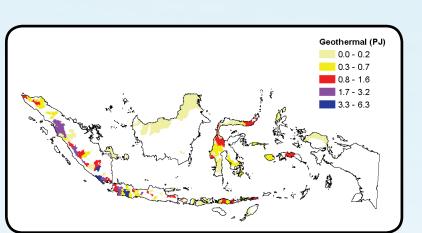


# An optimal renewable energy mix for Indonesia

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## Resources



Source: Ministry of Energy and Mineral Re-

Geothermal potential.

Woody biomass potential.

Source: Global Forest Model (G4M), IIASA.

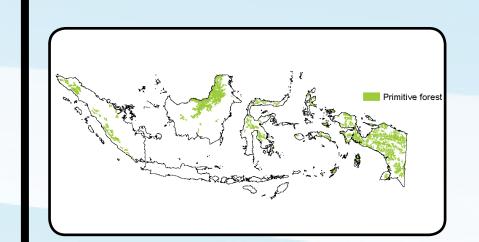
Geothermal & woody biomass are used as resources for a first approach.

Biomass can be traded between all the islands.

# Background and introduction

the government of Indonesia has established a 23 percent target for renewable energy by 2025, along with a 100 percent electrification target by 2020. The following approach will present how Indonesia can increase its renewable energy share in the power sector under diverse scenarios.

#### Environmental constraints



Indonesian primitive forest. Source: WRI, 2016. The primitive forest has been either used with some sever constraint or not at all for the production of power regarding the scenario.

# Techno-economic

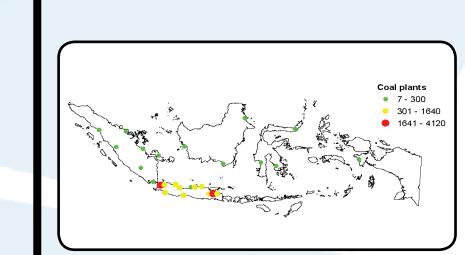
parameters

- Set up cost
- Production cost
- Production efficiency
- Emissions

# the cost of the full supply chain

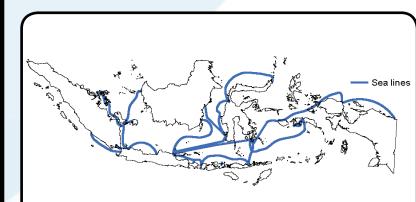
the cost of the full supply chain for the welfare of Indonesia, to identify optimal locations of renewable energy production plants.

#### Infrastructure



Existing coal plants (MW) suitable for co-firing.

Source: carma.org.



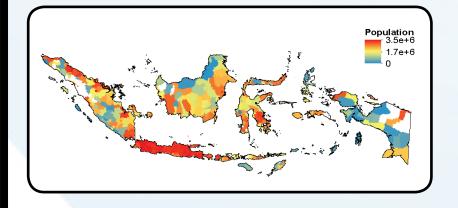
Major sea routes between the islands in Indonesia.

Source: Esri, 2016.

- Existing conversion sites
- Road, rail network, shiping lines
- Power stations
- Power lines
- Distribution costs

Power units can be setup at remote off-grid areas or/and grid connected areas.

# Energy demand



Indonesia population per province. Source: World Bank, 2015.

The energy demand is derived based on the population map and the provincial power consumption.

# Policy parameters

- Carbon tax
- Fossil fuel cost
- Subsidies
- Emission factors



#### Scenarios and examples of results

### Developed scenarios

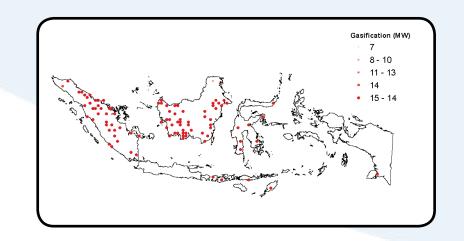
Scenario number	Demand <sup>1</sup>	Target <sup>2</sup>	Biomass share <sup>3</sup>	Primitive forest <sup>4</sup>
1	Historic	Free	100%	Yes
2	Java	Free	100%	Yes
3	Historic	23%	100%	Yes
4	Java	23%	100%	Yes
5	Historic	Free	20%	No
6	Java	Free	20%	No
7	Historic	23%	20%	No
8	Iava	23%	20%	No

- <sup>1</sup> The "historic demand" follows the the histroic growth of the power demand in each province until 2025.
- The "Java demand" follows the power consumption of Java as target for the other provinces.
- <sup>2</sup> A "free target" let the model optimize an optimal mix of renewable energy technologies for at minimal cost.
- The "23% target" represents a target of 23% of renewable energy mix in the power sector
- tor.

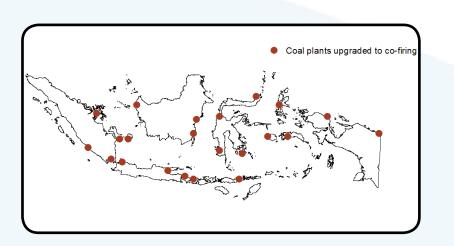
  The biomass share represents the share of the biomass available that can be collected
- <sup>4</sup> The primitive forest is either used for bioenergy up to a harvest share of 20% ("Yes") or not touched at all ("No").

for bioenergy purposes.

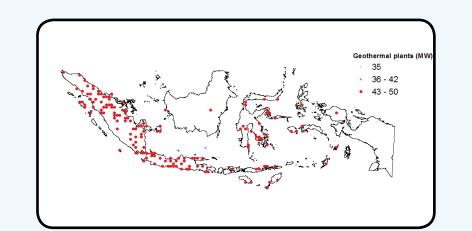
# Optimal plant locations



Gasification production plants based on forest residues (share of 20%) from non primitive forest.



Selection of coal plants to be upgraded into co-firing. A 5% co-firing is assumed. No primitive forest used.



Locations of geothermal plants.

#### Conclusion

- A free target scenario would lead to a 15% renewable energy share under a business as usual for the costs.
- A 23% target scenario would be reached with substantial increase of fossil fuel cost, or implementation of a carbon tax, or subsidies. However, significant contribution of natural gas is still seen to meet demand in areas that have low access to modern energy services.
- Not using the primitive forest would lower the bioenergy potential by a maximum of 4%.

# On-going Work

The model will be developed towards a full energy system (wind mills, solar PV plants, hydro power stations and gas power plants). The project will deliver policy recommendations on the optimal renewable energy mix for each province under given scenarios.

#### More information

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