WORKSHOP
Energy Big Push

Axis 2 - Performance Indicators of SES

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Objective

Proposal of performance indicators for selected Sustainable Energy Solution

Steps:

- Literature Review:
  Map the main SES performance indicators – technical, economic, social and environmental

- Evaluate the applicability and comprehensiveness of indicators
  Methodological considerations, interlinkages, etc.

- Provide preliminary results for validation and improvement of study results
  Brasilia workshop

- Final report
  Workshop inputs / insights

Indicators: what, why, how?

‘ A measure based on verifiable data that conveys information about more than just itself ’

(Biodiversity International Partnership, 2011)

- Beyond basic statistics and data
- Purpose dependent → issue of concern
- Holistic approach for decision-making

  Implications of selected energy, environmental and economic programmes, policies and plans, and their impacts on the shaping of development
- Interlinkages and trade-offs among various dimensions of sustainable development

Desirable attributes of indicators

- Relevant to users' needs

  Responsive to change in the issue of concern

- Scientifically valid

  Consensus on the causal relationship between the indicator and its purpose

- Practical

  Data availability, regular update and reasonable effort

→ Performance indicators: evaluate different energy production and use options relative to sustainability aspects

Environmental indicators

Water Use

Water Quality and Aquatic Biodiversity

Land Use

Soil Quality and Terrestrial Biodiversity

Greenhouse Gas Emissions

Non-GHG Emissions

Vulnerability and Risks

Techno-economic indicators

Efficiency of Energy Conversion and Use

Technology Readiness Level (TRL)

Technology Ownership

CAPEX

OPEX

Total Costs

Associated Infrastructure Requirements

Energy Diversity

Supply Chain Readiness

Social indicators

Job Creation

Income Generation

Access to Electricity

Directly Affected Population

Occupational Injury, Illness and Fatalities

Respect to Communities

Risks to Cultural Heritage

Political-institutional indicators

Simplicity of Environmental Licensing Process

Compatibility with Energy Policy and International Agreements

Compatibility with Regulatory and Institutional Framework

Selection of SES

- Sector level: current and future relevance with respect to economic performance, participation in energy supply and demand and environmental impacts
- Technology level: identified potential for deployment at scale in Brazil, future prospects regarding learning curves, relevance in energy policy and strategic development

Indicator assessment in Axis 2 → Pinpoint technologies that shall constitute the roadmap to the ecological transition and set the path to the Big Push for Sustainability in Brazil.

Selection of SES

Centralized Power Generation

Large Hydro
Small Hydro
Thermo power (bagasse)
Thermo power (biomass)
Solar PV
CSP
Onshore Wind
Offshore Wind

Mini / Micro Power Generation

Thermo power (biogas, agricultural residues)
Solar PV

Transportation

Light-duty vehicles (BEV, hybrid)
Urban buses (BEV, hybrid)
Trucks (BEV, hybrid)

Biofuels

Bioethanol
Biodiesel
Biogas (urban solid waste)
Biokerosene

Energy distribution and storage

Batteries
Smart grids

Preliminary Proposal of Performance Indicators Associated with Sustainable Energy Solutions

Environmental indicators

- Water Use
- Water Quality and Aquatic Biodiversity
- Land Use
- Soil Quality and Terrestrial Biodiversity
- Greenhouse Gas Emissions
- Non-GHG Emissions
- Vulnerability and Risks

Techno-economic indicators

- Efficiency of Energy Conversion and Use
- Technology Readiness Level (TRL)
- Technology Ownership
- CAPEX
- OPEX
- Total Costs
- Associated Infrastructure Requirements
- Energy Diversity
- Supply Chain Readiness

Social indicators

Job Creation

Income Generation

Access to Electricity

Directly Affected Population

Occupational Injury, Illness and Fatalities

Respect to Communities

Risks to Cultural Heritage

Political-institutional indicators

Simplicity of Environmental Licensing Process

Compatibility with Energy Policy and International Agreements

Compatibility with Regulatory and Institutional Framework

Technology Readiness Level (TRL)

TRL for all selected SES is 9

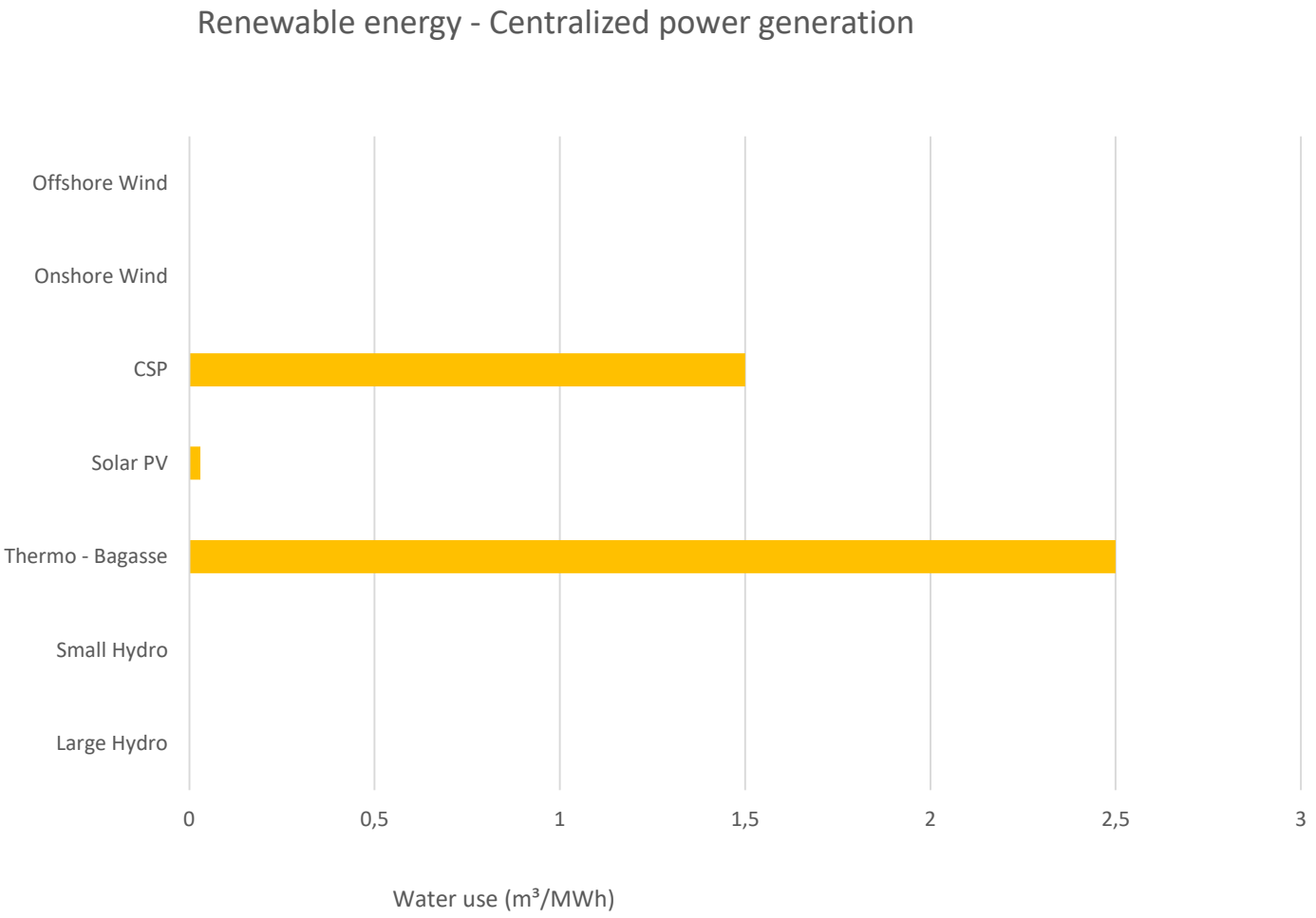
→ TRL 9: *Actual system proven through mission operation*

Except for:

- BEV buses
- BEV trucks
- Hybrid trucks

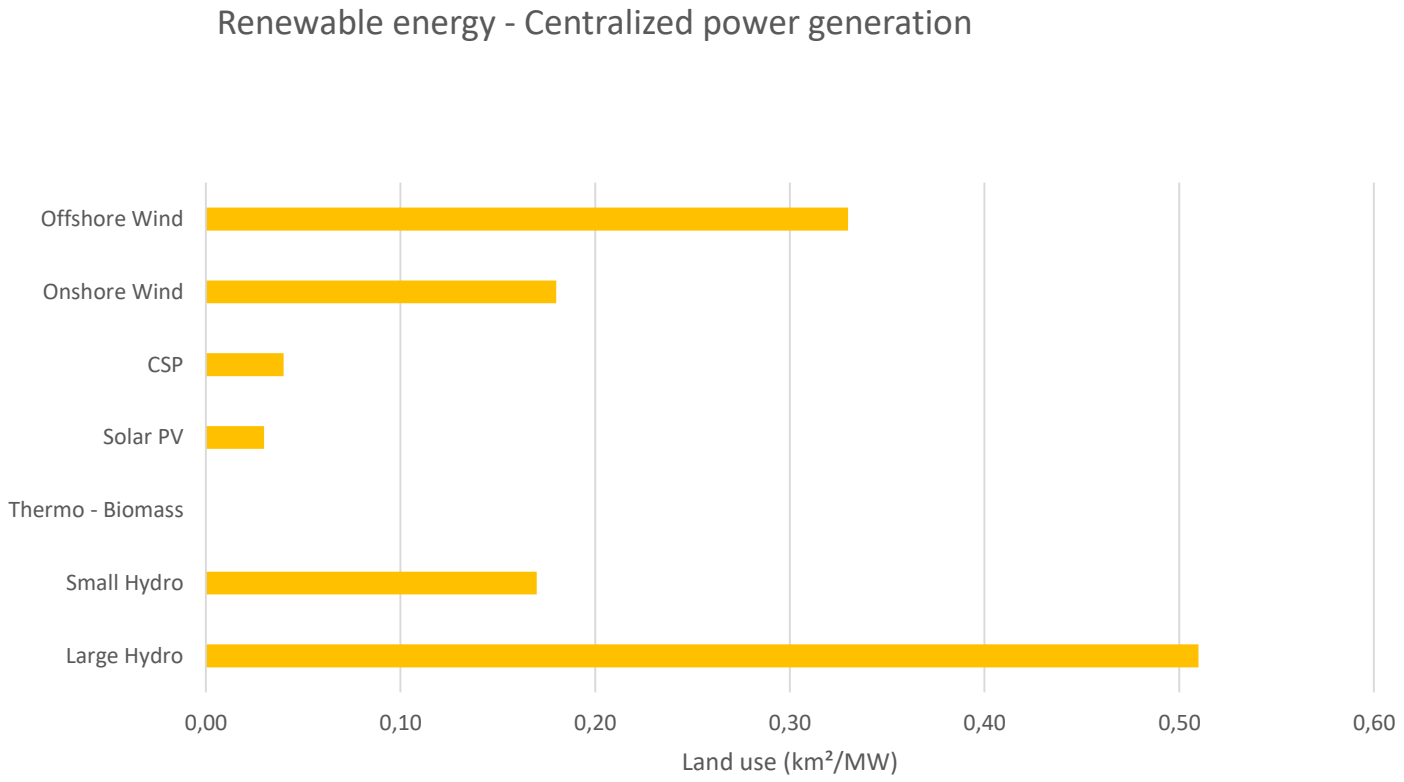
For which TRL is 8: *Actual system completed and qualified through test and demonstration*

Power generation – Water use



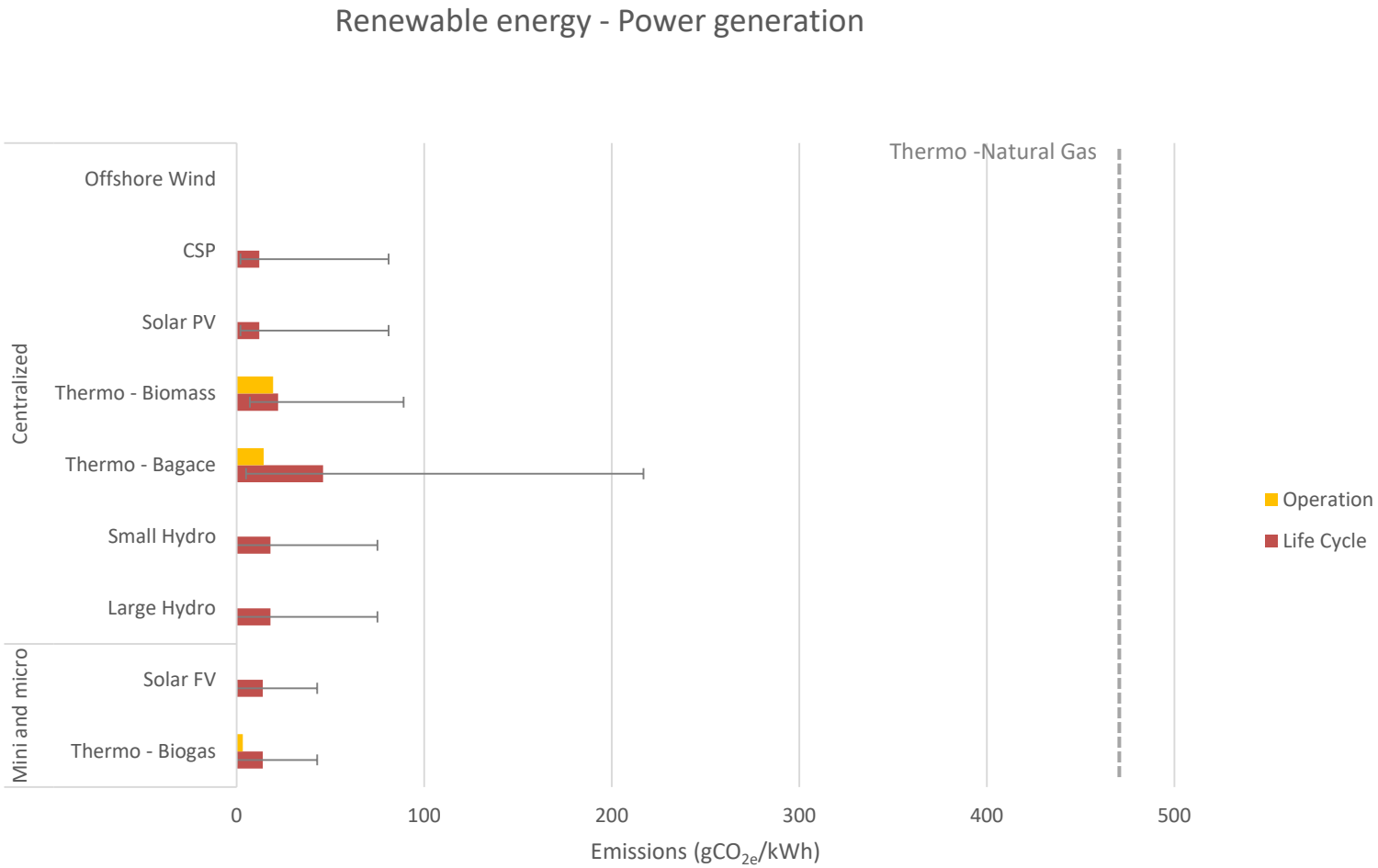
Source: (ANA, 2019; Bukhary, Ahmad e Batista, 2018)

Power generation – Land use



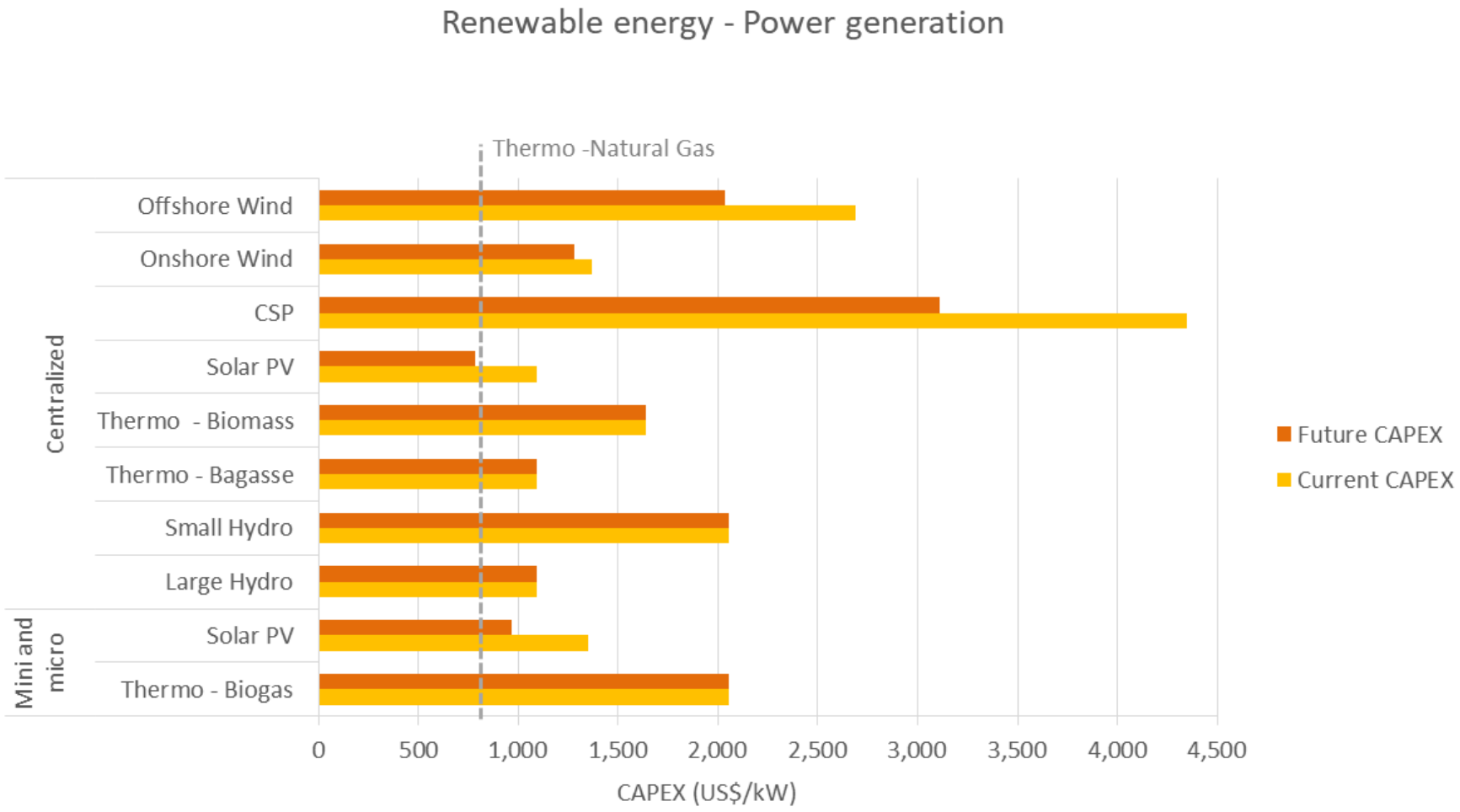
Source: (EPE, 2017; Bukhary, Ahmad e Batista, 2018; Simsek, Watts e Escobar, 2018; Musial et al., 2016)

Power generation – Greenhouse Gas Emissions



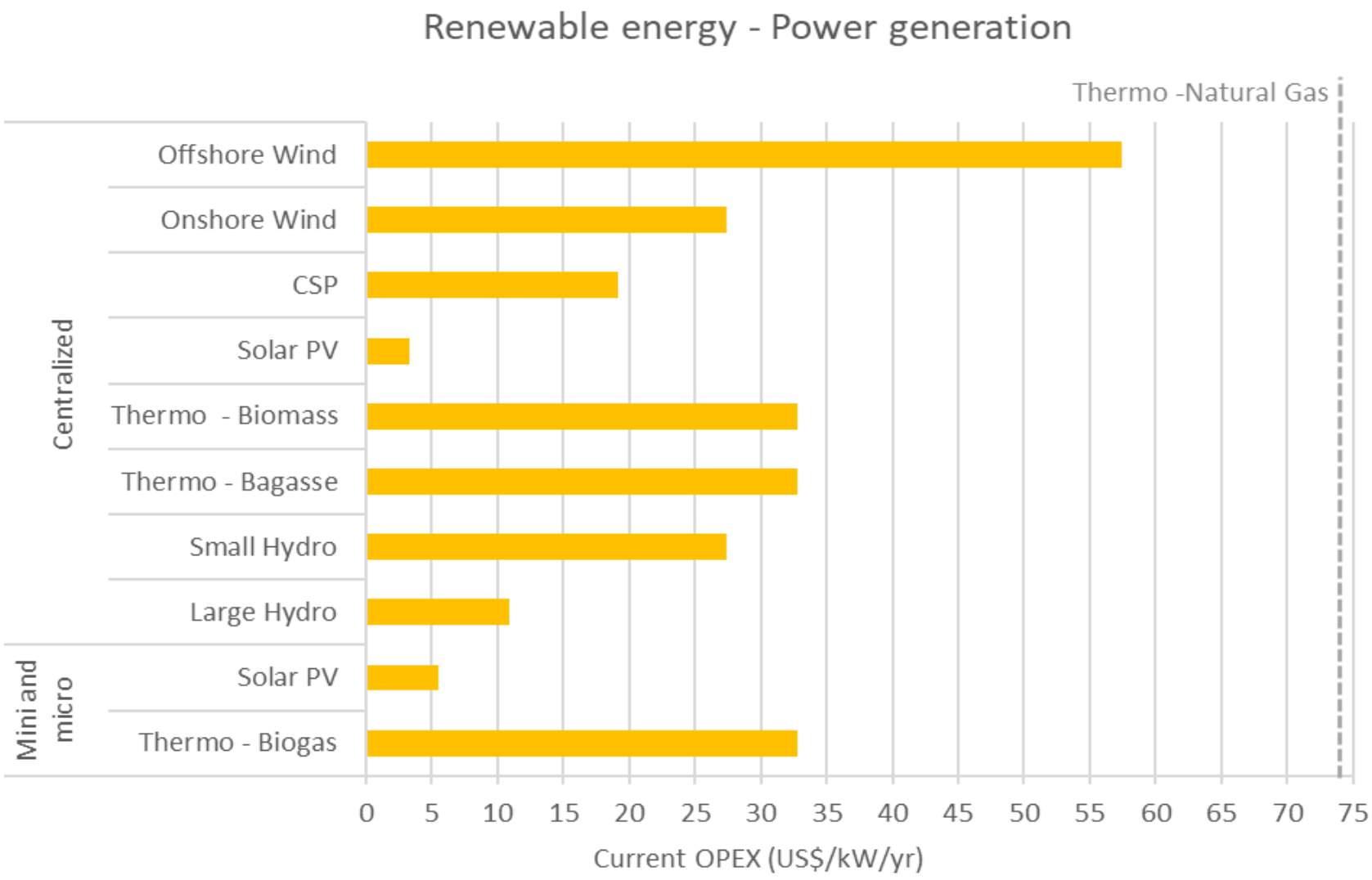
Source: IPCC (IPCC, 2006; Edenhofer et al., 2011)

Power generation - CAPEX



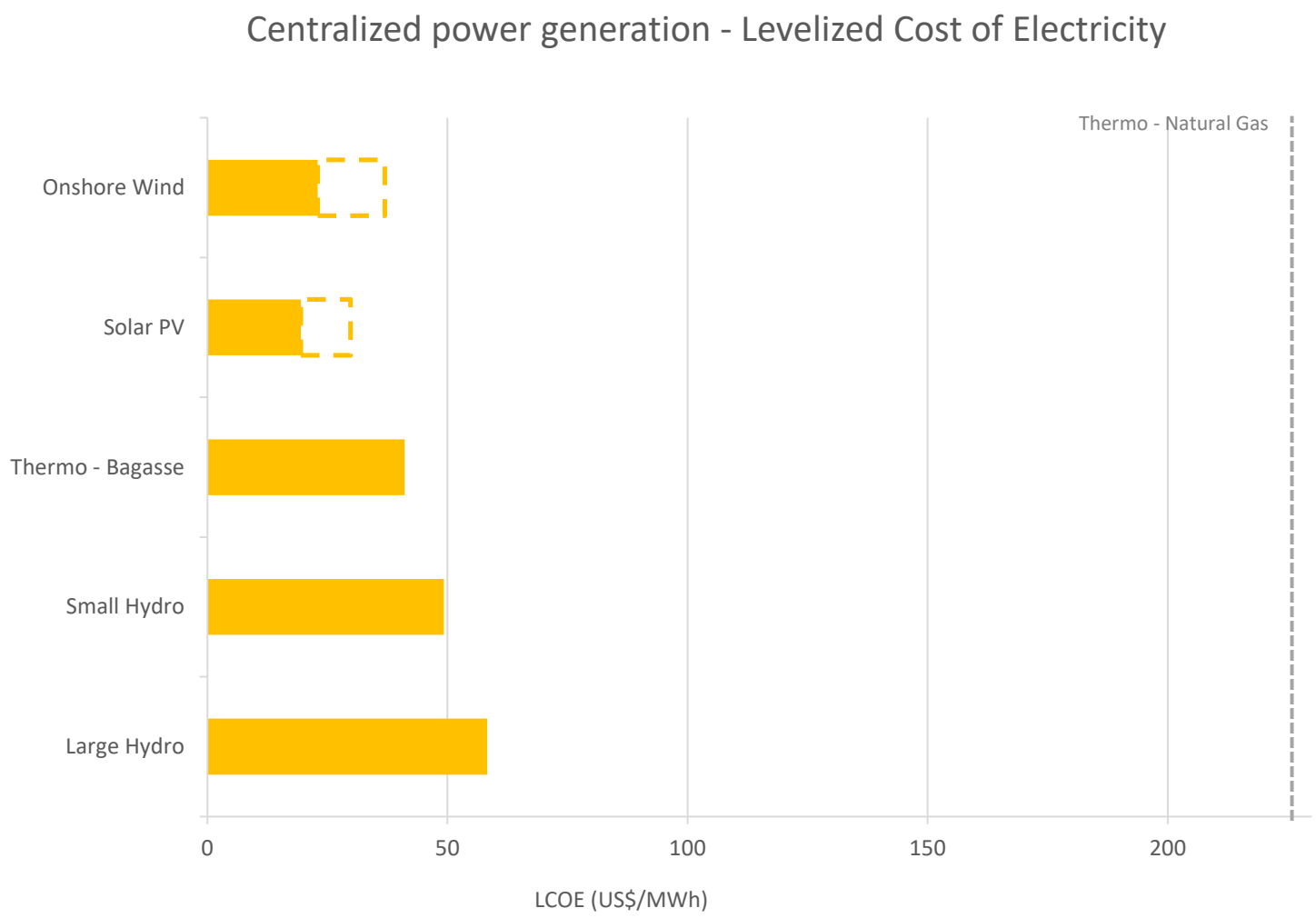
Source: (EPE, 2017, 2018c)

Power generation - OPEX



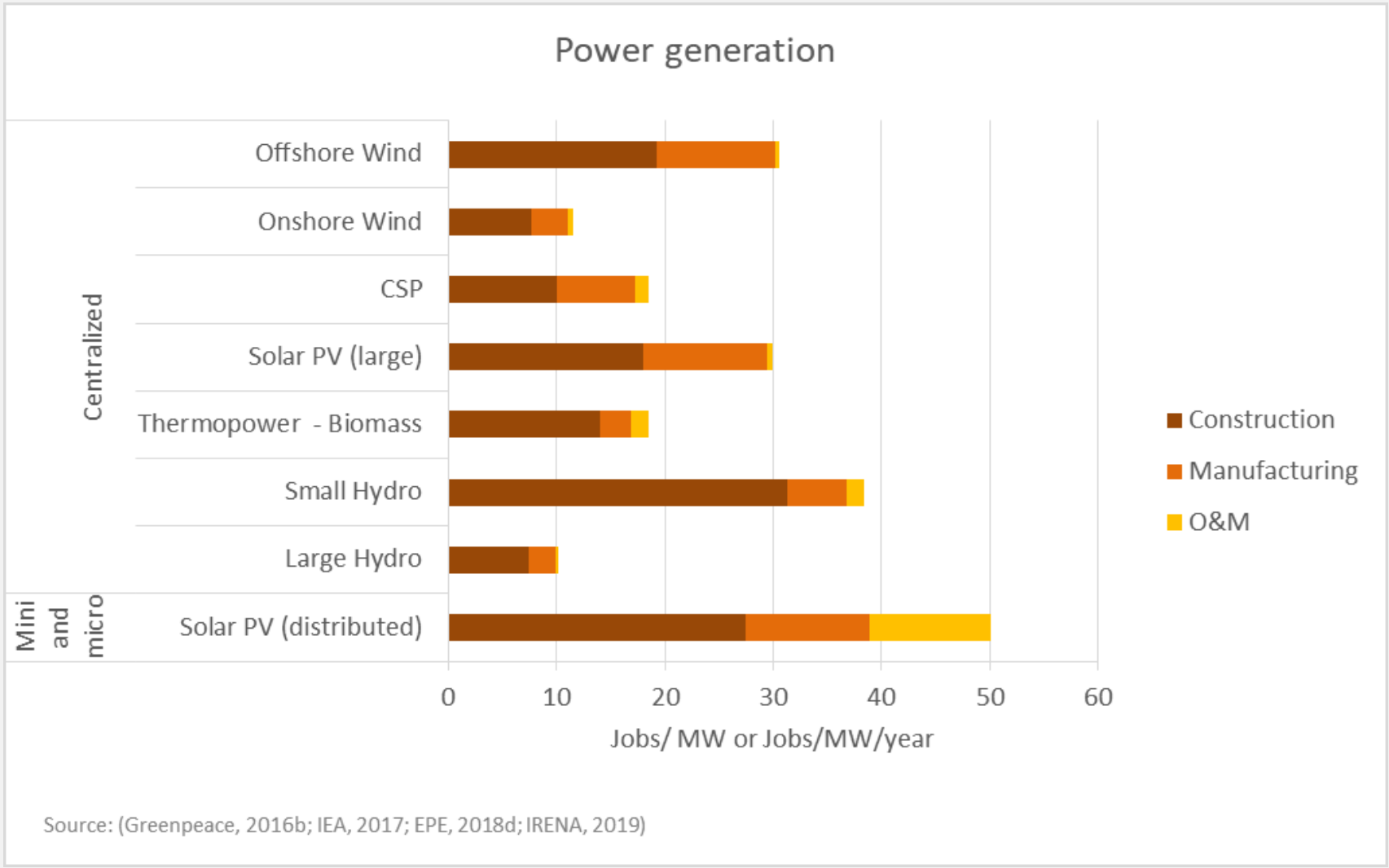
Source: (EPE, 2018c)

Power generation - LCOE



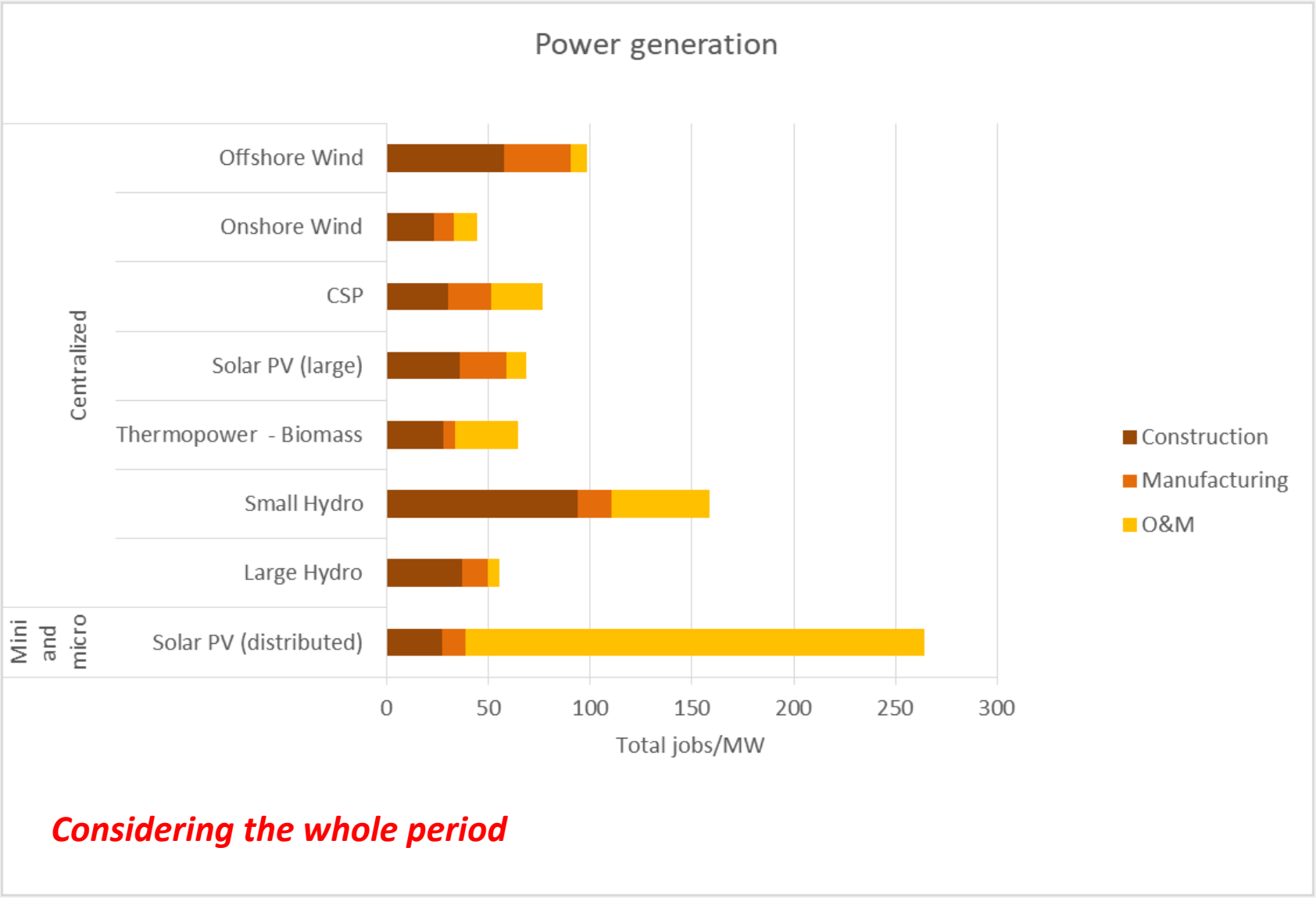
Source: (PSR, 2018)

Power generation - Jobs



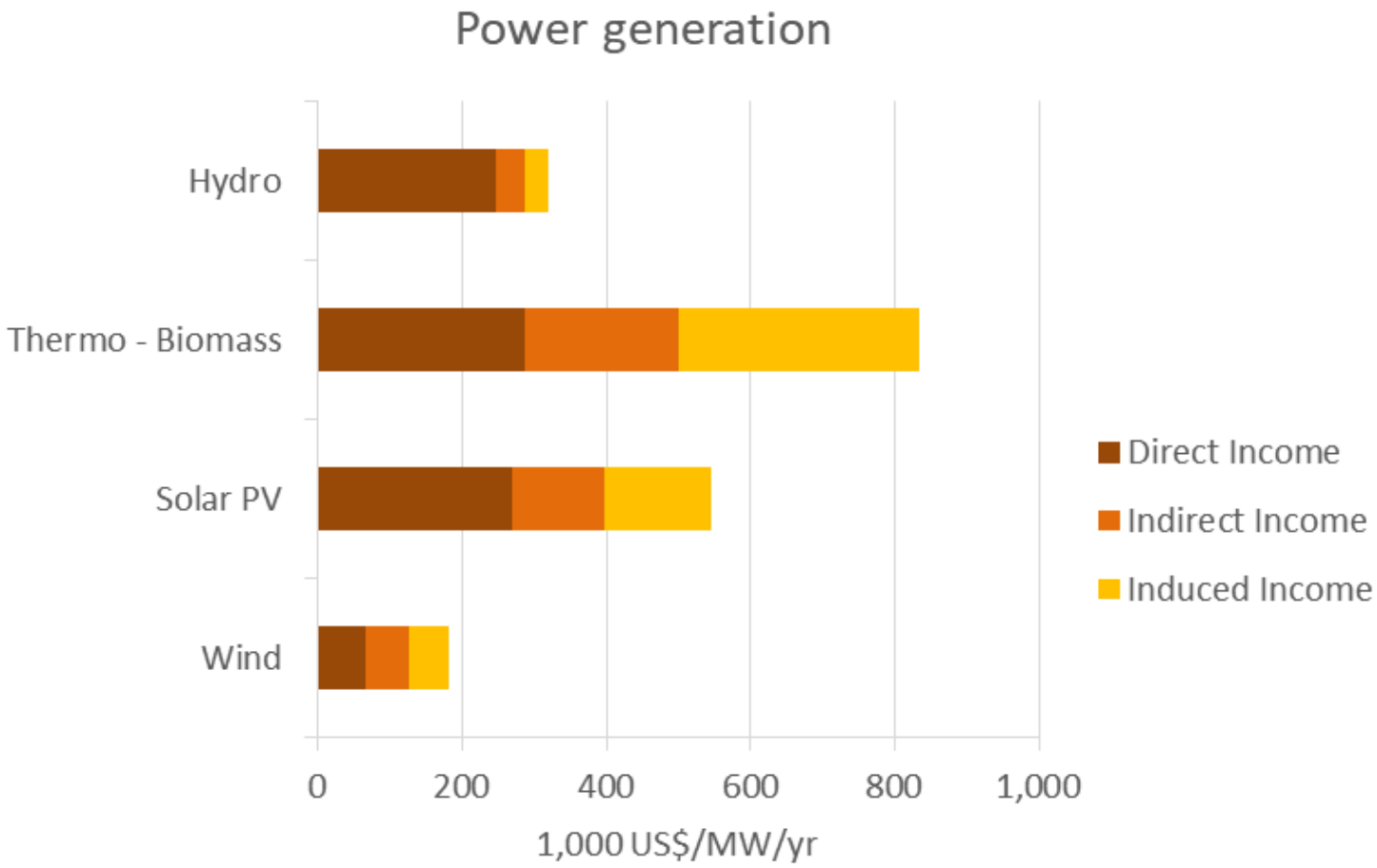
Source: (Greenpeace, 2016b; IEA, 2017; EPE, 2018d; IRENA, 2019)

Power generation – Jobs



Considering the whole period

Power generation - Income



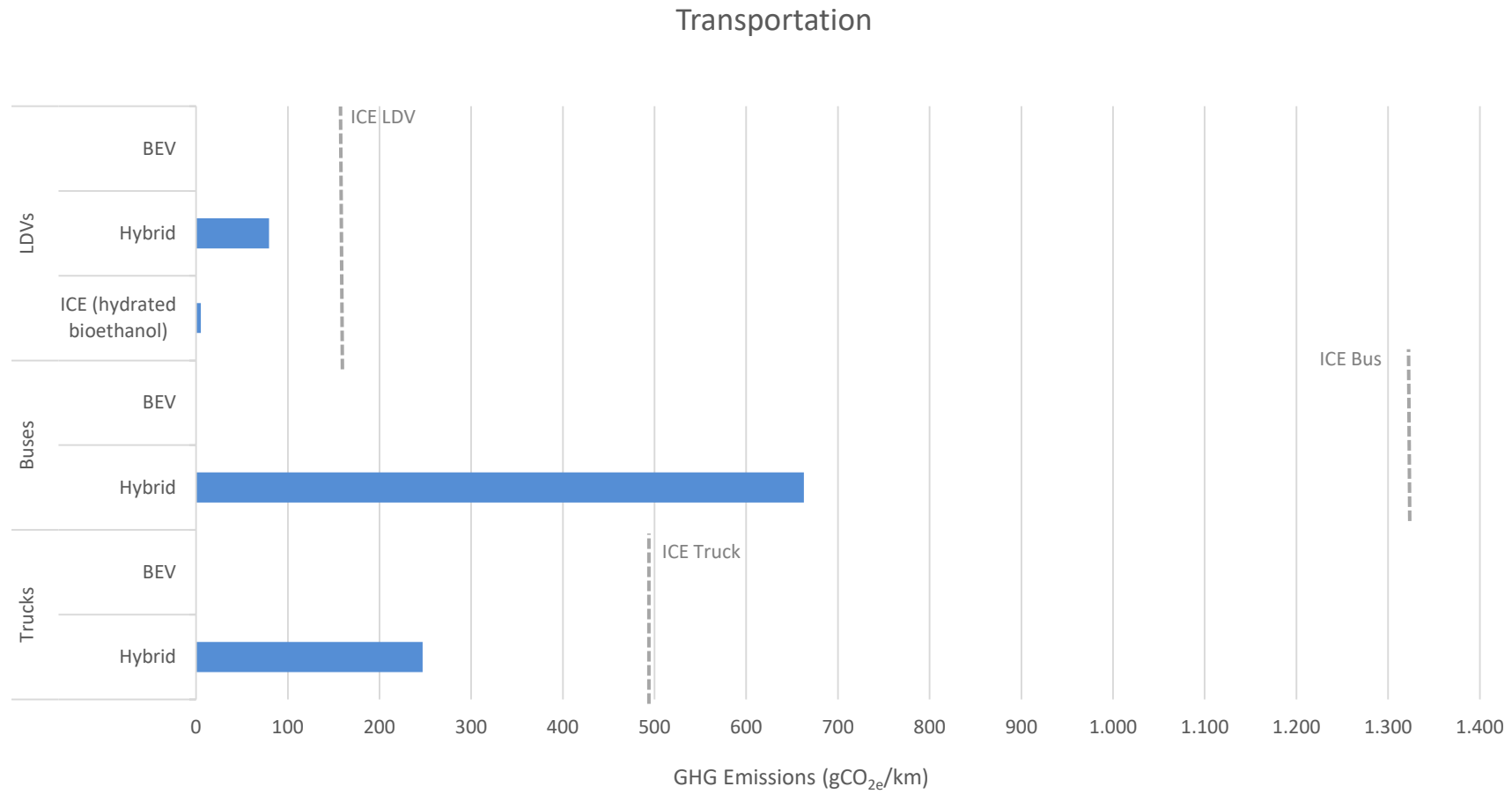
Source: Calculations based on (NREL, 2018)

Power generation

Other aspects to be considered

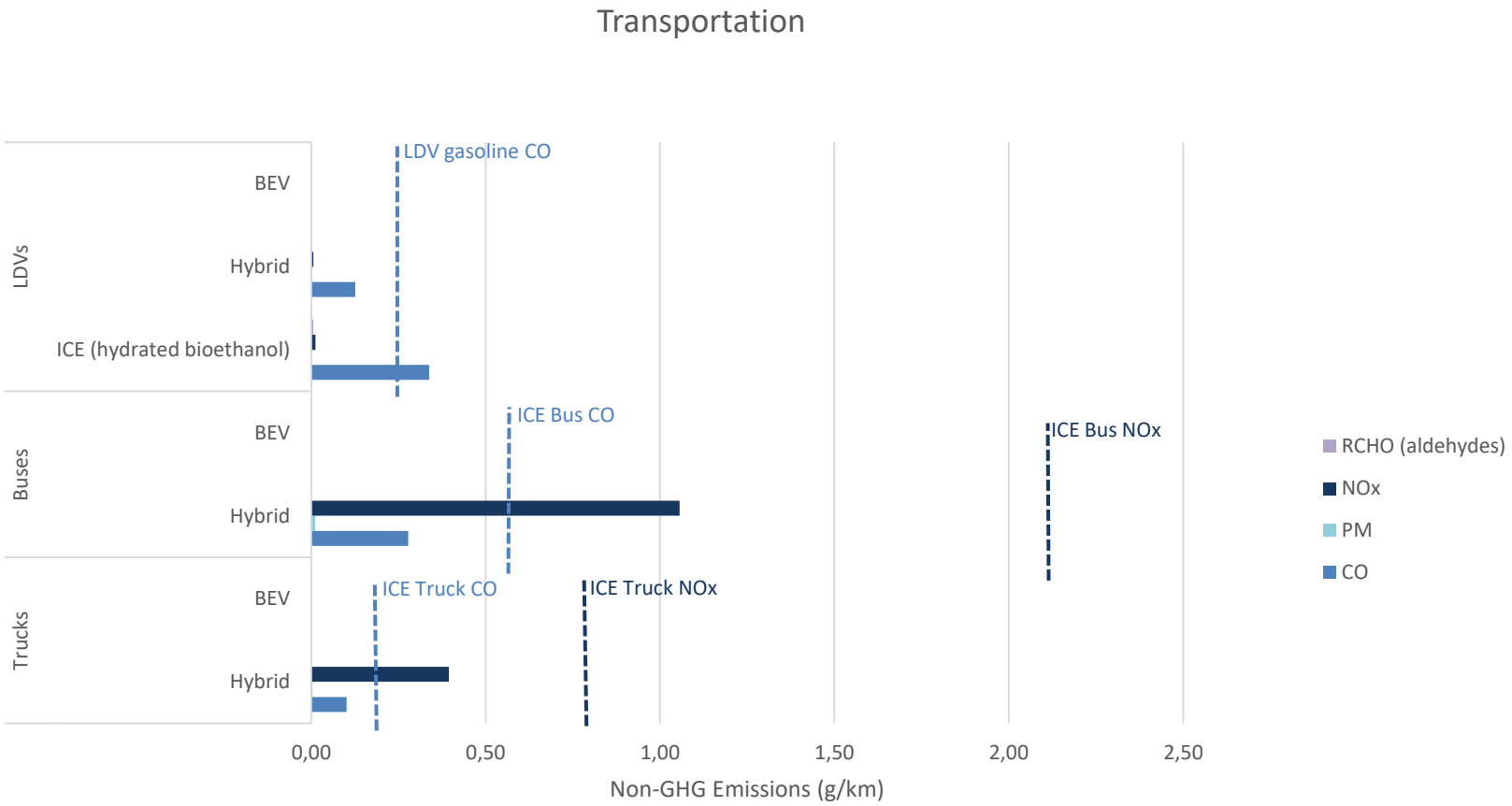
- Intermittency
- Reliability
- Risks

Transportation - Greenhouse Gas Emissions



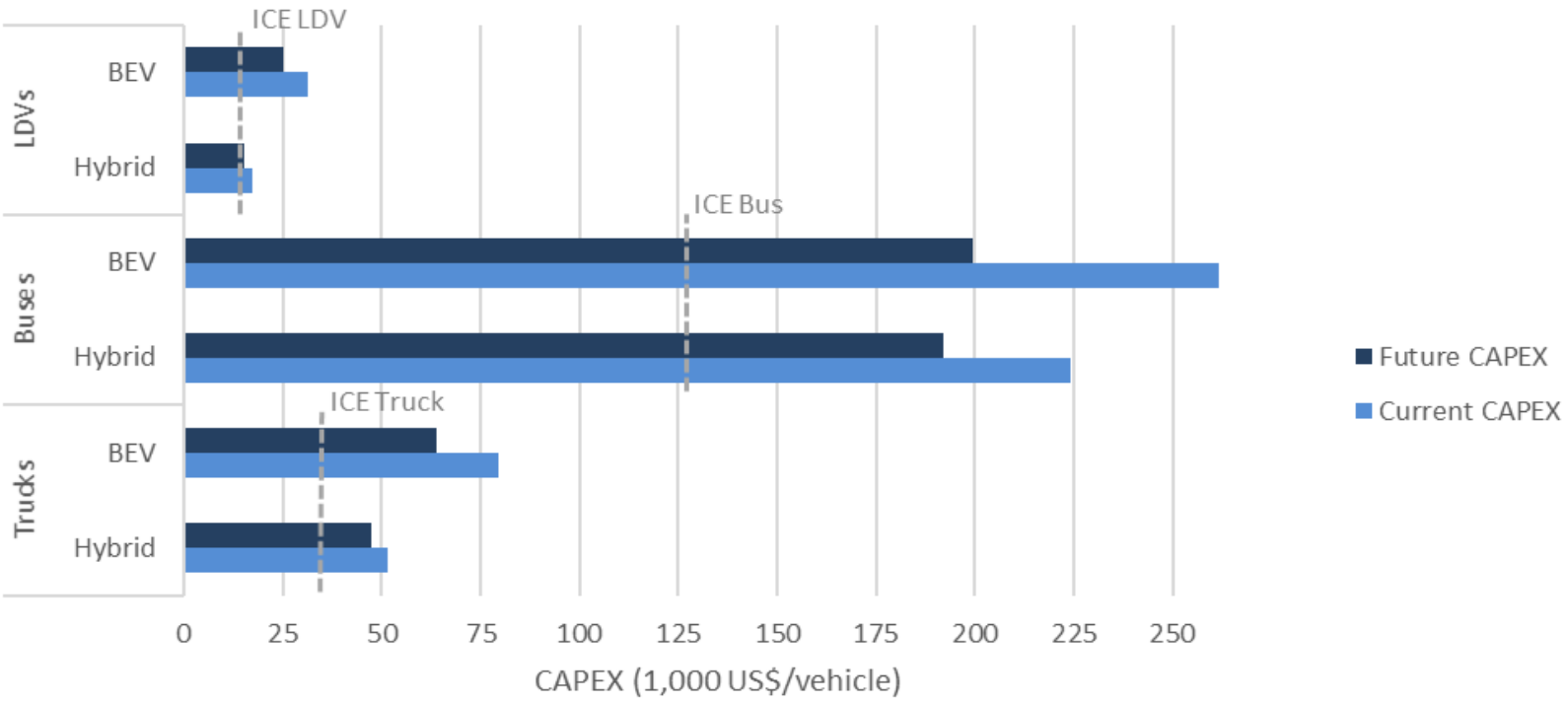
Source: (CETESB, 2019)

Transportation – Non-GHG emissions



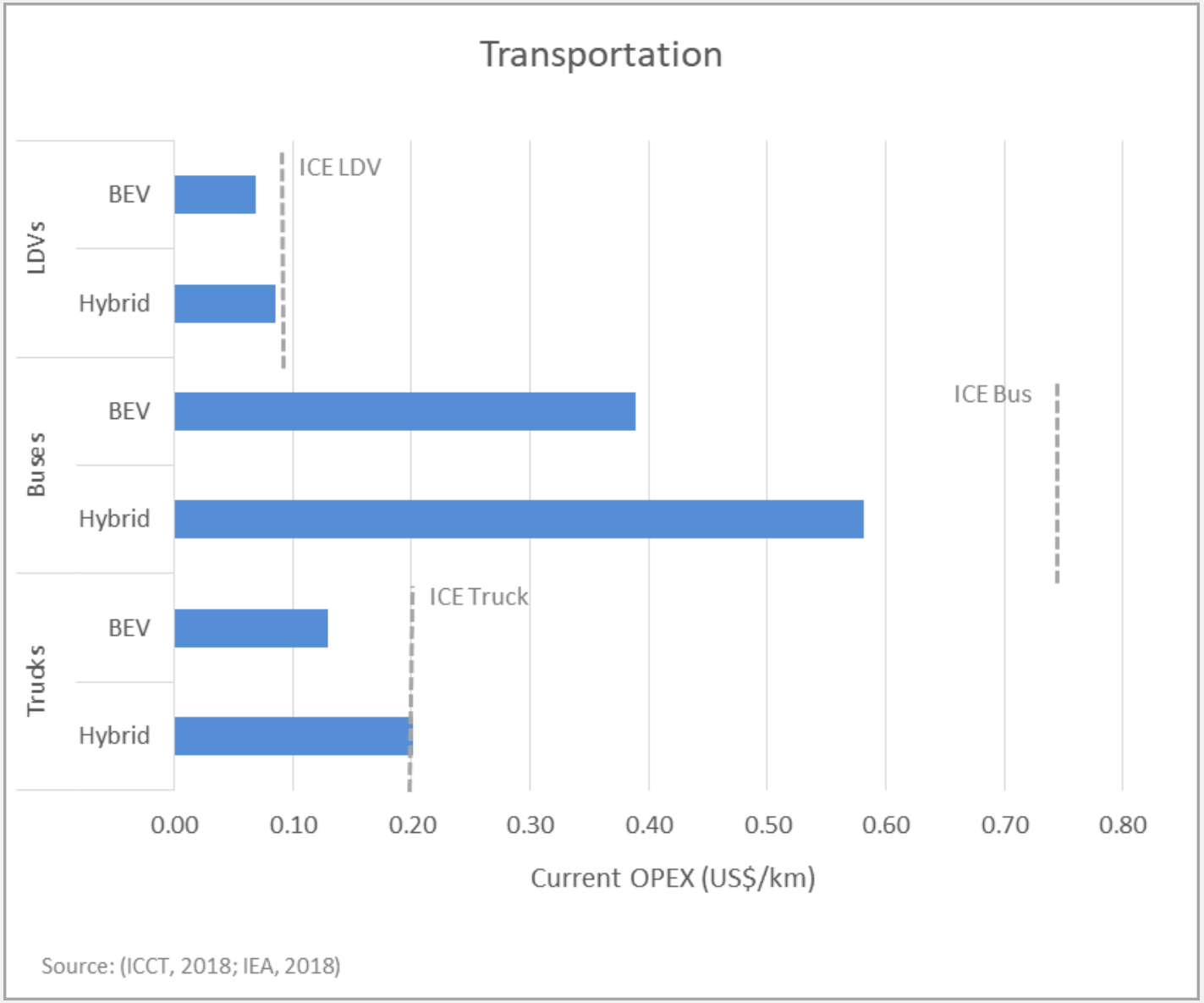
Source: (CETESB, 2019)

Transportation - CAPEX

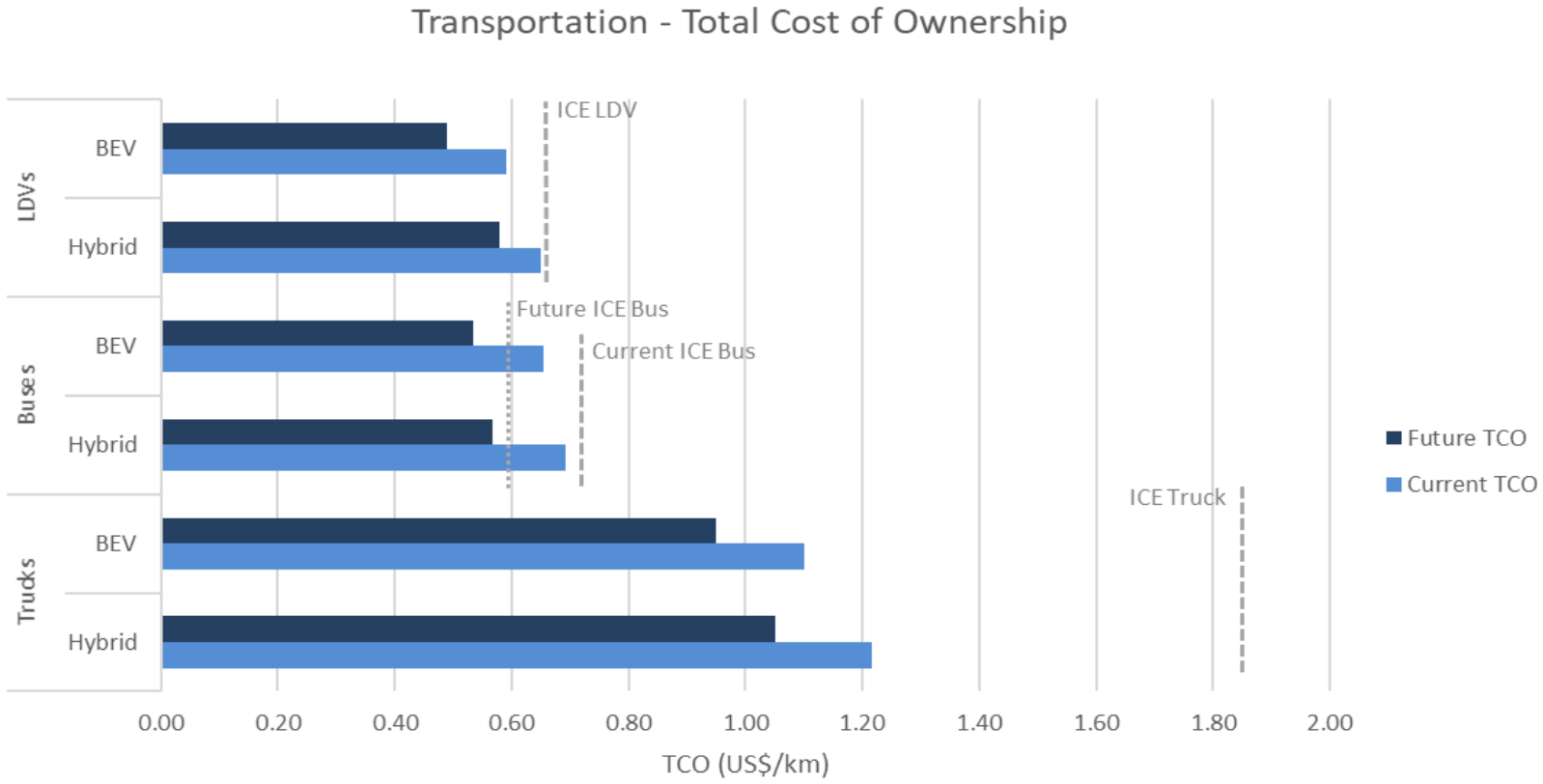


Source: Market values and (C40, 2013; Delft, 2013; DLR, 2015; Greenpeace, 2016a; ICCT, 2018; UCS, 2018)

Transportation - OPEX



Transportation - TCO



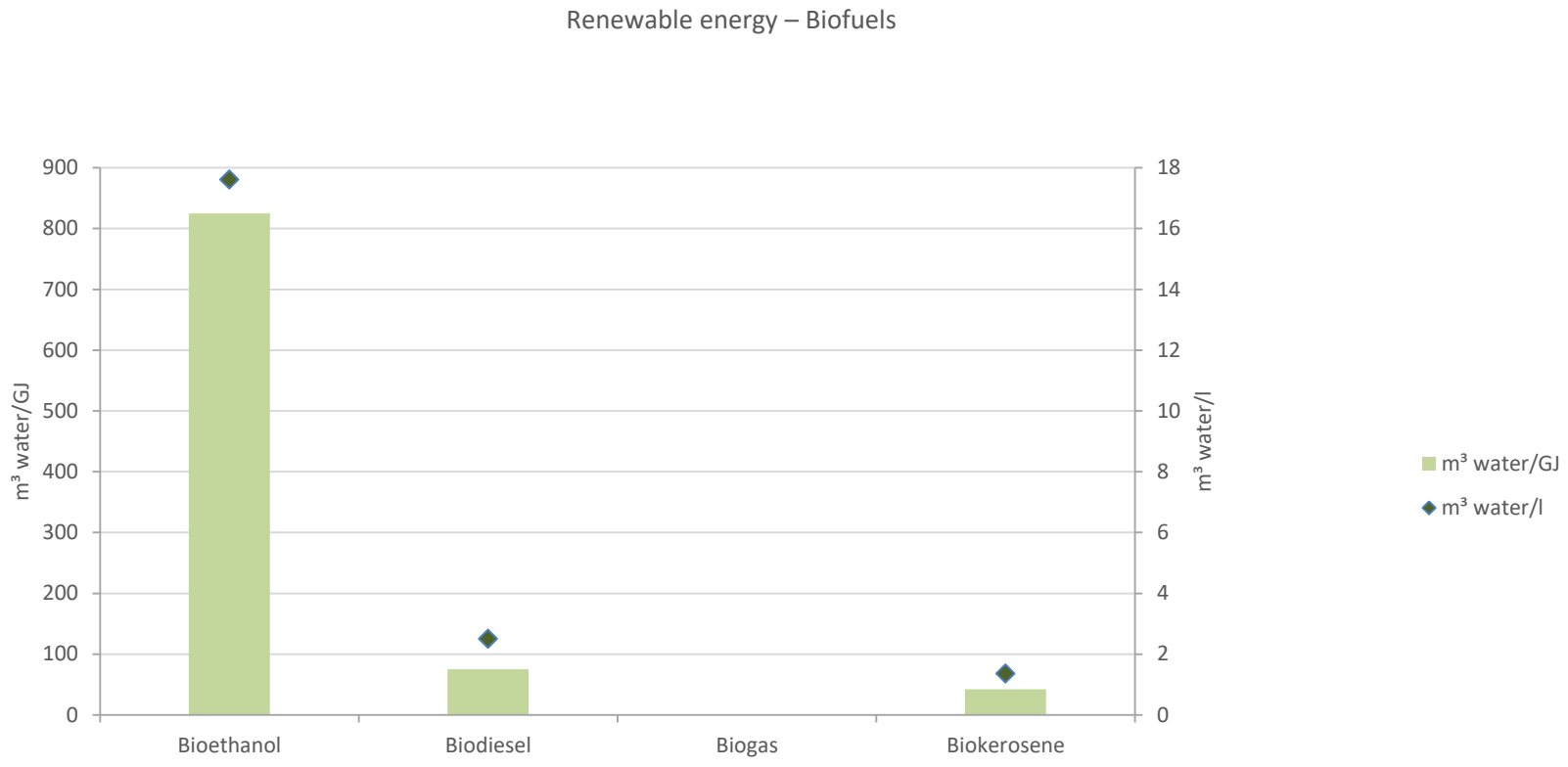
Source: (Hagman et al., 2016; Lajunen e Lipman, 2016; ICCT, 2018; IEA, 2019)

Transportation

Other aspects to be considered

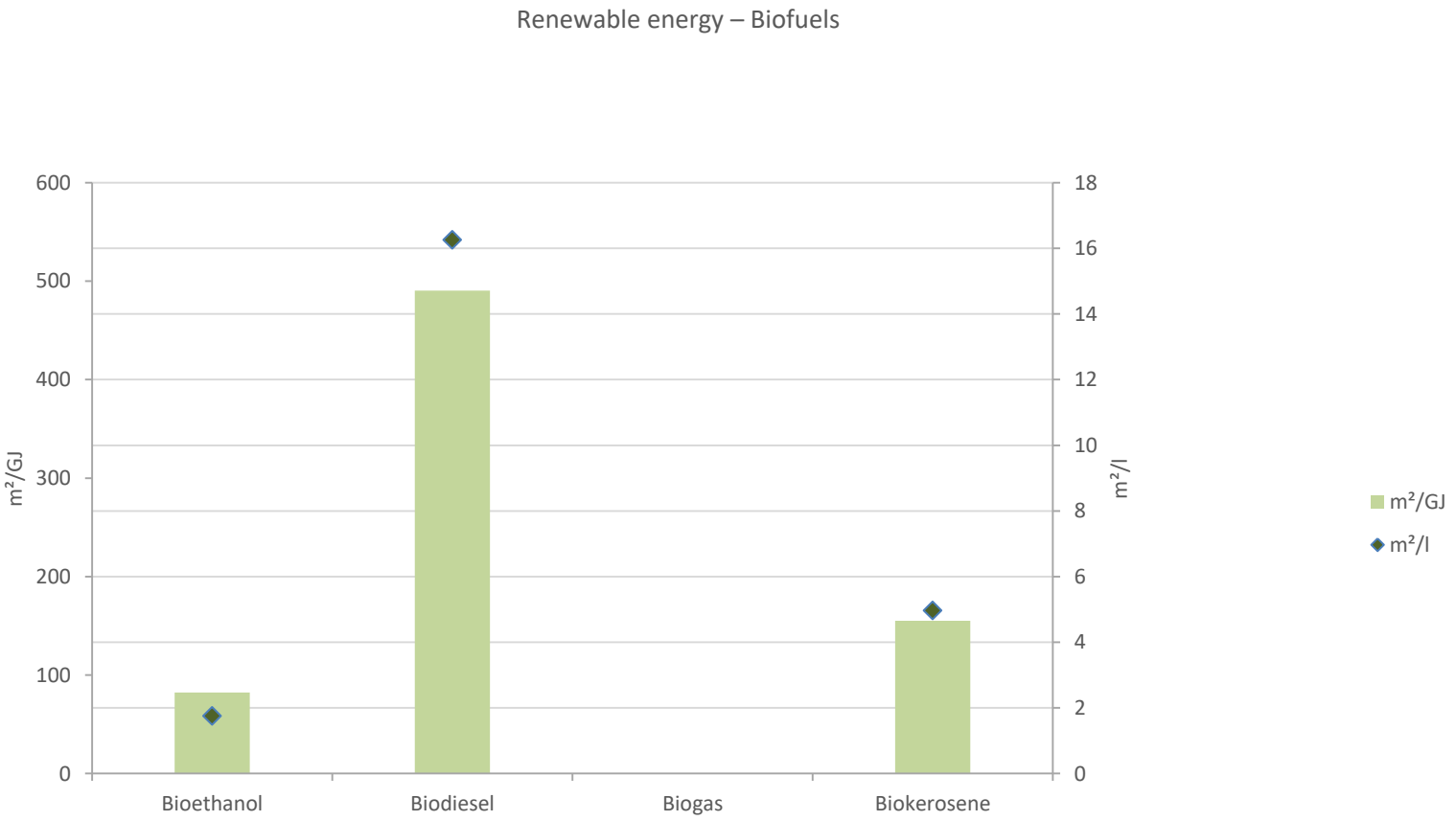
- Other modals
- Investments in infrastructure
- Co-benefits

Biofuels – Water use



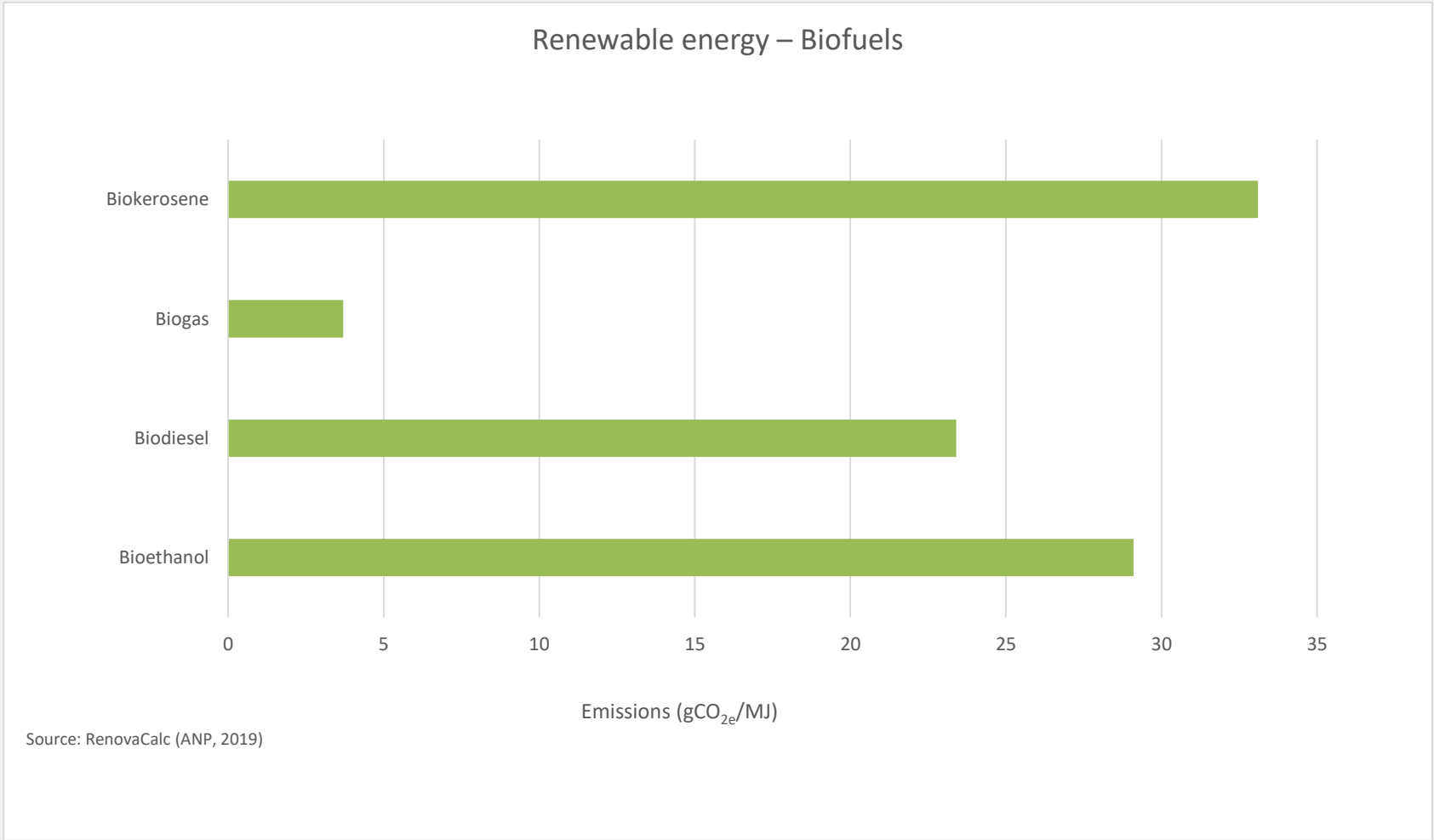
Source: RenovaCalc (ANP, 2019)

Biofuels – Land use



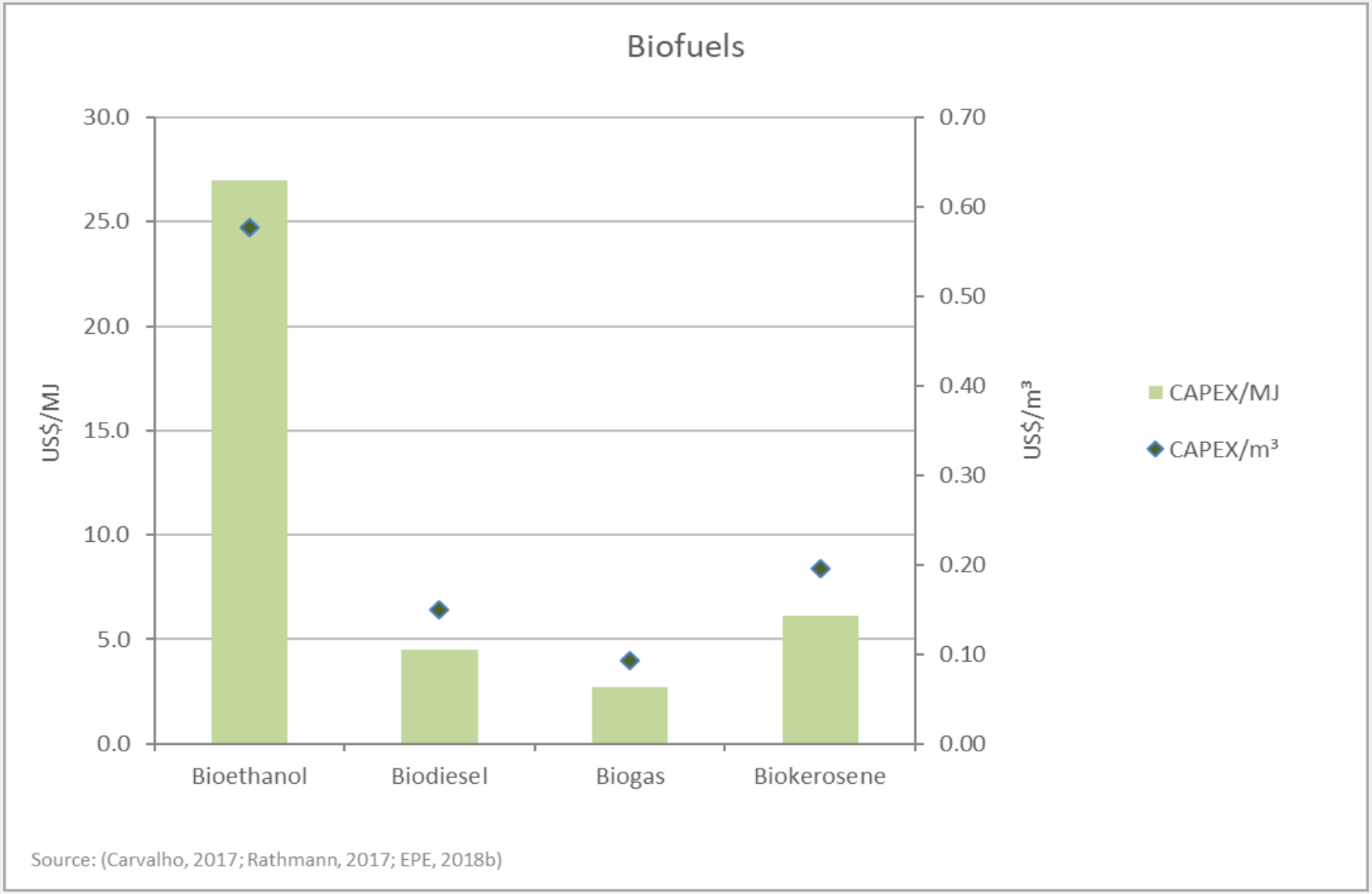
Source: RenovaCalc (ANP, 2019)

Biofuels - Greenhouse Gas Emissions



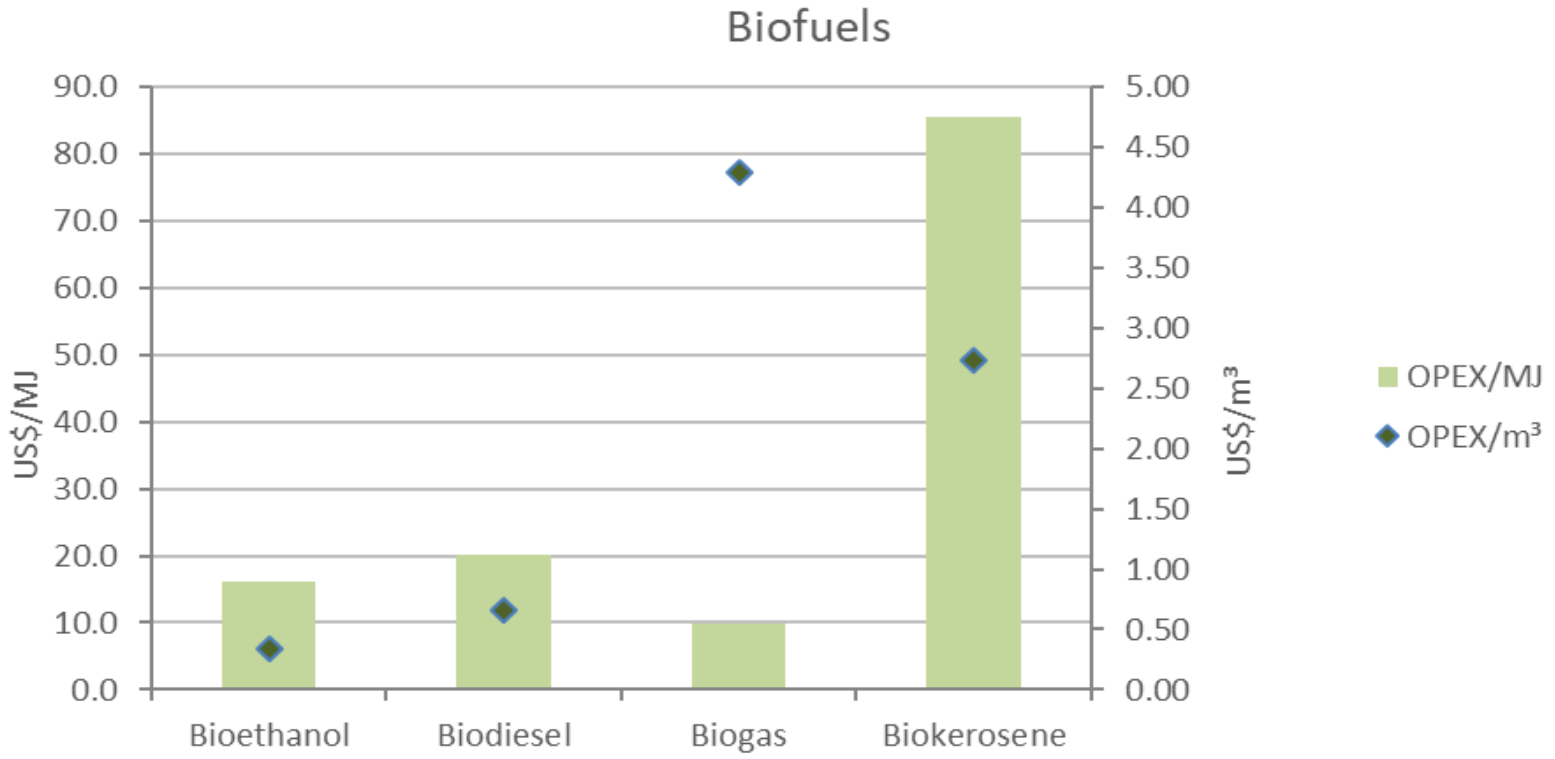
Source: RenovaCalc (ANP, 2019)

Biofuels - CAPEX



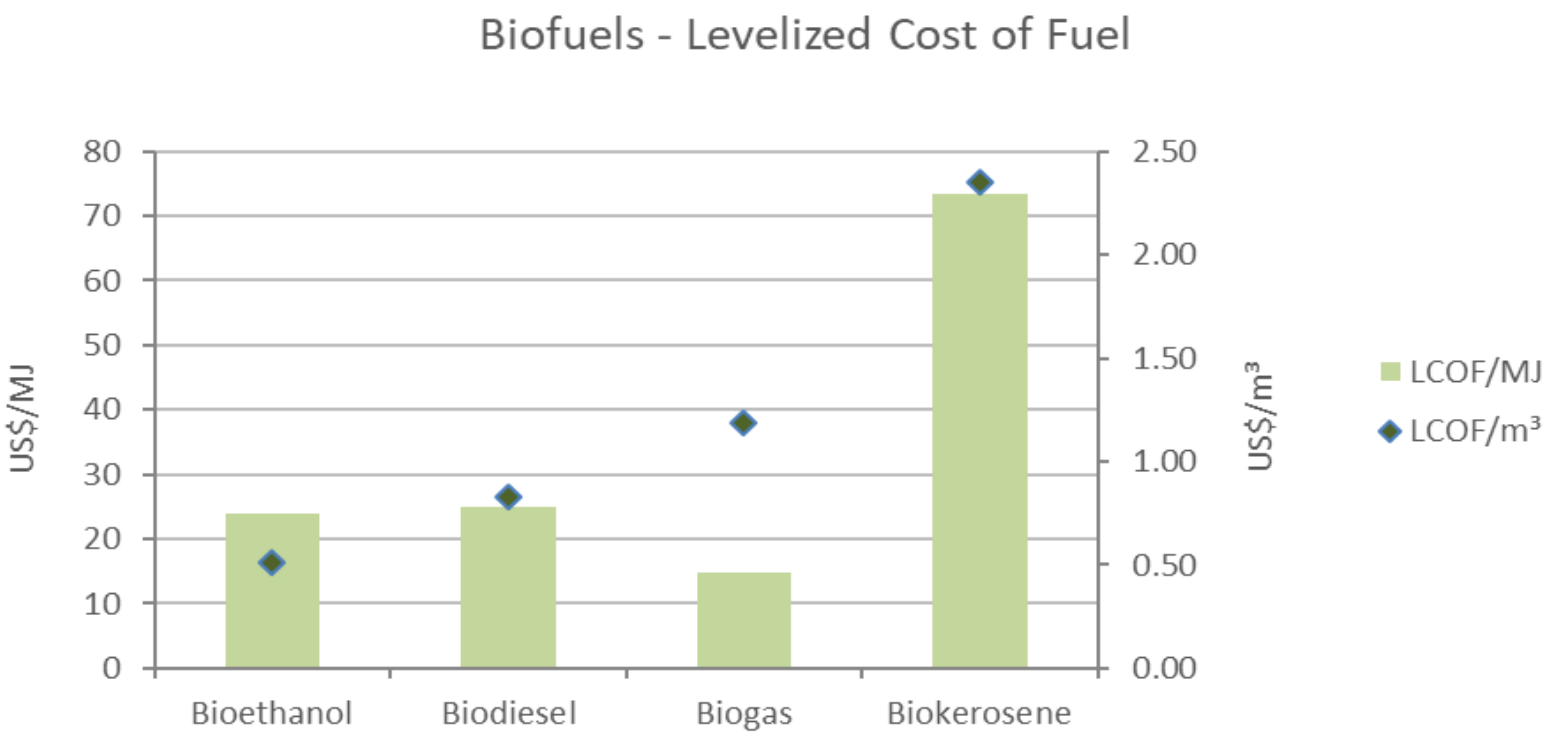
Source: (Carvalho, 2017; Rathmann, 2017; EPE, 2018b)

Biofuels - OPEX



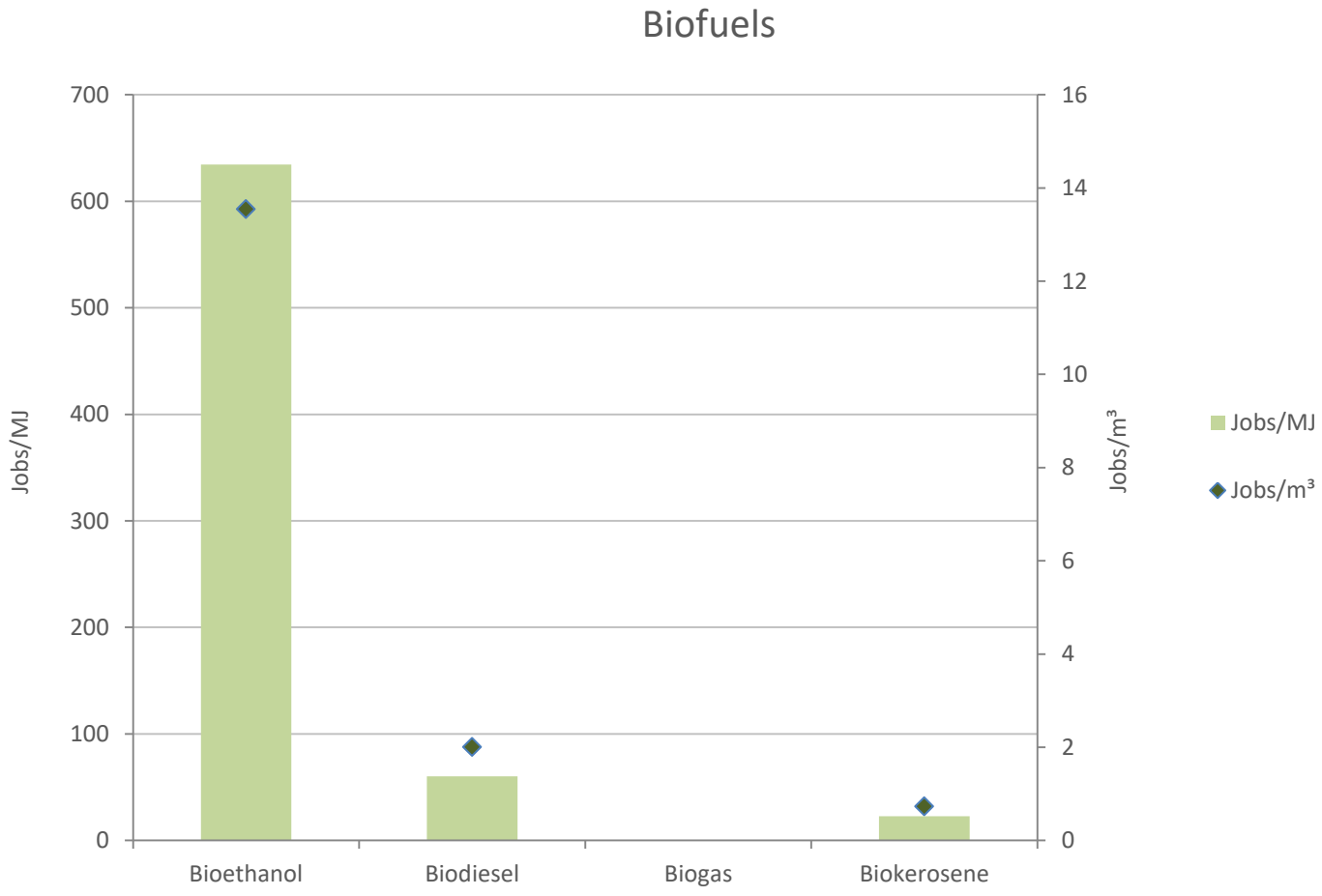
Source: (Carvalho, 2017; Rathmann, 2017; EPE, 2018b)

Biofuels - LCOF



Source: (Carvalho, 2017; Rathmann, 2017; EPE, 2018b)

Biofuels – Jobs



Source: (Wei, Patadia e Kammen, 2010; ANP, 2019; REN21, 2019)

Biofuels

Other aspects to be considered

- Pressure on land use
  Deforestation, sensitive biomes

Final considerations

- No silver bullet
- Weighted aspects, priorities
- The right questions to ask → a panel of indicators can be useful to help decision makers navigate by offering technical information on multiple dimensions
- Well informed decision making and coordinated efforts to foster the Big Push

Thank you!

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