

IEA Bioenergy

WEBINAR SERIES



Mobilizing Sustainable Bioenergy Supply Chains

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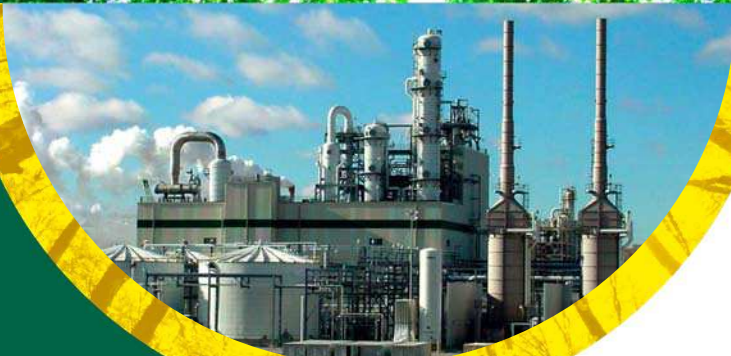
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IEA Bioenergy

Mobilizing Sustainable Bioenergy Supply Chains

Strategic Inter-Task study, commissioned by IEA Bioenergy

Carried out with cooperation among
IEA Bioenergy Tasks 37, 38, 39, 40, 42, and 43



Tat Smith

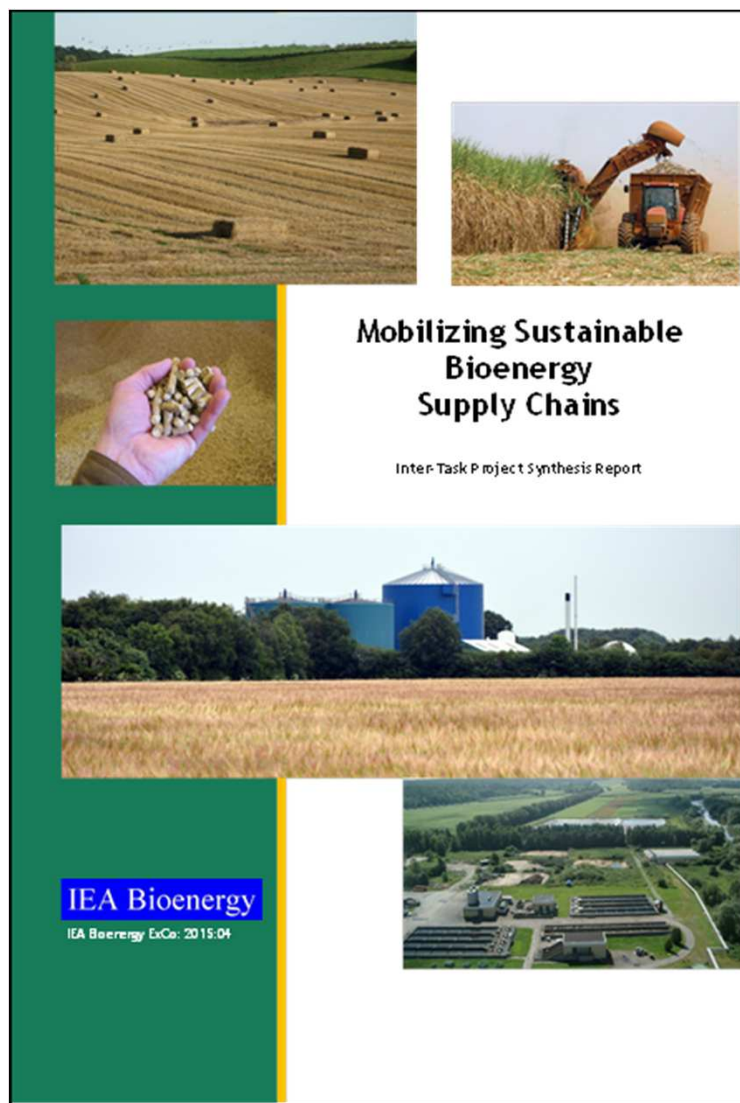
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IEA Bioenergy Task 43 – Biomass Feedstocks for Energy Markets



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Webinar based on:

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Project leadership – on behalf of over 70 contributors

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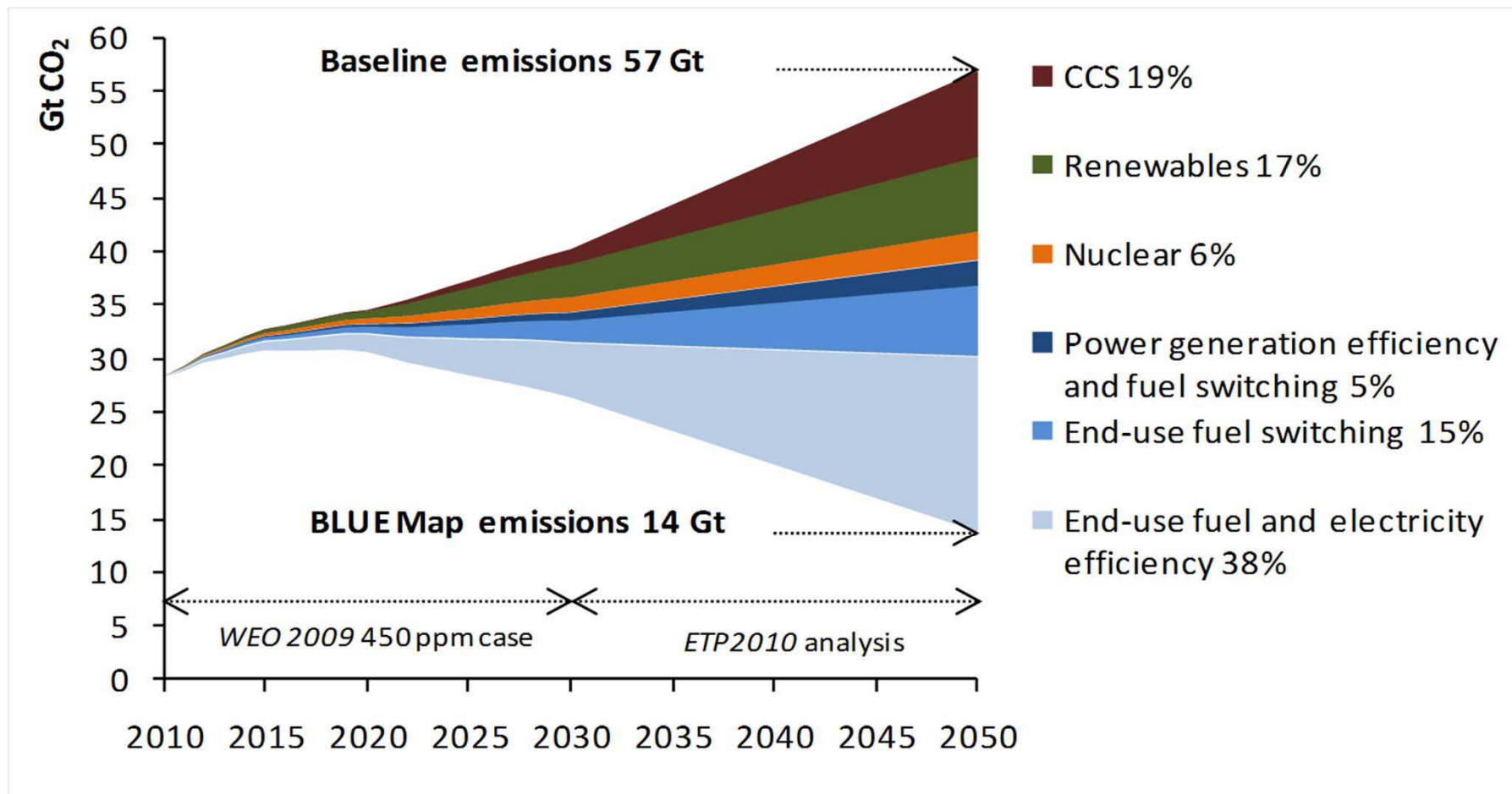
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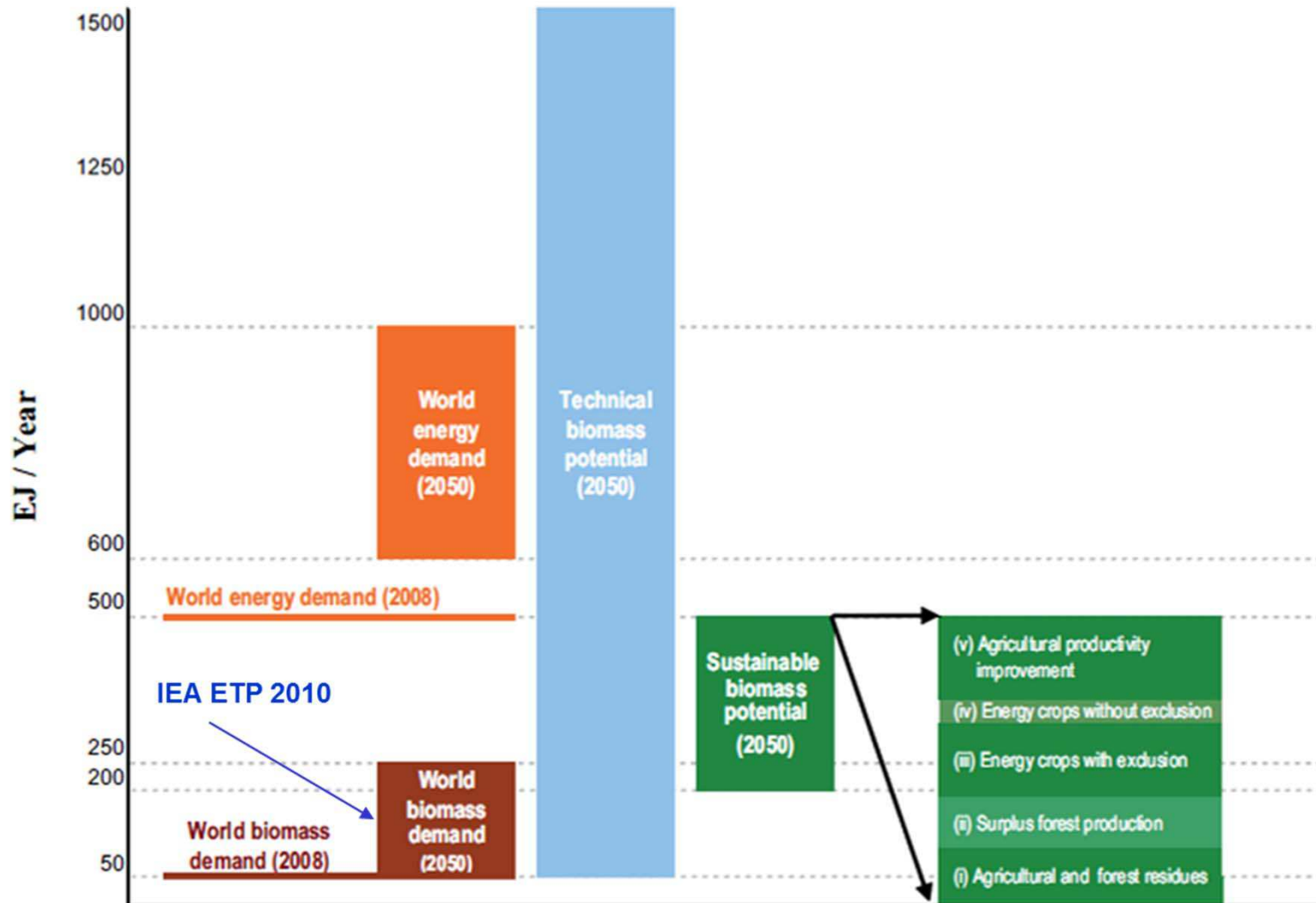
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Significant opportunities exist to reduce greenhouse gas emissions, increase domestic energy security, boost rural economies and improve local environmental conditions through the deployment of sustainable bioenergy and bio-based product supply chains



But there is huge uncertainty about how large a sustainable contribution bioenergy can make.



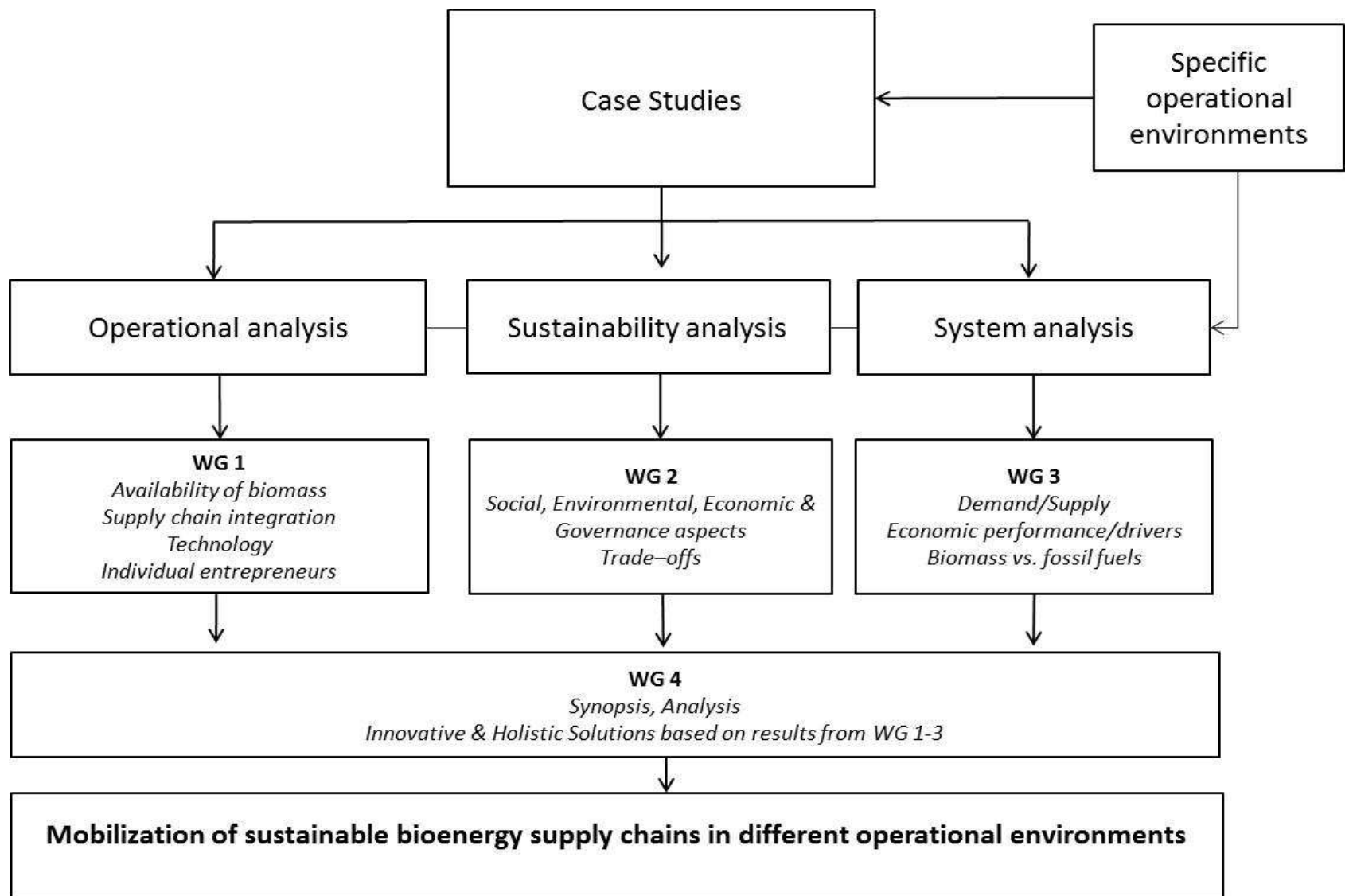
GLOBAL BIOENERGY PERSPECTIVES

- **Current bioenergy**
 - ‘Modern’ bioenergy: **10-15 EJ/year**
 - Total global bioenergy (2008): **50 EJ/year**
- **Deployment level suggested by IPCC scenarios by 2050**
 - 440-600 ppm CO₂^{eq} target: **80-150 EJ/ year**
 - <440 ppm CO₂^{eq} target: **118-190 EJ/ year**
- **Current production of forest and agricultural biomass**
 - Industrial roundwood: around **15 EJ/ year**
 - Major agricultural crops: about **60 EJ/ year**.

Is a 10-fold increase likely, desirable, sustainable?

The overall objective of this ‘mobilization’ project is to enhance the mobilization of sustainable bioenergy supply chains.

- Identify the necessary elements of a successful and sustainable bioenergy supply chain.
- Develop new and existing frameworks that seek to understand and explain the underpinning elements that contribute to sustainable supply chains.
 - Include elements of availability of feedstock, applicable conversion processes, GHG balances, land use issues, governance mechanisms and other aspects of bioenergy production and supply.
- Stimulate integration across complex systems which leads to transfer of knowledge to new and upcoming bioenergy technologies or feedstocks in different regions of the world.
- Inform the debate, improve governance, and contribute to mobilization of sustainable supply chains globally.



Overview of the structure of the inter-Task 'mobilizing' project.

Five supply chains have been evaluated from both the 'bottom up' and 'top down'

- **Boreal & temperate forests**
- **Agricultural crop residues for bioenergy and bio-refineries**
- **Regional biogas from MSW, oil palm residues and co-digestion**
- **Integration of lignocellulosic crops into agricultural landscapes**
- **Cultivating pastures and grasslands: the sugar cane ethanol case**



Boreal & temperate forests

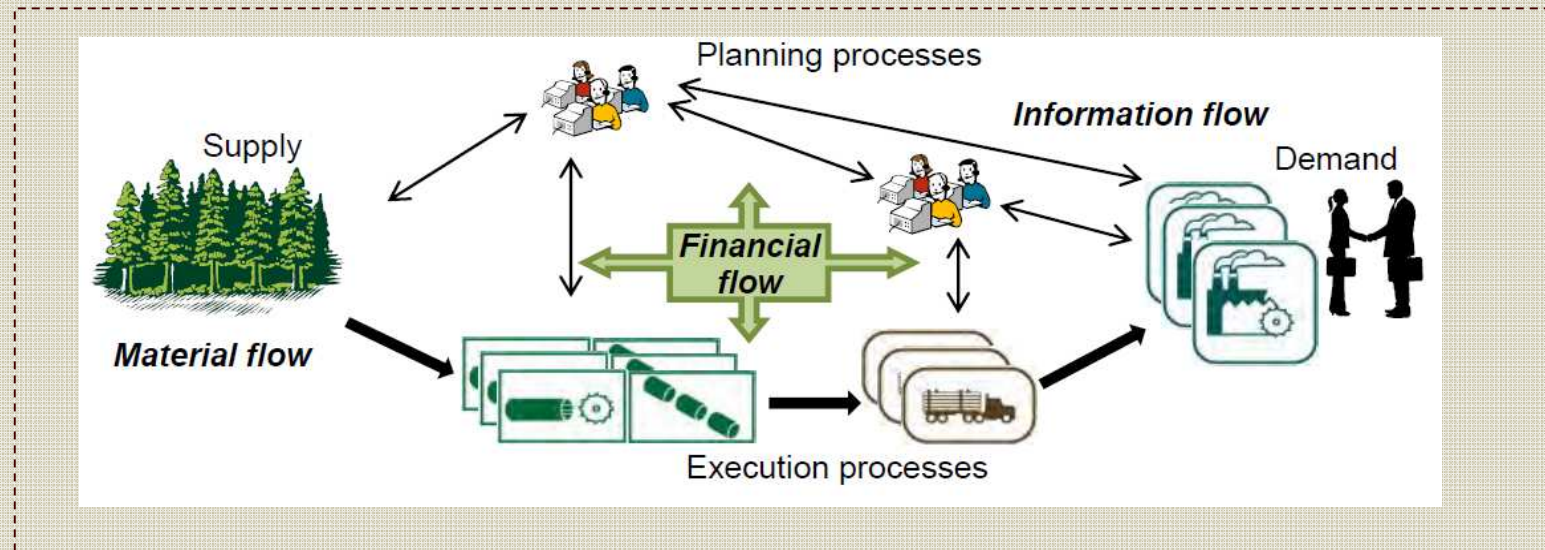


Coordinator: Evelyne Thiffault, Laval University, Canada

With contributions from: Antti Asikainen, Johanna Routa, Tanja Ikonen, Mark Brown, David Coote, Ger Devlin, Gustaf Egnell, Martin Junginger, Thuy Mai-Moulin, Patrick Lamers, David Paré, Jack Saddler, William Cadham, Susanna Van Dyk, Linoj Kumar, Bill White.

What are the major roadblocks and opportunities for mobilizing forest biomass supply chains in the boreal and temperate biomes?

Policy environment

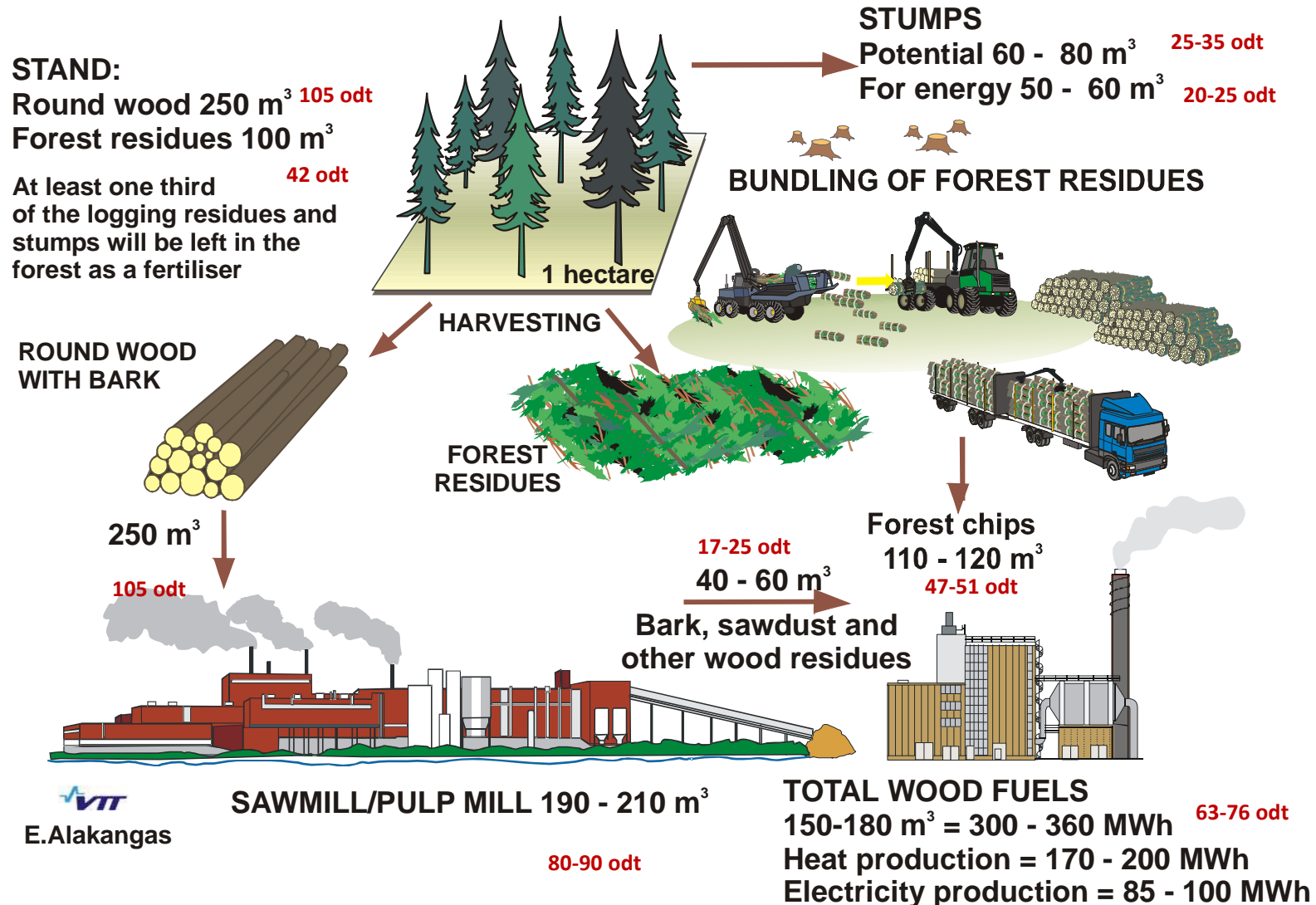


- Policy
- Supply
- Logistics and economics
- Conversion technologies
- Socio-economics
- Ecological sustainability
- Trade

Social, economic and environmental footprint

Current predominant forestry production system:

high value sawlogs and pulp and paper dominate operations



RECOMMENDATIONS FOR MOBILIZATION OF SUSTAINABLE FOREST BIOENERGY

- The **most important driver** to increase use of forest biomass for bioenergy is **policy-supported price** for feedstocks and energy products.
- There are significant opportunities for further mobilization through **enhanced technological and institutional learning**.
- **Trade offers opportunities/incentives** for biomass mobilization.
- One **social innovation** is the expansion of markets **through cooperative organization structures**, such as: forest biomass supply cooperatives; forest biomass energy firms; and forest biomass trade centers.
- **Integration of energy and forest systems** is essential to realise regional to global mobilization potentials.
- Achieving many of the opportunities listed above will require a **culture change in society and certainly in the forest and energy sectors**.
 - o Development of a shared vision, and recognition and acceptance of different views.
 - o Development of common sustainability criteria from local to global scales.
 - o Development of technical standards for bioenergy products to help remove trade barriers, increase market transparency and increase public acceptance.

Challenges for mobilizing significantly greater forest bioenergy

Substantial gains in mobilization (e.g. from ~4 to 14-28 EJ/year) can only be achieved with an increase in forest management intensity

- Increased roundwood-to- NPP* ratio, and
- Increased bioenergy-to-roundwood ratio

Sustainability issues will arise with intensification of forest management, therefore

- strong governance schemes and globally accepted sustainability criteria are essential.

A fundamental shift in the forest and energy systems of many countries is required.

- E.g. in Canada, reaching a Roundwood-to-NPP ratio of 10% required tripling the AAC*
 - requires drastic increase in management intensity
 - opening of 'unmanaged' forest areas
 - development of a shared vision
 - a considerable societal change for Canada.

* NPP = net primary productivity; AAC = 'annual allowable cut' as used in forest management

Agricultural crop residues for bioenergy and bio-refineries



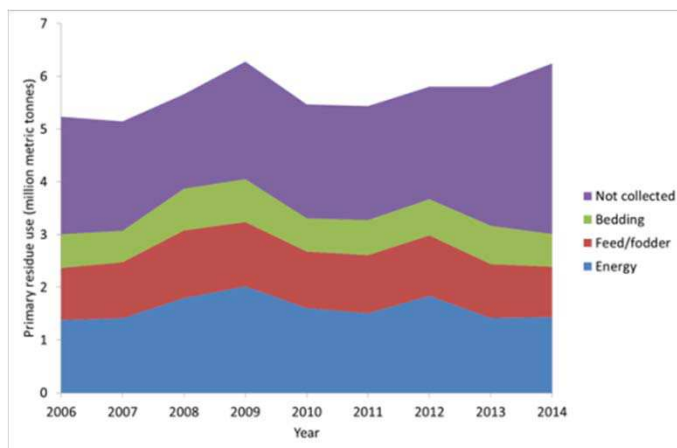
Coordinator: Niclas Scott Bentsen,
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With contributions from:
Patrick Lamers, Charles Lalonde, Inge
Stupak, Ian Bonner, Patrick Girouard, Jacob
Jacobson, Maria Wellisch, Jianbang Gan



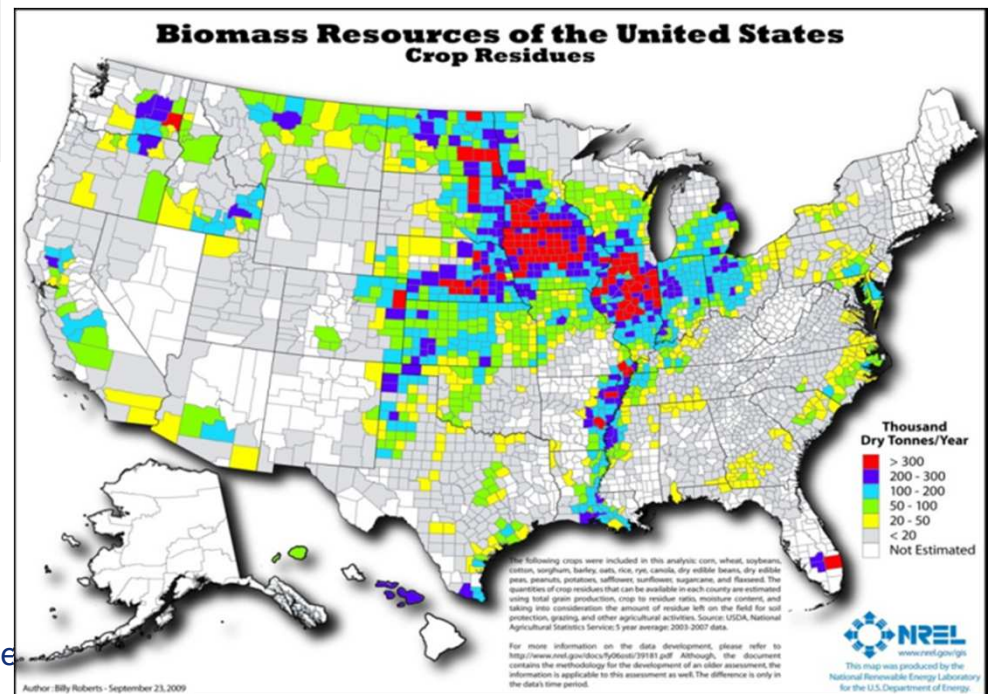
Case studies conducted in Denmark, the US and Canada show that there is a real potential for further development of viable bioenergy and biorefining supply chains based on agricultural crop residues, if there is:

- political support
- best practices are followed for residue removal, and
- there is continued supply chain development and optimisation.



Annual production and use of primary crop residues from Danish agriculture (Statistics Denmark 2015).

Crop residue potential in the continental United States (NREL 2007).
Bioenergy atlas
(<http://maps.nrel.gov/bioenergyatlas>).



Recommendations for mobilization include:

- **Establish a consistent and stable policy framework** that supports bioenergy and products made from renewable biomass and wastes.
- **Increase awareness of key stakeholders** about the availability of credible, transparent knowledge on processes, costs and sustainability aspects (e.g., for farmers, energy producers and other stakeholders along the supply chain) using a variety of social media and educational and extension programs.
- **Develop long-term contracts** to increase stakeholder confidence.
- **Provide incentives** for farmer groups, biomass aggregators and bio-processors **to bear the initial investment risk**.
- **Develop and distribute tools** to underpin the confidence of processors about consistent biomass supply, including quality and storage issues.
- **Develop Best Management Practices for soil health** for a variety of soil types and operating conditions that ensure residue removal is not detrimental in the long term.
- Develop and agree widely upon **credible sustainability guidelines**.

What amount of ag crop residues can be mobilized at global scales?

IRENA estimates that 13-30 EJ/year of agricultural residues must be used by 2030 to meet the Sustainable Energy for All (SE4All) target of doubling the share of renewable energy in the global energy mix before 2030 (Nakada et al. 2014).

The IPCC special report on renewable energy (Chum et al. 2011) reported a technical potential of agricultural residues by 2050 of 15-70 EJ/year.

However:

- agricultural crop residues are not as good a fuel as forest woody biomass for bioenergy to generate heat and power.
- These feedstocks are not grown in as high a density as forest biomass, meaning cost of crop residues can be high.

The analysis reported in this study indicates that IRENA and other projections may be possible to achieve with concerted effort at societal levels.

Biogas from Municipal Solid Waste (MSW), oil palm residues and co-digestion



Coordinator: Hans Langeveld, Biomass Research, Wageningen, The Netherlands
With contributions from: Heinz Stichnothe and Ruben Guisson

How much waste and residues are available globally?

Current global MSW production:

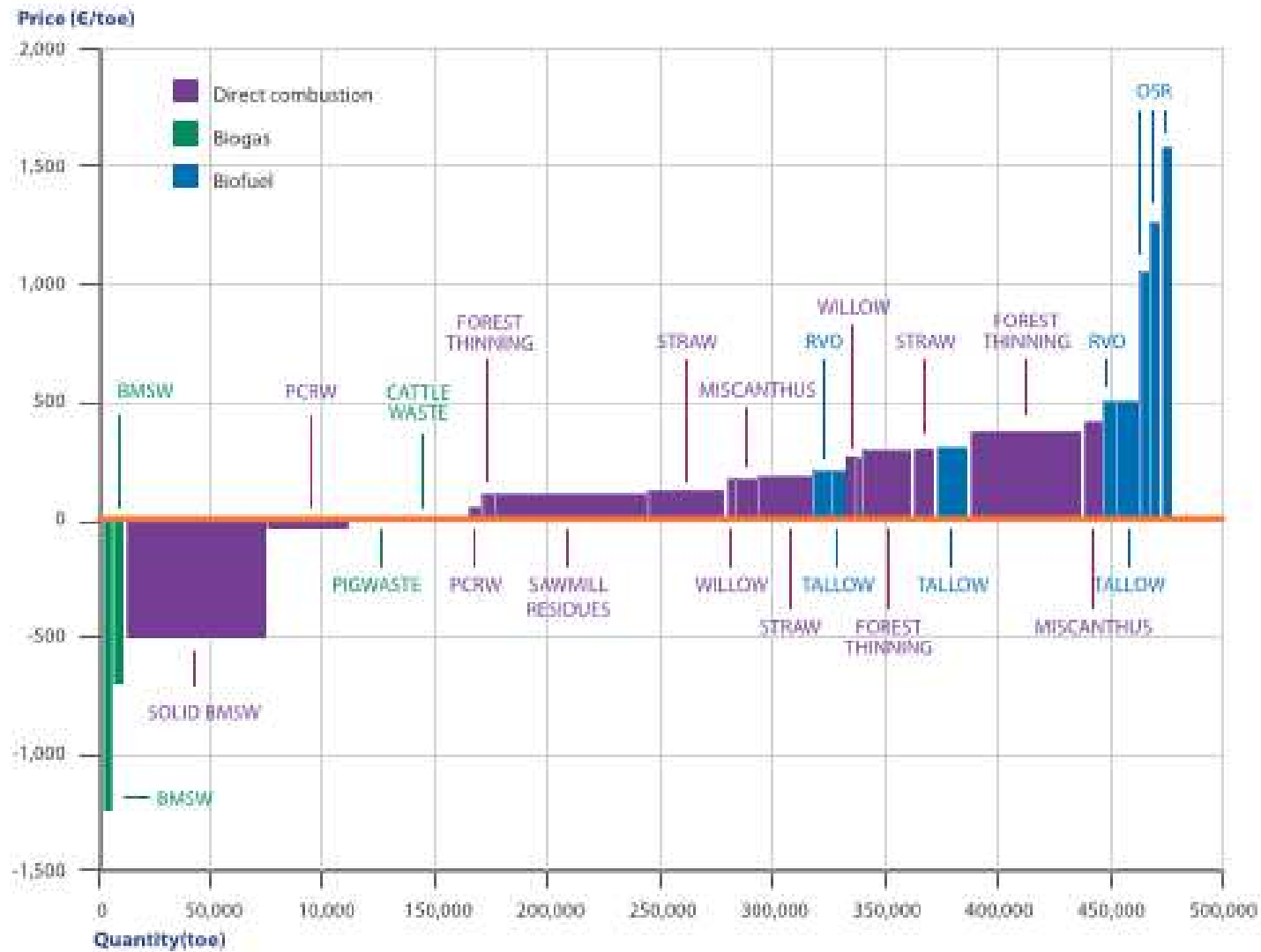
- 1.3 billion tonnes per year, is expected to increase to 2.2 billion tonnes by 2025 (World Bank 2012);
- about 560 million tonnes is of organic origin; the biogas potential is 48 million Nm³ or 1.0 EJ.
- By 2025, 6 billion tonnes of urban waste will contain 1 billion tonnes organic waste with a biogas potential of 86 million Nm³ (equivalent to 1.8 EJ).

Agricultural residues and wastes constitute feedstocks suitable for biogas production. Estimates include:

- all crop related waste (excl. manure and MSW) amounts to 2.2 billion wet tonnes today and 2.8 billion wet tonnes by 2020;
- manure amounts to 16 billion wet tonnes today and 18.8 billion wet tonnes by 2020; and
- straw amounts to 0.8 billion wet tonnes today and 0.9 billion wet tonnes by 2020 (E4Tech 2014).

A conservative estimate suggests biogas production in 2020 could generate some 5.3 EJ.

Cost-competitiveness of biogas is favorable compared to fossil fuels



Policy recommendations essential for biogas mobilization potentials to be achieved.

- **Policy inefficiencies, inconsistencies, and intrinsic barriers** need to be removed at local, regional, and national levels.
- **Consistent policy support** including sufficient economic incentives for investments in biogas installations & infrastructure for marketing and utilizing biogas, upgraded gas, and locally-generated electricity.
- Policies must **create a level playing field** with fossil fuels.
- **Improve the public image** of biogas production.
- **Improve business case** for digester performance.
 - Relatively low energy content per unit of feedstock, high initial investment costs, and considerable logistical complexity and cost.
 - Develop efficient logistical systems, investment in infrastructure, and RD&D to develop advanced hardware and management systems.
- **Develop biogas supply and value chains** (including access to the grid of many small biogas producers, biogas storage systems) **that are integrated with existing residue management systems** (e.g., collection of municipal waste, food waste) to improve the competitiveness of biogas production.
- **Reliable, long-term financial support** (e.g. feed-in tariffs) is especially essential for biogas production based on energy crops; since these crops are produced on agricultural land, production costs can be considerable.

Integration of lignocellulosic crops into agricultural landscapes



Coordinator: Ioannis Dimitriou, Swedish University of Agricultural Sciences

With input from: Mark Brown, Gerard Busch, Virginia Dale, Ger Devlin, Burton English, Kevin Goss, Keith Klein, Kevin McDonnell, John McGrath, Blas Mola-Yudego, Fionnuala Murphy, Christina Negri, Esther Parish, herbert Ssegane, Donald Tyler

What mobilization potential is there?

IRENA estimated the supply of energy crops required to double the share of renewable energy in the global energy mix by 2030 is 33-39 EJ/year (Nakada et al. 2014).

The IPCC special report on renewable energy (Chum et al. 2011) estimated the technical potential of dedicated biomass production on agricultural land by 2050 between 0-700 EJ/year (zero when no surplus agricultural land will be available due to food sector development).

Recommendations to significantly mobilize lignocellulosic crops.

- **Remove policy barriers** related to bioenergy and lignocellulosic crops that are currently of concern in specific countries.
- **Reduce the cost of lignocellulosic bioenergy technologies** as production systems mature, and costs fall as operational experience and the scale of production grows.
- **Level the playing field** across all energy production systems through concerted public policy discourse.
- **Improve the public image** of lignocellulosic crops for bioenergy and bio-based product production. Requires:
 - Increasing **stakeholder confidence and knowledge**
 - Increasing **available information** through varied media
 - **Broaden public discussion** of the true costs and benefits of dedicated energy crops to inform all stakeholders about the benefits of lignocellulosic crop supply chains.
- **Promote holistic approaches** to realize the value of biomass plantings for provision of all ecosystem services.

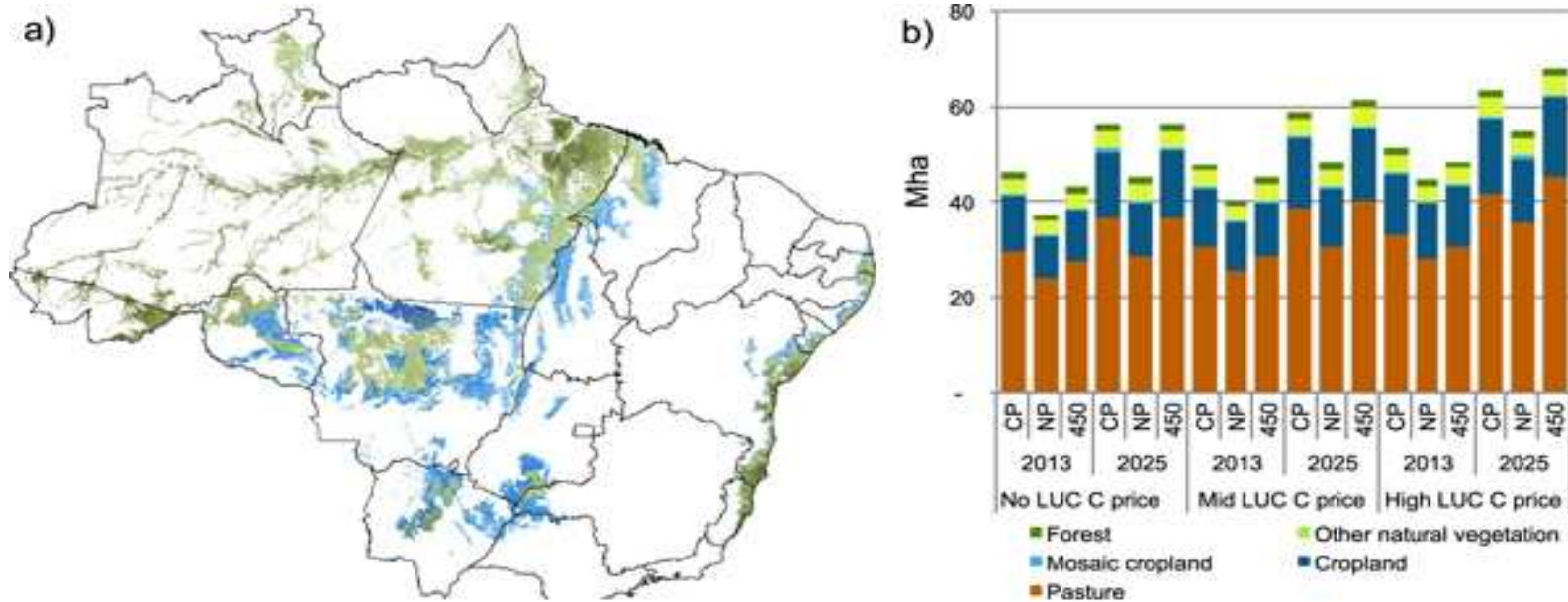
Cultivated Grasslands and Pastures in Brazil



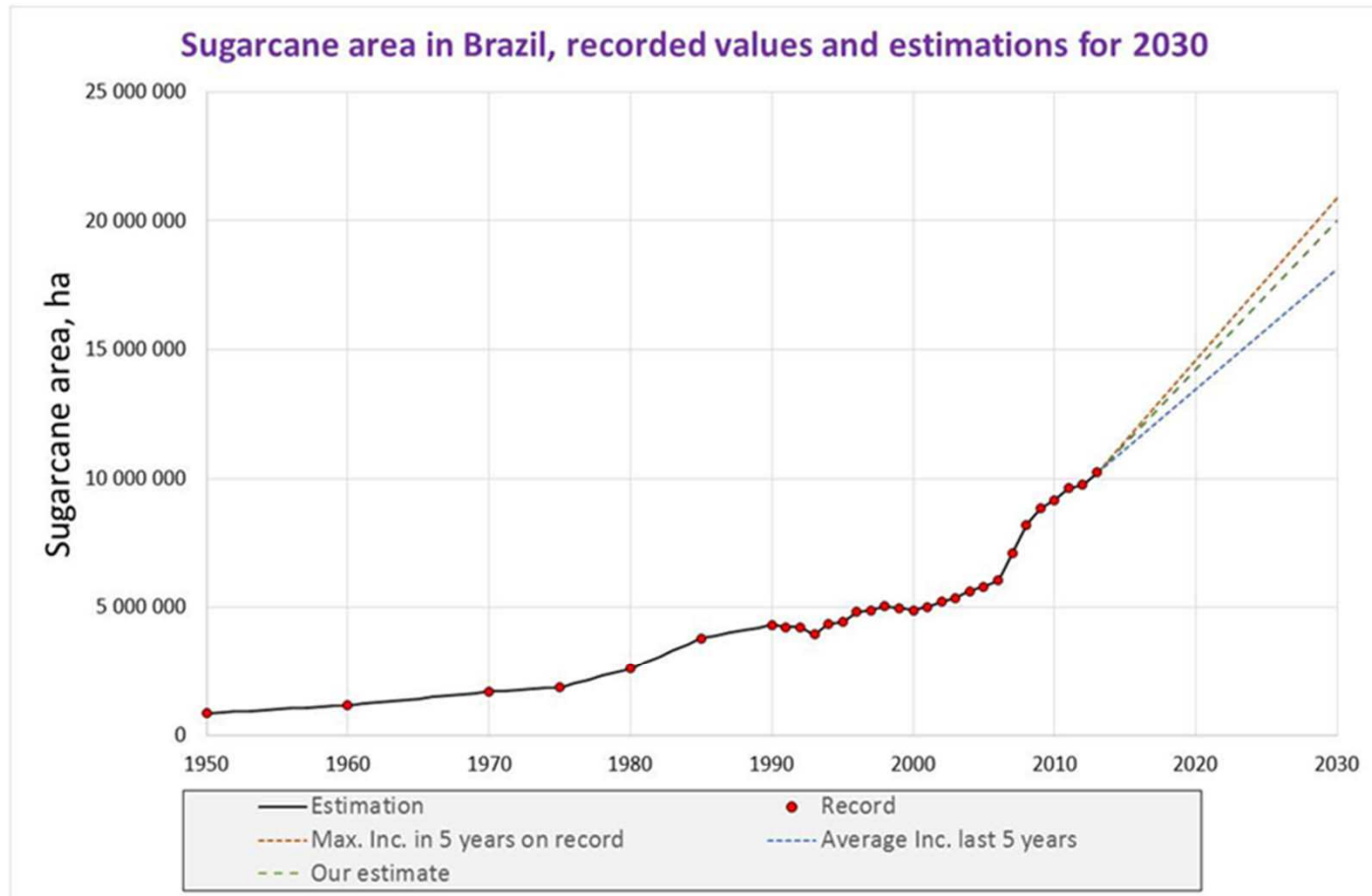
Coordinator: Göran Berndes, Chalmers University of Technology, Sweden

With input from: André Assunção, Alberto Barretto, Helena Chum, Andrea Egeskog, Oskar Englund, Julia Hansson, Y. Jans, Regis Leal, Rodrigo Maule, Durval Dourado Neto, Sérgio Paganini, Magnus Persson, Luis Rezende, Gerd Sparovek, Arnaldo Walter, Stefan Wirsenius.

Context for mobilization



Some 40–60 Mha could support profitable oil palm biodiesel production corresponding to approximately 10% of the global diesel demand, without causing direct LUC emissions or impinging on protected areas.



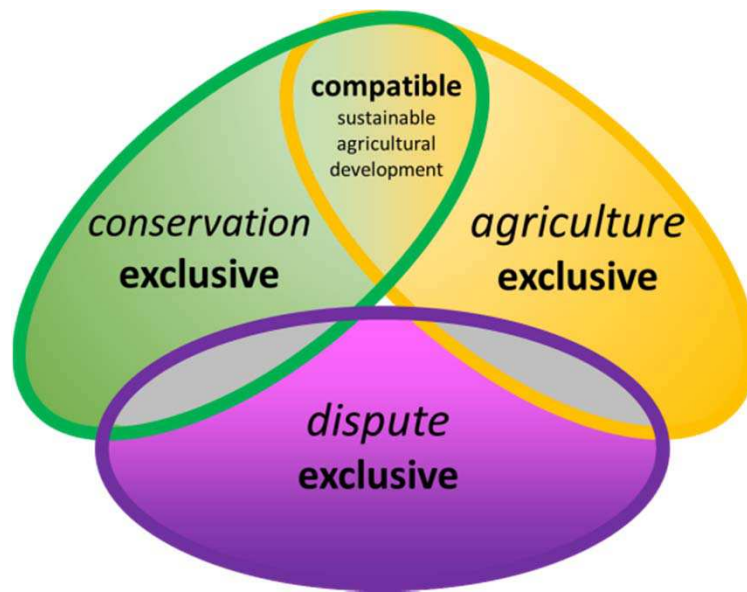
Historical expansion of sugarcane area in Brazil and a comparison of the average and maximum historical expansion rates (measured over 5 years) with the implied estimated expansion rate.

Most important barriers to mobilization

- **Few techno-economic barriers exist:** legal conditions for production are settled throughout Brazil, production systems are mature, and there is technology and capacity to rapidly increase production in response to increasing demand. Progress on infrastructure investments further strengthens capacity, including expanded export routes via the Amazon River basin.
- **Sustainably increasing food, biomaterials and bioenergy output requires structural shifts and incentives rewarding higher productivity.** This is especially important in cattle production where, historically, ample supply of new land in frontier regions has fostered a culture among producers and technology providers where management options to increase land-use efficiency are less important.

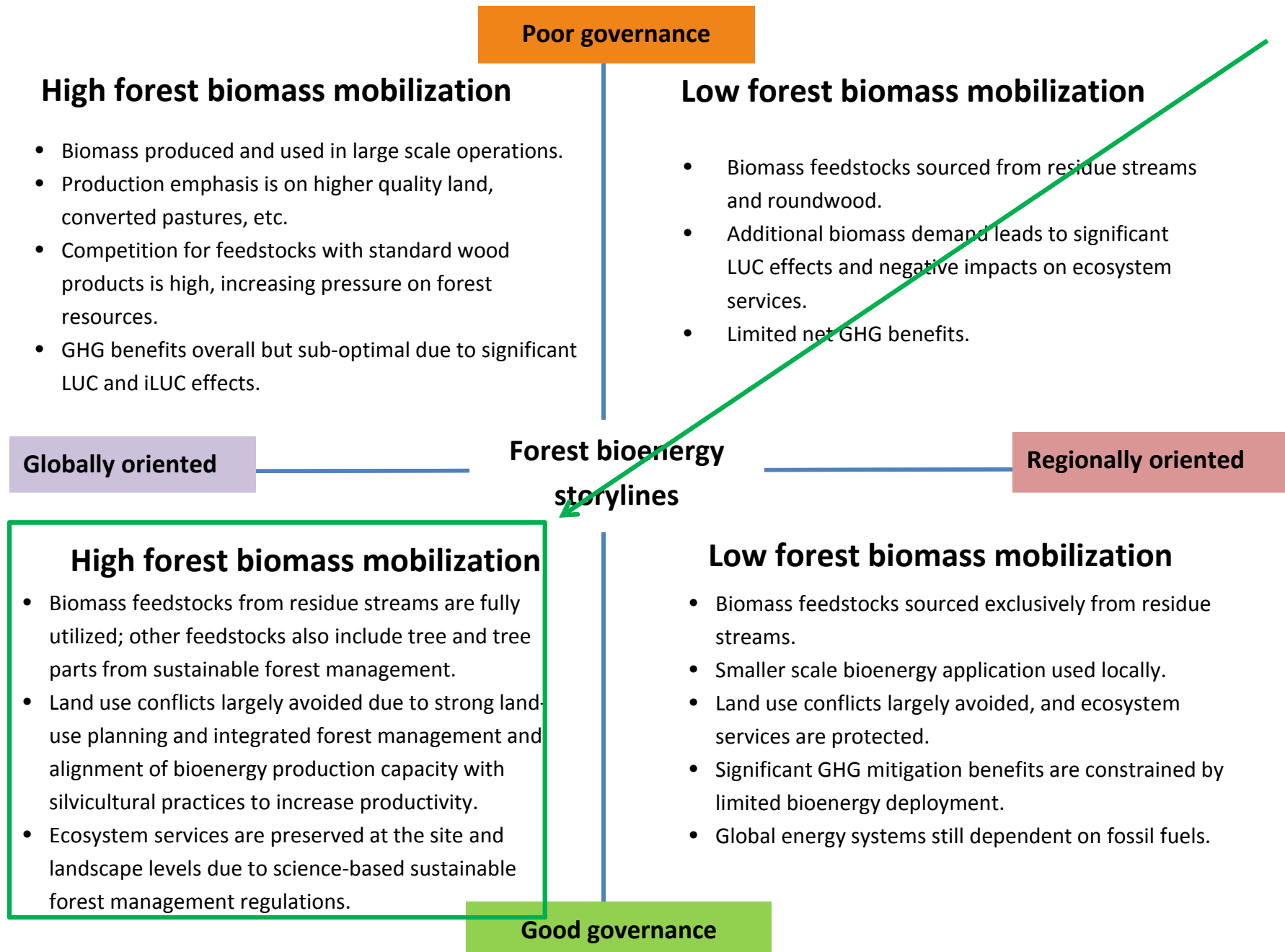
Most important opportunities for mobilization

- **Modelling and assessments reveal a huge mobilization potential;** the biomass production achieved in Brazil today can be multiplied without converting forests and other native ecosystems into agriculture land.
- **Expansion of irrigated systems can boost Brazilian production tremendously,** since the presently irrigated area is minimal when compared to the area suitable for irrigation from physical and logistical points of view. The low **use of irrigation is price driven**, and price changes for agricultural products can result in more intensive use of irrigation in double and triple cropping systems.
- **Realizing the opportunities for large scale mobilization that avoids significant natural ecosystem conversion requires incentives and regulation that complement governmental command and control and that promotes improved land productivity.**
- **Decision-support systems that integrate relevant biophysical and socio-economic data have been developed and are now used to guide mobilization of sustainable production systems for food, bioenergy and biomaterials** at several Brazilian ministries (Ministry of Integration, Ministry of Agriculture, Ministry of Agrarian Development).



Science-based information demonstrates compatibility between agricultural and conservation interests:

- Sufficient area to meet both conservation and production objectives
- Large scope for productivity gains supporting increased agriculture production -- increasing production does not require additional land
- Environmental issues are not the only reason why productivity gains are perceived to be important -- the agriculture sectors share an interest in productivity gains
- Environmental protection is a complex multi-stakeholder process with multiple initiatives. From this perspective, the current trends and achievements are positive.



Summary of identified opportunities for mobilization and benefits derived

Opportunities to encourage sustainable bioenergy supply chain mobilization

Technical

- Research and development of improved technologies and supply chain optimization
- Technology transfer from experienced regions to regions with minimal bioenergy deployment
- Learning-by-doing (e.g., starting small and scaling)
- System design optimizing local conditions and using existing infrastructure
- Biomass production that is aligned with existing silvicultural and agricultural practices

Institutional

- Clear and consistent policy definitions and goals for renewable energy
- Coordinated policies for forestry, agriculture, renewable energy and climate change
- Cooperative organizational structures along the supply chain
- Internationally accepted sustainability standards
- Good governance systems to guide sustainable practices
- Guaranteed long-term support (e.g., feed-in tariffs, renewable energy credits, subsidies)

Social & economic

- Competitive business case incl. valuation of co- and by-products & available financial investment capital
- Broad societal stakeholder consensus on pathways to achieve energy system transformation

Social, economic and environmental opportunities

- Reduced greenhouse gas emissions through replacement of fossil fuels
- Increased domestic energy security
- Rural economic development and employment opportunities
- Potential improvement in local environmental conditions
- Possible contribution to improving renewable resource management practices
- Added value to lands maintained in forestry and agriculture



Thanks!

Questions?



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