



# Annual Report FY2018/2019

*“innovation through engineering”*

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## Director's Foreword

For the past seventeen years, I had the privilege to lead an exceptional dynamic and agile engineering & operational team. Considering the make-up and character of this team, I have to be positive about the future, irrespective of challenges presented economically or within our operational environment.

The manufacturing climate in South Africa is not in a "good space" with the reported contribution to the GDP falling with 7% over the last 10 years. Within the engineering community we realise that structural changes must be effected if we are to ensure a future with manufacturing as a key economic contributor.

For context, eNtsa plays in the manufacturing and advance-engineering environment, and yes, we did not escape the challenges faced within this sector. With the termination of a long standing and anchor contract between eNtsa and Eskom, there was some anxiety on how we will bridge this set-back.

However, we quickly realised that these hindrances are not always negative and as a collective, we work hard strategically and innovatively re-engineer the organisation to unlock new opportunities to guide eNtsa in a much bigger and better direction.

Over the past financial year eNtsa as an organisation had to reinvent itself, show character and move forward irrespective of the economic decline. I believe that if you remain open minded in the hard times and show strength through your struggles, the end will hold some success for all.

In short, my message to the staff, no matter personal or professional, if you want to achieve your goals and dreams in life, you need to **wake up and go beyond your comfort zone**, and that is what I believe every individual in eNtsa did.

As a new eNtsa we embarked on a revitalisation programme to improve our effectiveness (less for more initiative) to stimulate new growth and prepare the organisation for eNtsa's Vision 2022 which will reposition eNtsa as an international, commercially viable engineering organisation while maintaining the eNtsa DNA of innovation through engineering. This new plan addresses the ways to increase revenue, reestablish a focus on Research and Development, development of staff to **increase profitability and sustainability and fast tract the creation of a spin out commercial entity**.

Looking forward, I realise we are facing considerable challenges, the challenge of assisting the manufacturing industry to embrace I4.0, power shortages, unemployment, the challenge of managing the parallel process of academia and commercialisation, increasingly flexible approach to do business, however I have every confidence in eNtsa's ability to meet these challenges.

**Prof DG Hattingh eNtsa Director**  
**March 2019**



## eNtsa: Overview

eNtsa is acknowledged internationally as an innovation hub that supports research, design and technology assimilation for the broader manufacturing sector, with a focus on the automotive, power generation and petrochemical industries. eNtsa, a registered engagement institute of Nelson Mandela University, hosts a number of programmes and projects to advance engineering support for technology and human resource development within South Africa.

eNtsa contributes to industry with a vast range of specialised services which are aimed to support and stimulate local innovation through supplier development initiatives. eNtsa is able to make much needed engineering skills, services and training more readily available to SMEs operating in the local manufacturing and automotive sector through our Technology Station Programme (TSP), supported by the Technology Innovation Agency (TIA).

Our Advanced Design & Modelling capabilities provides a comprehensive range of mechanical design and consulting services which range from mechanical part or systems design, through simulation of parts or systems by advanced finite element analysis (FEA).

Mechanical and material testing services, focuses on providing professional metallurgical services in the field of failure investigation and assessing process/production-related material challenges. Other services include material conformance testing with regards to material microstructure, chemical composition, environmental and mechanical properties.

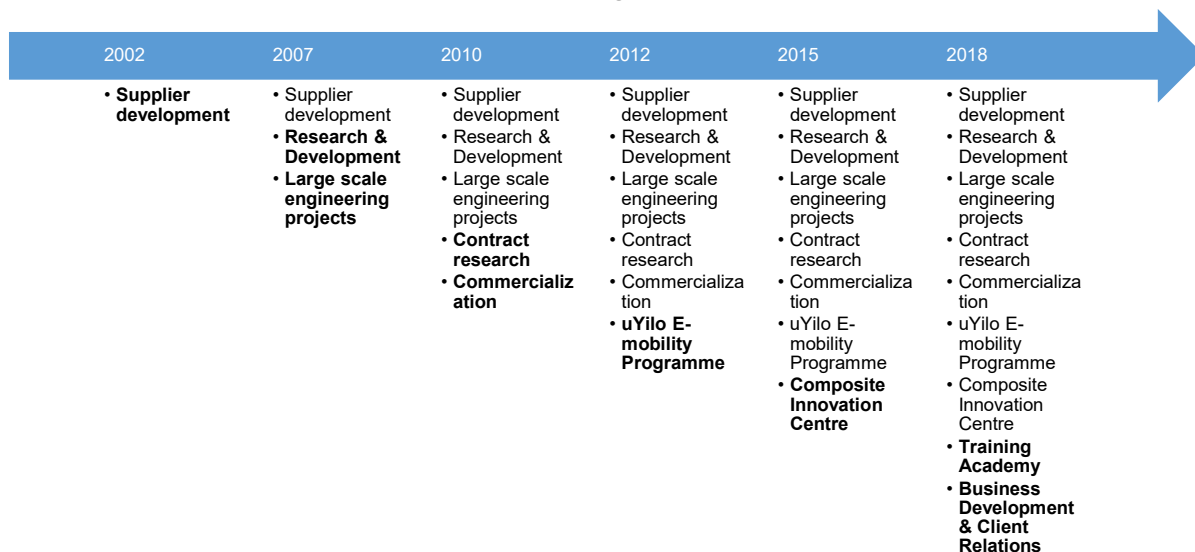
Our Training Academy initiative supports efforts focused at supplier development by providing skill development interventions to our staff & students, local industry and our engineering community.

The uYilo eMobility Technology Innovation Programme is a multi-stakeholder programme hosted by eNtsa and initiated by the Technology Innovation Agency (TIA), which operates with a mandate to actively enable, facilitate and develop the electric mobility industry in South Africa. The facilities and services established within uYilo extend across a National Accredited Battery Testing Laboratory, an Electric Vehicle Systems Laboratory and a Live Testing Environment that provides a holistic enabling environment for the development of the electric mobility eco-system in South Africa.

Industrial R&D focuses on joining technologies, such as solid state welding and laser processing. Expanding research and technology transfer particularly in the field of Friction Hydro pillar Welding and Laser processing (complex cutting, welding and metal deposition) within Nelson Mandela University and local industry, has been a key research area that has initiated various local and international collaborations. eNtsa is also the home of the internationally patented WeldCore® process.

eNtsa continuously strives to enhance technology innovation and to stimulate a climate of sustainable socio-economic growth in South Africa, and maintains strong relations with the Technology Innovation Agency (TIA) and the Department of Science and Technology (DST).

### eNtsa's developmental growth since inception



## About eNtsa

### Our vision

Engineering Innovative solutions for a sustainable future

### Our Mission

- To be a workplace of choice.
- To deliver innovative engineering solutions and services.
- To facilitate knowledge and skills development.
- To create new business and business opportunities.
- To develop a culture of innovation and entrepreneurship.
- To leverage local and international partnerships for socio economic growth.
- To develop an organisation that is adaptable, sustainable and motivated.

### Our Slogan

"innovation through engineering"

## Our Values

### Teamwork

- We are committed to common goals.
- We expect everyone to actively participate on the eNtsa team
- We openly communicate up, down and across the organisation. Communication builds trust and trust builds cohesion.
- We value the diversity of our workforce We willingly share our resources.
- Our attitude is for altitude.

### Teamwork



### Integrity

- We never compromise our principles or values.
- We act with integrity, communicate respectfully and accept responsibility.
- We require ethical, professional behaviour by all persons associated.
- We conduct our activities in an accountable and transparent manner.

### Integrity



### Innovation

- We nurture creativity and entrepreneurship.
- We take calculated risks to advance innovation.
- We learn from our mistakes and do not punish those who make them.
- We promote and reward ideas that advance our institutions and support sustainable development.

### Innovation



### Excellence

- We pride ourselves in delivering work that is of the highest quality.
- We strive to exceed expectations.
- We commit to quality management and continuous improvement.
- We take the responsibility for driving tasks and actions.

### Excellence



## Vision 2022

eNtsa is embarking on a revitalisation programme to kick start further growth and ready the organisation for the next exciting phase of its existence. A five-year strategy has been crafted within eNtsa's Vision 2022 that aims to transform eNtsa from a technology centre operating inside an academic framework to a:

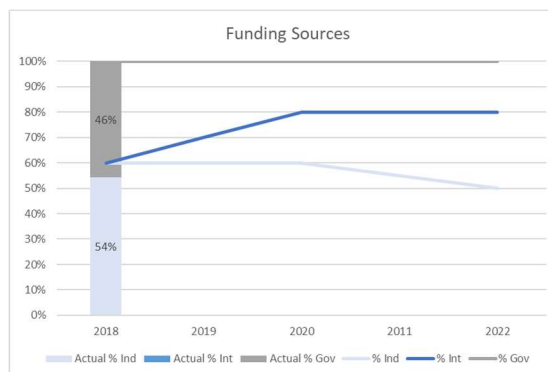
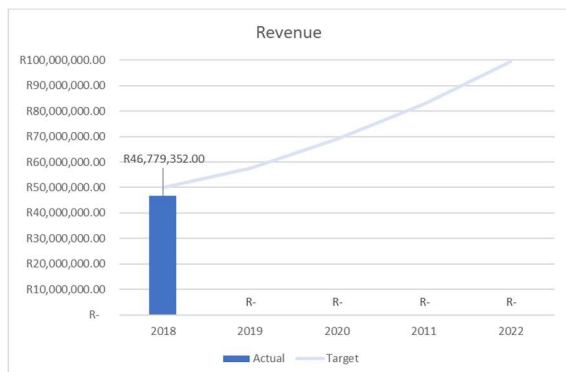
Word-class commercially viable engineering organisation that has a global footprint, while maintaining the core DNA of eNtsa, namely, innovation through engineering.

To achieve the ambitious goals of Vision 2022, focus will be placed on strategies that foster the following strategic aims:

- Increase revenue by **30% per year**,
- Increase the efficiency of HR to **increase profitability and sustainability**,
- Establish a **commercial arm** for eNtsa to provide new services, and
- reduce **government dependency** by shifting client base to local and international industry.



In a difficult financial and political year eNtsa has made progress towards Vision 2020



## Strategic priorities for 2019

SO1: **Less for More** – Effective operations with increased profitability

SO2: Strengthen **Brand eNtsa**

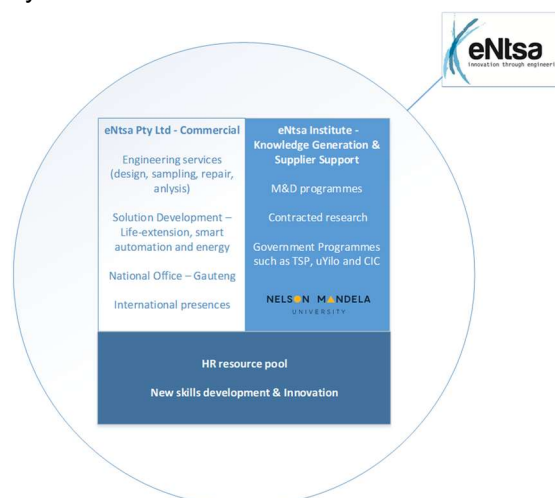
SO3: Create **Commercial Arm**

## Strategic action steps for 2019

Action Step 1: Targeted market development and R&D activities

Action Step 2: Implementation of eNtsa Communications Plan

Action Step 3: Roll-out of Spin-out Company





## Our Portfolio

### Development and Design Services

#### **Mechanical Engineering Design & Analysis Services**

- (CAE Services) • FEA analysis (simulation) and component design optimization (Linear, Non-linear and Thermal analysis) • Product optimization • Accurate CAD conversion • High quality 2D/3D drafting and part detailing • 2D to 3D Design translation • Part design verification

#### **Prototyping & Manufacturing:**

- 3D printing • EDM Wire cutting • EDM Die erosion • 5-Axis CNC • CNC-Turning & Milling • Water-jet cutting

#### **Failure Investigation:**

- Failure mode analysis • Material conformity • Simulation based analysis • Failure site

#### **Portable 3D scanning and Optical CMM:**

- Scan based design • Quality and control analysis

#### **6-Axis Robotic Laser Cell:**

- Laser welding • Laser cladding • Laser cutting

### Mechanical and Material Testing

#### **Mechanical testing:**

- Hardness • Tensile • Fatigue • Impact

#### **Material Composition:**

- Carbon and Sulphur analysis • Spectrographic analysis • Salt spray testing

#### **Optical Microscopy & Scanning Electron Microscopy (SEM):**

- Failure surface analysis (fractography) • Microstructural analysis • Weld penetration analysis • Coating thickness verification

#### **Residual Stress analysis:**

- Portable X-Ray diffraction • Portable High Speed Incremental Hole Drilling

#### **Stain and deformation measurement:**

- Portable digital image correlation (DIC) • Strain Gauge Measurement

### Process Control and Automation:

- Turnkey Automation Solutions • Circuit design

### Battery Testing:

- Lead-acid battery testing • Lithium-ion Cells Testing

#### **Other battery testing services include:**

- Low current cell testing (Coin and cylindrical) • Electrochemical Impedance Spectroscopy with model fitting capabilities (cells) • Start-stop testing of Enhanced Flooded Batteries

### Other specialisation areas and services:

- Customised innovative engineering solutions • Renewable 'green' energy • Joining Technologies • Friction Processing (FP) • Specialised training

## Engineering

### Contract research and projects

By Donnie Erasmus (Deputy Director: Projects and Commercialisation)

eNtsa's strategy from the 2018 strategic planning session, is "more for less", projects yielding higher returns on similar or less input. Business Development initiatives aligned with this strategy are assisting with identifying projects and building new strategic networks and partnerships. The institute's financial well-being and sustainability is directly linked to developing these networks and partnerships. This past year saw eNtsa partake in a project aligned to the Oceans Economy, with the design of a prototype Ocean Glider, which was a project somewhat outside the traditional scope of work.

Commercialisation is a high priority for eNtsa and is receiving the necessary attention, although slower than anticipated. Various role players have been engaged to assist with developing a strategy/plan for roll out of a commercial entity which is acceptable to all concerned, eNtsa and the Nelson Mandela University. The intention is to establish an industrial arm of eNtsa outside the university structure, the funded and research related programmes remaining within the university structures. This strategy has been identified as fundamental to sustainability, and to providing career advancement opportunities for the current staff complement.

Eskom has been one of eNtsa's prominent clients for the last couple of years engaging our team in projects related to industry research and services related to life extension. eNtsa's ability to do contract research based projects for Eskom came to an end in November 2018, due to Eskom not renewing the overarching agreement with all the Universities. Eskom still remains a key project partner for eNtsa and we are investigating alternative avenues through which to engage Eskom on a project basis. The past year highlighted the importance, however challenges, of a committed projects pipeline and order book. The silver lining to this with the loss of potential revenue in the short term from Eskom, forced eNtsa to re-evaluate the client base.

Annual utilisation of technologies developed by eNtsa, during planned maintenance and shutdown periods, particularly with respect to life prediction and life extension of high value components remains an important focus area and revenue stream. Early in 2019, Eskom published a tender for the supply of services for preventative machining on the LP 1&2 turbine rotors for Kendal power station. eNtsa was awarded the work and preventative machining was undertaken over a period of six weeks on the two turbine rotors. This work was done utilising platforms, developed and manufactured and funded in-house, with the express intent competing for this type of work.

eNtsa is currently in discussions with a Canadian group, with an office in Scotland, who steward oil rigs in the North Sea, surrounding repair techniques and technologies. Unique solutions to traditional engineering shortcomings in the construction of tube to tube sheet welding in heat exchangers is a big focus area at present and we are convinced that we can deliver a positive influence to the original equipment manufacturers of the heat exchangers. Metallurgical sampling and life prediction and extension services for high value components in the power generation and petro-chemical industries and solid state welding still remain of the major focus areas, however we want to broaden these focus areas capturing a larger section of the market. Engineering projects and contract research however still remain the major contributors to the sustainability of eNtsa and associated financial well-being of the institute.

The current world economic outlook is forcing industry to become innovative in their approach to maintenance and life extension philosophies. This is the space we want to be active in and be a recognised solutions provider.

## Welding & Materials Engineering

By Mr Louis Von Wielligh (Deputy Director: Welding and Materials Engineering)



The materials group, referred to as eNtsa Testing Services, provides professional metallurgical, mechanical and environmental testing services to industry as well as academia.

The group completed  $\pm 277$  projects for 60 different clients. From the 277 projects, 236 were considered primary industry projects while 41 was secondary industry or academic support projects. The average turnaround time improved from 6.4 days per project in the previous financial year to 5.6 days in the 2018/19 financial year. Compared to the previous financial year the number of completed projects increased by 33%, with the revenue generated increasing by  $\pm 7\%$ . This marginal increase in revenue relative to the increase in the number of projects completed highlighted that the distribution of revenue generated per project was skewed towards low revenue / smaller projects. A renewed emphasis should be placed on securing long term, high value contracts to serve as the foundation for growth while supporting SME's and our TSP mandate. In the new financial year.

In terms of human resources it was a challenging but rewarding year. We said farewell to Mr Marlon Koopman, our materials lab technician for the last 7 years. Mr Koopman left the group to join Advanced Laboratory Solutions as a sales representative for the Eastern Cape. The group therefore started the financial year with a completely new compliment of staff. We welcomed Ms Liezl Matthews, previously a self-employed materials engineering consultant. Ms Nthatsi Kolozi and Mr Jaco Allers, previously from the eNtsa Welding and Manufacturing groups respectively, as well as our first Metallurgical intern, Ms Nozipho Sibambo, from the University of Johannesburg. The intern position was funded by the CSIR TLIU programme which aims to provide students with in service training opportunities. It was a mutually beneficial programme which provided eNtsa with additional human resources while affording Ms Sibambo the opportunity to complete her practical training requirements in order to graduate. Based on the success of hosting our first intern we were able to obtain two new interns through the same initiative for the 2019/20 financial year.

On the accreditation front we continued with the implementation of the necessary systems and procedures to enable ISO 17025 accreditation and SANAS approval for our test methods. A major milestone was achieved in September 2018, when our Quality Assurance documentation was submitted to SANAS for review, the first step towards accreditation. The group is very thankful to Ms Natasha Erasmus for her hard work and dedication in the development and implementation of our QA system. The review was completed in February 2019 with no major findings. The next step is the initial assessment which is scheduled to take place in April 2019.

Alongside these activities, we continued with the improvement of our laboratory infrastructure and we are actively seeking funding for the acquisition of critical laboratory equipment to ensure sustainability and growth.

## Advanced Design & Modelling

By Dr Ian Wedderburn (Deputy Director: Engineering)

The Advanced Design & Modelling group within eNtsa provides a comprehensive range of services in terms of mechanical design consulting. Capabilities range from basic mechanical and CAD design through to advanced finite element analysis (FEA), which allows the group to provide a multidisciplinary mechanical design service platform. The group makes use of a number of leading CAD platforms that allow seamless interfacing with the varying client systems. Aligned with the CAD systems the team makes use of NX Siemens, advanced finite element analysis software, which provides linear and non-linear analytical capability.

The design group is capable of handling all phases of the mechanical design process from sketching through to detailed 3D CAD design and its associated issuing of detailed manufactured specifications and 2D CAD drawings. Other services include CAD draughting, component/design assessment, product development, re-engineering, design optimisation and 2D to 3D CAD translation. The group works closely with the automation capability within eNtsa. A vital component of any mechanical design process is component verification. The finite element analytical capability underpins the production of verified components and systems. The group has developed these services and has the capability to confidently provide FEA services to industry that cover linear static, buckling and non-linear (geometric, contact, and material non-linearity) approaches. Also included in the group's capabilities are modal, thermal and coupled thermo-structural analysis.

In conjunction with these design and analysis services, the group is also involved in component failure investigations where design assessment is coupled with material failure investigation to determine root causes of failure in working components or systems.

A recent addition to the group's work scope has been the inclusion of component assessment by small testing. Miniature sized samples allows for condition evaluation of in-service components by a minimally invasive means. These small samples allow metallurgical evaluations to be performed without the need for destruction of any part of the component. Importantly the test methods introduced allow for creep and mechanical property determination, which is traditionally only possible via sectioning out a considerable piece of the component.



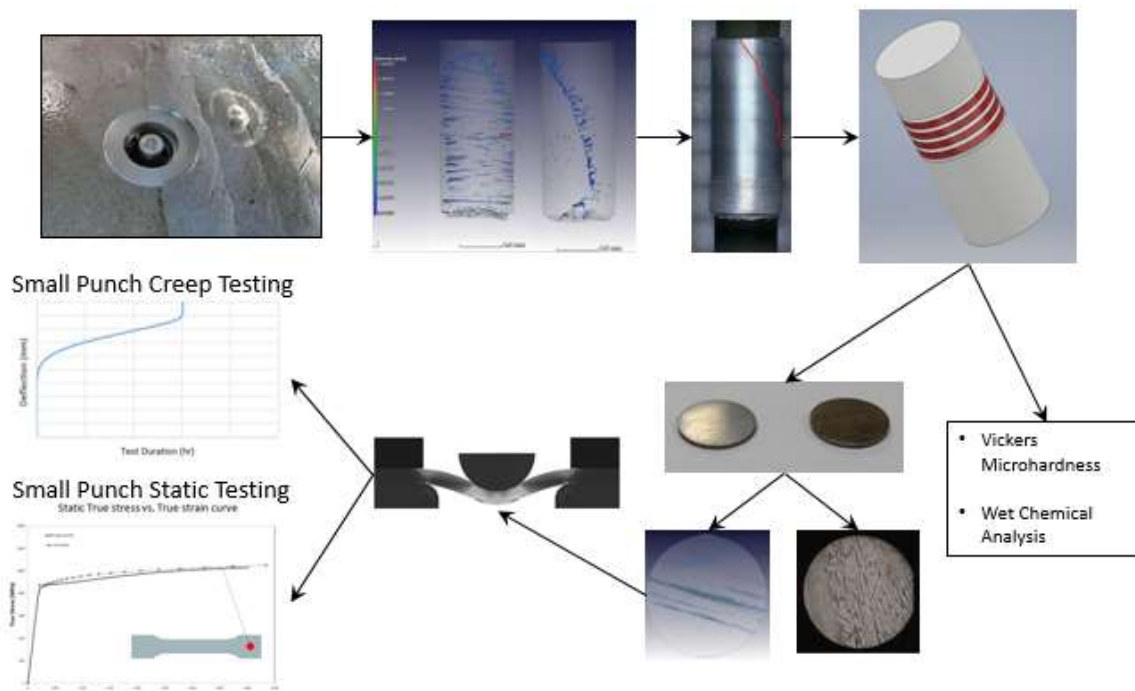
## Small Punch Testing Facility

By Dr Dreyer Bernard (Group Specialist: Life Extension)

The Small Punch Creep Testing facility has been operational nearly continuously since its establishment in 2016, with a total of 300 tests completed for various projects. The small sample value chain has been proven to deliver valuable information for ageing high temperature components, allowing the actual material state to be determined. An elaborate database has been established, which is presently being used in a research collaboration with the Centre for High Resolution Transmission Spectroscopy (CHRTEM) to generate a model which correlates sample microstructure and chemical composition with small punch creep rupture times.

Working closely with our clients, supplementary data from conventional creep test methods has been made available which has allowed the small punch testing to grow into the next phase of the project, namely refining life prediction models and correlating these to existing methods.

In the most recent project, 38 core samples are being evaluated which were removed during the 2018 shutdown and Indications have been given that further coring will take place during the 2019 shutdown.



**WeldCore® Value Chain**

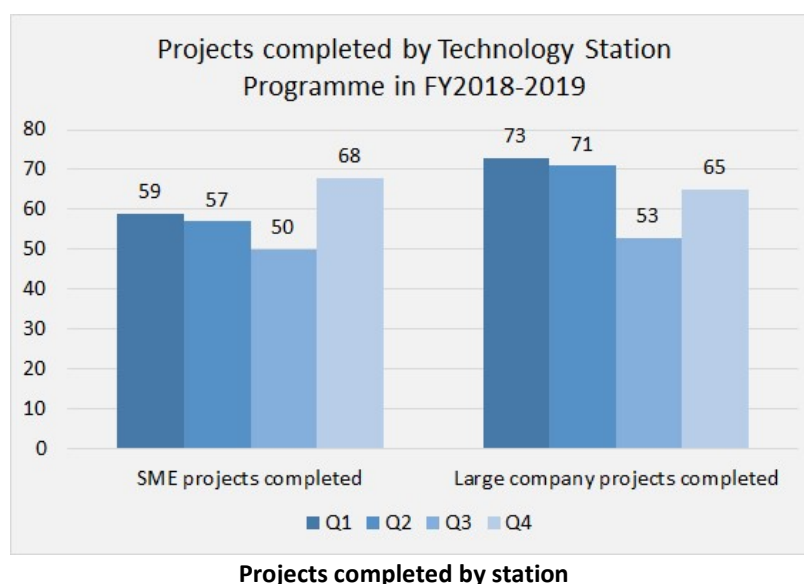


## Technology Station Programme

By Mr Julien De Klerk (Manager: Technology Station & Automation)

The supplier development initiatives, closely linked to the Technology Station Programme (TSP) within eNtsa, aims to support and stimulate local engineering innovation to improve the competitiveness of local manufacturers, thus enabling industry to exploit and develop new markets. With the support of the Technology Innovation Agency (TIA) and the Department of Science and Technology (DST), eNtsa is able to make fundamental engineering skills, services and training more readily available to SMEs allowing them to successfully operate in the local manufacturing sector according to international best practices.

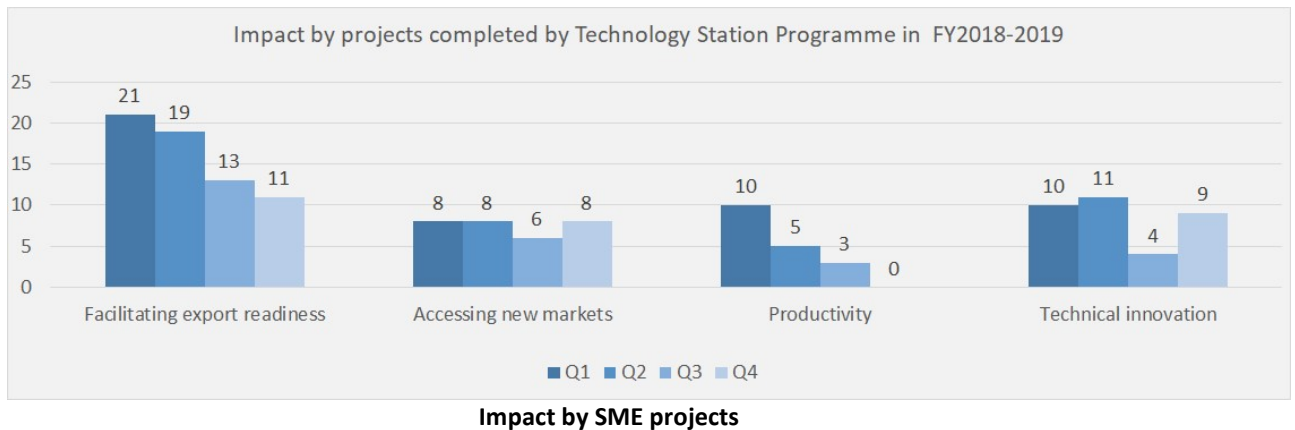
Between 1 April 2018 to 18 March 2019 eNtsa has assisted in 234 projects for 125 SMEs & Entrepreneurs. In the same period, 262 projects were completed for large companies, with an average of 23 large companies assisted each quarter. Below is a figure showing the quarterly distribution of projects.



Thus, 496 industry engagement interventions were completed over this period. This industry assistance covers a wide spectrum of testing, design, product/process development, technology demonstrations and manufacturing assistance.

In addition to project assistance, eNtsa places great importance on investing in human capital and assisting the local industry through skills development as well. During FY2018/19, 180 clients were assisted with training and knowledge transfer activities. This has been a great success, with this year being one of intentional training activities and training services to industry. This is possible through close internal collaboration with the training academy. This is an example of the benefit the Tech Station gains from eNtsa's structure.

All projects recorded as 'facilitating export readiness' enable the production of components and/or products destined, fully or in part, for export markets. Most of these clients require assistance in product design, process development, product quality verification or product testing in order to maintain or secure supply contracts for the export market. From the analysis done it can be observed that 64 of the projects completed in FY2018/19 had an element of export readiness identified. The areas of impact for the TSP projects completed in Q1 to Q4 FY2018/19 can be seen in the graph below.



Material and product testing performed in the eNtsa metallurgy lab has allowed the automotive component suppliers to maintain and monitor high product quality standards required by OEMs and distributors for export products. The need for this type of local support is highlighted by the South African Automotive Master Plan 2035.

ENtsa achieved 100% of the TIA SME project target and 257% of the TIA training target. With ongoing efforts to gain SANAS accreditation on the materials lab, close collaboration with the training academy and a strong focus on industry needs and trends, the Technology Station Programme at eNtsa has completed a successful year and is on a path to increase sustainability and support of our local manufacturing industry.

## Controls and Automation Group

By Mr Akshay Lakhani (Group Specialist: Automation and Controls)

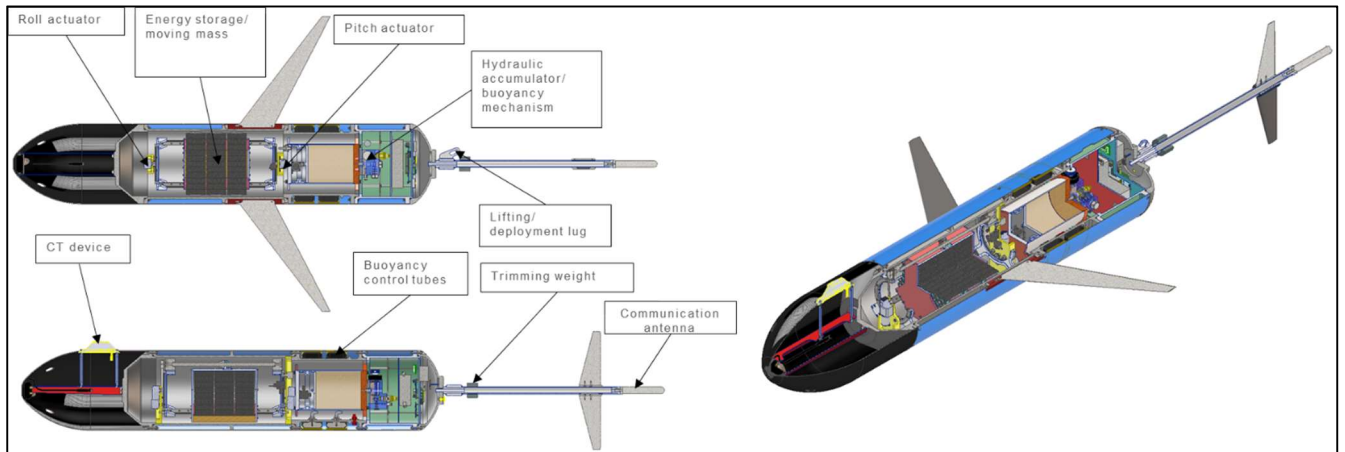
The Controls and Automation Group at eNtsa continues to develop novel solutions and assist the TSP group with the specialised skills. This year, the major focus was to develop IoT solutions to line ourselves with Industry 4.0, with continuous development of sustainable solutions within eNtsa's expertise.

Notable project completed in the green energy field was the design and development of a prototype off-road electric trailer. A synchronised motion system was developed so that the lead 4x4 electric quad would effortlessly tow the battery powered utility trailer. The trailer was fitted with state of the art programmable motion controller and LiFePO4 battery pack to drive a 10kW electric motor. A tandem wheel suspension setup is used to make sure maximum traction is achieved rough-road terrain.

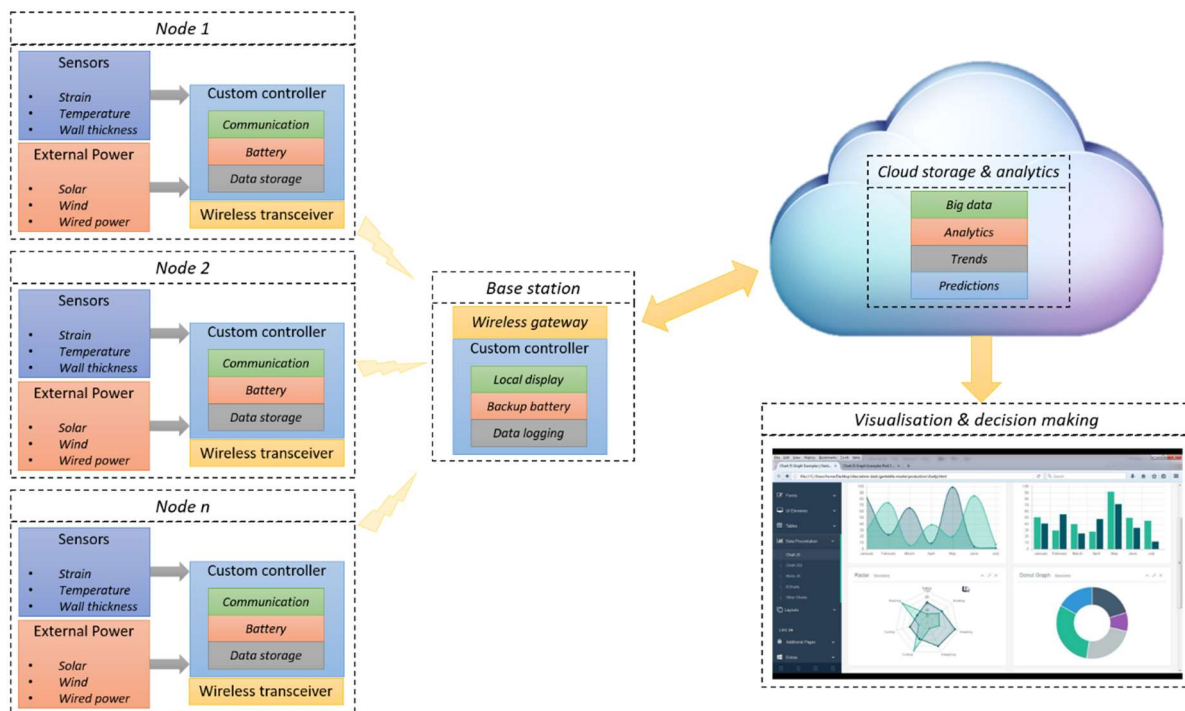


In alignment with the University's new Ocean Science campus, a marine glider was developed for oceanography data capture. A complete electro-mechanical system was design to allow the glider to move in ocean water to depths of 200 metres. FEA and fluid simulations were performed calculate and verify design parameters.





In terms of IoT and Industry 4.0, eNtsa has been embarking on an Online Condition Monitoring system. The system would be able to measure and control various sensors and actuators in remote harsh environments. The data captured would be sent to an online cloud server for storage and processing. A user customisable webpage will display the data and allow users to control actuators.



The Controls & Automation group is now focusing on R&D in exciting new areas that will unlock future developments.

## Composites Innovation Centre

By Mr Andrew Young (Director Engineering)

The Composite Innovation Centre (CIC) based at Nelson Mandela University (NMU) successfully completed an initial composites project in light-weighting – project title Weight Reduction of Composite Structures. The light-weighting project assisted in bringing the CIC to life with the development of skills and resources. The project explored the use of composites in four industry sectors; automotive, marine, renewable energy and aerospace.

Additional funding has been received for the research and development program through the CSIR as part of the Collaborative Fibre Composites Project (CFCPII), this included funding for additional equipment. The 4-axis hot wire cutter valued at R800k was delivered and installed on the 22-24th February and will assist with prototyping and the manufacture foam structures.

Based on a report on the outcomes of the CFCP II Workshop held in Port Elizabeth on 4 July 2018, it was agreed that a project should be supported for developing the skills and techniques for manufacturing of Class A composite panels – Panels without Rework or Finishing. This project will assist in identifying composites engineering short-comings in existing composite design, material and manufacturing technologies. The project is valued at 1.2mil. Additionally, this project will ensure that the CIC is equipped with the competencies to use the available equipment and provide the industry with accurate interpretation and design assistance.



**Hot-Wire Cutter and Autoclave**



**CIC Lab/Workshop**

## Training Academy

By Nadine J Goliath (Training Academy Manager)

eNtsa has identified industrial training and skills development as an additional opportunity to expand and broaden the customer base giving rise to the opportunity of launching an eNtsa Training Academy. This eNtsa's ambition is aligned with the University's Vision & Mission, aiming towards providing an environment generating cutting-edge knowledge and providing a platform for diverse educational opportunities to constructively contribute to a sustainable future, globally.

### Objectives

- To **continuously improve internal skillset and knowledge** in order to provide innovative services to our clients and strategic partners
- To **assist industry with skill upliftment interventions to bridge skill shortfall** move toward business operation according to best practices
- To **create a platform for local and international collaboration** aimed to encourage internationalisation of local markets
- To **encourage an environment of learning, teaching and engagement for the community** aimed at contributing towards effort of sustainability.

### Training intervention categories

eNtsa Training Academy aims to provide support by provide various types of services (administrative or technical). To organise interventions within the Academy the following categories have been identified:

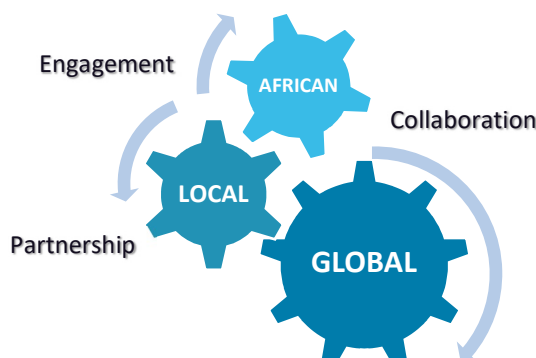
- **Internal training and engagement:** aimed at developing internal skill set or knowledge of internal University staff, interns and postgraduate researchers.



- **Industry focussed training and engagement:** aimed at industry members to develop necessary skills or knowledge in order to improve organisation operation or operational knowledge according to best available practices.



- **Community focused training and engagement:** aimed at supporting knowledge sharing, knowledge advancement and skill development between various members with in society in effort to promote collaboration and engagement.



## Pilot Project: Eskom EPPEI Engineering Practitioner Training Programme (EPTP)

In order to address the skills capacity gap within the power generation industry, more specifically within Eskom, Eskom Power Plant Engineering Institute (EPPEI) and eNtsa, through the Nelson Mandela University, put in place an agreement to create a platform and establish the necessary infrastructure required to bridge this skills gap within the South African and more generally Southern Africa power generation industry. The (EPPEI) was established in 2012 to increase skills capacity of engineers in Eskom.

Part of EPPEI's drive includes the Operators, Maintenance and Engineering Practitioners initiative which aims to create the opportunity for plant personnel to advance their knowledge, leading to an increase in their technical competence, allowing for more efficient operation and maintenance of Power Plants. Furthermore, this will create the opportunity for all plant personnel to advance their knowledge, leading to an increase in their technical competence, allowing for more efficient operation and maintenance of Power Plants

The objectives of the Engineering Practitioner Training Programme are as follow:

- To provide the opportunity to Engineering Practitioners to gain a thorough understanding of their job activities including engineering fundamentals and practical plant operation and maintenance requirements.
- Provide Engineering Practitioners an accredited certification of professionalism in their job profile.

The EPTP has a two phase approach. Phase I focusses on delivery of short courses and Phase II aim to establish a formal nationally accredited qualification with the assistance of HEI's allowing Eskom staff to obtain a formal qualification, while working, by attending accredited modules offered via the Engineering Practitioner Training courses. Phase I utilises a set out Building Blocks method to ensure that the necessary resources are engaged and the necessary milestones are reached to achieve effective execution of the project.

To date a number of **424** Eskom personnel has attended training to date from various business units within Eskom attending a variety of **6** courses.

Engagement is underway for the continuation of this project in the new financial year. The involvement of Universities of Technologies (UoTs), research facilities within HEI's and experts (within industry and a consultancy capacity) is a core focus to further develop efforts to ensure content technically relevant and applicable to Eskom.

## uYilo eMobility Technology Innovation Programme (EMTIP)

By Hiten Parmar (uYilo Director / Business Development Manager) & Edem Foli (Programme Manager)

The uYilo eMobility Technology Innovation Programme (uYilo) has been hosted within eNtsa, at Nelson Mandela University, for the past six years. uYilo is a multi-stakeholder collaborative programme which was initiated by the Technology Innovation Agency, in March 2013. Focused on enabling, facilitating and mobilising the electric mobility (eMobility) industry in South Africa, uYilo has established a foundation of specialised expertise and infrastructure towards accelerating the growth of eMobility in South Africa.

uYilo's facilities consist of a National Accredited Battery Testing Laboratory, Systems Laboratory for component level support and a Live Testing Environment that facilitates universal interoperability across the Smart Grid Ecosystem. uYilo is highlighted as a Strategic Initiative within the national Department of Transport's Green Transport Strategy (2018-2050) along Strategic Pillar 8, promotion of electric and hybrid-electric vehicles.

The uYilo Kick Start Fund supports eMobility technology advancements through applied research and development that leads to the local innovation value chain of eMobility products and services. The initiative seeks greater alignment to the Department of Trade and Industry's 2035 South African Automotive Masterplan, which aims to achieve 60% localisation.

Some Kick Start Fund projects completed in the FY2018/19 include: An off-road battery-powered utility trailer with synchronisation to a lead 4x4 Electric Quad, developed by Ubun2Tech, and induction motors and controllers for Kinetic Energy Recovery System, developed by Intelligent Machines – to achieve fuel consumption and emission reduction in heavy vehicles. A total of 24 applications were received for the FY2018/19 funding call, of which the following two applications received funding: the development of an electric vehicle (EV) Back Office Management System by QB Software and Consulting and 18650 Cylindrical Battery Pack Module for Mining Vehicles, by Battery Powered Industries.

In the FY2018/19, uYilo continued to serve on a number of national initiatives that enabled the uptake of eMobility in South Africa. uYilo is a member of the Department of Energy's South African Smart Grid Initiative (SASGI) and was involved in engagements regarding relevant policies, legislation and the national direction for Smart Grid technologies in the energy sector. uYilo continued to serve as the Secretariat of EVIA (Electric Vehicle Industry Association) and was also the official liaison member to NAAMSA (National Association of Automobile Manufacturers of South Africa) for electric vehicle technology.

The FY2018/19 also saw significant engagements with the public sector, private sector as well the international community, paving the way towards the uptake of eMobility in South Africa. uYilo won the 2018 Nelson Mandela University Research, Teaching and Engagement Award for their Smart-Grid Project, which tackled the challenges around energy management, electric vehicle charging infrastructure and how South Africa can work towards sustainable energy management for charging of electric vehicles, with inclusions of renewable energy. The project strengthened uYilo's partnerships and engagements with Nissan (South Africa and Japan global headquarters), BMW South Africa, Mercedes Benz South Africa, Tracker South Africa, Eskom and NUVVE Technology (USA).

uYilo has continued to play an integral role in the enabling and facilitation of business development initiatives that enable the uptake of eMobility in South Africa. Through multi-stakeholder collaborations and an alignment to global technology advancements that impact eMobility across transport, energy and ICT, uYilo has increased its local footprint while also leveraging on international exposure.



## Electric Vehicle Systems and Charging Infrastructure

By Mr Xander Theron (Senior Engineer: EV Systems)

The Electric Vehicle Systems facility provides a platform to facilitate electric vehicle compatibility with products sourced from a variety of global suppliers so as to accelerate the development and deployment of electric vehicle technologies in South Africa. In order to establish benchmarks and help set future technology goals, new technologies need to be evaluated from component level to the vehicle system level in terms of energy consumption, efficiency and performance.

Second life battery re-purposement forms part of the technology evaluation which looks at the application of Electric Vehicle battery packs once removed from the vehicle. One project included repurposing the traction battery into a 48V battery system, for an All-Terrain-Vehicle with the fitment of a new battery management system. The project was completed and currently in use towards gaining valuable experience and skills for the programme.

The conversion of two Tuk-Tuk's from the Nelson Mandela Bay Development Agency (MBDA) to electric drive served to demonstrate and showcase this eMobility technology within the city. The project involved uYilo converting the two Tuk-Tuks that have been used by the MBDA for tourism as well as education at the local science centre. The Tuk-Tuk's were ICE (internal combustion engines) and converted to electric drive with Lithium-ion battery packs and solar charging on the roof of the vehicles. The project is set for completion and handover in April 2019 with preliminary testing of the first platform completed.

Through the provision of credible information to all stakeholders, we are able to provide support in evaluating current and future technologies for electric vehicle components that will aid in the development and optimization of advanced technologies and hence expand commercial applications.

The Live Testing Environment facility serves as a Smart Grid simulator for the eMobility ecosystem to facilitate universal connectivity between electric vehicles and charging infrastructure. The facility supports demonstration, analysis and testing of electric vehicle fleets and smart grid technologies intended to aid in the development and optimization of advanced technologies and expand commercial applications with the focus on Smart Grids.

The various ecosystems elements include electric vehicles, charge points, solar energy generation, information communication systems that are enclosed within a micro-grid environment with a particular focus on smart grid interactions between the electric vehicles and the energy system.

The focus for the Micro-grid projects has been in the following areas:

- Data capturing of the energy efficiency algorithm with the various charging scenarios
- Training for internal staff and skills development
- IEC 61850 smart grid protocol implementation - key part of the further development of the uYilo smart grid which allows multiple smart subsystems to communicate with the Energy Management System (EMS). The communication protocol implementation will be aligned with distribution and national grid controllers.

The Vehicle-to-Grid bidirectional charger is the first in the continent to be installed at the uYilo facilities and further advancements on its integration has been taking place with an aggregator for monitoring and controlling for adaptation to local energy conditions. A new charge point with facial recognition and hand gesture has been installed to demonstrate the leading technology in electric vehicle charging solutions.

## Battery & Storage Systems

By Dr Nico Rust (Group Specialist: Energy Storage Systems) and Prof Ernst Ferg (Research Advisor)

The uYilo battery testing is an accredited testing laboratory that supports local R&D and manufacturing entities by providing accurate and reproducible testing services relevant to the evaluation of new storage solutions whilst also providing validation of existing battery technologies.

Accreditation of the uYilo testing laboratory through the South African National Accreditation System (SANAS) means that its results are recognized internationally, as SANAS is a member of the International Laboratory Association Cooperation. The laboratory has recently updated its quality system from ISO17025 (2005) to ISO17025 (2017), which places much more emphasis on measurement of uncertainty, risk management and impartiality.

The laboratory has maintained its accreditation status for the testing of lead-acid batteries since 2015 and is also accredited to test lithium-ion cells for stationary applications. The uYilo battery testing laboratory (SANAS lab no. T0676) is currently the only accredited testing laboratory in South Africa for Lithium-ion cells according to IEC62620 (Performance) and is in the process of further expansion to include Lithium-ion safety testing according to IEC 62133 (Safety).

The expansion of its services will support the establishment of local manufacturing of Lithium-ion cells at the University of the Western Cape as part of a THRIP project. The laboratory has also recently commissioned its 100V battery tester to accommodate 48V module testing, which uses a CANBus communication protocol to measure or control various battery management functions.

The uYilo battery testing laboratory also provides battery testing beyond the scope of its accreditation, for batteries used in UPS and renewable energy storage applications, automotive standards and is currently the only battery-testing laboratory in South Africa to provide Dynamic charge acceptance testing according to EN50342-6 for batteries used in micro-hybrid applications.

This service allows local battery manufacturers to develop and improve batteries in conjunction with automotive technology advancements. The requests for the above mentioned standard has increased to such an extent that the laboratory is in the process of adding additional capacity to the current tester to allow for more batteries to be tested at once.

The laboratory also provides a range of unique materials testing services to local manufacturers relating to the raw materials used in the manufacturing of lead-acid batteries. The testing facility is in the process of validating various analytical test methods for lithium ion batteries, more specifically for lithium manganese oxide raw materials.

The laboratory also does various non-battery related testing, which includes plastic material, pharmaceutical products, fragments or material of unknown origin and soil samples. The uYilo materials testing laboratory had its first external audit early in 2019, which was conducted by Aspen Pharmacare, and was commended regarding the quality system in place.

The uYilo programme is involved in various research projects related to developing battery materials for lithium-ion cells in 2018. A MSc project is aimed at studying the phase transitions involved in the synthesis of doped lithium titanate materials, which would be highly beneficial in the development of batteries for large-scale applications and reducing manufacturing costs. This project is in the final stages and will be submitted in 2019, with at least two publications expected on the work.

A BSc Honours project focused on the encapsulation of flame retardants for temperature-dependent release of flame retardants into the electrolyte of a battery, to reduce the safety hazards found in lithium-ion batteries. This work is currently studied further by a new MSc student.

In December 2018, Nomasonto Rapulenyane, a PhD (Chemistry) student completed and successfully graduated with her thesis title being "Development of high capacity lithium manganese rich cathode materials  $x\text{Li}_2\text{MnO}_3 \cdot (1-x)\text{LiMn}_{0.5}\text{Ni}_{0.5}\text{O}_2$  for lithium ion batteries". She worked on the collaborative project with the Energy group at the CSIR in Pretoria. Her work has contributed to the publication of one journal article and the filing of two local patents for the group.

Prof Ernst Ferg spent 8 months of 2018 on research sabbatical at the Deutsche Luft und Raum (DLR)-Institut für Vernetzte Energiesysteme in Oldenburg Germany. Besides the research work done with the group on the use of lithium ion batteries for starter lighting and ignition applications and the successful completion of a review article on the topic.

A number of collaborative projects are subsequently established with other research institutes that include Ostfalia Hochschule that will look at the field of lithium ion recycling and with Ingolstadt Hochschule that will look at having an exchange student to look at the developing of a battery management systems (BMS) that makes use of Artificial Intelligence (AI) to manage its state of health (SoH). The work done by Prof Ernst Ferg is continuing as part of a Masters Research work by a student Amelie Krupp at the Oldenburg University that is looking the developing of a suitable SoH monitoring system for lithium ion phosphate based batteries for their use in high power grid-system applications.'



## Electric Drive Trucks & Charging Infrastructure

By Mr Xander Theron (Senior Systems Engineer: EV Systems)

The Electric Vehicle Systems Laboratory provides a platform to facilitate EV compatibility with products sourced from a variety of global suppliers so as to accelerate the development and deployment of electric vehicle technologies in South Africa. In order to establish benchmarks and help set future research goals, new technologies need to be evaluated from component level to the vehicle system level in terms of energy consumption, efficiency and performance.

The second life battery application forms part of the new technology evaluation which looks at the potential of a second application of an Electrical vehicle traction battery. Repurposing an EV traction battery to a 48V Li-Ion battery for an ATV was done with the fitment of a new BMS. The project was completed and in use for the vehicle gaining valuable experience and skills for the programme.

The converting of two Tuk-Tuk's from the Nelson Mandela Bay developing agency (MBDA) to electric drive served to demonstrate and showcase this technology. The project involved converting the Tuk-Tuks used by the MBDA mainly for tourism as well as education at the local science centre.

The Tuk-Tuk's were ICE (internal combustion engines) and converted to electric drive with Li-Ion battery packs and solar charging on the roof of the vehicles. The project is set for completion and handover in April 2019 with preliminary testing of the first platform completed.



**Tuk-Tuk electric conversion**

Through the provision of accurate research results to all stakeholders, we are able to provide support in evaluating current and future technologies for EV components that will aid in the development and optimization of advanced technologies and hence expand commercial applications.

The Smart grid lab serves as a simulator for the eMobility ecosystem to facilitate universal connectivity between electric vehicles and the electrical charging infrastructure. The facility supports analysis, development and testing of EV's and smart grid technologies intended to aid in the development and optimization of advanced technologies and expand commercial applications with focus on Smart grids.

The various EV ecosystems elements include EV's, charge points together with data & information communication systems that are enclosed in a micro-grid environment with a particular focus on grid interactions between the EV ecosystem and the energy supplier.

The uYilo Smart grid has experienced technical difficulties with the inverter unit being out of commission for an extended time period which has been resolved.

The focus for the Micro-grid projects has been in the following areas:

- Data capturing of the algorithm with the various grid and charging scenarios
- Training for internal staff and skills development
- IEC 61850 communication implementation. The implementation of the IEC 61850 protocol is a key part of the further development of the uYilo smart grid which allows multiple smart subsystems to communicate with the Energy management system (EMS). The communication protocol implementation will be aligned with distribution and national grid controllers.

The Vehicle-to-grid bidirectional charger is the first in the country to be installed at the uYilo facilities and development on its integration has been taking place with an aggregator (external controller) to assess and adapt to local energy conditions for optimal grid impact. This technology will play a key role in the country struggling with energy security.

A new charge point with facial recognition and hand gesture has been installed to demonstrate the new technology in the electric vehicle charging field.



**uYilo Smart Grid area based at North campus**

Vehicle-to-grid interaction is a key component in advancing the technology of EV's, and South Africa's first vehicle-to-grid (V2G) charging station has been installed and commissioned in the uYilo LTE environment allowing development of integration and implementation within the LTE environment.

## Research

By Prof Danie G. Hattingh (Director) & Prof Ernst Ferg (Research Leader Battery Storage)

At eNtsa, we are in a fortunate position, from a knowledge and infrastructure point of view, to be able to explore the knowledge frontiers in a number of fields. The main areas currently being explored are; charging infrastructure and battery technology for e-mobility, laser processing with an emphasis on complex geometry laser metal deposition (LMD) components, Solid state joining technologies for Titanium and Aluminium sections and life prediction/extension models via small sample testing for high value engineering plant.

The industry focus related to automotive and electric vehicles, advance manufacturing sector, power generation and petrochemical industry. Research experience within batteries (lead acid) and solid state joining at the Nelson Mandela University (NMU) goes back as far as 1999.

The solid state joining research work formed the basis for the development of the innovative WeldCore® sampling and repair procedure. The removal of samples again assisted in advancing knowledge around small sample testing, which encompass small sample creep and static testing. The real commercial value of this academic research only became apparent with the adoption of the eNtsa developed coring and repair process into the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC) Section IX. This industry approved code acceptance allowed a number of research groups, nationally and internationally to unlock funding to evaluate new methodologies to characterise “aged” material properties and new life extension methodologies for optimal “safe plant life” operation.

The WeldCore® technology is a prime example of how ground-breaking academic research efforts, in this case by eNtsa through NMU, contribute to South African’s socio-economic development. This collaboration not only provides an entrance into the international arena of welding operations but also upskills the local workforce through training opportunities and interventions. Research around small sample testing, within the life extension regime, are now pushing the development of unique testing facilities all over the world.

Laser processing, including LMD and joining technologies received attention from 2015 when eNtsa installed the 4kW Laser robot cell at a cost of R15 million. Both, solid state- and laser welding are being increasingly adopted by various sectors within the manufacturing industry. The welding of materials with varying thicknesses at higher production rates proficiently with resultant small heat affected zones continues to attract more and more industrial interest in both friction stir and laser technologies. Currently, the materials receiving most of the attention from eNtsa research team, are Titanium and Aluminium. This is in line with the National Government’s Light Metals and Advance Materials Initiative to advance beneficiation and downstream economic benefits.

The battery group not only provides a technical and testing service to the local battery industry and developers in terms of raw materials analysis and product specific standard compliance testing, but also research and development (R&D) in the field of battery electrochemistry. The group’s research focus area are within two main broad fields. That being the development of battery related materials and the application of cells or batteries within specific systems. This would pertain mainly to two of the most common types of battery chemistries, that being the Lead-acid and Lithium-ion batteries.

Very strong linkages exist with the Department of Chemistry on South Campus, the focus of the research is to understand the chemical synthesis route in making the anode and cathode materials used in lithium-ion cells. This not only helps develop a better understanding of the crystalline structural orientation of the respective compositions and how they behave when subjected to deep capacity cycles, but also gives a way to possibly reduce the high costs that are associated in making the materials during their manufacturing processes. Aspects of the research are done in collaboration with the Wits Energy Materials group that give access to in-situ powder diffraction equipment. Other research undertaken by the materials group is the investigation of flame retardant additives to the organic electrolyte in order to reduce the high thermal risks that are associated with Lithium-ion batteries. Related research in the field of materials for lead-acid batteries is to look at various additives that are included during the electrode manufacturing that improves the life cycle of the batteries and to extend their use in typical vehicle applications such as Start-Stop.

With regards to the R&D of cells or batteries in systems, the group is currently active in using Lithium-ion batteries in low voltage high power applications such as a starter lighting and ignition of the internal combustion engine of conventional vehicles. This work is a continuation of Prof Ferg's sabbatical work in 2018 at the Deutsche Luft und Raum (DLR) Institute located in Oldenburg Germany. The project looks at the development of suitable battery management systems that can both provide the right protective safety circuitry for high current and low temperature applications in combination with Artificial Intelligence (AI) to develop suitable life cycle algorithms that can give a state of health model for a typical 12-14V battery. Projects are selected to develop the necessary skills to support the uYilo EV programme with regards to their mandate of expanding e-mobility in South Africa.

In summary, the research work around batteries/manufacturing/joining technologies, across the various registered research projects, allow eNtsa to explore and develop new optimised processes and applications with immediate economic benefit for transport and associated advance-manufacturing and engineering sectors. Within eNtsa there is a new drive to more assertively link business development opportunities with research in an attempt unlock new opportunities, cultivate entrepreneurial spirit among postgraduate students to engage in research that will create employment or business opportunities for South Africa.

Additionally, eNtsa is working with the Department of Mechanical Engineering at the Nelson Mandela University, Walter Sisulu University (WSU) and Cape Advanced Engineering (CAE) Energy (Pty) Ltd, a specialist mechanical engineering technology company that operates in the bio-energy and fuel technology sector, to assist with building research capacity at WSU. The training and support of students are linked to dry fermentation anaerobic bio-digestion demonstrator unit to be established in the East London area for produce bio-gas. The project is funded by the Department of Trade and Industry's THRIP program with the purpose to develop appropriate human resource capacity within this industry locally.

Research funds have been obtained from a variety of funders (including the Technology Innovation Agency, National Research Foundation, Light Metals Development Network, Titanium Centre of Competence, Eskom, Sasol, THRIP, Royal Academy of Engineering and eNtsa).

#### **International Experiments 2018:**

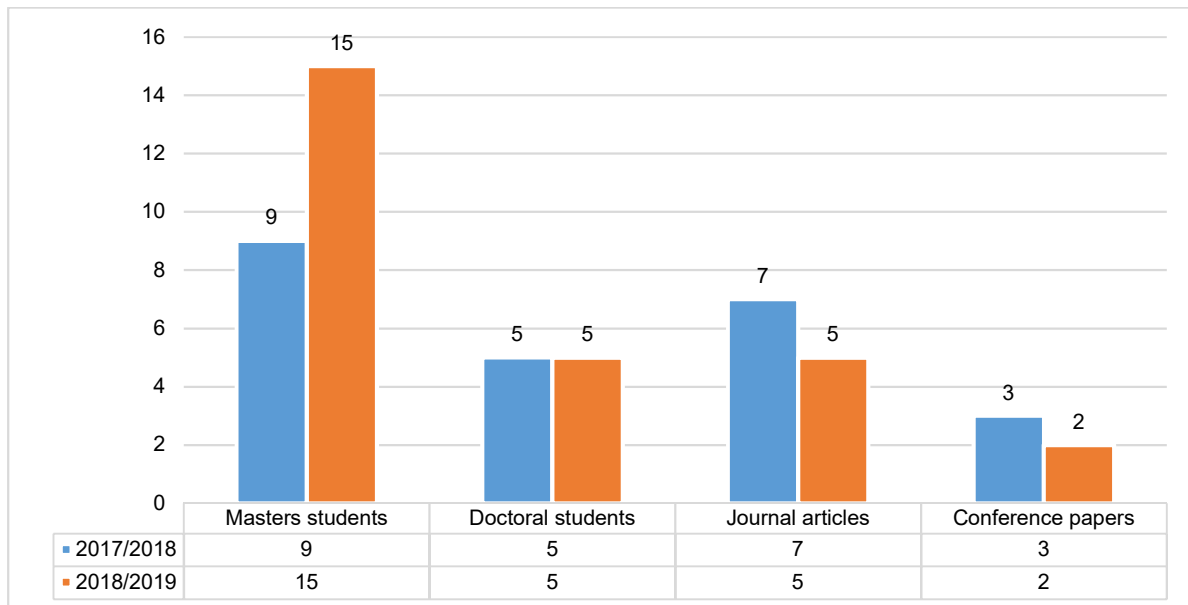
International Experiment - EUROPEAN SYNCHROTRON RADIATION FACILITY (ESRF), Grenoble France. (University of Plymouth, Malta Nelson Mandela, eNtsa and ESKOM)

Defining the relationship between Build Height, Residual Stresses and Sample Distortion of Ti6Al4V Components manufactured by Laser Metal Deposition (LMD)



**LMD manufactured Ti6Al4V parts evaluated on Beam line ID15 at the ESRF facility in Grenoble France.**

## Research outputs



Research associated outputs for 2018/2019 include the following:

- Current active students 2019 (see Annexure A)
  - Masters students: 15
  - Doctoral students: 5
- Interns: 14
  - 2 Metallurgy Interns from University of Johannesburg (1 current and 1 resigned in Jan 2019)
  - 4 Supplier Development Interns
  - 4 uYilo Energy Storage (3 active and 1 resigned November 2018)
  - 4 uYilo EV & LTE (3 active and 1 resigned December 2018)
- Journal articles: 5 (all from internationally recognised journals)
- Conference proceedings: 2 (local conferences)

## Operations

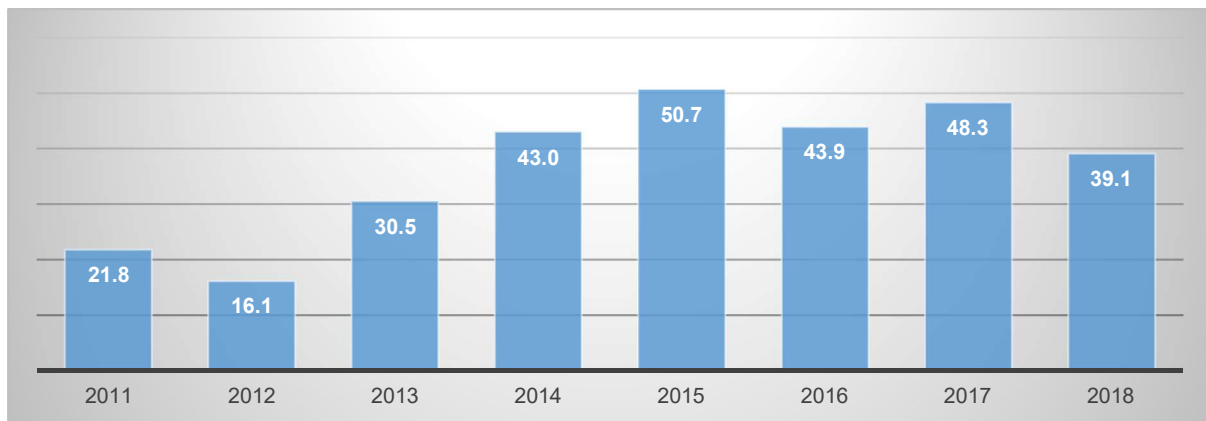
By Mrs Lucinda Lindsay (Deputy Director: Operations)

eNtsa’s Operations team is a well-integrated group of office professionals and technical support staff. This group is responsible for the operational function within eNtsa, interfacing with official university policies and procedures, which include human resource management, finance management, procurement, marketing, branding, facilities maintenance and general administrative support to the eNtsa team.

Staff within this group have a unique range of skills which allow us to provide a customised approach to service delivery and addressing the demand for interventions within the engineering and innovation sphere.

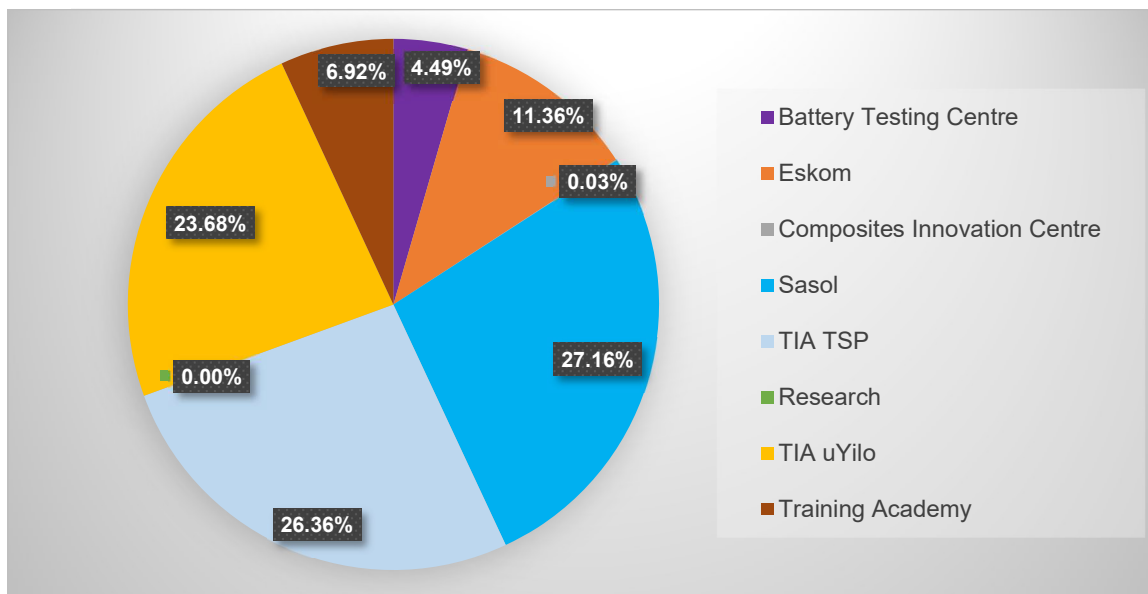
## Finance

The graph below depicts eNtsa’s turnover (in millions) since 2011:



**eNtsa Turnover (2011 – current)**

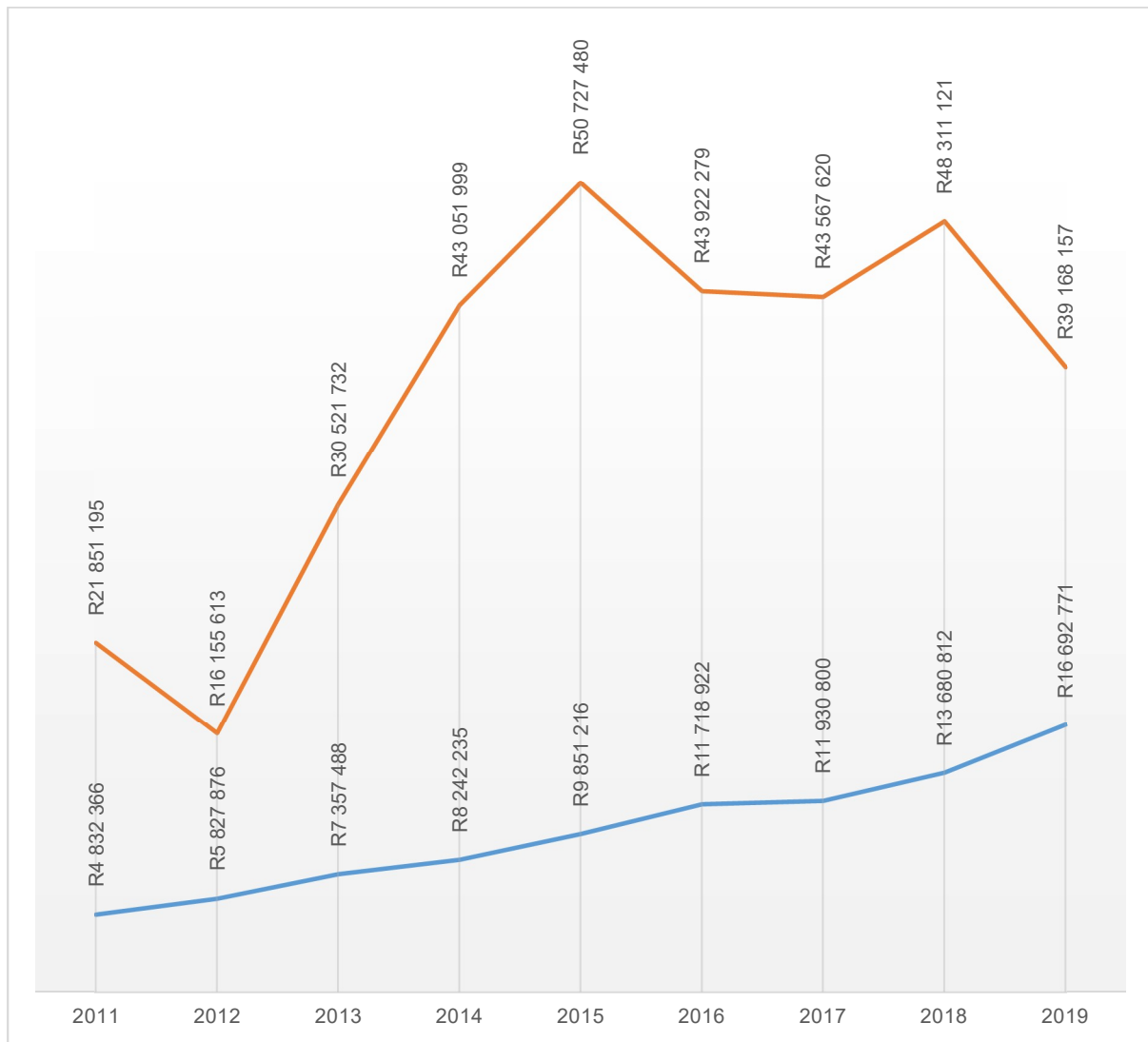
The graph below depicts eNtsa’s income sources for the FY2018/2019:



**eNtsa income sources 2018/2019**



The graph below depicts eNtsa's Human Resource Expense vs Turnover since 2011:



**eNtsa HR expense vs Turnover (2011 – current)**

## Our staff


eNtsa, initially established as the Automotive Components Technology Station (ACTS), started with a staff complement of three (3) people and has now grown into a highly skilled team of more than 50 comprising engineers, technicians, administrative professionals postgraduate researchers and interns. Our people, operating as a coherent team, are undoubtedly the most valuable assets of eNtsa. Our operation and sustainability thrive because of the unique abilities of our team, who daily execute eNtsa's slogan by actively living our values.















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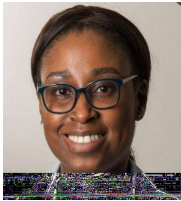





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<b>PhD Candidates (5)</b>		
 <p>Davies Tsikayi 209080067</p>	<p>PhD Mechanical Engineering (Full-time)</p> <p>First registration 20/01/2016</p> <p><b>Graduating April 2019</b></p>	<p><b>Influence of Laser Surface Treatment on Residual Stress Distribution and Dynamic Properties in Rotary Friction Welded Ti-Al-4V Components</b></p>
 <p>Frederikus Jonck 9514086</p>	<p>PhD Mechanical Engineering (Part-time)</p> <p>First registration: 05/04/2016</p>	<p><b>Quantifying the influence of powder alloying additions of Cu, Ni, Ti on the welded joint efficiency of pulsed Nd: YAG laser welded 6061 aluminium by investigating the microstructure evolution and mechanical properties</b></p>
 <p>Willem Pentz 20301001</p>	<p>PhD Mechanical Engineering (Part-time)</p> <p>First registration: 03/2012</p>	<p><b>Influence of process energy on stress corrosion susceptibility of a friction hydro pillar repaired steam turbine rotor disc blade locating hole</b></p>
 <p>Rapulenyane Nomasonto 215380797</p>	<p>PhD Chemistry (Full-time)</p> <p>First registration: 2014</p>	<p><b>Development of high capacity lithium-manganese rich cathode materials <math>x\text{Li}_2\text{MnO}_3 \cdot (1-x)\text{LiMn}_0.5\text{Ni}_0.5\text{O}_2</math> for lithium ion batteries</b></p>
 <p>Martin Smuts 210035447</p>	<p>PhD: Computer Science (Full-time)</p> <p>First registration: 04/2016</p> <p><b>Graduating April 2019</b></p>	<p><b>A Multi-Factor Model for Range Estimation in Electric Vehicles</b></p>

<b>Masters researchers (15)</b>		
 Narishe Mohlala 218215169	MEng Mechanical Engineering (Full-time)  First registration: 05/2017	<b>Development and Process Verification of Linear Friction Welding Platform for Small Ti6Al4V Coupons</b>
 Prince Chikamhi 211174920	MEng Mechanical Engineering (Full-time)  First registration: 05/2017	<b>Friction Stir Welding of Thin Section Aluminium Extrusions for Marine Applications</b>
 Aphelele Gili 219227535	MEng Mechanical Engineering (Full-time)  First registration: 03/2018	<b>Development of Pin-Less Friction Stir Welding for thin rolled titanium products</b>
 Amy Van Gend	MEng Mechanical Engineering (Part-time)  First registration: 03/2018	<b>Application of Laser Optical Measurement Techniques to assist with Planning, Design and Manufacturing Patient Specific Lower Limb Orthopaedic Prosthesis</b>
 Julien De Klerk	MEng Mechanical Engineering (Part-time)  First registration: 03/2018	<b>Provisional Title: Investigate the effect on the residual stress in thick walled components, due to localised Induction Heating as a Post Weld Heat Treatment (PWHT) solution for Friction Hydro-Pillar Processing (FHPP) welding</b>
 Charmaine Gelant 213346257	MSc Chemistry (Full-time)  First registration: 01/2017  <b>Graduating 2019</b>	<b>The morphological and electrochemical investigation of sol-gel synthesized spinel Li<sub>4</sub>Ti<sub>5</sub>O<sub>12</sub> used as anode material in Li-ion batteries</b>

 <p>Francis Le Roux 214032507</p>	<p>MEng Mechatronics (Full-time)</p> <p>First Registration Jan 2019</p>	<p><b>Intelligent Lithium-Ion Battery Management Systems for high current applications</b></p>
 <p>Amelie Krupp 4432437 (University of Oldenburg, Germany)</p>	<p>MSc Physics (Full-time)</p> <p>First registration January 2019</p>	<p><b>Incremental Capacity Analysis of LiFePO<sub>4</sub> batteries on single- and multi-cell-level</b></p>
<p>Nompilo Ntombela 214215156</p>	<p>MSc Chemistry (Full-time)</p> <p>First registration: January 2019</p>	<p><b>Encapsulation of flame retardant for lithium-ion battery</b></p>
 <p>Athi Prusente 218203195</p>	<p>MEng Mechanical Engineering (Part-time)</p> <p>First registration: 04/2016</p>	<p><b>Laser Welding of Thin Al-Mg-Si Sheet for Automotive Assembly Applications</b></p>
 <p>Boniface Tambro 219905274</p>	<p>MEng Mechanical Engineering (Full-time)</p> <p>First registration: 03/2018</p>	<p><b>Operational optimization of a dry fermentation digester for biogas production, applying the Acacia Mearnsii as feed stock</b></p>

 <p>Mpho Ntombana 212277448</p>	<p>MEng Mechanical Engineering (Part-time)</p> <p>First registration: 03/2018</p>	<p><b>An optimised pyrolysis process control to ensure consistent production of high calorific value charcoal</b></p>
 <p>Vatiswa Mgijima 220018200</p>	<p>MEng Mechanical Engineering (Part-time)</p> <p>First registration: 03/2018</p>	<p><b>The effects of process parameters and weld interface geometries on the hot plate welding of high – density polyethylene components</b></p>
 <p>Anele Mlamla 220018197</p>	<p>MEng Mechanical Engineering (Part-time)</p> <p>First registration: 03/2018</p>	<p><b>Optimization of the aerobic compost making process using digestate from anaerobic digestion</b></p>
 <p>Dumisani Ramncwana 210131896</p>	<p>MEng Mechanical Engineering (Part-time)</p> <p>First registration: 05/2018</p>	<p><b>Storage and pre-treatment of substrate, derived from Acacia mearnsii, for improved bio-gas production</b></p>