Implementing triple helix through *Listrik Kerakyatan* initiative: community-based energy from waste

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**Abstract.** As depicted by its three components, A (academic), B (business), and G (government), the Triple Helix principle aims at narrowing the gap between the competencies of university graduates and those required by businesses or industries in the real world, under the corridor of government rules and regulations. The main issues that will be addressed by the triple helix concept is the national policy to attain 23% of renewable energy portion by the year 2025. However, the conventional electricity construction, which usually prefer a large-scale interconnected system, is currently facing serious delay due to difficulties in acquiring land and permit. Moreover, such large-scale power plants are not sufficient to serve consumers that are scattered in more than three thousand islands in Indonesia archipelago. In addition, such big projects are mostly owned by giant investors that depend on foreign fund and technology, leaving no opportunity for local people to contribute and have ownership over their energy needs. STT PLN proposes a simple small-scale distributed generation that can be owned and managed by local people by using renewable energy sources that are available around the communities. Waste is the most attractive resources because by converting waste to energy, the problem of waste can be solved at the same time. Based on the research and pilot project that had been conducted in three locations, *Listrik Kerakyatan* (Community-based Electricity) is technically simple so it can be applied and managed by local people. It is also economically viable as the required capital is relatively small and affordable by small enterprises. The commutative law of math also says that 1x1000 = 1000 x1. Therefore, going by that law, the total capacity generated by 1000 units of small LKs can be similar to one large unit of conventional model.

1. **Introduction**

In this paper we will discuss how the three elements of triple helix are synergizing to create an innovation that is useful for the public and may solve some of the most critical issues that almost all urban environments try to currently solve: trash. The problem of trash is familiar, and it is one of the most common problem in urban areas. Indonesia, specifically, is the 4th most populated country in the world. With 260 million people overall and most of them are highly concentrated in urban Java, Indonesia is facing a major problem or waste and is struggling to manage and utilize waste properly.

According to a research done by Jenna Jambeck in 2015, currently Indonesia contributes up to 1.29 Million Metric Tons of plastic marine debris, ranking as the second highest contributor of plastic marine debris in the world[1]. And as can be imagined, along with the growth of the population, the number of waste produced will keep increasing. The problem of pollution that comes from waste, and
the problem of simply not enough land to contain waste, urban areas in Indonesia really need a solution to this problem.

2. The problem
With 284.83 million people, Indonesia is the fourth most heavily populated country in the world, following China, India, and the United States. According to Statistics Indonesia (Badan Pusat Statistik Indonesia), from almost 285 million people, more than half resided in urban areas[2].

![Figure 1. Indonesian Population Projection 2010 - 2035](image)

The steady movement, historically as well as forecasted, towards the cities are caused by several factors. First, the younger generations are becoming less interested in farming due to unclear system of income distribution amongst farmers (commonly, the money goes into bigger corporations or local, already established, businesses). Second, even though the cost of operating a business is much cheaper than in the cities, investors are still reluctant to do so due to lack of dependable infrastructure to transport goods (and sometimes, services), especially in more remote areas of Eastern Indonesia area such as Papua. Also, the government has been trying to improve the economy of its villages with the Dana Desa (Village Funding) program. In 2015, the government allocated Rp20.76 billion toward the funding, and as of 2017, it grew to more than Rp60 billion[3]. However, the program has its challenges, mainly that it heavily depends on the honesty and integrity of local officials who are authorized to manage the fund.

2.1. The problem of waste
The problem of waste accumulation is real. With the population growth, the increase in its concentration towards urban areas, as well as stagnation in the quality of waste management, Indonesia is in serious trouble.

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As shown in the table above, Indonesia is second top contributors of waste. With coastal population of 187.2 million people, in 2010 Indonesia has contributed 3.22 Million Metric Tons of waste. The Indonesian Directorate General of Waste Management stated that total waste in Indonesia will reach 68 million tons by 2019, and plastic waste will reach 9.52 million tons - 14% of the total waste.

So far, the effort of reducing waste by the government such as socializations and regulations have not reached the optimal target of minimizing waste that is produced daily. Not only focusing on prevention efforts, the Indonesian government is also trying to find ways to manage and turn waste into something useful.

2.2. The problem of equal electricity distribution

Many islands and areas in Indonesia still need to grow, especially the eastern region such as Papua, Nusa Tenggara Timur, and Maluku. In order to grow and develop, they need more businesses, factories, infrastructures, and neighborhoods. In order to even start building all of those, they need electricity. Therefore, the Indonesian government started to focus on equal distribution of electricity throughout the country, starting with the 10.000 MegaWatt (MW) program by president Susilo Bambang Yudhoyono in 2010, followed by the 35.000 MW program in 2015 by the next elected president, Joko Widodo. The 35.000 MW program is targeting to have at least 35.000 MW of electricity available for the nation by 2025.

As per 2017, the Indonesian government has managed to “electrify” 91% of the country. Today, Perusahaan Listrik Negara (PLN), the largest government-owned electrical company in Indonesia, who is in charge of the program has managed to finish 68% out of the total target. From that percentage, only about 8% are done by the government through PLN, and the other 60% are done by Independent Power Producers[4].

Table 1. 2010 waste estimates for top 20 countries ranked by mass of mismanaged plastic waste (millions metric tons per year)

| Rank | Country     | Econ. classif. | Coastal pop. [millions] | Waste gen. rate [kg/ppd] | % plastic waste | % mismanaged waste | Mislamaneg plastic waste [MMT/year] | % of total mismanaged plastic waste | Plastic marine debris [MMT/year] |
|------|-------------|----------------|-------------------------|--------------------------|----------------|-------------------|--------------------------------------|------------------------------------|---------------------------------|
| 1    | China       | UMI            | 262.9                   | 1.10                     | 11             | 76                | 8.82                                 | 277                                | 1.32–3.53                      |
| 2    | Indonesia   | LMI            | 187.2                   | 0.52                     | 11             | 83                | 3.22                                 | 101                                | 0.48–1.29                      |
| 3    | Philippines | LMI            | 83.4                    | 0.5                      | 15             | 83                | 1.88                                 | 5.9                                | 0.28–0.75                      |
| 4    | Vietnam     | LMI            | 55.9                    | 0.79                     | 7              | 13                | 1.83                                 | 5.8                                | 0.28–0.73                      |
| 5    | Sri Lanka   | LMI            | 14.6                    | 0.71                     | 7              | 84                | 1.59                                 | 5.0                                | 0.24–0.64                      |
| 6    | Thailand    | LMI            | 26.0                    | 1.2                      | 9              | 75                | 1.03                                 | 3.2                                | 0.15–0.41                      |
| 7    | Egypt       | LMI            | 21.9                    | 1.37                     | 13             | 69                | 0.97                                 | 3.0                                | 0.15–0.39                      |
| 8    | Malaysia    | LMI            | 22.9                    | 1.52                     | 13             | 57                | 0.94                                 | 2.9                                | 0.14–0.37                      |
| 9    | Nigeria     | LMI            | 27.5                    | 0.79                     | 8              | 13                | 0.85                                 | 2.7                                | 0.13–0.34                      |
| 10   | Bangladesh  | LMI            | 29.9                    | 0.43                     | 8              | 89                | 0.79                                 | 2.5                                | 0.12–0.31                      |
| 11   | South Africa| LMI            | 12.9                    | 2.0                      | 12             | 56                | 0.63                                 | 2.0                                | 0.09–0.25                      |
| 12   | India       | LMI            | 187.5                   | 0.34                     | 8              | 3                 | 0.60                                 | 1.9                                | 0.09–0.24                      |
| 13   | Algeria     | UMI            | 16.6                    | 1.2                      | 12             | 60                | 0.52                                 | 1.6                                | 0.08–0.21                      |
| 14   | Turkey      | LMI            | 14.0                    | 1.77                     | 12             | 18                | 0.49                                 | 1.5                                | 0.07–0.19                      |
| 15   | Pakistan    | LMI            | 14.6                    | 0.79                     | 13             | 88                | 0.48                                 | 1.5                                | 0.07–0.19                      |
| 16   | Brazil      | LMI            | 74.7                    | 1.03                     | 16             | 11                | 0.47                                 | 1.5                                | 0.07–0.19                      |
| 17   | Burma       | LI             | 19.0                    | 0.44                     | 17             | 89                | 0.46                                 | 1.4                                | 0.07–0.18                      |
| 18*  | Morocco     | LMI            | 17.3                    | 1.46                     | 5              | 68                | 0.31                                 | 1.0                                | 0.05–0.12                      |
| 19   | North Korea | LI             | 17.3                    | 0.6                      | 9              | 90                | 0.30                                 | 1.0                                | 0.05–0.12                      |
| 20   | United States| HIC          | 112.9                   | 2.58                     | 13             | 2                 | 0.28                                 | 0.9                                | 0.04–0.11                      |

*If considered collectively, coastal European Union countries (23 total) would rank sixteenth on the list.
According to the Indonesian Ministry of Energy and Human Resources (ESDM), there are still 5.8 million households and 2,500 villages without electricity, mainly on the eastern part of Indonesia. In the effort of distributing electricity to the rural and hard-to-reach areas, Indonesia is facing several problems:

- The areas that are still untouched by electricity in the large islands are located far away from the existing electricity networks
- The areas that are still “dark” on the smaller islands are too scattered
- The number of customers is small and scattered
- Mostly, electricity needs for the rural areas are only for households and used in the evening, not for industries.
- The cost to connect rural/remote areas are highly expensive. According to Sofyan Basir, the President Director of PT PLN Persero Indonesia, in an interview with CNBC’s research team, the cost to connect 1 household in Java is Rp1-2 million, while the cost to connect 1 household in Papua or Maluku is Rp150-200 million.

This means that not only it will be challenging to connect electricity to these areas in infrastructure, but also not economically viable to realize.

Conventionally, rural electrification is done by constructing distribution lines or installing diesel power plants. Since the location of the “dark” areas are far from the existing distribution lines, the cost to connect them will be very high.

If using diesel power plants, the effort and cost of purchasing and transporting the fuel to keep the power plants running will also be very high.

These options are not economically sound for the Indonesian government and does not seem to worth the investment that the government need to make in order to grow the economy of the rural areas.

3. Listrik Kerakyatan: A Community-Based Electricity

3.1. Definition of Listrik Kerakyatan
According to Supriadi Legino, one of the founders of Listrik Kerakyatan (LK), the concept of LK is defined as a model of electrical energy supply and development produced by distributed, simple, small-scale power plants using clean energy that are available in the surrounding areas, so it can be independently built and run by groups of local communities within regencies in the nation[5].

The concept of LK is focusing on empowering local communities, enabling the country to achieve energy security, which is defined as “the uninterrupted availability of energy sources at an affordable price” by the International Energy Agency[6]. If LK is equally and simultaneously implemented across the country,

3.2. The LK Process
Simply put, Listrik Kerakyatan is waste processing using local resources, through a process called peyeumisasi (a Sundanese term coined by LK founders), which is a type of fermentation using bioactivator, turning waste into energy.

The process is done locally in an area called Tempat Olah Sampah Setempat (TOSS), another term coined by the founders of LK, meaning local waste processing unit, using small 2m³ bamboo box where the trash is processed using bio activator which takes around 10 days before they are ready to be chopped and formed into briquettes or pellets, which then can be used to produce electricity, or as substitute of coal to fuel a stove, as seen below:
3.3. Criteria of LK
In order to stay true to its objective of empowering the people of Indonesia and Small-Medium Businesses, distributing electricity to remote areas, and solving the urgent problem of waste (especially in urban areas), there are several criteria of Listrik Kerakyatan:

- **Simple**
  LK units are small, having one or several TOSS comprised of small bamboo boxes, and keep it small-scale (producing 10-100 kW)

- **Clean**
  LK is producing clean and renewable energy. The source of energy is waste, mainly municipal waste, which will always be available, and the waste will be totally used up as electric energy or fuel for stove.

- **Fast**
  Construction time must be short. If the whole country is implementing LK, distributed to all regions including remote area, the government’s goal of 35,000MW will be obtained in just 2 years.

- **Self-sufficient**
  TOSS units are owned and managed by locals, using available resources (i.e. bamboo, waste)

- **Togetherness/teamwork**
  In order for LK to be successful, the communities in Indonesia must work together, simultaneously implementing LK.

3.4. Benefits of LK
When implemented and supported by not only the local communities, but also businesses and the government, Listrik Kerakyatan can be the answer to some of the country’s major problems, namely waste management, electricity distribution, as well as improving the economy and welfare of the people[7]. The benefits of Listrik Kerakyatan includes:

- **Small**
  Because of the small size, LK is easy to build. Local communities and villages can become their own Independent Power Producers. The small size also enables LK to be built anywhere
in the country. The briquettes and pellets produced are much easier to transport to remote areas compared to liquid fuel or coal.

- Improve the economy of local people and Small Medium Businesses
  LK doesn’t need large amounts of funding. To fund LK, villages can use their “Dana Desa” or village funding provided by the government or take advantage of the government’s subsidy for SMEs (or UMKM in Indonesia). LK also creates job opportunity for locals. These means that by enabling villages and local communities to become their own IPP, it acts as a source of income for them.

- Maximize the use of local material and manpower
  To build TOSS units, a lot of the required resources are available around the area. The community needs bamboo for the boxes, local mechanics can build their own processing machines such as the gasifier and the shredder, and waste as the energy source.

- Zero-waste concept
  LK actually implements the zero-waste concept as it processes waste to electricity or coal substitute. Its predecessors mainly produce fertilizers, and fertilizers are not of daily use. Often, the bags of fertilizer are piling up and taking up space because fertilizers are not of daily use. Unlike LK, which produces something that are consumed daily, and totally use up the briquettes or pellets.

4. Triple Helix: A Synergy

Schools in Indonesia’s formal education system is facing a paradox because they have to comply with government’s laws and regulations in one hand, but they also have to have an educational model that meets requirements from business and social environment. They are required to keep harmony in such paradox.

**HIGHER EDUCATION PARADOX**

- Law
- Regulations
- Procedures
- Accreditation
- Industrial Standard
- Recruitment practices
- Business Environment

**Figure 3.** Higher education paradox that may be answered by the Triple Helix concept

Triple Helix is a synergy between 3 entities: Academic – Business – Government to connect research and innovation with economic and social benefits.

A technical college in Jakarta called Sekolah Tinggi Teknik PLN (STT-PLN) is one of the key players in creating and implementing Listrik Kerakyatan. STT-PLN is implementing LK-TOSS with the support of Indonesia Power (Business) and Klungkung officials (Government).
Figure 4. The implementation of Triple Helix in STT PLN, a technical school

- **Academic**
  - STT-PLN is infusing its courses with renewable energy topics
  - STT-PLN, with Sonny Sundadjaya, created the LK innovation to turn waste into electricity
  - STT-PLN is focusing its research topic on LK for all departments
  - STT-PLN is implementing LK TOSS in Klungkung, Bali

- **Business**
  - Indonesia Power provides the tools and facilities needed for LK implementation on site
  - IP purchases, sells and distributes TOSS products
  - IP supports the R&D for further LK-TOSS research

- **Government**
  - The officials at Kabupaten Klungkung, Bali, established that LK is to be implemented in all villages under the Kabupaten of Klungkung

5. Conclusion
The concept LK is made possible by the synergy between Academic, Business and Government. The technical college, STT-PLN, has a role in creating and socializing the innovation, using its academic background to systemically manage the whole process. Indonesia Power as the business, has a role in further enabling STT PLN to implement the concept by not only allowing the college to use its facilities for the actual practice of TOSS and continuing the studies and tests of LK, but it also buys and distributes LK products. Finally, the local government of Klungkung Regency in Bali also has a big role in making LK possible to practice. The regent of Klungkung, I Nyoman Suwirta, established that LK is to be implemented there, and he just recently received the Top 40 Sistem Inovasi Pelayanan Publik (Sinovik) or Public Services Innovation Awards by the Ministry of Administrative and Bureaucratic Reform for two of its programs, one being this LK-TOSS initiative. The award was presented by Mr. Jusuf Kalla, the vice president of Indonesia on 7 November 2018.
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