Problem Based Learning: Teaching engineers to tackle the SDGs

7 Affordable and Clean Energy
Panel

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Poverty reduction remains a major challenge for the Government and people of Sierra Leone.

- Overall poverty rate is 57.0%, with 10.8% of the population living in extreme poverty.
  - Highest in the rural areas (poverty incidence of 72.4%), and lowest in urban Freetown (18.5%), thereby indicating that poverty in Sierra Leone remains a rural issue.

- The Government of Sierra Leone has established a plan for nationwide electrification to alleviate poverty.

- Despite the governmental emphasis on electrification, only about 15% of Sierra Leoneans currently have access to electricity, with the rate being only around 2% in the rural areas.
Overview

• Energy consumption in Sierra Leone:
  o Dominated by inefficient and polluting fuels such as kerosene for lighting and wood fuel and charcoal for cooking, which account for about 80% of the total energy use.
  o The economy has mainly depended on the consumption of imported petroleum products for electricity power generation and transportation.

• The renewable energy side of the sector remains a promising growth area for the country.

• Sierra Leone has abundant renewable energy resources
  o solar, hydropower, biomass, wind etc.

• Among these resources, hydropower has been developed and utilized on a commercial scale.
  o But only 61 MW of hydropower has been installed out of a total potential of over 1,513 MW.
Training Engineering Students to Tackle SDG7

- Solar PV Installation
Contributions of Undergraduate Students to Tackle SDG7

• Solar thermal refrigerator
  • Provides sustainable Agricultural cold storage solutions for rural areas in Sierra Leone.

• Solar water desalination system
  • Provides clean and safe drinking water for rural dwellers. This sustainable solution is expected to offer economic benefits as well as improvements in the health and well-being of the rural people.
Cooking in Sierra Leone is customarily done on open fires using biomass such as firewood and charcoal.

- Excessive deforestation, CO₂ emissions & respiratory infections due to significant smoke inhalation.

Interventions by USL students that can save millions of trees, does not smoke, and costs very little - solar thermal cooking:

- **Heavy Duty Solar Cooker**
- **Concentrating Solar Cooker**
Contributions of Undergraduate Students to Tackle SDG7

• **Pico Hydropower Plant**
  - Electrification of few households, a village, or a wayside business establishment

• **Solar Powered Chicken Egg Incubator**
  - Handles 100 eggs
  - Affordable to the average poor farmer dwelling in the rural areas of Sierra Leone.
Current Project on SDG7: Integrated Research into the Utilities and the Urban Environment (InRUE)

• Funded by the RAE Higher Education Partnerships in Sub-Saharan Africa (HEP-SSA) to showcase the role of engineering in driving economic development

• ‘Hub and Spoke’ model
  ➢ **Hub** = **USL** (lead) facilitated with bilateral secondment with local industry partners = **EGTC, UNOPS & Westwind Energy**

• Co-ordinate knowledge sharing workshops & reports with **Spoke Universities** = **Njala** and **UK Partners ICL & HP3M**

• Start date: 1st October 2019 - Completion date: 9th August 2021
Project Objectives

- Positioning academic research around innovative solutions that address the most significant national and regional challenges;
- Improving regional engineering capacity in addressing SDG 7;
- Developing a two-way learning model that links industry challenges with research based solutions;
- Disseminating learning outcomes and methodologies with other industry sectors and regional partners;
- Developing skills in entrepreneurship and commercialisation.
Integrated Research into the Utilities and the Urban Environment (InRUE)

- **Project Outcomes**
  - **2 Cohorts** of Year 4 students taken through programme of collaborating with industry to identify solutions to significant problems
  - Graduates better prepared for the work environment - recognised as having *developed skills* and expertise in *problem based learning*
  - Graduates provided with *value added skills and experiences* + specialist knowledge of industry problems and working to tackle those associated with SDG7
  - USL as hub will formalise the *introduction and engagement of industry based problem* learning modules within the curriculum
  - Concept of introducing industry *specialist in delivering curriculum* in affordable and clean energy
  - Development of a framework to create a regional *Centre of Excellence* for SDG7 at USL
Integrated Research into the Utilities and the Urban Environment (InRUE)

• **Engagement with Local Industry Partners**
  
  - **Academic staff** from FBC undertaking relevant placements in industry
  - **Engineering students** from the USL & Njala undertaking research projects and work placements with local industry partners
  - Industry partners’ staff deliver courses, workshops and supervise student research projects
  - Industry partners’ staff improve their CPD through involvement with universities
Sahban Alnaser | Presentation outline

- Jordan Electricity Sector: Overview
- PV Incentive Schemes: Challenges
- Transition Towards Self-Consumption PV Schemes
- Role of Residential Batteries
- Case Studies: Real Jordanian Distribution Networks
- Remarks
Jordan Electricity Sector: Overview

• Peak demand of 3.5 GW (relatively small electricity system compared to 60 GW in the UK)
• However, 90% of electricity energy needs is produced from imported fuel sources
• Jordan Government target → 50% of electricity from local resources by 2030
  • Renewable energy law in 2012 → 10% of electricity needs are currently supported from renewables

Do the current energy policies support the Governmental targets?
Net Metering PV Incentive Scheme

- Net-metering is a high PV incentive scheme
  - Potential to achieve zero electricity bill
  - Annual electricity bills is calculated based on the: **Annual** import energy – **Annual** export energy
PV Impacts on Distribution Networks

Reverse power flows → network issues (voltage rise and overloading of network assets)
Jordanian 33 kV Real - Distribution Networks

- Rural network topology
- Long distribution networks (max length ~ 55km feeder)
- 4400+ residential customers
- 7 MW PV systems already connected to the MV networks - Residential PV is challenging
- Integrated Models of MV/LV distribution networks

Networks are traditionally demand driven

23MW peak
166 MV/LV subs
Jordanian Real Distribution Network: Net-Metering Results

- Net-Metering scheme
  - PV is sized to meet annual energy consumption
  - PV impacts are assessed versus different PV penetrations

Net-metering enables only 20% of residential customers with PV
Transition Towards Self-Consumption PV Scheme

• Alternative regulatory scheme is needed to reduce PV export and increase local energy self-sufficiency
Self-Consumption PV Scheme @ 30% Energy Sufficiency (Net-Billing)

- PV system is sized for each customer to achieve 30% of energy consumption from PV

Net billing enables **100% PV penetration** within the distribution networks constraints.
50% Energy Sufficiency – Role of Residential Batteries

- Lithium-Ion battery prices fell 80% from 2010-2017
- **With managing** of batteries and PV, it is possible to achieve 50% energy sufficiency within network constraints

Control for the benefit of user only

Control for the benefit of both user and network
Remarks

• Jordan Governmental target aims to achieve 50% of electricity energy needs from local resources by 2030

• Current net-metering PV scheme enables only 20% of customers with PV due to distribution network constraints

• Transition towards self-consumption scheme enables larger PV penetration and improve self-sufficiency

• Batteries could be a crucial PV enabler technologies, However Governmental subsidy scheme is needed to support their capital cost and allow the management of batteries to solve network issues