DISTRIBUTED PROVISION OF (ENERGY) SERVICES AND THE POTENTIAL USE OF DECISION SUPPORT SYSTEMS TO IDENTIFY PROJECTS

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CSIR Built Environment

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ACP S&T Programme

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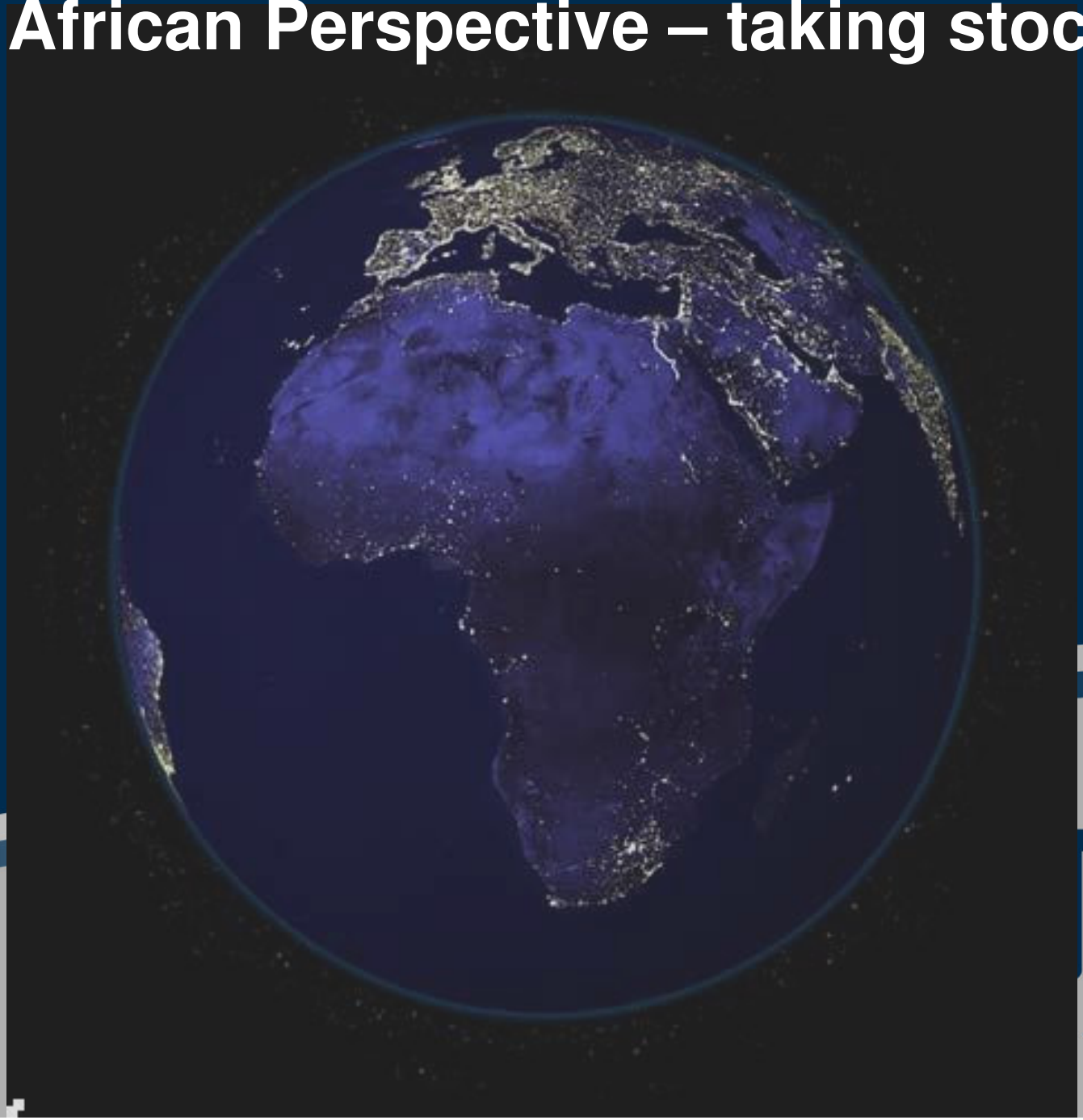
An African Perspective – taking stock



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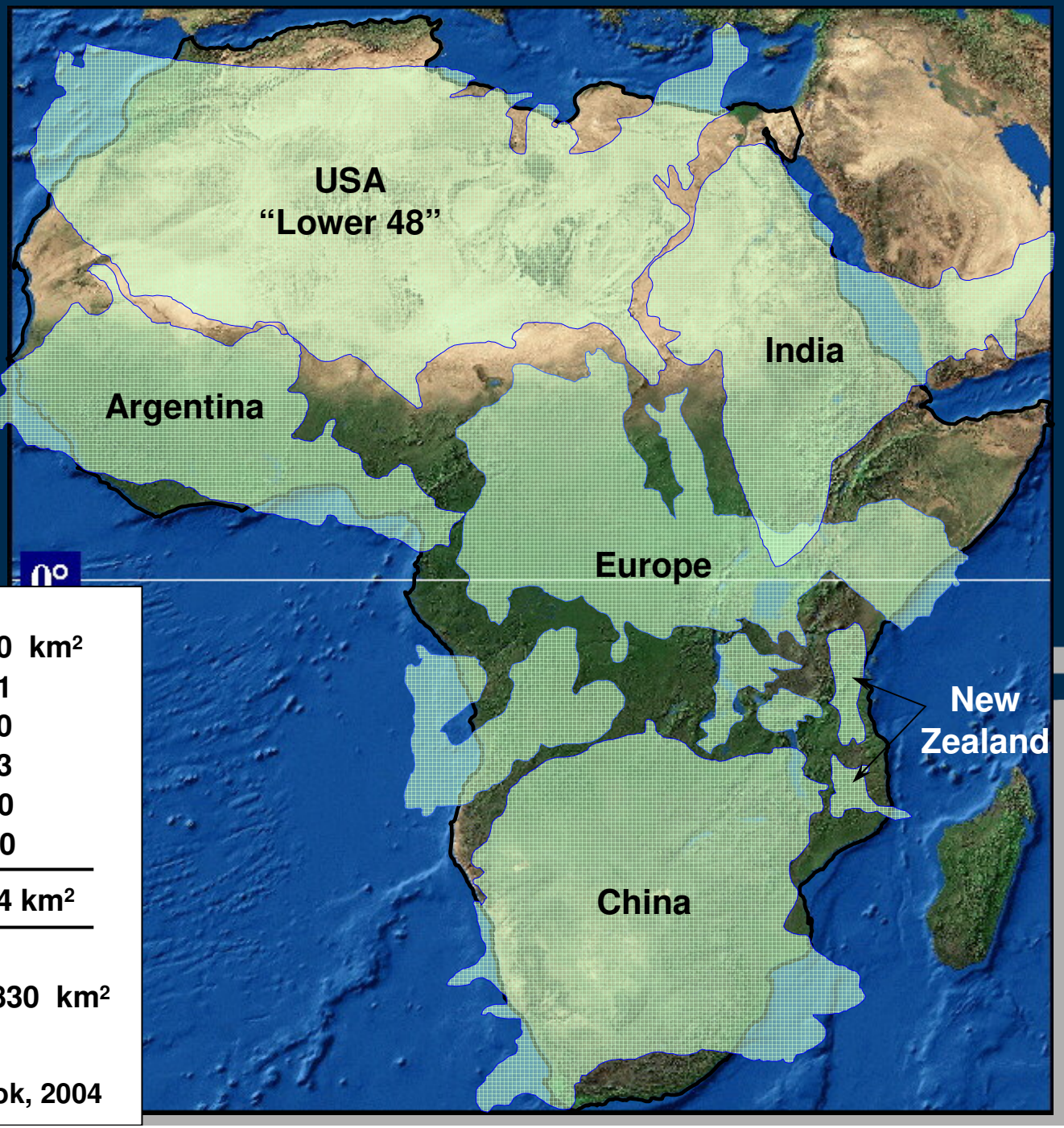
The Context



China	9,596,960 km²
USA	9,363,071
India	3,287,590
Europe	4,936,973
Argentina	2,766,890
New Zealand	268,680
TOTAL :	30,220,164 km²

Area of Africa: 30,318,830 km²

Source: World Factbook, 2004

Question:
How do we move Africa from a ‘cow-patty’ energy economy to a modern energy economy?

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A Fundamental Challenge

A fundamental challenge is to redefine the paradigm for sustainable development in the energy context

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Basic Premise for Sustainable Development

Energisation and electrification is only sustainable if there are economic activities to pay for it

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Development Challenge

The challenge is to increase access to safe and affordable energy services to enable productive economic activities and improvement in quality of life whilst decreasing the harmful side-effects of current energy practices

RATIONALE FOR ENERGIZATION PROJECTS

- Africa's economic priorities strongly formed by need to alleviate poverty
- 500 million African people without access to modern forms of energy
- Meeting of Millennium Development Goals
- Gain experience by piloting energy projects - "action research"
- Implementation of projects supported by sound research & development

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Why were projects initiated?

- **Policy Objectives relating to Energy White Paper**
  - ✓ Increasing access to affordable energy services
  - ✓ Improving energy governance
  - ✓ Stimulating economic development
  - ✓ Managing energy related environmental and health impacts
  - ✓ Securing energy supply through diversity
- **Shift in Emphasis**
  - ✓ Past = Number of Connections
  - ✓ Future = Sustainable Economic and Social benefits
  - ✓ Better “bang” for Governments buck
  - ✓ Payment for services

CSIR ENERGY SCENARIOS FOR AFRICA

SCENARIOS

Help us to

- consider key forces driving change
- understand the dynamics of the environment
- recognize new possibilities
- make decisions

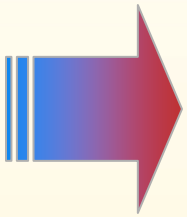
- Understand future Science and Technology requirements, and plan the necessary research and development

CSIR – Shell African Energy Scenarios

Key drivers and pivotal forces in Africa, southern Africa and South Africa

Global Energy Drivers

- Technology
- Resource constraints
- People and priorities



Africa Energy Drivers

- NEPAD and AU energy policies
- Poverty reduction
- Good governance
- Appropriate technology choice

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APPROPRIATE TECHNOLOGY CHOICES:

- Choices taken by Africa in the near future on its energy economy will have far reaching consequences on:
  - socio-economic development
  - sustainable use of ecosystems and
  - its non-renewable resources

  on a continental scale

IN MAKING THESE CHOICES……..

Many decision support processes will be required:

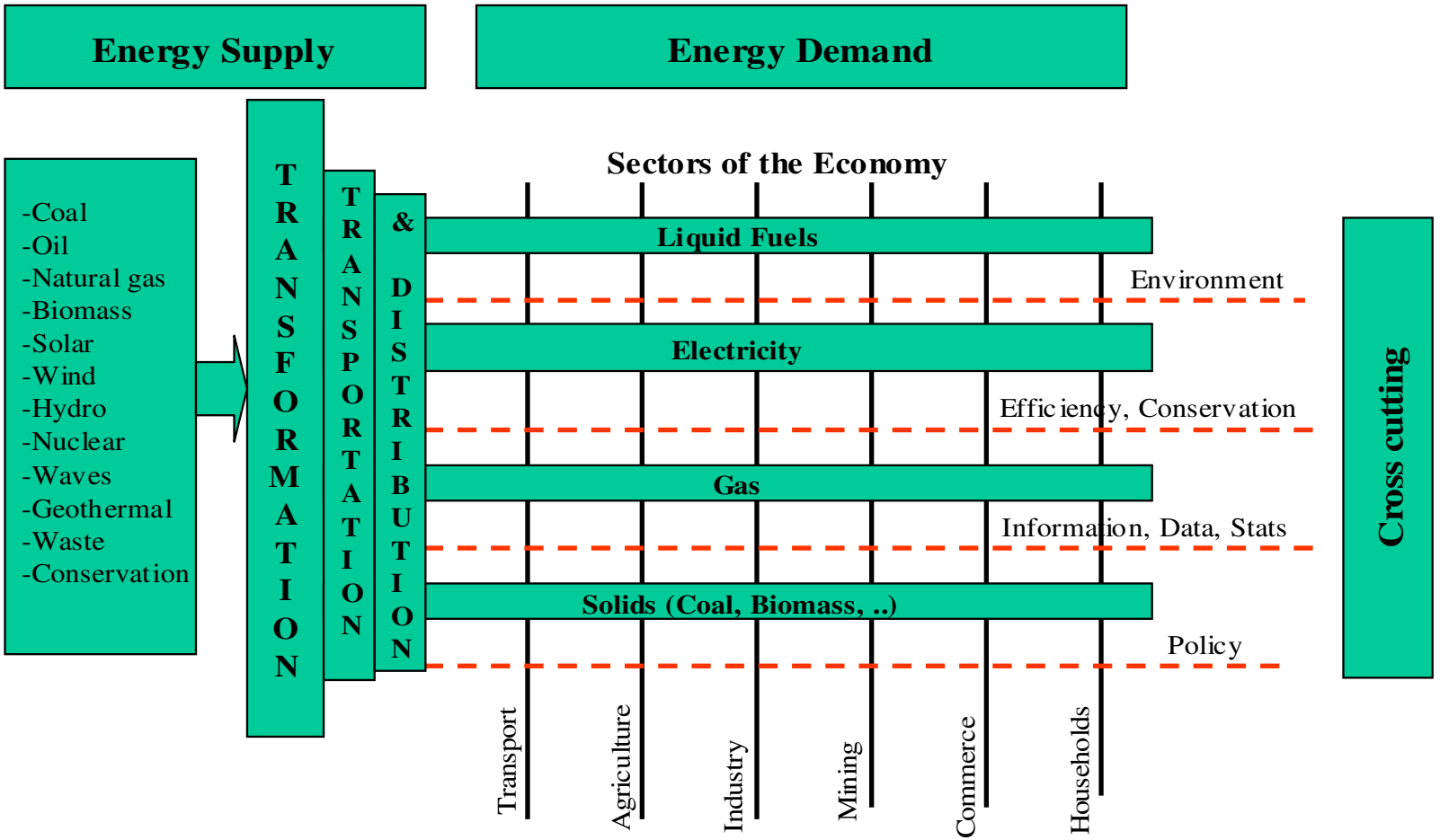
- Need access to good information, data & statistics

Dearth of good information, data & statistics in Africa:

- Obvious priority area for further investment

“To measure is to know”

Holistic nature of the energy economy



Courtesy: Dr G Venter - CSIR

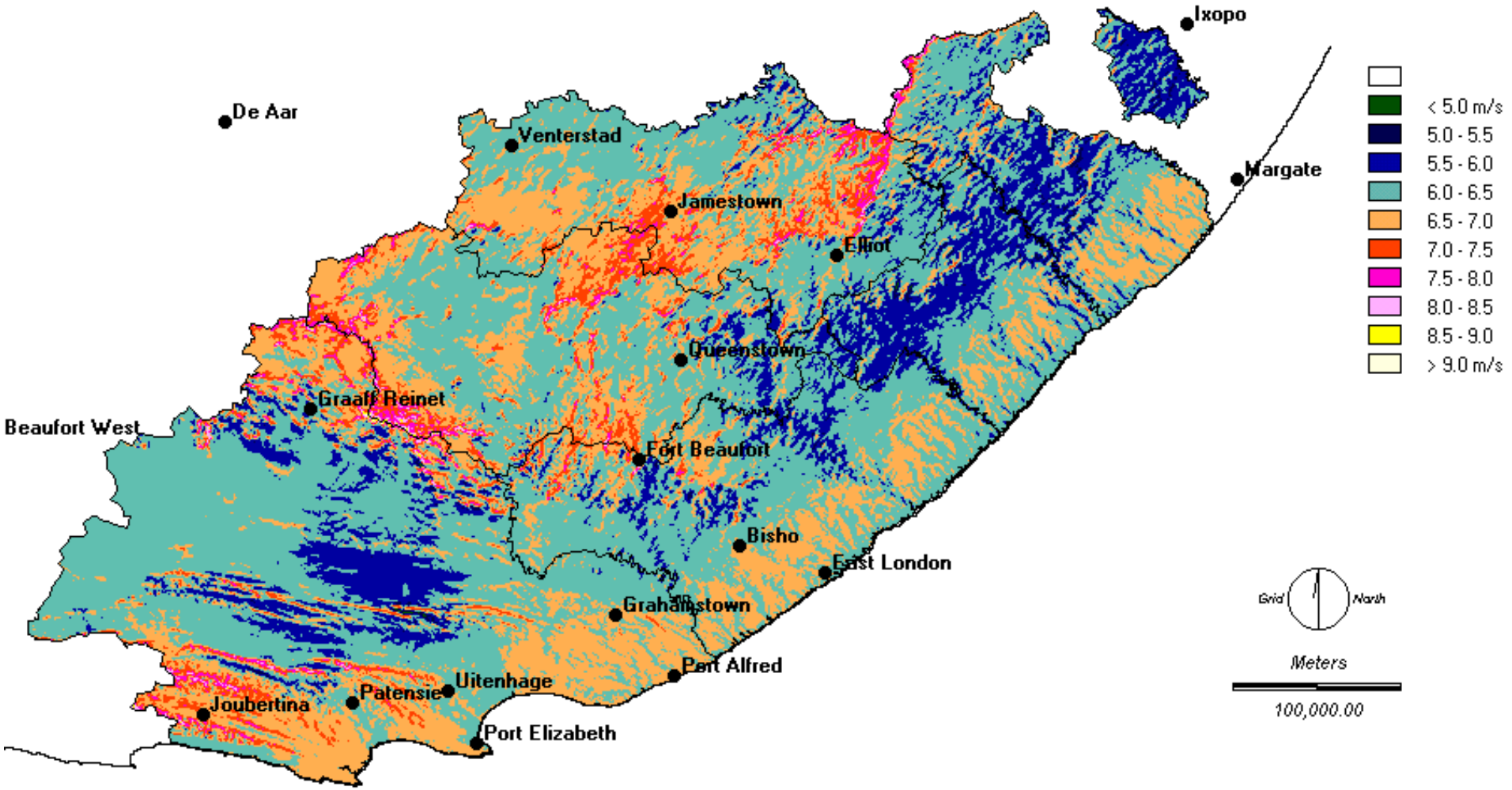
Case study: Renewable Energy for Rural Electrification in Eastern Cape

- **3 year multinational EU-SA investigative project**
- **Objective: identify rural electrification opportunities using renewable energies linked to existing & new economic activities**
- **Renewable energy resources investigated: wind, mini-hydro & biomass**
- **Geographic Information Systems (GIS) to present & interpret results**
- **Output: identification of implementable projects – emphasis on objective technological evaluations**

Possible demand from new economic activities (demand side)

- Agriculture
  - irrigation
  - processing
- Forestry processing
  - sawmills
  - pulp
- Eco-tourism
  - Wild Coast

Wind assessment at 60 m height



Lifetime unit cost calculations for supply side & demand side options

- 6.0% discount rate net of inflation
- 15 year term
- Systems sized for annual potential energy demand
- Electrical distribution costs included
- Separate approaches for wind, hydro, biomass
- Various economic activity options investigated

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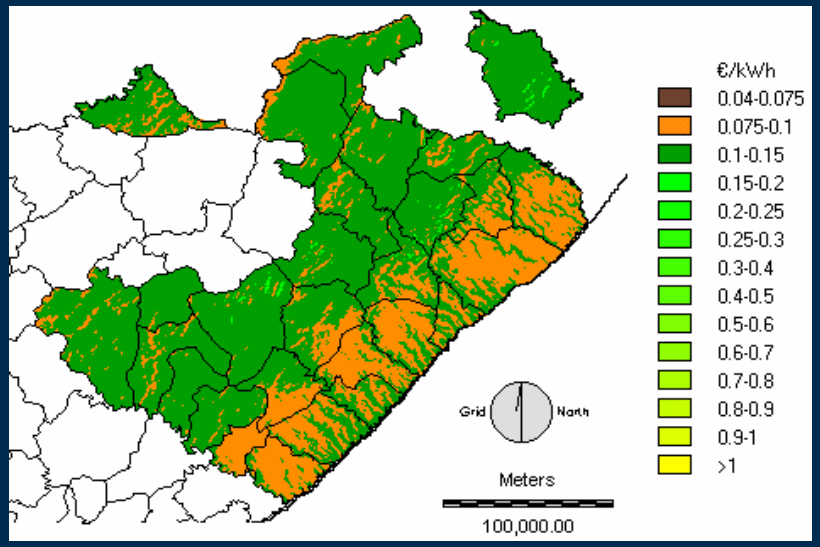
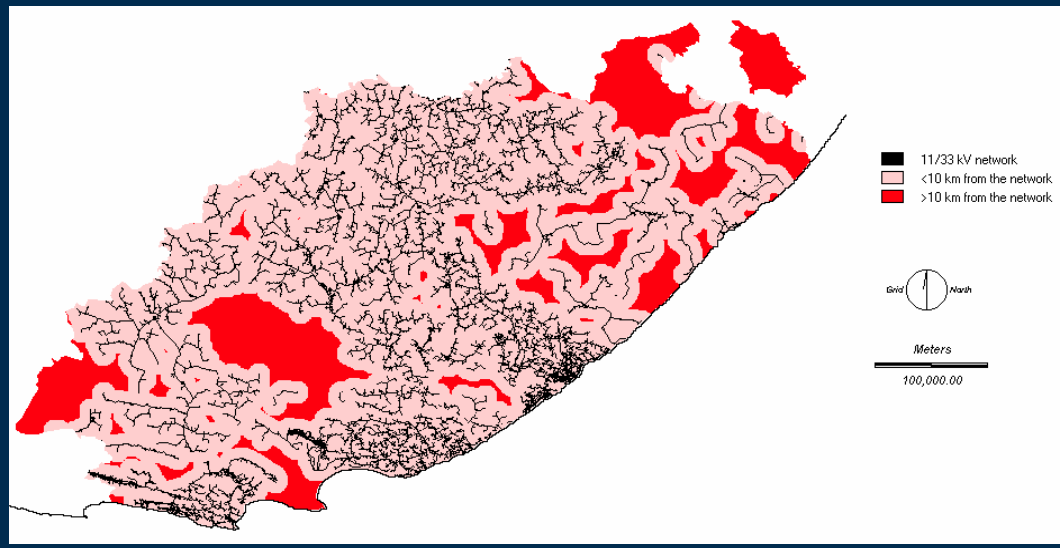
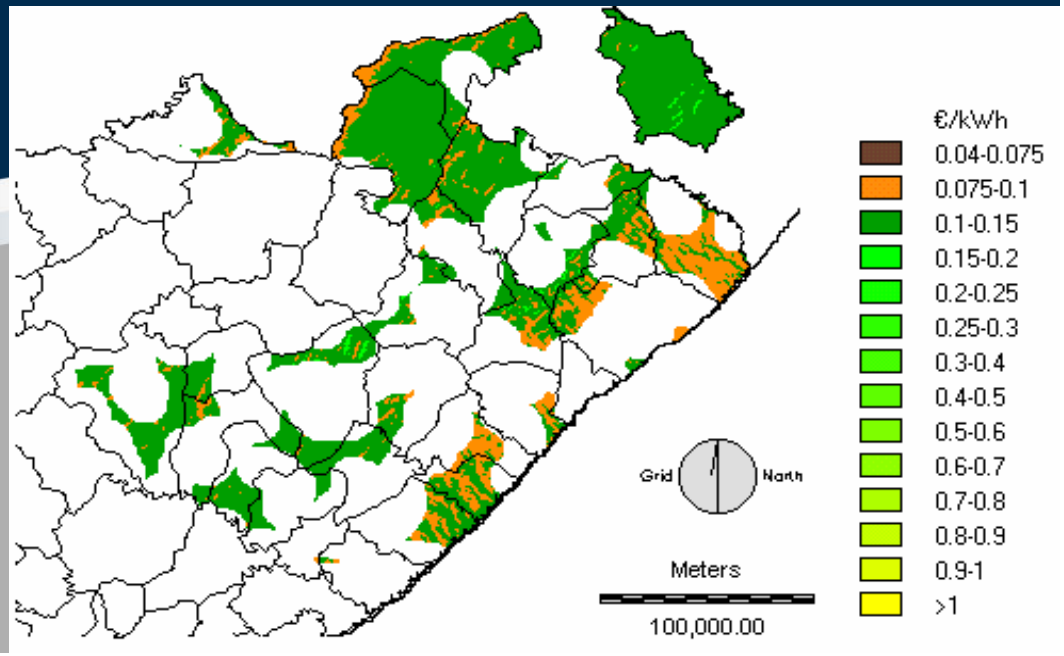
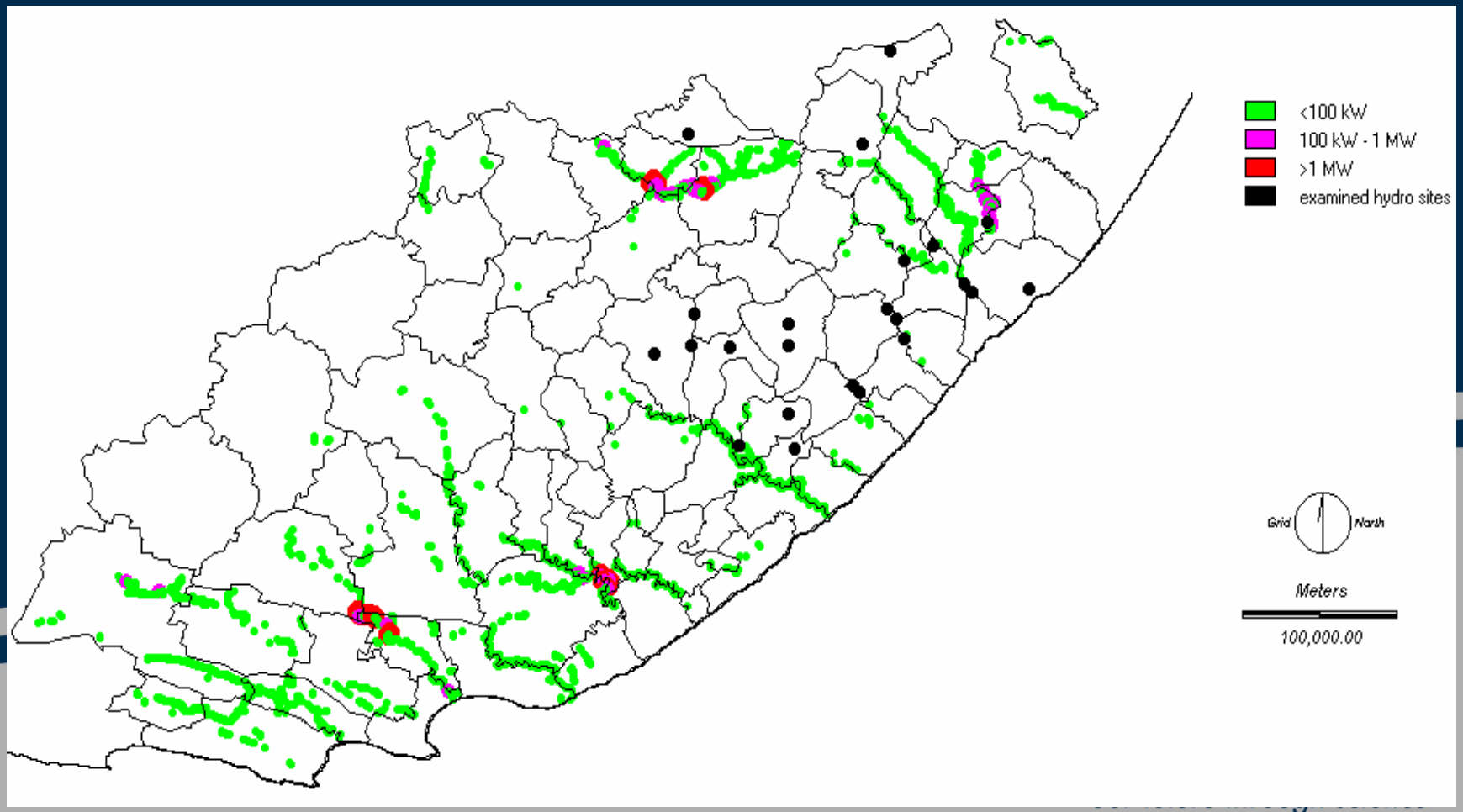
Example: geo-spatial analysis to determine costs of wind generated electricity



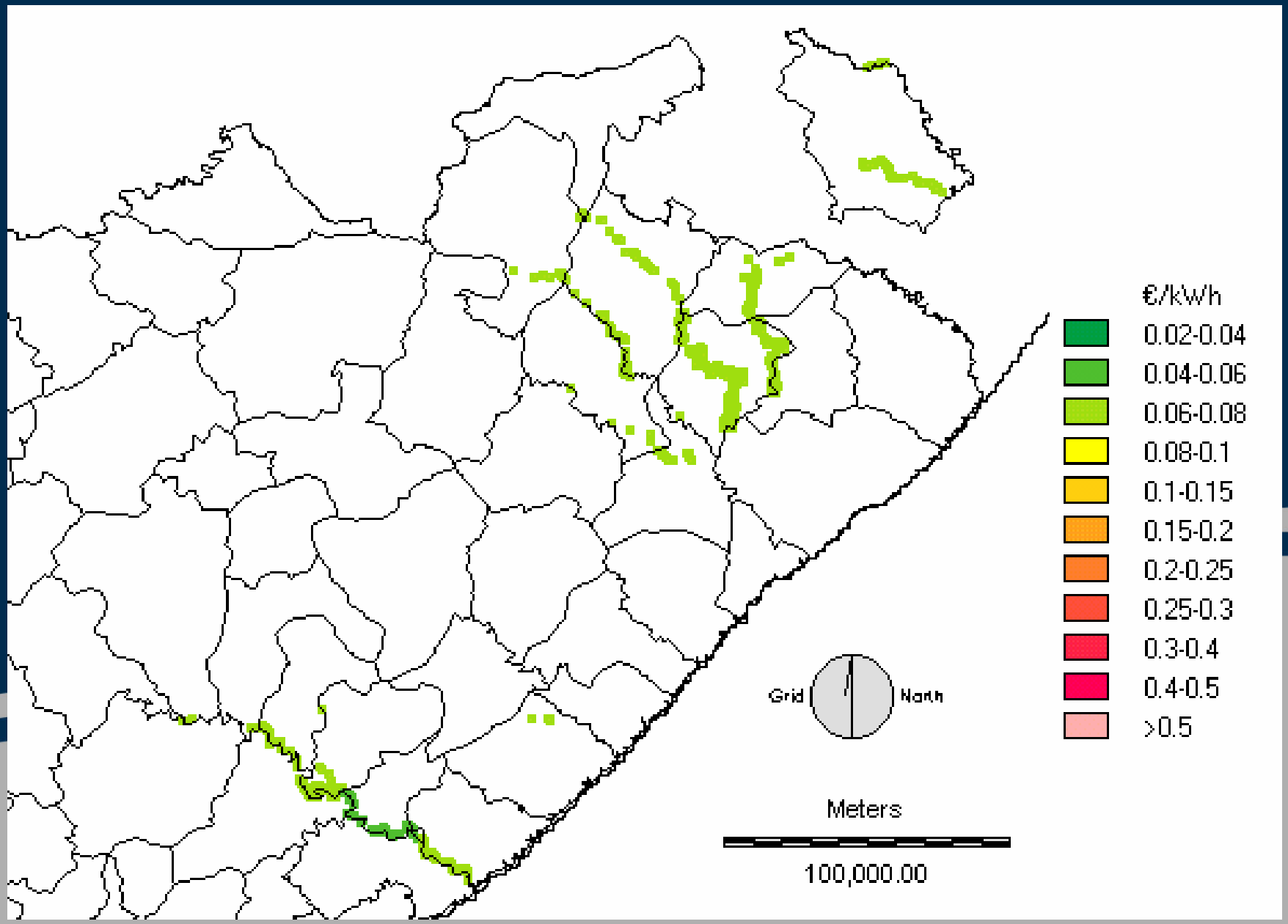




Potential small hydro sites larger than 10kW identified by modelling techniques (supply side)



Cost of electricity from hydro



Biomass generation technologies

Technology type	*Capacity*	*Availability*	*Efficiency*
Pyrolysis gasification IGCC/steam cycle >	*10 Mw_e*	*92%*	*32%*
ARBRE-type gasification CCGT	*>5 MW_e*	*82%*	*27%*
Combustion steam cycle	*>5 MW_e*	*95%*	*24%*
Small-scale gasification	*<1 MW_e*	*50%*	*19%*
Pyrolysis oil CCGT	*<5 MW_e*	*95%*	*38%*

Impact of Eastern Cape Project

- Obtained first hand understanding of complexity of poverty alleviation – technical & non-technical
- Developed Integrated Energy/Economic Framework – algorithm for poverty alleviation
- Identified energy projects at Hluleka Nature Reserve & Lucingweni village on Wild Coast

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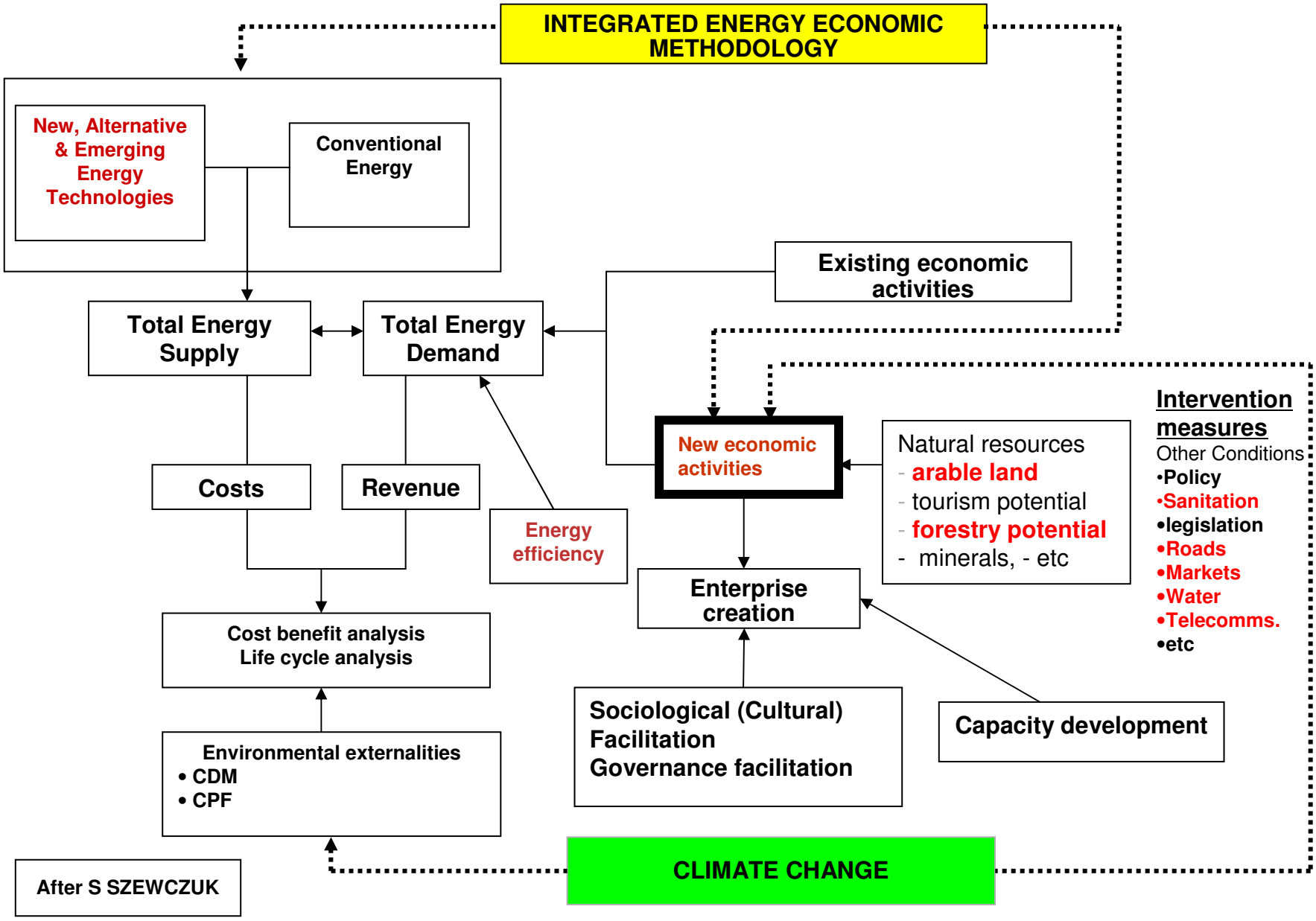
INTEGRATED ENERGY ECONOMIC FRAMEWORK



Hybrid mini-grids: Hluleka & Lucingweni

- Minister of Minerals & Energy mandated the NER (now NERSA) to facilitate piloting hybrid mini-grids
- Experience & understanding gained to inform decision & policy makers
- NER contracted CSIR to develop implementation plan
- Implementation partner – Shell Renewables
- Integrated Energy/Economic Framework applied
- Mini-grids integrated with providing potable water
- Energy efficiency concepts applied
- At Lucingweni – new economic activities initiated based on high value crops – done with Agricultural Research Council (ARC)

Hybrid Mini-Grid Energy Systems

Hluleka Nature Reserve

Lucingweni village

Agricultural Research Council (ARC): Identifying & training entrepreneurial farmers

Impact of research work

- Department of Energy (DoE) – funded a project to independently review the pilot hybrid mini-grid energy systems

- Department of Science & Technology (DST) – mini-grids were used as a case study in study on “Technology Transfer for Poverty Alleviation”

- CSIR: lessons learnt applied to
  - updating Integrated Energy/Economic Methodology
  - Investigating conversion of organic waste into biogas
  - Investigations into distributed/decentralised power generation – in particular those systems with wind energy technologies
  - Developing numerical models that simulate and evaluate targeted and systemic interventions for a virtual rural village by studying the effect of different development economic strategies in a community – prior to any implementation
  - Identifying shortcomings in wind data resource map
  - Scoping CSIR’s Integrated Research Infrastructure Platform (IRIP)

Integrating analytical tools into development planning

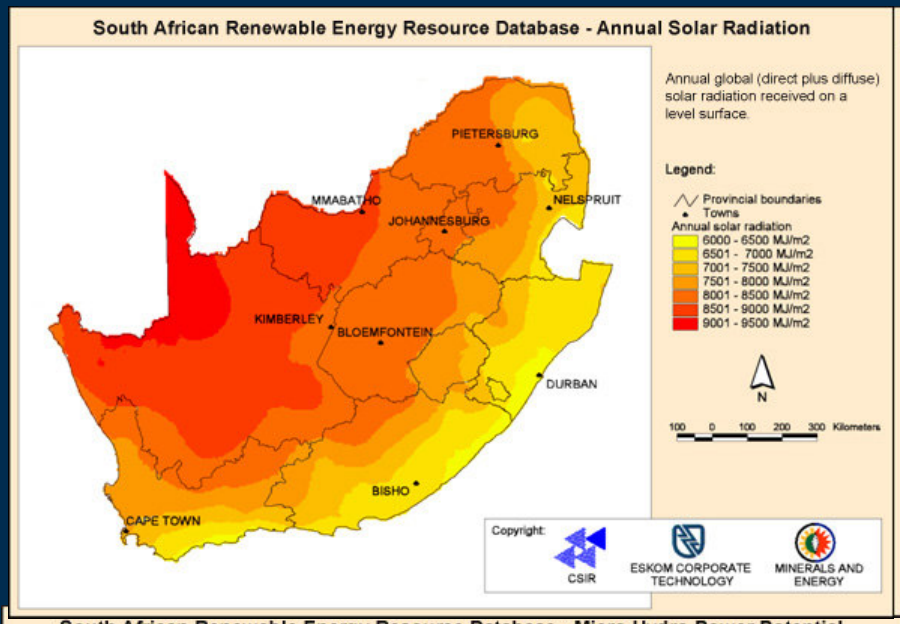
Much information is readily available in electronic format

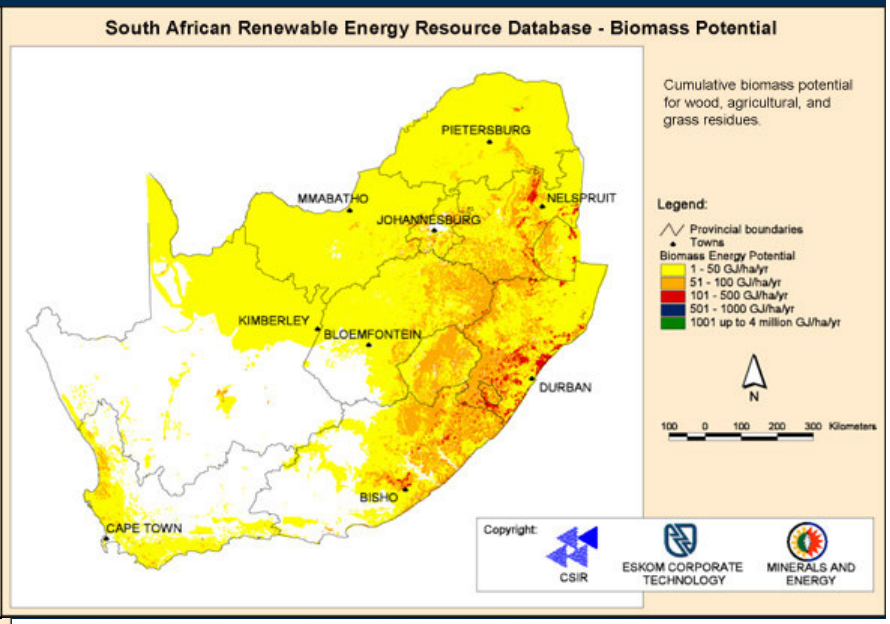
- Natural resources
- Physical data e.g. rainfall, conservation areas
- Social/economic data e.g population, water supply,

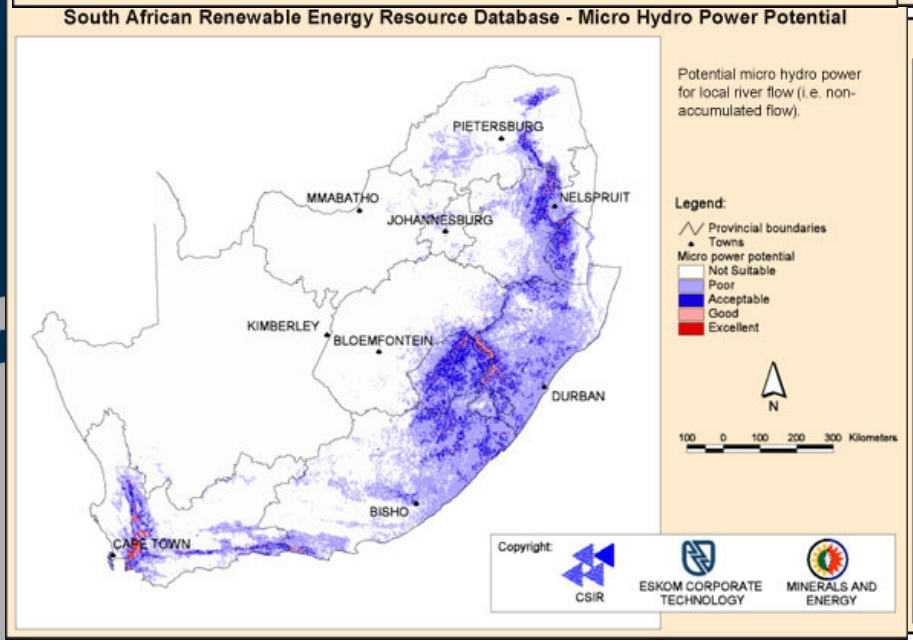
Can Information and Communication Technologies be used to assist in economic planning?

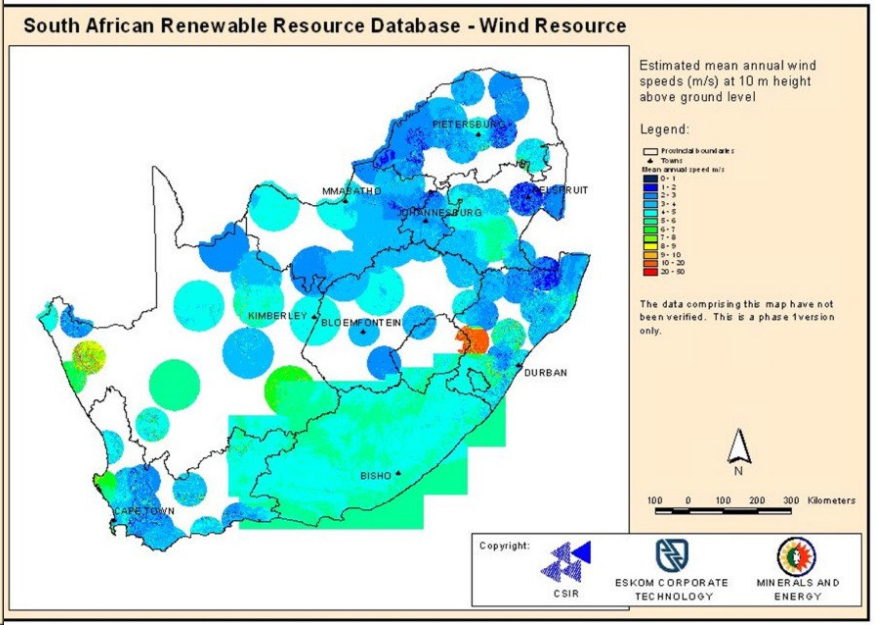
South African Renewable Energy Resource Database (SARERD)

- A joint project between DoE/CSIR/Eskom

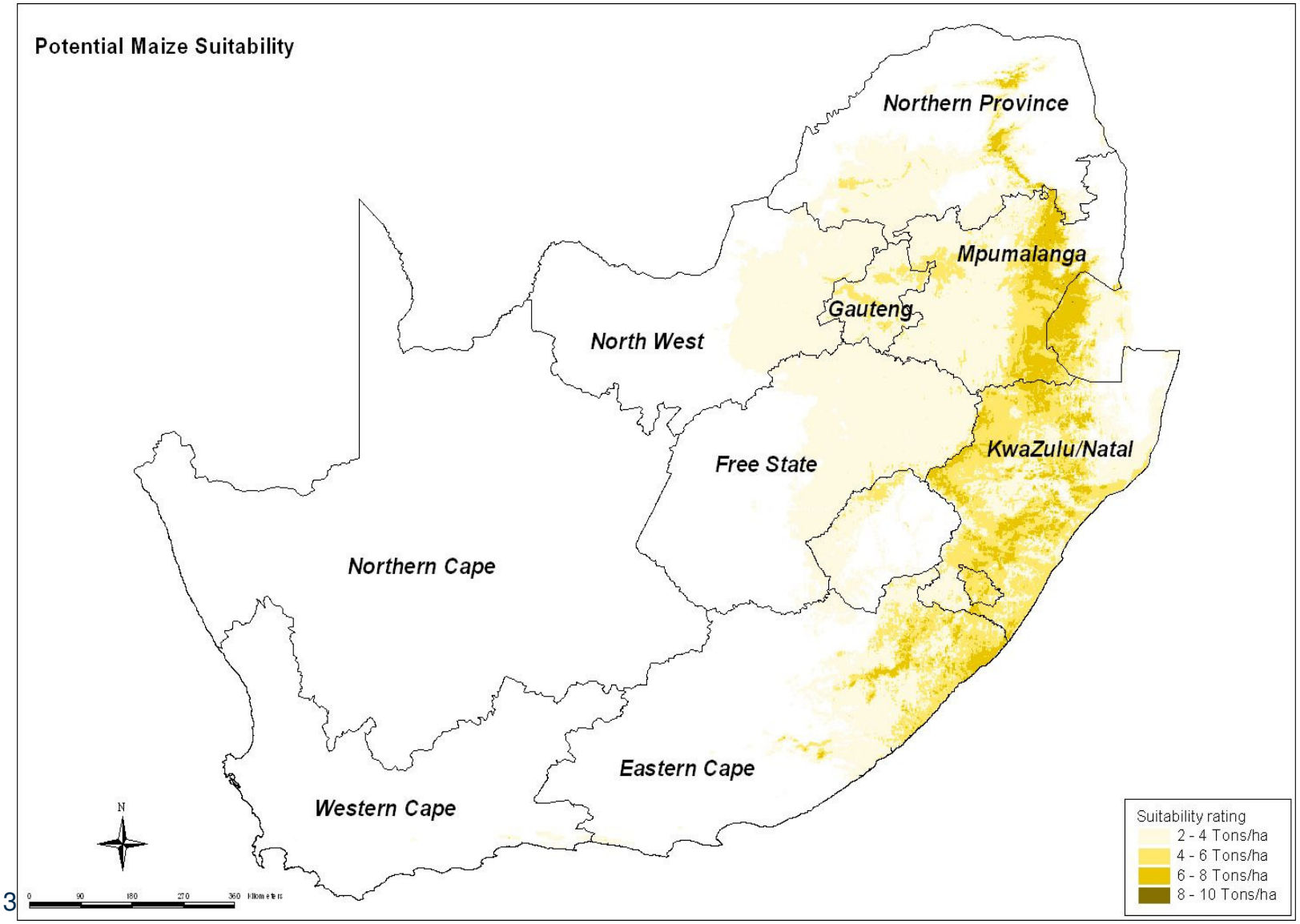




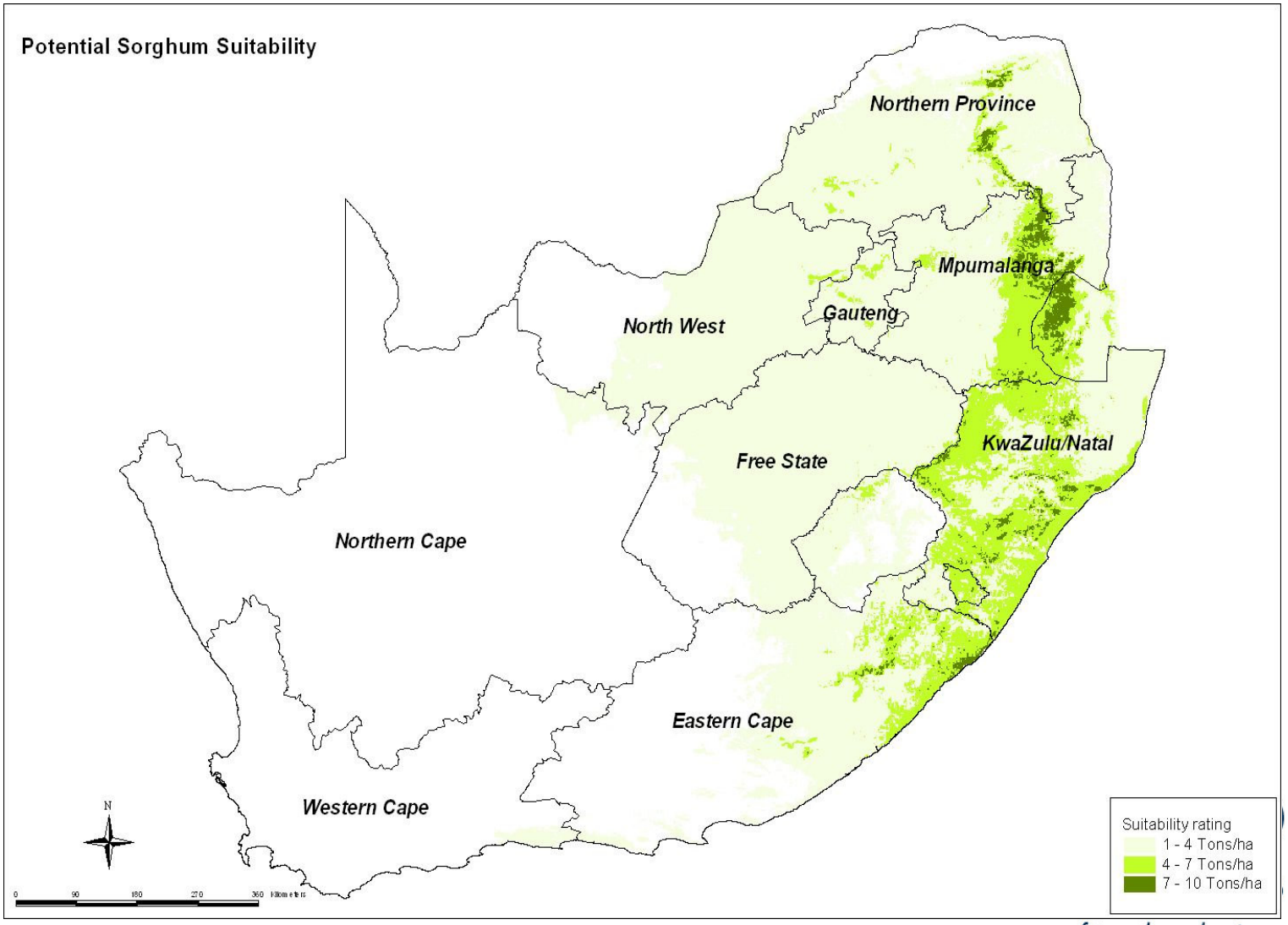




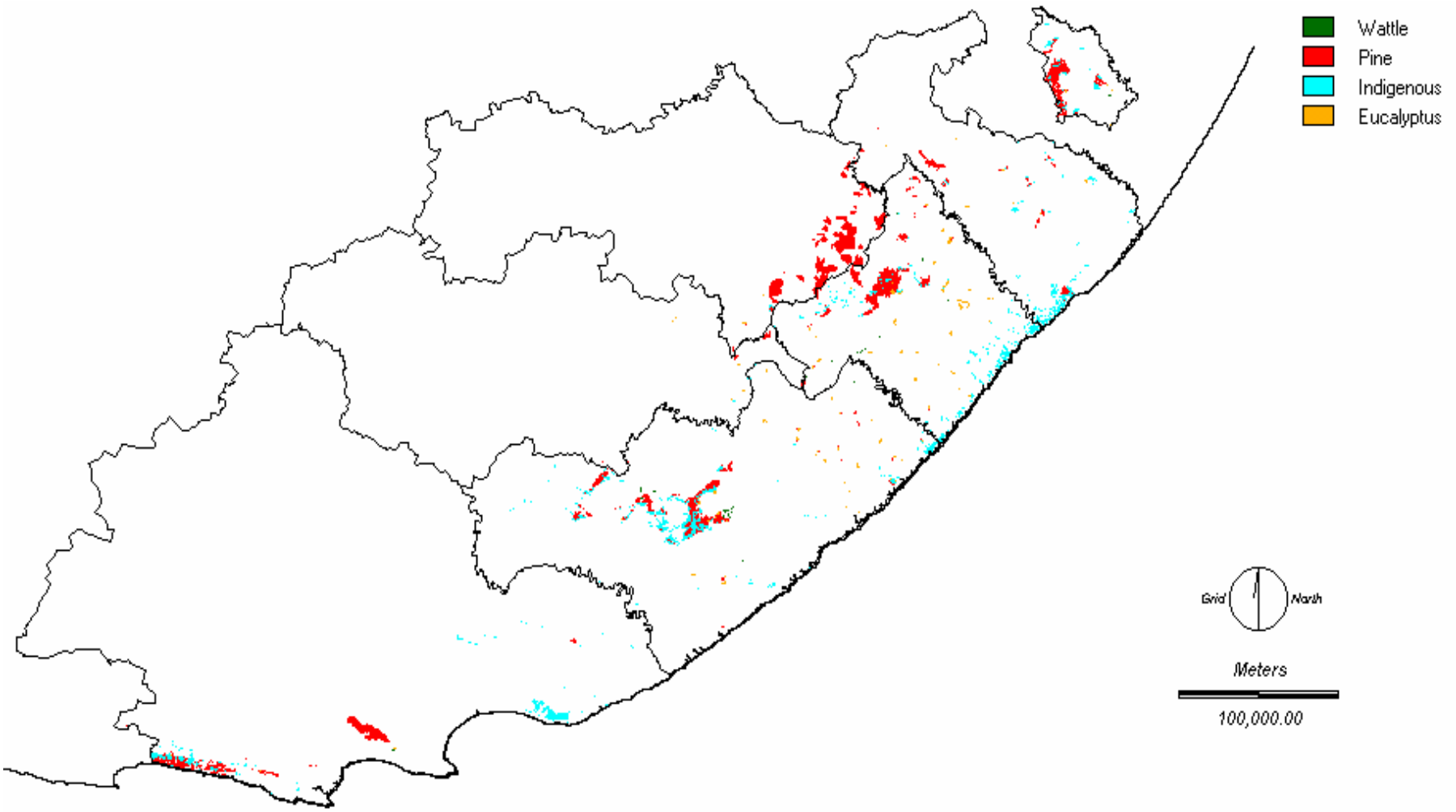
Potential Maize Suitability: demand side



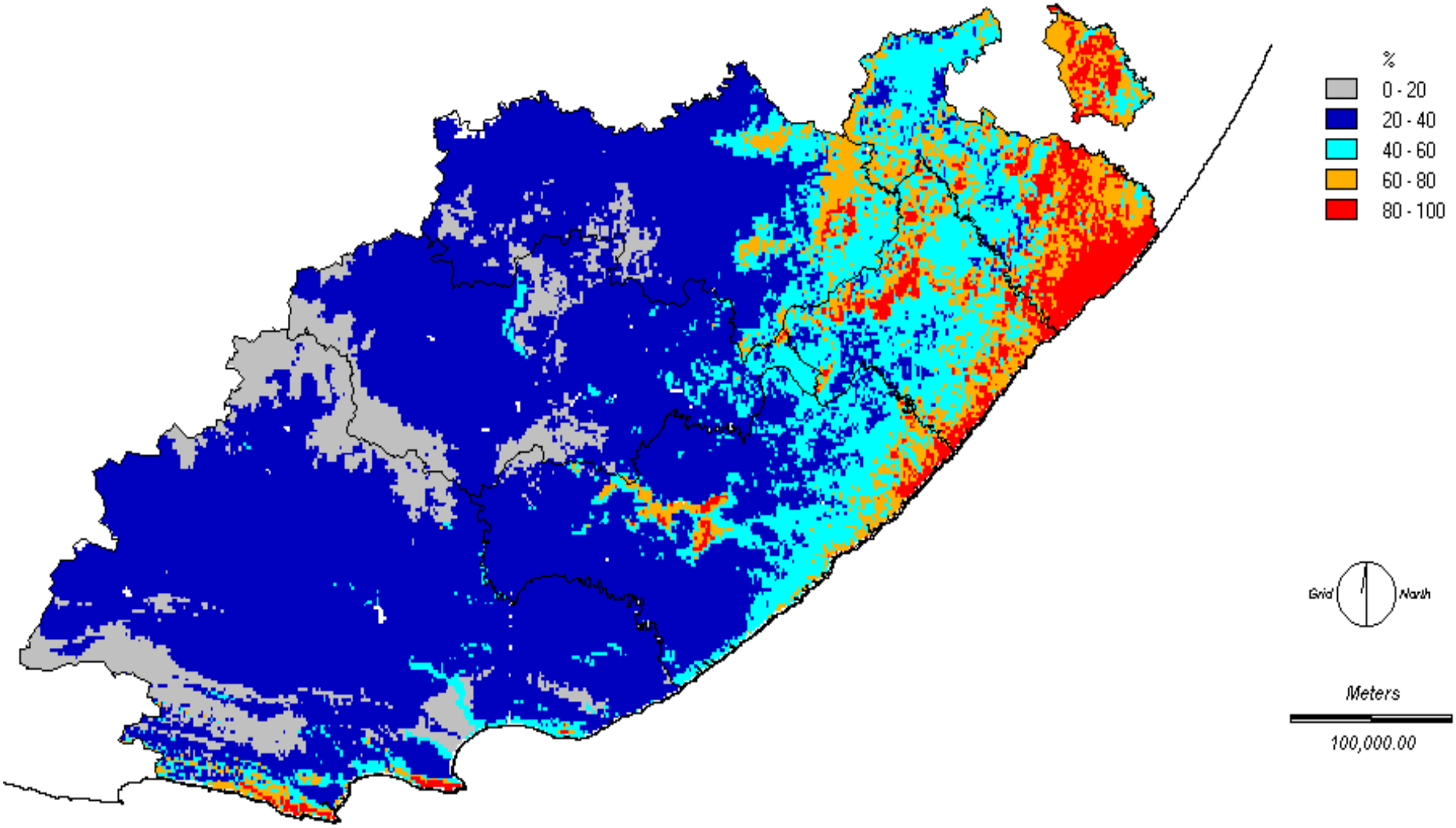
Potential sorghum suitability: - demand side



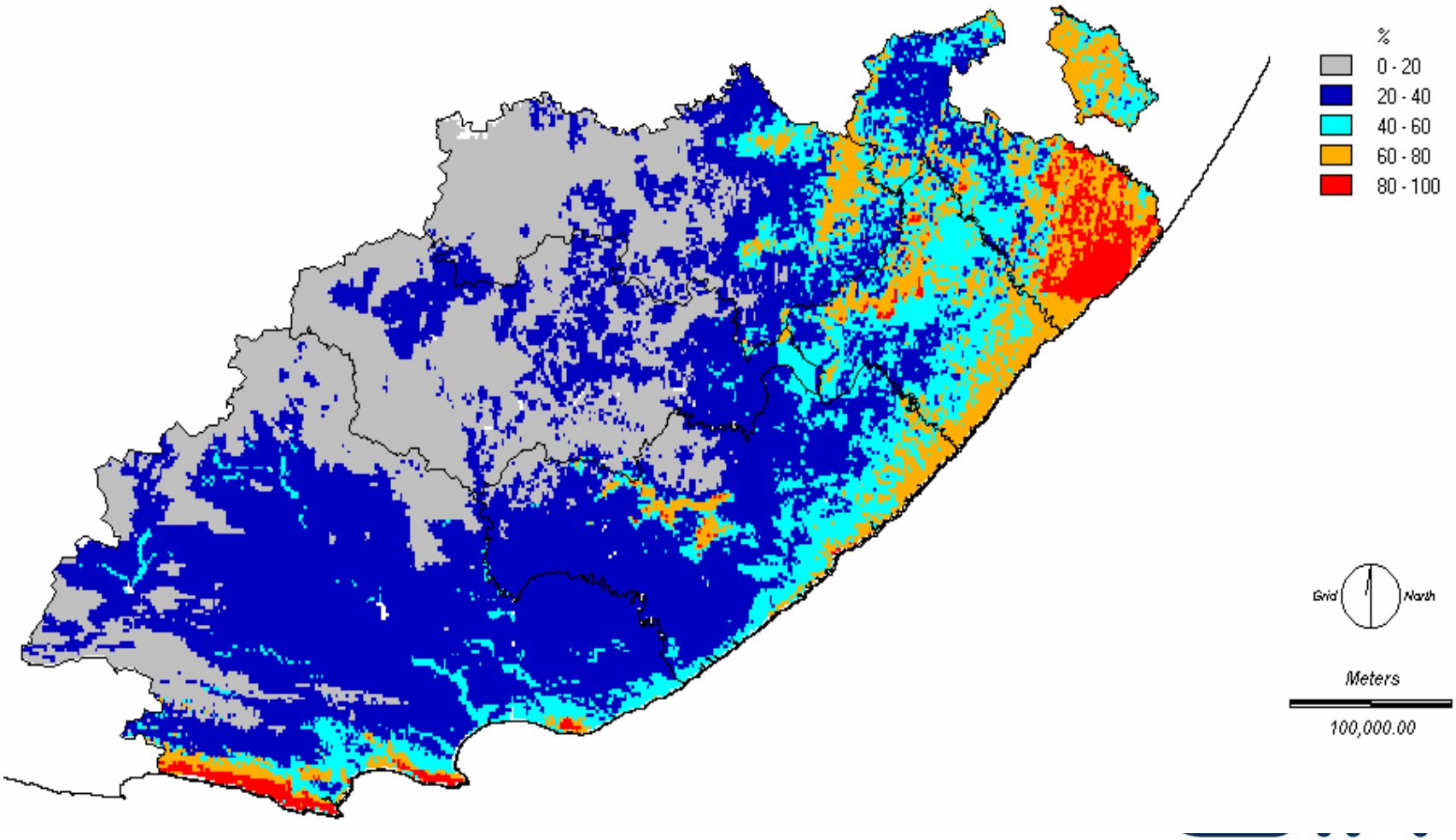
Existing forestry in Eastern Cape Province



Potential for Pine in Eastern Cape



Potential for Eucalyptus in Eastern Cape



HomerGIS: off-grid electrification planning tool

- Planning tool being developed by CSIR, Eskom and DoE
- HOMER – optimisation software sourced from the National Renewable Energy Laboratory (NREL) of the USA
- South African Renewable Energy Resource Database (SARERD) – wind, solar, hydro and biomass database being developed by CSIR, DME & Eskom
- Geographic Information Systems (GIS) – integrated Homer and SARERD
- Current SA wind atlas inadequate
- Further development of HomerGIS on hold awaiting updated wind atlas

Wind Atlas for South Africa

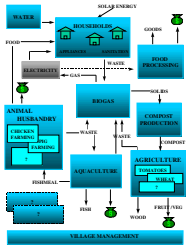
- 3 year project to update SA's wind resource map
- Global Environment Facility (GEF) and Danida funding
- SANERI – financial manager of project
- CSIR – wind monitoring and micro-scale modelling
- University of Cape Town – meso-scale modelling
- South African Weather Services – extreme winds
- Risø of Denmark – technical support
- Wind data – develop grid connected wind farms & mini-grids – both essentially distributed generation systems

Wind Atlas Study Area

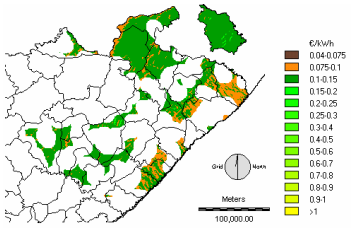
Rural Energy &Economic Development (REED)

SYSTEMIC ENERGY ECONOMIC METHODOLOGY (SEEM)

Simulation & modelling to study effect of different development strategies in a community



Model flowchart



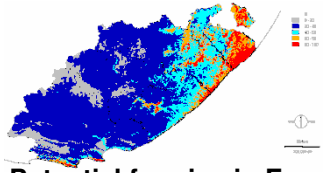
Example of a model in GIS

SARED:
South African Renewable Energy Database

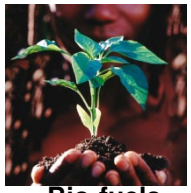
HomerGIS:
CSIR/DME/Eskom off-grid electrification planning tool

GREEN ADVANCED SUSTAINABLE PRODUCTS (GASP)

Develop supply chain linkages between rural enterprises and multinationals where natural/renewable resources are value-added



Potential for pine in E Cape



Bio-fuels

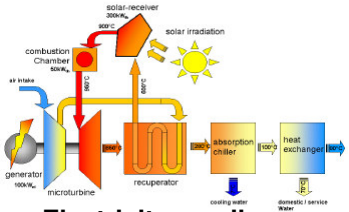
Natural composite materials components for aerospace

ENERGY EFFICIENCY EFFECTIVENESS (E3)

Supply & demand side technologies & manufacturing processes that ensure efficient use of energy & resources

Solarised gas turbines

Wood composite blades



Electricity, cooling, warming

RURAL ENERGY ACTIVE LABORATORY (REAL)

Validation process in community where intervention measures can be followed over time, monitored, evaluated, documented & fed back

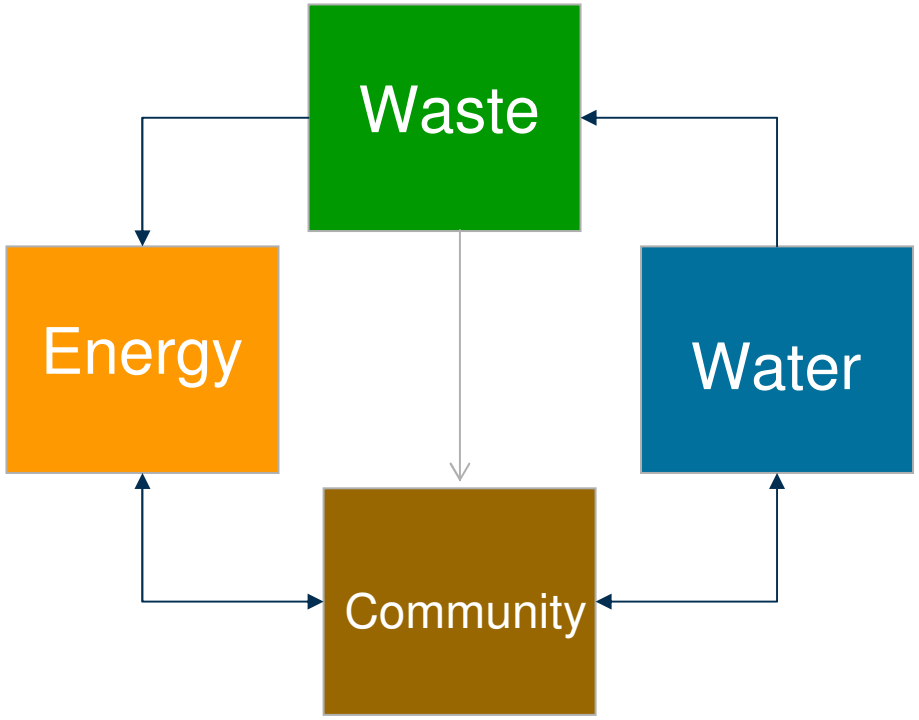
Sociological facilitation

Example: planting citrus for local market

Lucingweni – candidate for REAL?

Core of CSIR's Integrated Research Infrastructure Platform (IRIP)

Develop an integrated R&D platform to optimise the technical delivery services for sustainable human settlements through a systems approach



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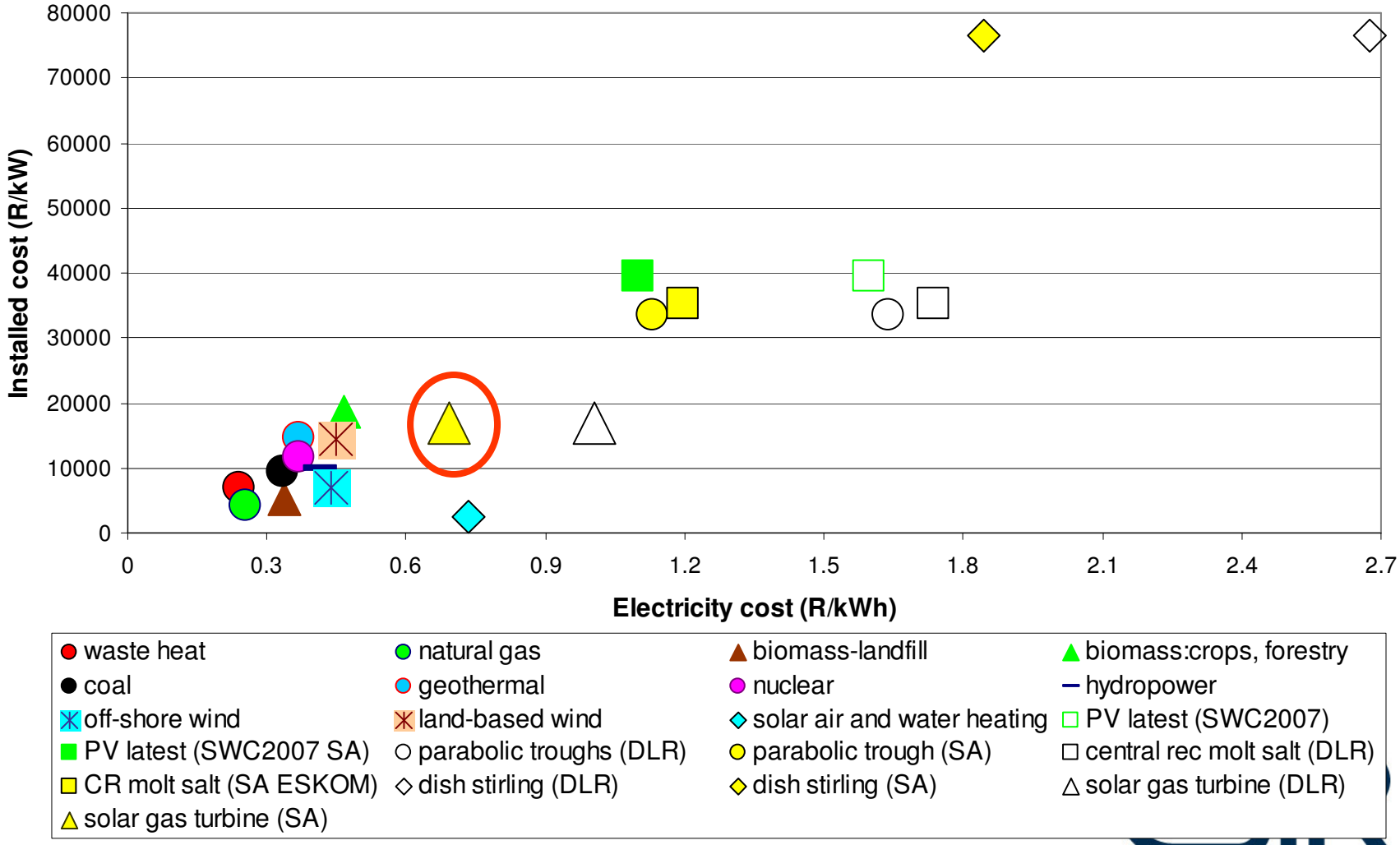
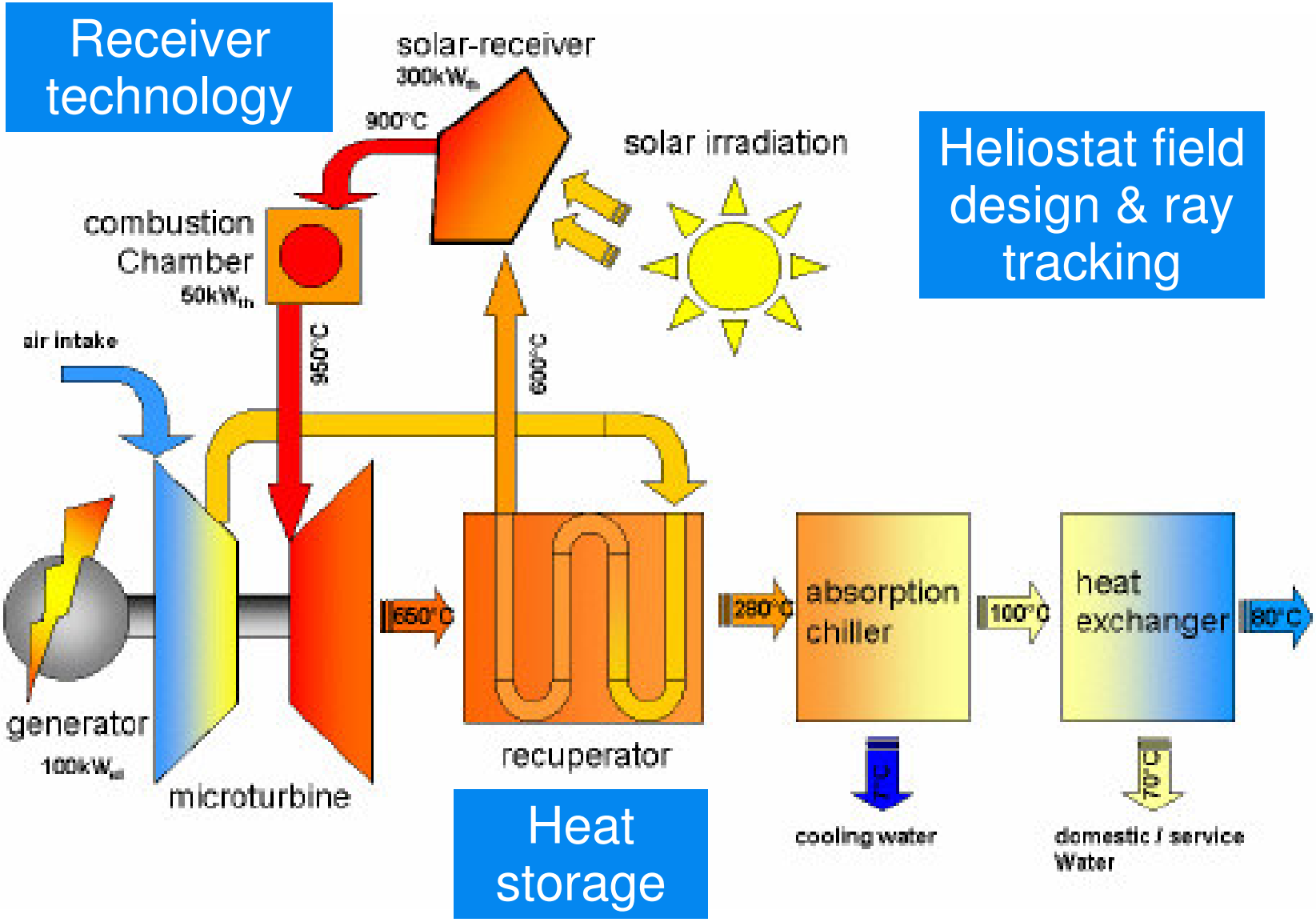
Concentrating solar power technology

Comparative costs*
(In ZAR, note SA cheaper than DLR projects in Spain)



*After Thomas Roos - DPSS

Components of mini solar hybrid power plant



Microturbines – power core of IRIP

Microturbines are derivatives of the turbocharger

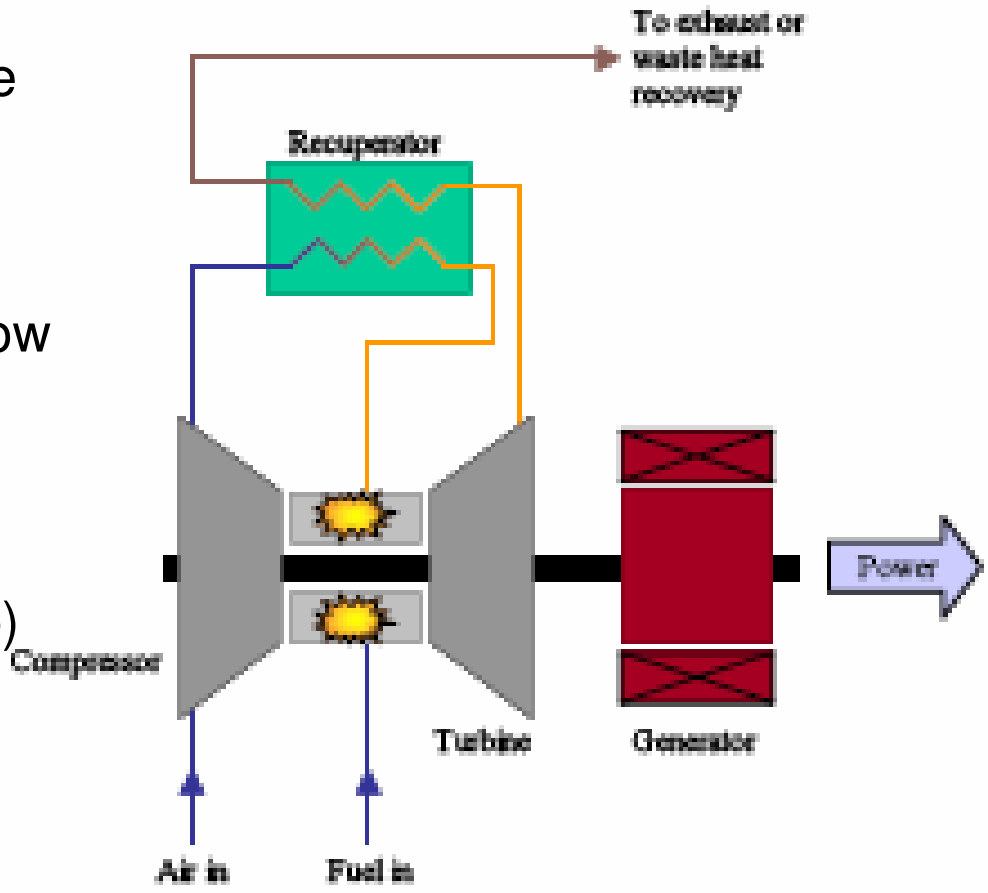
Typical output range 20-300kW

Relatively advanced technology now becoming commercially available

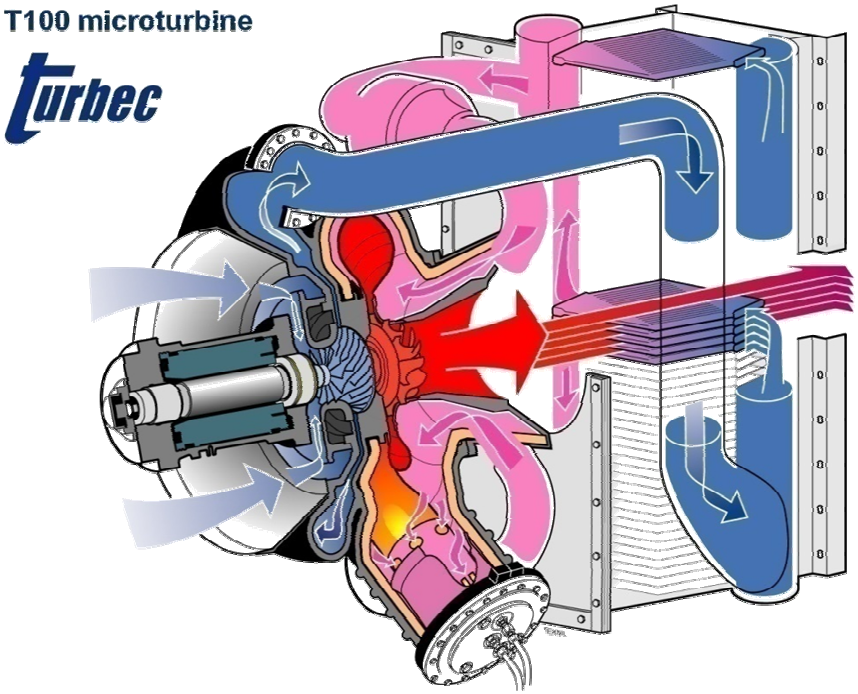
Building on CSIR know-how & expertise (built novel technology demonstrator, but funding dried up)

Exhaust heat can be used for

variety of applications, eg heat for AD



Turbec 100kw microturbine



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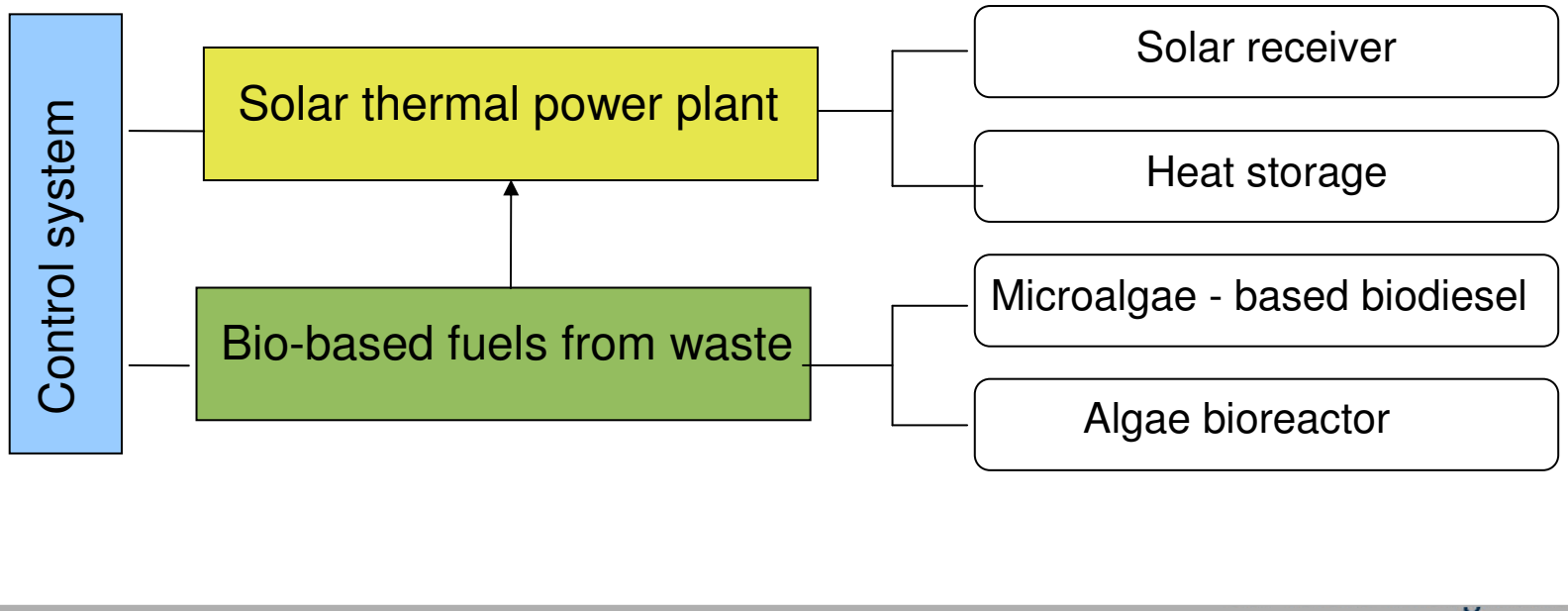
Future work related to distributed generation

- CSIR's Integrated Research Infrastructure Platform (IRIP)
  - Provision of services close to point of use
  - Based on micro-gas turbine (SA core team still in place)
- Strengthen links with experts – local & international
- Short term: demonstrate system on CSIR capmus
- Medium term: integrate into small rural villages
- Longer term: integrate into rural communities



Future work

- **Demonstrate methane rich biogas production by combining multiple sources of organic waste streams in anaerobic digester**
- **Demonstrate running of microturbine on biodiesel**
- **Demonstrate 'fuelling' of microturbine with both biogas and solar thermal energy – not done as yet and also seems to be novel**
- **Potential collaboration with EU & other international partners**
- **Patents, Intellectual Property?**
- **Wind atlas project: transfer lessons learnt to other renewable resources**
- **Lessons learnt – contributing to sustainable human settlements**
- **Ultimate objective:**
  - Development of a tool to identify a number of small bankable distributed generation projects that could be aggregated up into a project portfolio that will interest bankers and reduce transactional costs

THANK YOU