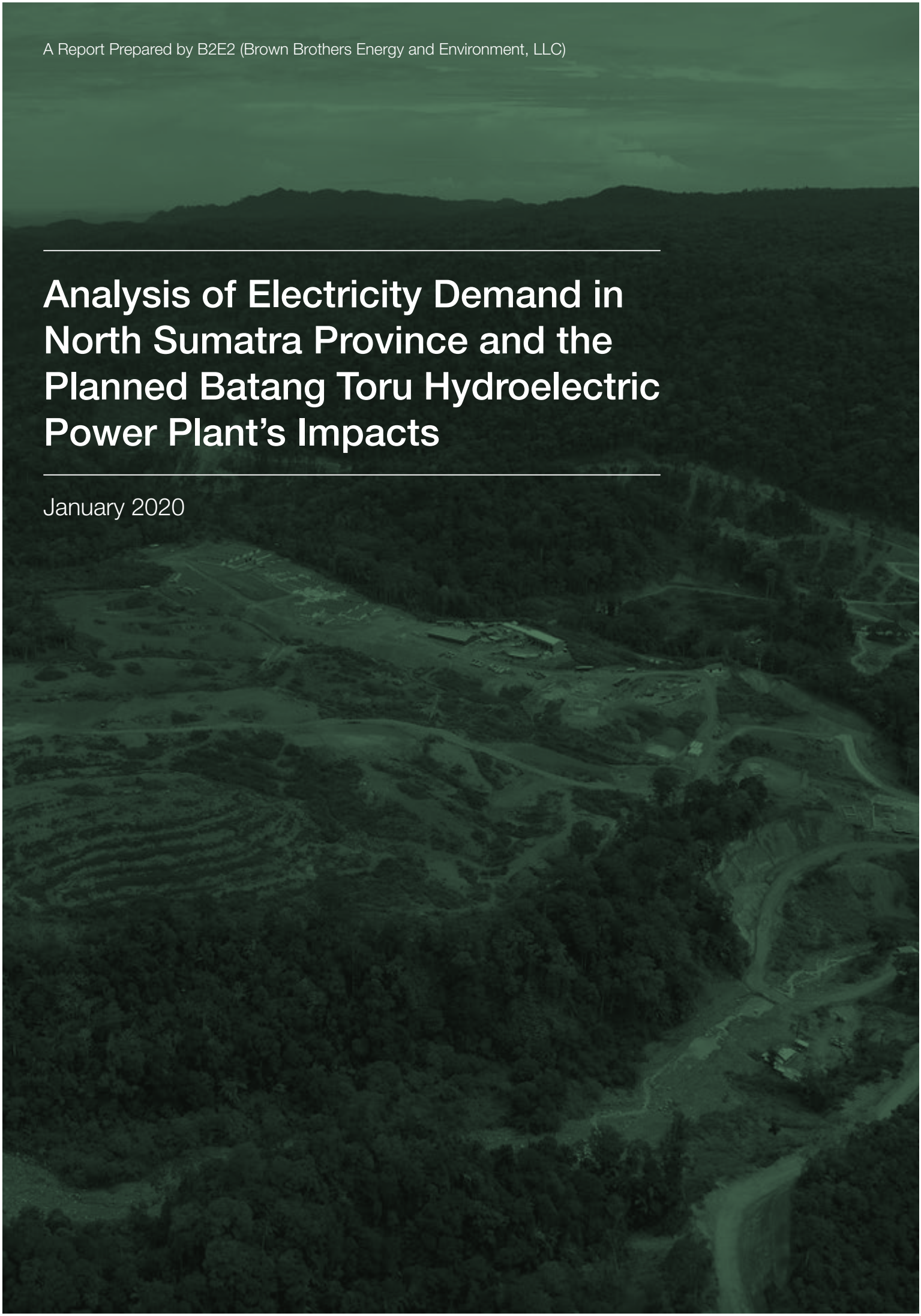

A Report Prepared by B2E2 (Brown Brothers Energy and Environment, LLC)

Analysis of Electricity Demand in North Sumatra Province and the Planned Batang Toru Hydroelectric Power Plant's Impacts

January 2020

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CO2	Carbon dioxide – a greenhouse gas
ESIA	Environmental and social impact assessment
GDP	Gross domestic product
GHG	Greenhouse gas
GW	Gigawatt, a billion Watts
GWh	Gigawatt hour
IESR	Institute for Essential Services Reform
IPP	Independent power producer
kV	Kilovolt, a thousand volts
kW	Kilowatt, a thousand Watts
LNG	Liquid natural gas
MMBtu	Millions of British Thermal Units
MW	Megawatt, a million Watts
MWh	Megawatt hours
NSHE	North Sumatra Hydro Energy, operator of Batang Toru
PJB	Pembangkitkan Jawa Bali, a subsidiary of PLN
PLN	Perusahaan Listrik Negara, Indonesian state electricity company
PPA	Power purchasing agreement
RUPTL	Rencana Usaha Penyediaan Tenaga Listrik or Business Plan for the Preparation of Electricity, the Government of Indonesia's primary national power planning document
Sympatric	Occupying the same geographical range without loss of identity
USD	US dollar

Executive Summary

This economic analysis of the Batang Toru hydroelectric dam project and its impact on the energy grid in North Sumatra, Indonesia finds that the claims advanced by North Sumatra Hydro Energy exaggerate both the need for and the benefits of the project.

The full report demonstrates that the Batang Toru project, which threatens to cause the first extinction of a great ape in all of recorded history, is an unnecessary endeavor.

The report shows that the Batang Toru dam is not necessary for meeting Indonesia's energy needs in the region. North Sumatra used to have an energy deficit, but that is no longer the case. And with 80 new plants planned to be built or expanded in the next decade, the Batang Toru dam is wholly unnecessary to meet North Sumatra's electricity demand in the future.

Proponents of the dam have also overestimated its value in fighting climate change while ignoring other options. This new analysis shows that the company has been inflating the potential climate impact of the hydroelectric dam by in excess of 33 to 55 percent, depending on the comparison.

The dam's backers contend that Batang Toru will ease Indonesia's balance of payments deficit by rendering the import of diesel less necessary. In fact, there is no evidence that the dam will replace diesel power plants. It is far likelier that the dam would displace gas fired power plants, which can be built for one third the price of the dam, and which, to the extent they burn domestically-produced gas, will have a positive balance of payments impact.

Bottom line: There may have been a rationale for the Batang Toru hydroelectric dam when it was proposed in 2012, before the identification of the Tapanuli orangutan, and in a very different energy situation. But there's no need for it in 2020.

1. Background

The Batang Toru Hydroelectric Power Plant ("Batang Toru") is a hydroelectric power plant that is being developed in South Tapanuli district, North Sumatra province, Indonesia in the lowlands of the Batang Toru ecosystem.

Batang Toru is intended to be a run of river hydroelectric power plant. If built, it would use the gradient of the Batang Toru River to generate electricity through a diversionary power canal and tunnel rather than a single large dam. The purpose of the tunnel would be to build up water pressure over more than a dozen kilometers to spin four turbines. The infrastructure proposed for Batang Toru includes:

- A relatively small reservoir and dam. The dam is intended to impound enough water during off-peak hours to allow all four turbines to run at full output during the peak six evening hours;
- A long tunnel eight meters in diameter that will run parallel to the Batang Toru River in a westerly direction, from the reservoir and dam, 50 to 300 meters beneath the ground, for a distance of more than 13 km, to a power house;
- A power house, where the water would be divided into four streams to spin four turbines, which will generate electricity;
- A 275 kV transmission line that would carry electricity back up the river valley and connect to an (as-yet-unbuilt) 275kV transmission line running north and south, called the Western Corridor.

The Batang Toru ecosystem is home to many different rare and threatened animal species including the Sumatran tiger (*Panthera tigris sumatrae*), the sun bear (*Helarctos malayanus*), the tapir (*Tapirus indicus*) and birds such as the Great Argus pheasant (*Argusianus argus*). It is also home to six endangered and vulnerable primate species including siamangs (*Symphalangus syndactylus*), agile gibbons (*Hylobates agilis*) and the recently discovered species of Tapanuli orangutan (*Pongo tapanuliensis*).[1] It is one of the few areas in the world where three ape species coexist sympatrically, that is to say, within the same geographical range. The Batang Toru ecosystem is biologically diverse with over 310 species of bird recorded, 80 species of reptiles, 64 species of frogs and toads, and more than 1,000 tree species.[2]

From an engineering standpoint, the Batang Toru hydropower project appears well-designed. However, the project's infrastructure will destroy or isolate three out of five habitat blocks of a newly-discovered species, the Tapanuli orangutan, one of only seven species of Great Ape on Earth (or one of eight if humans are counted).[3]

The Tapanuli orangutan lives in the lowlands where the infrastructure associated with Batang Toru is to be built, and in three areas of adjacent highlands. Fewer than 800 individual Tapanuli orangutans remain, and they are found only in the Batang Toru ecosystem. So important are the implications of the Batang Toru plant for the future of the Tapanuli orangutan that the "area of influence" of the hydropower project is itself one of the five zones of orangutan habitation described by scientists.

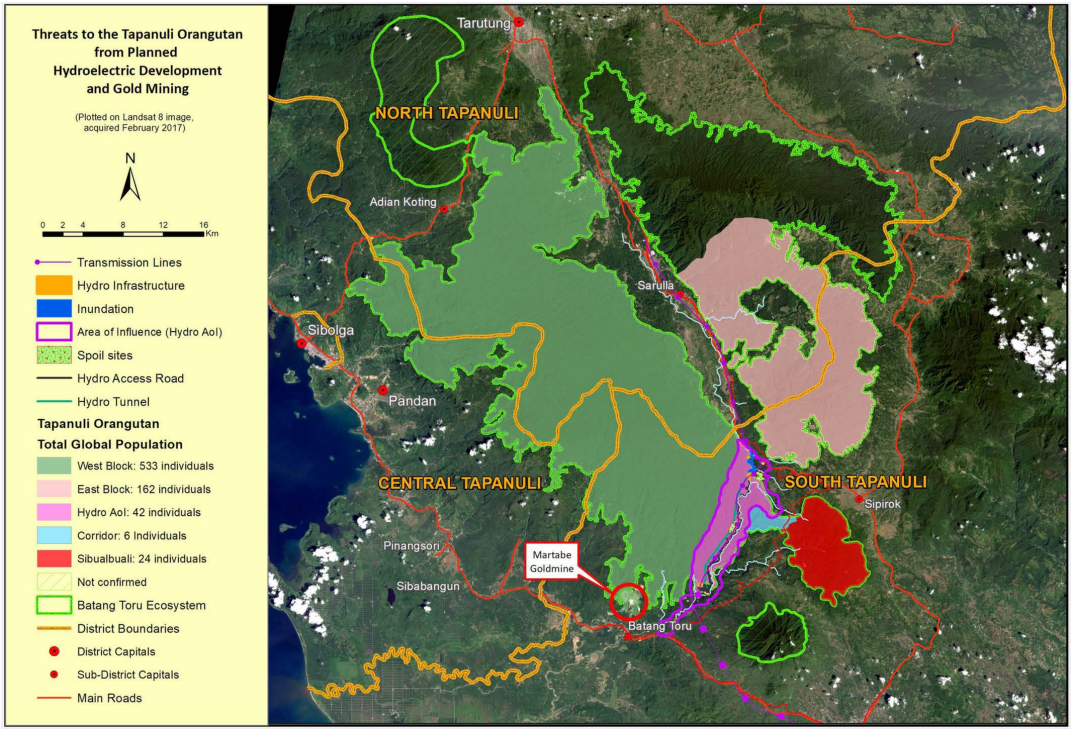
1. "Towards Sustainable Management of the Batang Toru Ecosystem" (translated from Edisi III dari "Menuju Pengelolaan Lestari Ekosistem Batang Toru). Yayasan Ekosistem Lestari. November, 2017 and https://www.batangtoru.org/biodiversity/monitoring-station/
2. "The Batang Toru Ecosystem for World Heritage." Yayasan Ekosistem Lestari. November 2018
3. Smithsonian National Museum of Natural History. "What does it mean to be human?" http://humanorigins.si.edu/evidence/genetics

Shown in **Figure 1** (below), the five areas are:

- An eastern zone with 162 individuals
- A western zone with 533 individuals
- An "area of influence" where the infrastructure of the dam is to be located, which runs along the southern edge of the western zone, with 42 individuals
- A transitional zone with 6 individuals which serves as a land bridge to…
- A southern zone -- the Sibualbuali Reserve -- with 24 individuals

Proponents and opponents of Batang Toru appear to agree that the infrastructure of the dam will lead to the displacement, and in some cases, death of the orangutans living in the third zone, and the permanent genetic isolation of those living in the fourth and fifth zones, more than 70 individuals in all.

Figure 1: Five zones of habitation of the Tapanuli Orangutan[4]



According to a paper by William F. Laurance of James Cook University the area of influence (along the Batang Toru River, colored purple in **Figure 1**, above) provides a nursery-like function for the entire population:

The area to be affected is [the Tapanuli orangutan's] prime habitat, where they occur in their highest abundances. These habitats are rainforests on rich alluvial soils, which may well be functioning as a crucial 'population source' (an area with a high number of breeding animals), which is vital for sustaining the overall population.[5]

Those opposing the project emphasize that the impact on the area of influence of the dam will also impede efforts to maintain and increase connectivity between the west and east block which will lead to the eastern population of 162 individuals becoming non-viable.

4. Wich, Serge et al. "The Tapanuli orangutan: Status, threats, and steps for improved conservation." Conservation Science and Practice. April 17, 2019 https://conbio.onlinelibrary.wiley.com/doi/full/10.1111/csp2.33
5. Laurance, William. "Tapanuli Orangutan: A Follow-up Letter to Indoensian President Joko Widodo." Alliance of Leading Environmental Researchers and Thinkers. August 16, 2018 http://alert-conservation.org/pressreleases/2016/9/14/lorem-ipsum-dolor-sit-amet

Batang Toru's backers concede the fact that the proposed project will do significant damage to the small population of the world's most newly-discovered (and likely the most vulnerable) species of great ape, the Tapanuli orangutan. "Indeed it is sad that the population [of Tapanuli orangutan] in the east block (162) and in Sibualbuali reservation (24) are not viable due to long-term separation and fragmentation,[6] man-made and natural disasters."[7] However, they maintain that this is an acceptable loss, because of what they purport to be the project's electrification, climate change mitigation and balance of payments benefits.

This paper will explore whether now, and in the future, there is a need for the power that could be produced by the Batang Toru hydroelectric power plant, and the extent to which the plant would actually deliver the benefits that backers tout, such as mitigation of greenhouse gas emissions and a reduction of Indonesia's balance of payments deficit.

The paper considers two broad questions:

- **Chapter 2** examines whether North Sumatra province is currently in need of the electricity that could be produced by Batang Toru, and analyzes climate mitigation and balance of payment claims.
- **Chapter 3** looks at whether the province is likely to need electricity that could be produced by Batang Toru in the medium to long term.

6. The follow-up letter also debunks this assertion that the populations have been isolated over the long-term, saying "high-resolution remote-sensing imagery reveals numerous forest connections over the Batang Toru River, which would permit Tapanuli orangutans to cross the river." http://alert-conservation.org/pressreleases/2016/9/14/lorem-ipsum-dolor-sit-amet
7. Hafild, Emmy. "Orangutan, hydro power plant can coexist" Jakarta Post. July 26, 2019 https://www.thejakartapost.com/academia/2019/07/26/orangutan-hydro-power-plant-can-coexist.html

2. Is there *currently* a need in North Sumatra province for the electricity that could be produced by Batang Toru and are other ancillary benefits as significant as claimed?

This chapter examines whether North Sumatra province currently requires the electricity that could be produced by Batang Toru, and the likelihood of other benefits.

The chapter examines five separate arguments put forward by the backers of the Batang Toru project, namely, that it will:

- Free sizable numbers of North Sumatrans from living in darkness, and reduce the incidence of blackouts
- Replace "diesel-fired power plants rented from overseas"
- Enable Indonesia to reduce emissions of between 1.6 and 2.2 million tons of CO2 per year
- Produce power for the highest demand hours ("peak power")
- Alter the nation's balance of payments

A. Electricity availability and blackouts

Dam backers have publicly argued that if Batang Toru is built "our children will be able to study at night."[8] The implication of the argument is that if Batang Toru is not built, the children of North Sumatra will not have the electricity to study at night. This is a contention worth exploring.

According to Indonesia's Directorate General of Electricity, the rate of electrification of North Sumatra province as of 2016 was 95.8 percent (see **Figure 2**, on page 10). This makes North Sumatra one of the best-electrified provinces in the nation, exceeding, for example, East Java (rate of electrification 89.16 percent) and Bali (rate of electrification 92.2 percent) – raising questions about whether and how this project was prioritized to meet electrification needs.

Applying North Sumatra's 2016 rate of electrification to its 2017 population of 14.26 million would appear to place the number of persons living in homes without electricity at just short of 600,000, and some of these are children who do homework.

However, many of the 600,000 North Sumatrans without power live on Nias, an island so far out in the ocean that it will remain unaffected no matter how much power generation is added on the Sumatra 'mainland.' Nias has a population of 756,762 according to the 2010 census, and its grid has yet to recover from the 2004 to 2005 Boxing Day earthquake and tsunami events. Because it is located a great distance offshore the much larger island of Sumatra, Nias cannot be reached by the North Sumatra grid, and cannot benefit from the augmentation of power generation on North Sumatra. In other words, the full electrification of North Sumatra is unlikely to happen until the situation on Nias is solved. Any power generated by Batang Toru would be immaterial to Nias.

8. Ventura, Bona. "Soal Batang Toru, Tokoh Adat Serukan Merdeka dari Intervensi LSM Asing." SindoNews.com. August 19, 2019 https://ekbis.sindonews.com/read/1431259/34/soal-batang-toru-tokoh-adat-serukan-merdeka-dari-intervensi-lsm-asing-1566188505

Figure 2: Rates of Electrification in Indonesia (by province)[9]

It is true that in years past, North Sumatra province has experienced rolling blackouts. But this phenomenon has diminished since 2017. The blackouts appear to have been caused by a combination of inadequate generation and deficiencies in the transmission/distribution grid, both of which have been or are being resolved.

Inadequate generation has now been remedied. **Table 1** (below) shows that the availability of electricity began to surpass peak demand in 2017. This new surplus has significantly reduced the number of blackouts in the province.

Table 1: From electricity deficit to surplus in North Sumatra province

Year	Availability of electricity	Peak demand	Deficit/surplus	Source
2014	1,376 MW	1,655 MW	Deficit of (279) MW	Okefinance: 2018[10]
2017	2,200 MW	1,950 MW	Surplus of +250 MW	Kompas: 2017[11]
2018	2,133 MW	1,833 MW	Surplus of +300 MW	Okefinance: 2018

*Improvements are being made in transmission and distributio*n. An array of ongoing improvements to the grid and to electrical distribution in North Sumatra will diminish blackouts even more in the near future. With respect to electrical distribution, between now and 2028, 540 kilometers of 500 kV transmission lines are expected to be built; 1,193 kilometers of 275 kV; 1,108 kilometers of 150 kV; and 220 kilometers of 75 kV.[12] See **Figure 6** on page 24.

There will, of course, still be intermittent blackouts due to what are described by a local official of the Indonesian national electricity company (PLN) as "disturbances related to the grid, or natural disturbances such as rain and lightning."[13]

9. Republic of Indonesia, Ministry of Energy and Mineral Resources, Directorate General for Electricity. "Activity Report for the Directorate General for Electricity for 2016." Page 23.
10. Prasetyo, Erie. "Perkembangan Pembangunan Listrik di Sumut, dari Krisis hingga Surplus." Okefinance. October 27, 2018 https://economy.okezone.com/read/2018/10/27/320/1969836/perkembangan-pembangunan-listrik-di-sumut-dari-krisis-hingga-surplus
11. Leandha, Mei. "Pasokan Listrik Sumut Surplus, Tapi Pemadaman Masih Ada..." Kompas.com. July, 9, 2017 https://properti.kompas.com/read/2017/09/07/141436621/pasokan-listrik-sumut-surplus-tapi-pemadaman-masih-ada
12. "RUPTL PLN 2019-2028." Ministry of Energy and Mineral Resources, Republic of Indonesia. http://gatrik.esdm.go.id/assets/uploads/download_index/files/5b16d-kepmen-esdm-no.-39-k-20-mem-2019-tentang-pengesahan-ruptl-pt-pln-2019-2028.pdf. Page A-25
13. Leandha, Mei. "Pasokan Listrik Sumut Surplus, Tapi Pemadaman Masih Ada..." Kompas.com. July, 9, 2017 https://properti.kompas.com/read/2017/09/07/141436621/pasokan-listrik-sumut-surplus-tapi-pemadaman-masih-ada

The single event that was most instrumental in lifting the scourge of rolling blackouts from North Sumatra was the arrival and activation in 2017 of a floating power plant. The next section discusses the relevance of the floating power plant.

B. Will Batang Toru replace diesel-fired power plants rented from foreign nations?

One claim backers of Batang Toru make is that it will replace "diesel fired power plants rented from foreign nations" ("pembangkit listrik berbahan bakar solar yang disewa dari luar negeri").[14]

It is true that the state power company PLN is renting a number of floating power plants from the nation of Turkey, and that the largest of these (240 MW) is producing power for North Sumatra province. However, North Sumatra's floating plant currently uses natural gas, not diesel.[15] According to a press release, "*The first Powership to run on Natural Gas in Indonesia will be Karadeniz Powership Onur Sultan located in Medan [where] the infrastructure of Natural Gas already exists*."[16]

The distinction between gas and diesel is important, because natural gas generates between half to two thirds of the greenhouse gas (GHG) emissions of diesel, as explained in **Section C**, and has less impact on Indonesia's balance of payments, as explained in **Section E**.

In any case, because of the planned additions to power substations in the North Sumatra province, diesel fired power will be rendered increasingly obsolete for reasons unrelated to Batang Toru. More than half the planned substation additions will directly connect villages to the grid for the first time. Overall, between now and 2028, additions to existing substations, and construction of new substations, are planned to occur in 101 locations. **Table 2** (below) recapitulates these changes and additions.

Table 2: Substations in North Sumatra to be built, extended or updated, between now and 2028[17]

Voltage of substations	Number to be built, extended, or updated
500	2
500 to 275	2
275	10
275 to 150	7
150	26
150 to 20	54
Total	**101**

Table 2 shows that more than half (54 out of 101) of the substation additions or extensions between now and 2028 will be those which take 150 kV power lines and step them down to 20 kV, a voltage appropriate for delivering electricity to villages. It is likely that most of these villages now run on smaller diesel fired generators. Providing grid power to these villages for the first time will render their continued use of free-standing diesel generators mostly unnecessary. In short, these improvements in substation infrastructure will decrease the dependence of these villages on diesel power, completely irrespective of whether or not Batang Toru is built.

14. Ventura, Bona "Soal Batang Toru, Tokoh Adat Serukan Merdeka dari Intervensi LSM Asing" SindoNews.com https://ekbis.sindonews.com/read/1431259/34/soal-batang-toru-tokoh-adat-serukan-merdeka-dari-intervensi-lsm-asing-1566188505 Also, in an op-ed in the Jakarta Post, a Emmy Halfild, a project backer writes that Batang Toru will "replace a floating diesel-based generator that supplies 500 megawatts of electricity to North Sumatra."
15. Ong, Soh Chin. "Powering the Remote Corners of the World" Shell: Inside Energy. "April 18, 2019 https://www.shell.com/inside-energy/karadeniz-onur-sultan-powership-indonesia.html
16. Karadeniz Holdings. March 19, 2018 https://www.karadenizholding.com/en/detay/276
17. "RUPTL PLN 2019-2028." Ministry of Energy and Mineral Resources, Republic of Indonesia. http://gatrik.esdm.go.id/assets/uploads/download_index/files/5b16d-kepmen-esdm-no.-39-k-20-mem-2019-tentang-pengesahan-ruptl-pt-pln-2019-2028.pdf. See Table A2.14 on pages A-26 through A-28 Note: Table A2.14 erroneously gives the total number of substations to be built, extended or upgraded as 103, whereas in fact only 101 such instances are noted. The miscount is due to the fact that the table skips numbers 15 and 16.

C. Will Batang Toru reduce Indonesia's CO2 emissions by 1.6 to 2.2 million tons per year?

The website of North Sumatra Hydro Energy (NHSE), the company that is trying to build Batang Toru, maintains, "The power plant is set to contribute to the reduction of Indonesia's carbon emissions by as much as 1.6-2.2 megatons per year."[18] The NHSE website, however, does not substantiate the basis on which these calculations are made.

A source that does attempt to quantify the CO2 emissions reductions that could be made possible if Batang Toru were to replace higher-emitting sources of electricity is the project's Environmental and Social Impact Assessment (ESIA). The Batang Toru ESIA cites a 1.6 million CO2 tons per year reduction figure, but contains no support for the higher 2.2 million tons per year figure.

As can be seen from **Figure 3** below, the ESIA derives the 1.6 million tons figure by using a 2015 nationwide average emissions factor for the entire country of Indonesia of 0.7568 tons CO2 per MWh, and multiplying that by Batang Toru's assumed generation of 2.124 million MWh per year, with the resulting claim that 1,607,447 tons CO2 per year can be avoided.[19]

Figure 3: Excerpt from Batang Toru ESIA from which the figure of 1.6 million tons/year in CO2 emissions reduction appears to have been derived

The emission reduction of the Project applied a factored CO_2-e emission rate for the average power generation mix in Indonesia. The combined margin emission factor of Indonesia dated 31 March 2015 published by IGES was adopted, which is 0.7568 tCO_2/MWh.

According to the feasibility study, the Project will generate 2,124,000 MWh per year. The corresponding emission reductions from the Project during operations period are shown in *Table 1.19*.

Table 1.15 GHG Reductions of the Project during Operation

Power generation (MWh)	Emission factor (tCO_2/MWh)	GHG reductions (tCO_2-e)
2,124,000	0.7568	1,607,447

Applying a nationwide average figure to a local environmental electricity market decision as the ESIA has done is an unacceptable analytical practice. National figures are irrelevant because availability of a zero-carbon generating resource in North Sumatra does not permit less fossil fuel power to be used in, for example, Kalimantan or Java. The relevant issue is what particular fossil fuel resources on Sumatra are likely to be used less, thus generating fewer emitted tons of CO2, if alternative electricity is available from Batang Toru.

The most likely alternative generation is from natural gas that emits considerably less CO2 than the national average figure of 0.7568 tons per MWh. To estimate actual emissions reductions, we need to examine fuels and generation efficiency of the actual local generators that would be displaced if Batang Toru were to start running.

- As discussed above, if Medan's floating gas power plant is replaced by Batang Toru (setting aside the fact that the floating plant is only 240 MW, or less than half the size of Batang Toru), the relevant question is the amount of CO2 emitted by natural gas fuel consumed per MWh by the simple cycle turbines on that floating plant.

18. See PT North Sumatra Hydro Energy "What does a powerplant have to do with climate change?" https://pt-nshe.com/eng/detail.php?aWQ9MzcmcmFuZG9tPQ==
19. "Environmental, Social and Health Impact Assessment" https://nsheweb.files.wordpress.com/2018/08/batang-toru-hydropower_esia_final-240217.pdf Page 689 out of 1,266

- Alternatively, if we consider the recently announced 800 MW power project in North Sumatra (the Sumbagut 1, 3 and 4 combined cycle natural gas power project – see Section D below) the relevant question is CO2 emitted by natural gas fuel consumed by new combined cycle projects of that type.

A simple cycle gas combustion turbine like that found on the floating plant in Medan is relatively similar to a jet engine and emits a blast of hot gas. According to company sources Sumbagut 1, 3 and 4 will instead be a "combined cycle" plant, the most fuel-efficient type of natural gas generation.[20] A combined cycle plant captures the waste heat otherwise lost in the jet engine-like blast by channeling the hot gas through a "Heat Recovery Steam Generator" to make steam that can then run an additional steam turbine — essentially such a plant "recycles" the energy from the hot jet blast.

In assessing the CO2 emissions of various power plants in North Sumatra, it is important to recall that:

- Different fuels can be combusted to generate electricity, and the total emissions produced are a combination of the carbon content of the particular fuel and the efficiency in terms of amount of fuel needed by the generation device.
- The heating value of various solid and liquid fuels are measured in millions of British thermal units (MMBtu).
- The emissions per unit of heating value are measured in kilograms of CO2 per MMBtu combusted. The efficiency of generators is measured in MMBtu consumed per unit of electricity produced (MMBtu/MWh).

Table 3 below contrasts the likely savings in emissions of Batang Toru if it were to replace either the floating power plant or the Sumbagut 1, 3 and 4 projects. The table uses figures from the U.S. government for efficiencies of combustion turbines and combined cycle power plants, but these efficiency figures are relatively stable across manufacturers and have not meaningfully changed in recent years within technologies.

Table 3: Specific greenhouse gas savings vs. general figures provided by Batang Toru*

Generator	**Floating power plant**	**Sumbagut 1,3 & 4 project**	**Indonesia 2015 average**
Equipment**	Gas Turbine	Combined Cycle	Mixed
Fuel	Natural Gas	Natural Gas	Various
Tons CO2 per MMBtu Used	0.0531	0.0531	
x MMBtu per MWh Generated	9.6	6.35	
equals Tons CO2/MWh	0.509387755	0.336938776	0.7568
x 2,124,000 MWh/year	2,124,000	2,124,000	2,124,000
equals Alternative Emissions	1,081,940	715,658	1,607,443
Reduction from lower end of CO2 reduction estimate of 1.6 million tons CO2/year	(525,504)	(891,785)	0
Percentage of lower end of CO2 reduction estimate of 1.6 million tons CO2/year	**67%**	**45%**	**100%**

* Natural gas emissions figures used are 117 pounds/MMBtu or 117/2205 = 0.0531 metric tons/MMBtu
** Source US Energy Information Agency, "Cost and Performance Characteristics of New Generating Technologies," Annual Energy Outlook 2019. See Table 2 on page 11.

The table above shows that if Batang Toru were to replace the existing floating gas power plant there would be a reduction in greenhouse gas emissions one third less than the lowest estimate of Batang Toru's proponents. If Batang Toru were to replace a combined cycle gas power plant it would reduce greenhouse gas emissions less than half of the lowest estimate of Batang Toru's proponents. In other words, even the smallest estimate of greenhouse gas reductions promised by Batang Toru's backers are inflated on the order of 33 to 55 percent, depending on the comparison. Bottom line, Batang Toru's backers are significantly overstating its greenhouse gas emissions benefits.

20. For example, see reference in Deloitte's 2016 Report "35,000 MW: A Light for the Nation." Page 45. https://www2.deloitte.com/content/dam/Deloitte/id/Documents/finance/id-fas-35000mw-a-light-for-the-nation-noexp.pdf

D. Is Batang Toru's power irreplaceable?

NSHE, the company that aims to build Batang Toru, maintains that the project "is specially designed as a peaker power plant." NHSE also contends that Batang Torus's power cannot be substituted by power from the nearby Sarulla geothermal plant, because "the geothermal plant is designed as a baseload power plant. The geothermal plant is not suitable for peak load operation."[21] The implication is that Batang Toru is a peak power producer, an assertion further reinforced by the project's website which states, "Batang Toru Hydroelectric Power Plant is able to support peak loads and will supply 2,124 GWh/year of energy."[22]

It is true that the project uses river flow to fill its small dam 18 hours a day, and then releases that water during six peak hours in the evening (from 6pm to midnight), thereby providing valuable peak evening power. It is also true that not all electrical utilities in North Sumatra (those that burn coal, for example) can generate "peak power" in this same way. Utilities that produce peak power in North Sumatra are in the minority, while the majority of the province's utilities (coal plants, for example) run close to 24 hours a day and produce "baseload power." However, the claim of Batang Toru's peak evening production brings with it a significant omission of fact.

To state matters plainly, Batang Toru is not a pure producer of peak power. Rather, at most 52.6 percent of its power is produced during peak hours and the 47.4 percent balance is produced during off-peak hours.

- The project's backers state that it will produce 2.124 million MWh per year, total.
- If the project were to deliver 100 percent of its peak 510 MW during six hours of every single evening in the year, maximum peak hour output would be only 1.117 million MWh per year. That is, during peak hours (6pm to midnight) Batang Toru would produce 510 MW by running four turbines that produce 127.5 MW each, totaling 510 MW, times 6 hours per day, 365 days a year, or 1.117 million MWh per year.
- The balance of the 2.124 million MWh per year, or 1.007 million MWh, is baseload power from running one or two turbines during the day or the middle of the night on a "run of river" basis.

Is Batang Toru's peak power irreplaceable? In fact, a ready substitute already exists: The floating power station has been online for the last two years, and produces peak power. Moreover, Sumbagut 1, 3 and 4, a new three-unit combined cycle natural gas power plant, is expected to come on stream in three phases in 2022 (200 MW), 2024 (300 MW), and 2028 (300 MW).[23]

In its company website, Reconsult, an Indonesian consulting company, confirmed that it had completed the Feasibility Study for Sumbagut 1, 3 and 4. Reconsult reports that a company called PJB (a subsidiary of the national power company, PLN) has been assigned by PLN to develop the three plants. In the text below Reconcult uses the phrase "2 on 1 configuration," which means that there will be two gas combustion turbine generators that will funnel their combined hot exhaust gases to make steam supplying a single steam turbine generator:

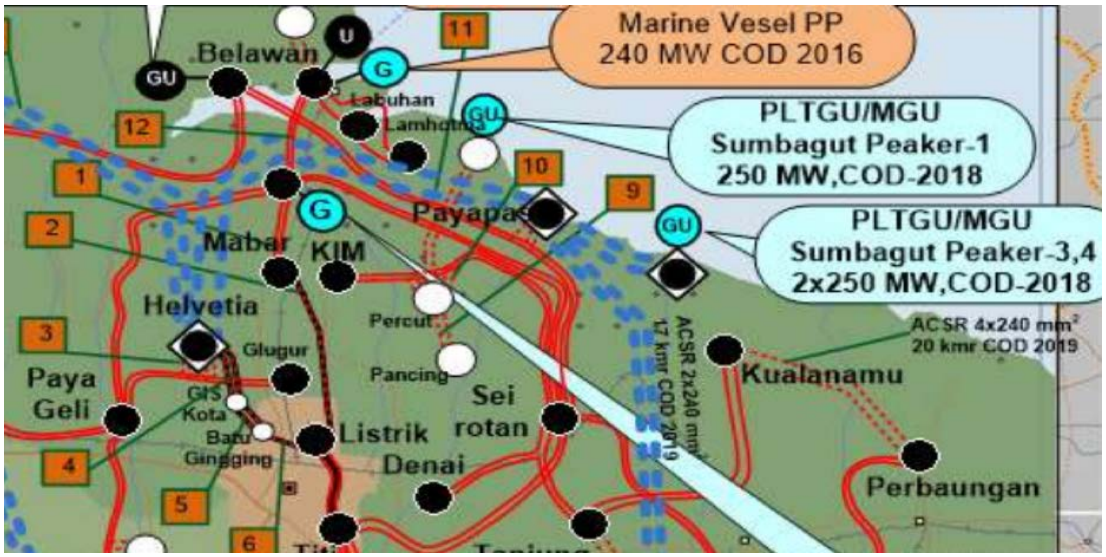
21. NHSE, "Common Misconceptions about Our Projects." E-mail to former US Ambassador to Indonesia Robert Blake.
22. "Beranda - North Sumatera Hydro Energy: https://pt-nshe.com/eng/index.php
23. RUPTL PLN 2019-2028." Ministry of Energy and Mineral Resources, Republic of Indonesia. http://gatrik.esdm.go.id/assets/uploads/download_index/files/5b16d-kepmen-esdm-no.-39-k-20-mem-2019-tentang-pengesahan-ruptl-pt-pln-2019-2028.pdf, page A-20. See also Puspa, Anitana Widya. "PLN 56 GW Infrastruktur Pembangkit Listrik, Proyek Apa yang Disesuaikan?" Bisnis.com. Februrary 25, 2019. https://ekonomi.bisnis.com/read/20190225/44/893120/pln-56-gw-infrastruktur-pembangkit-listrik-proyek-apa-yang-disesuaikan Note that the authors only have public information on the status of this project. However, whether or not the particular project described is actually completed on the publicly announced schedule, the particular plant serves as a good example of the alternatives to the Batang Toru hydro project that are being actively considered.

In an attempt to seize the opportunity to become an IPP developer of … Sumbagut 1, 3, 4 that have been listed in the RUPTL, PT Pembangkitan Jawa Bali (PJB) assigned Reconsult to conduct the Feasibility Study of … PLTGU Sumbagut 1, 3, 4. PT PLN (Persero) has since assigned PJB as the developer of the projects with majority shares in consortium with qualified partners. PLTGU Sumbagut 1, 3, 4 would be developed in 2 on 1 configuration.[24]

An article from the energy industry information service provider Inframation reported that although many would-be independent power producers (IPP) have been hesitant to enter into the negotiation of gas Power Purchasing Agreements (PPAs) with PLN (due to the latter's insistence on selling gas to these plants at commercially unfavorable rates and terms), that Sumbagut 1, 3 and 4 are "understood to be [only one of two] new IPPs going ahead and engaged in negotiating PPAs with PLN."[25]

A Directorate General of Electricity map in **Figure 4** below shows Sumbagut 1, 3 and 4, marked with light blue circles, and their location along the Malacca Straits, a few kilometers to the northwest of Medan city limits.

Figure 4: Three gas-fired producers of peak power to be built northwest of Medan[26]



The Sumbagut 1, 3 and 4 plant is technically capable of running 24 hours a day to produce baseload power, but in practice, it appears to be intended to run mostly, if not exclusively, during peak hours. This highly efficient gas plant, when it is completed, is likely to produce roughly 1.6 times more peak power than Batang Toru (800 MW vs. 510 MW).

24. Recounsult. "Our Experience." http://www.reconsult.co.id/ourexperience/detail/pltgu-jawa-3-and-pltgu-sumbagut-1-3-4-800-mw/ The qualified partner referred to in the passage above is Nebras, a gas company based in Qatar.
25. "APAC: New Analysis: Indonesia strives to strengthen gas prospects" Inframation. May 28, 2018 https://www.inframationgroup.com/apac-news-analysis-indonesia-strives-strengthen-gas-prospects As for Sumbagut 2, it is a completely separate, gas-fired power plant in Aceh province, producing peak power.
26. "RUPTL PLN 2016-2025." Ministry of Energy and Mineral Resources, Republic of Indonesia. page 229 http://www.djk.esdm.go.id/pdf/RUPTL/RUPTL%20PLN%202016-2025.pdf In contrast to Reconsult and PJB, which characterize Sumbagut as a three-unit 2x1 combined cycle power plant producing 800 MW, the Directorate General of Electricity Figure 4 (above) appears to have characterized the plant as three units of 250 MW simple cycle turbines.

As for the 47.4 percent of Batang Toru's output that is proposed to produce baseload power, the North Sumatra power landscape has many other sources that can serve as substitutes. In 2015, Pangkalan Susu, a 440 MW coal fired power plant became operational. A new and larger stream of cleaner baseload power is now also available from the 330 MW Sarulla geothermal power plant, which went on line in 2017 (220 MW) and 2018 (110 MW).[27]

As for the future of baseload power in North Sumatra, the Sarulla geothermal power plant is slated to add another 300 MW of clean power in coming years.[28] Another geothermal power plant, Sorik Marapi, is scheduled to add another 240 MW of fossil fuel free power to the province's generation of baseload power in five annual stages from 2019 to 2023.[29]

In short, contrary to NSHE's contention that peak power generated by Batang Toru is not readily substitutable, the reality is that Batang Toru's peak power is already in the process of being rendered optional -- if not actually unnecessary -- by new, efficient, comparatively-low-emission, gas-fired generation. Current and future additions in clean geothermal power capacity in North Sumatra province will render Batang Toru's possible future baseload power capacity fully substitutable as well.

E. Will Batang Toru provide balance of payments relief to the Republic of Indonesia?

Batang Toru's backers contend that the plant will bring about significant savings to the nation because it will enable less diesel to be imported for purposes of generating electricity. For example, NHSE's Director of Communication and External Affairs stated earlier this year, "Using hydropower, the government can conserve outflows of capital of up to US$ 400 million per year, because it will not be necessary to use fossil fuels that must be imported" ("*Dengan memakai sumber energi air maka pemerintah bisa menghemat pengeluaran devisa hingga US$ 400 juta per tahun, karen tidak menggunakan bahan bakar fosil yang mesti diimpor*").[30]

More recently, the same NHSE Director contended, "With the capacity of 510 MW, that means that there will be savings in the use of diesel of USD 400 million per year" ("*Dengang kapasitas 510 MW berarti ada penghematan dari pemakain bahan bakar Solar senilai US$400 juta/tahun*").[31]

These contentions merit further exploration. It is true that Indonesia has balance of payments problems, and that these derive, in part, from the fact that Indonesia now produces less oil (and refines less diesel) than it consumes as a nation. To fill that oil and fuel deficit, the government (through the national oil company, Pertamina) imports oil as well as other types of oil-derived fuels, including diesel, and then sells these to various public and private users. Because Pertamina is required to sell some of these fuels (including diesel) domestically at artificially low prices, and because of other inefficiencies, it does not fully recover the cost of these imports.

27. Richter, Alexander. "330 MW Sarulla geothermal plant in Indonesia completed with third unit online," Think Geoenergy. http://www.thinkgeoenergy.com/330-mw-sarulla-geothermal-plant-in-indonesia-completed-with-third-unit-online/ Also, page 139 of the RUPTL PLN 2016-2025 http://www.djk.esdm.go.id/pdf/RUPTL/RUPTL%20PLN%202016-2025.pdf
28. "RUPTL PLN 2016-2025." Ministry of Energy and Mineral Resources, Republic of Indonesia. page, 231 http://www.djk.esdm.go.id/pdf/RUPTL/RUPTL%20PLN%202016-2025.pdf
29. Ibid. Page 139. The site of the future Sorik Marapi geothermal plant may, however, be located within the volcanic crater of a mountain of the same name, Sorik Marapai, which appears to be located inside the Batang Gadis National Park, making it a potentially problematic option. One piece of evidence which suggests that Sorik Marapai geothermal plant may be inside the park is a table inside the Directorate General of Electricity's 2016 RUPTL report, which notes that future built capacity of the Sorik Marapi plant could be limited by national park authorities. See page 231.
30. Prakoso, Rangga. "PLTA Batang Toru Berkontribusi Kurangi Pemanasan Global." Beritasatu. September 22, 2019 https://www.beritasatu.com/nasional/576355/plta-batang-toru-berkontribusi-kurangi-pemanasan-global; furthermore in a private correspondence between an editor of the Jakarta Post and a prominent conservation scientist, the editor contended, "One of Indonesia's BOP [balance of payments] problem is big current account deficit mainly caused by oil import. The Batang Toru project will save the government billions of dollars a year."
31. Prakoso, Rangga. "Menghentikan PLTA Batang Toru Sama dengan Menebang" Investor Daily Indonesia. September 22, 2019 https://investor.id/business/menghentikan-plta-batang-toru-sama-dengan-menebang-12-juta-pohon

For this reason, because the government must pay for oil and other fuels (like diesel) with dollars, and is unable to recover all of those outlays, diesel imports do contribute to the national balance of payments problem, that is to say, more dollars flowing out of Indonesia than flowing in.

Proponents of Batang Toru say that when it goes on line, it will be possible to take some diesel power stations off line. Following this line of reasoning, when those diesel power stations go off line, the government will be able to import less diesel, spend fewer dollars, with some balance of payment relief resulting.The problem with this line of reasoning is that, as already discussed in detail in **Sections B, C and D** (above), the power plants to which Batang Toru's peak power is most comparable are not diesel power plants, but gas-fired plants that produce peak power, namely, the existing floating simple cycle gas power plant and the three upcoming land based combined cycle gas power plants (Sumbagut 1, 3 and 4). None of the proponents of Batang Toru have specified which diesel fired power stations it is that will be taken off line if Batang Toru is built, with the exception of those who have erroneously stated that Batang Toru will replace a rented and/or floating power plant that burns diesel, when in fact the power station to which they refer burns gas – see **Section B** above).

On the subject of Indonesia's balance of payments, an additional matter to be taken into consideration is the comparatively high cost of capital of hydroelectric power plants compared to gas fired power plants. Reports suggest that Batang Toru will cost USD 1.6 billion to build.[32] USD 1.6 billion divided by 510,000 kilowatts means the plant will cost USD 3,137 per kilowatt to build. This is on the low end of the current range of costs of capital for hydroelectric power plants, which are on the order of USD 3,000 to 4,000 per kilowatt of capacity.[33]

For purposes of comparison, the cost of building the Sumbagut 1, 3 and 4 combined cycle gas fired power plant, which is the most direct comparator to Batang Toru, is reported by the plant's developer to be USD 831 million for 800 MW of capacity, or USD 1,038 per kilowatt. This is a reasonable figure since a US Department of Energy's 2019 Report puts the costs of capital for such projects at USD 999 per kilowatt.[34] Thus, in round terms, Batang Toru is likely to be three times as expensive as the gas power plants in North Sumatra that are slated for construction.

Much of Batang Toru's outlay of capital will ultimately flow overseas, in particular to China's Sinohydro (which is building the plant), and to China's Zhefu Holdings (the majority owner of the plant).[35]

Some facts to consider when weighing the impact on balance of payments of Batang Toru:

- Batang Toru will cost in the order of US 1.6 billion to build, in comparison to $831 million for Sumbagut 1, 3 and 4.
- This means that Batang Toru will be about USD 769 million more expensive to build. Assuming interest on borrowing is ten percent, the cost of paying back the USD 769 million increment would be USD 90 million over 20 years. Since the rate of interest of the loan to build Batang Toru is not known, it is prudent to assume annual debt repayments will be between USD 75 and 100 million per year over 20 years, in order to pay back the incrementally higher costs of capital of Batang Toru vs. Sumbagut 1, 3 and 4.

32. "Batang Toru Dam." BankTrack. https://www.banktrack.org/project/batang_toru_dam
33. US Department of Energy puts cost of "Conventional Hydropower" shows USD 2,948/kW for the least expensive plant that could be built in the U.S. Pacific Northwest. (See footnote following for link.) The International Energy Agency has a higher USD 4,000/kW figure shown at https://iea-etsap.org/E-TechDS/PDF/E06-hydropower-GS-gct_ADfina_gs.pdf
34. "Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2019." U. S. Energy Information Administration. January, 2019 https://www.eia.gov/outlooks/aeo/assumptions/pdf/table_8.2.pdf
35. "Damming Evidence." Sumatran Orangutan Society. Page 3 https://www.orangutans-sos.org/content/uploads/2018/05/Damming-Evidence.pdf

- Batang Toru will consume water (which is free, for now) while Sumbagut 1, 3 and 4 will consume gas, which will have to be paid for with dollars. The gas consumed by Sumbagut 1, 3 and 4 will cost about USD 50 million per year (assuming a price of imported LNG from Qatar of USD 7/MMBtu).[36] However, this is demonstrably less than the annual outlays of USD 75 to 100 million required to repay Batang Toru's incrementally higher capital costs.
- Payments for imported gas would flow abroad to Qatar. But if the gas is domestically produced (consider the dozens of cargoes of East Kalimantan and West Papua LNG that offload annually at the Arun regassification terminal, just up the coast from Sumbagut 1, 3 and 4, with most of that natural gas being piped into North Sumatra), then 70 percent of the payments for that domestic gas (after recovery of costs)[37] will flow as dollars into the Indonesian Treasury, which will help, not hurt, Indonesia's balance of payments.
- Finally, Batang Toru will be built by Sinohydro, whose record in building dams (and other forms of infrastructure) on three other continents has been shown to be characterized by sub-standard practices, cost overruns and, at times, outright fraud and corruption. The watering down of concrete at the pouring of Malaysia's Bakun Dam (caught on video) and the splintering apart of machinery within months of completion of Ecuador's Coco Codo Sinclair dam (reported in the New York Times) are especially clear examples of the types of construction and operations risk entailed in using Sinohydro. See **Table 4**, below.

Table 4: Allegations of fraud, non-standard practices, and corruption related to Sinohydro projects on three continents

Nation	Project	Issues and Allegations	Source
Armenia	NW Highway	Substandard concrete and road drainage	http://cargoarmenia.am/news/i-339
Botswana	Sir Seretse Khama Airport Expansion	Cost overruns and delays. Project terminated. Sinohydro takes payments of USD 527 million (representing 90 percent of project costs)	https://old.cbw.ge/business/foreign-media-corruption-activities-sinohydro-winner-millionaire-tenders-georgia/
Ecuador	Coco Codo Sinclair Dam	7,648 cracks in dam machinery; reservoir clogged with silt; dam runs at half of capacity. Former Vice President, Minister of Energy and an Anti-Corruption official, all caught on tape discussing taking of bribes in relation to dam. All now in prison.	https://www.nytimes.com/2018/12/24/world/americas/ecuador-china-dam.html
Indonesia	Jati Gede Dam	Questions in relation to manner in which land was acquired, and in regard to compensation for resettlement	https://www.business-humanrights.org/en/indonesia-alleged-inadequate-compensation-for-jatigede-dam-resettlement-sinohydro-responds
Uganda	Road building	Misrepresentation of project experience and project completion results in blacklisting by AFDB	https://www.afdb.org/en/news-and-events/integrity-in-development-projects-african-development-bank-and-sinohydro-reach-settlement-agreement-on-fraudulent-practice-18158
Venezuela	La Cabrera Power Plant	$50 million bribe paid to Chavista businessman Diego Salazar after contract signed	https://panampost.com/editor/2018/11/30/venezuela-chinese-companies-paid-large-bribes-to-win-major-infrastructure-bids/?cn-reloaded=1
Zimbabwe	Kabiba Power Station	$553 million price-tag alleged to embody a 100 percent mark-up	https://old.cbw.ge/business/foreign-media-corruption-activities-sinohydro-winner-millionaire-tenders-georgia/

In brief, the cost of building Batang Toru is so much higher than alternative sources of peak power in North Sumatra that it is unrealistic to suggest that Batang Toru will favorably impact Indonesia's balance of payments. The alternative to hydropower for now, gas-fired power, will have a positive impact on Indonesia's balance of payments, so long as the gas piped in from Arun and consumed in North Sumatra continues to be of domestic provenance.

36. Budiman, Aditya and Robby Irfany "Govt to Finalize LNG Purchase from Qatar." Tempo.com. October 24, 2017 https://en.tempo.co/read/912565/govt-to-finalize-lng-purchase-from-qatar
37. In most cases, the Government of Indonesia recovers 70 percent of the proceeds from the sale of domestically produced gas (after costs of production and liquefying are deducted).

F. Summary of chapter findings

To summarize the findings of this chapter:

- North Sumatra is almost fully electrified, and rolling blackouts are largely a thing of the past. The province has a power surplus. In view of the addition of 240 MW of gas fired peak power in 2017 and ongoing improvements in grid infrastructure, the building of Batang Toru would not materially improve access to nor the regularity of power supply in the province.
- Batang Toru will not replace "diesel power plants rented from foreign countries." In fact, there are no such rented diesel power plants, at least not in North Sumatra. There is a rented floating gas-fired power plant in Medan. But the climate change and balance of payments implications of burning gas are quite different from those of burning diesel.
- Based on the erroneous assumption that Batang Toru would replace the average carbon output of all utilities nationwide, it is claimed that the commissioning of Batang Toru would result in reduction of 1.6 million tons of annual CO2 emissions per year. In fact, the most likely forms of generation to be replaced by Batang Toru are either an existing rented floating simple cycle gas fired power plant in Medan (which if replaced by Batang Toru, would result in relative terms in an annual reduction of CO2 emissions of 1.1 million tons per year) or the forthcoming combined cycle gas Sumbagut 1, 3 and 4 power plants (which if replaced by Batang Toru, would result in relative terms in an annual reduction of CO2 emissions of 700,000 tons per year). In other words, the most conservative estimate of CO2 emissions savings put forward by the proponents of Batang Toru is still between 33 to 55 percent too high, depending on the comparison being made.
- In spite of the efforts of the owners and proponents of Batang Toru to characterize the plant as a producer of peak power, only half of the plant's output is peak power. The remainder is baseload power.
- Batang Toru's proposed future peak power capacity is already being rendered unnecessary by a 240 MW floating gas fired power plant, and will be rendered even more unnecessary by another 800 MW in new gas fired peak power which will come on line in 2022 (estimated 200 MW), 2024 (estimated 300 MW) and 2028 (estimated 300 MW).
- As for Batang Toru's possible future baseload power capacity, this has already been rendered superfluous by the commissioning of the 440 MW Pangkalan Susu coal plant in 2015, and that of the 330 MW Sarulla geothermal power plant in 2017 and 2018. Batang Toru's contribution to provincial baseload power will be rendered even more superfluous by the incremental addition of another 300 MW in capacity to Sarulla, with the first such increment slated to occur as early as 2022, as well as another 240 MW of geothermal power at completely new site, Sorik Marapi.
- The claim that Batang Toru will put diesel power plants out of business is wrong, or at the least, unsubstantiated. For this reason, the claim that Batang Toru will alleviate the negative balance of payment impact to the nation caused by the import of diesel is similarly flawed. What is true is that the high capital costs of building Batang Toru will lead to the outflow of dollars from Indonesia and into the bank accounts of the Chinese contractor that will build the plant, as well as the Chinese holding company that owns the majority of the plant, all to detriment of Indonesia's balance of payments.

In short, there is no compelling evidence that North Sumatra province is at this moment in need of the electricity that could be produced by Batang Toru. Meanwhile, Batang Toru's climate benefits have been greatly exaggerated, while its balance of payment benefits may be the opposite of what is claimed.

With all of that having been said, it still important to consider whether North Sumatra might be in need of the electricity that could be produced by Batang Toru in the future. This is the subject of the next chapter.

3. Will North Sumatra province need the electricity that would be produced by Batang Toru in the future?

As shown in *Table 1*, North Sumatra's availability of electricity exceeded peak demand by 300 MW in 2018 (the last year for which data is available). But how long will that surplus last?

As the province's demand for electricity continues to grow, is there a danger that North Sumatra could be revisited by the rolling blackouts that plagued the province prior to the summer of 2017?

These questions compel us to consider forecasts for energy demand in North Sumatra. The Directorate General of Electricity's RUPTL reports provide such forecasts. However, experts contend that what the RUPTL reports put forward are not estimates, but overestimates. A joint publication of Indonesia's Institute for Essential Services Reform (IESR) and Monash University observes,

Assessing future demand growth is a challenging endeavor. In many cases, demand projections are driven by political targets, e.g. on GDP developments. Also, very often, energy efficiency potential is not adequately reflected. Therefore, in many growth projections in particular of emerging economies, demand growth assumptions tend to be higher than actual growth observed.[38]

The IESR/Monash report goes on to say,

This is also the case for Indonesia. Using the previous RUPTL reports … and comparing these against actual consumption figures in ... Sumatra, we can observe a trend of forecasts that are rarely met or exceeded.[39]

Historically (from 2012 to 2017), Sumatra's energy consumption grew by 5.8 percent. In spite of this modest historical rate of growth for energy demand, the RUPTL report of 2018 (covering the years through 2027) forecasts that Sumatra's energy consumption will grow by 9.2 percent. As a correction to this overly-robust RUPTL projection, the IESR/Monash report offers "an alternative scenario for each province based upon the following assumptions as compared to the RUPTL's original forecast."[40]

- "Industrial loads growth is only half of what is expected in RUPTL (e.g. instead of a 10 percent annual growth a 5 percent annual growth would be assumed)."
- "In the residential sector … a per household energy intensity reduction target of 10 percent."
- "We assumed energy intensity for the commercial sector was 10 percent lower than in the RUPTL."
- "Public load forecasts remain unchanged."[41]

38. Institute for Essential Services Reform and Monash University. "A Roadmap for Indonesia's Power Sector: How Renewable Energy Can Power Java-Bali and Sumatra." February 2019. Page 27 http://iesr.or.id/wp-content/uploads/2019/04/COMS-PUB-0021_A-Roadmap-for-Indonesia_s-Power-Sector.pdf
39. Ibid.
40. Ibid.
41. Ibid, page 28

Based on this more realistic basket of assumptions, the IESR/Monash report forecasts that energy consumption in Sumatra will grow by 7.2 percent from 2018 to 2027, not 9.2 percent. **Figure 5** below shows what power growth in Sumatra looks like according to the RUPTL vs. IESR/Monash.

Figure 5: Forecasts for the growth of consumption of electricity by the 2018 RUPTL in its original form (left) and with modifying and/or more realistic assumptions (right)[42]

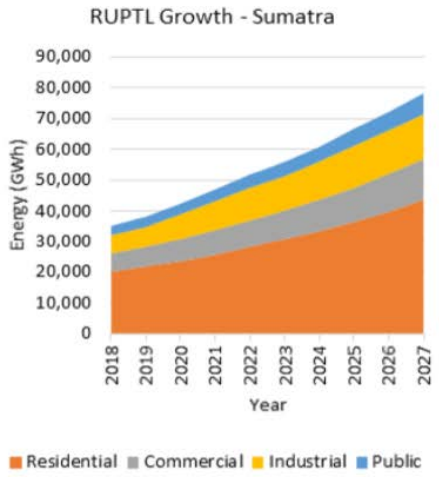


Figure 13 Growth in energy consumption by segment (RUPTL) – Sumatra

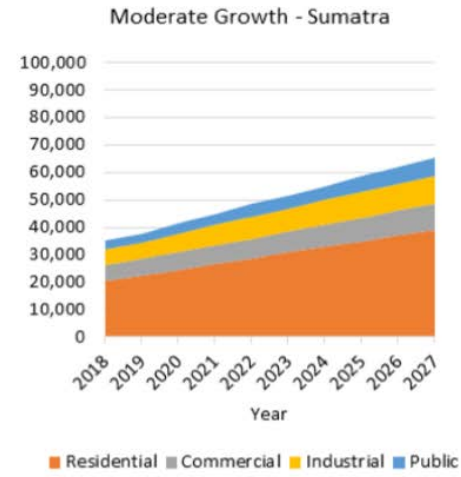


Figure 14 Growth in energy consumption by segment (Moderate growth) Sumatra

The RUPTL is very closely watched by the rest of the Indonesian government and the global power sector. To put this another way, the RUPTL is a planning document with real-world implications. The Ministry of Energy and Mineral Resources and PLN are both required to drive construction of power plants at speeds that match the growth assumptions of the RUPTL. Moreover, global private investment decisions are often taken based on the growth projections of the RUPTL. As a result of the RUPTL's overly-robust assumptions for growth of demand for electricity in North Sumatra, too many power plants are being built in the province. Although this poses financial risk to PLN, there is a silver lining: A spate of overbuilding leaves the Ministry of Energy and Mineral Resources and PLN with the luxury of deciding which plant or plants can be safely discontinued.

As things stand now, a vast range of power plants are being planned for North Sumatra. **Table 5** above shows that if all power plants specified in the 2019 RUPTL document to be built are built, and if power demand grows at a robust but still realistic annual rate of 7.2 percent, that North Sumatra's power supply will be twice as high as peak demand from 2024 onward, even in the absence of Batang Toru, as long as all other plants in the province are built according to plan and on schedule.

42. Ibid, page 29

Table 5: Planned supply and forecasted demand for power in North Sumatra (without Batang Toru)						
Year	**Actual/ forecasted peak demand in MW**	**Number of plants planned to be added or upgraded**	**Capacity of added plants and upgrades in MW**	**Cumulative provincial power capacity in MW**	**Surplus provincial power capacity in MW**	**Installed capacity divided by peak demand (1)**
2018	1,833 (2)	0	0	2,133 (3)	300	1.2
2019	1,965	11	550.4	2,683.4	718.4	1.4
2020	2,106	14	441.6	3,125	1,019	1.5
2021	2,258	26	250	3,375	1,117	1.5
2022	2,421	5	778	4,153	1,732	1.7
2023	2,595	4	446.8	4,599.8	2,004.8	1.8
2024	2,782	6	1,094.2	5,694	2,912	2.0
2025	2,982	3	965	6,659	3,677	2.2
2026	3,197	4	164	6,823	3,626	2.1
2027	3,427	4	422	7,245	3,818	2.1
2028	3,674	3	560	7,805	4,131	2.1

1. All figures in this column are rounded to the nearest one-tenth.
2. 2018 peak demand is a real number from Table 1. Peak demand in all subsequent years starts from that baseline, and assumes an annual growth in demand of 7.2 percent. All figures in this column are rounded to the nearest whole number.
3. 2018 supply is a real number taken from Table 1. New plants to be added (not including Batang Toru) or existing plants to which there will be new phases total 80. These 80, together with the outputs (in MW) of each, are taken from Table A 2.10 on pages A-18 to A-20 of the 2019 RUPTL report.[43] Of the 80, nine burn gas, seven are geothermal, 39 are mini-hydro (defined as 10 MW and below), six burn coal, seven are biogas or biomass, two are solar, and ten are full-sized hydroelectric or pump storage. None of the sources of electricity of these plants (with the exception of solar) are prima facie precluded from producing electricity at full capacity during evening peak hours, and thus, if these plants were/are built or added to, they should be able to contribute to peak load at their stated capacities.

Although not every one of the 80 planned new power plants, or additions to existing power plants, aggregated in **Table 5** above will move ahead, they represent a clear indication of the growing bounty of power choices that will become available in North Sumatra during the next decade. All of them constitute alternative sources of power to either the peak or the baseload power that is proposed to be generated by Batang Toru.

The 80 new plants -- or new additions to existing plants -- that are compiled in **Table 5** include Sumbagut 1, 3 and 4, future producers of gas-fired peak power, discussed at length in **Chapter 2**. **Table 5** also includes the five-stage ramp-up of a geothermal plant in the south of the province, Sorik Marapi, which is eventually slated to run at a full capacity of 240 MW.

North Sumatra is also slated to vastly expand its hydropower capacity. As shown in **Table 6** on page 23, nearly 50 hydropower plants (or groups of such plants) totaling 2,177 MW, more than quadruple the capacity of Batang Toru (510 MW), are scheduled to be built in areas that do not (as far as we know) overlap with or fragment the exclusive habitat of the Tapanuli orangutan.[44]

43. RUPTL PLN 2019-2028. Ministry of Energy and Mineral Resources, Republic of Indonesia.
44. This is not to say the impacts of each of these hydroplants will be benign. Large-scale hydropower dams are being phased out in much of the developed world for good reason (see BBC story from 11/5/19 “Large Hydropower dams ‘not Sustainable’ in the developing world” https://www.bbc.com/news/science-environment-46098118). But a detailed analysis of each of these proposed hydroprojects is beyond the scope of this paper.

Table 6: Hydroelectric power plants (excluding Batang Toru) planned for North Sumatra (2019-2028)[45]					
Name of plant	**MW**	**Year**	**Name of plant**	**MW**	**Year**
Aek Sisra Simandame	4.6	2019	Batang Toru 5	7.5	2021
Hasang	26	2019	Batu Gajah	10	2021
Lae Kombih 3	8	2019	Huta Padang	10	2021
Parluasan	10	2019	Kandibata 2	10	2021
Rahu 2	6.4	2019	Kineppin	10	2021
Sei Wampu	9	2019	Lau Gunung	10	2021
Sidikalang 2	7.4	2019	Ordi Hulu	10	2021
Anggoci	9	2020	Raisan Hutadolok	7	2021
Hasang	13	2020	Raisan Nagatimbul	7	2021
Hidro Sumatra	10	2020	Simbelin 1	6	2021
Kandibata 1	9.7	2020	Simonggo	8	2021
Parmonangan 2	10	2020	Sisira	9.8	2021
Sion	10	2020	Asahan III	87	2023
Sungai Buaya	3	2020	Asahan III	87	2024
Aek Pungga	2	2021	Mini Hydro – quota	129.6	2024
Aek Sibundong	8	2021	Hydro – quota	720	2025
Aek Sibundong (IPP)	10	2021	Hydro – quota	129	2026
Aek Sigeaon	3	2021	Mini Hydro – quota	20	2026
Aek Silang 2	10	2021	Hydro – quota	62	2027
Aek Situmandi	7.5	2021	Mini Hydro – quota	20	2027
Aek Tomuan-1	8	2021	Simonggo	90	2027
Bakal Semarak	5	2021	Pump Storage 1	250	2027
Batang Toru 1	7.5	2021	Mini Hydro – quota	10	2028
Batang Toru 3	10	2021	Pump Storage 1	250	2028
Batang Toru 4	10	2021	**Total**	**2177**	

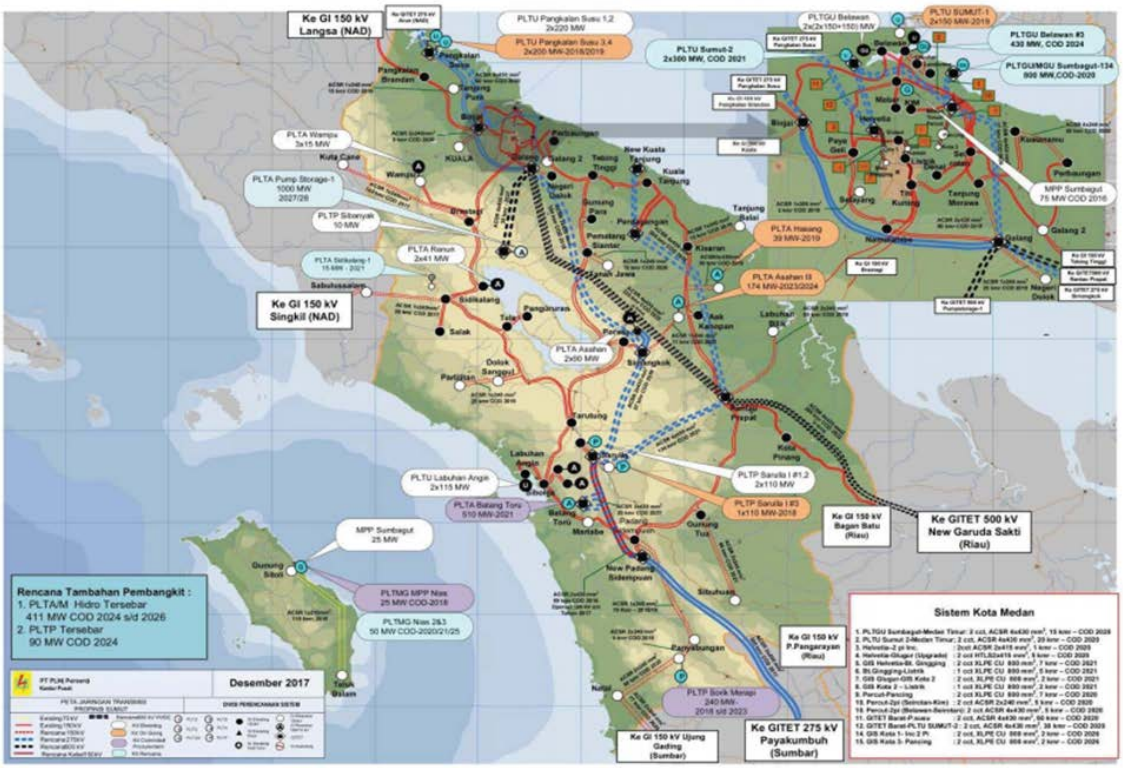
North Sumatra is also scheduled to add 51.7 MW in solar capacity.[46] With that said, the manner in which solar power in North Sumatra is planned for in the 2019 RUPTL (two single lines in a single table, in the distinct minority of proposed additions to the grid, and in no case tied to any actual location) suggests that solar power in North Sumatra is not an idea to which a great deal of deal of thought and creative energy has been devoted by national energy planners.

In sun-soaked North Sumatra, electricity from solar (during the day) would pair well with gas-fired power at night. For this reason, the Directorate General of Electricity and PLN 's neglect of solar in North Sumatra is a major missed opportunity. But this should in no way overshadow the more elemental fact that gas (peak power), geothermal (baseload power) and hydroelectric (both peak and baseload power) generating capacities in the province are being considerably augmented.

Considering North Sumatra as a single unit of analysis for purposes of power supply and demand is a deeply conservative assumption, in light of the fact that, as discussed at length in **Section 2E**, Aceh province's Arun regassification terminal pipes significant volumes of natural gas into North Sumatra. Moreover, large volumes of coal-fired electricity are set to be wheeled from South Sumatra and Riau provinces into N. Sumatra province on a soon-to-be built 500 kV transmission line (see the parallel dotted black line intersecting with the SE edge of N. Sumatra province in **Figure 6** on page 24).

45. RUPTL PLN 2019-2028." Ministry of Energy and Mineral Resources, Republic of Indonesia. See Table A 2.10 on pages A-18 to A-20 of the 2019 RUPTL report
46. Ibid.

Figure 6: Existing and planned transmission of electricity in North Sumatra province (*Source: 2018 RUPTL*)



Since we don't really know whether North Sumatra will in the future become a net energy 'importer' or 'exporter' (vis-à-vis other provinces), this paper adheres to the same analytical framework as the one in the Directorate General of Electricity's annual RUPTL reports, namely, analyzing production and consumption of electricity in North Sumatra on provincial basis. On the basis of that assumption, we forecast that power supply in North Sumatra will double peak demand starting in 2024, even without Batang Toru being built.

The main message of this chapter, then, is that the Directorate General for Electricity's over-planning for electricity in North Sumatra has resulted in an array of existing and forthcoming peak and baseload power plants in the province that could render the construction of Batang Toru optional, if not unnecessary. North Sumatra is spoiled for power choices. Batang Toru does not have to be built.

4. Conclusion

The measurement that scientists use to determine whether a species is on a trajectory toward extinction is if that population is declining by one percent a year.[47]

The entire population of the Tapanuli orangutan is comprised of 767 individuals. In the space of the few years that it would take to build Batang Toru (completion is targeted for 2022), opponents and defenders of the project appear to agree that 72 of those individuals will either be killed or permanently genetically isolated. This means that over a three-year period, the project will nearly triple the rate of decline of the population of the Tapanuli orangutan above what is required for its extinction.

Proponents of Batang Toru argue that driving the Tapanuli orangutan toward extinction is a price worth paying because the project will help to meet the current and future power needs of North Sumatra province. These defenders raise what they perceive as the climate change mitigation, peak power, and balance of payments benefits of Batang Toru. All of these arguments have been examined in this paper, and all have been found wanting.

1. North Sumatra is almost fully electrified, and rolling blackouts are largely a thing of the past. The province has a power surplus. In view of the addition of gas fired peak power in 2017 and ongoing improvements in grid infrastructure, the building of Batang Toru would not materially improve access to nor the regularity of power supply in the province in the short term.
2. Batang Toru will not replace "diesel power plants rented from overseas," as there are no such plants in North Sumatra. There is a rented floating gas-fired power plant. But the climate change and balance of payments implications of burning gas are quite different from those of burning diesel.
3. It is claimed that the commissioning of Batang Toru would result in reduction of 1.6 to 2.2 million tons of annual CO2 emissions per year. These are vast overestimates. Reductions made possible by Batang Toru are more likely to be on the order of 700 thousand to 1.1 million tons of CO2 annually.
4. In spite of the efforts of the owners and proponents of Batang Toru to highlight the plant's production of peak power, only half of the plant's output is peak power. The remainder is baseload power.
5. The need for Batang Toru's proposed peak power capacity is already diminishing, due to the existence of a 240 MW floating gas plant, and the likely future construction of 800 MW in new gas fired peak power which will come on line in 2022 (200 MW), 2024 (300 MW) and 2028 (300 MW). Like Batang Toru, these gas plants produce peak power during the night and could also produce baseload power during the day, if needed.
6. As for Batang Toru's proposed contribution to the province's baseload power, this is already being rendered unnecessary by the commissioning of the 330 MW Sarulla geothermal power plant in 2017 and 2018, and could be rendered even more superfluous by a 300 MW "expansion" in capacity at Sarulla[48] starting in 2022,[49] as well as a the "high possibility"[50] of 240 MW in new geothermal power at Sorik Marapi.[51] Another excellent option for the production of power during the day, would be solar power, to which the Directorate General of Electricity and PLN, should give greater consideration.

47. Wich, Serge et al. "The Tapanuli orangutan: Status, threats, and steps for improved conservation." Conservation Science and Practice. April 17, 2019 https://conbio.onlinelibrary.wiley.com/doi/full/10.1111/csp2.33
48. "RUPTL PLN 2016-2025." Ministry of Energy and Mineral Resources, Republic of Indonesia. Page 231 http://www.djk.esdm.go.id/pdf/RUPTL/RUPTL%20PLN%202016-2025.pdf
49. Ibid. Page 139
50. Ibid. Page 231
51. Ibid. Page 139

7. Batang Toru will not put diesel power plants out of business, and thus will not alleviate the negative balance of payment impact to the nation caused by the import of diesel. However, the high capital costs of building Batang Toru will lead to the outflow of dollars from Indonesia and into the bank accounts of the Chinese contractor that will build the plant, as well as the Chinese holding company that owns the majority of the plant, all to the detriment of Indonesia's balance of payments.
8. Sinohydro, the contractor that is building Batang Toru has a global track record of fraud, non-standard practices, and corruption on three continents, all of which suggests that Batang Toru has significant construction and operations risks.
9. The Directorate General of Energy's overly-robust projections of power demand have led to an overbuilding of power plants in North Sumatra. This may be a blessing in disguise, as it could mean that there are many excellent substitutes available for the peak power (**Point 5** above) and baseload power (**Point 6** above) that Batang Toru aims to produce.

If built, Batang Toru will take one of only eight (if humans are included) species of great ape on the planet, the Tapanuli orangutan, some distance down the road to extinction, possibly past the point of no return. To some, this might be acceptable if the benefits of the project are what is being promised. But in most cases, the purported benefits of the project are illusory, exaggerated, or the opposite of what they are claimed to be.

There is no over-riding electricity supply, climate change mitigation or foreign exchange rationale for Batang Toru to be built.

5. About the Authors

David W. Brown, Ph.D. is an expert in Indonesia's natural and extractive resource sectors. From 2003 to 2006, he was head of the Forest Sector Restructuring Team for the first phase of the UK Department of International Development (DFID) Multi-Stakeholder Forestry Program (MFP), and from 2007 to 2014 he was a World Bank Senior Advisor on the Extractive Industries Transparency Initiative (EITI). As of 2020, David is consulting with the Asian Development Bank (ADB) and the Organization for Economic Cooperation and Development (OECD).

David also has private sector experience, having advised the world's largest mining company BHP Billiton on the governance of its Indonesian mining operations (from 2014 to 2016), and having served as a Forest Sector Commodities and Equities Analyst with the global investment bank of Dresdner Kleinwort Benson in Indonesia (from 1997 to 1998).

David's 2001 PhD dissertation at the University of Washington was on the Indonesian and Malaysian forest products industry, and whether the Indonesian government and the Malaysian states of Sarawak and Sabah were setting timber revenues at levels that made economic sense, and if not why not. Support for the research for the dissertation was provided by a US Fulbright grant (in Malaysia, where David was resident in the Institute for Strategic and International Studies (ISIS) in the Office of the Prime Minister of Malaysia) and a Social Sciences Research Council International Pre-Dissertation Fellowship (in Indonesia, where David was resident first in the World Bank, and then in the University of Indonesia's Faculty of Economics).

From 1989 to 1991, David was an Energy Legislative Assistant to US Senator Max Baucus, and previously was an Energy Legislative Assistant to US Congressman Wayne Owens.

David was a Telluride Scholar at Cornell University from 1983 to 1985, where he was awarded a BA in Political Economy. From 1980 to 1982 he attended the prestigious Deep Springs College.

Jeffrey D. Brown, MBA is a Principal in B2E2. He is also a Research Fellow at Stanford University's Steyer Taylor Center for Energy Policy and Finance. Jeff was a principal co-author of a major study completed in collaboration with the Hoover Institute examining worldwide funding constraints and policy barriers to financing green energy projects entitled "Making Green Energy Investments Blue Chip." From 2015 to 2019, he was a Lecturer at both Stanford Graduate School of Business and Stanford Law School, where he taught a graduate level course entitled "Clean Energy Project Development and Finance." For the last two years, he has been a core member of a multi-stakeholder working group convened by the Stanford Woods Institute for the Environment that is studying how hydropower can address climate change without adverse environmental impacts. Jeff now serves as Director of Energy Economics at the University of Wyoming's Enhanced Oil Recovery Institute.

Jeff does significant additional consulting work on environmental and economics issues. With David, he conducted extensive studies in 2016-2018 on strategies to improve economics of sustainable forestry concessions in Kalimantan, with the aim of staving off legal or illegal conversion to palm oil plantations. Current electric sector projects involve carbon sequestration and lowering capital cost and speeding adoption of low carbon power sources.

Previously, Jeff was Senior Vice President at Seattle-based clean energy development firm Summit Power Group. Immediately preceding Summit, Jeff had retired as a Managing Director in the bond financing division of Bank of America Merrill Lynch. Prior to Merrill Lynch, Jeff spent 20 years working as an investment banker for Goldman Sachs in New York, Hong Kong, and Seattle. During his investment banking career he advised clients or completed transactions relating to virtually every type of energy and electric generation project, from Liquefied Natural Gas in the Middle East, natural gas pipelines, coal and natural gas power plants, wind, solar, geothermal, biomass, municipal solid waste, large and small hydropower, and nuclear.

Jeff has an MBA with distinction from Harvard Business School, and graduated Magna cum Laude in Economics from Harvard College. He was a Harvard National Scholar as well as being a State of Oregon Presidential Scholar in 1975.