The role of research in the southern African sugarcane processing industry future

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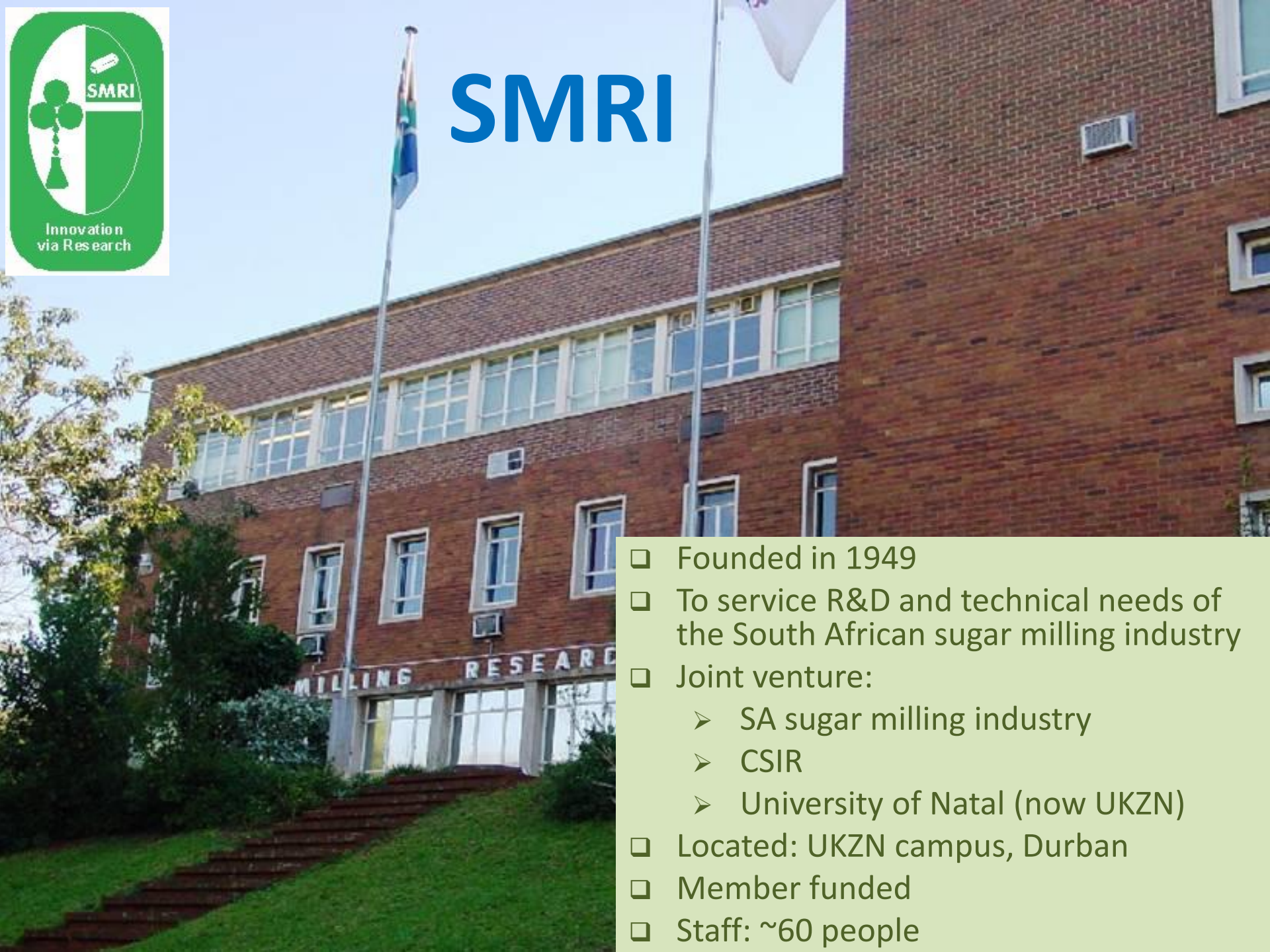
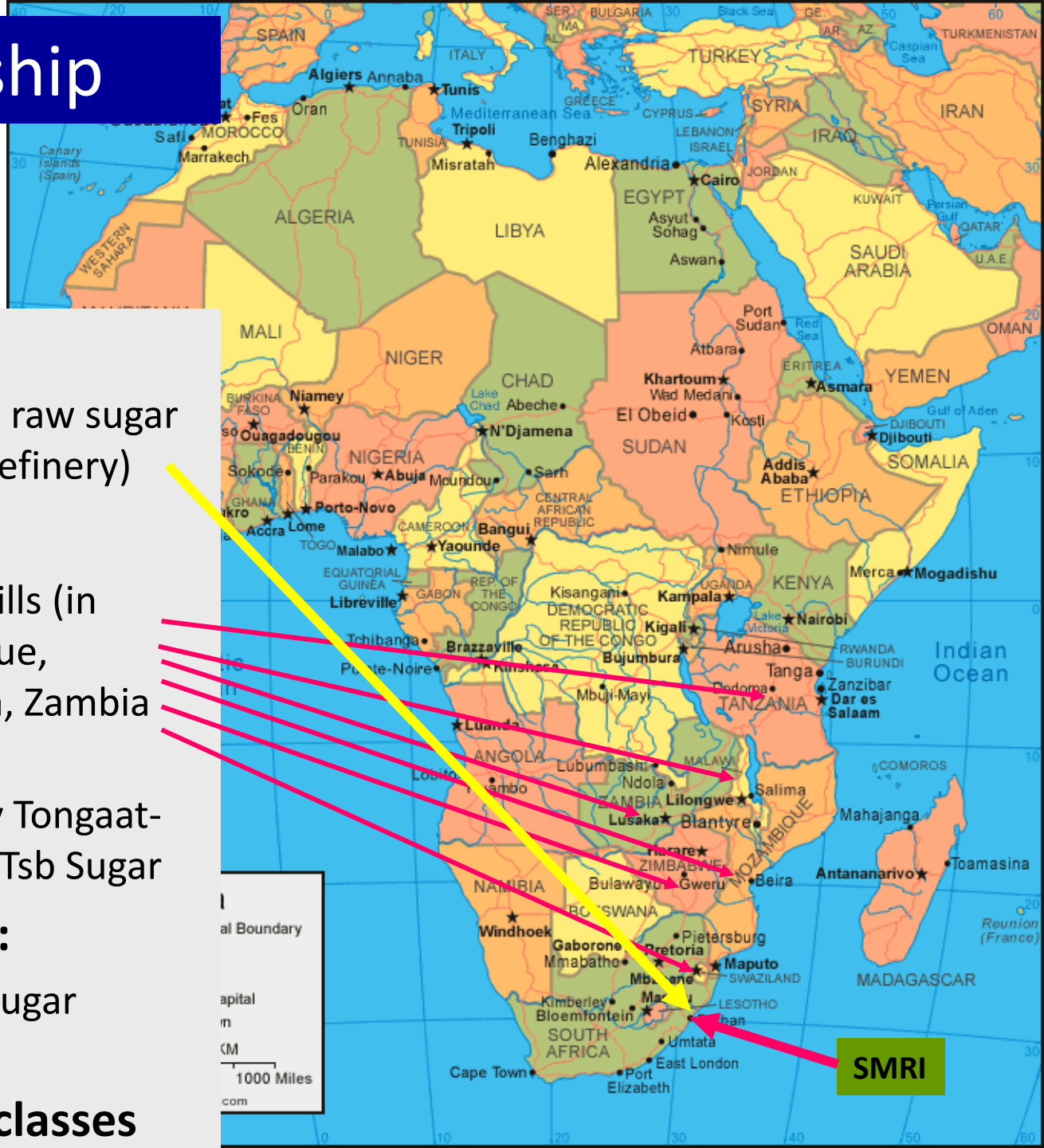
SMRI



- Founded in 1949
- To service R&D and technical needs of the South African sugar milling industry
- Joint venture:
  - SA sugar milling industry
  - CSIR
  - University of Natal (now UKZN)
- Located: UKZN campus, Durban
- Member funded
- Staff: ~60 people

SMRI Membership

- **Full members:**
  - SA sugar milling (14 raw sugar factories + central refinery)
- **Affiliate members:**
  - 13 non-SA based mills (in Malawi, Mozambique, Swaziland, Tanzania, Zambia and Zimbabwe)
    - Fully or partly by Tongaat-Hulett, Illovo and Tsb Sugar
- **Associate member:**
  - The South African Sugar Association
- **New membership classes**



Sugarcane value chain

Biosystems

Biomass Production

Harvesting & Transport

Cane Varieties
Sun
Soil
Water
Fertilisers
Pesticides
Labour

Labour
Machinery
Fuel

Biorefinery

Biomass Processing/ Conversion

Products

Foods, Fuels
Chemicals
Energy

Product Transport

Markets

Byproducts/
Effluent

Machinery
Chemicals
Labour

Machinery/Fuel

Integration

REVENUE

Biorefinery Concept

Biochemical Platform
Enzymes, Fermentation

Sugars & Biomass Residue

Chemical Platform
Acid, alkali, Supercitical fluids

Fuels, Chemicals & Materials

Combined Heat & Power

Thermochemical Platform
Combustion, Pyrolysis, Gasification

Relatively low hanging fruit

- Cogeneration and 1G ethanol are the obvious products to diversify into
  - SA industry in discussions with SA Govt.
- Infrastructure already in place for collecting and processing bulk biomass - competitive advantage over:
  - Other renewable energy sources
  - Green field projects

Not so low hanging fruit

- Need to enable the industry to unlock the full potential of the biomass
  - Beyond just ethanol and co-gen
    - High complexity!
    - Novelty creates challenges
- Biochemical route (Industrial Biotech)
  - For higher value chemicals (e.g. organic acids, biopolymers)
    - 1st Generation: S, F, G – easy, well known, feedstock cost?
    - 2nd Generation: lignocellulosic – many challenges still...
      - e.g. pre-treatment
- Thermochemical route
    - Gasification for:
      - Integrated Electricity Co-generation (high efficiency)
      - Synfuels (such as SASOL Fischer-Tropsch route)

Challenges of Biorefinery approach

- Profit optimisation of multiple products rather than sugar recovery
  - Must add value rather than just reduce costs
  - Maximise: $\frac{\sum \text{value of products}}{\sum \text{costs of production}}$
  - Easier said than done!
    - Integrated techno-economic modelling required to direct decision-making

- Factories to change from being "*energy self-sufficient*" to "*energy efficient*"
  - "Wasting heat is wasting money"

Challenges of Biorefinery approach

- Integration of multiple products
  - Competing for resources/energy
  - Front-end processes may disable certain back-end processes
  - Environmental/effluent concerns with different processes
  - Costs of technology
  - Novelty of technology in ‘traditional’ industry

Challenges of Biorefinery Research

- Integrated techno-economic modelling required to direct research efforts
  - Challenge: detailed or broad or both??
- Until then, where to focus?
  - Sugar likely to remain core product
  - Suggests that value addition should come from **fibre**
    - Liberation of chemical potential in complex lignocellulosic biomass is required
    - Not yet 'cracked' commercially

Biorefinery Concept

energy efficiency drive

Steam, Electricity

Biorefinery Techno-economic Modelling

Fractionation/ Preparation

- Mechanical
- Biochemical
- Thermal
- Chemical

Conversion

- Thermochemical
- Biochemical
- Chemical

Separation

- Distillation
- Crystallisation
- Mechanical
- Chromatography
- Membranes
- Chemical

Biomass (Sugarcane)

Major research focus required

Energy Products

Chem Products

Chem Interm; Value-add

Technology needs

- Collection and handling of bulk biomass
- Pre-treatment and fractionation of fibre
- Energy densification technologies
- Processes to deliver new products with minimal waste generation
- Low-cost technologies for converting “waste” to energy/value-added products
- Improving energy efficiencies of existing processes

Techno-economic questions

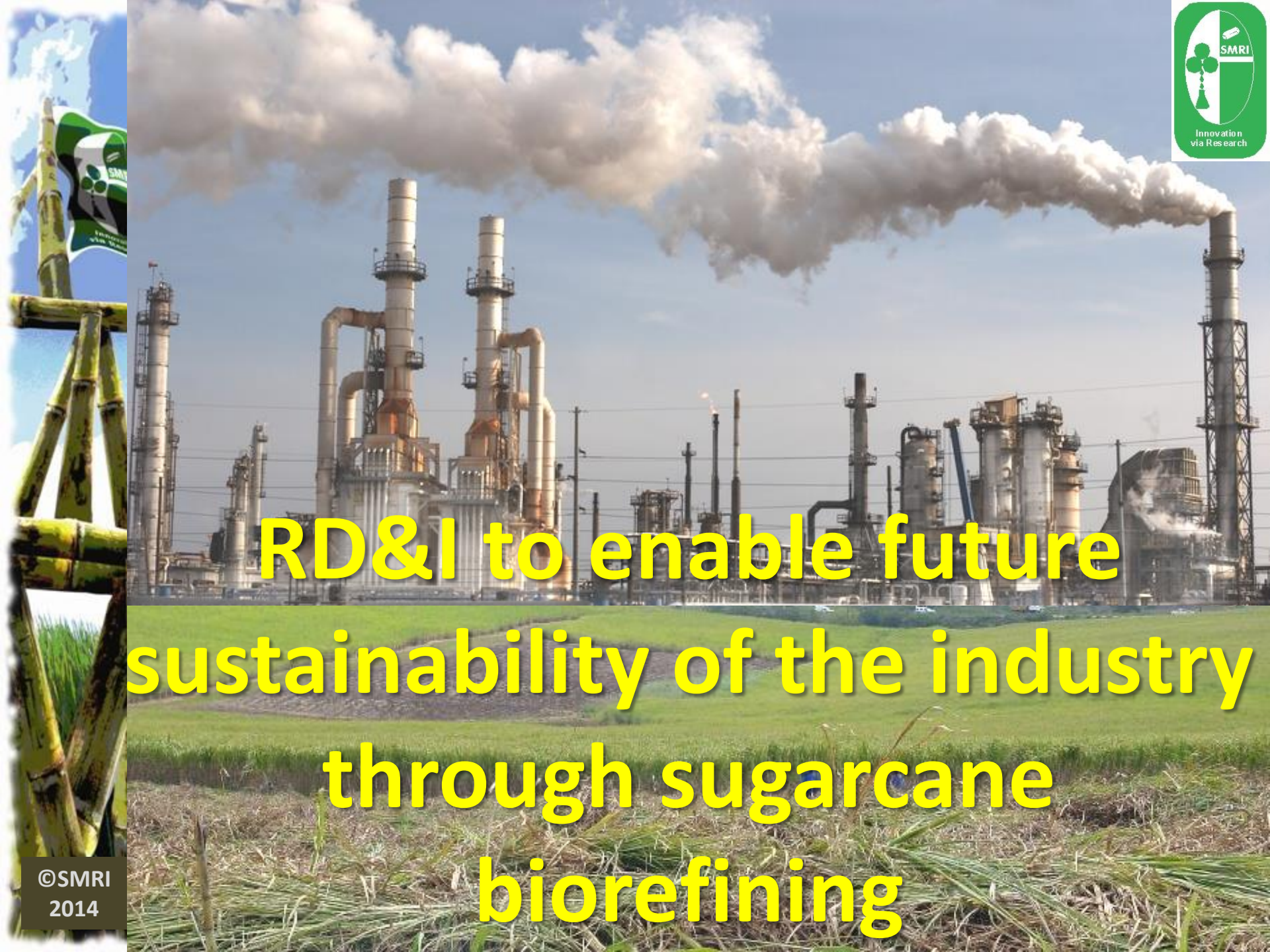
- Large scale vs decentralised processing?
- Commercial use of EtOH vs local area use (<1.2 ML/y)
- Until higher value products and markets established, what is impact of industry move to EtOH/cogen in short/med term?
- Limited markets for speciality products – how to develop industry-wide platform?

Challenges of Biorefinery approach

- Innovation required!!
  - Radical innovation (not incremental)
  - Enhanced rate of innovation
    - Critical mass issues
  - Novel solutions: Process & Products
    - Limited expertise outside of sugar
      - Product quality
      - Market knowledge
    - New value chains required
    - Cost of technology
    - Creation of new waste streams

How is the SMRI responding?

- SMRI Research Strategy driven by NEEDS of industry
  - Adopting a Biorefinery concept
- Exploring opportunities to enhance:
  - amount of strategic and focussed sugarcane research conducted
  - rate of technological innovation required for sustainability of the industry
- Significant investment into research required
  - Funding;
  - Grow critical mass;
  - Collaboration;
  - Strategic partnerships
- Driving initiatives to leverage significant funding for RD&I


RD&I to enable future sustainability of the industry through sugarcane biorefining
SMRI
Innovation via Research
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