

# Delivery of sustainable supply of non-food biomass to support a resource-efficient Bioeconomy in Europe

S2Biom workshop, Piran, Slovenia, 16 June, 2016

## Sustainable supply of non-food biomass for a resource efficient bio-economy: Review on the state-of-the-art

Dr Ilze Dzene, Dr Rainer Janssen  
WIP-Renewable Energies, Germany



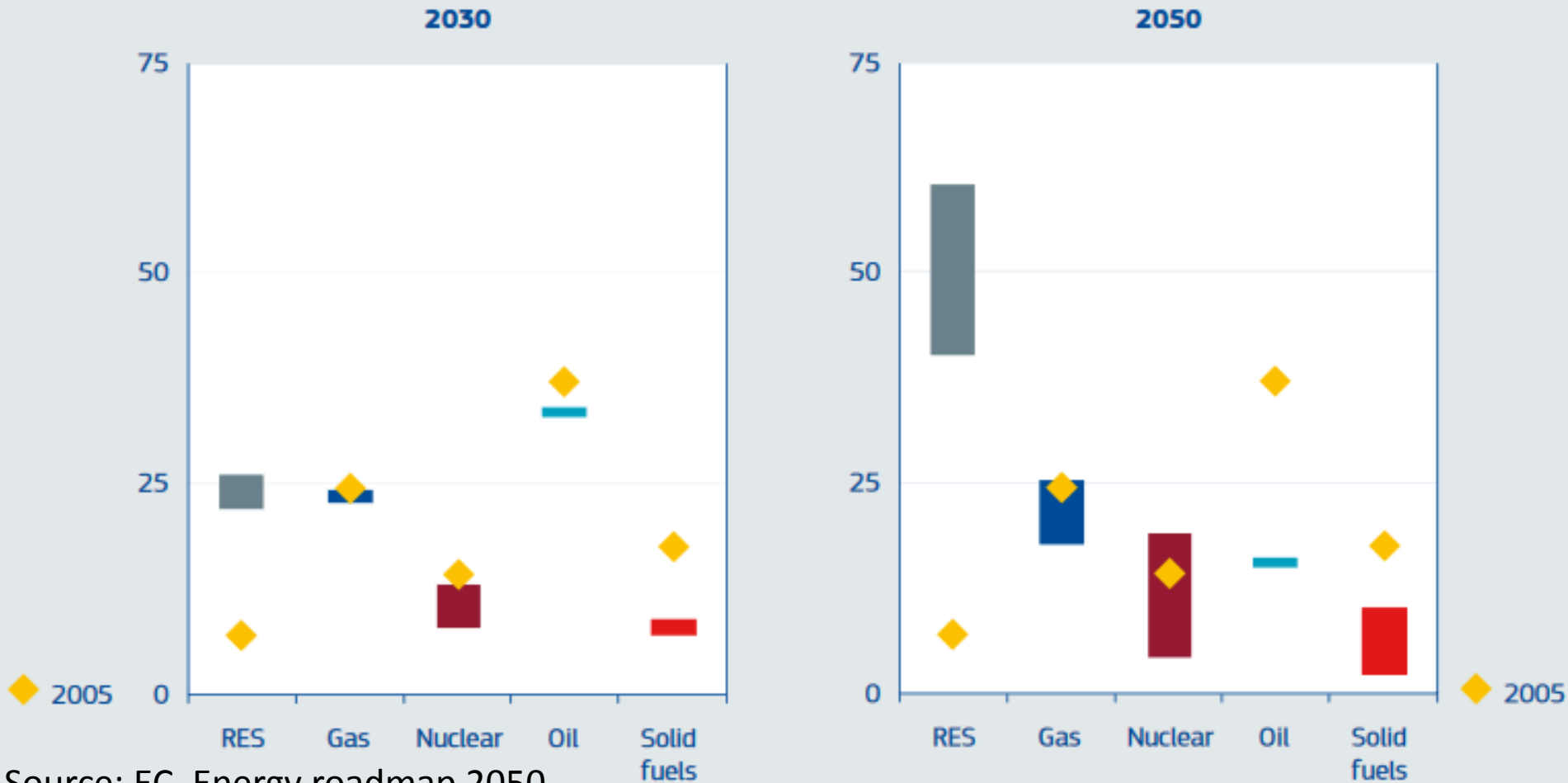
- **Primary production of renewable energy, (EU-28, 2012):**
  - 177 million toe (7,400 PJ) - 22.3% of total primary energy production from all sources
  - Biomass and renewable waste – most important RES, accounting for 65.5% of primary renewables production
- **Gross inland energy consumption<sup>1</sup> of RES, (EU-28, 2012):**
  - ~185 million toe (7,750 PJ) - 11% of total gross inland energy consumption
  - Biomass and renewable wastes provided 7.3% (123 million toe or 5,150 PJ) representing around two thirds of this share

<sup>1</sup> Gross inland energy consumption = primary production + recovered products + net imports + variations of stocks – bunkers

- **2020:**
  - to decrease greenhouse gas (GHG) emissions by 20%,
  - to increase energy efficiency by 20%
  - to raise the share of energy consumption produced from renewable resources to 20% as compared to 1990
- **2030:**
  - 40% GHG emission reduction
  - 27% share of energy consumption produced from renewable resources compared to 1990
- **2050 (Energy Roadmap 2050):**
  - 80-95% GHG emission reduction compared to 1990
  - Several decarbonisation scenarios are developed

# Policy context: RES projections

EU decarbonisation scenarios — 2030 and 2050 range of fuel shares in primary energy consumption compared with 2005 outcome (%)



Source: EC, Energy roadmap 2050

- **Bio-economy** → **Strategy “Innovating for Sustainable Growth: a Bio-economy for Europe”** → **greater, more sustainable use of RES, taking environment into account**
- **Resource efficiency** → **Roadmap to a resource efficient Europe** → **outline of the structural and technological changes needed by 2050**
- **Circular economy** → **replacing linear economy**

**Resource efficient bio-economy** ensures that the supply of biomass remains sustainable while achieving the EU policy targets

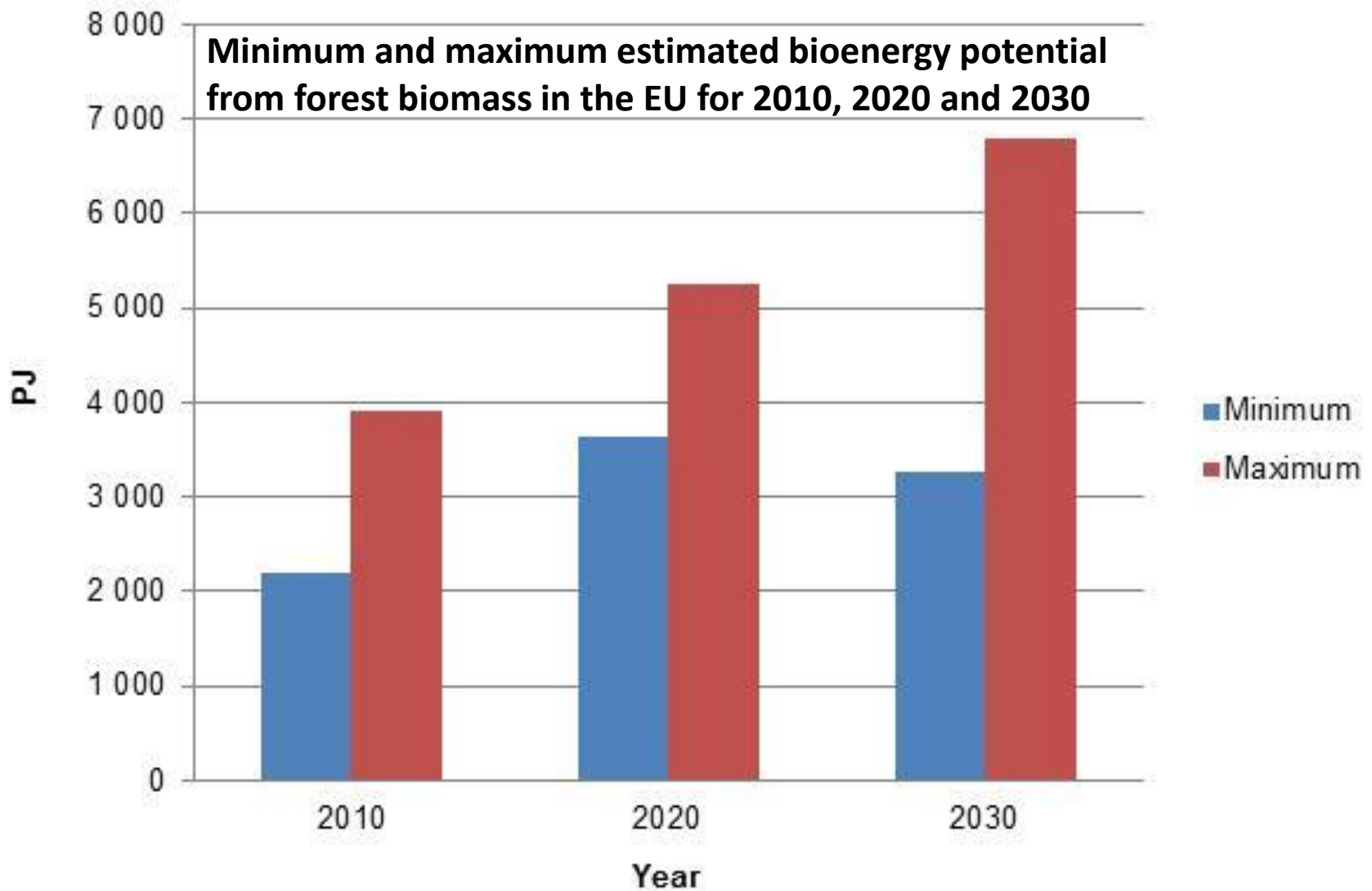
- **Aim of the state-of-the-art review:**
  - To provide an overview about various studies which investigated the present and potential sustainable supply of non-food biomass in the EU
  - To use it as a baseline for the update, comparison and refining of the datasets of S2Biom project
- **Present use and potential of sustainable supply of non-food biomass:**
  1. Forest biomass
  2. Non-food lignocellulosic crops
  3. Agricultural residues
  4. Residual biomass from waste

- **Currently the most important source of renewable energy in EU**
- **Accounts for around 1/2 of the EU's total renewable energy consumption**
  - 92.5 million toe or 3,850 PJ (2012)
- **Expected in 2020 (according to NREAPs), biomass (mainly woody) used for heating, cooling and electricity:**
  - ~ 42% of the 20% RES target for 2020

- **Forests and wooded land (EUROSTAT, 2010):**
  - covers 180 million ha
  - 42.4% of EU land area
  - between 2000-2010, the forest area in EU increased by 2%
- **The growing stock of forests in EU (2010):**
  - 24.4 billion m<sup>3</sup>,
  - 22 billion m<sup>3</sup> are available for wood supply (~90%)
- **The primary energy production from forestry in the EU-27 (2010):**
  - 9.8% of the total primary energy (80.8 million toe or 3,400 PJ)
  - 48.5% of the total renewable energy



# Sustainable potential supply of forest biomass



# 2. Non-food lignocellulosic crops

- **Non-food lignocellulosic crops:**
  - Unsuitable for human or animal food consumption
  - Grown for the purpose of producing biomass for energy and/or material purposes in an agricultural rather than a forestry context
  - They can be cut and harvested for biomass over successive years without re-cultivation or sowing
  - The whole crop can be harvested and used for energy production
- **Two broad types of energy crops:**
  - **Perennial herbaceous crops** (Miscanthus, switchgrass, reed canary grass, giant reed, perennial rye grass...)
  - **Woody crops** known as short rotation coppice (SRC) (e.g. willow, poplar, eucalyptus...).

# Present use of non-food lignocellulosic crops

- **Statistics of non-food lignocellulosic crops plantations are almost inexistent in many European countries**
- **Statistics account for total bioenergy cropping area:**
  - 5.5 million ha of agricultural land
  - 3.2% of the total cropping area
- **Cultivation shares:**
  - 82% oil crops for biodiesel production
  - 11% sugar and starch crops for bioethanol production
  - 7% crops grown as feedstock for biogas production
  - <1% of SRC crops for heat and electricity generation

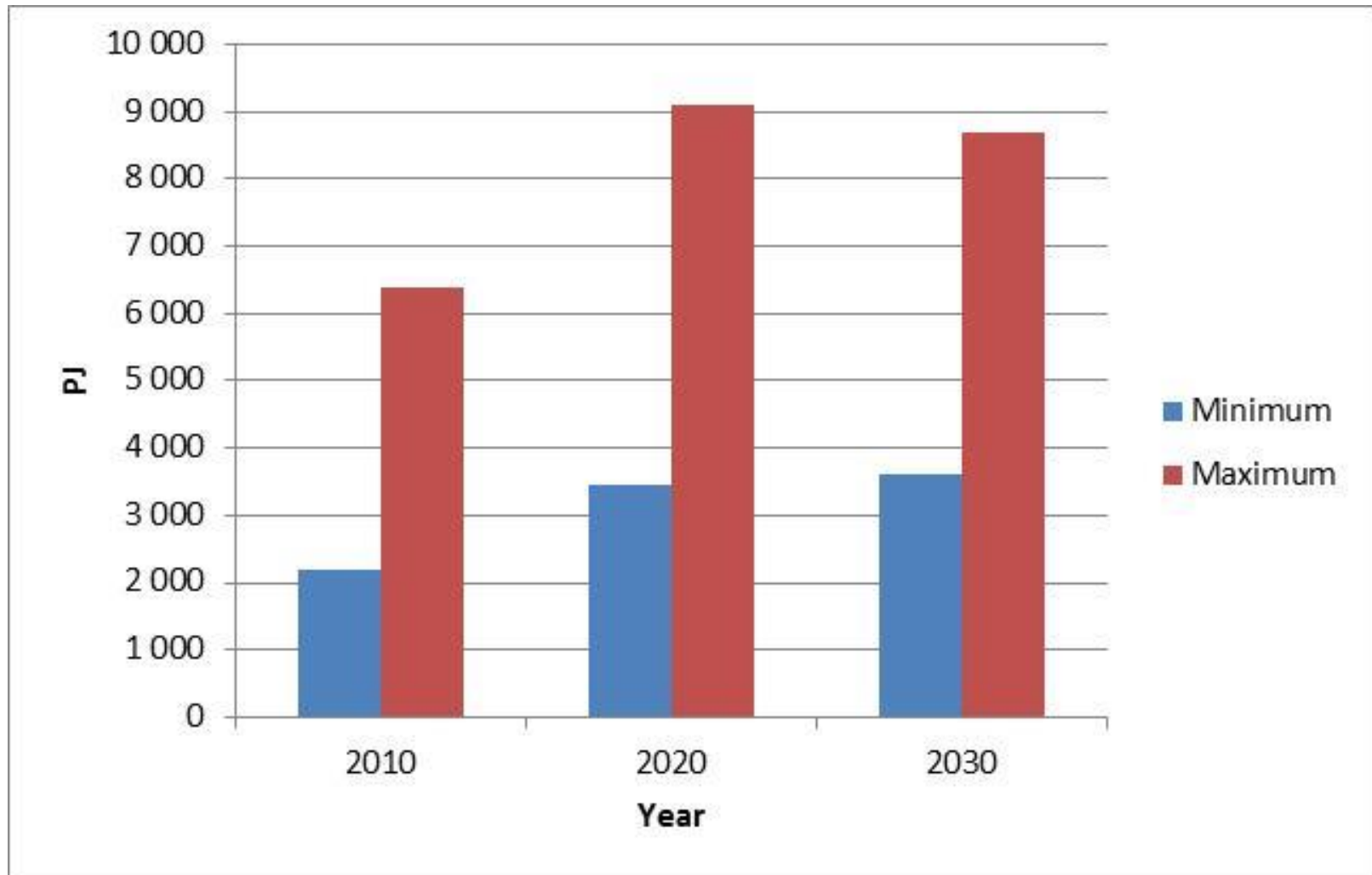
# Sustainable potential supply of non-food lignocellulosic crops



- **Several potential studies include areas of:**
  - fallow land in agriculture
  - other unutilised land within the current agricultural land area
  - recently abandoned agricultural land
  - recently abandoned arable land
  - contaminated land
- **Different opinions on including arable land**
- **Lack of data - significant challenge to the accurate identification of land areas with potential for non-food lignocellulosic crop cultivation**

# Sustainable potential supply of non-food lignocellulosic crops

Minimum and maximum estimated bioenergy potential from non-food lignocellulosic crops in the EU for 2010, 2020 and 2030 (including arable land)



# 3. Agricultural residues

- **Classification of agricultural residues:**
  - **Primary** - resulting from primary agricultural operations
  - **Secondary** - produced during the processing of crops into food or other products
- **The use of agricultural residues for energy productions depends on their properties and characteristics, e.g.:**
  - **Moisture content:**
    - Dry residues -> combustion, gasification
    - Wet residues -> anaerobic digestion
  - **Lignocellulose content**
- **Alternative markets and uses should be considered**
- **Competition for land use and resources is highly avoided**

- **Primary renewable energy production from agriculture in the EU-27 (EUROSTAT, 2010):**
  - 2.1% of the total primary energy produced (17.6 million toe or 750 PJ)
  - 10.6% of the total renewable energy production
- **Most of this share comes from energy crops**
- **No data on the share from agricultural residues for bioenergy production on EU level**

# Sustainable potential supply of agricultural residues



## Types of agricultural residues considered in the study

### Primary:

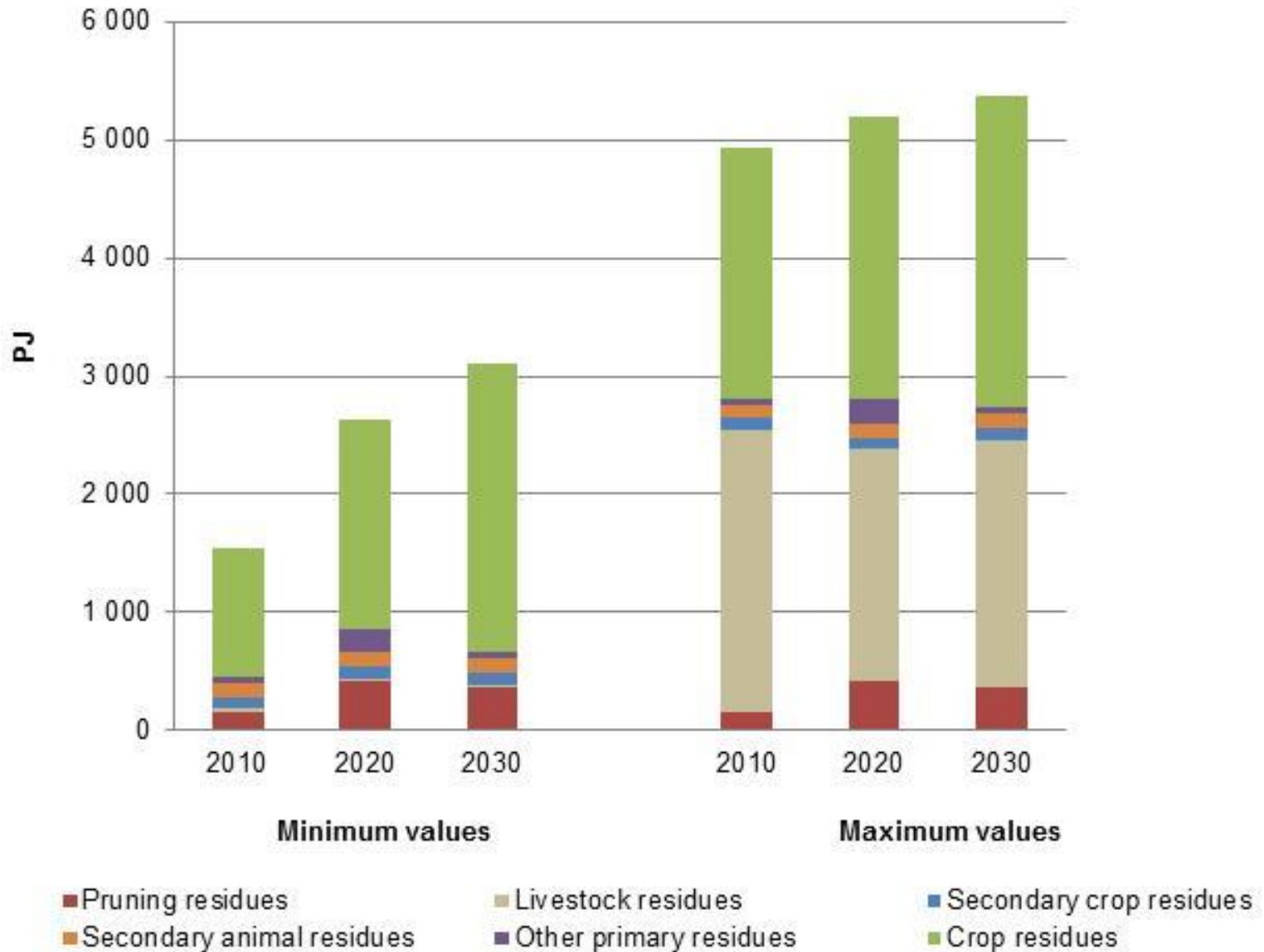
- Crop residues – parts of the crop that are not harvested during standard agricultural operations
- Pruning residues – woody material from pruning and cutting from plantations of soft fruit, citrus, olives and vineyards
- Livestock residues – manure
- Other primary residues – mowing from permanent and abandoned grasslands, roadside verge grass

### Secondary (agro-industrial residues):

- Secondary crop residues
- Secondary animal residues – animal waste of food preparation and products



# Total potential supply from agricultural residues



# 4. Residual biomass from waste

- **Waste is a material which an entity wishes to dispose of (EU Waste Framework Directive)**
- **In the context of biomass, waste will occur in the forestry and agricultural businesses (covered before) as well as in biodegradable municipal waste – bio-waste and sludge**
- **Bio-waste:**
  - Green waste from parks and gardens (MC: 50-60%, lignocellulose)
  - Kitchen waste (MC up to 80%, no lignocellulose)
- **Bio-waste management options:**
  - Apart to prevention at source, collection (separate or mixed)
  - Anaerobic digestion (energy recovery) and composting
  - Incineration (with and without energy recovery)
  - Landfilling

- **The overall potential for separately collected bio-waste in EU-27:**
  - up to 150kg/inhabitant/year (including kitchen and garden waste from households, park and garden waste from public estates, and waste from the food industry)
  - 80 million tonnes
  - ~30% (24 million tonnes) is collected separately and treated biologically
- **Total Municipal Solid Waste (MSW) in the EU (2012):**
  - 33% landfilled, 24% incinerated, 27% recycled and 14% composted
  - Contains between 30 and 40% bio-waste (ranges from 18-60%)
  - EUROSTAT (EU-28, 2012): gross energy consumption of the renewable part of MSW - 8.84 million toe (370 PJ)

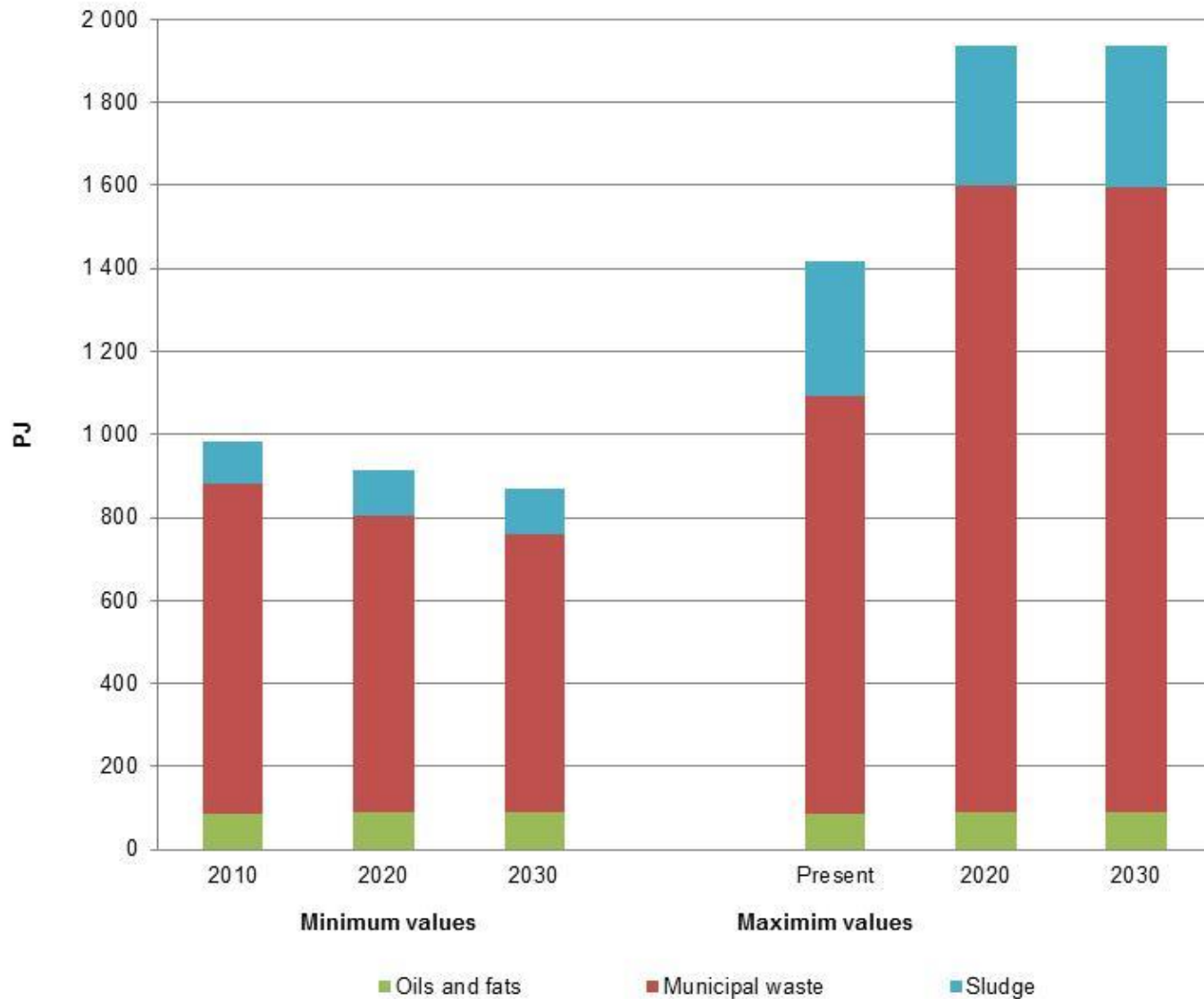
# Sustainable potential supply of residual biomass from waste



## Types of residual biomass from waste considered in the study:

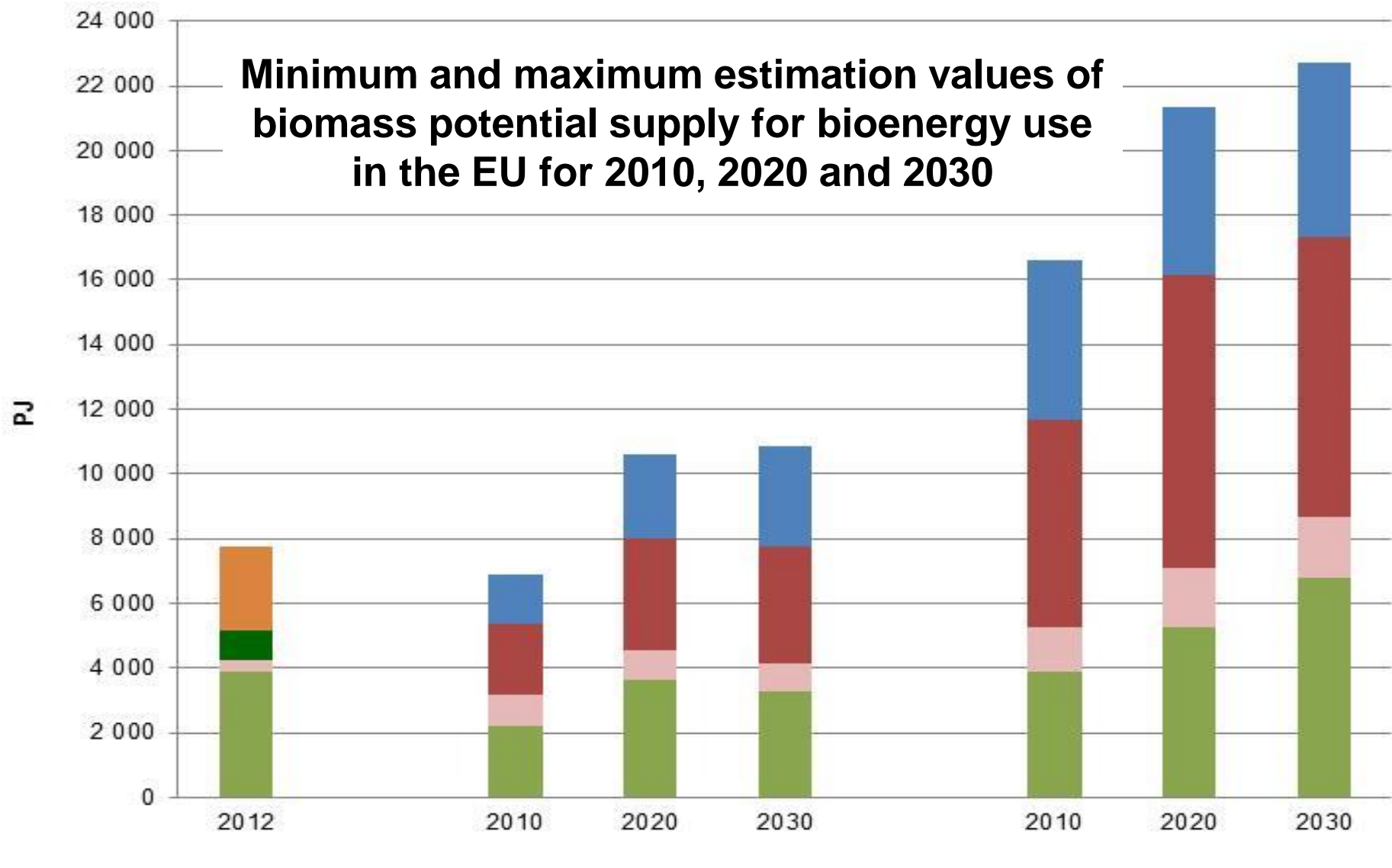
- **Biodegradable Municipal Waste** – any waste that is capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, and paper and paperboard (Council Directive (1999/31/EC)72)
- **Used oils and fats**
- **Common sludge (industrial effluent sludge)** – all kinds of sludge originating from wastes, waste water treatment and water preparation

# Summary of the residual waste potential



- **Sustainable biomass is a limited resource**
- **Currently biomass is providing more than 60% of renewable energies in the EU and is expected to provide more in 2020 and 2030**
- **EU has a potential to provide between 6,900 PJ and 16,600 PJ from biomass for its energy consumption today**
- **These estimates could increase to:**
  - 10,600 - 21,350 PJ in 2020
  - 10,850 - 22,700 PJ in 2030
- **The current supply of biomass for energy is not exhausted and biomass can supply more in the future**

# Minimum and maximum estimation values of biomass potential supply for bioenergy use in the EU for 2010, 2020 and 2030



RES gross inland energy consumption

Minimum biomass supply

Maximum biomass supply

- Forest biomass
- Non-food lignocellulosic crops
- Other biomass resources
- Biomass from waste
- Agricultural residues
- Other RES

- **Biomass potentials from forestry and waste are relatively stable over time**
- **Waste and agricultural residues has a potential that is currently barely exploited for energy generation**
- **Large uncertainty exists on how much biomass from agriculture can be supplied**
- **For the future, non-food lignocellulosic crops and agricultural residues seem to be the key for a genuine expansion of biomass supply once biomass from forestry and waste are stable**
- **The S2Biom project aims at filling the gaps of uncertainties by providing updated harmonized datasets on the sustainable delivery of non-food lignocellulosic biomass at local, regional and pan-European level for energy and material use**



Read full study:

**Khawaja C., Janssen R. (2014).  
Sustainable supply of non-food  
biomass for a resource  
efficient bioeconomy: A review  
paper on the state-of-the-art.  
WIP-Renewable Energies**

**Download from S2Biom project  
website:**

**[www.s2biom.eu](http://www.s2biom.eu)**



**Sustainable supply of non-food biomass  
for a resource efficient bioeconomy**

*A review paper on the state-of-the-art*

**Thank you for your attention !!**

**Contact:**



**WIP Renewable Energies  
Dr. Ilze Dzene, Dr. Rainer Janssen**

**Address: Sylvensteinstr. 2, D-81369 Munich, Germany**

**E-mail: [ilze.dzene@wip-munich.de](mailto:ilze.dzene@wip-munich.de)**

**E-mail: [rainer.janssen@wip-munich.de](mailto:rainer.janssen@wip-munich.de)**

**URL: [www.wip-munich.de](http://www.wip-munich.de)**

