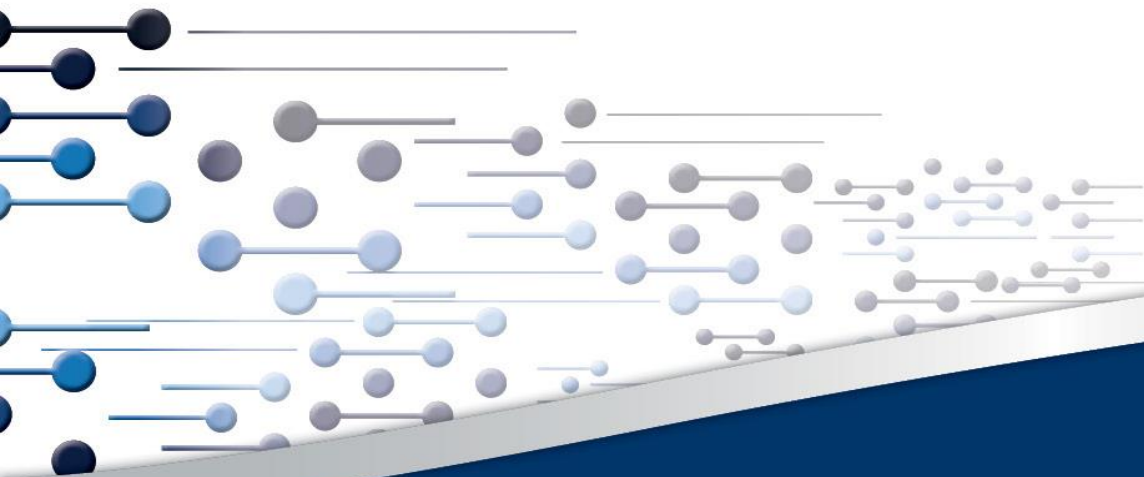


Research Need for High Renewables Futures

Presentation at the Stakeholder Consultation Workshop
for on the State of Renewable Energy in South Africa

CSIR Energy Centre

Pretoria, 28 November 2016



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Crescent Mushwana

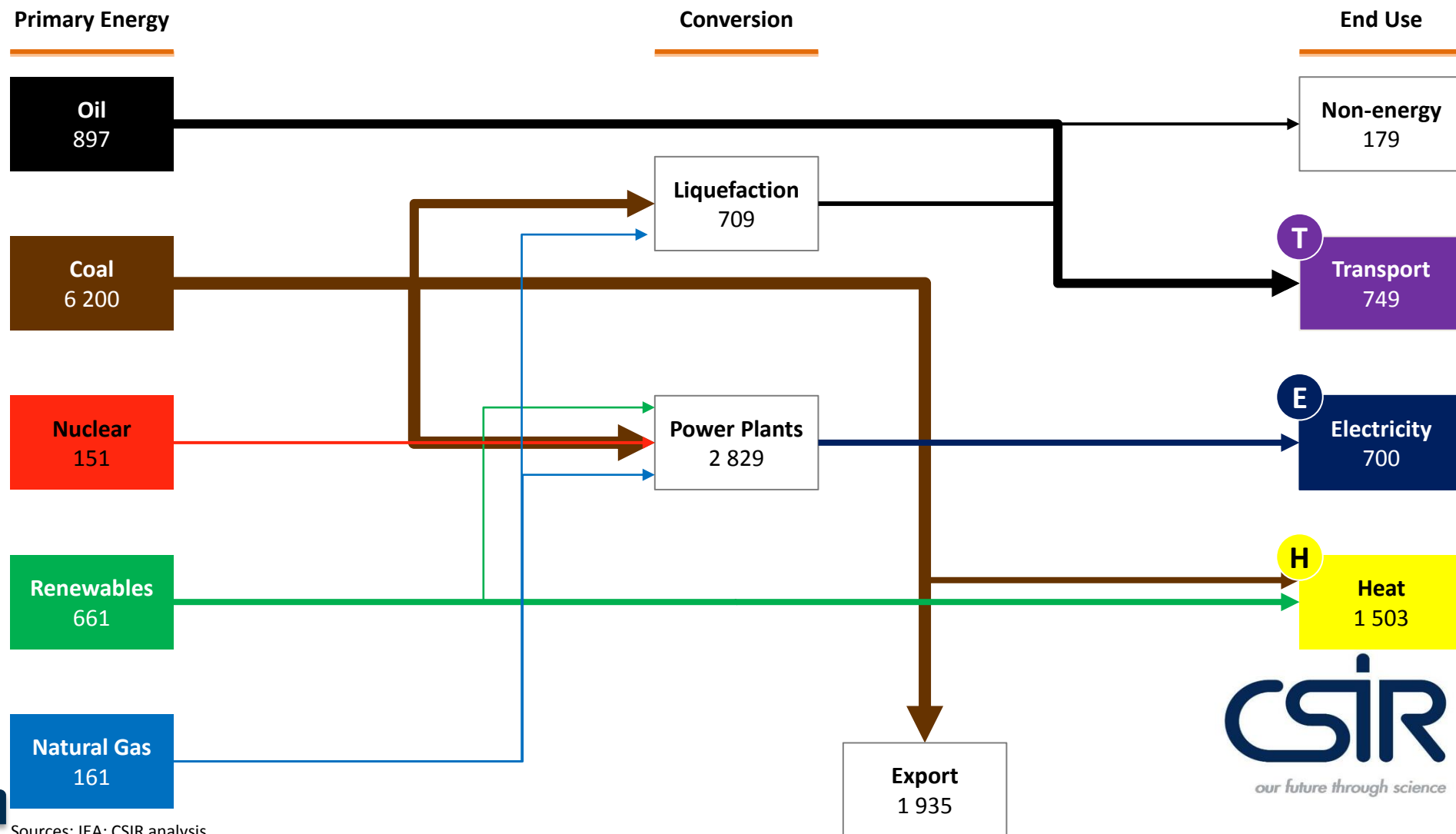
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our future through science

South Africa's energy system relies on domestic coal and imported oil

Simplified energy-flow diagram (Sankey diagram) for South Africa in 2014 in PJ



Today, very little sector coupling – electricity relatively easy to decarbonise, but transport and heat sector more challenging

Primarily supplied by

Decarbonisation potential

E

Electricity

Coal

Very high RE potential
RE fully cost competitive

T

Transport

Oil

Liquid biofuels limited potential
Needs coupling to electricity

H

Heat

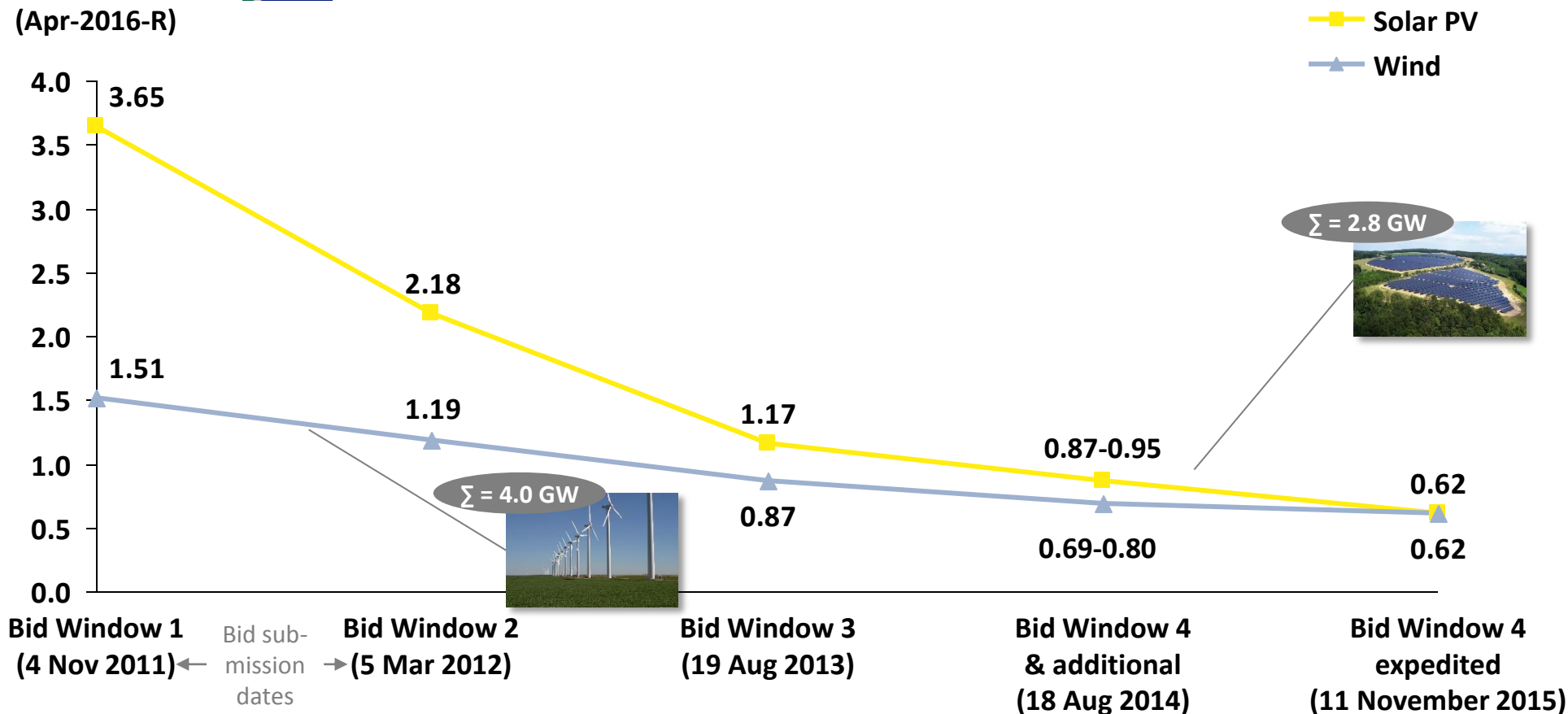
Coal/biomass
Electricity

Biomass limited potential
Needs coupling to electricity

E Competitive tender outcome: new wind/solar PV projects very cheap

First four Bid Windows' results of Department of Energy's RE IPP Procurement Programme (REIPPPP)

Average tariff
in R/kWh
(Apr-2016-R)



Sources: South African Department of Energy IPP Office's publications on results of first four bidding windows <http://www.energy.gov.za/IPP/List-of-IPP-Preferred-Bidders-Window-three-04Nov2013.pdf>; http://www.energy.gov.za/IPP/Renewables_IPP_ProcurementProgram_WindowTwoAnnouncement_21May2012.pptx; <http://www.ipprenewables.co.za/gong/widget/file/download/id/279>; IPP Office on Bid Window 4 expedited; StatsSA on CPI; CSIR analysis

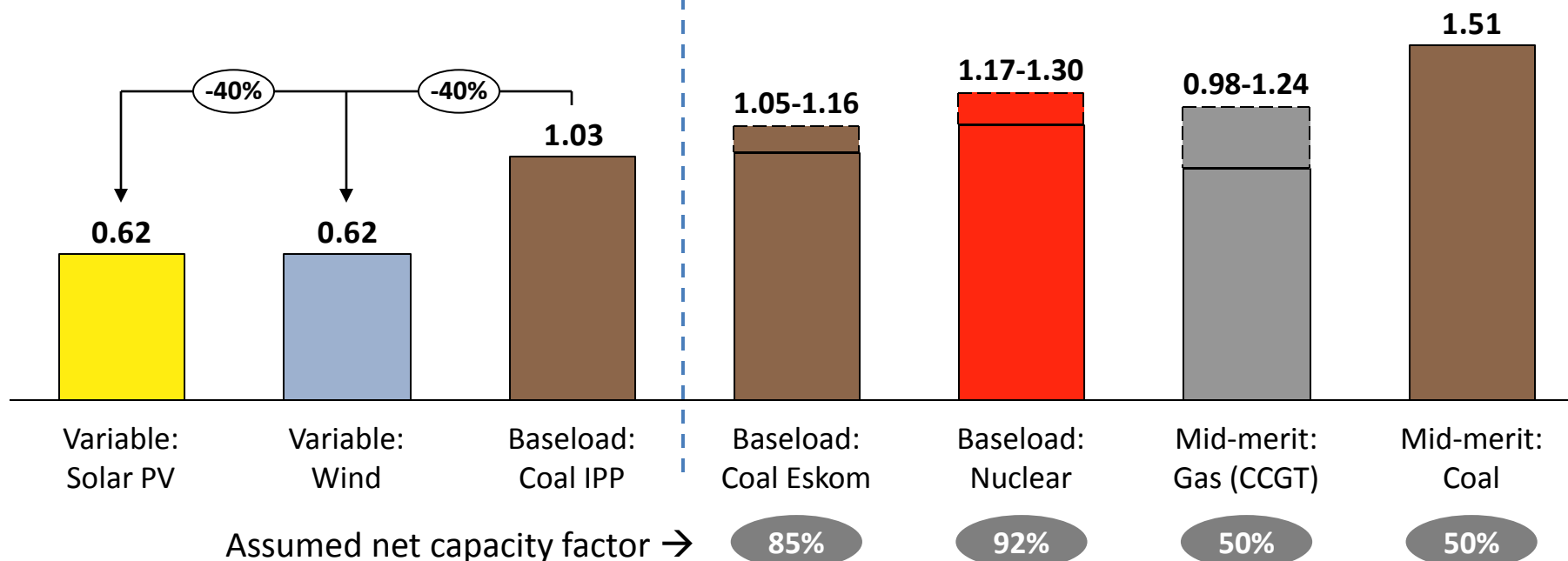
Consequence of renewables' cost reduction for South Africa: Solar PV and wind are 40% cheaper than new baseload coal today

**Lifetime Cost
per Energy Unit
in R/kWh**

(Apr-2016-R)

Actual new-build tariffs

Assumptions-based new-build cost



Note: Changing full-load hours for conventional new-build options drastically changes the fixed cost components per kWh (lower full-load hours → higher capital costs and fixed O&M costs per kWh); Assumptions: Average efficiency for CCGT = 55%, OCGT = 35%; nuclear = 33%; IRP costs from Jan-2012 escalated to Apr-2016 with CPI; assumed EPC CAPEX inflated by 10% to convert EPC/LCOE into tariff; Sources: IRP 2013 Update; DoE IPP Office; StatsSA for CPI; Eskom financial reports for coal/diesel fuel cost; EE Publishers for Medupi, Kusile & nuclear cost; CSIR analysis

E Additional renewable electricity sources in South Africa

Biogas from

- Municipal solid waste
- Waste water
- Agricultural waste
- Animal waste
- Energy crops



→ additionally: source of CO₂

Other forms of biomass

Hydro



CSP

Power-to-Power storage

- Pumped hydro
- Battery storage



T Transport sector consists of a number of sub-sectors

Ground transportation of people



Ground transportation of goods



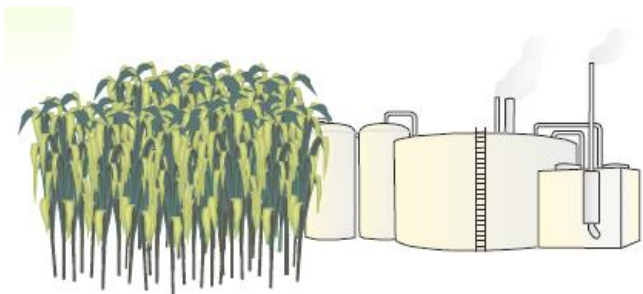
Aviation



Shipping

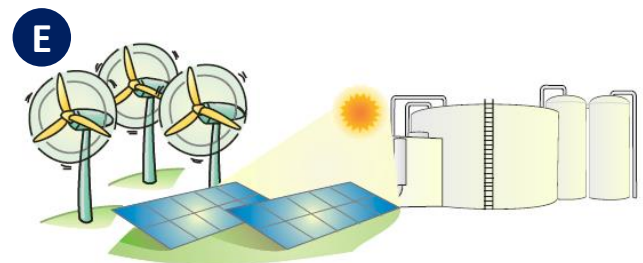
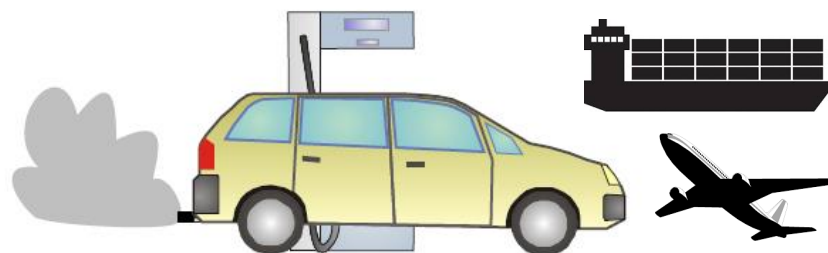


T In-principle options to decarbonise transportation



Liquid biofuels

- Biodiesel
- Bioethanol
- Biogas



Power-to-Gas/-Liquids

- H₂
- Methane
- Methanol
- Other liquid fuels



Power-to-eMobility

- Electricity



T Liquid biofuels with limited technical potential → supplementary

Today's annual liquid fuels consumption in South Africa:

- 11 000 million litres of petrol
- 13 000 million litres of diesel
- 2 200 million litres of jet fuel
- 500 million litres of fuel oil

=====

26.7 billion litres of liquid fuels per year

Arable land in South Africa: 120 000 km²

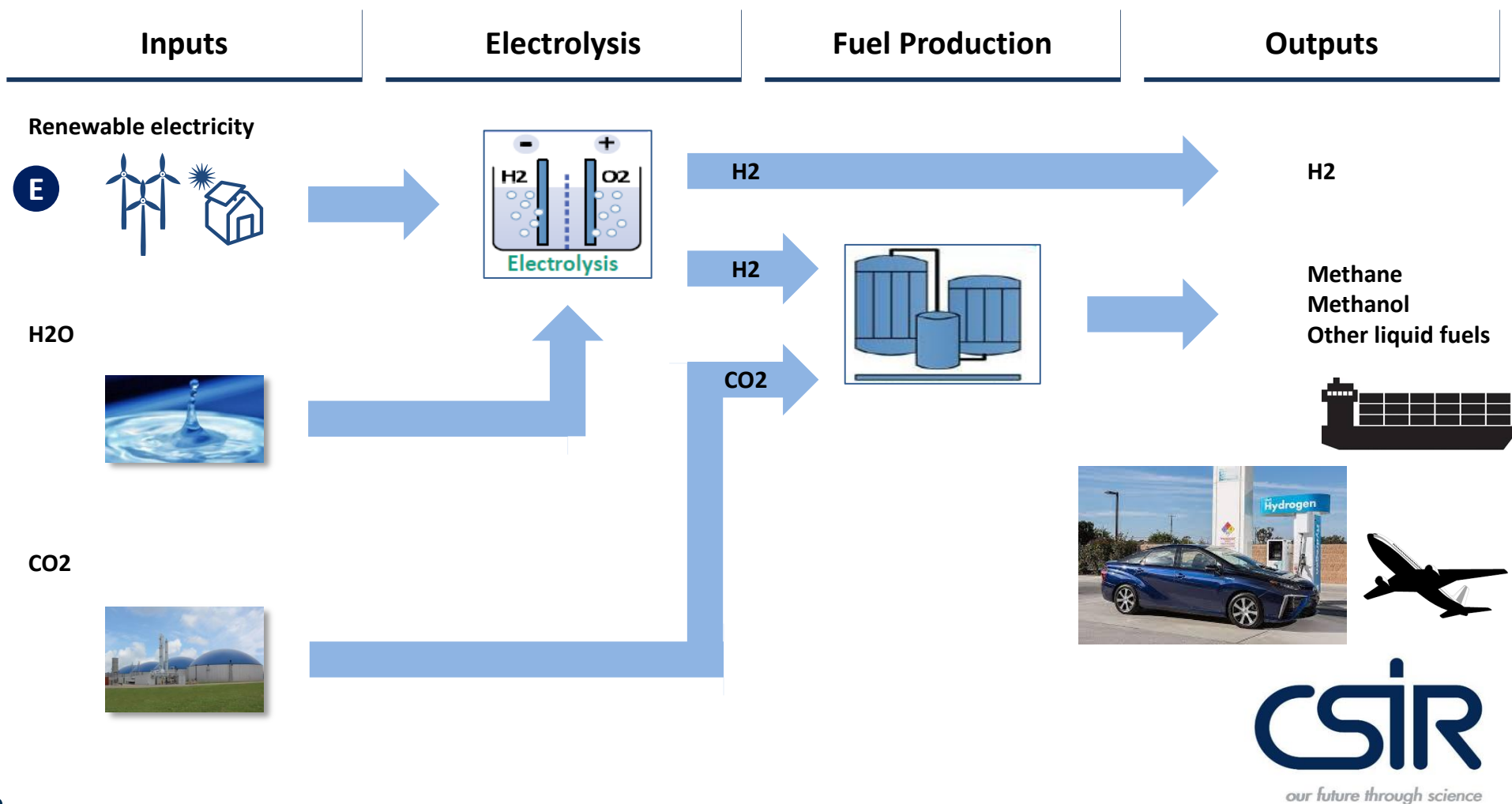
Average production of biofuel per hectare: 2 000 l/ha/yr

→ All arable land in South Africa could produce 24 billion litres of liquid fuels per year

→ Today's liquid fuel demand (without growth) could not be supplied by biofuels



T Hydrogen or hydro-carbons can be produced from RE electricity



Power-to-eMobility: battery driven for urban areas and highway overhead lines for long-distance transport of goods

Electrification of passenger transport



Electrification of transport of goods



Space heating/cooling and warm water largely electrified already in RSA, industrial process heat to be converted from coal to electricity

Space heating/cooling



Industrial process heat

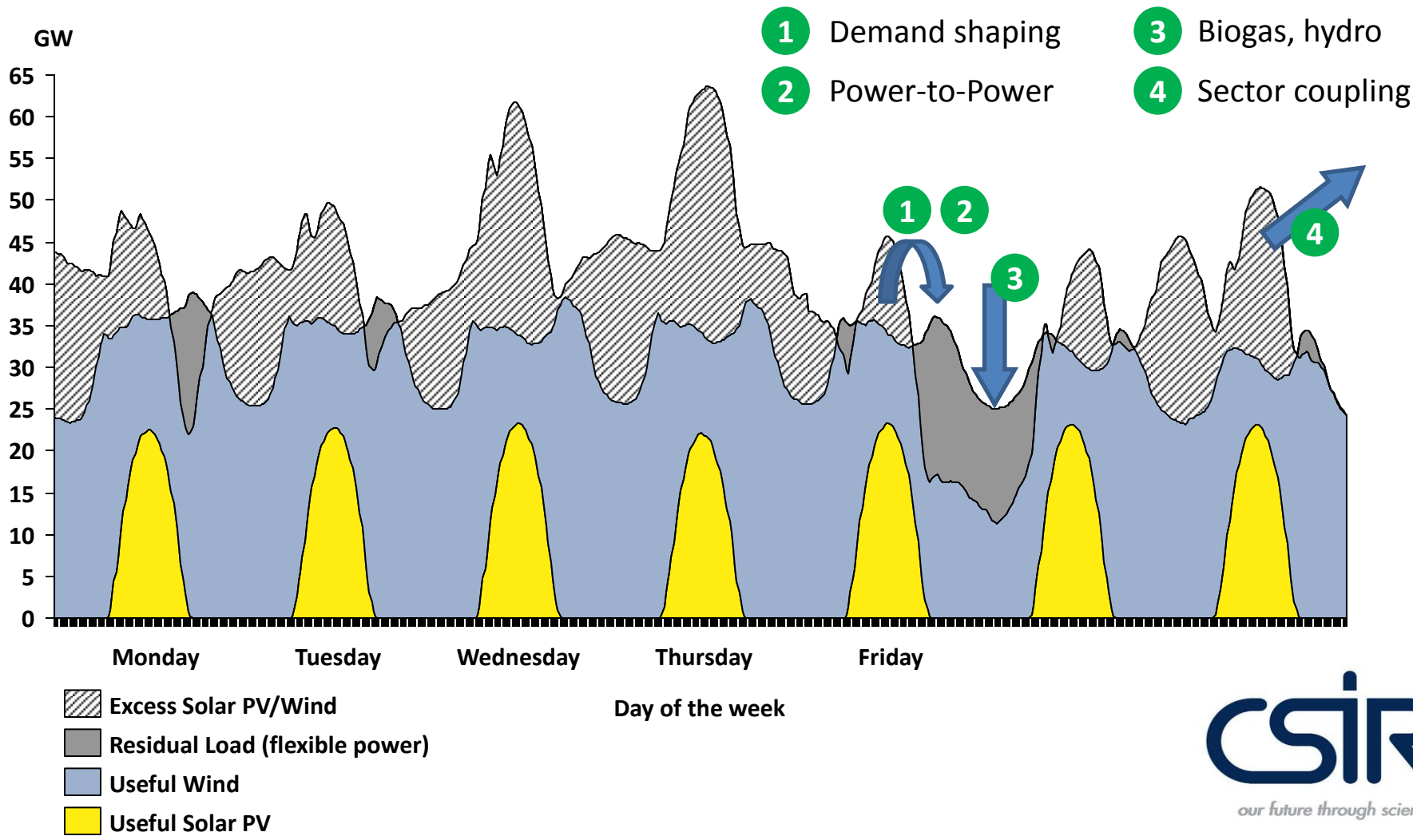


Warm water



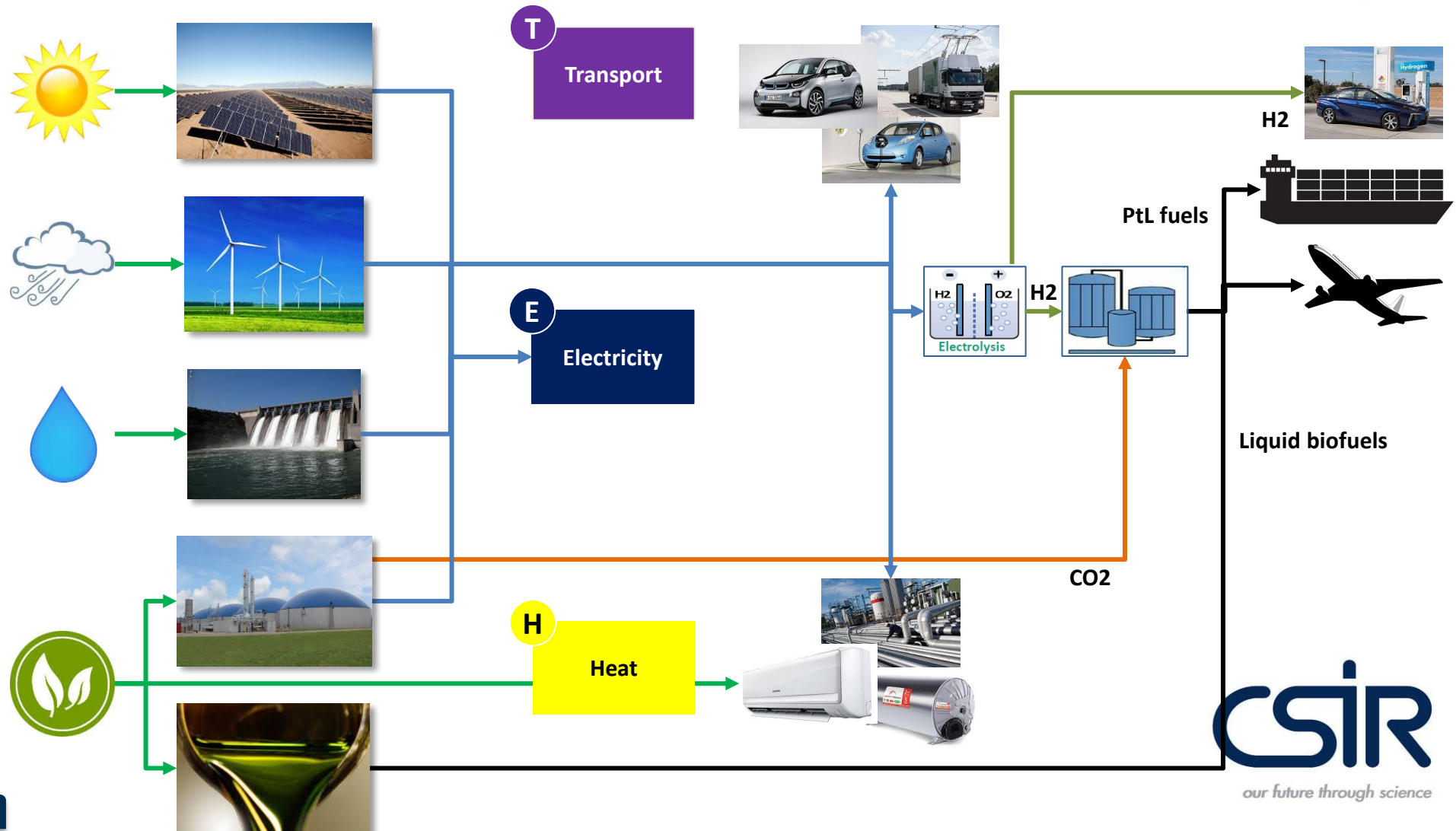
E Future energy system will be built around variability of solar PV & wind

Actual RSA demand and simulated 15-minute solar PV/wind power supply for the week from 15-21 Aug 2011

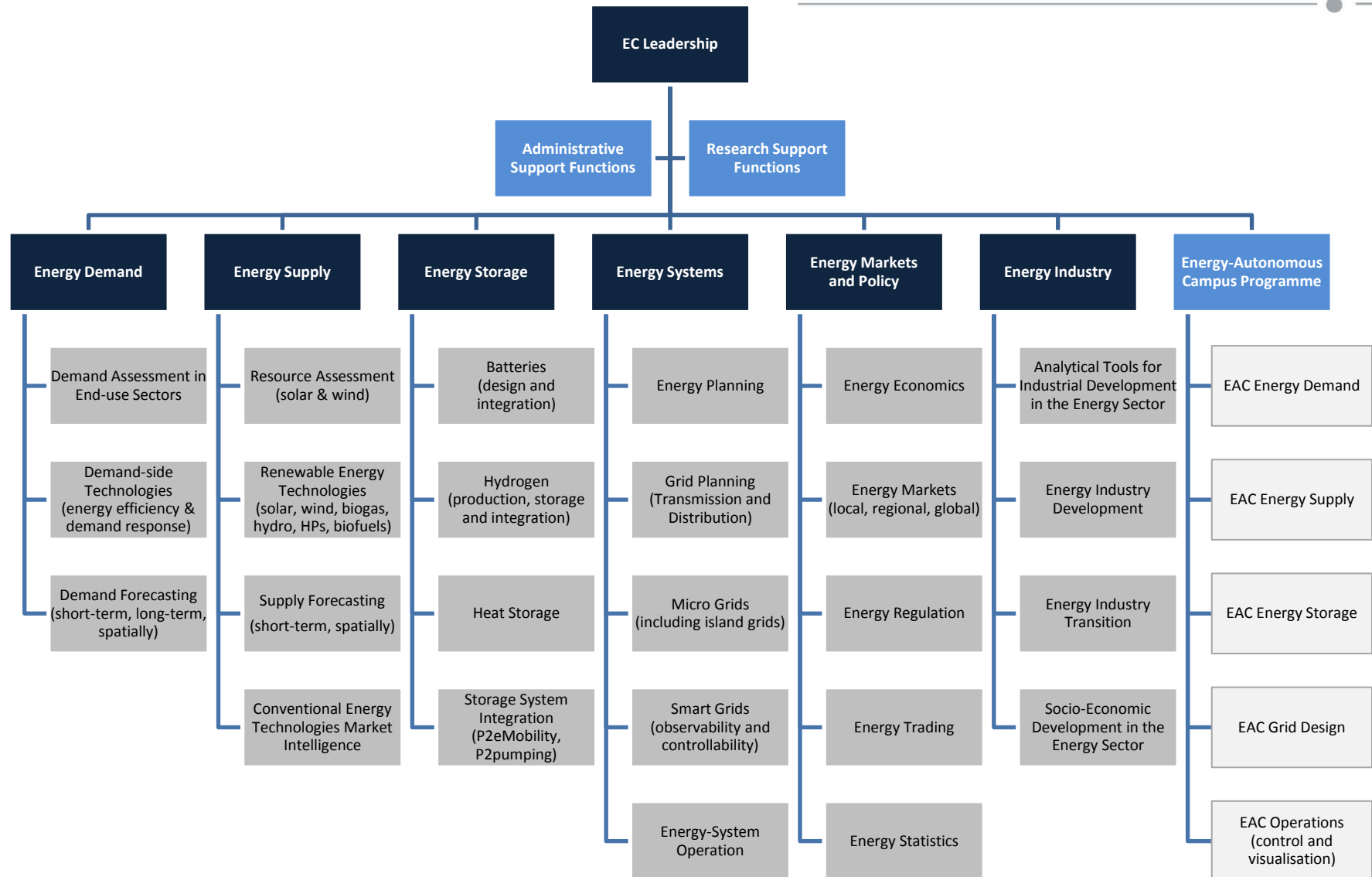


South Africa's energy system could rely 100% on domestic renewables

Hypothetical energy-flow diagram (Sankey diagram) for South Africa in the year 20??



CSIR's new Energy Centre streamlines and expands CSIR's energy research offerings in five areas – today: >25 employees, growing



Immediate power system studies required to enable a high renewables

Inertia studies

Fault level studies

Power Quality and Reliability studies

Electro Magnetic Transient studies

Cost of Collector Substations studies

Ha Khensa

Re a leboha

Siyathokoza

Enkosi

Thank you

Re a leboga

Ro livhuha

Siyabonga

Dankie

