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# Engineering Capability in Rwanda

## Final Project Report

**27 March 2009**

SISTech

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## Glossary

DfID - UK Department for International Development

EAC - East African Community

EDPRS - Economic Development and Poverty Reduction Strategy

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ELECTROGAZ Rwanda Utility for Production, Transmission, and Distribution of Electricity and Water

ETO – technical school (*École Technique Officielle*)

HIDA - Human Resource Development Agency

ICE – Institution of Civil Engineers (UK)

IER – Institute of Engineers Rwanda

KIST – Kigali Institute of Science and Technology

MIFOTRA - Ministry for Public Service and Labour

MININFRA - Ministry of Infrastructure

NUR – National University of Rwanda

RECO - Rwanda Electricity Corporation

RPSF - Rwanda Private Sector Federation

RWASCO - Rwanda Water and Sewage Corporation

SAICE - South African Institution of Civil Engineering

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*"The ability of a country to follow sustainable development paths is determined to a large extent by the capacity of its people and its institutions…"* – UN Agenda 21

# 1 ENGINEERING AND DEVELOPMENT

External evidence for the need of development of engineering capacity at all levels in Africa is widely shared. For example Professor Calestous Juma FRS (UN Millennium Project Task Force Advisor and also Professor of the Practice of International Development, Kennedy School of Government, Harvard University) recently stated:

"At least three key factors contributed to the rapid economic transformation of emerging economies. First, these countries invested heavily in basic infrastructure. Second, they nurtured the development of small and medium-sized enterprises and with it the development of operational, repair and maintenance expertise, and a pool of local technicians. Third, governments supported, funded and nurtured higher education institutions, as well as academies of engineering and technological sciences."

He was supported in this view by Sir David King FRS (a previous UK Government Chief Scientific Advisor), who stated:

"The key to sustainable development in Africa – that is, development that does not rely indefinitely on foreign aid – is the creation of infrastructure. Part of this is a purely physical matter: a question of civil engineering. The business and finance communities in African nations identify the lack of good roads, railways, air and water transport facilities, energy and water supplies, and telecommunications networks as one of the main obstacles to economic growth."

The obstacles to this are a combination of a lack of investment and the shortage of local engineering and technical capacity.

# 2 INTRODUCTION

In April 2008 Linda Bihire, the Minister of Infrastructure of the Republic of Rwanda, contacted the UK Institution of Civil Engineers (ICE) asking for guidance and help in developing local engineering capacity by establishing a professional body of engineers in Rwanda. Rwanda did not have any such organisation at that time and Ms Bihire as a UK-educated civil engineer was keen to engage with the ICE to promote the engineering profession in Rwanda. Dawie Botha, the Executive Director of the South African Institution of Civil Engineering (SAICE), has also stated his interest in working alongside ICE in supporting this aim.

The ICE was willing to assist, as it has an aim of advancing engineering within Africa and had been involved in related work. A number of years ago, the ICE had been contacted by the Department for International Development (DfID) to assist the development of professional Engineering Institutions in a number of developing countries referred to as the Strengthening Professional Engineering Associations Project (SPEAP). That project revealed a close relationship between the lack of engineering competence and poverty and identified a clear need to upgrade engineering skills.

Additionally, in collaboration with the Royal Academy of Engineering (RAEng) and the African Engineers Forum, the ICE is a lead partner in The African-UK Engineering For Development Partnership which aims to strengthen the networks of engineers across Africa, build the capacity of African engineering profession and promote mutually beneficial links between engineers in the UK and Africa.

To support Ms Bihire's request, SISTech was granted funding in December 2008 for the project 'Engineering Capability in Africa' by the UKNC UNESCO Scotland Committee. SISTech has close links to the ICE through Prof. Paul Jowitt, who is Executive Director of SISTech and President-elect of the ICE.

The objective of the project was to establish the skills, professional capacity and current gaps in the areas of construction, civil engineering and infrastructure – in terms of

numbers, needs and institutional capacity in Rwanda. As such, it will provide important baseline information for the ICE in their support of the new professional body of engineers in Rwanda, as well as helping to underpin other engineering capacity building work in Rwanda.

The project methodology is based on the approach of the 'Numbers and Needs' research undertaken by SAICE and led by Allyson Lawless, then SAICE President. The 'Numbers and Needs' report (Lawless 2005) analysed the state of the civil engineering profession in South Africa, examining the supply of and demand for engineers; and the status of education and professional development. The report makes a set of recommendations for a variety of stakeholders, many of which have since been addressed. The SISTech project 'Engineering Capability in Africa' was designed to address the same issues with respect to Rwanda and/or Malawi; it was subsequently decided to focus solely on Rwanda, because of Ms Bihire's request and the wealth of local contacts available. This decision was made in agreement with the UNESCO Scotland Committee.

The project took place between December 2008 and March 2009. Key to the project was the establishment of a network of in-country contacts, consisting of stakeholders in education, government, civil society and the private sector. Many of these contacts were interviewed in-person during a visit to Rwanda by a SISTech project researcher, using semi-structured interview techniques. This report is based upon information gathered during these interviews; a SISTech survey of Rwandan higher education establishments; and desk-based research. Data sets were also provided by local professional organisations and government departments. Brief biographies of the members of the project team are given in Appendix A below.

The remainder of this report sets out the analysis of engineering capability in Rwanda. It first assesses the demand for engineers, by considering the contribution of engineering to the country's development goals and plans for projects to meet them; then describes the current available supply of engineers, based on the capacity and capability of the education sector and the labour market. A gap analysis approach is then used to identify the disparities between the demand and the supply, in terms of numbers and needs; and a number of recommendations are made for policies or projects that could address these needs.

# 3 CONTEXT: RWANDA

Rwanda is a small, densely populated country with a population of around 10 million people. Rwanda has few natural resources and very little industry; around 90% of the population are engaged in (mainly subsistence) agriculture and the primary exports are coffee and tea. There is limited land to support the growing population and the land is not suitable for large scale agriculture.

GDP per capita is $420 (IMF 2008), which may be compared to that of the UK ($45,681) and to the average for sub-Saharan Africa of $1,984. Income inequality is high – Rwanda has a Gini index[1] of 47 (UNDP 2008) – and there is significant urban/rural inequality. More than one-third of the population is in extreme poverty (defined as being unable to obtain minimum food requirements), and over half are in poverty i.e. unable to provide for basic non-food requirements.

The country is landlocked and has a historical lack of transport infrastructure. High transport costs add to the costs of exports, making Rwandan goods less competitive, and also make imports more expensive – for example petrol in Rwanda is very expensive.

Another key challenge is lack of electricity. Only around 6% of households are connected to the grid, and these are mainly in urban centres. For those who are connected, electricity is expensive and the supply is unreliable. The great majority of Rwandans (even the urban

[1] The Gini index is a measure of income inequality, with values from 0 (perfectly equal) to 100 (perfectly unequal). Rwanda's score of 47 may be compared to values for the UK of 36, the US of 41 and Tanzania of 35. Japan, Sweden and Denmark have the lowest values, each with 25; Brazil and South Africa have among the highest at almost 60. (UNDP 2008).

middle classes) use wood or charcoal for cooking and heating, which has led to deforestation and associated environmental problems.

However, the country is economically and politically stable and has ambitious plans for the future – see section 4.2 below.

# 4 DEMAND - NATIONAL DEVELOPMENT GOALS

The demand for civil engineering professionals (civil engineers and technicians) in any country is driven by the work available to them. The work opportunities are determined by the quantity, range and scale of engineering projects, construction and infrastructure development included in national development plans, or initiated by the private sector.

This section assesses the demand for engineers by considering the contribution of engineering to the Rwanda's development goals and to the plans for projects to meet those goals.

## 4.1 The Millennium Development Goals

The international context for development is set by the Millennium Development Goals (MDG), which derive from the Millennium Declaration adopted by 189 nations during the UN Millennium Summit in September 2000. The goals set out targets to address world's main development challenges, i.e.

1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Promote gender equality and empower women
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/AIDS, malaria and other diseases
7. Ensure environmental sustainability
8. Develop a Global Partnership for Development

The eight goals - to be achieved by 2015 – are broken down into quantifiable targets that are measured by 60 indicators (UN 2008). Table 1 lists a selection of the targets and indicators.

Some of these goals are directly dependent upon engineering solutions. For example, one target is to reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation; clearly this is a matter of infrastructure. Many of the other goals and targets are indirectly dependent upon engineering – the extension of education and health services will require construction of schools and clinics; these will require provision of electricity and water as well as roads for access. And the goals for poverty reduction are dependent upon economic development which (as the quotations in section 1 above underline) is in turn dependent upon physical infrastructure.

## 4.2 Rwanda's Development Goals

### 4.2.1 Rwanda Vision 2020

In the late 1990s the Rwandan government set out its ambitions for the future of the country, in the 'Vision 2020' plan. The plan seeks to transform Rwanda into a middle-income country by the year 2020, by way of the development of education and basic infrastructure, including urban planning, and to develop Rwanda into a knowledge- and services-based economy. It includes specific development goals and targets, many of which explicitly involve engineering – for example, there are targets for the extension of access to electricity, and for the expansion of the country's road network. And (as mentioned above) the majority of the goals implicitly depend upon the development of infrastructure.

The goals of Vision 2020 have since been incorporated into the Economic Development and Poverty Reduction Strategy (EDPRS).

### 4.2.2 The Economic Development and Poverty Reduction Strategy

Rwanda's medium-term development aims for the period 2008-2012 are set out in the Economic Development and Poverty Reduction Strategy (EDPRS). The EDPRS is a step towards Rwanda achieving its longer term development aspirations as documented in Rwanda Vision 2020 and the 2015 Millennium Development Goals.

The EDPRS contains interim targets for the indicators set out in the MDGs and Vision 2020. A selection of these targets is set out in table 1 below. These are clearly very ambitious, although some real progress has been made since 2000 – for example access to electricity has been increased from 2% of the population in 2000 to 4% in 2006-7 and 6% today. But there has been little progress on the key MDG poverty goal to halve the proportion of people whose income is less than $1 a day. For Rwanda, this means reducing the proportion from 60% in 1990 to 30% in 2015. The 2007 figure is 57%, showing that little progress has been made.

For infrastructure, the key objectives set out in the EDPRS are to reduce transport costs both within the country and between Rwanda and the rest of the world, and to ensure security of energy supplies by increasing domestic energy production from a variety of sources.

In higher education, the objectives include an increase in the number of Master's programmes in science, with an increase from 80 student places per year to 200 by 2012.

| Selected Indicators (Vision 2020 and MDG) | Baseline 2000 | Value 2006/7 | Vision 2020 - Target 2010 | Vision 2020 - Target 2020 | Progress to Vision 2020 Targets | MDG - Target 2015 | MDG - Benchmark 2012 | Progress to MDG Target |
|---|---|---|---|---|---|---|---|---|
| **MDG 1: Eradicate extreme poverty and hunger** | | | | | | | | |
| Poverty (% below national poverty line) | 60.4 | 56.9 | 40 | 30 | | 30.2 | 34.7 | |
| Road network (km/km$^2$) | 0.54 | | 0.56 | 0.6 | | | | |
| Access to electric energy (% of population) | 2 | 4.3 | 25 | 35 | | | | |
| Annual electricity consumption (Kwh/inhabitants) | 30 | | 60 | 100 | | | | |
| **MDG 2: Achieve universal primary education** | | | | | | | | |
| Primary school net enrolment (%) | 72 | 90 | 100 | 100 | | 100 | 94 | |
| Primary school completion rate (%) | 22 | 52 | 100 | 100 | | 100 | 74 | |
| **MDG7 Ensure environmental sustainability** | | | | | | | | |
| Access to safe/clear water (%) | 64 | 64 | 80 | 100 | | 82 | | |
| Wood energy in energy consumption (%) | 94 | | 50 | 50 | | | | |
| Urban population (% of total population) | 10 | 17 | 20 | 30 | | | | |

Table 1: Selected goals for development (Vision 2020 and MDG).

MDG benchmark 2012 figures record progress required to be on-track to realise 2015 MDG targets.
Progress towards targets is either on track (green), off track (red) or too early to tell (yellow).

## 4.3 Infrastructure Development Plans

Several major energy projects are planned in Rwanda. Some of these are described in table 2, which also lists major transport developments. The plans are ambitious: the Lake Kivu gas concession alone will more than double the amount of electricity currently generated in the country, and could enable Rwanda to sell electricity to neighbouring countries as well as making possible the extension of electric supply to many more Rwandan homes.

There is currently no railway in Rwanda but there are plans to extend the Tanzanian railway from Isaka to Kigali, which would allow Rwandan passengers and goods more direct access to the port of Dar Es Salaam. The railway and a proposed new international airport would serve a 'free trade' export processing zone.

A number of smaller-scale energy and road projects are also underway or planned. All of these will contribute to Rwanda's development and economic growth by providing much-needed infrastructure, but it should be noted that all of the major engineering projects are being carried out by foreign firms. This is due to a lack of local capacity: firms capable of undertaking such projects simply do not exist in Rwanda.

One of the targets in the Vision 2020 goals is for the proportion of Rwandan people living in urban areas to increase from 17% in 2006-7 to 30% by 2020. This is based on the idea that planned urbanisation can reduce poverty. The recently launched Kigali Master Plan (Kigali City Council, 2009) details the plans for Kigali, including infrastructure such as roads, drainage, and street lighting. The masterplan includes plans for the building of new housing - with utility connections – and the demolition of current informal housing.

| Selected major infrastructure projects | Project Description | Status | Funder | Contractor (where known) |
|---|---|---|---|---|
| **Energy projects** | | | | |
| Lake Kivu gas power | A $325 million scheme to extract dissolved natural methane gas from the lake and use it to generate 100 MW of electricity. The project will be constructed in two phases with the first phase of 25 MW becoming operational in 2010 and the second phase of 75 MW going into operation in 2012. | Agreement recently signed. | Public Private Partnership (PPP). | ContourGlobal, a US firm. |
| Rusumo Falls hydroelectric | Possible 62 MW of electricity shared between Rwanda, Tanzania and Burundi. | Seeking finance to carry out feasibility study. | | |
| Rusizi III hydroelectric | Possible 145 MW, shared between Burundi, Rwanda and Democratic Republic of the Congo. | At feasibility study stage. | Sponsored by the EU. | |
| Nyabarongo hydroelectric | 28 MW, costing $100 million. | Under construction. | Government of India / Export-Import Bank of India. | Bharat Heavy Electricals Ltd and Angelique International Ltd (both India). |
| **Transport Projects** | | | | |
| 60km highway | Cost is around $70 million. | | African Development Bank; donors. | Strabag (Austria). |
| East African Community (EAC) railway - Isaka to Kigali | Extension of the Tanzanian railway from Isaka to Kigali (and also to Musongati, Burundi). Cost is estimated at around $4 billion, including upgrading the connecting Tanzanian lines. | Feasibility study completed. | The project is likely to be funded by a PPP, but funding has not yet been secured. | A German firm, DB International, has done a feasibility study for the project. |
| New international airport | A new airport development at the outskirts of Kigali. | At design stage. | PPP – yet to be secured. | A British engineering company, TPS Consult, is working on a detailed design. |

Table 2: A selection of major infrastructure projects currently in planning or under construction in Rwanda.

# 5 SUPPLY – ENGINEERING CAPACITY AND CAPABILITY

This section describes the current available supply of engineers, based on the capacity and capability of the education sector and the labour market. Current capacity building initiatives, including the new Institute of Engineers Rwanda, are also described.

In February 2009 the HIDA, the Rwanda Human Resource Development Agency (a government agency under the Ministry for Public Service and Labour, MIFOTRA) published a draft National Skills Audit report (HIDA 2009). The Skills Audit used surveys of employers to obtain information about employee characteristics, staff turnover, vacancies and projected staff requirements for the short and medium terms. This report makes use of some key finding of the Skills Audit; the interested reader can find much more information in the HIDA report. A 'skills gap' is defined as the difference between the available personnel and the requirement in the sector, as a percentage of the requirement.

## 5.1 School Education

School education in Rwanda is (since 2008) compulsory and free of charge for the first nine years – six years of primary school (P1 to P6) and the first three years of secondary (S1 to S3). Students who pass their S3 exams may stay on for three more years (S4 to S6) to study for 'A' levels[1]. The 'A' level exams result in an overall numerical score, which determines whether the student is eligible for entry to university.

Primary enrolment rates are high, and Rwanda is on track to meet its goal of universal primary enrolment. Secondary school enrolment lags behind, and is currently around 17% (DfID 2008). There is approximate gender parity in primary and secondary education.

The recent change from six to nine years of compulsory education, along with the concurrent change from French to English as a teaching language, has intensified the lack of teachers. The HIDA skills audit found a 17% shortage of secondary school science teachers, that 38% of secondary teachers are not themselves educated beyond secondary level, and that only 42% hold a degree.

The quality of science and mathematics teaching in secondary schools is (anecdotally) described as variable, but there are initiatives to improve it. The National Education Board is responsible for the national curriculum.

## 5.2 Technical and Vocational Training

Alongside academic secondary education, there is also a technical and vocational stream, into which pupils may go after year S3. This is delivered by ETO (*école technique officielle*) schools, which train students for careers in the trades or crafts, e.g. as plumbers, electricians or construction workers. Recently, two of the ETO schools have started to offer diploma and advanced diploma courses, similar to the UK HNC and HND qualifications. The President's Office of Science and Technology is developing the curricula for these courses.

## 5.3 Higher Education

The 2003 census showed that there are only 0.5% of graduates in the population, compared to the African average of 4%. However, the gross enrolment rate at tertiary level is 3.2%, which is regionally comparable. The number of students in the eighteen Rwandan higher learning institutions, six of which are publicly funded, increased from 10,000 in 2002 to 27,787 in 2005.

Two of these universities produce civil engineering graduates. The Kigali Institute of Science and Technology (KIST) offers BSc degrees in Civil Engineering and in Water & Environmental Engineering. The National University of Rwanda (NUR) in Butare offers a BSc degree in Civil Engineering. In each university, the courses are 4 years in length. The NUR also offers a Masters level degree in Water Resources and Environmental Management. Both universities' courses are fully- or over-subscribed, with demand from qualified

[1] Rwandan 'A' levels are roughly equivalent to UK 'A' levels.

applicants exceeding the places available. Each of the civil engineering courses produces around 50 graduates per year. It is interesting to note that few of these graduates are women.

Both KIST and the NUR report staff vacancies and a shortage of qualified teaching staff. They experience serious problems in recruiting staff, partly because the number of qualified graduates in the country is so low but also because of relatively low university staff salaries – it is common for engineering lecturers to leave for better-paid jobs in the civil service. The HIDA Skills Audit found that there is a serious lack of science (including engineering) lecturers, with 44% of the required staff posts vacant. This lack of teaching capacity is one reason for the lack of Masters level degree programmes.

The level of qualification of the science teaching staff is also less than optimal. Only 24% of science lecturers have a PhD and 45% have a Masters degree. Of the rest of the staff, those who have only a first degree are 25% and the other 5% have other (lesser) qualifications.

### 5.3.1 Student Industrial Placements

Both undergraduate Civil Engineering courses require the student to undertake short periods of industrial training. NUR students undertake two periods of three or four weeks of such training, with an extended visit to an employment site; KIST students undertake a six week industrial attachment each year. These placements, according to senior academic staff, often suffer from a lack of supervision – the companies or government departments to which the students are placed do not have the capacity to spend enough time with the students, or they do not have the skills required to supervise them.

SISTech received detailed feedback from one public sector student placement, regarding a number of NUR students. The students were judged to be technically very competent, but weak on report writing and data analysis skills.

### 5.3.2 Future Masters Programmes

If Rwanda is to develop its potential for mining and for the exploitation of geothermal energy, it will need geo-science graduates. KIST may introduce geology and geo-engineering courses in the future.

There are plans for Master's programs in transport engineering and transport economics at KIST to start in 2009. This is being driven by the Ministry of Infrastructure and would be funded by the World Bank, but the funding is not yet certain. The course would produce around 25 graduates each year, and it could be possible for working engineers to attend individual MSc modules as in-service training courses.

## 5.4 Labour Market

The HIDA Skills Audit survey of the public sector received a high response rate and gives comprehensive coverage of the sector. The private sector response rate was less good, and in some areas – including engineering and construction – did not receive enough returns to be fully useful. This is due to a combination of a lack of firms available to be surveyed, and a lack of responses from those which were.

Over the whole economy, the public sector skills gap was found to be 31%, and the private sector gap to be 62%. Figures are also given for the building and construction and the engineering sectors; the engineering sector is not broken down further into engineering discipline or speciality.

Nationally, these skills gaps were found to be

| National skill gap (gap in category, %) | | | | | |
|---|---|---|---|---|---|
| | Managers | Professionals | Technicians | Artisans | Overall |
| Building and Construction | - | 100 | 90.6 | 44.8 | 46.3 |

| | | | | | |
|---|---|---|---|---|---|
| Engineering | 44.4 | 72.1 | 30.1 | 49.1 | 50 |

The building and construction sector has no managers or professionals - 100% gap was reported - whilst the gap for technicians (i.e. foremen and engineering assistants) was reported at 91%. The report states that 'there were no building and construction professionals reported among the survey's respondents', which seems surprising. It may be that professionals employed in the public sector to commission and supervise construction works tend to categorise themselves as working in (civil) engineering rather than in construction.

In the public sector, the skills gaps are

| Public sector skill gap (gap in category, %) | | | | | |
|---|---|---|---|---|---|
| | Managers | Professionals | Technicians | Artisans | Overall |
| Building and construction | - | 100 | 90.6 | 42.8 | 47.9 |
| Engineering | 57.1 | 70.3 | 31.4 | 3 | 36.1 |

In the private sector, the reported skills gaps are given in the following table. The missing data for the skills gaps in the building and construction sector means that insufficient data was available to estimate the gaps, as discussed above.

| Private sector skill gap (gap in category, %) | | | | | |
|---|---|---|---|---|---|
| | Managers | Professionals | Technicians | Artisans | Overall |
| Building and construction | - | - | - | 45.5 | 45.5 |
| Engineering | 36.4 | 72.9 | 30.1 | 51.7 | 51.4 |

The conclusions of the skills audit are stark – there are huge skills gaps across all sectors. In the engineering and construction sectors, the skills shortages signify a serious risk that the goals for infrastructure and managed urbanisation will not be met, or that Rwanda will have to continue importing expensive skilled labour for infrastructure development. The lack of private sector responses in the construction sector underlines the lack of firms available.

## 5.5 Capacity Building Initiatives

There are many current and recent policy initiatives and plans for capacity building in Rwanda.

The National Science, Technology and Innovation (STI) Policy provides a framework for the integration of science and technology into all sectors of the economy and identifies the need to build STI capacity to meet economic and social development goals. DfID in involved in the implementation of the Science, Technology and Innovation for Results (STIR) project which aims to provide the legal, regulatory and institutional frameworks required to implement the policy.

In 2007 the Government of Rwanda and the World Bank carried out a series of needs assessments and actions plans for capacity-building and knowledge transfer in key areas, including appropriate technology, geothermal energy, and the delivery of clean drinking water to rural areas. These reports are included in the book 'Building Science, Technology, and Innovation Capacity in Rwanda' edited by Watkins and Verma (World Bank 2008).

HIDA has a mandate to 'guide, facilitate and coordinate' the implementation of capacity building interventions in the public sector, private sector and civil society organisations, and was created in response to the government's Multi-Sector Capacity Building Program (MSCBP). In order to address urgent short to medium term skills gaps, the agency plans to

set up a professional skills development fund, which will allow 'high flier' young and mid-career public sector staff to obtain training at home or abroad.

Public sector employers such as the Ministry of Infrastructure do currently send staff abroad for training such as Master's degrees, but there is not always enough sufficient money available to do this.

At the tradesman / artisan level, one pilot initiative currently in operation has placed a number of inexperienced ETO graduates into public or private sector jobs for a year, half funded by the government. The employer has no obligations to the ETO graduate after the year, but it is hoped that they will be kept on, or that the experience will help them to find other work. This initiative is being under the responsibility of the new Workforce Development Agency.

In higher education, many UK and other universities work with Rwandan institutions, exchanging students, staff and expertise. One such initiative is the Scotland-Rwanda Universities Steering Committee which oversees links between the higher education sectors in the two countries and has facilitated visits by Scottish academics to Rwanda and Rwandan academics to Scotland.

### 5.5.1 The Institute of Engineers Rwanda

The Institute of Engineers Rwanda (IER) was formally constituted in December 2008. The nascent institute is being funded by the Ministry of Infrastructure for the first 12 months, but it is intended to become self-financing and independent within one year.

The IER has had around 200 membership applications so far, and expects around 1000 eventually across all levels of membership. An initial meeting last year was attended by around 100 engineers, who were recruited by press and radio adverts.

The strengthening of 'civil society' is a common goal in development initiatives, due to its association with democracy, and indeed the strength of civil society is used by the UNDP as one measure of political freedom. The creation of the IER is a good example of this kind of development, in addition to its goals for developing engineering capacity.

The government of Rwanda also intends to create an Engineers Registration Board – a compulsory register of all engineers (and probably technicians) of all disciplines. This will require new legislation but should be in operation later this year (2009). The Registration Board is distinct from the IER and will serve a different purpose; it is intended to give some guarantee of minimum standards and accountability, especially in the construction sector.

# 6 GAP ANALYSIS

The previous two sections have set out the demand for engineering skills in Rwanda, in terms of development goals and plans; and the current available supply, based on the capacity and capability of the education sector and the labour market.

This section discusses the disparities between the demand and the supply, in terms of numbers and needs. A number of recommendations are then made for policies or projects that could address these needs.

## 6.1 Quantitative Gaps

The HIDA Skills Audit shows that Rwanda suffers severe shortages of skilled personnel in most sectors. In engineering and construction, current capacity is at only around half of that required by the employers who were surveyed. The lack of data for private sector engineering and construction firms simply emphasises the shortage of these firms.

The Rwandan Private Sector Federation recently carried out a Business Census which may give more detail regarding the numbers of engineering firms in existence. Unfortunately SISTech have so far been unable to obtain a copy of the Census. However, evidence from public sector makes it clear that contractors for major projects are all international firms. Local companies and staff are recruited, but mainly for maintenance work (e.g. road maintenance contracts) or for the simple components of projects – in effect, the manual

work. This is due in the main to a lack of capacity, both in terms of personnel and of engineering firms with the required skills and experiences.

## 6.2 Qualitative Gaps

From discussions with university staff and (mainly public sector) employers of engineers in Rwanda, SISTech found some recurrent comments on the capabilities of engineers in Rwanda.

KIST and NUR graduates have strong technical skills, but lack knowledge of project management, economics and planning. Work placement students were found to be weak on report writing and data analysis skills. This is not helped by the poor quality of many of the placements, which are in turn caused by employers' lack of experienced staff availability.

In industry and in the public sector, one key problem is the lack of experienced senior engineers. This means that supervision and informal on-the-job training for younger engineers is lacking, and also that graduates often go into senior jobs without the appropriate experience, due to the overall lack of supply. Some professionals, therefore, lack the experience and training necessary for their roles. In particular, the public sector is lacking expertise in monitoring and evaluation of contracted work and in supervising projects. Another key problem is the lack of structured in-service training available.

# 7 RECOMMENDATIONS

As a result of this analysis, the SISTech team has made some recommendations for actions that could be implemented immediately and at low cost, that could complement the existing capacity building initiatives described in section 5.5 above and help address the qualitative skills gaps. Many of these suggestions were made by interviewees during the project research in Rwanda.

Public sector procurement has an important role to play. The training of local workers could be made a contractual requirement for major contracts; and increasing the input of local labour, goods and services should be a priority. These issues are explored in detail in a recent briefing note published by the ICE and Engineers Against Poverty and entitled 'Increasing local content in the procurement of infrastructure projects in low income countries' (Wells and Hawkins 2008).

In higher education, there are two broad areas of opportunity. One is to improve experiential learning, i.e. to get students into better quality work placements. The other is to invite experienced professionals into universities to teach, either as short term visiting lecturers or simply by delivering guest lectures or seminars. Both of these approaches would allow students to learn from practitioners and gain insights into real project experience. Both could also provide a good opportunity for corporate social responsibility for foreign private sector firms working in Rwanda.

A key challenge for the IER will be to improve in-service training for graduates and young professionals. This could take place online at low cost – a knowledge transfer portal could give access to case studies of good practice or to more formal online training. The IER is also likely to coordinate conferences to enable knowledge exchange among professionals.

Academic knowledge exchange between Rwandan universities, as well as regionally and globally, should be encouraged and expanded.

There are millions of Rwandan citizens living abroad, both in the East African region and further afield, who contribute greatly to Rwanda's development. The IER or other agencies could further harness the intellectual diaspora to encourage return, or short-term contribution of skills. The UNDP TOKTEN (Transfer of Knowledge Through Expatriate Nationals) programme arranges short-term volunteer posts for experienced professionals; this programme does exist in Rwanda but it does not currently focus on engineers.

# 8 CONCLUSIONS

It is clear that capacity building is central if the goals outlined in section 4 above are to be met in a sustainable fashion. Without increased numbers of engineers, and improved skill

levels, Rwanda will be unable to meet its development needs without using expensive international personnel. The new IER is an important part of the institutional infrastructure required to help build up the necessary skills. The ICE plans to support the IER where possible and one of the aims of this report is to provide baseline information to facilitate that support, and to provide some ideas for the forms the support could take.

Some of the findings set out in this report were presented to the UNESCO Scotland workshop 'Good Practice in International Development' on the 18th March 2009, and the feedback obtained has been incorporated into the report.

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# Appendix A Project team members

| Team Member |
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| **Paul Jowitt BSc (Eng), PhD, DIC, CEng, CEnv, FICE, FIPENZ, FCGI, FRSA, FRSE** is Professor of Civil Engineering Systems at Heriot-Watt University (Edinburgh, UK) and Executive Director of the Scottish Institute of Sustainable Technology. He is currently Vice President (International Development) of the Institution of Civil Engineers (ICE) and is scheduled to take up the position of President in November 2009. Paul was Chair of the ICE Presidential Commission - "Engineering without Frontiers" - examining the engineer's contribution to meeting the UN Millennium Development Goals. He is the author of the ICE's 6th International Brunel Lecture - "Engineering Civilisation from the Shadows" which addresses the twin issues of Poverty and Climate Change, and is delivered in 16 different countries to date. He was a contributor to the collection of essays published by the Royal Academy of Engineering (RAEng) *Engineering Change – Towards a Sustainable Future in the Developing World.* The authors include Professor Calestous Juma FRS, Sir Gordon Conway FRS (Chief Scientific Advisor, DfID) and Allyson Lawless (former President of SAICE) on Scarce Skills or Skills Gaps. |
| **Dr Malcolm Chrisp** is Director of Teaching and Learning in the School of the Built Environment at Heriot-Watt University. He is also the coordinator of Heriot-Watt Project Student Secondments with Challenges Worldwide to a number of countries in the developing world. He is currently developing educational links and partnerships in Africa. |
| **Marielle Murray** is a Project Manager at SISTech, with over seven years experience of managing a range of projects in the field of sustainable development and community planning. Recently she was Project Manager for the Royal Academy of Engineering 'Transport in the Living City' project. |
| **Dr Suzy Goodsir** is a Senior Project Researcher at SISTech. As part of the research for her MSc in Ecological Economics she undertook a field trip to Tanzania to study aspects of human development and environmental protection in developing countries. Suzy visited Rwanda in February 2009 to meet key figures who can help support the development of engineering in Rwanda. |