

Landscape and Technology Offerings in the Renewable Energy Sector of the Western Cape, South Africa

Eugène van Rensburg

Dept. of Process Engineering
Stellenbosch University
Western Cape Province
South Africa

eugenevrb@sun.ac.za



City of Cape Town, Western Cape, South Africa

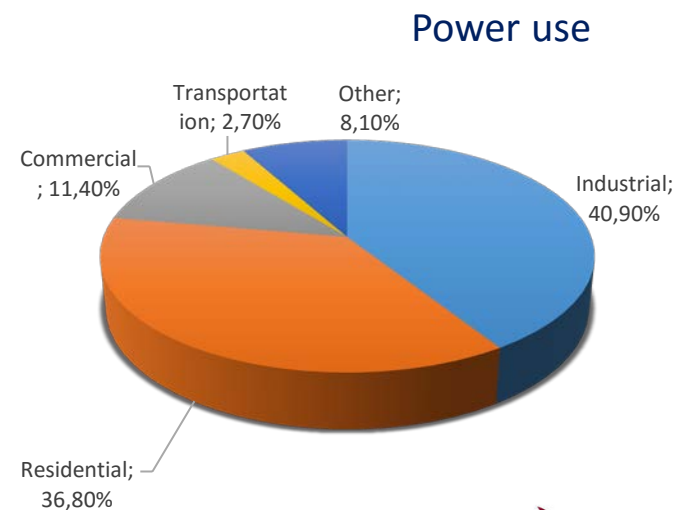
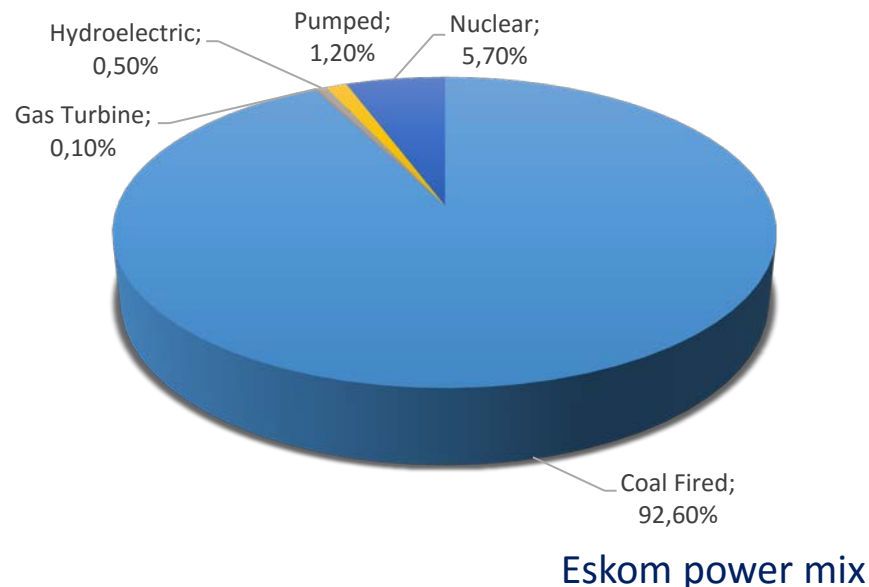


Stellenbosch, the heart of the Winelands



South Africa – Key facts

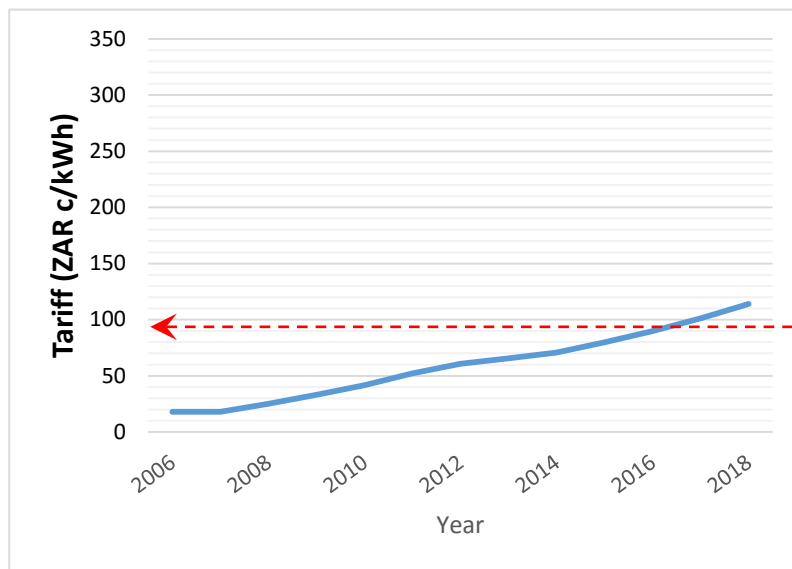
- Most advanced power market in Africa
- Eskom net output of 35.6 GW_p
 - 85% of SA electricity
 - 40% of Africa electricity
- RE accounts for ~5% of SA electricity
- Integrated Resource Plan
 - Change from high coal (85%) to medium coal (48%)
- Electricity procured from IPPs
- Eskom – single buyer of IPP electricity
- REIPPPP primary vessel – RE development
 - Procured over 6.3 GW_p
 - 2.5 GW_p feeding into grid
 - Further 6.3 GW_p to be procured
 - Attracted ZAR194 bill investment (CAN\$ 19.4 bill)



RE – Increasingly competitive

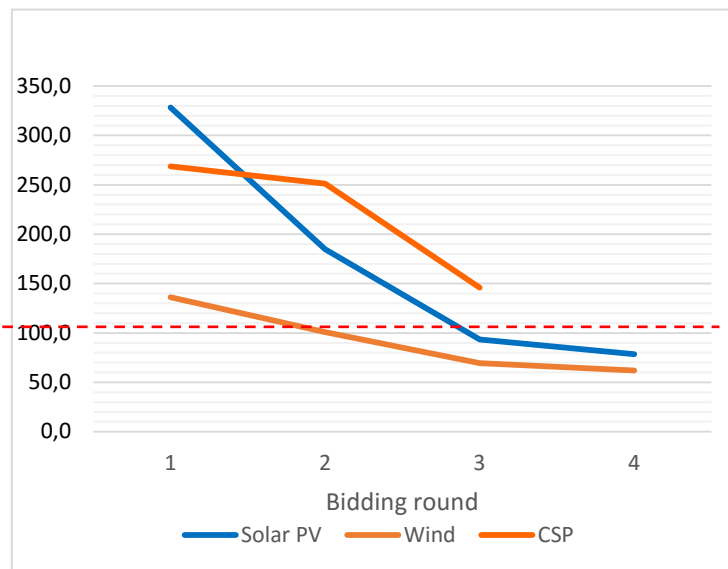
Eskom tariffs

ZAR c/kWh



REI4P bidding tariffs

ZAR c/kWh



REIPPPP Concept



energy

Department:
Energy
REPUBLIC OF SOUTH AFRICA



Public Private Partnerships



New generation capacity



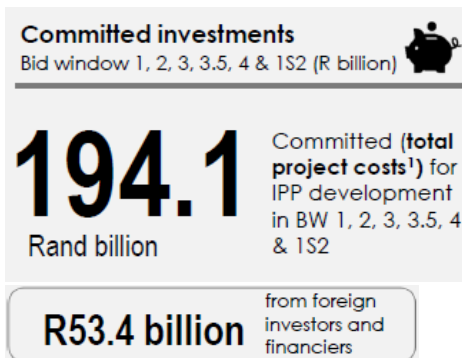
Industrialisation mechanism



Socio-economic development

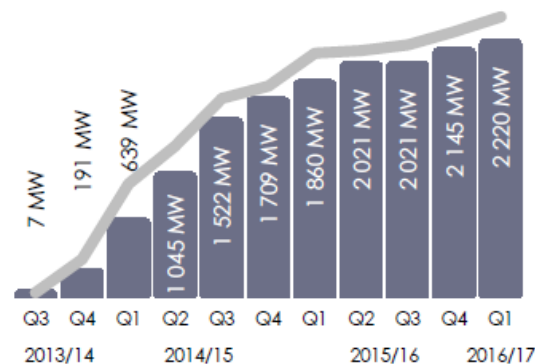


REIPPPP Infographic

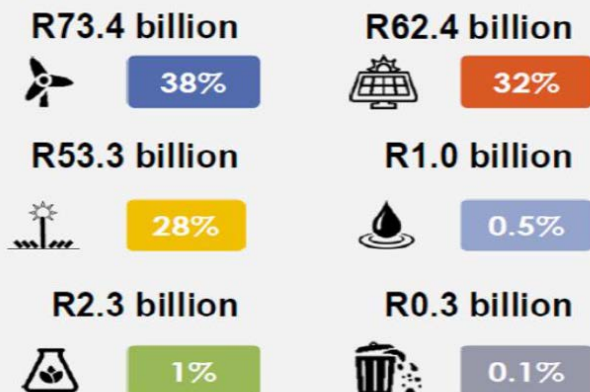


megawatts operational (MW)

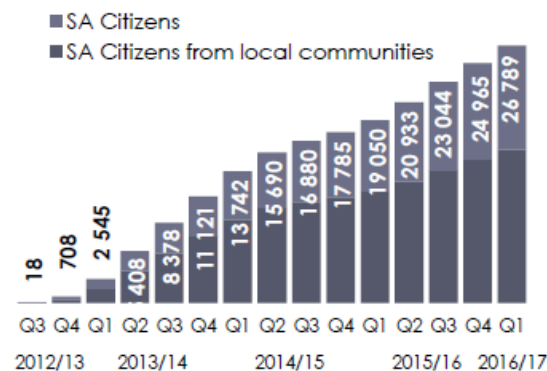
planned: 2466 MW



Technology share of investment Total Project Costs (Rand billion)



employment creation³ (job years)⁵



Abengoa solar plant investments



- Khi Solar 1 Upington: 50 MW, superheated steam (Khi stands for Khoisan)
- KaXu Solar 1 Pofadder: 100 MW, parabolic trough with storage (open skies)
- Xina Solar 1 Pofadder: 100 MW, parabolic trough with storage (guinea-fowl)



Investment opportunities in SA & Western Cape



Agriculture

Solar irrigation

R29 bn market (SA)

Sustainable agriculture

Tools, data analysis, machinery rentals, local manufacturing, financing

Conservation agriculture

R114 m market, ~R1 bn potential market (SA)

Solar energy for packhouses

R1 bn potential market (WC)

Controlled environment agriculture

R600 m potential market; 15% growth p.a. (WC)

Precision agriculture

Tech & services to improve water & energy efficiency



Energy services (SA-wide)

Solar PV systems & components

500 MWp installed capacity & R2 bn investments predicted (2016-2019)

Local manufacturing & assembly

Solar PV systems and components – systems require compliance with local content regulations

Energy efficiency retrofitting

100 000+ public buildings require retrofitting



Utility scale renewable energy (SA-wide)

Independent power production

Ministerial determination for 6.3 GW, more RE generation capacity: 11 GW (670 MW wind; 450 MW solar) p.a.

Rest of Africa

RE deployment in the rest of Africa, some programmes mirroring REIPPPP

Local manufacturing

Through REIPPPP local content requirements



Waste

Municipal PPP

Public-private partnership projects of R1.3 bn (WC)

Secondary materials

Robust & growing market for plastics, metals, e-waste, etc.

Construction & demolition waste

Growing reuse & recycling market



Water

Industrial water reuse

Recycling & resource recovery; R600 m market: (WC)

Water & energy

Opportunities for efficiency & use of renewables

Local resource development

Brackish water desalination, ground, storm & grey water



Bioeconomy & resource efficiency

Food value retention

R600 m value through improved cold chain management & waste reduction (WC)

Solar thermal

>R100 m industrial-scale installations, R3.7 bn potential market for agri-processing (SA)

Biogas

For LPG replacement, heating & electricity generation: >R450 m market, R18 bn potential market, 395 MW potential generation (WC)



Overview of technology activities

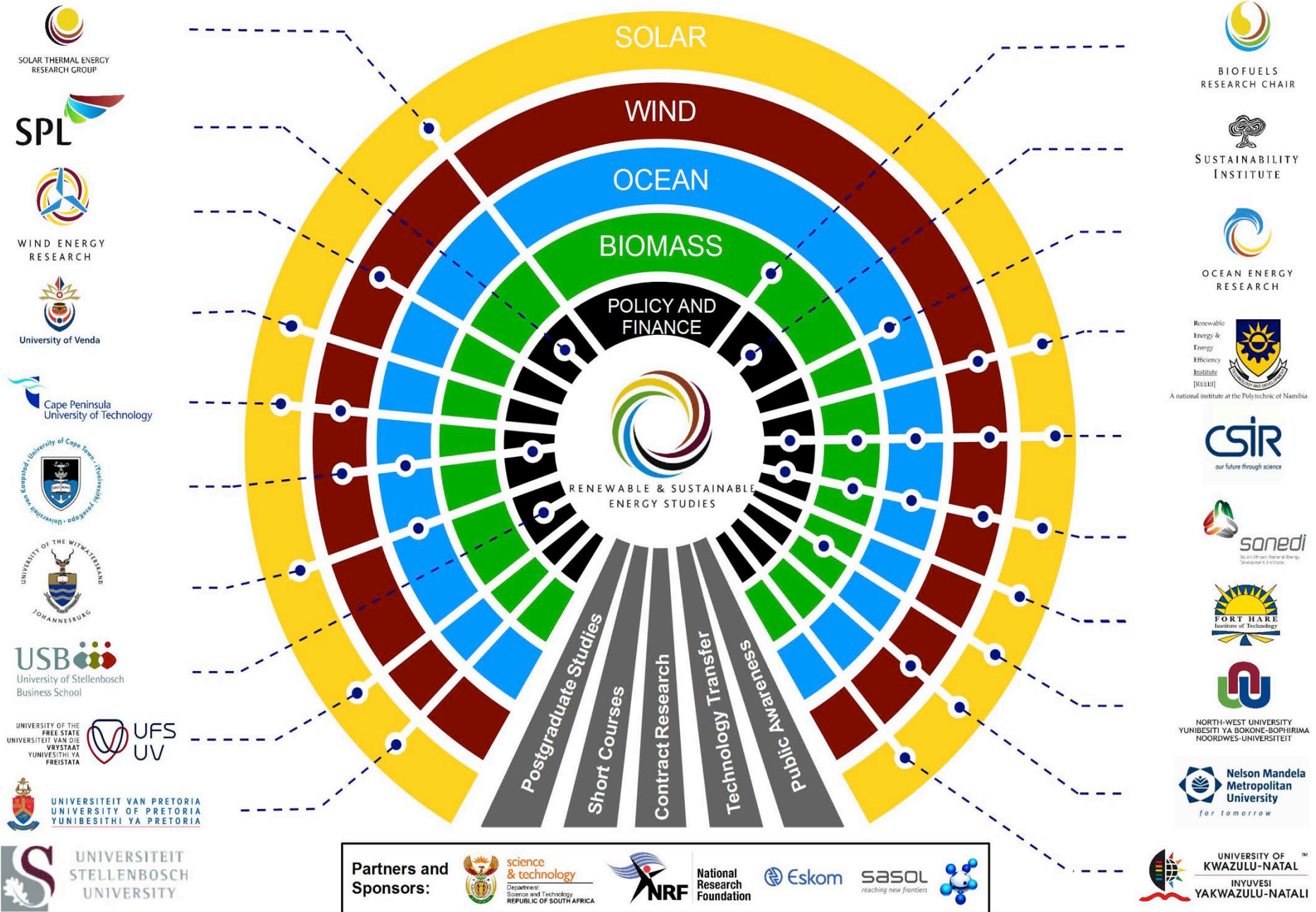




RENEWABLE & SUSTAINABLE ENERGY STUDIES



CRSES ACADEMIC NETWORK



Overview of CRSES activities

- Facilitate **renewable energy research, teaching and projects** at Stellenbosch University (“Front Door for Renewable Energy at Stellenbosch”)
- Facilitate, coordinate and fund **postgraduate programmes** and modules
- **Influence research** focus areas and funding opportunities
- Conduct **contract research** and specialist consulting projects for public and private institutions
- Increase **public awareness** of renewable energy
- Short courses (see website)



Prof Wikus van Niekerk

wikus@sun.ac.za



SAURAN

- **High-resolution, ground-based solar radiometric data**
- Available from stations across **Southern African region**
 - South Africa
 - Namibia
 - Botswana
 - Reunion Island
- Direct normal irradiance (DNI), global horizontal irradiance (GHI) and diffuse horizontal irradiance (DHI)
- Free data access
- www.sauran.net

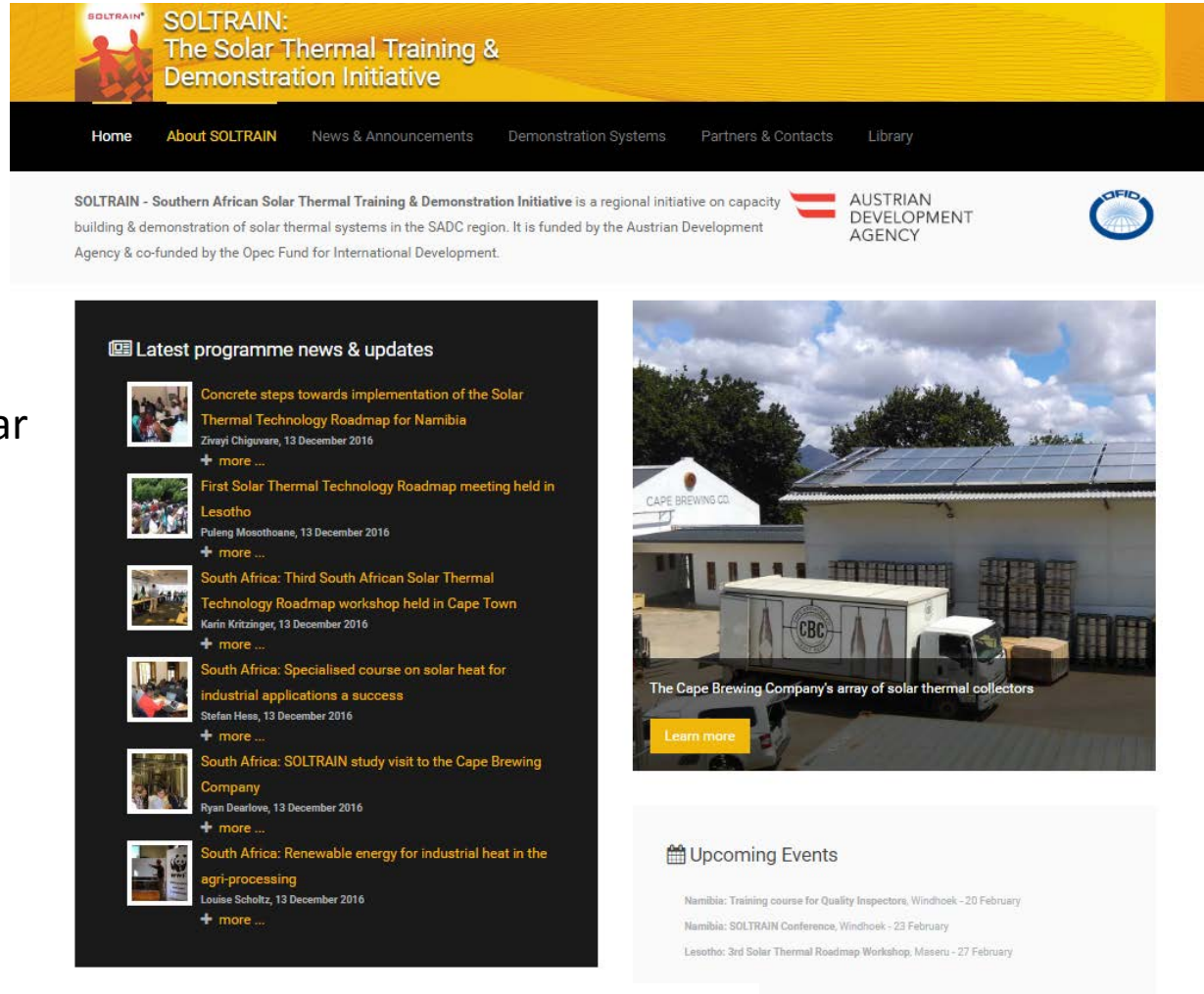


Southern African Universities Radiometric Network
Solar Radiometric Data for the Public



SOLTRAIN: Solar Thermal Training & Demonstration Initiative

- Funded by Austrian Development Agency
- Raising **awareness** of the potentials in **solar thermal technology**
- Building of **competence** in solar thermal technology
- Creating solar thermal **technology platforms**
- Demonstrating that solar thermal technology works
- soltrain.co.za



The screenshot shows the SOLTRAIN website homepage. The header is yellow with the SOLTRAIN logo and title. Below is a navigation bar with links: Home, About SOLTRAIN, News & Announcements, Demonstration Systems, Partners & Contacts, and Library. A text block describes SOLTRAIN as a regional initiative on capacity building and demonstration of solar thermal systems in the SADC region, funded by the Austrian Development Agency and co-funded by the Opec Fund for International Development. Logos for the Austrian Development Agency and OPEC are shown. A 'Latest programme news & updates' section lists six news items with dates from December 2016, each with a thumbnail image and a 'more...' link. A large image on the right shows a white building with solar collectors on the roof, with a truck in front. Below this is a 'Learn more' button. At the bottom, an 'Upcoming Events' section lists three events: a training course for Quality Inspectors in Windhoek (20 February), the SOLTRAIN Conference in Windhoek (23 February), and a 3rd Solar Thermal Roadmap Workshop in Maseru (27 February).

SOLTRAIN: The Solar Thermal Training & Demonstration Initiative

Home About SOLTRAIN News & Announcements Demonstration Systems Partners & Contacts Library

SOLTRAIN - Southern African Solar Thermal Training & Demonstration Initiative is a regional initiative on capacity building & demonstration of solar thermal systems in the SADC region. It is funded by the Austrian Development Agency & co-funded by the Opec Fund for International Development.

Austrian Development Agency

Latest programme news & updates

- Concrete steps towards implementation of the Solar Thermal Technology Roadmap for Namibia**
Zivayi Chiguvare, 13 December 2016
[+ more ...](#)
- First Solar Thermal Technology Roadmap meeting held in Lesotho**
Puleng Mosothoane, 13 December 2016
[+ more ...](#)
- South Africa: Third South African Solar Thermal Technology Roadmap workshop held in Cape Town**
Karin Kritzinger, 13 December 2016
[+ more ...](#)
- South Africa: Specialised course on solar heat for industrial applications a success**
Stefan Hess, 13 December 2016
[+ more ...](#)
- South Africa: SOLTRAIN study visit to the Cape Brewing Company**
Ryan Dearlove, 13 December 2016
[+ more ...](#)
- South Africa: Renewable energy for industrial heat in the agri-processing**
Louise Scholtz, 13 December 2016
[+ more ...](#)

The Cape Brewing Company's array of solar thermal collectors

[Learn more](#)

Upcoming Events

- Namibia: Training course for Quality Inspectors, Windhoek - 20 February
- Namibia: SOLTRAIN Conference, Windhoek - 23 February
- Lesotho: 3rd Solar Thermal Roadmap Workshop, Maseru - 27 February

SOLTRAIN Country Partners



STERG: Solar Thermal Energy Research Group

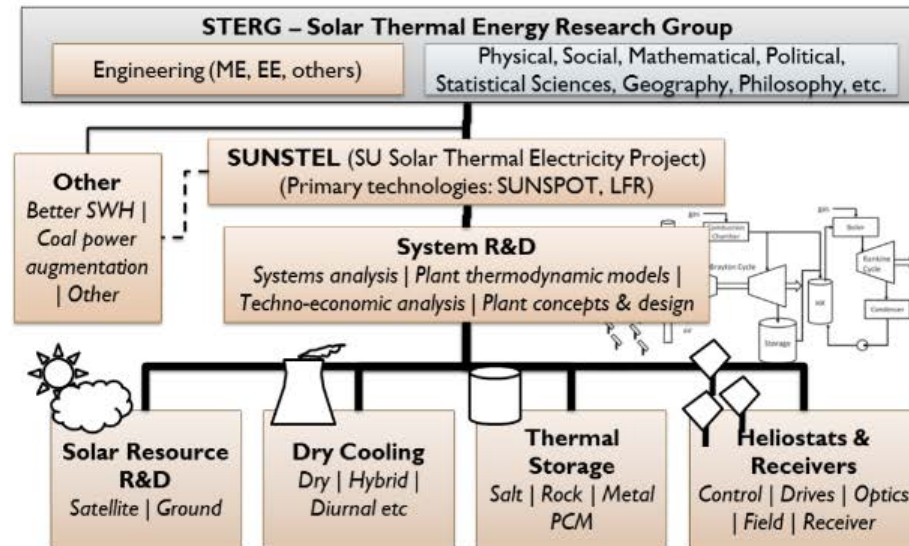


ABOUT JOBS **RESEARCH** EVENTS NEWS CONTACT 

RESEARCH

We focus exclusively on solar thermal energy research but we do this in a multidisciplinary environment.

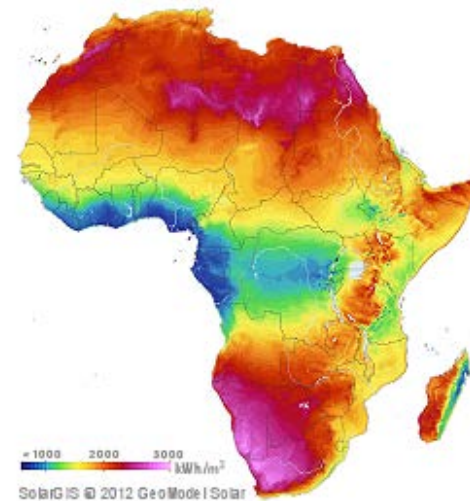
- **CSP** system concepts, development & analysis
- Thermal energy **storage**
- **Condenser cooling** (wet, dry & hybrid)
- **Heliostat and overall collector** R&D
- **Linear Fresnel collector** R&D
- **Stirling dish** R&D
- **Solar resource** assessments, measurements & **GIS mapping**
- Application of solar heat in industry
- sterg.sun.ac.za



GeoSUN Africa



- **Services** to solar developers
- **Rooftop PV**
- **Solar data and map products**
- Other services
 - Short courses
 - Expert studies
- geosun.co.za





Riaan Meyer

riaan.meyer@geosun.co.za

Thermographic inspection of PV modules with drones.
Hotspots detected and automatically classified.
Detailed database with the location & severity of defected panels



UNIVERSITEIT • STELLENBOSCH • UNIVERSITY



Decentralized low energy water treatment systems



River filter in Stellenbosch
“Constructed swamp”



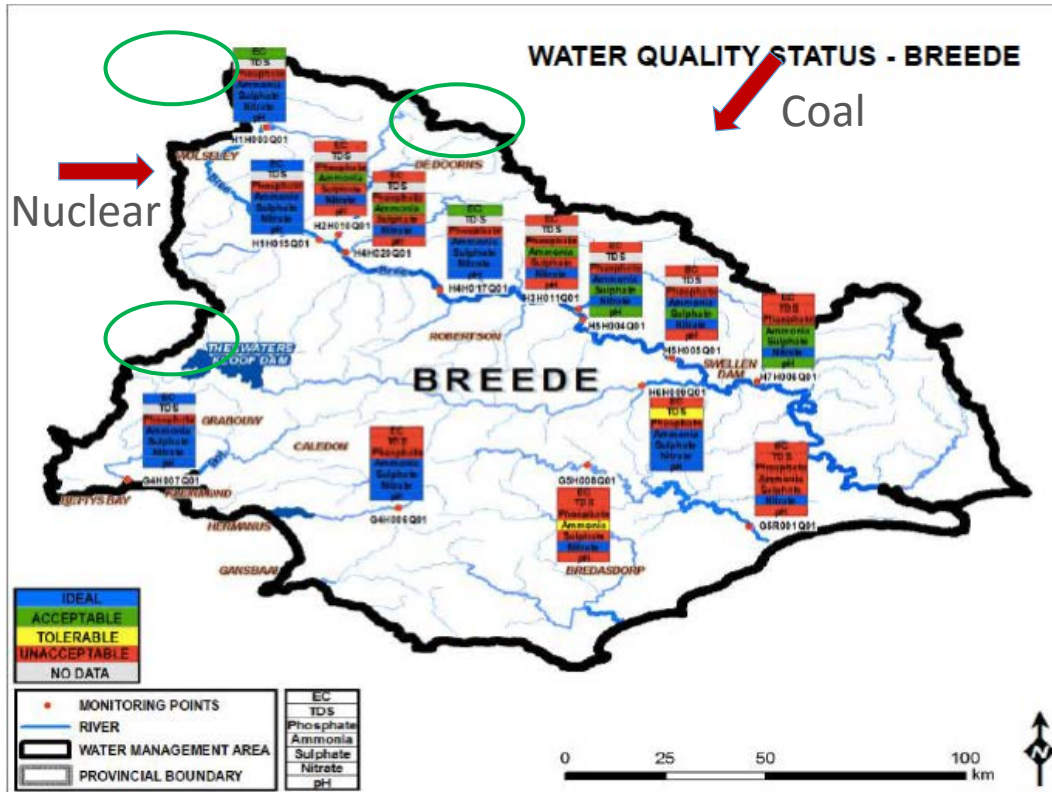
Prof Gideon Wolfaardt
gmw@sun.ac.za



European Union Horizon 2020 project
No 689925



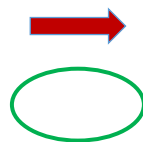
Large scale interventions to reduce energy consumption for food production



- Connect dams in catchment area
- Water transfer/irrigation under pressure from source
- Improves water quality
- Decreases external energy dependence for irrigation

Current Energy Input

Energy Potential





BIOFUELS
research chair

Senior Chair in Energy Research

- Stellenbosch University – hosts SANERI Chair of Energy Research (CoER)
 - R&D and Process Development of all aspects of Biorefineries
 - Preferred route for biofuels/bioenergy production
 - Co-production of high value chemicals & materials
- Chemical/Thermochemical/Biological conversion
 - Biomaterials & biowastes
 - kg scale process development
- Supported by process simulation/techno-economic & life cycle analyses



Prof Johann Görgens
jgorgens@sun.ac.za

Process Engineering



Prof Emile van Zyl
whvz@sun.ac.za

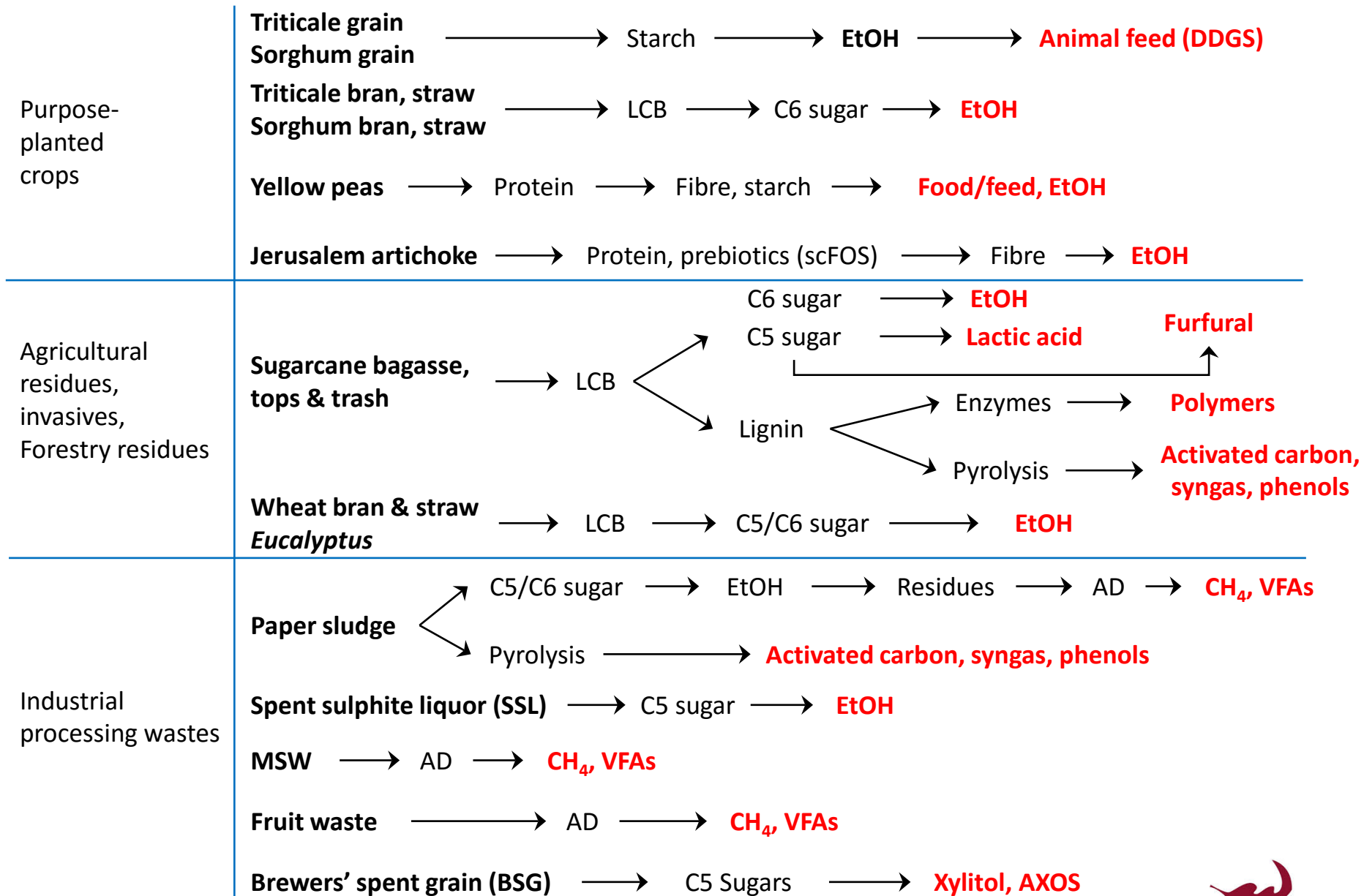
Microbiology



Prof Marinda Bloom
mv4@sun.ac.za



Biorefinery concepts developed at Stellenbosch

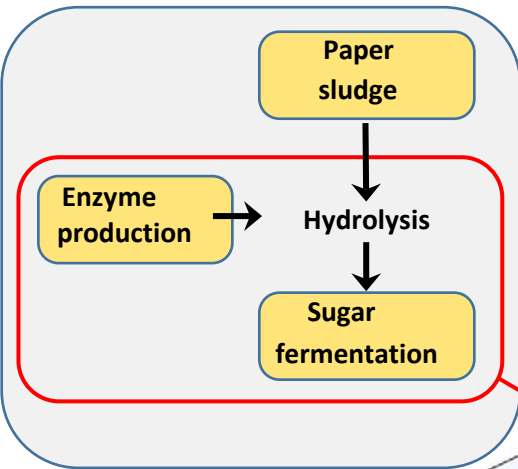


Biofuels from waste & waste streams

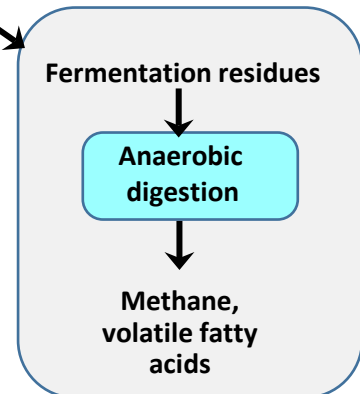
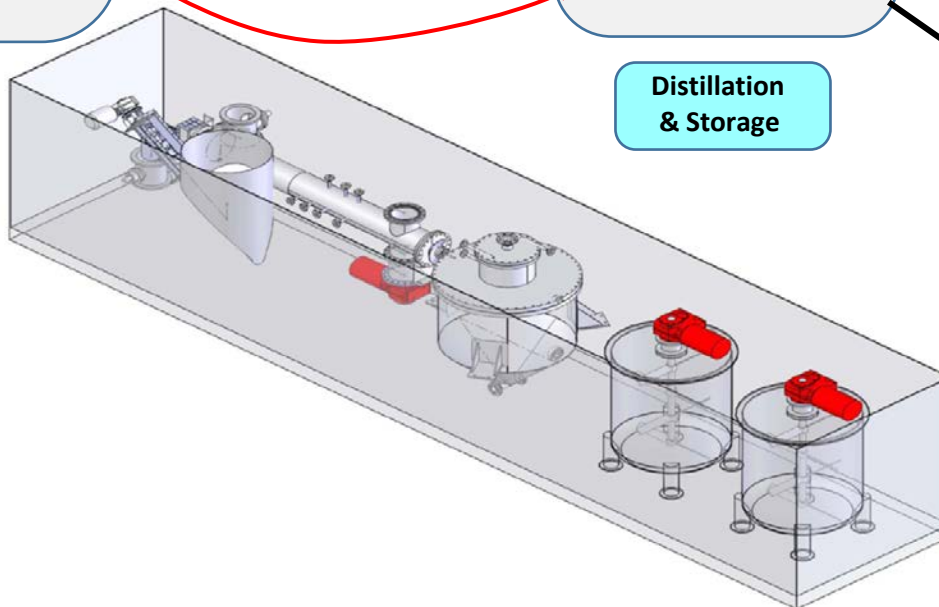
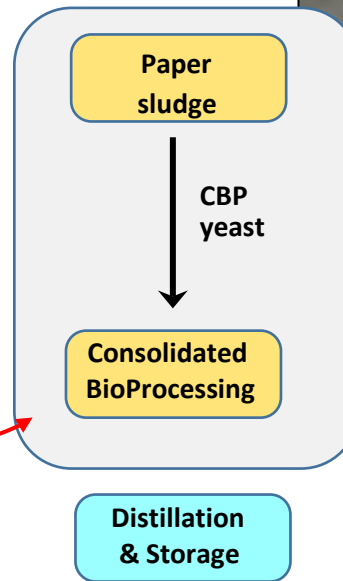


Consolidated processing of paper sludge

Traditional Approach

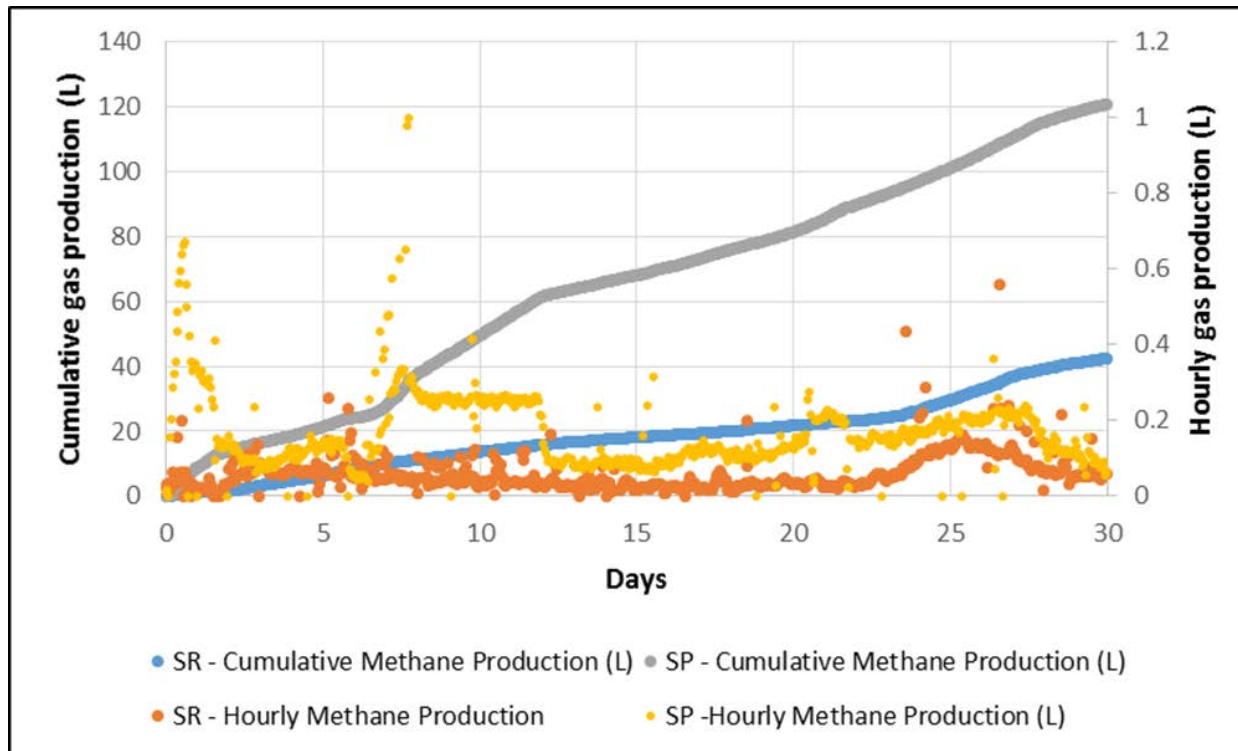


Stellenbosch Approach



Paper waste valorisation – EtOH vs. Biogas

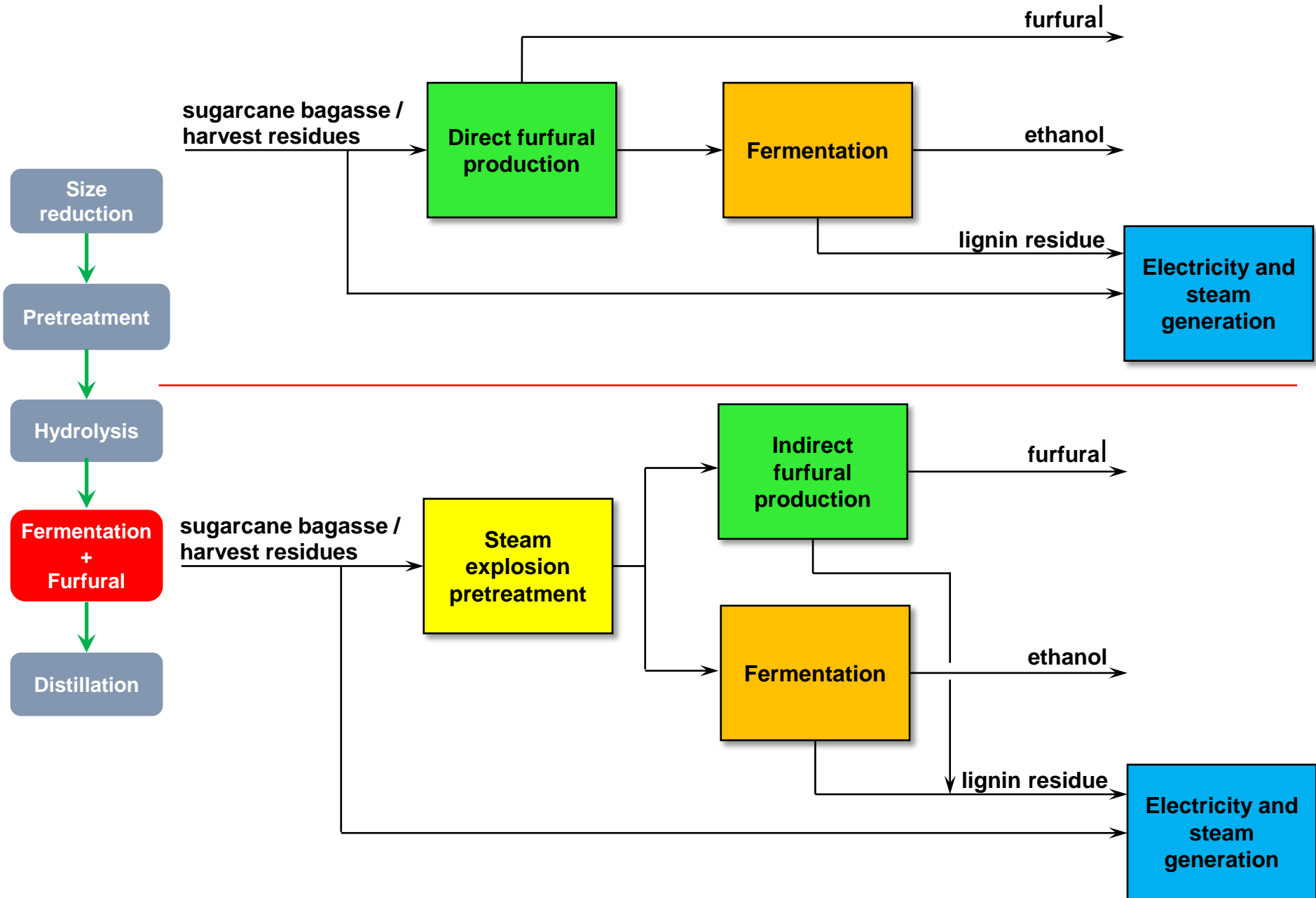
- Work in our group
 - AD of paper sludge waste and paper sludge fermentation residues
- PS Fermentation residues more than double BMP than raw PS
 - Makes a solid case for sequential fermentation – AD from waste paper



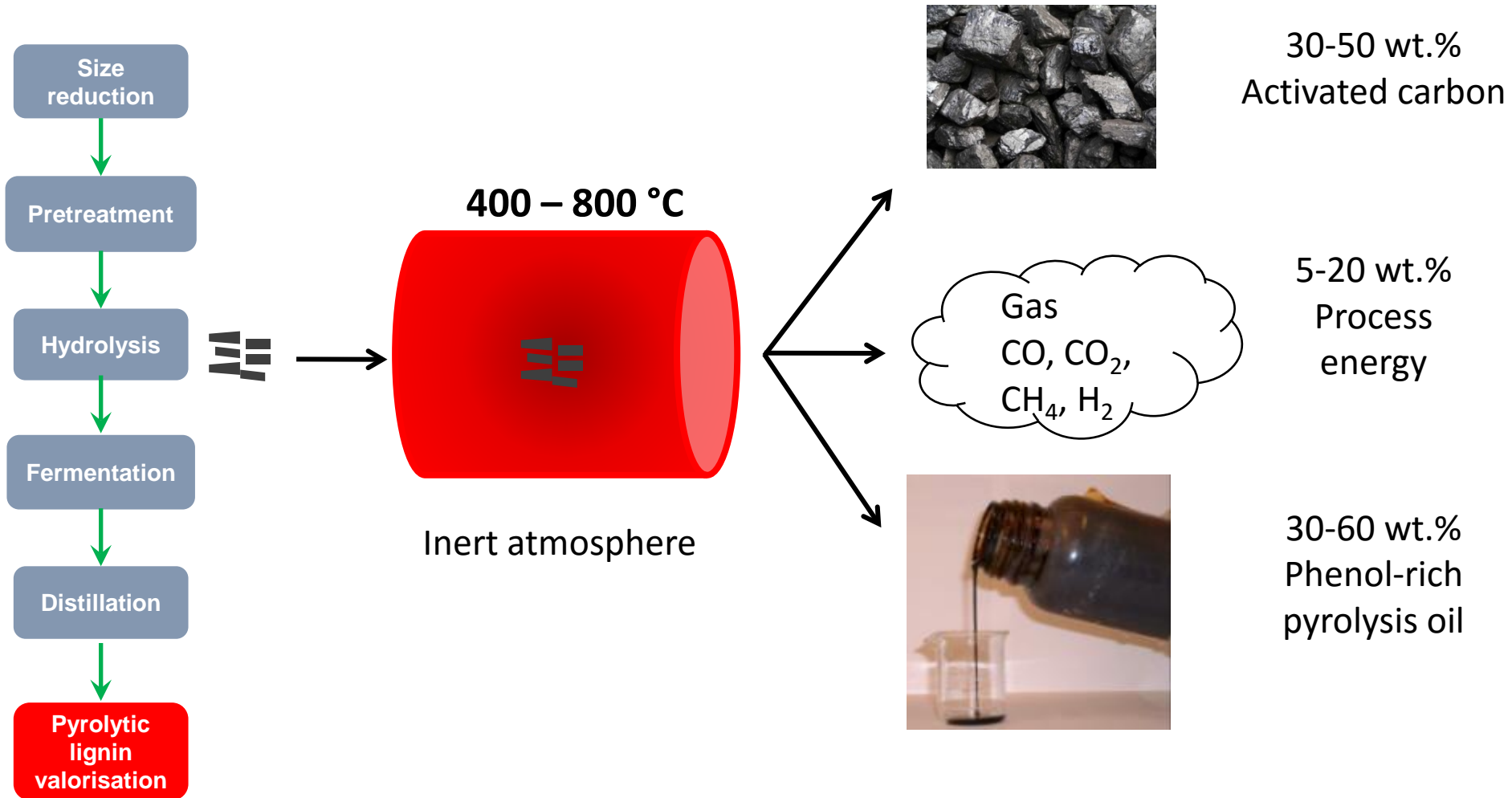
SR: Sludge Raw; SP: Sludge Processed



Integrated furfural production from **sugarcane bagasse**

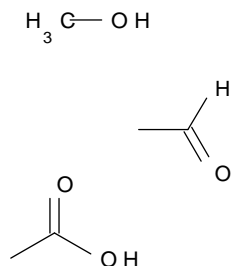


Lignin pyrolysis



Lignin pyrolysis oil composition

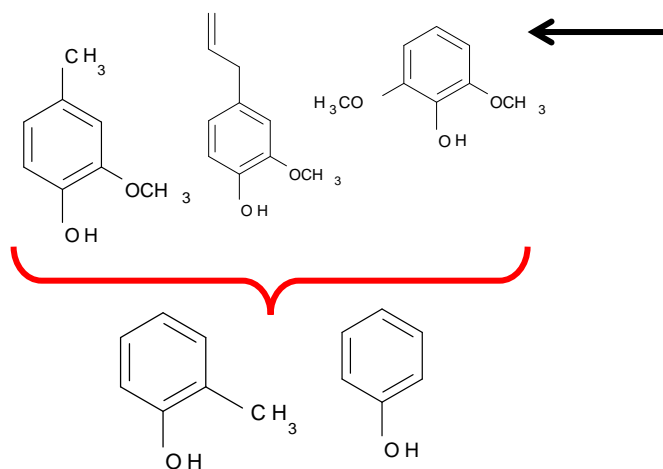
C₁-C₄
compounds



Methanol, aldehydes,
carboxylic acids

Water
5-20 wt.%

Phenols
Complete
depolymerisation
Several compounds < 3 wt.%



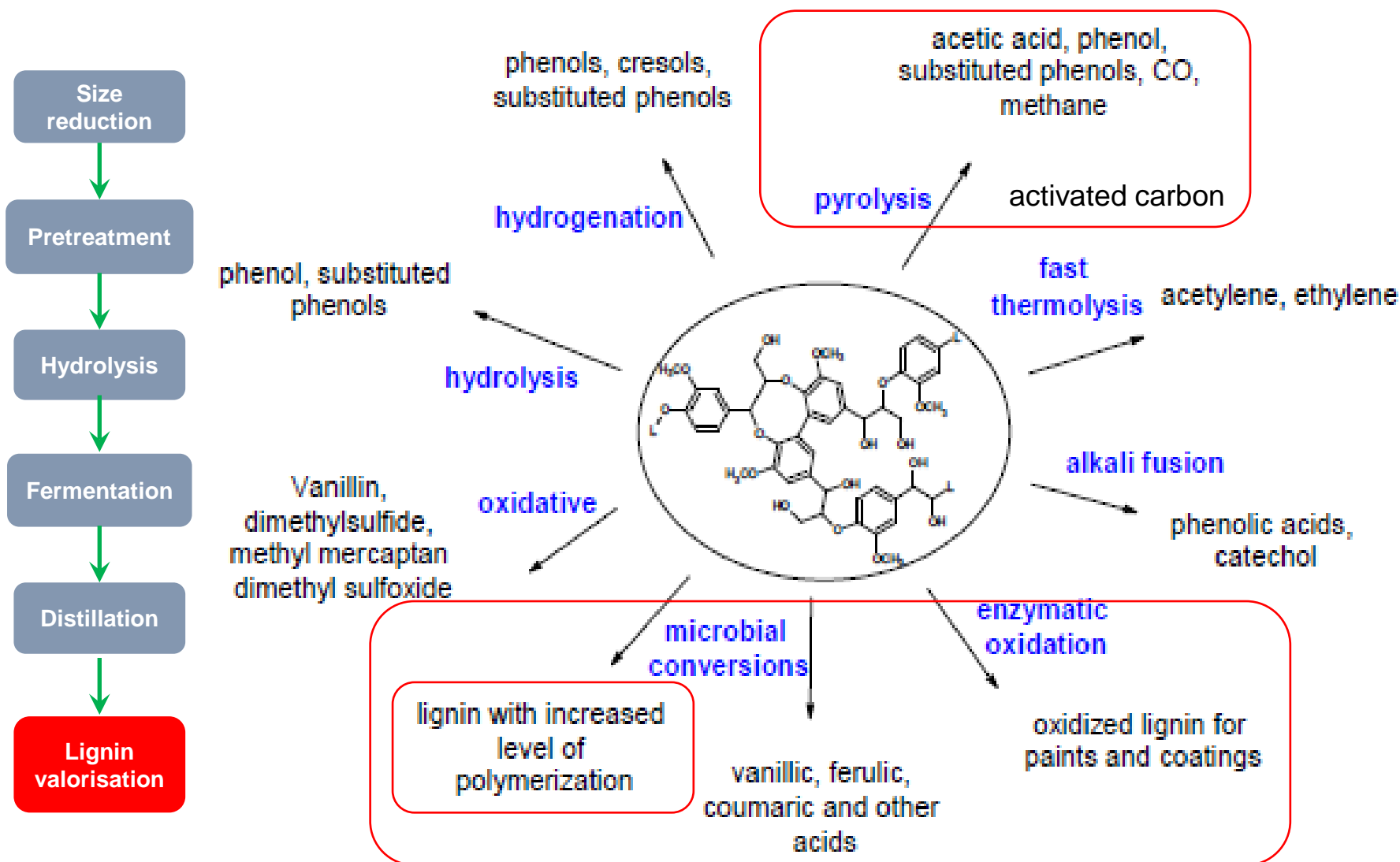
Oligomers
Incomplete
depolymerisation
2-5 monomers
10-30 wt.%

Catalyst

- 1) Improve depolymerisation
- 2) Increase selectivity towards specific phenols



Summary of lignin catalytic transformations



Applications for Western Cape – EtOH

- Alternative initiative: EtOH/Diesel blends
- City of Cape Town: Interest in investing in Scania ED95 busses
 - High volumes of bus transport/road freight/heavy haulage
 - High particulate emissions – greatest source of air pollution
- Alternative: 7-16% ethanol-diesel blends
- Opportunities
 - Substantial diesel volume replacement
 - Decreased emissions
 - Decreased dependence on fossil fuel sources
 - Environmental benefits
- Challenges
 - EtOH/diesel blends requires 0.5-1% additives to improve miscibility
 - SA diesel mostly by FT, low aromatic content – challenging even at <5% EtOH
 - Lock-in of EtOH/diesel blend consumer
 - Closed networks required where freight company owns dedicated depots/filling stations
 - Legislation does not allow for EtOH/diesel blends
 - ED95 not certified by DOE & SABS
 - 7-16% blends considered experimental



14-15 November
CTICC, Cape Town South
Africa



Academic wind conference hosted by SAWEA

In proud partnership with the Global Wind Energy Council (GWEC)

Sister event to the industry-focussed annual **WINDABA** conference.

Offers a platform for

international, high-quality academic exchange

broad spectrum of research topics in wind power
technical, environmental, socio-economic and policy aspects

The inaugural WindAc Africa conference in 2016.

WindAc is on-track to become

the premier international academic wind conference on the African continent



www.windac-africa.com



THE ACADEMIC HOUR FOR WIND POWER



SOUTH AFRICA'S PREMIER WIND ENERGY
CONFERENCE & EXHIBITION

SAVE THE DATE

EARLY BIRD RATES AVAILABLE

14-15 NOVEMBER 2017, CTICC
CAPE TOWN, SOUTH AFRICA

www.windac-africa.com

15-16 NOVEMBER 2017, CTICC
CAPE TOWN, SOUTH AFRICA

www.windaba.co.za

For more information please contact:

Kirsten Francis:
(Windaba & WindAc)
E: kirsten@windaba.co.za
E: kirsten@windac-africa.com
T: +27 21 448 5226

Yolanda Adams:
(Windaba & WindAc)
E: yolanda@windaba.co.za
E: yolanda@windac-africa.com
T: +27 21 448 5226

Dr. Valerie Bischof-Niemz:
(WindAc)
E: valerie@windac-africa.com
E: valerie@sawea.org.za
T: +27 61 541 6140



An official event of the
South African Wind Energy Association
and Global Wind Energy Council



Conclusions

- Western Cape at forefront of RE development in SA
- Strong RE development structure and political buy-in (REIPPPP)
- Most tech advances in solar and wind energy, biomass rapidly advancing
- Good alignment with RLS - Energy
- Several opportunities for collaboration

- Contacts

Eugene van Rensburg (Stellenbosch Univ): eugenevrb@sun.ac.za

Lauren Basson (Green Cape): lauren@green-cape.co.za

Valerie Bischof-Niemz (WindAc): valerie@sawea.org.za







FAKULTEIT INGENIEURSWEESE
FACULTY OF ENGINEERING



UNIVERSITEIT
STELLENBOSCH
UNIVERSITY



Overview of research activities

- Solar Thermal Energy
 - STERG: Solar Thermal Energy Research Group
- Wind Energy
 - Direct-drive permanent magnet generators
 - Grid integration
 - Conditioning monitoring of large wind turbines
- Bio-Energy
 - 2nd Generation – Lignocellulose to bio-ethanol
 - Thermal conversion (Pyrolysis, gasification, combustion)
 - Bio-diesel
- Ocean Energy
 - Wave energy
 - Ocean current (Agulhas)
 - Resource and technology assessment
- Photovoltaics
 - Focus on PV systems
- Sustainable Development
- Systems Thinking

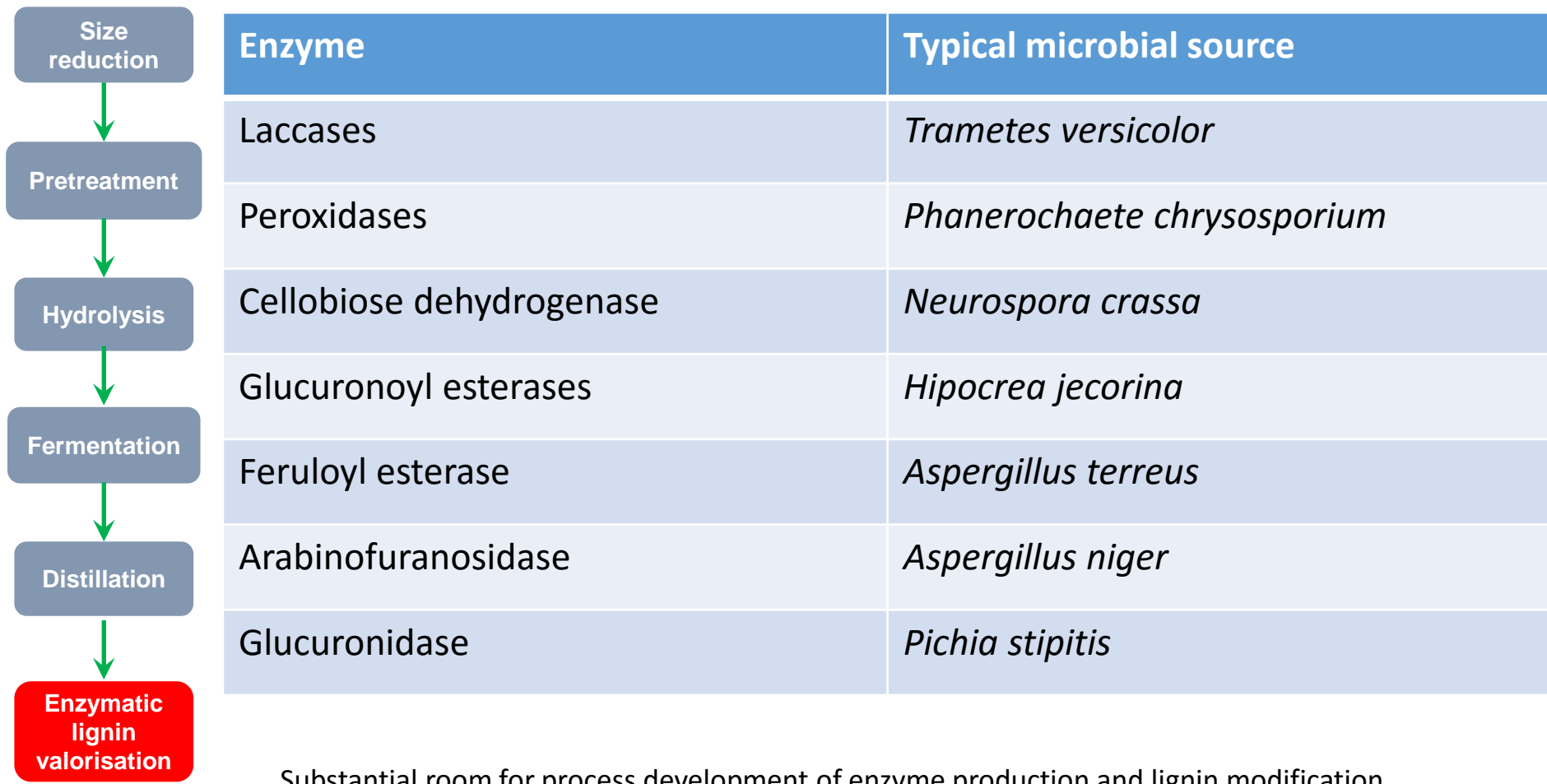


Examples of flagship projects

- Wind Energy Training Centre – SARETEC at CPUT
- National Solar Energy R&D Centre – On-going
- National Solar Resource Database and Maps (SAURAN)
- National Energy Modelling Network
- National Postgraduate Programme in RE



Typical enzymes for lignin repolymerisation



Hierarchy of societal needs

