Arcelormittal South Africa
Industry perspective on challenges and successes in Industrial Energy Efficiency

15 Oct 2019

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Agenda

1. Steel Industry – quick overview
   - Production and usage
   - Process Routes

2. Why is Energy Efficiency important in the Steel Industry

3. Saldanha Works IEE implementation

4. Challenges in Energy – an Industry Perspective
   a. Differences in challenges between Developing/Emerging and Developed countries
   b. Internal and External Challenges
   c. Industry Solutions
   - Some Examples of Regulatory challenges & Best Practices

5. Successes in Industrial Energy Efficiency @ Vanderbijlpark
   - VDBP Energy strategy improvement components VSD's
   - Total Energy Efficiency Performance
   - Energy Ideas
   - 3rd Party funding
   - Electricity Metering Plan
   - Training : Knowledge and Skills
   - Conclusion

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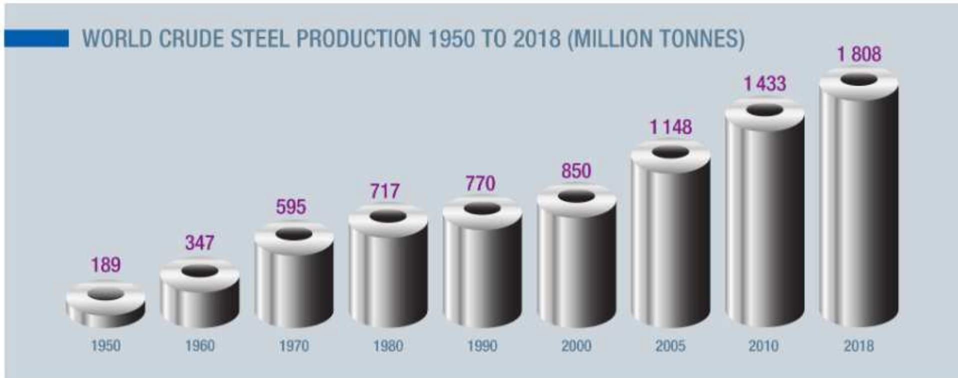
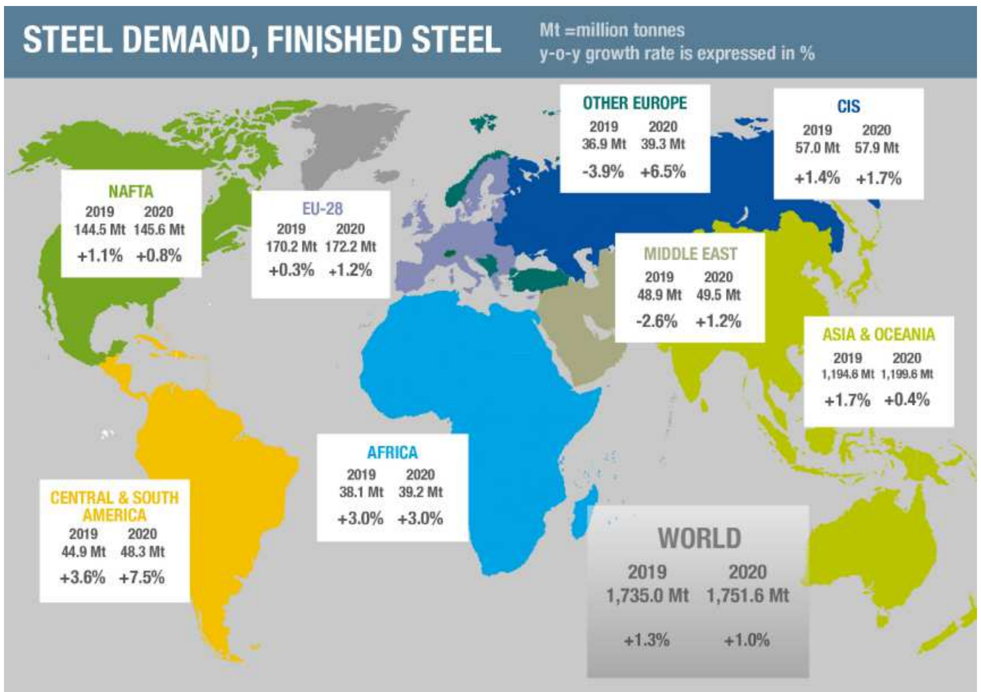
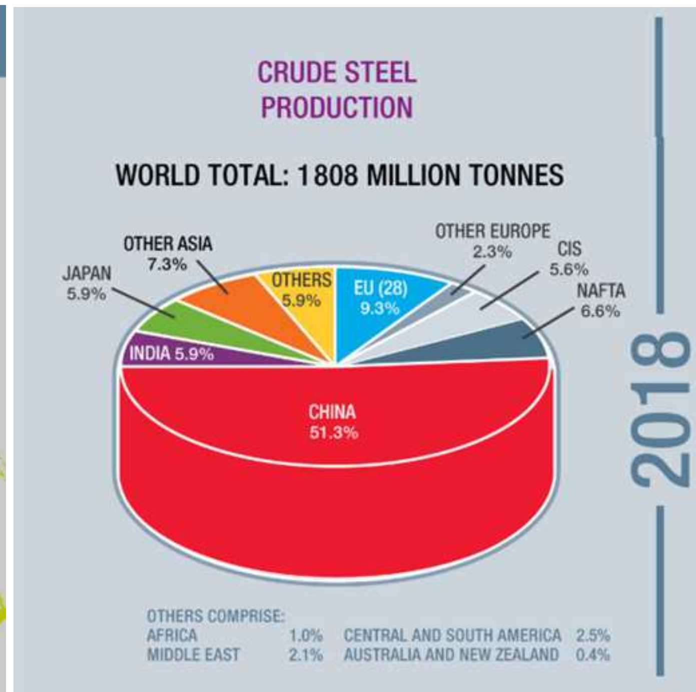
Steel Industry Overview – World Steel Organisation



- Some growth in steel demand expected
- Chinese steel demand remains robust owing to government stimuli
- Steel demand in the developed world reacts to a weaker trade environment
- Developing economies (excluding China) present a positive but mixed picture
- African demand flat with South African demand declining





https://www.worldsteel.org/media-centre/press-releases/2019/worldsteel-short-range-outlook-april-2019.html

https://www.worldsteel.org/media-centre/press-releases/2019/world-steel-in-figures-2019.html

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2. Why is Energy Efficiency Import in the Steel Industry

- **Energy Cost Route Dependent : 25%-40%**
- Energy & Capital Intensive : Require **17% EBIDTA** to be sustainable (McKinsey report & World Steel Association)

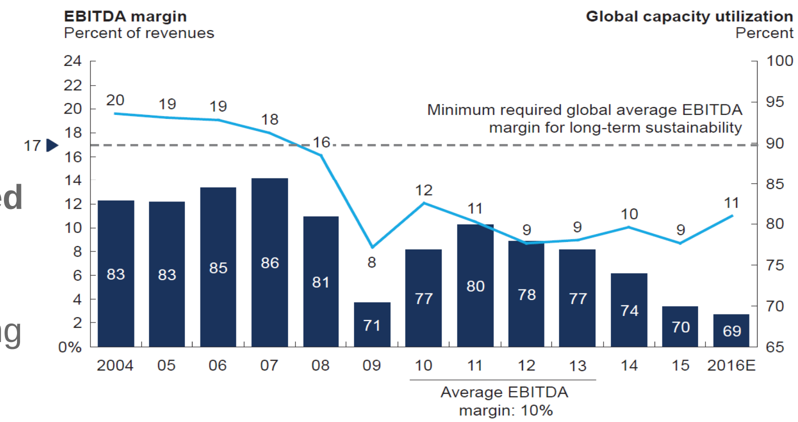
Future improvements & energy efficiency Steel production

- Today's best-available steelmaking **processes have optimised** energy use.
- Medium-term energy efficiency improvements in the steel industry are expected through **technology transfer**, or applying best-available technology to outdated steel plants worldwide.
- **Breakthrough technologies are expected** to lead to major changes in steel manufacturing (2030 and beyond).

Not ALL bad…

- **Steel saves energy over product life cycles**
  - While steel products require energy to be produced, they can
    - offer savings over the life cycle of the product, sometimes greater than the energy used during their production.
    - example, over 20 years, a three-megawatt wind turbine can deliver 80 times more energy than is used in the production and maintenance of the of the material used
- Steel in the **circular economy**
  - Steel can also reduce product life cycle energy use and emissions in other ways, by maximising the value of resources through improved product design, recovery and reuse, remanufacturing and recycling.

With growing overcapacity, average EBITDA has deteriorated to below the level of long-term sustainability



1 Considering sample of 81 companies

SOURCE: World Steel Association (worldsteel); Corporate Performance Analytics, by McKinsey

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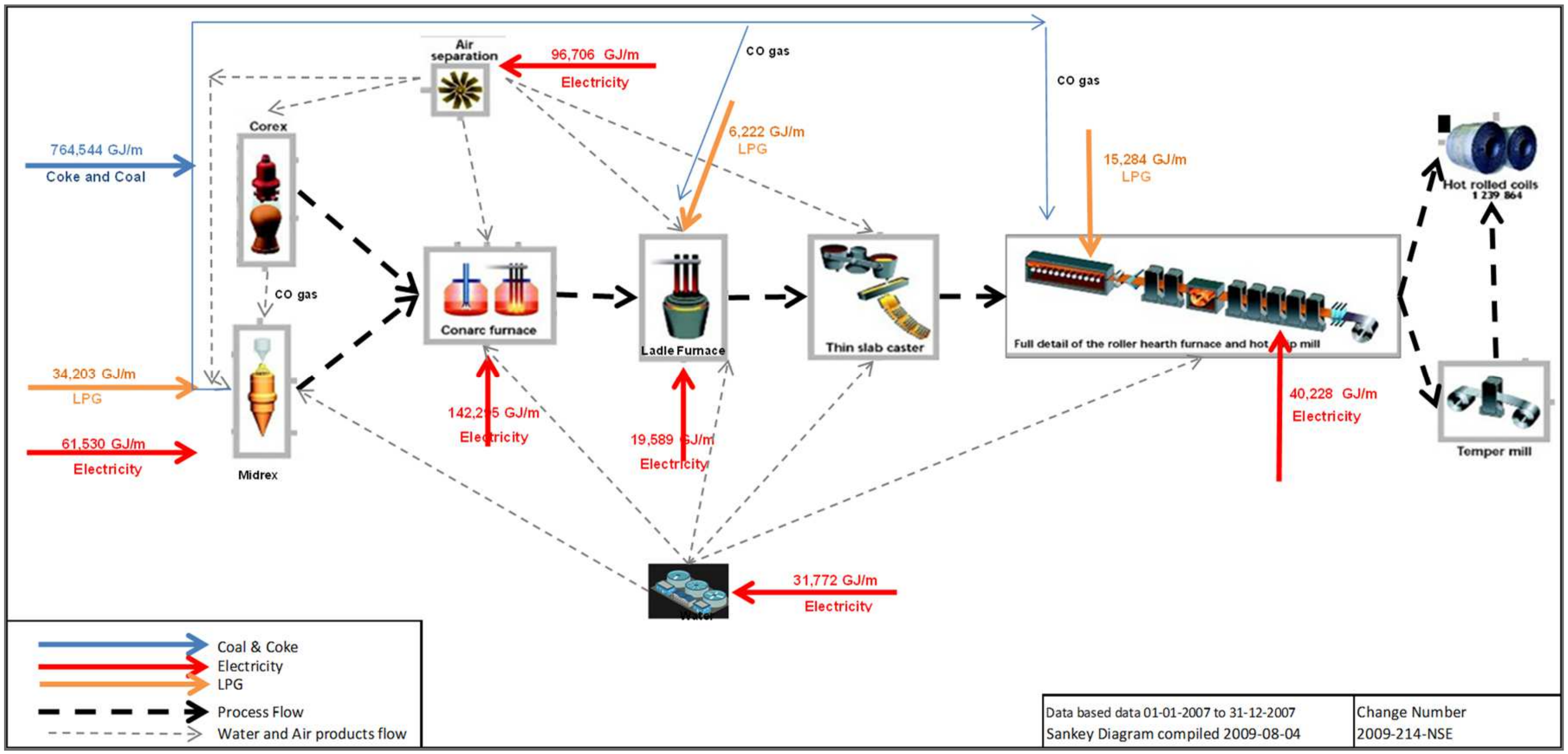
Key Themes – Challenges – an Industry perspective

- **Actual Results :** Arcelormittal Saldanha Works
- **Difference** between challenges for **Developing/Emerging economies** and **Developed** Countries
- **Internal** (Company) and **External** (Policy and Regulatory) Challenges
- **Industry solutions** : creative and can find solutions
  - Funding Solutions
- **Biggest Challenges** (usually related to the “BIG” solutions) in the **Policy and Regulatory Environment**
  - Often uncertain, restrictive, complex and unclear

Statistical information

- Electricity demand : 160 MW (R1.15 billion p.a.)
- Daily water consumption: 8 000 kilo liters (world best for an integrated steel plant)
- Manpower: 548 permanent employees – support 7600 sustainable jobs ("Assessing the Manufacturing Sector and its multiplier effect on the South African Economy ", The Research Division, Pan African Investment & Research Service, 30 November 2011.
- Sales output: 1,1 million ton HRC/annum



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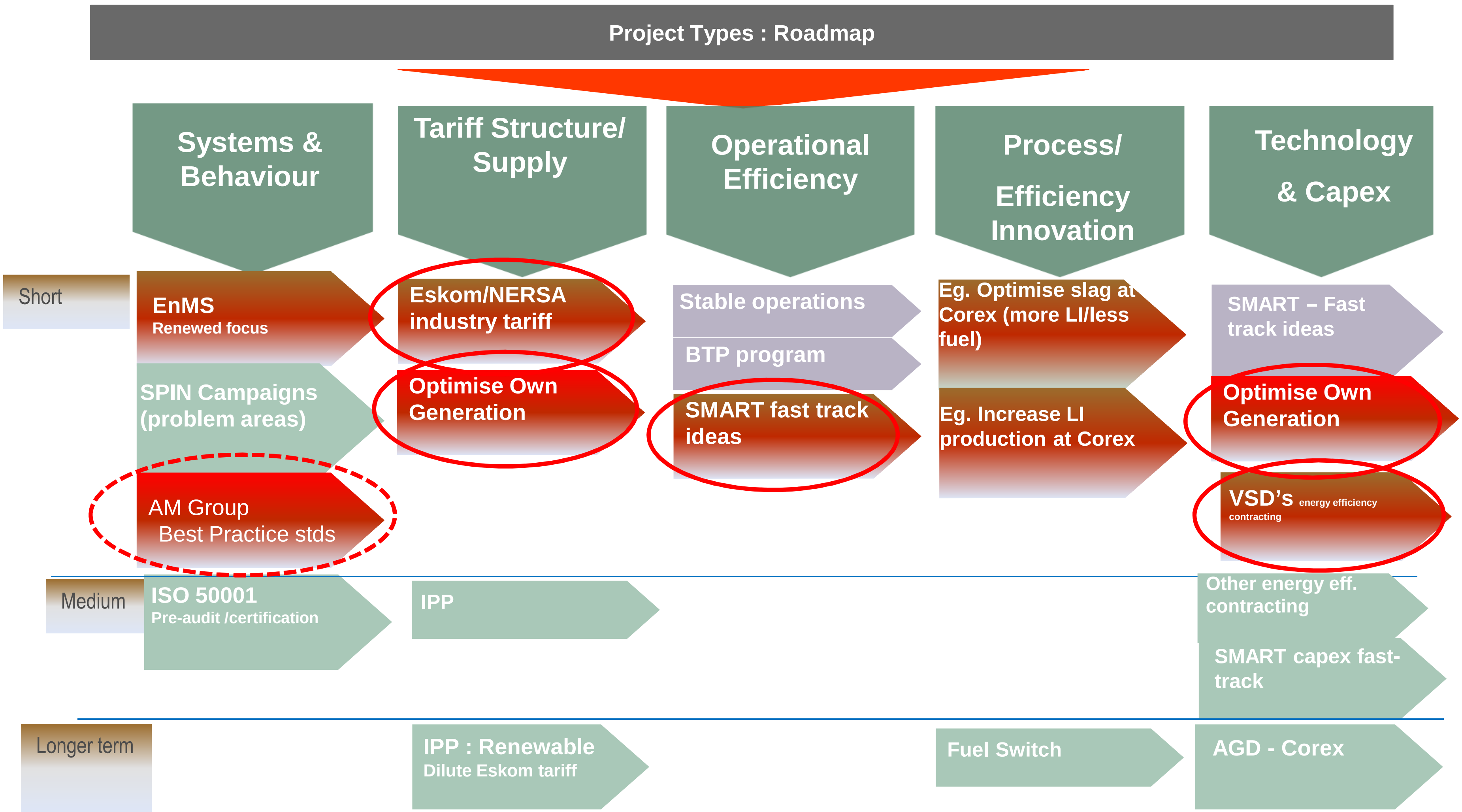
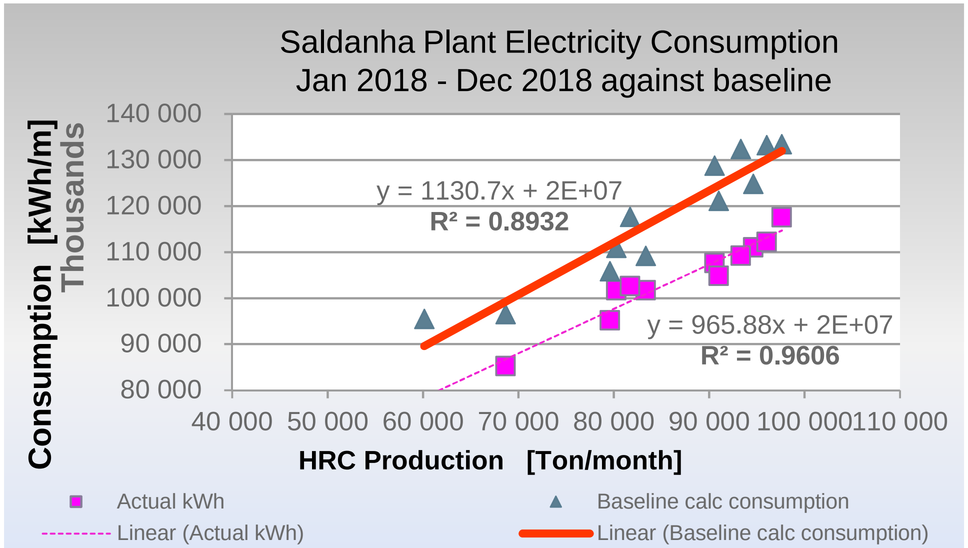
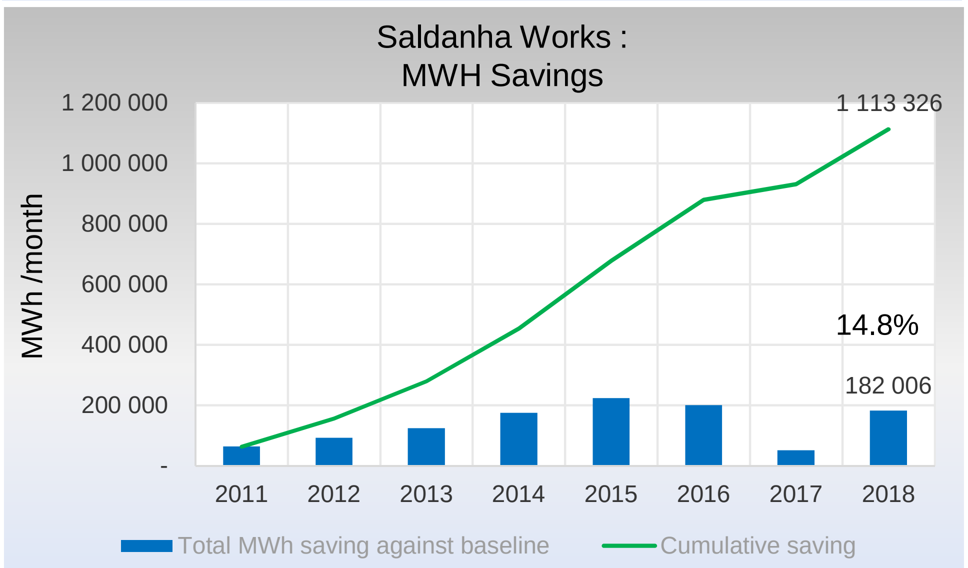
Energy Efficiency Approach



3. Arcelormittal Saldanha Works IEE Results





Results Summary

Energy Saving against Regressions	% Reduction 2010 vs 2018
Total Full production	**15%**
Total (low production scenario)	19%
LPG	54%
Electricity	15%
Coke+coal	15%

How : Key Focus

- Low Capital
- EnMS
- Energy Manager & team
- Awareness & Behavior
- Cross Boundary leakage
- Baseload reduction

Next Inflection point :

- Technology investment
- Continue Process innovation

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4a. Challenges for IEE implementation : Developing/Developed economies

Developing/Emerging Economies

- Policy frameworks new – unintended consequences for new policies/ implementation pains
- **Policy certainty an issue**
- Policy Changes, Government changes
- Basic infrastructure and utility challenges – translating into increased cost
- Skills, transport and logistical challenges
- Lower productivity levels
- Higher inflationary environments
- Availability of capital/ perceived barriers and higher risks for investors

Developed Countries

- Well developed policies optimized over time
- Economies well established
  - high education levels,
  - good infrastructure,
  - optimized and paid off utility and infrastructure networks
  - high productivity
- Low inflationary environment,,
- Availability of capital
- Low perceived risks
- Access to R&D and new technologies

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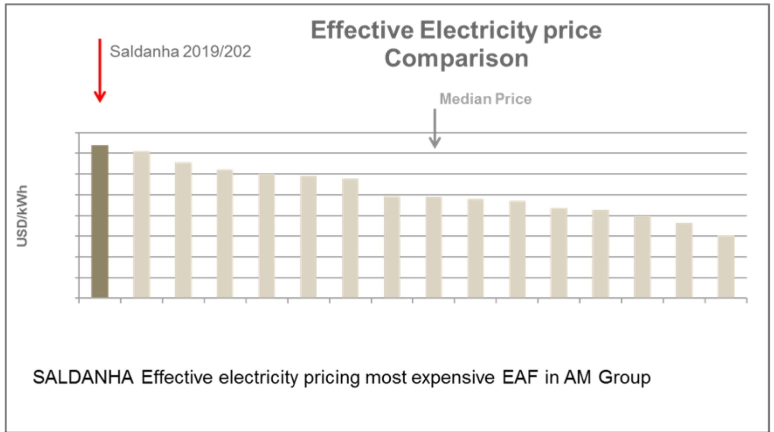
4b. Challenges for IEE implementation for Industry

Economic Challenges : South Africa

- **Expensive Energy**

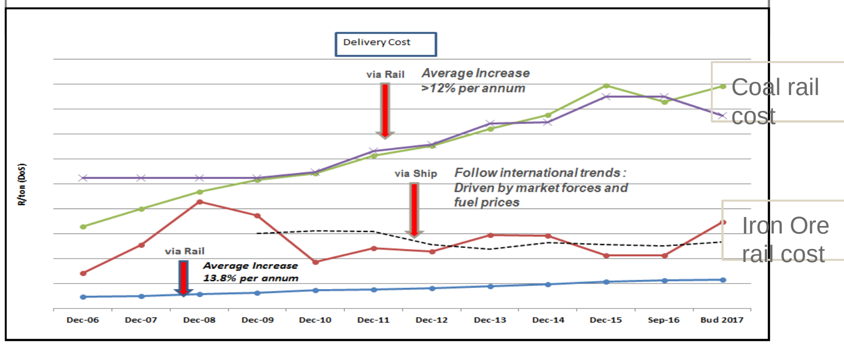


- **Expensive Rail**

  Av. 12% YOY increase = 2x CPI

  – **Extremely challenging for Manufacturing and beneficiation**

  – **Similar challenges in most African countries**



- **Expensive Ports (+88% global average)**

  FYI (Page 10)

  https://www.worldbank.org/en/country/southafrica/publication/south-africa-economic-update-more-innovation-could-improve-productivity-create-jobs-and-reduce-poverty
  http://documents.worldbank.org/curated/en/779551505322376708/South-Africa-economic-update-innovation-for-productivity-and-inclusiveness

  . “Although port costs ***have declined significantly since 2012***, they **remained 88 percent higher than the global average in 2016/17**. Bringing down cargo and inland handling costs, and improving port efficiency, can support innovation. Furthermore, South Africa’s port tariffs continue to favour the transport of minerals over manufactured goods. This increases the cost of technology absorption that occurs via the import of capital goods in the form of advanced technology**. It also makes the country a less competitive destination for export-oriented industries.”

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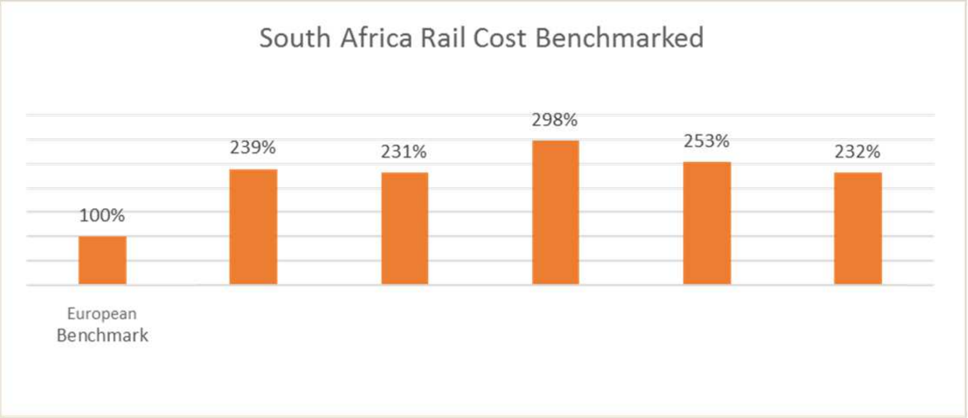
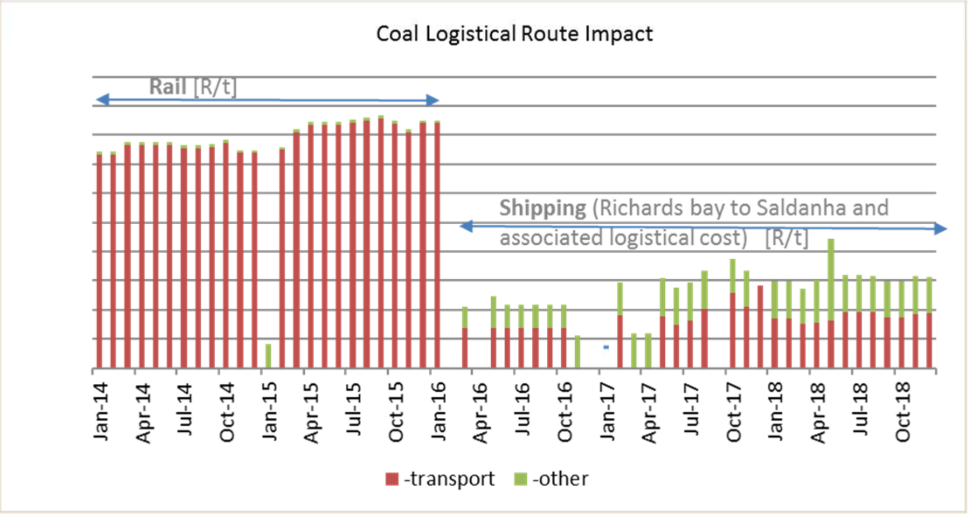
4b. Challenges for IEE implementation for Industry

Benchmark data Logistic routes:

- International benchmarking within the group revealed TFR rates are +/- 250% higher

- Saldanha moved coal supplies from rail to ship with a significant cost saving
  - Considering the additional handling and logistical chain it is surprising and a further illustration of the uncompetitive TFR rail rates.
  - Port cost is 88% higher than the world average according to the World Bank Study. There is thus also uncompetitive rates build into the shipping route, but it is still more cost effective than rail.





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4b. Challenges for IEE implementation for Industry - Internal

Developing Countries – Africa and South Africa

Internal Challenges :

- **People :**
  - Knowledge & Skills: Energy Efficiency knowledge & skills (e.g. UNIDO programs to address)
  - Organisational Structure – Energy manager/level in organization etc.

- **Management System**
  - Energy KPI's, Target and Tracking against
  - Integrated as part of the business strategy

- **Equipment**
  - Age and performance of Equipment
  - Access to new technology

- **Funding/ Capital**
  - Challenging environment (Steel industry: pressure on margins due to structural oversupply since 2009)
  - Very few plants operate average of 17% margin required for sustainable operations and investment
  - Competing for Capital on equal footing
    - Safety, Environmental, Risk, Return and energy projects
  - Long Term Sustainability questions due to structural economic challenges – cannot commit to longer terms contracts
    - Impacts on ability to resolve issues and commit to long term contracts with cost benefits and updated energy efficient technology

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4b. Challenges for IEE implementation for Industry - External

Focus : Developing Countries – Africa and South Africa

External Challenges:

- **Policy Certainty**
  - Better to have a adequate policy than an everchanging policy striving for perfection
    - Policy certainty is a critical aspect for investment – keep in mind that in the energy environment 15-30 year contracting the norm…

- **Clarity for the implementation and administrative processes associated with policies**
  - What is required
  - Where/how and how long to get the approvals/licenses etc – current NERSA < 10MW embedded generation

- **Complexity, overlaps & Timelines**
  - Number of departments/involvement to approve
  - Overlaps in legislation

- **Regulated environment – ensure globally competitive**
  - Can achieve the opposite, result in inefficiency and eliminate potential benefits/solutions
  - Result in structural barriers for sustainability, investment and IEE
    - Eskom/Transnet Rail/ Port Cost

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4c. Challenges for IEE implementation for Industry – Industry Solutions

- A few examples (but not limited to) :

Lack of availability of Capital & Aged Equipment/Assets

- Off-balance Sheet Funding
- Service contracts (VSD's, lighting etc.)
- Off-take agreements
- Private Sector loans (World Bank etc.)

Skills and Resources

- UNIDO IEE Capacity building in Developing Countries
- Consultants to assist with implementation of energy programs

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Example - <1MW & 10MW imbedded Generation in RSA

- Confusion on legal and legislative framework for own power generation or off-take scenarios
- Market not open yet, though there is in principle room for <1MW and <10MW generation
- <1MW – exempted from generation license (register with NERSA –process for registration not defined)
- 1-10MW : need generation license form NERSA & need to show that the installation comply with the IRP
  - Current IRP not approved and previous IRP 2010 (outdated)
  - Currently a blanket approval in principle of all installation < 10MW, but still no administrative process at NERSA on how to handle and process applications.
- >10 MW : require full generation license application (test against valid IRP and grid code compliance etc.)

PPA (Power Purchase agreements) - difficult outside the DOE's renewable buy-in tariff process. Obstacles for private projects – ***Its ALL ABOUT RISK*** *(and who carries it)*

- Price & termination clauses an issue
- All licenses difficult to coordinate – round robins for approvals etc.
- Off-taker view :
  - Finding right partner difficult
  - Forecasting and contracting 20 year pricing difficult within corporate structure
  - Complexity and rigid contracting practices requiring off-taker to take on all the risk problematic
- Funders/Bankers view
  - ***More interested in larger scale projects – require same transaction cost and resources as smaller projects***
  - Developed portfolio funding to aggregate size of investment, diversify exposure to any single supply/off-take agreement and cross subsidise projects to spread risks/income
    - Can be mixture of less and more attractive projects – as long as the portfolio makes sense the investor would still consider.

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Example - <1MW & 10MW imbedded Generation in RSA (cont.)

Practical concerns :

- Experienced Contractors with proven track record
- Grid Connection : some in place but not with required approvals
  - even exemption projects need to have grid connection approvals from ESKOM – no process in place to fast track <1MW or <10MW applications,
  - Municipalities can only approve once documentation from NERSA and Eskom has been submitted
  - Municipalities supportive and allow connections – still unlawful and risk to investor/developer; impacts on finance ability of projects.
- Finding a way for municipalities to transition from Eskom On sale model to wheeling income from IPP's within the municipality – deregulation required to enable this.

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Example - LNG Importation and Gas-to-Power

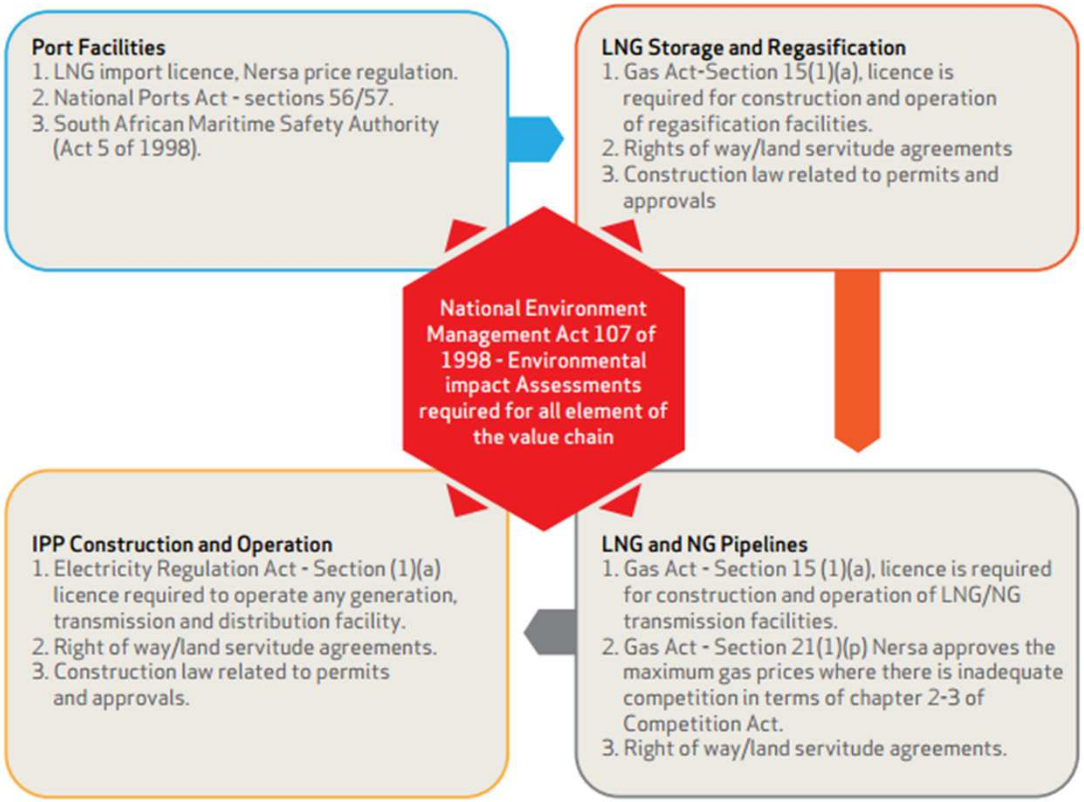

Figure 19: Regulatory Considerations for New Gas to Power Development

1. **NERSA**
2. **Ministerial Departments required to align and approve**
   - DOE (Now mining & Energy)
   - DEA
   - DTI
   - Transport (Port's authority)
   - State Owned Enterprises

     (included in Strategy and Procurement activities)
     - ✓ Transnet
     - ✓ Eskom

- Timelines unclear
- Administrative process Complex
- COSTLY
  - ➢ just land based EIA = R4m
  - ➢ No guarantee on return

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Other Examples – Best Practice

Kafita Co-operative Society
Mpanta Solar Mini Grid, Mpanta's First Light
ZAMBIA

The company
Kafita Co-operative Society is a non-profit organisation located in Mpanta, Samfya District. Formed in the year 2010, it aims to encourage fish farmers to venture in other forms of farming such as aquaculture, poultry farming, vegetable growing and animal husbandry.

The challenge
Mpanta is an isolated area about 45 km away from the main grid. The area has been relying on traditional methods of lighting such as paraffin lamps and candles. Since the site has abundant sunlight throughout the year, solar was the energy source proposed. The estimated demand for the area was billed at 60 kW. To further expand the plant in case there would be a further increase in demand, an extra 40 kW was needed. Power is mainly used for basic home appliances such as lighting, TVs, radios and cell phone charging. The major barriers, which the plant needed to overcome, included having an alternative backup power-source as well as the community's ability to pay.

Opportunities for renewables
Renewable energy is a vital source of energy and a key driver of economic activity meant to improve the standard of living in the area.

Renewable solution
This project brought new life to the area as the standard of living by the people in the area improved. Kafita gained new skills through entrepreneurship training as well as marketing skills. To increase its capacity of 60 kW, it made steps to source for funding to expand the plant through another solar generation plant as well as to purchase a three-phase generator during times of emergency. To reduce the risk of shortfall in payment, it came up with a program called investment subsidies and micro financing in which all the beneficiaries would be included. These steps taken meant that the cooperative would increase the number of its users and therefore breakeven and realise an optimal return on investment.

Project financing and costs
The total project cost was billed at 875,000 €. It was financed through a long-term loan facility by UNIDO. Venture capital was not considered. The pricing model used is a fixed monthly charge based on estimated usage per household. The project is currently not economically viable as it is unable to meet the productive use capability. It is expected to pay off through government funding.

Project outcome
480 household benefited from having regular access to electricity. The community experienced a new renewable energy source that was pollution free. This has led to new plans to develop a renewable energy agricultural farm. This project has been a learning experience as it has enabled the project developer to improve on the type of equipment and business model to use in other projects. The lesson learnt has enabled the project developer to plan for upgraded solar mini grids to be undertaken in other parts of the region with more advanced equipment to sustain demand.

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https://www.africa-eu-partnership.org/sites/default/files/documents/are_best_practices_africa_2014.pdf

Kafita Co-operative Society (Zambia)

- Solar – mini grid (Mpanta)

Challenge

- Isolated area
- Demand 60kW (+ 40kW for future requirements)
- Alternative back-up power source required
- Communities' ability to pay

Opportunity

- Renewable energy – can drive economic activity

Project Financing

- Long term loan from UNIDO
- Pricing model – fixed monthly charge (based on estimated household requirement)
- Currently not viable – not meeting productive use capability

Project Outcome

- 480 households with access to electricity
- New plans for a renewable energy agricultural farm
- Project developer equipped through lessons learned to plan further projects with upgraded mini-grids and technologies to overcome the issues experienced with this project

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Other Examples – Best Practice

Alliance for Rural Electrification
BEST PRACTICES 2014

Case study 16
Smart Hydro Power GmbH
GADA hamlet
NIGERIA

Source: Smart Hydro Power

SMART HYDRO POWER

The company
Smart Hydro Power from Germany develops, fabricates, commercialises and operates pico hydropower plants. Its standard off-grid plant is a 5 kW kinetic system which does not require any other infrastructure than an anchor point. It can be combined with other sources like photovoltaic and installed in a modular way up to 25 kW.

The challenge
Nigeria struggles with severe energy shortages. Many rural areas, and even large cities like Abuja villages and populations are not connected to the grid. Gada is a small hamlet (village) based in the north of Nigeria which is not included in any development plan.

Opportunities for renewables
Gada lies directly at a river with year round water flow. In the dry season, stones form a natural canal with high flow stream.

Renewable solution
Smart Hydro Power Nigeria built a single-phase grid between the seven houses of Gada and a machine house for the inverter and all other electrical equipment. Together with the villagers and the help of the parent company, Smart Hydro Power Nigeria employed the first rural electrification project with kinetic hydropower in Nigeria. One single turbine generates approx. 15 kWh per day to the inverter house and the small village. Villagers participated in the entire installation process and were empowered to run operations.

Project financing and costs
The reference project was financed by Smart Hydro Power Nigeria. The people from Gada consider building up a workshop, which, in future, would contribute to this unique source of power supply.

Project outcome
The small hamlet of Gada with seven huts and approximately 40 members benefits in total from the project. The project is thought to be an example of an inexpensive and mainly standardised way of rural electrification ad has been presented to the Nigerian officials.

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https://www.africa-eu-partnership.org/sites/default/files/documents/are_best_practices_africa_2014.pdf

Gada Hamlet (Nigeria)
- 5kW kinetic unit @ 15kWh/day (modular to 25kW)

Challenge (Nigeria)
- Severe energy shortages
- Many areas/cities not connected to the grid
- Gada – small and rural and not included in any development plans

Opportunity
- Next to river : all-year water flow
- Single phase grid from hydro-power between 7 houses

Project Financing
- Renewable energy – can drive economic activity

Project Financing
Smart Hydro Power Nigeria financed project

Project Outcome
- 40 members benefit with access to electricity
- Example of inexpensive standardized rural electrification.
- New plans for workshop in Gada (economic benefit)

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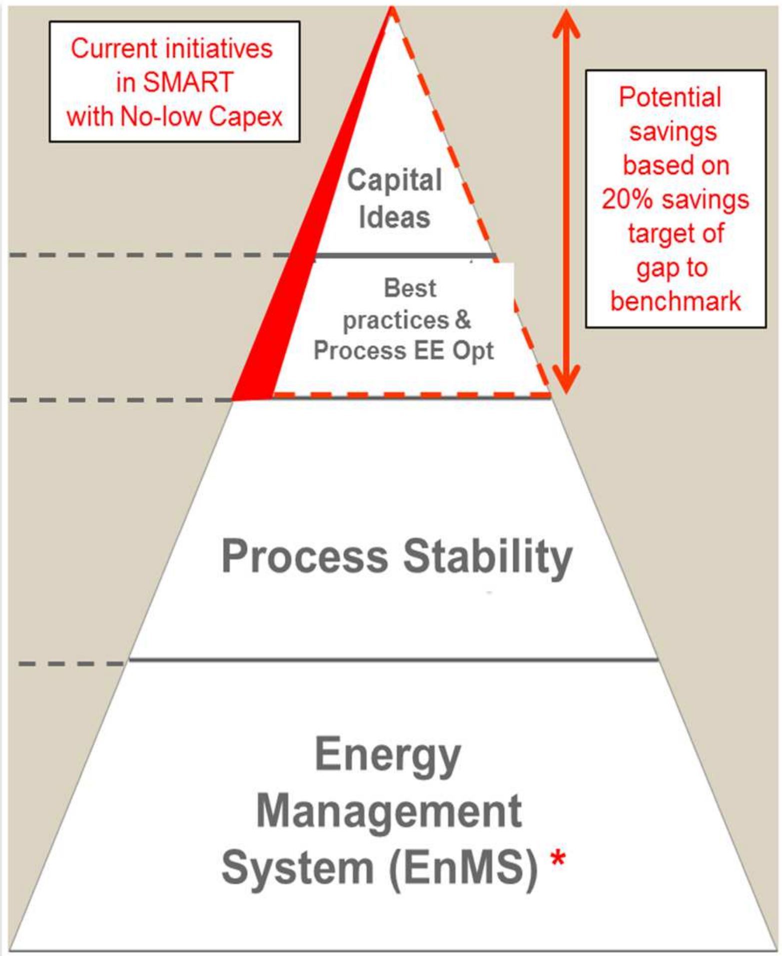
Policy & Industry

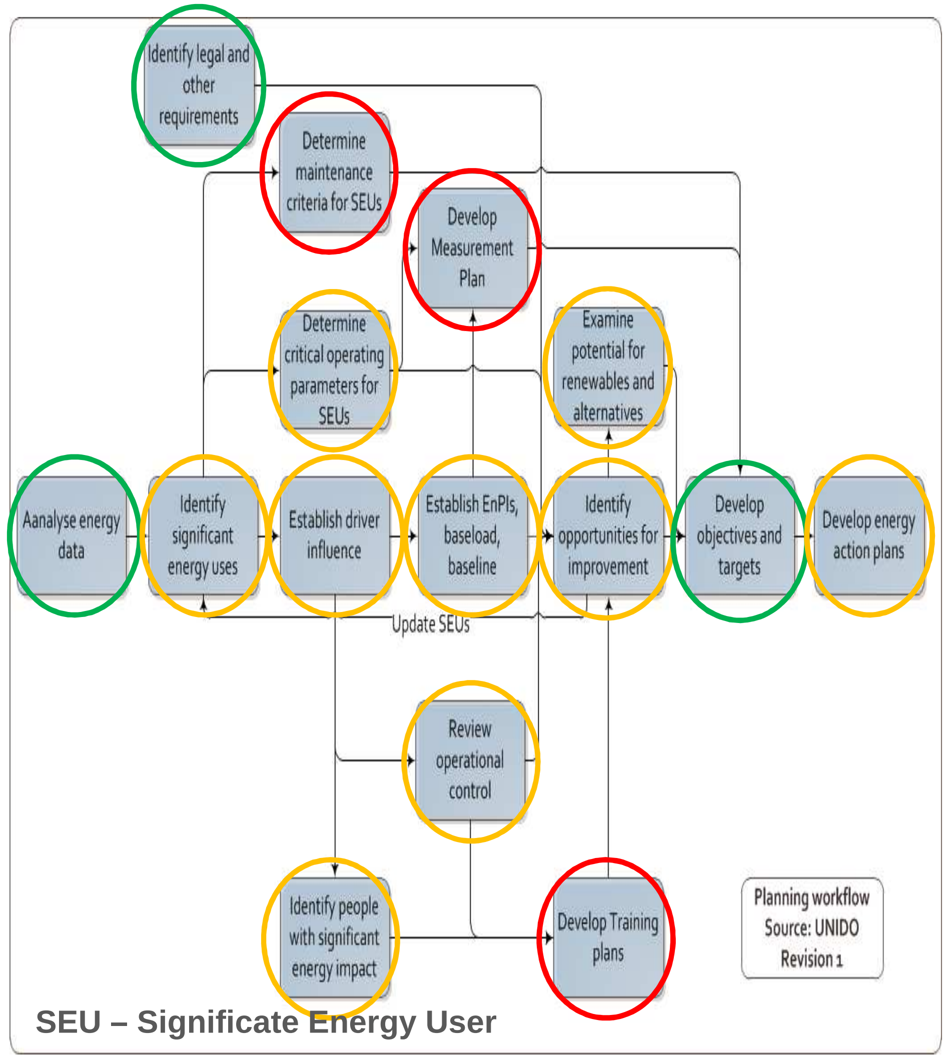
- ***Make it EASY and VIABLE for Industry to do the right thing!!***

Successes in Industrial Energy Efficiency

VDBP Energy strategy improvement components - a successful energy program consists of 3 interdependent building blocks



A successful energy program consists of 3 interdependent building blocks



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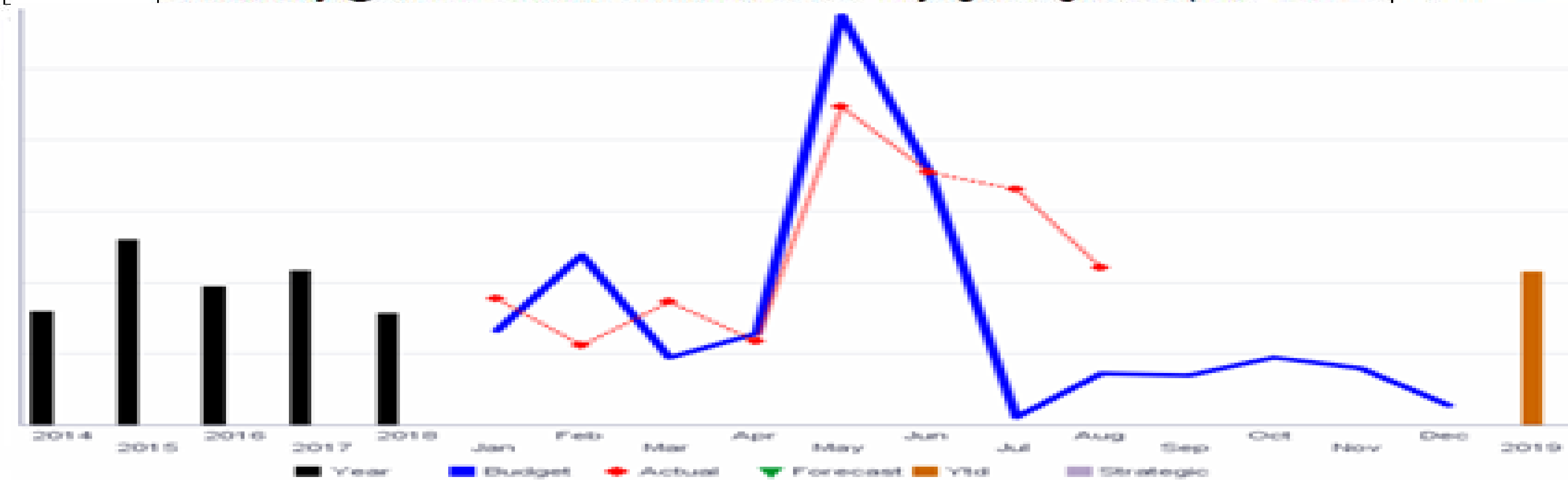
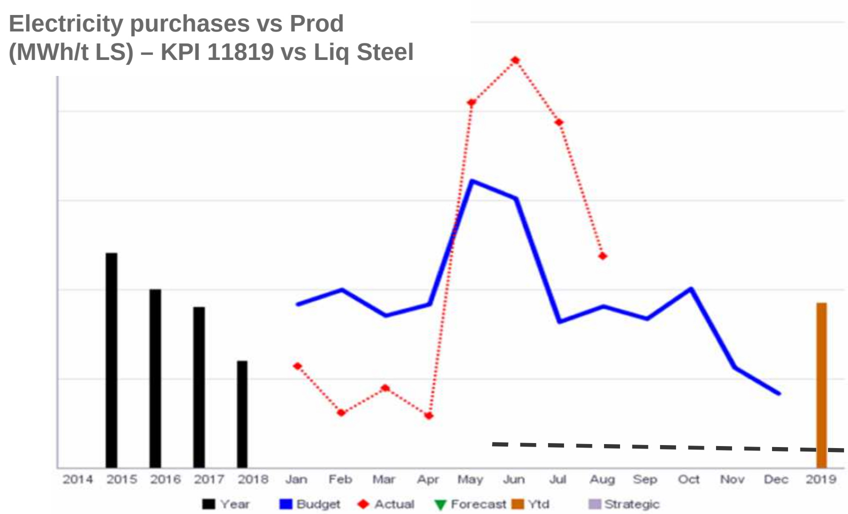
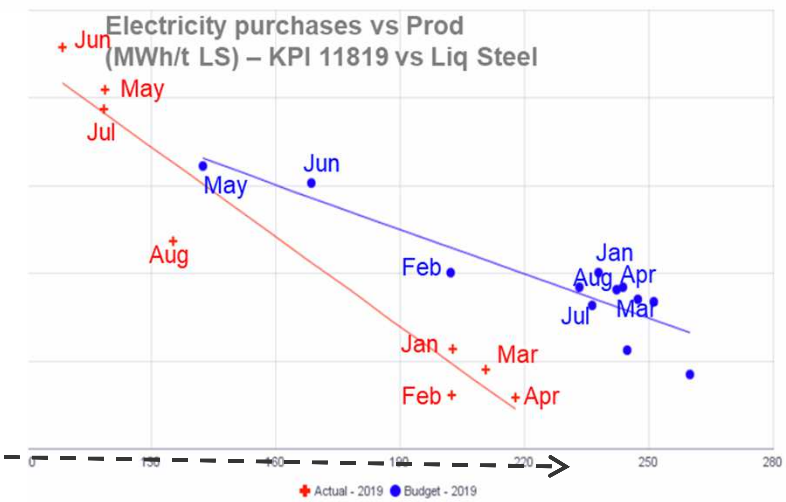
Total Energy Efficiency Performance trend improved with
10-15% ito kWh / ton LS taking production variability into account

Kpi Number	KPI Description	Unit
11844	VDB - Infr - Total Energy VDB Consumption = Coal - Coke Stock Dev + Electricity @ 9.208 GJ/MW + Natural Gas + Cryogenic gasses (GJ / Ton LS	Gj/ton liquid steel







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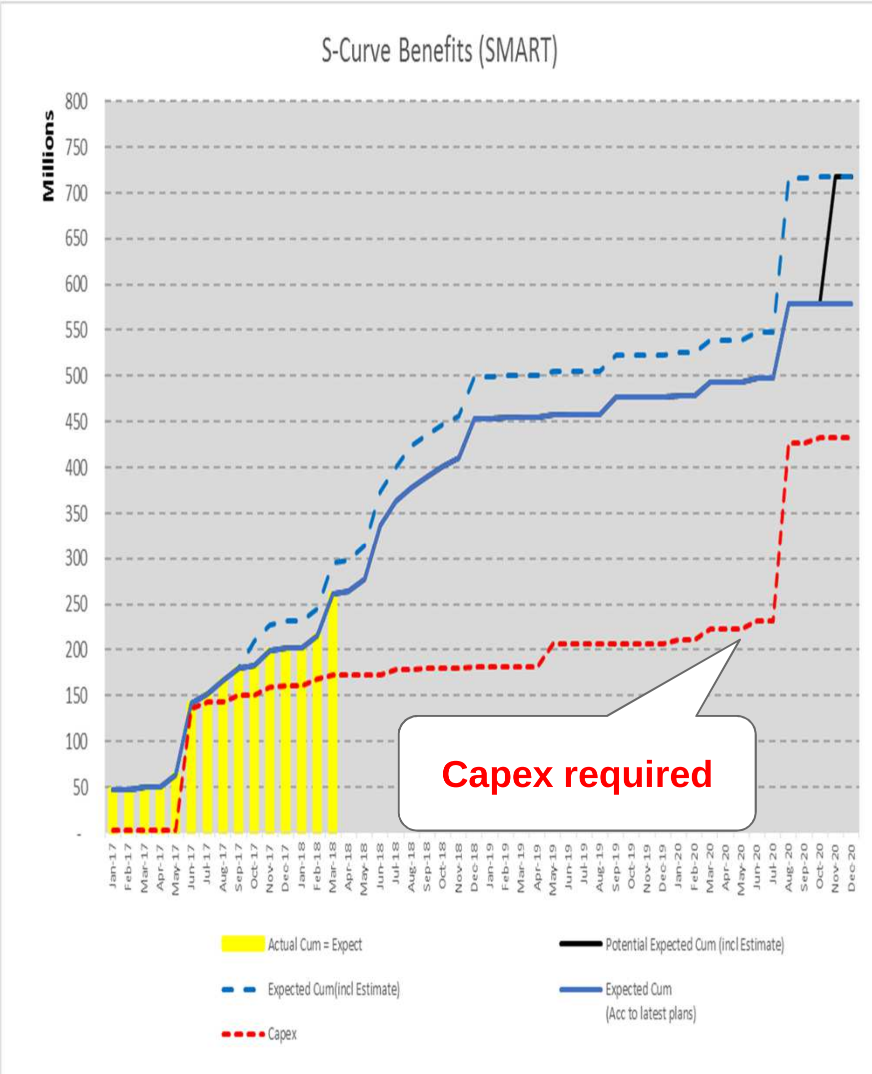
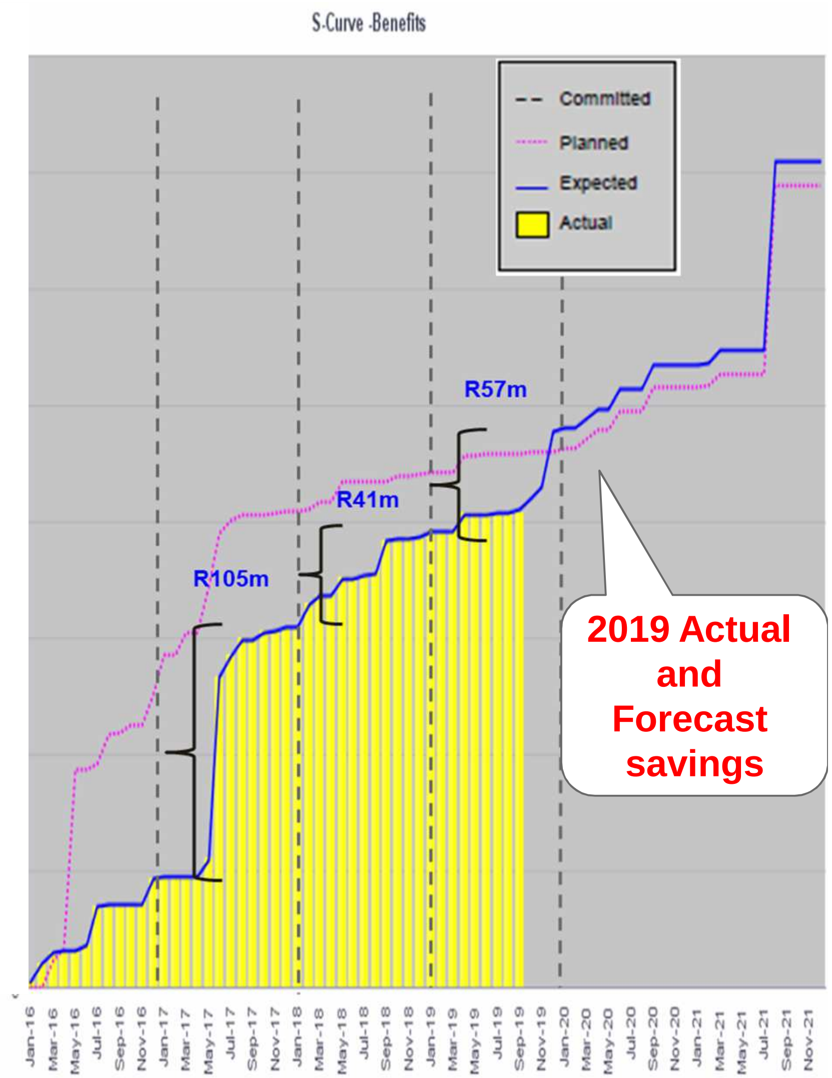
All Energy Ideas – Coal, Electricity, Natural and Cryogenic Gases

Annualized savings, Rand million





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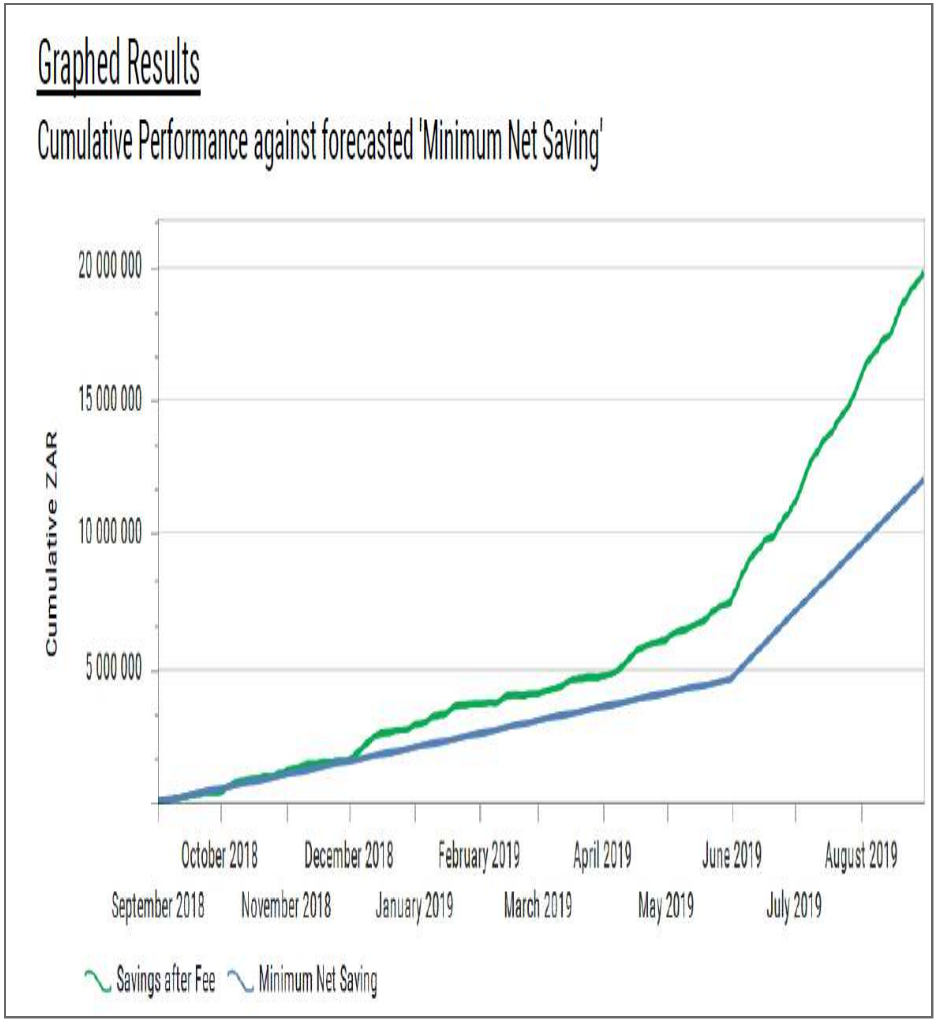
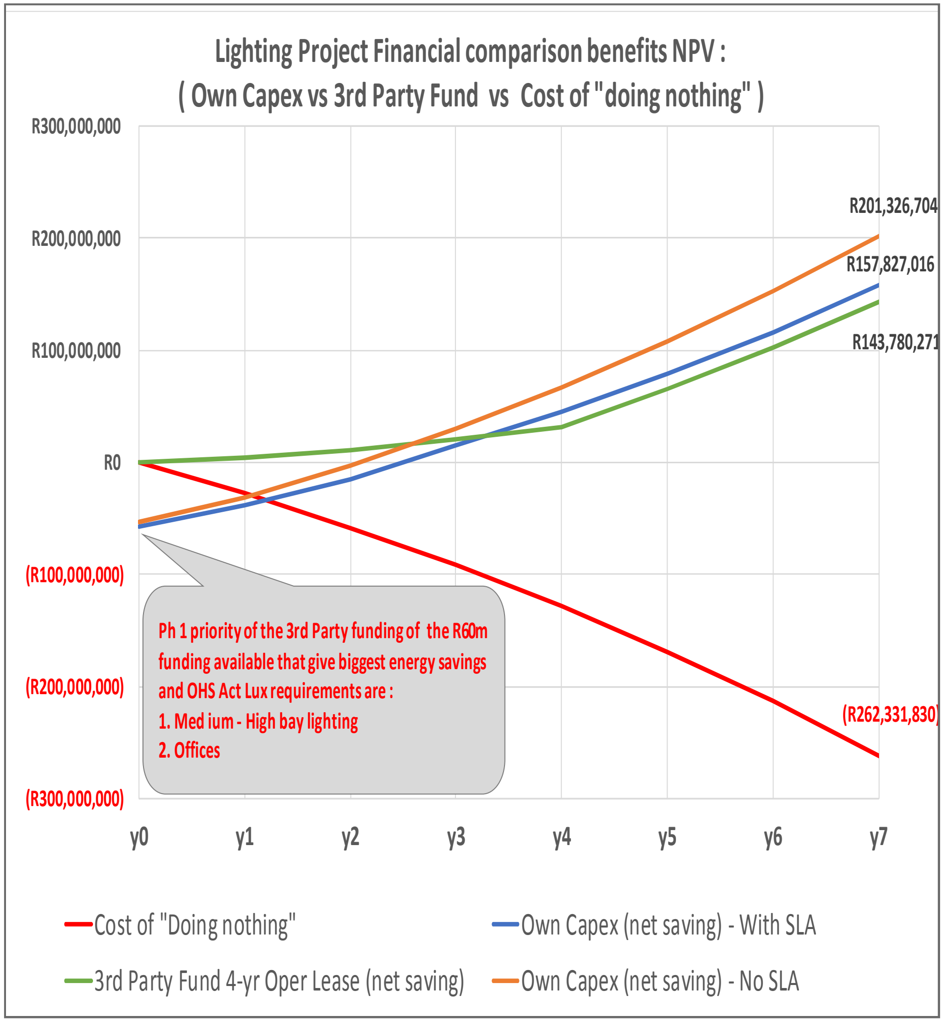
3rd Party funding be rolled out to more VSD, Lighting, Solar, Waste heat

- Example VSD's 3rd Party funding savings of R34m savings with No Capex from Nov 2016.
- Understand the cost of "Do-Nothing" when we have limited capex





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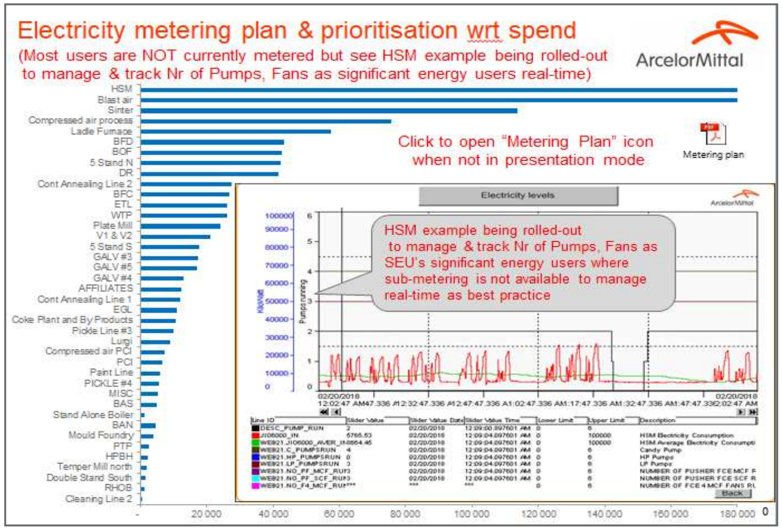
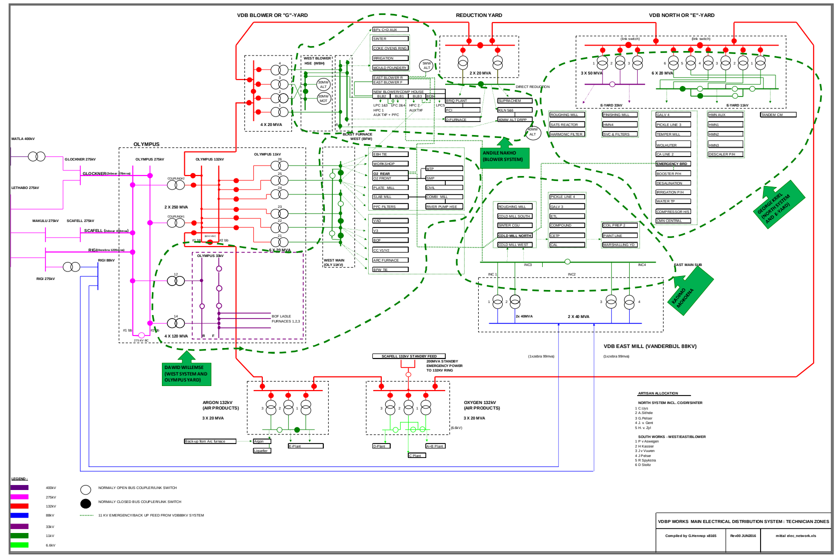
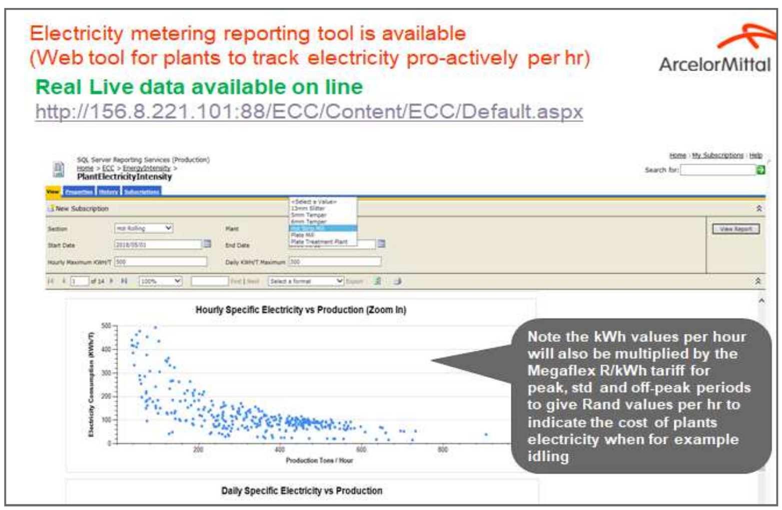
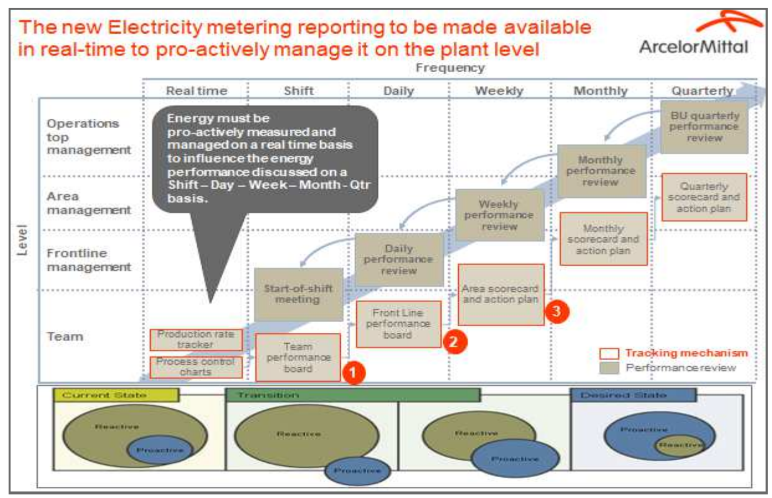
Electricity Metering Plan

How do we manage what we do not measure accurately and still put systems in place to ensure improvement ?









AM Vanderbijlpark – IEEP Journey to improve energy knowledge and identify energy case studies that can be implemented as training opportunities

- First encounter with IEEP – Dec 2013
- EnMS 2 day training – Feb 2014
- EnMS Expert level training - May 2014
  - - Financial Benefits ito ID & ranking of ideas (Energy roadmap developed)
  - - Energy metering & auditing
  - - Reporting and Monitoring
  - - Data Analysis (Energy efficiency vs Prod energy driver graphs)
  - - Measurement and verification to monitor and sustain savings
  - - 3 EnMS Expert level Arcelor Mittal graduates

EnMS

Energy Management Systems Implementation

- CASO 2 day training – June 2014
- PSO 2 day training – Mar 2014
- PSO Expert Level training – Jul 2014
- FSO 2 Day Training – Sep 2014
- FSO Expert Level Training – Oct 2014
- SSO 2 Day Training – Sep 2014
- SSO Expert Level Training – Feb 2015
- CASO Expert Level Training – Feb 2018
- Case studies in Pumps / Fans / VSD's – Oct 2019

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Vanderbijlpark – Engagement Proposal with IEEP

- Short Term (1 year)
  - Complete deep steam, compressed air and fan systems assessments and implement no / low cost savings projects
  - Broaden management and worker awareness of EnMS
  - Capacitate all maintenance & Engineering staff through a series of 2 day and expert level end user workshops in steam, fans, pumps, motors, compressed air.
  - Refine cogeneration and Waste Heat Recovery strategy
  - Implement 2 year payback projects from steam, fan, pump and compressed air assessment findings
  - Host IEEP process heating training & identify optimisation opportunities

Long Term (2-3 years)
  - Develop EnM champions and expand EnMS to all facilities
  - Compile best practice guides and logic tools
  - Explore Renewable Energy options

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Conclusion

- EnMS assisted with a structured approach to unlock energy efficiency
- EnMS system even more critical in sustaining these savings
- There must be resources to implement the plan (Human and Capital)
  - Resource allocation learnings
  - Capital allocation learnings – “new cash generation” vs risk ratios
- The resources (people) must be equipped with the applicable skills to identify, drive and implement energy efficiency
- Awareness and education is a critical part for sustained savings and can never be stopped
- Stability and reliability is a prerequisite for optimisation efforts – maintenance strategies must support this to prevent leakage on energy efficiencies

Current Challenges :

- Access to Capital
- Skills retention impacting on training need and numbers, as well as expert system optimisation input/audits to potentially counter the skills loss
- Regulatory constraints impacting on ability to implement imbedded generation/ LNG importation etc.

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QUESTIONS???

References & Sources

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6. Renewable Energy and Energy Efficiency Partnership (REEEP), Alliance to Save Energy, American Council On Renewable Energy (ACORE), **Compendium of Best Practices - Sharing Local and State Successes in Energy Efficiency and Renewable Energy from the United States**, 2010, https://www.reeep.org/sites/default/files/Compendium%20of%20US%20Best%20Practices.pdf

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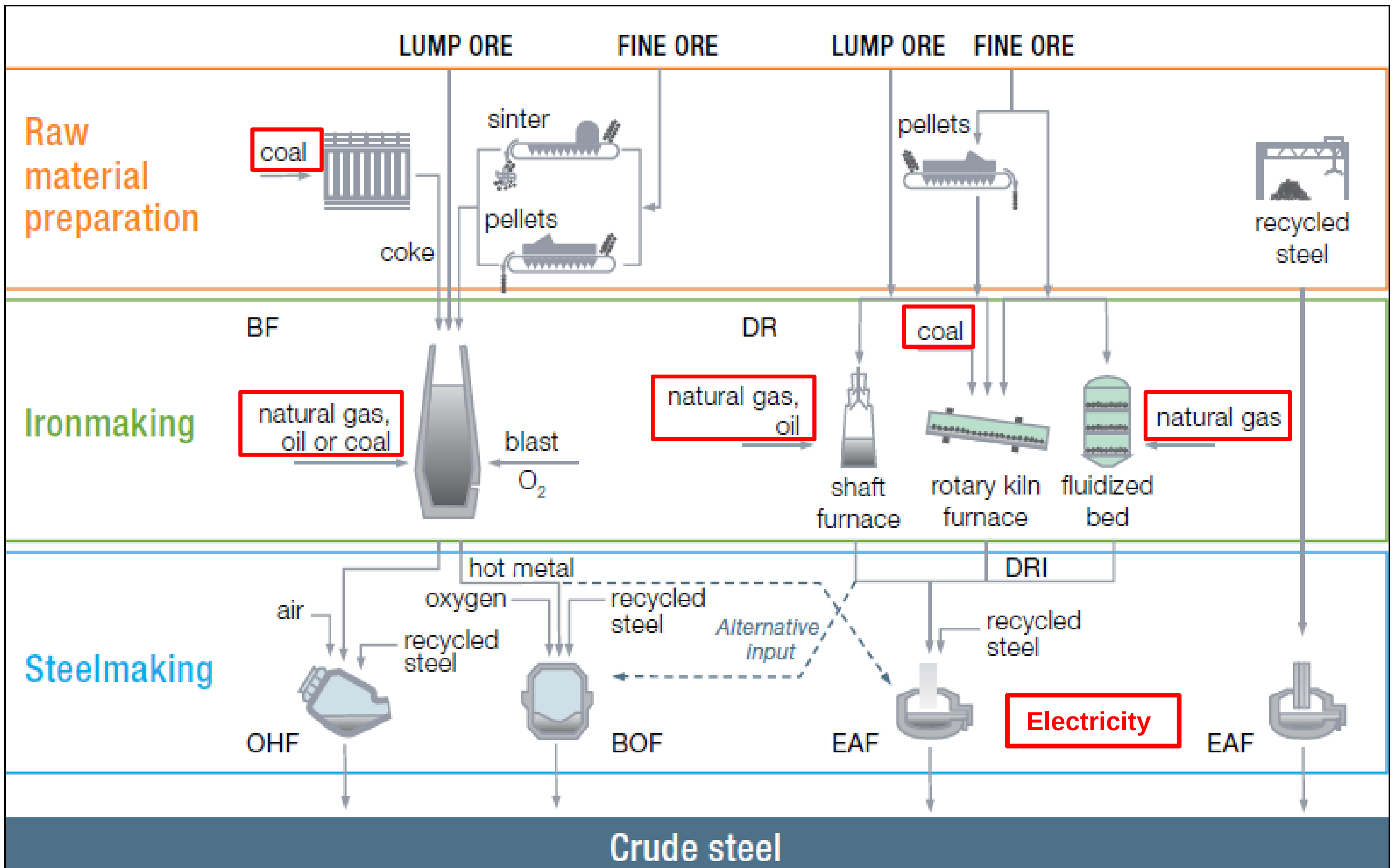
2. Why is Energy Efficiency Import in the Steel Industry

Coal
- Blast Furnace,
- Coke making
- Sinter making

Electricity
- EAF
- Air Separation
- Rolling mills
- Motors/pumps/compressors

Natural gas/ LPG
- DRI Production
- BF injection
- Furnaces
- Power generation

Oil
- Steam generation

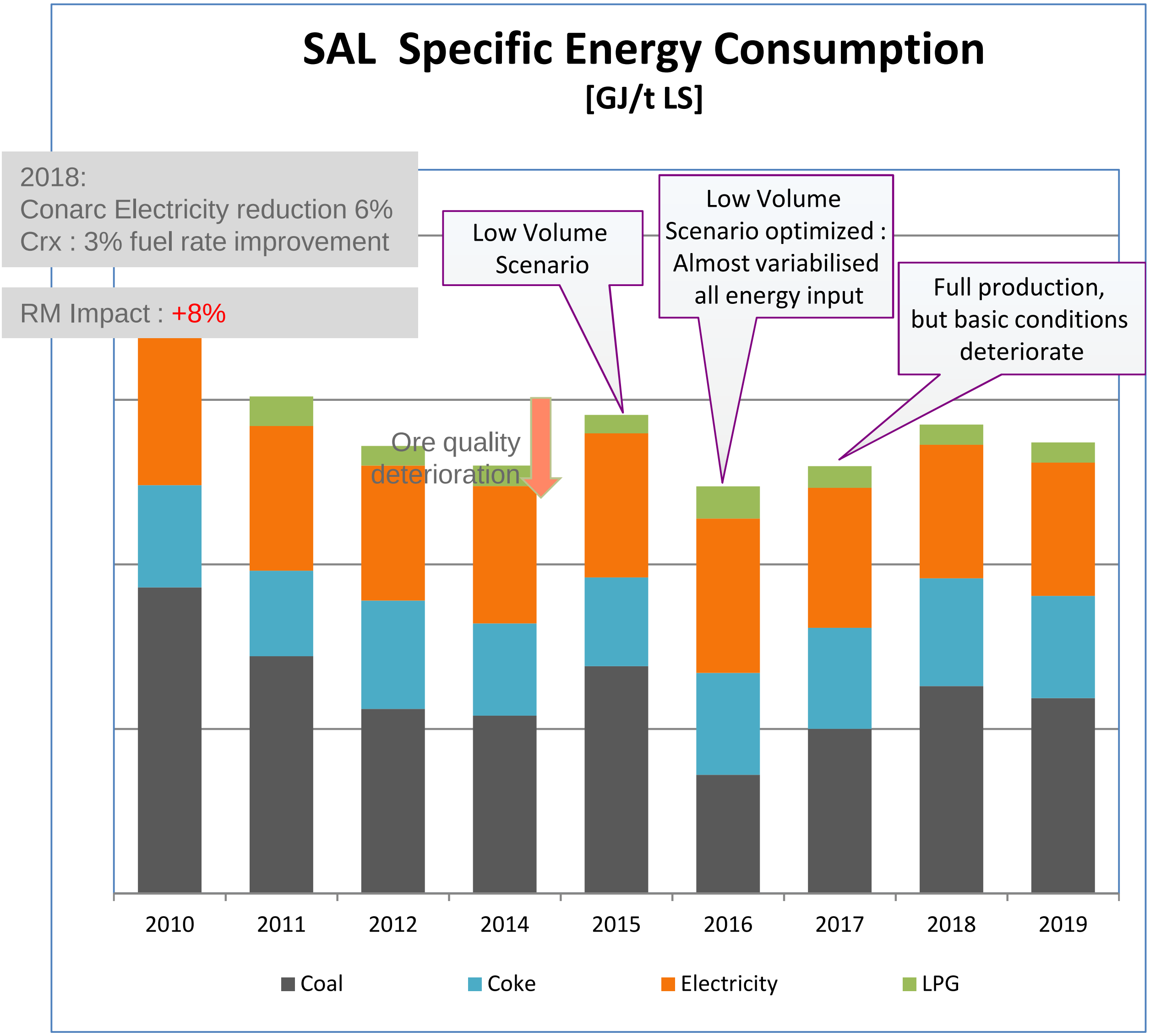


World Steel Association : FACT SHEET Energy use in the steel industry

Energy Cost Route Dependent
25%-40%

Saldanha Works Energy Performance

EnMs implementation 2010/2011



Results Summary

Specific Energy	% Reduction 2010 vs 2019 YTD
Total Full production	**17%**
Total (low production scenario)	21%
LPG	54%
Electricity	14%
Coke+coal	15%

How : Key Focus

- Low Capital
- EnMS
- Energy Manager & team
- Awareness & Behavior
- Cross Boundary leakage
- Baseload reduction

Next Inflection point :

- Technology investment
- Continue Process innovation

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Other Examples – Best Practice – Large Scale Renewable

Morocco :

- electricity consumption is projected
  - double by 2025
  - 5x by 2050.
  - Importing 96 % of its energy

- Decisions : Renewable energy.
  - set targets - increase generation
    - 42 % from renewables by 2020
    - 52 % by 2030
  - reducing energy consumption
    - by 12 % by 2020 and
    - 15 % by 2030 through enhanced energy efficiency.
- Achieved in 2016:
  - 400 GWh from solar thermal technologies,
  - 1662 GWh from solar energy and
  - 3000 GWh from wind in.

Noor Project : renewable energy (CSP)

- supported through investments from the World Bank, European Union, the African Development Bank and bilateral finance from countries such as Germany and France.
- workers hired mostly Moroccans
- planned to produce 500 MW at the conclusion of the project.

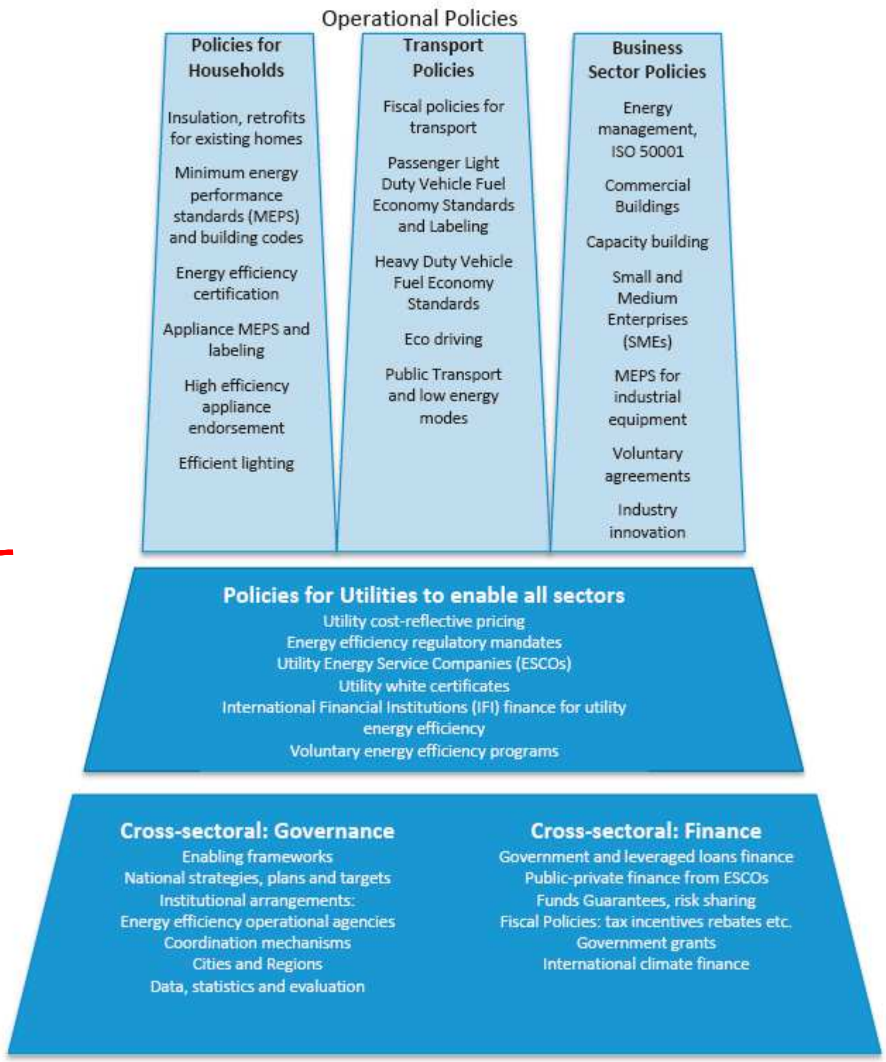
Challenges :

- However, the country is also facing challenges, mainly in the implementation phase:
  - several energy projects are behind schedule, and a
  - real participatory strategy and decentralized approach of the energy transition still needs to be established.

https://germanwatch.org/sites/germanwatch.org/files/Best%20Practices%20on%20Renewable%20Energy%20in%20Africa.pdf

Requirements for supportive Policy and Regulatory Environment

Figure 1. Summary of Best Practice Policies for Energy Efficiency



Start

A foundation of cross-sectoral governance and finance policies

Independent Regulator Assist if :

Transparent

Fair

Accountable

- Credible & Predictable regulatory decisions
- Certainty :
  - ✓ Market Access
  - ✓ Tariffs
  - ✓ Revenues

INVESTMENT

- United Nations Economic Commission for Europe – Best Policy Practices for Promoting Energy Efficiency, 2015
- Anton Eberhard, Katherine Gratwick, Elvira Morella, Pedro Antmann, Independent Power Projects in Sub-Saharan Africa : Investment trends and policy lessons, Elsevier, 0301-4215, 2017