



Arise



Advanced Research on Innovations in Sustainability and Energy (ARISE) of the University of Twente,
Raja Ampat Research and Conservation Centre, and Papua Diving Raja Ampat.

CERTIFICATE OF RECOGNITION

Presented to

Kunaiifi

For participation as a speaker in the
WORKSHOP ON SUSTAINABLE ISLANDS
at the Island of Kri, Raja Ampat, West Papua, Indonesia, 15-22 October 2017
User experiences with the reliability of electricity supply in Indonesia

Enschede, 22 October 2017

Principal Organizer

Prof. dr. A.H.M.E. Reinders
Director of ARISE



WORKSHOP ON SUSTAINABLE ISLANDS

KRI ISLAND – RAJA AMPAT – WEST PAPUA - INDONESIA

OCTOBER 15 - 22, 2017

ABOUT THE WORKSHOP **SUSTAINABLE ISLANDS**

An island is any piece of land that is surrounded by water. Inhabited islands can therefore be considered as unique, isolated communities that have to rely on their own resources. Energy, food and water supply are the most predominant needs of islanders. Wouldn't it be wonderful if these needs could be provided in a sustainable manner without the creation of emissions and other waste? In this way, the local ecology and biodiversity can be protected as well.

This workshop Sustainable Islands seeks for sustainable, and affordable, solutions for remote islands in the Indonesian archipelago, in particular in the Raja Ampat region of West-Papua which is considered the global epicenter of tropical marine biodiversity. Located off the northwest tip of or Bird's Head Peninsula on the island of Papua in the Province of West Papua, a group of 1,500 limestone islands of Raja Ampat spread as part of the coral triangle which houses the world's richest coral reef ecosystem.

The sustainable solutions resulting from the workshop Sustainable Islands will be focused on combining sustainable energy, clean water supply and sustainable management of food supply and waste streams on islands in this tropical area. The results will be used to develop a research plan and to set up an implementation project.

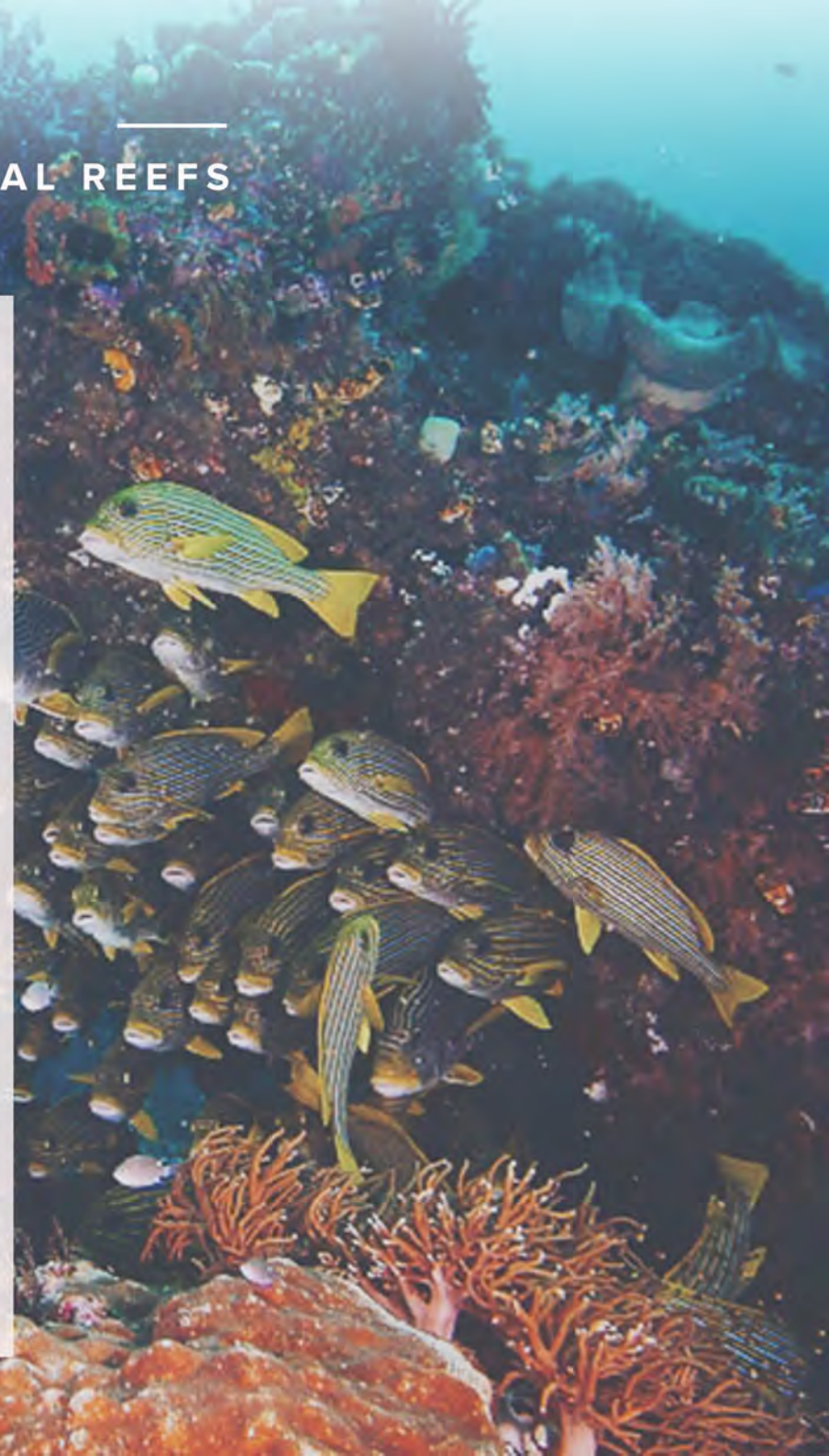


THE IMPORTANCE OF CONSERVATION OF CORAL REEFS

Coral reefs are home to 25% of all marine life on the planet. In fact the variety of life supported by coral reefs rivals that of the tropical forests of the Amazon or New Guinea. But, without urgent action to address climate change, pollution, overfishing and other threats these beautiful and life-sustaining organisms could disappear. (WWF 2017 and WRI Reefs at Risk).

According to World Resource Institute (WRI), Southeast Asia is considered the global epicenter of marine diversity. Its 100,000 km² of coral reefs (34% of the world's total) are home to over 600 of the 800 reef-building coral species in the world. More than 450 million people live within 60 km of coral reefs, with the majority directly or indirectly deriving food and income from them (Seaweb). Counting only the economic value of fisheries, tourism, and shoreline protection, the costs of destroying 1 km of coral reef ranges between US\$ 137,000 - 1,200,000 over a 25-year period. At present, 58% of the world's coral reefs are potentially threatened by human activity.

Coral bleaching happens due to elevated temperatures of the water in seas and oceans because of global warming. Unfortunately, coral reefs can easily die from bleaching, and it takes a lifetime to recover. Therefore coral bleaching is threatening the food supply and income of many people that live in the vicinity of coral reefs as well as the biodiversity of marine life of our planet. From 1876-1979 only three bleaching events were recorded, whereas 60 are on record from 1980 until 1993 (Glynn 1993). In 2002 more than 400 events were recorded (Reef Education Australia and UNEP). The 3rd global coral bleaching event (2014-2017) is by far the longest and most widespread event in recorded history (Underwater Earth 2015). In 2017, it was concluded that an estimated 70% of shallow-water corals of the Great Barrier Reef had died. Scientist indicate that the future of coral reefs looks grim and that urgent action on climate change is required (The Guardian 2017).



THE ISLAND OF KRI

► THE ISLAND OF KRI

The workshop will take place at the Island of Kri, Raja Ampat. Kri is 75km away (1.5 hours by speedboat) from the port of Sorong on the northwest coast of West Papua, Indonesia. It is located in the center of the Raja Ampat Marine Park. One of the reasons for visitors to come to the Island of Kri is because the famous 'Cape Kri' reef which holds the World's Record for the highest number of fish species ever counted. The world record at Cape Kri was close to 400 different species of fishes in one single dive.

Kri is a good place for a workshop on sustainable islands because of the Raja Ampat Research and Conservation Centre and cottages provided by Papua Diving.



► HOW TO GET THERE?

A typical route to get to Kri:

1. Take an international flight to one of the recommended International airports in Indonesia, either Jakarta or Makassar,
2. Connect to a domestic (Indonesian) flight to Sorong (SOQ-Domine Edward Osok Airport). Airlines like Sriwijaya & NAM Air, Express Air and Garuda operate with regular flights.
3. Connect to transfer services provided by resort companies or managed by local people between Sorong airport and the Island of Kri.

The workshop participants are eligible for a free scheduled transfer:

1. Arrival Sunday: boat will depart from Sorong around 09:30 am (do not arrive later than 08:45 am in Sorong),
2. Departure Sunday: boat will arrive around 09:00 am in Sorong (do not book a flight that leaves Sorong before 10:30 am).



PROGRAM

SUNDAY 15 OCTOBER 2017

Arrival on Kri Island and informal introduction

MONDAY 16 OCTOBER 2017

Presentations by participants about sustainable energy, clean water supply and sustainable management of islands in the Raja Ampat archipelago. In the morning program: Keynote Speech from the Bupati of Raja Ampat, Mr. Abdul Faris Umlati, SE.

TUESDAY 17 OCTOBER 2017

Morning program: more presentations, afternoon program: a guided brainstorm with participants about possible solutions regarding the topics above mentioned.

WEDNESDAY 18 OCTOBER 2017

Further visit of Kri and other nearby islands by boat.

THURSDAY 19 OCTOBER 2017

Morning program regarding report writing for a research and implementation project on sustainable energy, clean water supply and sustainable management for sustainable islands.

FRIDAY 20 OCTOBER 2017

Morning program regarding report writing for a research and implementation project sustainable energy, clean water supply and sustainable management for sustainable islands.

SATURDAY 21 OCTOBER 2017

Rest day which can be used for recreation

SUNDAY 22 OCTOBER 2017

Departure.

LOCATION

RARCC Meeting Space.

CONFIRMED SPEAKERS:

- Angele Reinders (University of Twente: PV Systems for Sustainable Islands),
- Max Ammer (RARCC, Indonesia),
- Angele Reinders (University of Twente, The Netherlands),
- Elisabeth Veronica Wambrauw (University of Cendrawasih, Indonesia),
- Frits Bliet (DNV GL, The Netherlands),
- Herbert Innah (University of Cendrawasih, Indonesia),
- Hugo Heitling (Orange Delta, Singapore),
- Kunaifi (University of Twente, The Netherlands and UIN Sultan Syarif Kasim Riau, Indonesia),
- Penny Hestianti Marsella (PLN, Indonesia),
- Richard Corkish (University of New South Wales, Australia),
- Zulkifli (Office of Energy and Mineral Resources – The province of Riau, Indonesia).

ABOUT RARCC

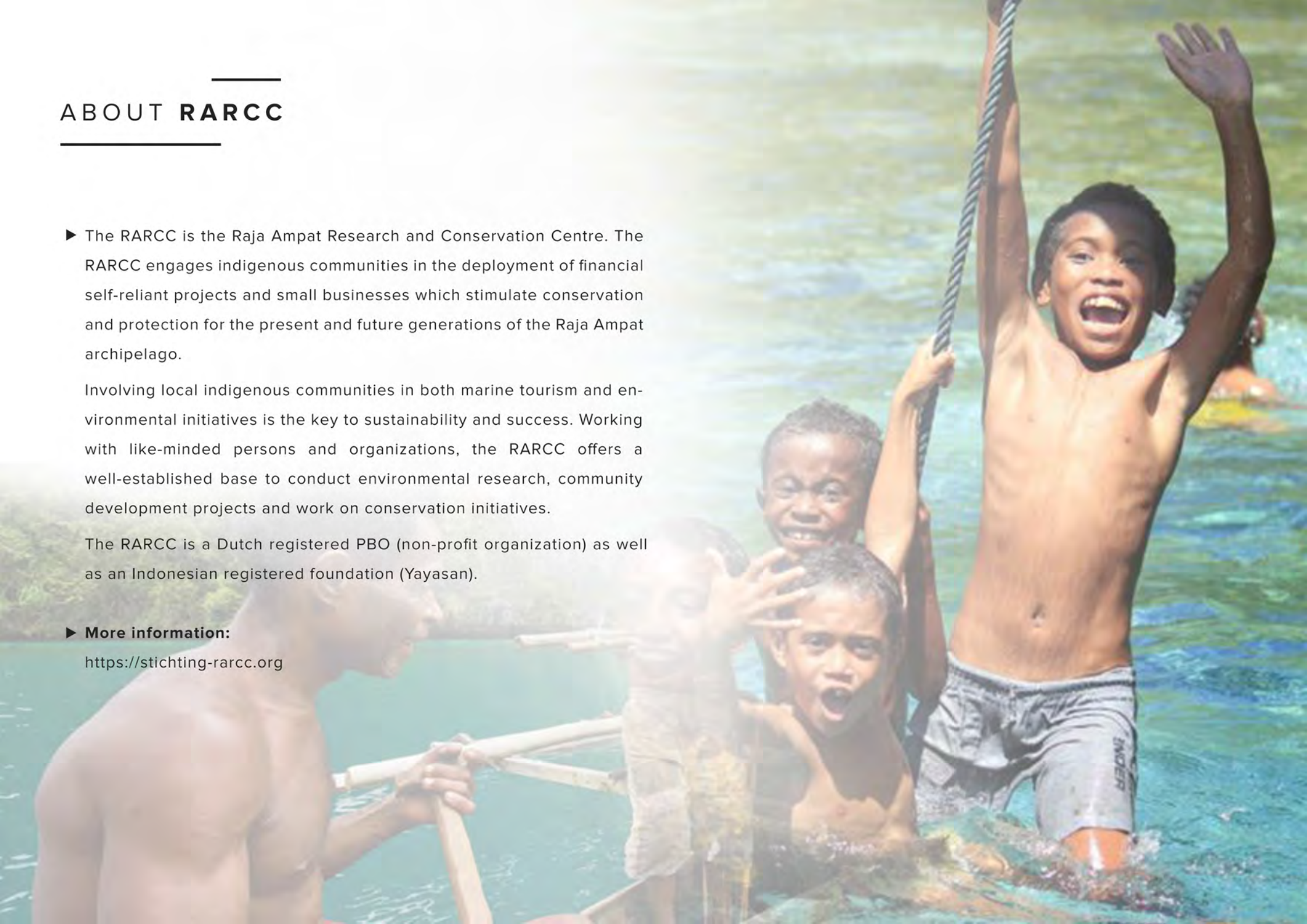
- ▶ The RARCC is the Raja Ampat Research and Conservation Centre. The RARCC engages indigenous communities in the deployment of financial self-reliant projects and small businesses which stimulate conservation and protection for the present and future generations of the Raja Ampat archipelago.

Involving local indigenous communities in both marine tourism and environmental initiatives is the key to sustainability and success. Working with like-minded persons and organizations, the RARCC offers a well-established base to conduct environmental research, community development projects and work on conservation initiatives.

The RARCC is a Dutch registered PBO (non-profit organization) as well as an Indonesian registered foundation (Yayasan).

- ▶ **More information:**

<https://stichting-rarcc.org>





ARISE

► **MISSION STATEMENT OF ARISE**

Research on Sustainable and Energy-Efficient Solutions

► **WHY ARISE?**

Energy and sustainability are topics that are highly positioned on the present agenda of politics and research funding organizations in the Netherlands and in Europe. Naturally since we don't have a planet B, we all understand why we need to protect our environment, but still though, the deployment of fossil fuels dominates energy provision in our society. This is a context which can't be ignored as a challenge and an opportunity at the same time. Therefore we like to look for alternatives. This ambition has become even more important in the framework of the climate conference COP-21, which was successfully completed in 2015 with international commitments to limit global CO2 emissions to relatively safe levels leading to a global warming of just 2°C with an aspiration of 1.5°C.

These goals will only be achievable by a large scale implementation of low emission technologies. Logically, more sustainable and energy-efficient energy solutions should be locally embedded at locations where people live, work and commute. These three aspects: living, working and transportation are the core directions to the research and educational activities of ARISE which stands for 'Advanced Research on urban Innovations in Sustainability and Energy'.

► **MORE INFORMATION**

<http://www.arisetgether.nl>



► **PARTNERS**

- 1 RARCC (Raja Ampat Research and Conservation Centre)
<https://stichting-rarcc.org>
- 2 Papua Diving: accommodation and recreation activities
<https://papua-diving.com>

► **CONTACT US:**

For information about the workshop:

Angele Reinders

Email: a.h.m.e.reinders@utwente.nl

For registration of accommodation:

Jimmy Praet

Email: info@papua-diving.com

► **ARISE**

University of Twente

PO Box 217 7500AE ENSCHEDE

The Netherlands

<http://www.arisetgether.nl>

IMAGE SOURCE:

<http://papua-diving.com>

<http://awesomwallpaper.com/wallpapers/raja+ampat+islands>

<http://myhdwallpapers.in>

<http://www.engineersjournal.ie/2016/06/28/commercial-solar-pv-make-sense-ireland/>

<http://solartribune.com/how-much-are-solar-panels/>

<http://www.alamy.com/stock-photo/raja-ampat-people.html>

Arise



Workshop Sustainable Islands Final Program

October 15 to 22, 2017, Kri, Indonesia

Organizers: Angèle Reinders, ARISE, University of Twente, a.h.m.e.reinders@utwente.nl
and Kunaifi, ARISE, University of Twente and UIN Sultan Syarif Kasim Riau, k.kunaifi@utwente.nl

Day 1

Sunday, 15 October, 2017

Departure from Sorong at 8:45 am and arrival at RARCC and Kri Eco Resort, Kri.

Informal introduction of participants at dinner in the Restaurant of Kri Eco Resort at 18:30h

Day 2

Monday, 16 October, 2017

Start of workshop 'Sustainable Islands' with presentations by participants about sustainable energy, clean water supply and sustainable management of islands in Indonesia.

Time	Presentation and Speaker or Activity
7:00 h	Breakfast
8:30 h	Departure to workshop (walking or by boat depending on the tide) Location: Lounge Area of Sorido Bay Resort, first floor
9:00 h	Start of morning program Welcome to Kri, Max Ammer (RARCC, Indonesia)
9:10 h	Opening of the workshop, Angèle Reinders (University of Twente, The Netherlands)
9:20 h	Keynote presentation by the Bupati of Raja Ampat, Mr. Abdul Faris Umlati, SE (Indonesia)
10:30 h	Break
11:00 h	Making a difference in Raja Ampat, Max Ammer (RARCC, Indonesia)
11:20 h	Renewable energy access and socio-economic development impacts in the Papua Province, Herbert Innah (University of Cendrawasih, Indonesia)
12:30 h	End of morning program, return to Kri Eco Resort (walking or by boat depending on tide)
13:00 h	Lunch in Restaurant of Kri Eco Resort
13:45 h	Return to Sorido Bay Resort (walking or by boat depending on tide)
13:15 h	Start of afternoon program User experiences with the reliability of electricity supply in Indonesia, Kunaifi (University of Twente and UIN Sultan Syarif Kasim Riau, Indonesia)
14:00 h	Development of new and renewable energy to increase electrification in Riau Province, Izul Zulkifli (Office of Energy and Mineral Resources – The province of Riau, Indonesia)
14:45 h	Break
15:15 h	The potential of solar photovoltaic systems for sustainable islands, Angele Reinders (University of Twente, The Netherlands)
16:00 h	Tidal energy and clean water supply at islands, Hans van Mameren (Orange Delta, Singapore)
16:45 h	End of the workshop program of this day
18:30 h	Dinner in the Restaurant of Kri Eco Resort



Day 3
Tuesday, 17 October, 2017

Time	Presentation and Speaker or Activity
7:00 h	Breakfast
8:30 h	Departure to workshop (walking or by boat depending on the tide) Location: Lounge Area of Sorido Bay Resort, first floor
9:00 h	Start of morning program PLN's experiences with island electrification programs, Penny Hestianti Marsella (PLN, Indonesia)
10:00 h	Presentation by journalist of Eco-business (to be announced later)
10:30 h	Break
11:00 h	Smart energy systems, Frits Bliet (DNV GL, The Netherlands)
11:45 h	Sustainability measures in island development, Elisabeth Veronica Wambrauw (University of Cendrawasih, Indonesia)
12:30 h	End of morning program, return to Kri Eco Resort (walking or by boat depending on tide)
13:00 h	Lunch in Restaurant of Kri Eco Resort
13:45 h	Return to Sorido Bay Resort (walking or by boat depending on tide)
13:30 h	Start of afternoon program Brainstorm sessions with participants about Sustainable Islands, guided by Angele Reinders (University of Twente, The Netherlands)
16:45 h	End of the workshop program of this day
18:30 h	Dinner in the Restaurant of Kri Eco Resort



Day 4

Wednesday, 18 October, 2017

Excursion to nearby islands by boat.

Time	Presentation and Speaker or Activity
7:00 h	Breakfast
9:00 h	Departure to island Mansuar and visit of Yenbuba (independent village with indigenous community) Next travel to Arborek which is an island and village which depends on tourism.
12:00 h	Picnic lunch
13:00 h	Return to Kri by the island Gam including a visit of the natural habitat of the mangrove forest and its unique flora and fauna
15:30 h	End of the excursion
18:30 h	Dinner in the Restaurant of Kri Eco Resort

Day 5

Thursday, 19 October, 2017

Time	Activity
7:00 h	Breakfast
9:00 h	Report writing for a research and implementation project on sustainable energy, clean water supply and sustainable management for sustainable islands. The format for this report will be supplied by organizers of the workshop. The report will be further processed into a research proposal that will be submitted on 1 November, 2017. Location: Restaurant and Lounge of Kri Eco Resort
13:00 h	Lunch in Restaurant of Kri Eco Resort
14:00 h	Leisure time for snorkling, diving, kayaking and paddle boarding. OR Report writing, see above for details.
18:30 h	Dinner in the Restaurant of Kri Eco Resort



Day 6
Friday, 20 October, 2017

Time	Activity
7:00 h	Breakfast
9:00 h	Report writing for a research and implementation project on sustainable energy, clean water supply and sustainable management for sustainable islands. The format for this report will be supplied by organizers of the workshop. The report will be further processed into a research proposal that will be submitted on 1 November, 2017. Location: Restaurant and Lounge of Kri Eco Resort
13:00 h	Lunch in Restaurant of Kri Eco Resort
14:00 h	Leisure time for snorkling, diving, kayaking and paddle boarding. OR Report writing, see above for details.
18:30 h	Dinner in the Restaurant of Kri Eco Resort

Day 7

Saturday, 21 October, 2017

Time	Activity
7:00 h	Breakfast
9:00 h	Leisure time for snorkling, kayaking and paddle boarding. There won't be any diving activity this day.
13:00 h	Lunch in Restaurant of Kri Eco Resort
14:00 h	Voluntary program element: Bird Watching Trip to see the red paradise bird in the wild Part of the payment of this trip will be donated to indigenous communities in Raja Ampat Registration at management of Kri Eco Resort
18:30 h	Dinner in the Restaurant of Kri Eco Resort

Day 8

Sunday, 22 October, 2017

Departure to Sorong at 7:00 h or 9:00 h.

Thanks for attending this workshop on Sustainable Islands

See you soon again, in 2018!



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USER EXPERIENCES WITH THE RELIABILITY OF
ELECTRICITY SUPPLY IN INDONESIA

KUNAIFI

[UNIVERSITY OF TWENTE & UIN SUSKA RIAU]

WORKSHOP ON SUSTAINABLE ISLANDS

KRI ISLAND, RAJA AMPAT, WEST PAPUA, INDONESIA, 15-22 OCTOBER 2017





OUTLINE

- Indonesia in Brief
- Energy demand and electricity supply in Indonesia
- Reliability of Electric Power
- Questions and Approaches
- Results:
 - SAIDI & SAIFI
 - Household experiences
 - Results from measurement at distribution grids
- Conclusion & Discussion
- Limitation of study

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INDONESIA IN BRIEF

POPULATION

255 mil. (2015) (4th)

2 SEASONS

rain & dry

3 TIME ZONES

UTC +7 to +9

**TROPICAL
COUNTRY ON
THE EQUATOR**

LARGEST ECONOMY IN SEA

GDP 2016: \$936 bil (16th)



ENERGY DEMAND AND ELECTRICITY SUPPLY

World



<http://www.tungkuindonesia.org>

**2.7
billion**

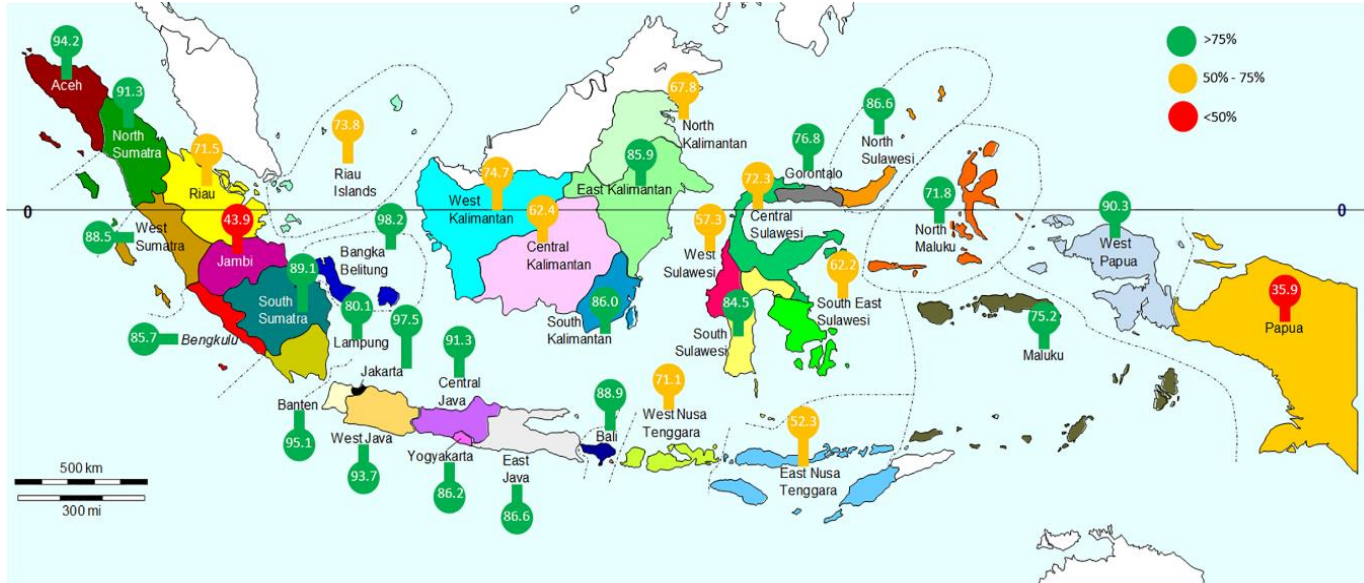
people in the world
remained reliant on
solid biomass as a
cooking fuel in 2015.

**1.2
billion**

without access to electricity.

Source: IEA (2016)

ENERGY DEMAND AND ELECTRICITY SUPPLY IN INDONESIA



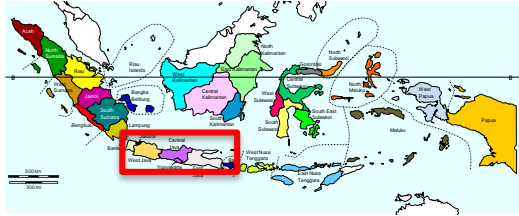
35 Million
 People without electricity in Indonesia in 2015 (PLN 2016)

The total electricity consumption
201 TWh 2015
2008 TWh 2020
 MEMR (2016).

Overall electrification ratio in Indonesia was 86% in 2015
 36% in Papua, around 65% in some provinces in Sulawesi, Kalimantan and Timor 98% in Jakarta [PLN Statistics 2016]

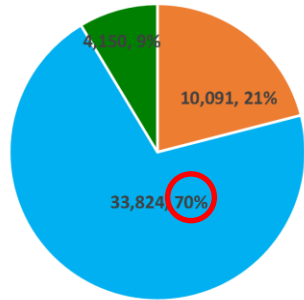


ENERGY DEMAND AND ELECTRICITY SUPPLY IN INDONESIA



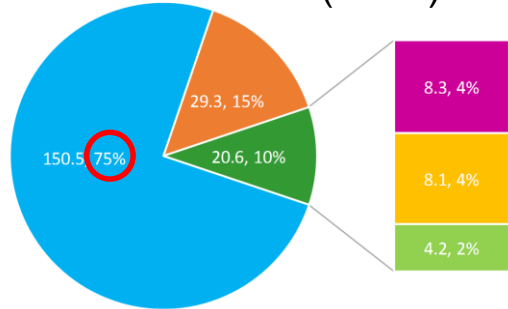
JAVA

Area: 6.7%
Population:
57% (2013)



Sumatra Java & Bali Eastern Indonesia

(a)



Java & Bali Sumatra Kalimantan Sulawesi Maluku, Papua, Nusa Tenggara

(b)

DISTRIBUTION GAP

93.3%

The rest of Indonesia

Lacking of electricity

[huge power development potential]

- (a) Power generation capacity in 2015 (MW);
- (b) Electrical energy selling in 2015 (TWh).

The Indonesia economy struggles with electricity supply deficits and low quality

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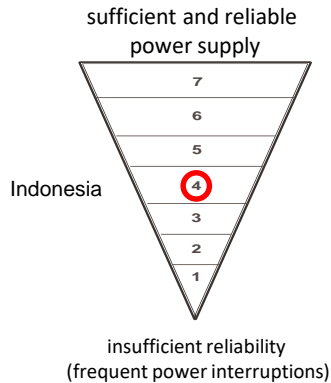
Based on (Ministry of Energy and Mineral Resources 2016).

ENERGY DEMAND AND ELECTRICITY SUPPLY IN INDONESIA



Power supply continuity issues:
frequency and voltage fluctuations,
power restrictions,
frequent blackouts.

Far from big cities or in islands: electricity service only for 6 to 12 hours per day - mainly from diesel generators

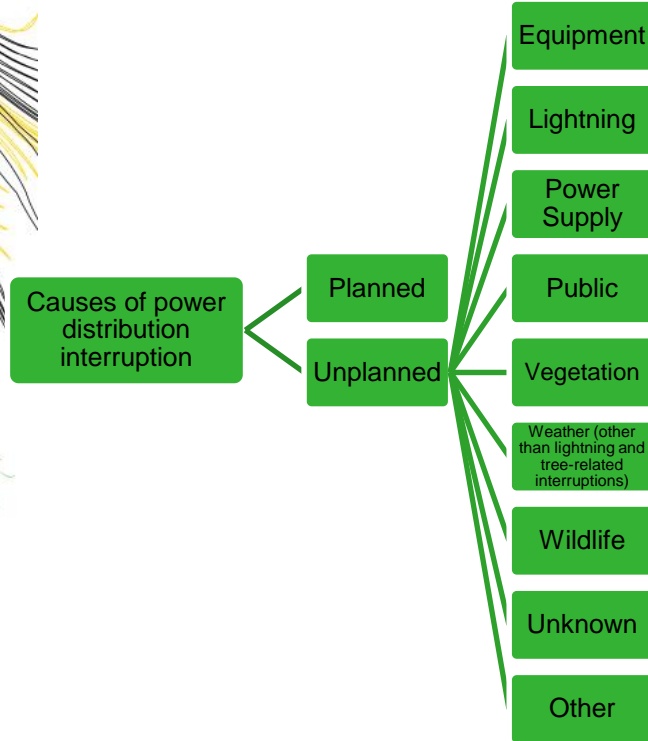


**Indonesia
Power
Reliability
Level 4 out of 7**

(CRO Forum 2011)

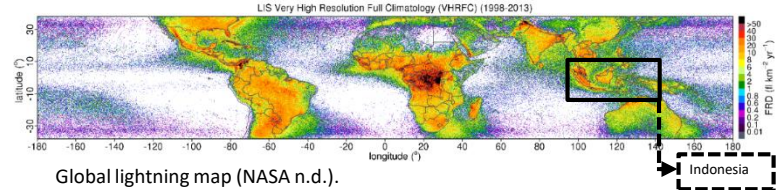


ENERGY DEMAND AND ELECTRICITY SUPPLY IN INDONESIA



Indonesia is among the countries with highest lightning or flash density in the world
 (Zoro and Mefiardhi 2006),
 (Christian, et al. 2003).

LIGHTNING CAUSES MOST OF OUTAGES IN INDONESIA
 500kA system: 56%
 150 kV system: 28%
 70 kV system: 69%
 20 kV systems:90%



- Major causes of outage :
- Planned [maintenance], sometimes with prior notice,
 - Equipment,
 - Lightning,
 - Power supply [dry seasons]
 - Vegetation [heavy rain]

Other causes:
 equipment failures, vegetation, and overconsumption by the public

QUESTIONS AND APPROACHES

How reliable is the electric power supply by distribution networks (DN) in Indonesia from the perspective of users and does this compare to official data?”

1. What is the officially reported reliability of power supply in Indonesia? → 1. Desk Study
2. How do users in urban areas of Indonesia experience their power supply in practice? → 2. User Study
3. What is the actual power quality in distribution grids in Indonesia? → 3. Measurements on Distribution Grid



QUESTIONS AND APPROACHES

Desk Study

Study on Annual reports from PLN during the period of 2010 to 2015

Reports are in Bahasa Indonesia.

Contain information about SAIDI & SAIFI

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$$SAIDI = \frac{\sum(r_i \times N_i)}{N_T}$$

r_i : Restoration time or the duration of interruption in service area i ,
 N_i : Total number of customers interrupted in service area i ,
 N_T : Total number of customers served in service area i .

$$SAIFI = \frac{\sum(N_i)}{N_T}$$

N_i : Total number of customers interrupted in service area i ,
 N_T : Total number of customers served in service area i .

QUESTIONS AND APPROACHES

Field Research



Table 1. Study locations and reasons for selection.

City	Province	Regional location in Indonesia	Electrification ratios of the city's provinces in 2015*	Assumption about the level of DN reliability	Period of the field survey
Pekanbaru	Riau	West	71	Best	27/03 – 14/04
Kupang	ENT	Central	52	Medium	24/04 – 29/04
Jayapura	Papua	East	36	Worst	02/05 – 09/05

* PLN (2016) [2].

QUESTIONS AND APPROACHES

Field Research – End User Survey

Generally structured questionnaires (open-ended and closed-ended questions)
'face-to-face' semi-structured interviews.

1. Would you accept an increase in your electricity bill for a better electricity service?
2. How much increase in your electricity bill would you find acceptable?
3. Do you have a backup generator at home?
4. Do you experience a stable electricity voltage at home?
5. Have you ever experienced a blackout at home?
6. On an average, how often in a month do you experience blackouts?
7. On an average, how long is the duration of the blackouts that you experience?
8. At what time of day a blackout event would incur most losses to you?
9. On an average, what is the duration of a blackout that would incur economic losses to you?





QUESTIONS AND APPROACHES

Field Research – End User Survey

The responses from respondents were used to estimate the P-SAIFI and P-SAIDI. “P”: ‘perceived.’

P-SAIFI: the average frequency of interruption experienced by the respondents in the number of outage events per customer per year.

-> “on an average, how often do you experience blackouts in a month?”

P-SAIDI: the user experience about the average duration of each interruption in hours per customer per year.

-> “On an average, how long is the duration of the blackouts that you experience?”

QUESTIONS AND APPROACHES

Field Research – End User Survey

$$MFD_{P-SAIFI} = \frac{\sum_{i=1}^4 (x_{Fi} * N_{f_{Fi}})}{N}$$

$$P - SAIFI = C * \frac{\{\sum_{i=1}^4 (x_{Fi} * N_{f_{Fi}})\} * 12}{N}$$

$$MFD_{P-SAIDI} = \frac{\sum_{i=1}^5 (x_{Di} * N_{f_{Di}})}{N}$$

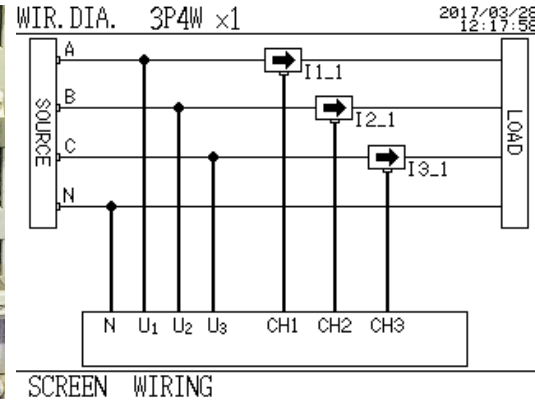
$$P - SAIDI = \frac{\sum_{i=1}^5 (x_{Di} * N_{f_{Di}}) * P - SAIFI}{N * 60}$$

f_{F1} : < 3 times,
 f_{F2} : 3 - 5 times,
 f_{F3} : 6 - 10 times
 f_{F4} : > 10 times.

x_{F1} : 1.5 times,
 x_{F2} : 4 times,
 x_{F3} : 8 times
 f_{F4} : 11 times

QUESTIONS AND APPROACHES

Field Research – Power quality measurements



Pekanbaru : 15 days [UIN Suska Riau University].

Kupang : BMKG [5 days]

Jayapura : BMKG [7 days]

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RESULTS

SAIDI and SAIFI

SAIDI given in average hours of outage duration per customer per year, SAIFI given in average outage events per customer per year. Data sources: PLN (2011-2016) [2, 22-26].

SAIDI:

Riau: 11.8 hours/year (59 minutes of outage per month).

Papua: 38 minutes/month

ENT: 17 minutes/month.

SAIFI:

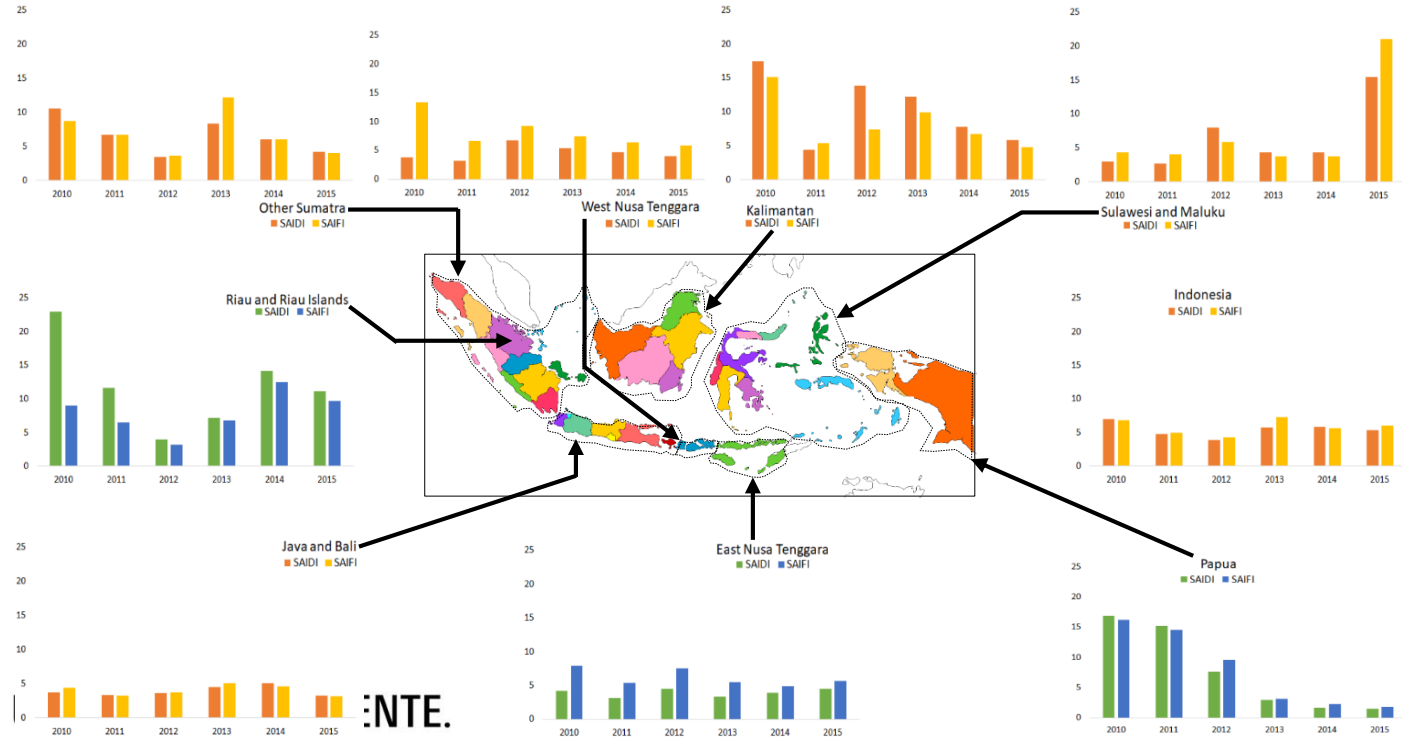
Riau and Papua: 7.9 events per year at each location

ENT: 6.1 events per year

Therefore, among the three provinces, Riau has the worst quality of electricity service, followed by Papua and next ENT.

RESULTS

Results – SAIDI and SAIFI



RESULTS

Results – Household experiences

300 questionnaires in
total.
average response rate:
68%.

Target respondents:
household member
responsible to electricity
service (contracting and
paying).

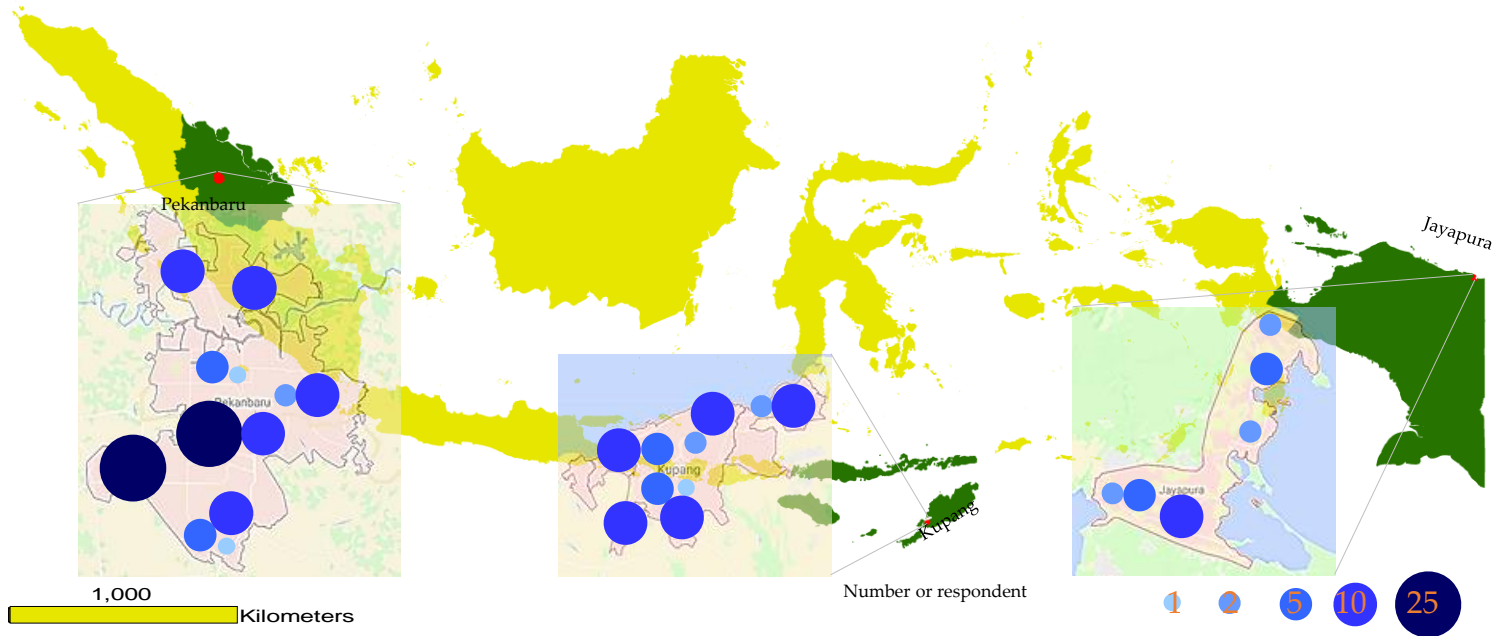
Respondents we
selected based on
random sampling.

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	Pekanbaru	Kupang	Jayapura
No. of respondent	114	65	26
Address in the city (%)			
- Urban-core	53	45	23
- Sub-Urban	47	55	77
Monthly income (%)			
- High	28	5	4
- Upper-Middle	43	28	50
- Lower-Middle	17	49	27
- Low	6	15	0
- Not answer	6	3	19
Sex (%)			
- Male	49	51	42
- Female	51	49	58
Age groups (%)			
- 18-29	11	5	31
- 30-49	63	54	58
- 50-64	23	35	12
- 65+	4	6	0
Education (%)			
- No school	0	2	0
- Basic school	8	14	0
- High school	50	42	0
- Undergraduate	30	38	8
- Postgraduate	5	3	85
- Not answer	7	2	8

RESULTS

Results – Household experiences



RESULTS

Results – Household experiences

- Experienced voltage stability (based on visual observations): Pekanbaru (82%), Kupang (49%), Jayapura (50%)
- WTP: 68% in Kupang, 58% in Jayapura and 56% in Pekanbaru
- To avoid the cost of outages, households at three cities are willing to bear a 10%-30% increase in their monthly electricity bill.
- The average electricity expenditure of households in the urban core of Jayapura is IDR 350,000 (\approx \$ 27) per month. Assuming the similar monthly cost of electricity for households in Pekanbaru and Kupang, it can be estimated that households are willing to pay \$ 3 to \$ 8 extra per month or \$ 1c - \$ 3c per kWh for improved reliability (Rp. 130 – Rp. 400 per kWh).
- Genset possession: Jayapura (65%), Pekanbaru (21%), Kupang 14%.

RESULTS

Results – Blackout Events

- Two households stated never encountered any outage.
- The majority of respondents in the three cities experience 3 to 5 blackouts or less per month. However, in Kupang, 31% of the respondents experience 6 to 10 blackouts per month.
- The average duration of each blackout event typically takes 1 to 2 hours for more than half of respondents in each city.
- Around 12%-15% of respondent experience outage with a duration of more than 2 hours each.
- None of the respondent experience a blackout which takes less than 5 minutes.
- If a blackout is reaching one hour long, it starts to evoke losses to most of the respondents.
- The timing of interruptions that could incur losses to users are those occurring between 6 am to 12 am and 6 pm to 12 pm. Within those periods of time, electricity is highly required for work, business, and domestic activities.





RESULTS

Results – P-SAIFI & P-SAIDI

P-SAIDI:

Pekanbaru : 21 hours/customer per year (2.6-folds than the PLN's SAIDI)

Kupang : 24 hours/customer per year (3.9-folds)

Jayapura : 24 hours/customer per year (3-folds)

P-SAIFI

Pekanbaru: 16 (1.3-times of the PLN's SAIFI)

Kupang: 18 (4.6-times)

Jayapura: 21 (2.7-times)

Standard deviation:

P-SAIFI:

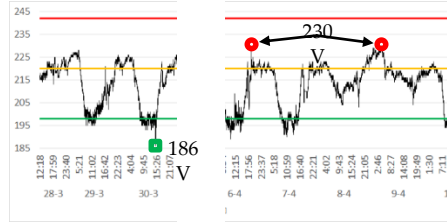
Pekanbaru (3 number of interruption/customer per year),

Kupang 3.1,

Jayapura 2.8

RESULTS

Results –measurements at the distribution grid



Pekanbaru

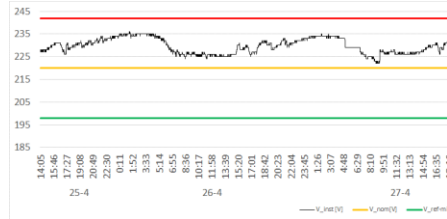
Measurement interval: 1 minute.

Duration of measurements:

Pekanbaru (15 days),

Kupang (5 days),

Jayapura (7 days).



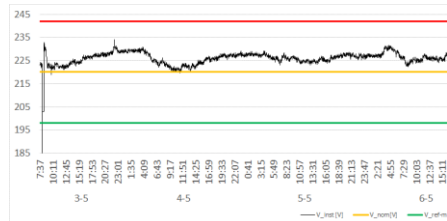
Kupang

rms nominal voltage in Indonesia: 220 V

highest allowable limit of voltage: 242 V

lowest allowable limit of voltage: 198 V

Source (MEMR (2016)).



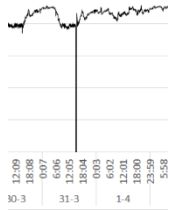
Jayapura

Most fluctuate voltage can be found in Pekanbaru.

Voltages in Kupang and Jayapura have less fluctuation

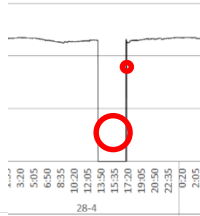
RESULTS

Results –measurements at the distribution grid



Pekanbaru

two short blackouts in 15 days, around 30 minutes each



Kupang

Two blackouts in Kupang in 5 days. Each was longer than 2 hours



Jayapura

3 blackouts in 15 days, duration 10 – 40 minutes



DISCUSSION

Correlations:

SAIDI, SAIFI, and electrification ratio

- Significant positive relationship between the reported SAIDI and SAIFI,
- Less correlation between SAIDI and ER or SAIFI.

P-SAIDI, P-SAIFI, income, WTP

- strong positive correlations between P-SAIDI and P-SAIFI,
- negative correlations between P-SAIDI and household's income in Pekanbaru and Kupang,
- weak positive correlation between P-SAIDI and income in Jayapura,
- weak positive correlation between P-SAIDI and WTP at all cities,
- More low-medium income families are willing to pay extra for an improved power reliability than high-middle or high-income families (because genset possession among higher income families)



LIMITATION OF STUDY

Different sizes of area of observation:

SAIDI – SAIFI (provincial areas - 664 km² to 154,000 km²)

P-SAIDI – P-SAIFI (city areas - 180 km₂ to 936 km₂)

The number of respondents could be increased and be more equally distributed over the three locations.

The duration of the measurements of voltage and outage events of the electricity grid could be increased.

The method of estimating the average duration of outage time experienced by respondents could be improved because it is hard for anybody to exactly estimate in time if being asked about how long something took place in the past.

The results depend on the local conditions, therefore findings of this study could be different in other areas with a different system and societal situations.

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GENERAL CONCLUSION

This study is unique and fills a void in existing real-life data on experienced power quality

This is the first independent study in Indonesia that evaluate the user experiences about the reliability of power supply by the distribution grid and how are the user experiences compared to the reported data from the utility.

P-SAIFIs are 4-folds to 14-folds than the PLN's SAIFIs.

P-SAIDIs are 8-times to 12-times of the PLN's SAIDIs

Meaning: the reported reliability indices do not always demonstrate the actual experience of the grid users.

The reliability of power supply in these three cities in Indonesia could be improved considerably.

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BMKG
Data support



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