced use of biomass to energy production can *promote economic development* providing essential services, significantly increasing food safety and security, communications, and enabling education (Ch 12,14,15).

In high income economies the benefits can include reduced costs of energy, increased price stability, economic development and reduced GHG emissions. Negative aspects (which can be mitigated) *may* include competition for biomass (for food, feed, fiber); indirect land use effects; use of “new” land (biodiversity, soil carbon loss).

Interconnectivity with key goals and policies -3

Environment:

Climate change mitigation may lead to much larger bioenergy utilization. Evidence of reduced GHG emissions based on LCA (Ch 17) has been in some communities embodied in legislation (Ch 20). Mandates, subsidies and carbon taxes are used.

Improvements in water and fertilizer use, and productivity; and *synergies with food production* are important developments.

Mitigating local pollution requires technology for "traditional" bioenergy; and cleaner fuels.

Food security:

In developing economies: → economic development→ food security

Developed economies: ↑food commodities→ food security (Ch 4)

Legal framework must allow bioresources and other energy (and food) supplies to effectively contribute to local and national goals.

Conclusions: leading to Policies

Policy decisions are best informed when they consider bioenergy as a valuable option for Energy Security.

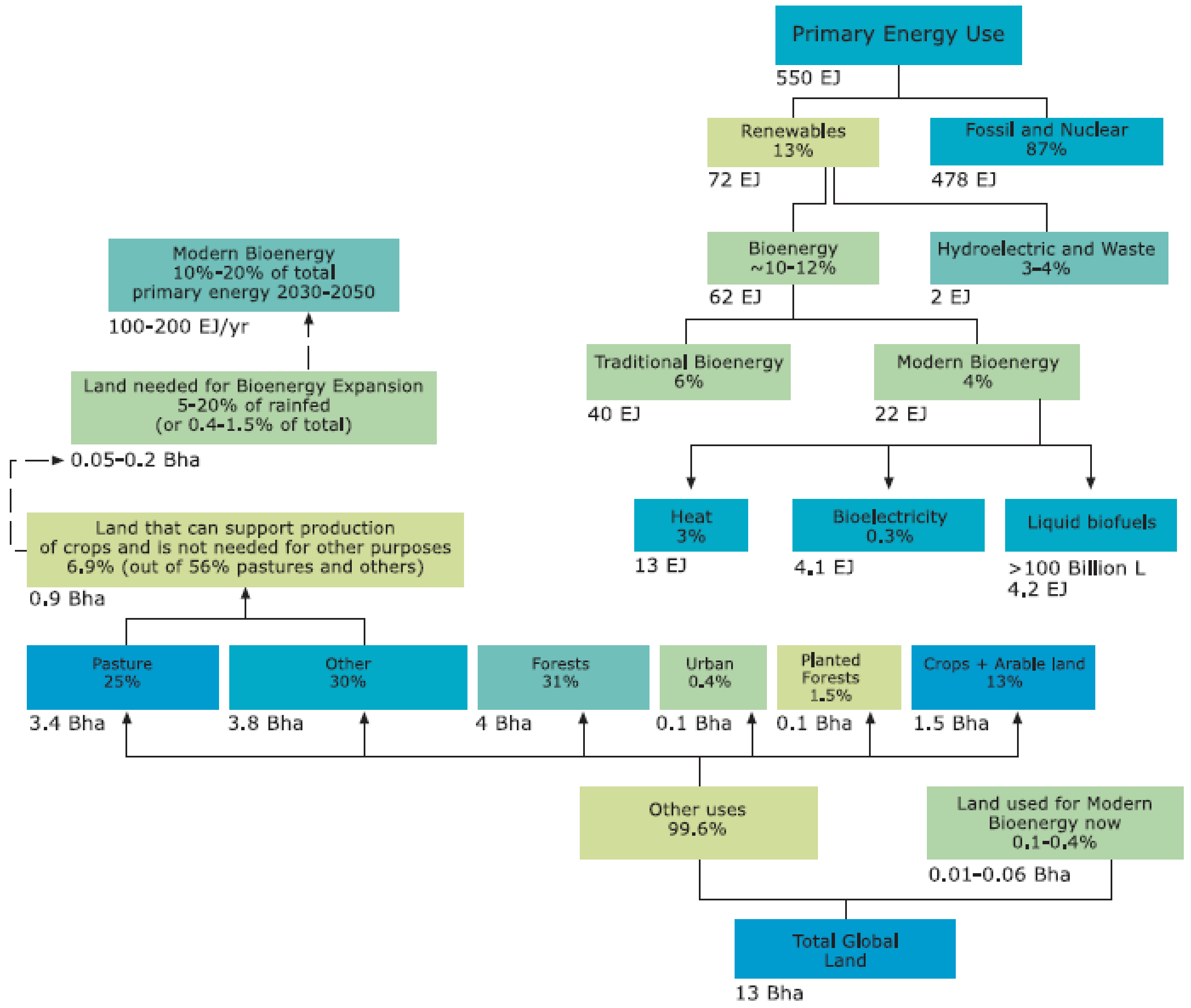
Modern, efficient bioenergy technologies (Ch 12,10) can contribute to energy security, and help improve the management of other key issues (social, economic, environmental). *They may present positive synergies to address multiple policy priorities, like energy access (health, education) economic development (jobs), and environmental stewardship.* Bioenergy systems offer economic resiliency within an uncertain policy environment. *National and local level issues/resource availability must always be considered.*

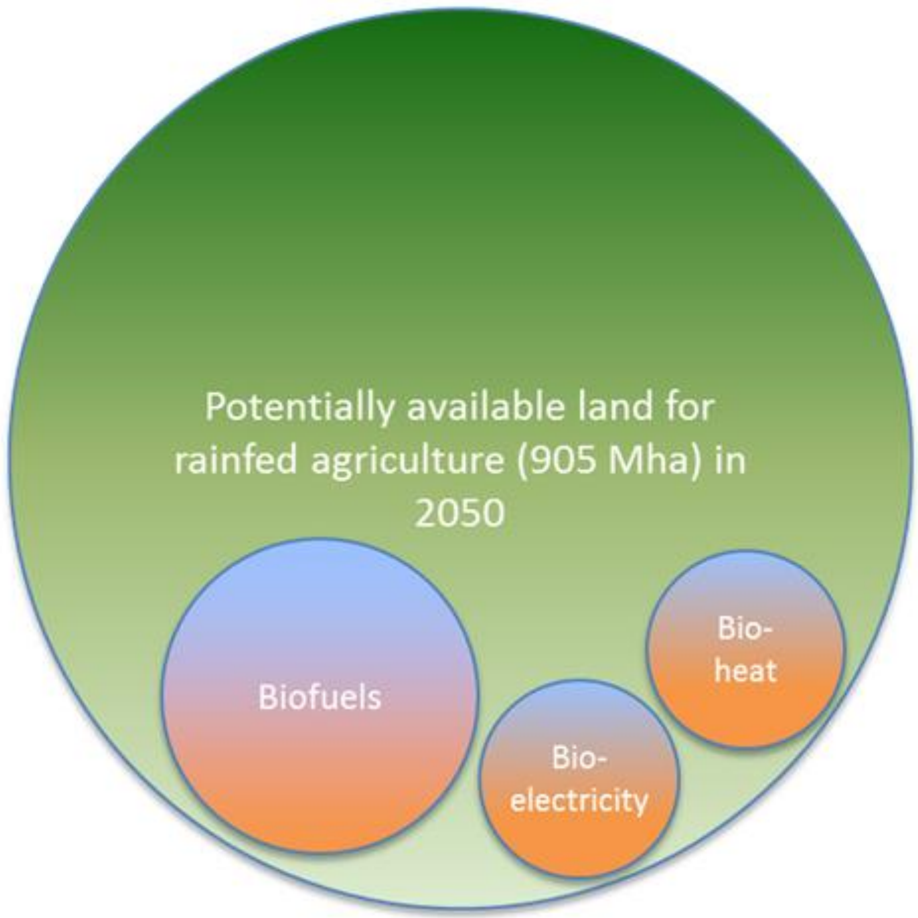
Today's policy environment may present policy interactions that inhibit economic attractiveness of bioenergy. A level playing field of fiscal policies, *including subsidies and externalities*, is important to creating a long-term investment environment for sustainable bioenergy, in the transition to sustainable energy systems.

Economically efficient markets can contribute to energy security through commoditization of trade for bioenergy products (national, regional policies).

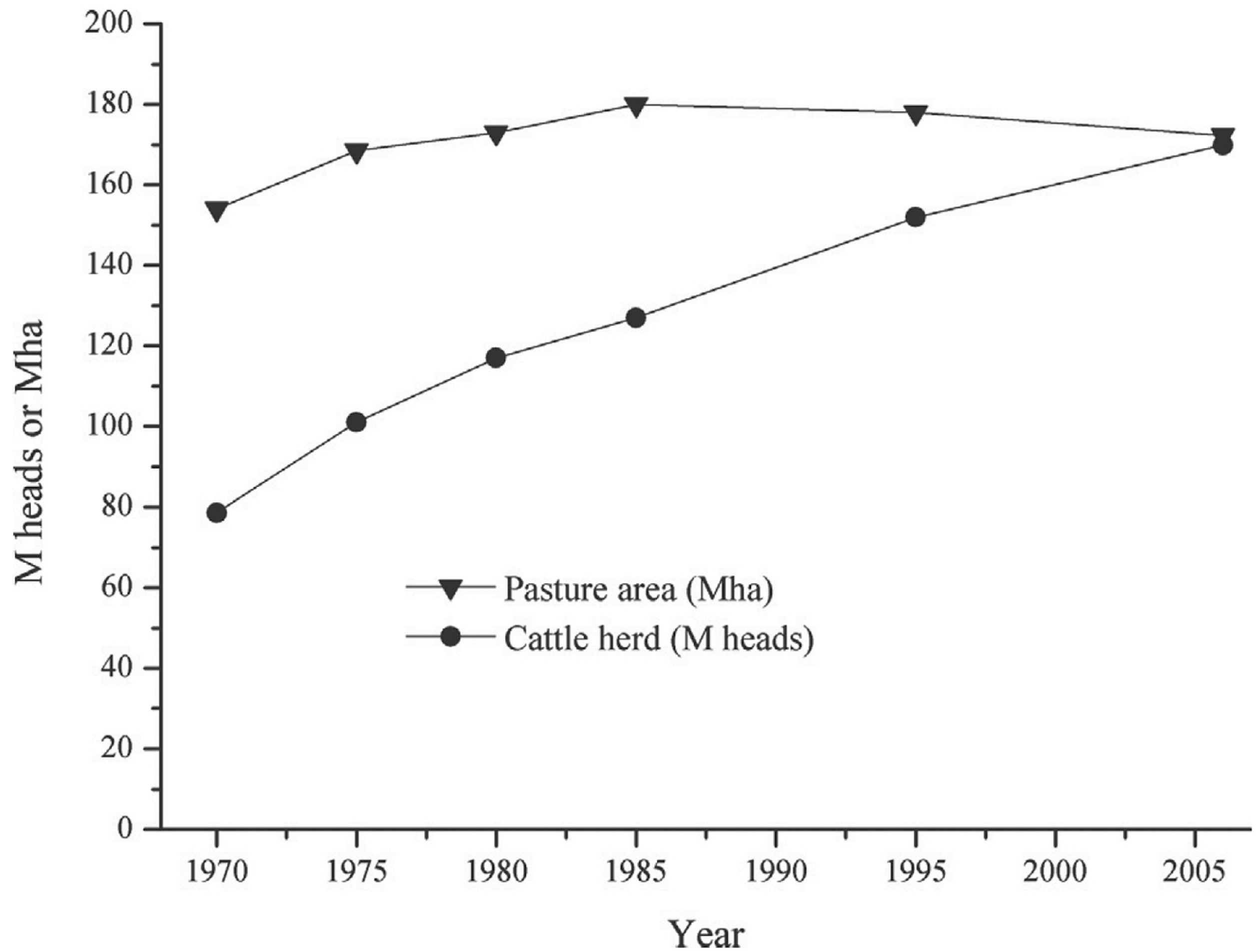
iLUC GHG evaluations, biofuels, 2008 →2015 (gCO_2e / MJ)

	Corn (Eth)	Sugar cane (Eth)	Sugar beet (Eth)	Palm (BD)	Rape (BD)	Soy (BD)	Model
Searchinger et al., 2008	104.0	111.0	n.a.	n.a.	n.a.	n.a.	FAPRI
EPA, 2010	26.3	4.1	n.a.	n.a.	n.a.	43.0	FAPRI
CARB, 2009	30.0	46.0	n.a.	n.a.	n.a.	62.0	GTAP
Hertel et al., 2010	27.0	n.a.	n.a.	n.a.	n.a.	n.a.	GTAP
Tyner et al., 2010	15.2-19.7	n.a.	n.a.	n.a.	n.a.	n.a.	GTAP
Al-Riffai et al., 2010	n.a.	17.8-18.9	16.1-65.5	44.6-50.1	50.6-53.7	67.0-75.4	MIRAGE
Laborde, 2011	10,0	13.0-17.0	4.0-7.0	54.0-55.0	54.0-55.0	56.0-57.0	MIRAGE
Marelli et al., 2011	13.9-14.4	7.7-20.3	3.7-6.5	36.4-50.6	51.6-56.6	51.5-55.7	MIRAGE + JRC
Bauen et al., 2010	n.a.	8.0-27.0	n.a.	8.0-80.0	15.0-35.0	9.0-67.0	Causal-descriptive
Moreira et al., 2012	n.a.	7.6	n.a.	n.a.	n.a.	n.a.	Causal-descriptive
GREET1_2013	9.2	n.a.	n.a.	n.a.	n.a.	n.a.	GREET
CARB, 2014	23.2	26.5	n.a.	n.a.	n.a.	30.2	GTAP
Elliott et al. 2014	5.9	n.a.	n.a.	n.a.	n.a.	n.a.	PEEL
Laborde, 2014	13,0	16,0	7,0	63,0	56,0	72,0	MIRAGE + JRC
Harfuch et al., 2014	n.a.	13.9	n.a.	n.a.	n.a.	n.a.	BLUM
CARB, 2015 (proposed)	19.8	11.8	n.a.	71.4	14.5	29.1	GTAP


Primary Energy Use
550 EJ
Renewables
13%
72 EJ
Fossil and Nuclear
87%
478 EJ
Bioenergy
~10-12%
62 EJ
Hydroelectric and Waste
3-4%
2 EJ
Traditional Bioenergy
6%
40 EJ
Modern Bioenergy
4%
22 EJ
Heat
3%
13 EJ
Bioelectricity
0.3%
4.1 EJ
Liquid biofuels
>100 Billion L
4.2 EJ
Modern Bioenergy
10%-20% of total
primary energy 2030-2050
100-200 EJ/yr
Land needed for Bioenergy Expansion
5-20% of rainfed
(or 0.4-1.5% of total)
0.05-0.2 Bha
Land that can support production
of crops and is not needed for other purposes
6.9% (out of 56% pastures and others)
0.9 Bha
Pasture
25%
3.4 Bha
Other
30%
3.8 Bha
Forests
31%
4 Bha
Urban
0.4%
0.1 Bha
Planted
Forests
1.5%
0.1 Bha
Crops + Arable land
13%
1.5 Bha
Other uses
99.6%
Land used for Modern
Bioenergy now
0.1-0.4%
0.01-0.06 Bha
Total Global
Land
13 Bha



Land occupied by bioenergy crops under a scenario where bioenergy (modern and traditional) delivers 200 EJ/yr in 2050 (22%)
Potential available, from rainfed suitable land: (Alexandratos & Bruinsma, 2012)



Pasture area and cattle herd in Brazil (IBGE 2007)

Numerous Initiatives for Multilateral Action Seek multiple contexts for bioenergy implementation with multiple positive sustainability outcomes

A Unique Partnership:

United Nations

THE WORLD BANK

UNITED NATIONS DECADE OF SUSTAINABLE ENERGY FOR ALL 2014-2024

Sustainable Bioenergy High-Impact Opportunity

UNEP United Nations Environment Programme environment for development

International Resource Panel

UNITED NATIONS SYSTEM-WIDE EARTHWATCH

FAPESP SÃO PAULO RESEARCH FOUNDATION

SCOPE

SCIENTIFIC COMMITTEE ON PROBLEMS OF THE ENVIRONMENT of the INTERNATIONAL COUNCIL FOR SCIENCE (ICSU-SCOPE)

Integrated Scientific Assessments

IRENA International Renewable Energy Agency

OECD BETTER POLICIES FOR BETTER LIVES

Sustainability frameworks

Food and Agriculture Organization of the United Nations

GBEP Global Bioenergy Partnership

Voluntary Sustainability Standards

International Energy Agency iea

Working together to ensure reliable, affordable and clean energy

IEA International Low-Carbon Energy Technology Platform: **Bioenergy how2guide**

Integrative:
- Feedstocks for energy markets
- Sustainable international bioenergy trade
- Climate change effects
- Commercializing liquid biofuels
- Integrated biorefineries

IEA Bioenergy

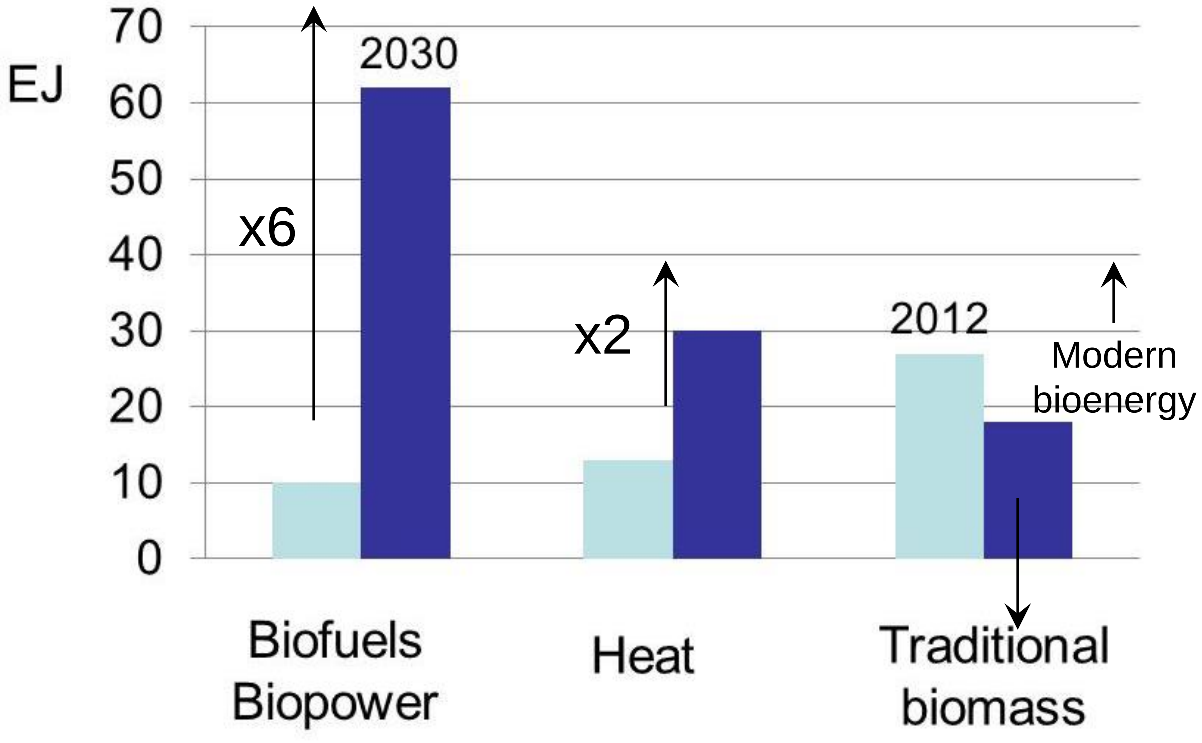
Technical: Combustion, gasification, pyrolysis, waste management, biogas

Large Scale ⟵ Bioenergy ⟶ Small Scale

Aggressive Goals for Global Bioenergy Expansion

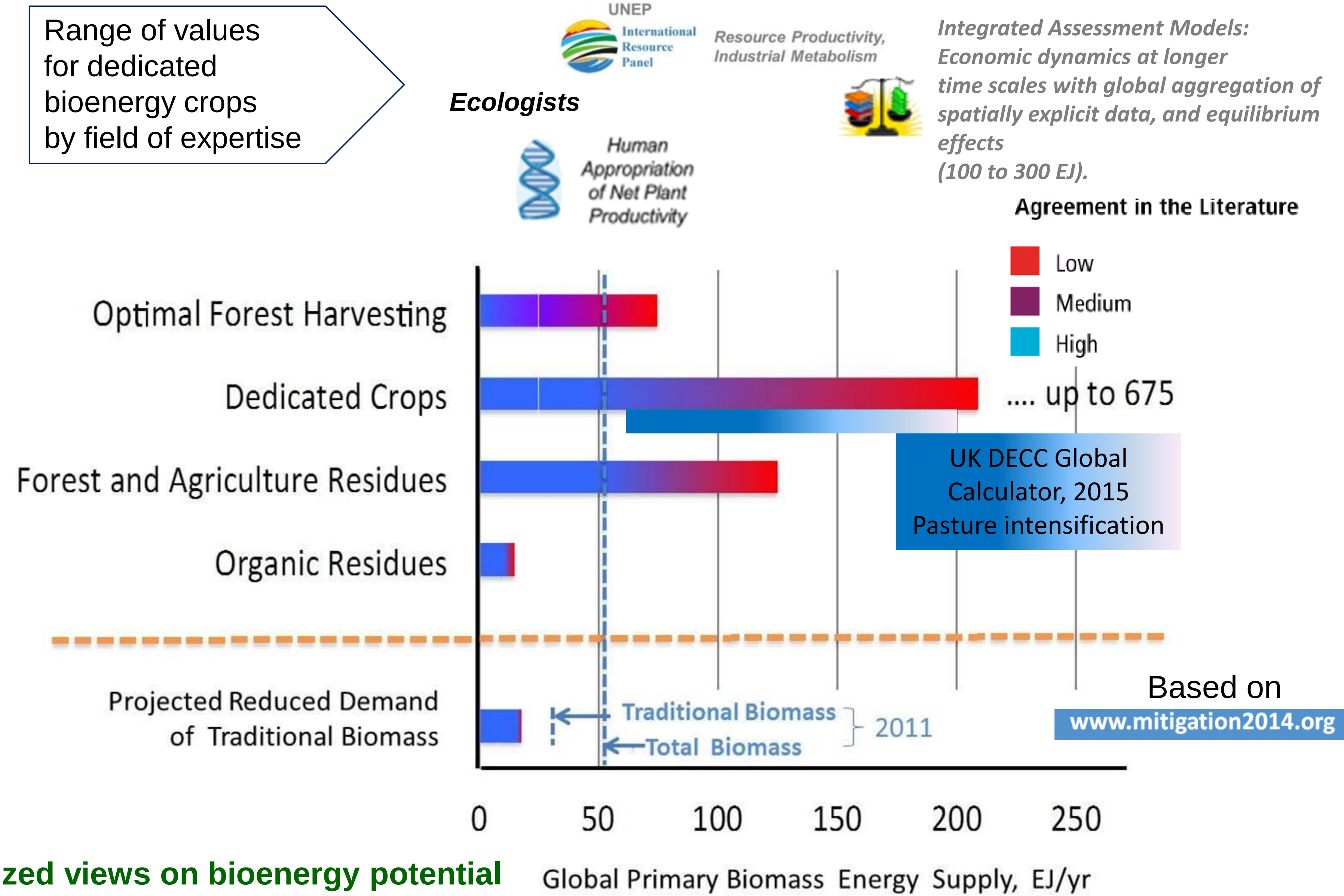
United Nations Decade of Sustainable Energy for All: 2014-2024

"Double the share of renewable energy, double efficiency improvement rate, and give universal access to modern energy by 2030." **SE4ALL:** Sustainable Energy for All: http://www.se4all.org.



IRENA (2014), REmap 2030: A Renewable Energy Roadmap, Summary of Findings, June 2014. IRENA, Abu Dhabi. www.irena.org/remap

Expanding Sustainable Bioenergy in conjunction with agriculture, forestry, good governance, reducing environmental and ecological impacts



Polarized views on bioenergy potential

Based on evolving methodologies that need field data for validation and verification in specific landscapes and watersheds