



# UNLEASH Problem Statements

**March 2018**

Prepared by: Tan Yan Tyng; Li Ang  
Reviewed by: Siah keng Boon

# Problem 1



## Challenges

Globalization has provided significant benefits to the majority of the world's population. However, there is a segment of impoverished community especially in developing economies that remains unserved and being left behind in basic services such as water, sanitation and electricity which are basic human rights and essential for human dignity. The lack of these essential services is also a major contribution to the inferior health, education and a whole host of social problems such as shortened life expectancies, employability as consequences. In short, the lack of such essential services entrap these swathes of impoverished community around the developing and emerging economies into a downward spiral and contributing to the increasing wealth gap of the haves and have-nots. This problem, if not resolved, will contribute to the growing frustration and anger of these communities and other and fuel the anti-globalization movement. Instead of a demographic dividend, the host country will instead face a demographic time-bomb.

However, it is understood that a very limited access to resources and know-hows are often faced by these communities, technologies without requirement of high level operational knowledge while creating jobs are the most suited. How do we find such holistic solution to provide sustainable energy and clean water requires us to think creatively, through innovation, through integration of technologies which represents this century's technologies and yet affordable to these local communities who are clients and also the host governments.

To solve the aforementioned challenges, we will start with developing ideas and solutions to these three key sub challenges, with strong possibility to integrate them as one solution eventually:

1. Low cost portable water purification system for improving water cleanness and sanitation.
2. Economical distributed renewable energy resources suitable for the local communities.
3. Major or micro grid-based energy storage economy for efficient usage of energy.

# Problem 1.1

## Low Cost Portable Water Purification System

### Statement

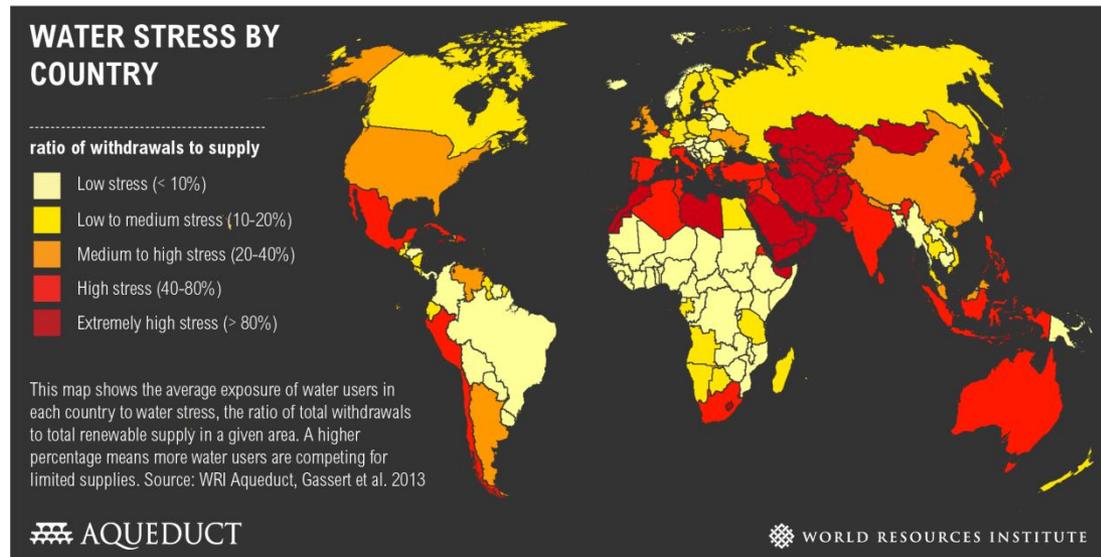
Water scarcity has been an increasing concern faced by many countries in the world. This problem is especially severe in remote areas where clean, potable water is not easily accessible due to limitation in piping network. As a result, remote villages are often subjected to poor living conditions and sanitation.

To explore and propose alternative affordable solutions that can be used to provide clean water to remote villages so as to improve their living conditions and sanitation. You may start approaching this problem from advanced portable filtration systems, specifically those that make use of membrane and filtration technologies.

### Relevant Data

#### United Nations Information and Statistics

- In 2017, 40% of the world's population faces water scarcity
  - ❑ 2.1 billion people are living in countries with lack access to safely-managed drinking water
  - ❑ Over 4.5 billion people lack adequate sanitation
- More than 2 billion people globally are living in countries with excess water stress
  - ❑ Water stress is defined as the ratio of total freshwater withdrawn to total renewable freshwater resources. The threshold for water stress is 25%, above which it would be considered excess and indicates a stronger probability of future water scarcity
- By 2050, at least one in four people is likely to live in a country affected by chronic or recurring shortages of fresh water



### References

Source: World Resources Institute, 2013

- [1] UN Sustainable Development Goal 6: <https://sustainabledevelopment.un.org/sdg6>
- [2] World Resources Institute Water Stress: [www.wri.org/blog/2013/12/world-s-36-most-water-stressed-countries](http://www.wri.org/blog/2013/12/world-s-36-most-water-stressed-countries)
- [3] UN World Water Development Report 2018: <http://unesdoc.unesco.org/images/0026/002615/261579e.pdf>

# Problem 1.2

## Economical Distributed Renewable Energy Resources

### Statement

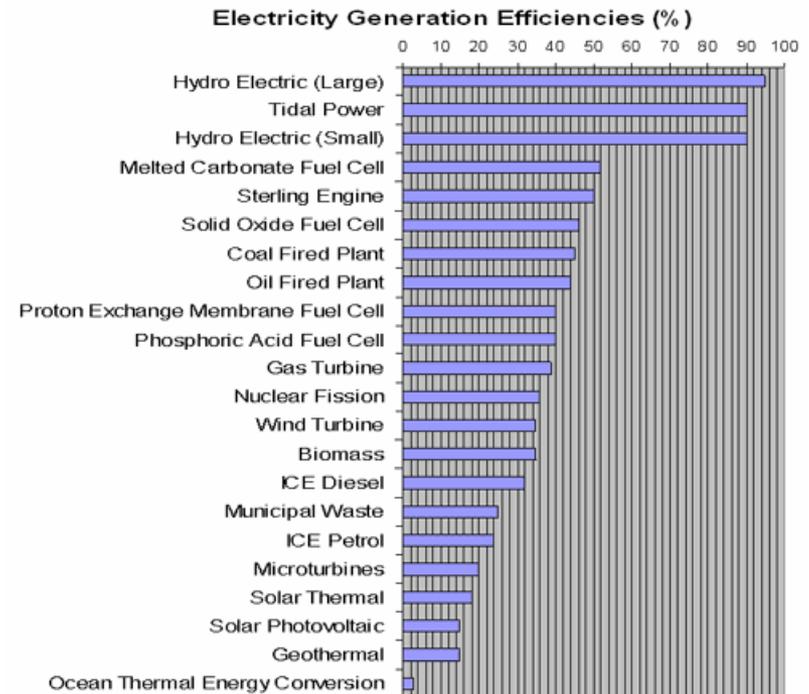
Despite the increasing adoption of renewable energy solutions, a majority of the energy supply to the impoverished communities is still from conventional fossil fuels and this is certainly unsustainable. Moreover, building infrastructure to connect these communities with national electricity grid, particularly the remote ones, is not economical. To explore distributed renewable energy solutions is a key to serve these communities for basic energy needs in the replacement of current fossil fuel, while also reducing environmental impact. Suitable solutions can be also re-adopted to cities to further increase distributed renewable energy portfolio and improve reliability. You may begin by looking at electricity generation using fuel cells which can utilize locally generated marsh gas, or any other feasible alternatives (See the figure below for an idea of existing electricity generation methods and efficiencies).

### Relevant Data

- Fossil fuels accounted for 81% of total energy demand in 2017
- Global energy-related carbon dioxide emissions went up by 1.4% in 2017, up to a historic high of 32.5 gigatonnes

### References

- [1] International Energy Agency Global Energy and CO2 Status Report 2017  
<https://www.iea.org/newsroom/news/2018/march/global-energy-demand-grew-by-21-in-2017-and-carbon-emissions-rose-for-the-firs.html>
- [2] World Energy Council, World Energy Resources Report 2016 <https://www.worldenergy.org/wp-content/uploads/2016/10/World-Energy-Resources-Full-report-2016.10.03.pdf>



Source: Eurelectric, 2013

# Problem 1.3

## Grid-based Energy Storage Economy

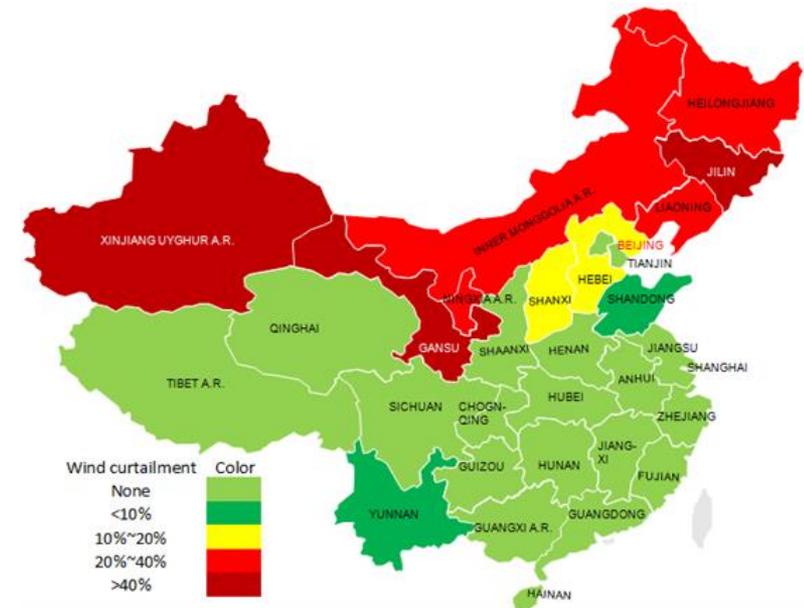
### Statement

Renewable energy sources such as solar and wind are able to provide sustainable and environmentally friendly energy with low carbon footprint. However, the technologies are dependent on weather conditions, and the resultant fluctuations in load can lead to wastage of generation capacity and grid imbalance. Supply demand balancing by converting excess electron to molecules as storage is a potential solution to mitigate this problem. However, existing technologies such as batteries for energy are still too expensive for large scale deployment. Tapping on existing gas grid network can be an alternative affordable energy storage solution to reduce wastage of cheap energy while benefitting communities at remote areas. For example, this spare electricity can be diverted to electrolyzers to enable storage of energy in the form of hydrogen.

### Relevant Data

#### Casestudy: China Power Curtailment

- In March 2017, China National Energy Administration (NEA) had to prevent project approvals for new wind power projects for 6 major wind producing provinces due to their high curtailment rates, ranging from 13 – 43% where 4 of the 6 provinces (Jilin, Gansu, Ningxia, Xinjiang) have been constantly flagged due to high curtailment rates
- In 2015, national curtailment levels for wind and solar were 15% and 13% respectively
- High curtailment rates are due to significant installed capacity, low power demand, and/or transmission bottleneck constraints
- From 2011 to 2015, wind curtailment cost China's energy sector RMB 51 billion (USD 7.7 billion)



Q1 2016 Wind Power Curtailment Levels by Province  
Source: Azure International, 2016

### References

- [1] China cleantech news: <http://www.azure-international.com/en/news/china-cleantech-news.html>
- [2] China's wasted wind power: <http://www.paulsoninstitute.org/paulson-blog/2016/08/10/the-costs-of-chinas-wasted-wind-power/>

# Problem 2

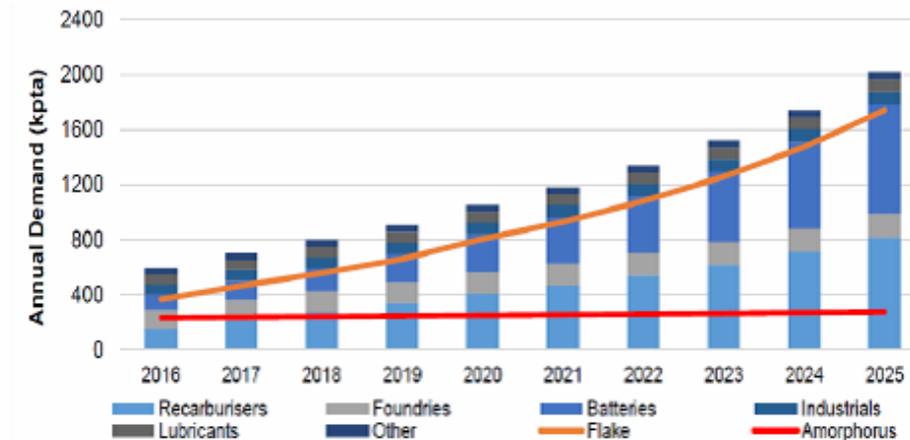
## Graphene Production

### Statement

Graphene is regarded as the “holy grail” of materials, due to its superior properties as compared to existing materials. While possible applications for graphene are extensive, it is still a long way from being economical. This is partially due to the high cost of one of its key raw materials, pure graphite, as the supply of pure graphite is unable to meet its demand. On the other hand, amorphous carbon and other carbon based chemicals are easily and abundantly available in many industries (including waste). However, there is no economical solution to convert amorphous carbon into pure graphite. Explore and propose possible solutions which enables the conversion of amorphous carbon to graphite at an economical level.

### Relevant Data

#### Overall Natural Graphite Demand 2015-2025e



CANACCORD Genuity Specialty Minerals & Metals, Nov 20<sup>th</sup> 2016, Fig. 56, page 35

Source: Canaccord, 2016 <http://www.masongraphite.com/investors/about-graphite/default.aspx>