Colombia continues to offer great bioenergy opportunities as its economy develops. Colombian businesses, research institutes and government generally share the vision that Colombia should develop a domestic bio-based economy to foster innovation and to spur the modernization of the agricultural sector. Stakeholders feel that the entire production chain from biomass cultivation to bio-energy, bio-pharmaceuticals, bio-plant protection products and bio-cosmetics need further attention.

All the basic beneficial conditions for a sustainable bio-based sector are present:
- A large and productive land base and considerable water availability with ample room for further efficiency increases.
- A well-organized agricultural sector.
- A well-organized physical and knowledge infrastructure.
- Governmental policy and business priorities in place to increase the role of renewable energy, stimulate rural development, build competitive export oriented sectors and protect the environment (climate, soil, biodiversity, water).

Market opportunities for sustainable bio-based economy:
Despite its powerful economic development, its rich natural resources and its competence in agriculture and forestry, Colombia faces challenges to sustain and spread that economic activity. Rural regions are still quite underdeveloped for example, and the country is still a fairly modest player in the international bioenergy markets of bio-ethanol, palm oil and biosolids compared to e.g. Brazil, Canada and Indonesia. The country has an excellent window of opportunity to take a leading position in the market for premium sustainable bio-based products, both for export and for national use.
Key facts

Economy
Colombia has so far maintained a healthy economic growth rate (over 5% in 2011) and its economy is likely to grow further.

<table>
<thead>
<tr>
<th>Country snapshot: Economic and Demographic Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
</tr>
<tr>
<td>GDP, US$bn</td>
</tr>
<tr>
<td>GDP per capita, US$</td>
</tr>
<tr>
<td>Real GDP growth, %</td>
</tr>
<tr>
<td>Population, mn</td>
</tr>
</tbody>
</table>

Source: BMI Macroeconomic Databases

Energy sector in Colombia
Colombia produces roughly 9,000 MW a year of hydroelectric power, which amounts to 66% of its electricity. It also generates approximately 4,000 MW of fossil fuel (80% natural gas, 20% coal). In dry years such as during El Niño periods, the split between hydro and fossil fuel generation is about 50-50%. During particularly wet years, hydro can supply 80% of the country’s electricity needs.

In response to growing demand Colombia is planning a 32% increase of hydroelectric capacity by 2018.

Renewable energy
Colombia has set goals to increase renewable energy on the grid: to 3.5% by 2015 and to 6.5% by 2020. Currently the share considered ‘renewable energy’ – small hydro (<10 MW) and wind is 1.4%.

Colombia also has many diesel ‘mini-grids’ in remote areas where conventional power generation is more expensive. The goals for renewables there are 20% by 2015, and 30% by 2020. Renewable energy currently accounts for about 8% of the load in the remote areas.
Missing knowledge: valorisation

Colombian know-how is lacking when it comes to a better utilisation of residual biomass from its huge by-products flows. Knowledge and capacity building is required in valorisation (including restrictions and sustainability issues), in available biomass conversion technologies and in optimal exploitation of biomass residuals.

Bioenergy Production

Colombia is one of the largest producer of biofuels in Central and South America. During 2009, the country produced 324.7 million litres (mL) of ethanol and 173,043 tonnes (t) of biodiesel. The country has implemented mandatory blends for gasoline-ethanol (10%) and diesel-biodiesel (5%) since 2008.

Six bioethanol and seven biodiesel production plants are currently in operation that use sugar cane and palm oil as their main feedstock respectively. The total production capacity is about 1.1 mL per day of ethanol and about 1.7 mL/day of biodiesel. Biofuels generate an estimated 24,000 direct and 48,000 indirect jobs.

Colombia has been producing sugarcane and palm oil since the early 1900s. Not including coffee, each of these contributes to approximately 4% of the GDP in the agricultural sector. A key factor in the production cost of biofuels is the feedstock productivity. Here Colombia benefits from its high yield in sugar cane, oil palm and cassava, where it ranking among the top countries in the world.

Potential for expansion

Land availability facilitates an increase in bio-ethanol production. Out of the 114 million hectares of the national territory, only 40,000 ha are devoted to bio-ethanol production and the Ministry of Agriculture and Rural Development (MARD) estimates the area with potential for sugarcane production at 3.9 million ha.

The Ministry of Agriculture has acknowledged in multiple publications that the increase of land use and biomass production will need to develop sustainably, in compliance with the key sustainability criteria that are in place and in development in Colombia and abroad (European RED, Roundtable initiatives, etc.) as an essential prerequisite to exporting biomaterials and biofuels to the world market.

Opportunities

A recent fact finding mission to Colombia commissioned by NL Agency mentions multiple opportunities for biomass valorisation.

- The Colombian palm oil, sugarcane and banana sectors are interesting for energy and bio-based economy applications from the perspective of both sustainability and scale (medium to large). Medium to large scale initiatives are possible here: e.g. CHP (process improvement), biogas production, and solid biomass processing for export. In the banana sector, medium to large scale opportunities exist in ethanol production, biogas projects, re-utilization and further processing of solid biomass and other bio-based applications.
- Sugarcane (panela production in small-scale trapiches, see page 4 box 1) and coffee are interesting more from a sustainability perspective and in terms of rural development (mostly energy, some bio-based economy). In these sectors, small scale opportunities (ethanol production facilities, small biogas applications, small bio-based initiatives can be developed further.
- Initiatives in bamboo, euphorbia tirucalli, lupinus mutabilis and montrichardia arborescens might also be interesting from a sustainability, rural energy applications, or bio-based economy perspective.
- Opportunities exist in capacity building: developing biomass valorisation scenarios, biomass conversion technologies (e.g. second generation biofuels and other bio-based economy applications), land use and soil management modelling, GIS modelling, sustainability criteria and certification. These are all seen as necessities by most consulted stakeholders and they apply to most government, knowledge and business initiatives.
Key developments in Colombia

Bioenergy projects are characterized by feedstock production, logistics and conversion. Identification of their strengths and limitations is crucial for success.

<table>
<thead>
<tr>
<th>Estimated biomass potential from agricultural waste</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crop Year: 2010</strong></td>
<td><strong>Residue type</strong></td>
</tr>
<tr>
<td>Palm oil</td>
<td>Residues</td>
</tr>
<tr>
<td>Sugar cane</td>
<td>Bagasse</td>
</tr>
<tr>
<td></td>
<td>Leaves</td>
</tr>
<tr>
<td>Panela sugar cane</td>
<td>Bagasse</td>
</tr>
<tr>
<td></td>
<td>Leaves</td>
</tr>
<tr>
<td>Banana</td>
<td>Trunks</td>
</tr>
<tr>
<td></td>
<td>Fibre</td>
</tr>
<tr>
<td>Coffee residue</td>
<td>Husk</td>
</tr>
</tbody>
</table>

Fig. 4

Relevant trends and theoretical potential
The large potential of biomass resources offers sustainable entrepreneurs new business opportunities:

- The Colombian sugar cane industry increasingly sees its own potential as a feedstock producer and has built strategic policy around this goal;
- Large amounts of agricultural residues (i.e. empty stalks, fibres or husks and bagasse) offer power and heat production opportunities via direct combustion or co-digestion biogas plants;
- Coffee and bananas have great untapped potentials for feedstock.

Biomass from Agriculture
Agricultural production takes a large role in the Colombian economy.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Product</th>
<th>Annual production</th>
<th>Cultivated area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm Oil</td>
<td>Palm Oil</td>
<td>942.000 tons</td>
<td>427.367 ha</td>
</tr>
<tr>
<td></td>
<td>Bio diesel</td>
<td>443.037 tons</td>
<td></td>
</tr>
<tr>
<td>Coffee</td>
<td>Coffee beans</td>
<td>469.000 tons</td>
<td>921.060 ha</td>
</tr>
<tr>
<td>Banana</td>
<td>Bananas</td>
<td>95 million Boxes</td>
<td>47.000 ha</td>
</tr>
<tr>
<td></td>
<td>Sugar Cane</td>
<td>22.728.758 tons</td>
<td>223.905 ha</td>
</tr>
<tr>
<td></td>
<td>Sugar</td>
<td>2.339.998 tons</td>
<td></td>
</tr>
<tr>
<td>Sugar Cane</td>
<td>Molasses</td>
<td>254.206 tons</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bio ethanol</td>
<td>341.190 m³</td>
<td></td>
</tr>
<tr>
<td>Cocoa</td>
<td>Chocolate</td>
<td>41.800 tons</td>
<td>96.000 ha</td>
</tr>
<tr>
<td>Grains</td>
<td>Corn</td>
<td>918.072 tons</td>
<td>295.082 ha</td>
</tr>
<tr>
<td></td>
<td>Sorghum</td>
<td>16.411 tons</td>
<td>3.939 ha</td>
</tr>
<tr>
<td></td>
<td>Soy</td>
<td>39.555 tons</td>
<td>18.538 ha</td>
</tr>
<tr>
<td></td>
<td>Wheat</td>
<td>23.350 tons</td>
<td>10.348 ha</td>
</tr>
<tr>
<td></td>
<td>Pea</td>
<td>56.250 tons</td>
<td>14.360 ha</td>
</tr>
<tr>
<td></td>
<td>Kidney Bean</td>
<td>77.584 tons</td>
<td>59.659 ha</td>
</tr>
<tr>
<td></td>
<td>Oats</td>
<td>2.672 tons</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Barley</td>
<td>5.681 tons</td>
<td></td>
</tr>
</tbody>
</table>

Source: Augura, Asocaña, Federación Nacional de Biocombustibles de Colombia, 2012, Fenalco, BMI Colombia Agribusiness Q2 2013

Fig. 3 Agricultural production in Colombia (2012)

Business opportunities and experiences

Investment climate
The solid economic growth of Colombia attracts substantial Foreign Direct Investment (FDI) and further growth is expected. Bio-energy projects may benefit from government subsidies and credits that most of the times require local partnerships. Business start-up is better facilitated in the last years, though bureaucracy remains an important obstacle. The main concern with long-term investment is weak infrastructure conditions and the return of internal strife.

Triggers for investment
- Colombia has a wealth of natural resources and ample flows of potential feedstock;
- The country has a large, young labour force that is increasingly literate;
- The potential of the bio-energy sector is large and in its early development stages;
- Opportunities exist in R&D, development of agricultural projects, deployment of (new) technologies and in providing specific expertise.
Entrepreneurship in Colombia

Three sustainable biomass projects are supported by NL Agency:
• Pilot project: Torrefaction of bamboo pellets;
• Cleaner production methods for sugar cane trapiches
• Generation and application of biogas from Palm Oil Mill Effluent (POME)

Projects supported by NL Agency Sustainable Biomass Programmes

Sustainability for small trapiches
Trapiches are the small sugar cane mills that provide much of Colombia’s ‘panela’ sugar. The 20,000 trapiches are often family-run small businesses with production methods of poor sustainability and efficiency. Environmental consultant GSMP aims to make these mills cleaner and more efficient by improving storage facilities, improving the drying, transportation and burning conditions of bagasse, by improving working conditions, and raising production yields.

Why Colombia?
GSMP’s Harold Martina, initiator: ‘Our company GSMP has improving sustainable production methods in Colombia as its core business, so this project came naturally to us. Colombia has great potential for biomass and the bio-economy because of its substantial coffee, banana and sugar industries. These sectors produce huge flows of byproducts and residues, all them potential feedstock.

With the current economic upswing comes the resolve and the resources to introduce sustainable production on a scale that makes a difference. For example, the trapiches we’re working with used to be scattered small businesses, but they had just merged into a communal enterprise. That gives you a platform to build on.’

What are the lessons learnt?
‘Lessons are many and diverse. Firstly, to embrace, involve and trust the collective knowledge and ideas of local communities. For the people you meet, what’s lacking is not the ideas themselves, but the organized power and the resources to follow through. Secondly, that government policy can be a catalyst for change. New regulation is being introduced that spells the end for the conventional Colombian trapiche. So our plans fell on fertile soil. Also, we found a competent partner in the Colombian Centre for Cleaner Production, the CNPML. Finally, speaking the language helps – a lot.’

Do’s and don’ts
• Do establish a local understanding and support base for your project;
• Do understand competing interests;
• Do obtain a full understanding of legal procedures and policies;
• Do build a network of contacts and understand your partners’ culture and position;
• Do start your business locally, not from a distance.
• Don’t attempt to transplant foreign ideas into the Colombian context
• Don’t shield your idea too much from local interests - you probably need their support
• Avoid the paternalistic approach

Relevant other contacts
Useful contacts for entering the Colombian bioenergy market:
• Dutch embassy in Colombia: http://colombia.nlambassade.org/locaties/ambassade-in-bogota.html
• CORPODIB: http://www.corpodib.com.co/
• Federación Nacional de Biocombustibles: www.fedebiocombustibles.com

Relevant ministries and government agencies:
• Ministerio of Mining & Energy: www.minminas.gov.co
• Ministry of Environment, Housing and Territorial Development: www.minambiente.gov.co
• Ministry of Agriculture and Rural Development: www.minagricultura.gov.co
• Ministry of Economic Development: www.mindesa.gov.co
• Comisión de Regulación de Energía y Gas: www.creg.gov.co
• Unidad de Planeación Minero Energética: www.upme.gov.co
• Superintendencia de Servicios Públicos Domiciliarios: www.superservicios.gov.co
• IPSE - Planning Institute for Energetic Solution: www.ipse.gov.co
• The Dutch Ministry of Economic Affairs: wwwagentschapnl.nl

NGOs and others involved in NL Agency's sustainable bio-energy programmes:
• Both Ends: www.bothends.org
• Fauna and Flora International: www.fauna-flora.org
• Netherlands Centre for Indigenous Peoples: www.indigenouspeoples.nl
• Oxfam Novib: www.oxfamnovib.nl
• World Wildlife Fund Colombia: www.wwf.org.co
Second-generation torrefied bamboo pellets for export

The techno-economic potential of bamboo as a sustainable source of energy is thought to be substantial. Spearheaded by the Energy research Centre of the Netherlands (ECN) and joined by Imperial College London, the Technological University of Pereira and the Colombian Bamboo Society (CBS), this two-year research explores the possibilities of torrefied (‘roasted’) bamboo, successively converted into pellets and imported from Colombia for co-firing in the Netherlands and the EU.

Why Colombia?

Robin Zwart, ECN: ‘Colombia already has certified bamboo forest and plantations serving a furniture industry that uses substantial amounts of bamboo as base material. The residues from these forest and plantations as well as from the furniture industry and their potential to be a sustainable feedstock for bio-energy were what triggered our research.’

What are the lessons learnt?

‘One of the things we soon learned is that the residual flow from the furniture industry is in itself unfit for use as co-firing material due to certain chemicals used for preservation after the bamboo leaves the plantation. However, we learned that a fair share of the bamboo actually doesn’t leave the plantation, unfit for use in furniture production. Therein now lies a viable feedstock.’

‘Another discovery was that neither government nor business had considered bamboo as potential energy source before our research came underway. A list provided by Colombian policymakers failed to include the plant, though it gets increasing attention as energy source elsewhere in the world. Indeed, our research is slowly reaching promising results.’

Role of innovation, science and technology

Relevant Colombian policies

Energy and climate

- Transformative Production Program built to foster public-private innovation
- €11 Million budget for bio-based policy until 2014
- National Climate Policy is being drafted

Transport

- All vehicles sold from 2012 onwards must accept B20 and E85 fuels
- Biofuel mandates tend to vary
- June ’11 biofuel mandate 10% for B10, 7% B7, 8% E8

Agriculture

- Policy aims to increase farmlands
- Policy focuses on conservation of primary forest and development of production forestry
- Commercial plantations to increase from 0.4% to 1.4% before 2014

Biomass and sustainability

Colombia has a wealth of resources but faces various threats to sustainability. Conversion of ‘new lands’ to bio-energy production, for instance, presents a serious threat to biodiversity and may harm the position of small landholders, landless/nomadic and indigenous people.

To take into consideration when developing a sustainable project:

a) Interaction between food supply and energy;
b) Scale-up effects;
c) Price mechanisms;
d) Government policies;
e) Knowledge of local network and communities;
f) New crops;
g) Resource competition.
Public support for project development and bio-energy

**Supporting sustainable biomass in Colombia**

<table>
<thead>
<tr>
<th>Production Stage</th>
<th>Incentive</th>
<th>Eligible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedstock cultivation</td>
<td>40% of cost of investment</td>
<td>Newly established perennial plantations until 2015</td>
</tr>
<tr>
<td></td>
<td>10 years exemption from income tax</td>
<td></td>
</tr>
<tr>
<td>Soft loans</td>
<td></td>
<td>Small and medium size producers. Large producers only if associated with small and medium size producers. Not only for biofuel feedstocks</td>
</tr>
<tr>
<td>Processing</td>
<td>Free Trade Zone benefits</td>
<td>Biofuel production facilities (biodiesel and ethanol plant)</td>
</tr>
<tr>
<td>Retailing</td>
<td>Exempt from 16% sales tax Exempt from 25% fuel tax</td>
<td>Biofuels (ethanol and biodiesel)</td>
</tr>
<tr>
<td>Price setting</td>
<td>Government sets price: highest of three formulas:</td>
<td>Biofuels (ethanol and biodiesel)</td>
</tr>
<tr>
<td></td>
<td>1. Basic price set by government</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Fossil based fuel prices + price of processing biofuels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Cost of incorporation of biofuel: feedstock price + supplement for processing and transport.</td>
<td></td>
</tr>
</tbody>
</table>

Source: Ecofys

**Fig. 5**

**Supporting sustainable biomass: Colombia-Netherlands**

The economic upswing that Colombia is witnessing has lead the government of The Netherlands to shift its approach from development cooperation to economic cooperation. Because this policy shift is currently underway, many existing policies and facilities have been suspended. In addition, a ‘transition facility’ has been established. Colombian and Dutch parties may call on the facility to assist them in establishing mutually beneficial business relationships and to fill in gaps in their knowledge of the country.

NL Agency has a vast network of contacts and can provide information based on many years of experience in supporting projects and executing government policies on biomass and energy. It offers entrepreneurs support and information.

**Trade with Colombia**

The EU is the second most important trading partner for Colombia, after the US. Europe imported goods worth € 4.7bn in 2010: agricultural products, fuels and mining products (coal). Exports from the EU to Colombia stood at € 3.9bn in 2010: mainly machinery, chemicals and manufactured products.

**Examples of bio-energy-related entrepreneurs:**

- Bio-methanol-producer BioMCN and biomass trader SBTC together seek to co-operate with organic products company DAABON from Colombia;
- Development organisation SNV has expressed an interest to invest in small-scale bio-energy production in Colombia;
- Sustainable energy pioneer Diligent Energy Systems Colombia has built two facilities in Colombia that produce bio-ethanol from waste materials.
NL Agency offers support

Transition facility
The Dutch government is currently reshaping a lot of its trade and funding policies on Colombia, in light of its re-assessment of the country from development partner to economic partner. To bridge the transition, a transition facility has been set up. Colombian and Dutch parties may call on the facility to assist them in establishing mutually beneficial business relationships and to fill in gaps in their knowledge of the country.

At present a K2G-project (knowledge institution-to-government) is underway with the aim to provide capacity building and research in order to draft sustainable biomass policies, practices and instruments. The project is a direct co-operation with the Colombian Ministry of Agriculture (Ministerio de Agricultura y Desarrollo Rural, MADR), and involves other relevant governmental bodies and identified non-governmental stakeholders where needed.

More information
Transition facility:
www.agentschap.nl/programmas-regelingen/transitiefaciliteit-tf

G2G/K2K:
www.agentschap.nl/programmas-regelingen/government-government-g2g-en-knowledge-knowledge-k2k