Integrated Energy Planning and Modelling

The integrated view on the energy system, modelling as a tool for decision support for sustainable energy planning of Cities

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Current Activities and status quo of the EnerKey project

- Development of a communal project cooperation among the involved cities starting with a cooperation of the project initiative „Energy efficiency at schools“ involving the city of Stuttgart and a commune or regional administration of the Gauteng region.
- Integration of two PhD thesis into the project framework of EnerKey:

  - Philip Goyns: “Modelling of Transport Energy and Externalities in the Johannesburg Area”, University of Johannesburg, Environmental Management and Energy Studies Promoter: Dr. Chris Cooper

  - Colins Imoh: “Rejuvenation of Cities through the Development of Energy Implementation Strategies”, Energy Research Centre, University of Cape Town Promoter: Dr. Gisela Prasad

- Introducing energy systems model TIMES to South African EnerKey partners and DME in a Workshop in Johannesburg, June 21st-23rd
- Meeting IER and ERC in Cape-Town in July 2006 to collaborate PhD student exchange
- Development of a working plan for the different sectors of scope (Energy supply, housing energy, mobility, socio-economics, etc.) in particular concerning the application and development of instruments and tools for analysing the impact of certain technologies and processes (e.g. housing energy with Energy concept advisor IBP) and for the integrated energy planning (e. g. with TIMES, IKARUS -TM)

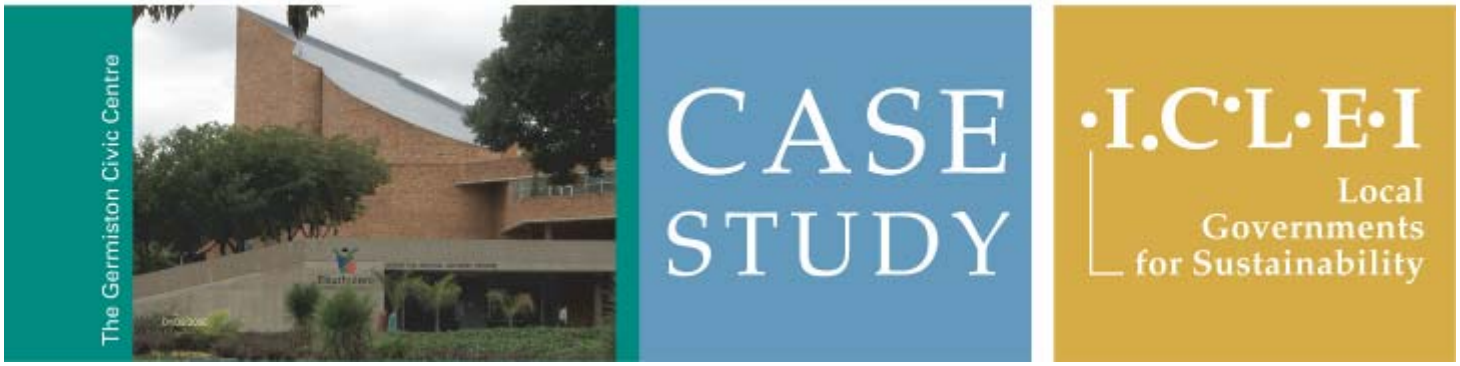
EnerKey Workshop in Johannesburg, Nov. 05: Proposal for a Scoping Study for Integrated Energy Planning (IEP)

- Tasks: Data evaluation
  Situation analysis (incl. Externalitites)
  Review of existing studies and planning approaches
  Evaluation and adaptation in TIMES
  Cooperation amongst EnerKey stakeholder/participants

- Participants: Municipalities of JoBurg, Tshwane, Erkuhuleni, UJo, ERC, NGOs, CSIR, Energy Providers, Consultants, IER

- Result: Conceptual framework for Integrated Energy Planning in the following project phases of EnerKey

Data evaluation: Consideration of technological innovations on the supply side and energy efficiency improvements on the demand side in Gauteng



Improving Energy Efficiency in

Ekurhuleni Metropolitan Municipal Buildings

Costs:	73 000 €
Savings:	330 000 kWh/a
	0.38 kt CO2/a

Situation analysis

South African government requested all municipalities to generate action plans for energy, environment and transport

Tshwane and Erkhuleni have accomplished that (State of Energy Report, …).

Johannesburg has so far only published an integrated transport plan 2003-2008

These reports can provide a solid starting point for EnerKey activities

Situation analysis
Other Energy-related MEGACITIES project

- **Hyderabad-Bangalore (India):** City planning holistic approach and "know-how" transfer for India (SHAKTI)

  Project coordinator: ElfEr Karlsruhe

- **Ningbo (China):** Model of the chinese Megacity of the future

  University Weimar (Construction Engineering, International Transfer point for environmental technologies, Bionet)

- **Ningbo (China):** Sustainable and energy efficient city planning

  Univ. Duisburg-Essen (Department for traffic and transportation)

- **Ürümqi (China):** Controlling cycles of matter with environmental impacts for a sustainable city development in a arid environment

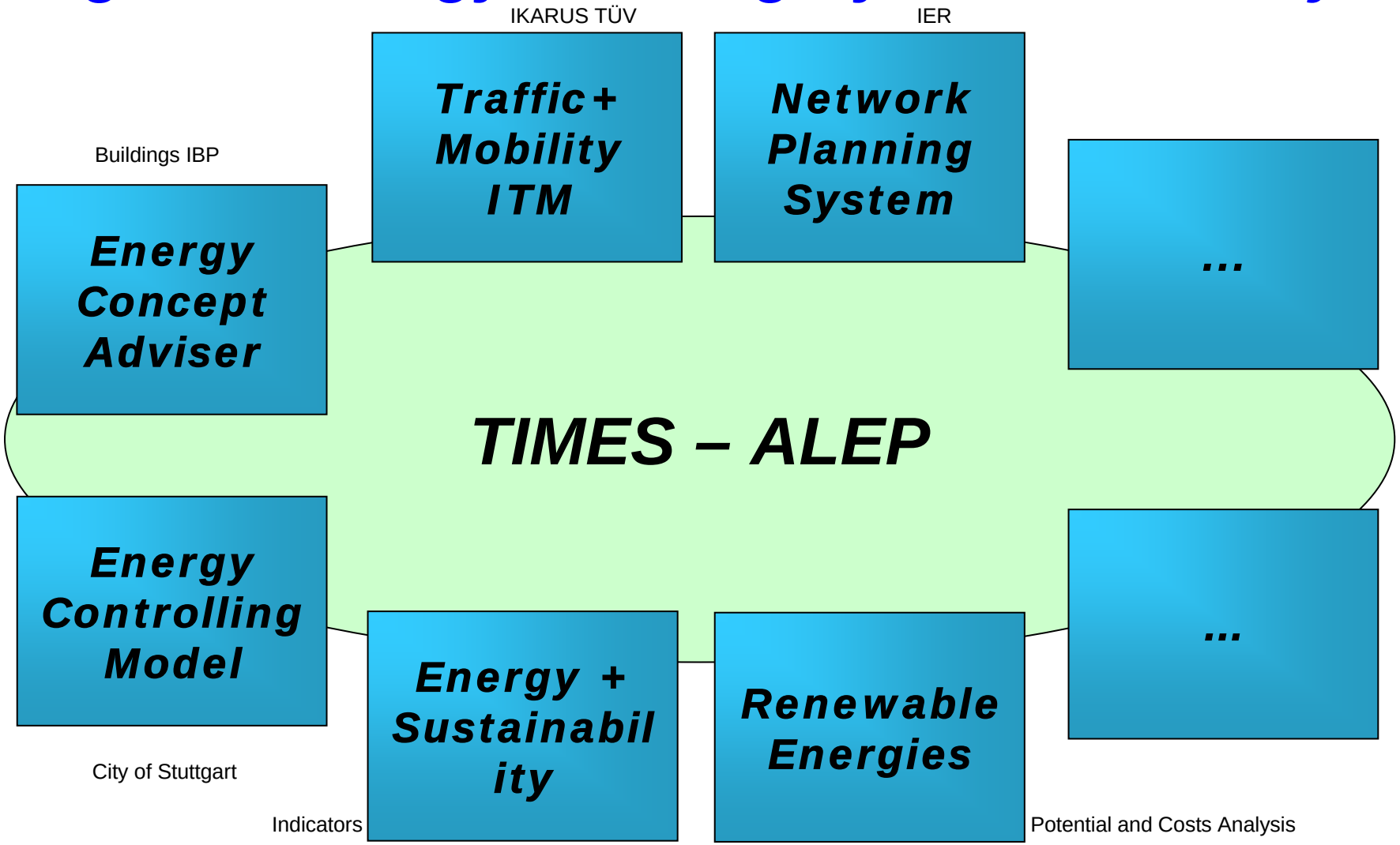
  Geographic Institute of the University Heidelberg

Proposals for pilot studies within EnerKey

1. School Project: Energy Efficiency, Fuel Switch and Renewable Energy
2. Residential Thermal Energy
3. Scoping Study IEP
4. Mobility & Traffic, Infrastructure & Planning Air quality and emissions – linking to vehicle activity and associated modelling
5. Institutionalising the implementation of solar water heating systems

=> Integration and performance assessment in TIMES

Integrated Energy Planning System - *EnerKey*



Why energy systems modeling ?

Energy system models are an essential tool to enable policy makers to see the implications of current decisions on energy sustainability in the future.

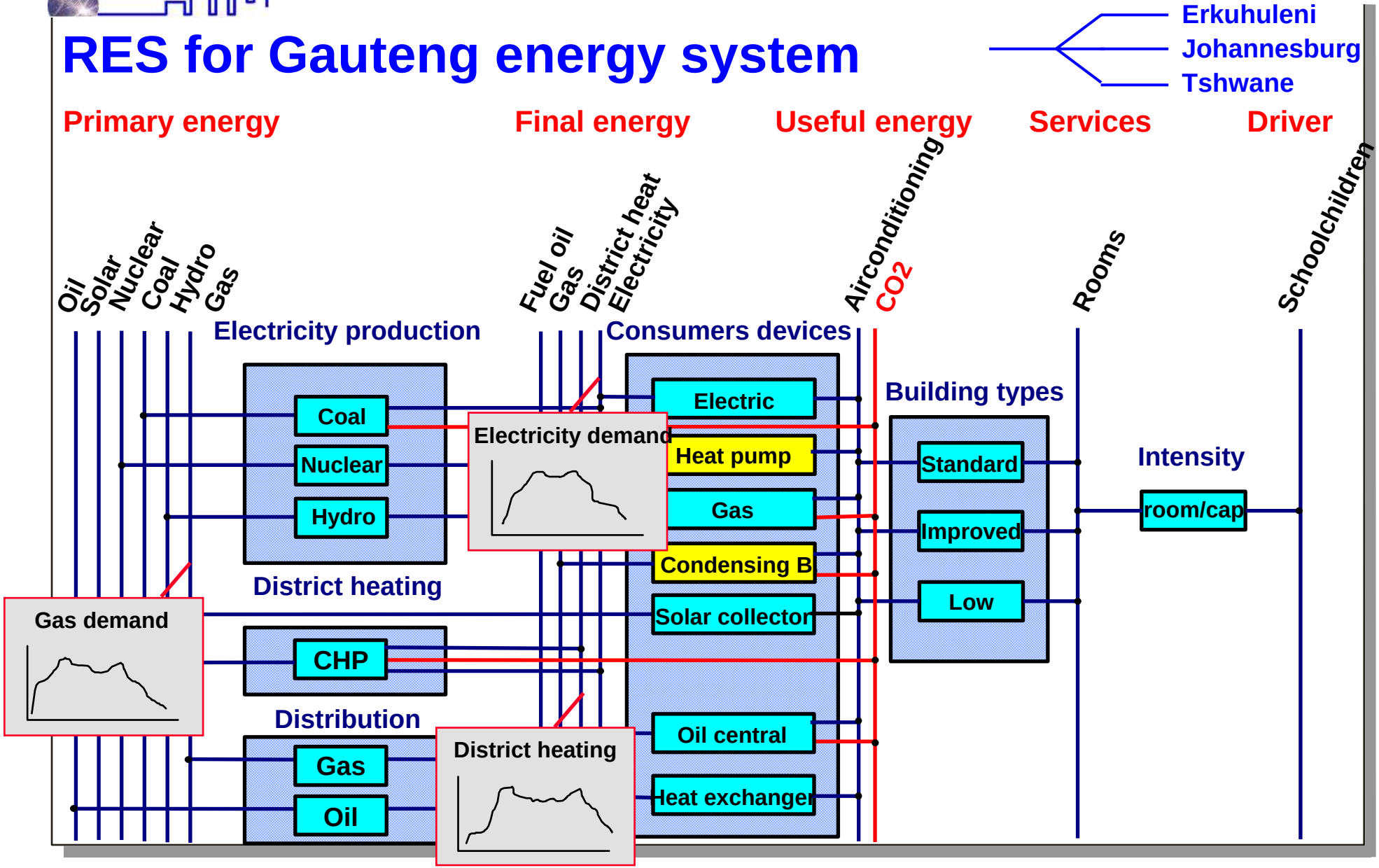
The models are designed to find, among different alternatives, the one which satifies the best market allocation of limited resources, *e.g. biomass, natural gas*, taking into account different exogenous constraints, *e.g. emission limits*, and decision criteria.

In ***EnerKey***, the integrated model approach can be adopted to assess the overall energetic, economic and environmental effects and results for the different municipalities, the Gauteng region in total and for developing an overall energy and sustainability strategy.

The energy systems model can show the conflict potential of different planning goals and objectives.

RES for Gauteng energy system

Erkuhuleni
Johannesburg
Tshwane



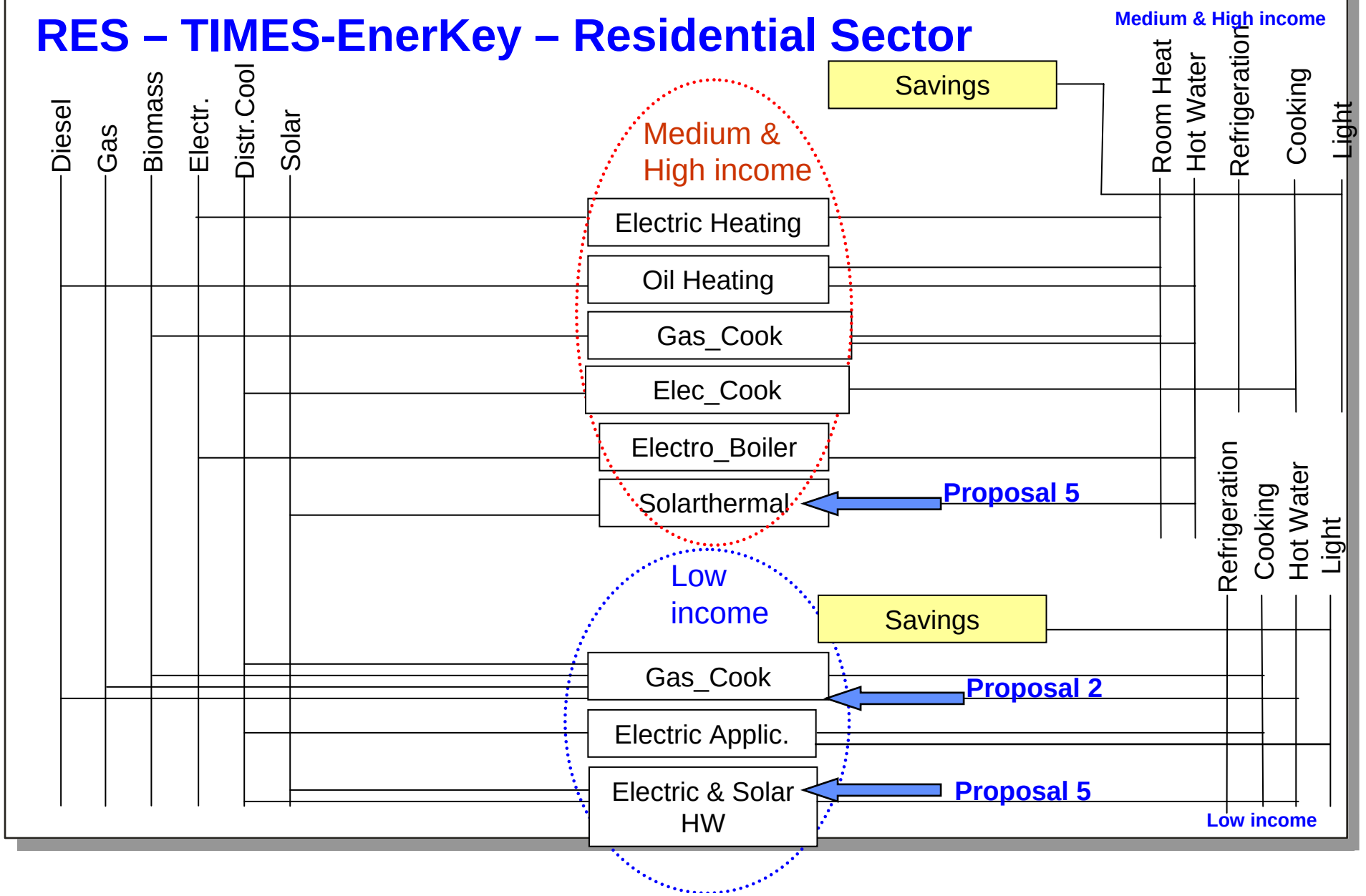
Building the RES – important aspects (I)

- Formulation of problems, challenges and key questions
- Adequate representation of the local conditions
- Representation of ongoing and recent activities, e.g. pilot studies
- Pre-Selection of political measures and instruments
- Taking into account the data availability
- Using existing know-how

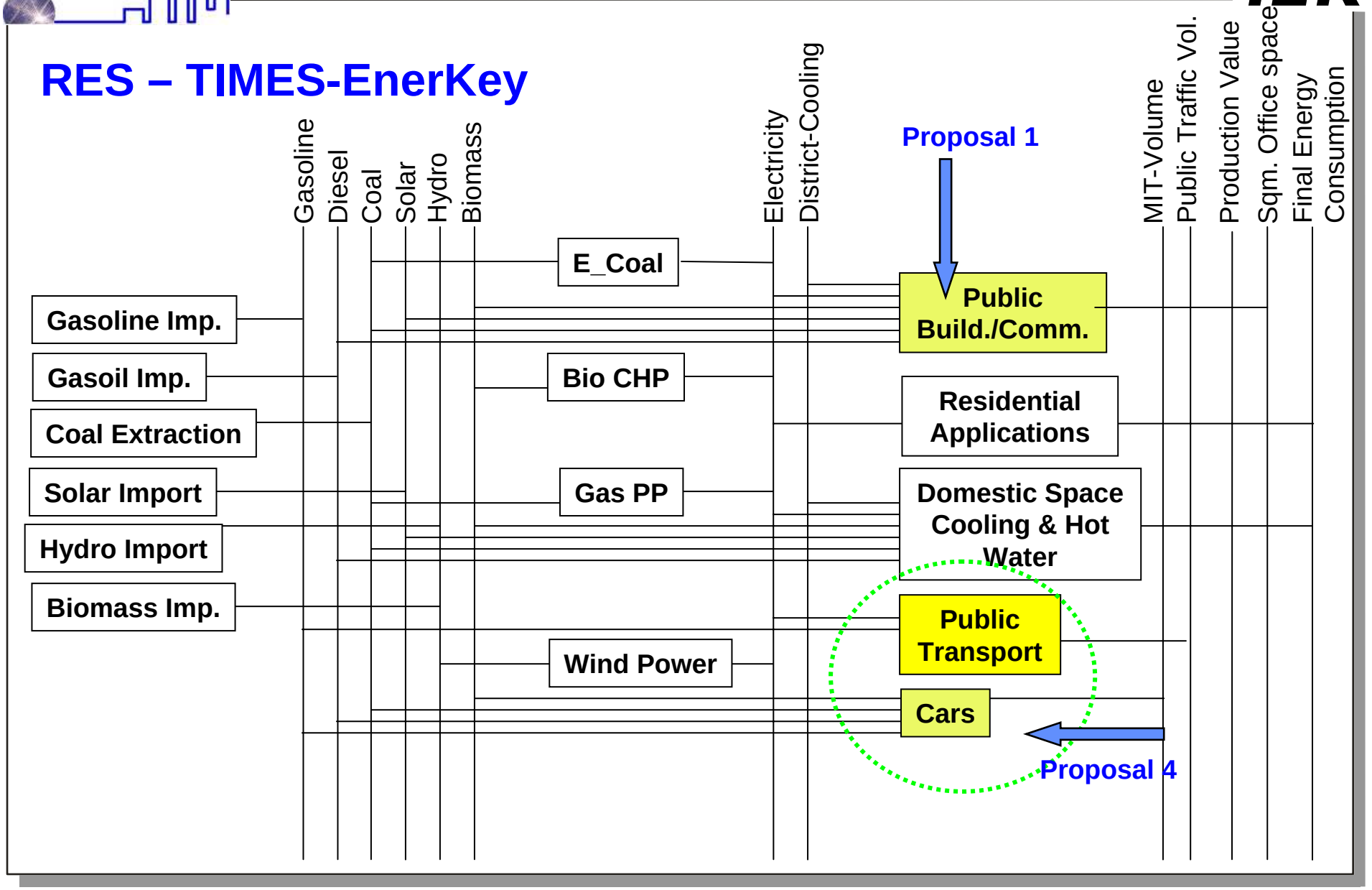
Building the RES – important aspects (II)

1. Significance of transport sector
   a) Public transport –oil use –
   b) World Cup 2010
2. Separation of residential sector
3. Demand specifications
   a) Low heat demand
   b) High demand for cooling
4. Electricity generation
   a) Blackouts
   b) Possible cooperation with ESKOM (27 knot model) (?)
5. …

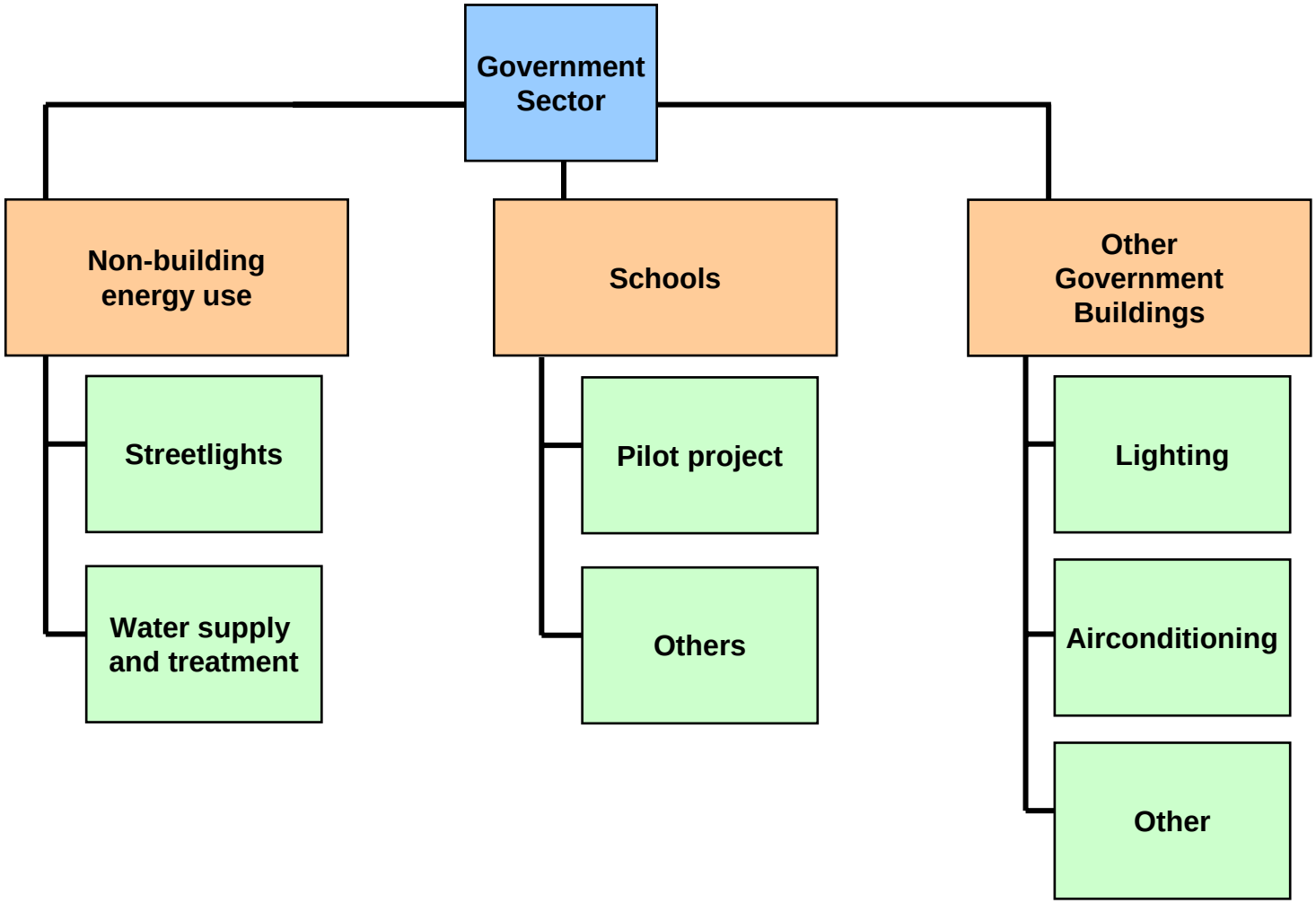
RES – TIMES-EnerKey – Residential Sector



RES – TIMES-EnerKey



RES – TIMES-EnerKey – Governmental Sector



Acquisition and availabilty of data

- Collecting statistical data on energy consumption by sectors and technology type, especially in the segment of the pilot project
- Economical and technical data on electricity and heat/cooling generation facilities and heat/cooling transmission and distribution system
- Data and assumptions for socio economic drivers
- Identification of first technical and environmental data for new energy technologies on the demand and the supply side

Socio-economic drivers: Population, economic growth and employment

- Population
- GDP in ZAR per Capita
- Industrial development in the separate branches
- Average living area in m^2
- Transportation demand in Person-Kilometers
- Freight demand in Tonne-Kilometers
- …

Example for technical, economic and ecological characterization of technologies

- **Gas boiler:**

- Efficiency	(FLO_FUNC):	70 %
- Investment costs	(NCAP_COST):	15 Mill. €/(PJ/a)
- FOM costs	(NCAP_FOM):	0.1 Mill. €/(PJ/a)
- Availability	(NCAP_AF):	100 %
- Technical lifetime	(NCAP_TLIFE):	30 a
- Construction time	(NCAP_ILED):	0 a
- Past investments	(NCAP_PASTI):	1980: XX PJ/a 1995: YY PJ/a
- Emissions factor CO2	(FLO_SUM):	55.5 kt/PJ
- Emissions factor NOX	(FLO_SUM):	0.0085 kt/PJ

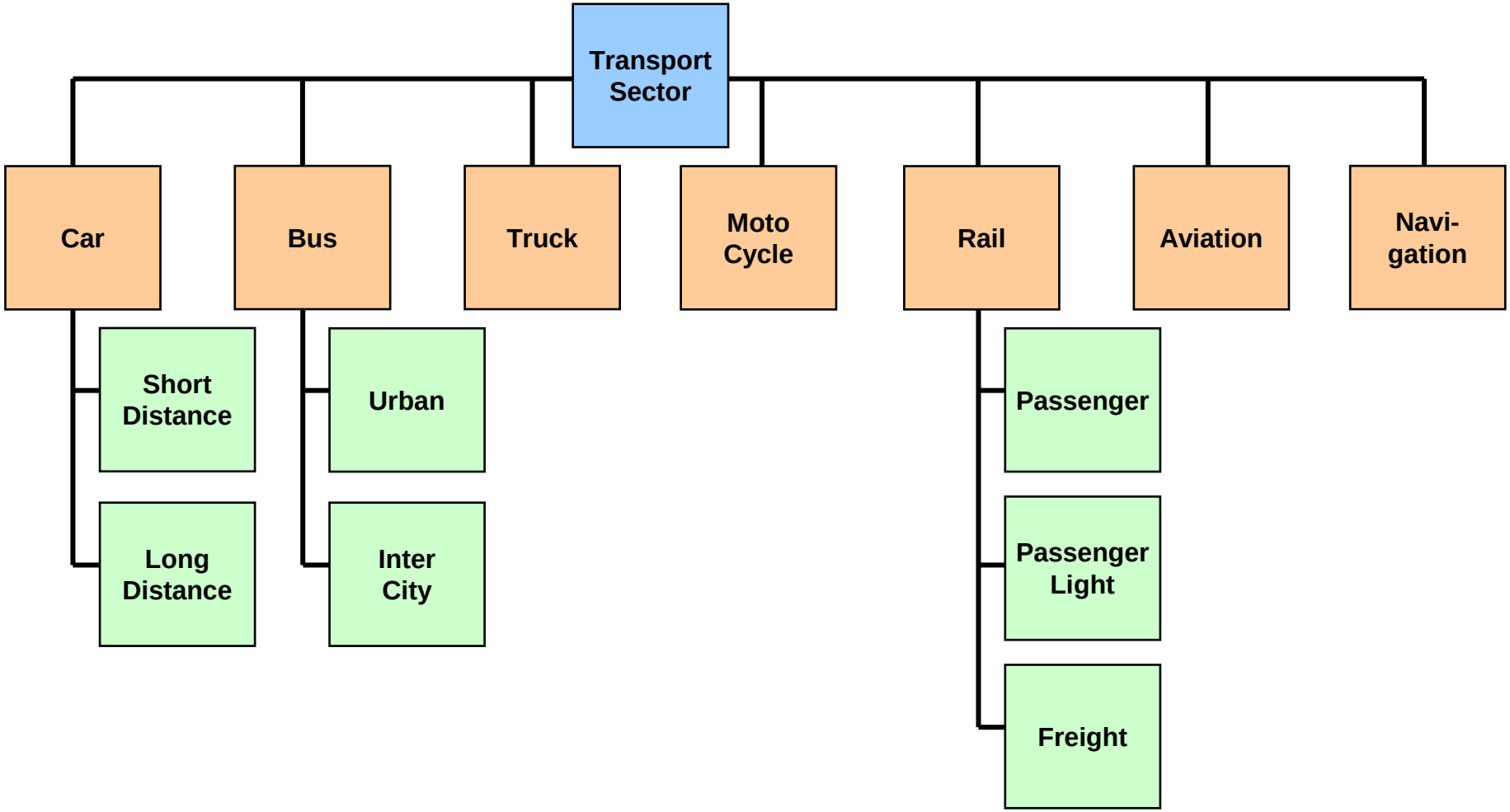
- Import price natural gas: 4.3 Mill. €/PJ (constant 2004 – 2016)

Conclusions and Recommendations

- The trade-off between energy, economic and environmental policy, and the differing views of the various stakeholders involved, often make consensus building very challenging.
- The ability to take into account the weighted preferences of the various stakeholders with respect to different goals, e.g. economic versus environmental goals, can be directly considered in the modelling framework.
- Energy systems models as tools for decision support allow an integrated view on different alternatives taking into account the existing interactions among sectors and energy conversion chains with respect to the three dimensions of sustainability on the long-term time scale
- Scoping study on ***IEP*** represents a first central element for the continuation of the EnerKey project !!!

„DANKE“ for the attention!

Transport sector in TIMES (proposal)



Transport sector in TIMES (proposal)

- **Statistical values:** Consumption (PJ), Traffic volume (pkm, tkm, vehicle stock)
- **Input values:** Long/Short Distance Efficiencies (lt/100 km), Fractional Shares, Infrastructure (Lifetime, Investment Costs, Fixed/Variable Costs), Time Slices

Fuels:

- Liquified Petroleum Gas (LPG)
- Motor Spirit
- Kerosenes / Jet Fuels
- Diesel Oil
- Residual Fuel Oil
- Natural Gas
- Bio Fuels
- Electrical Energy
- Hydrogen

Infrastructure:

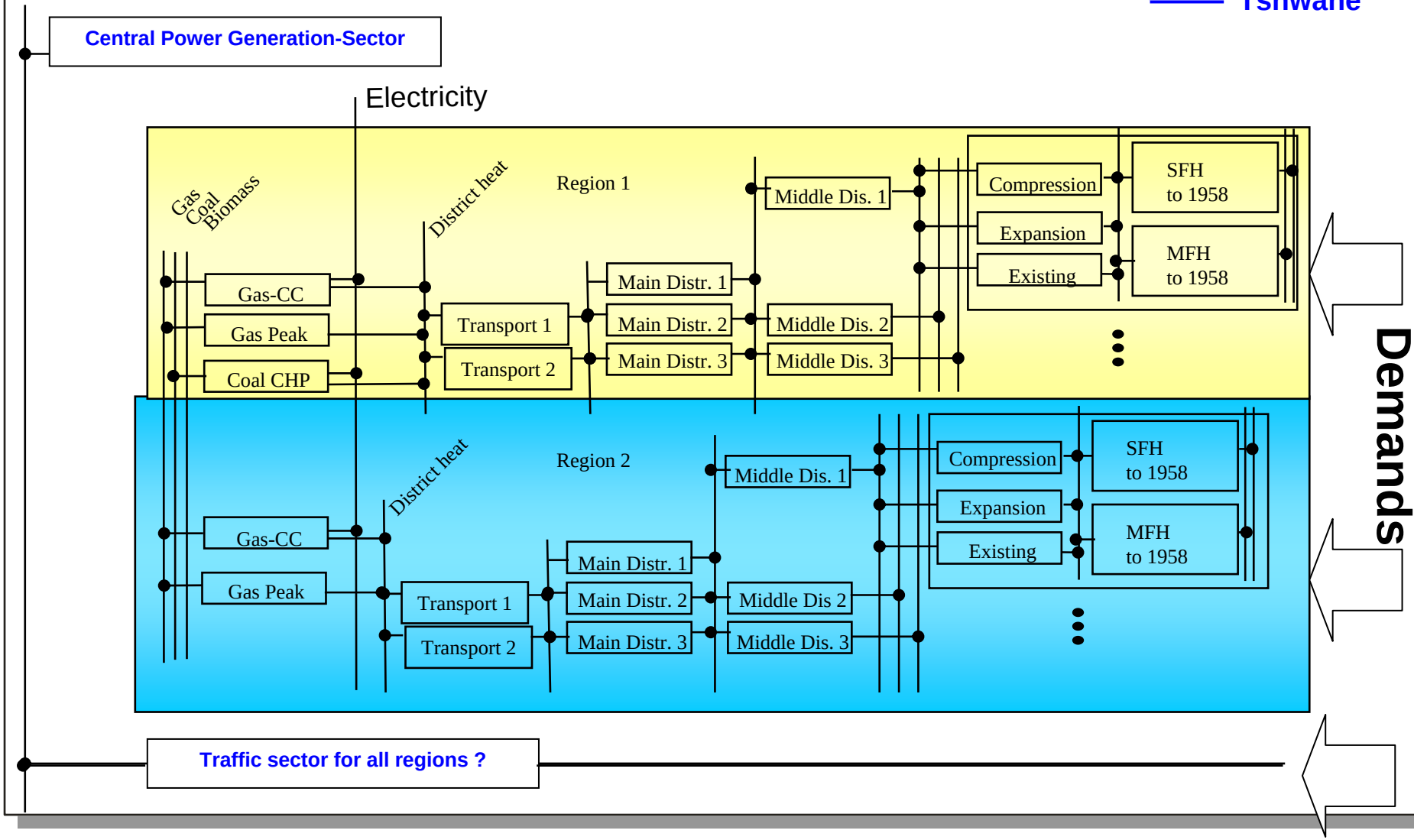
- Base Year Infrastructure
- New Infrastructure

Time Slices:

- 4 Seasons (R, S, W,F)
- Day, Night, Peak

TIMES – Regionalized Area – model

- Erkuhuleni
- Johannesburg
- Tshwane



Results of TIMES (Examples)

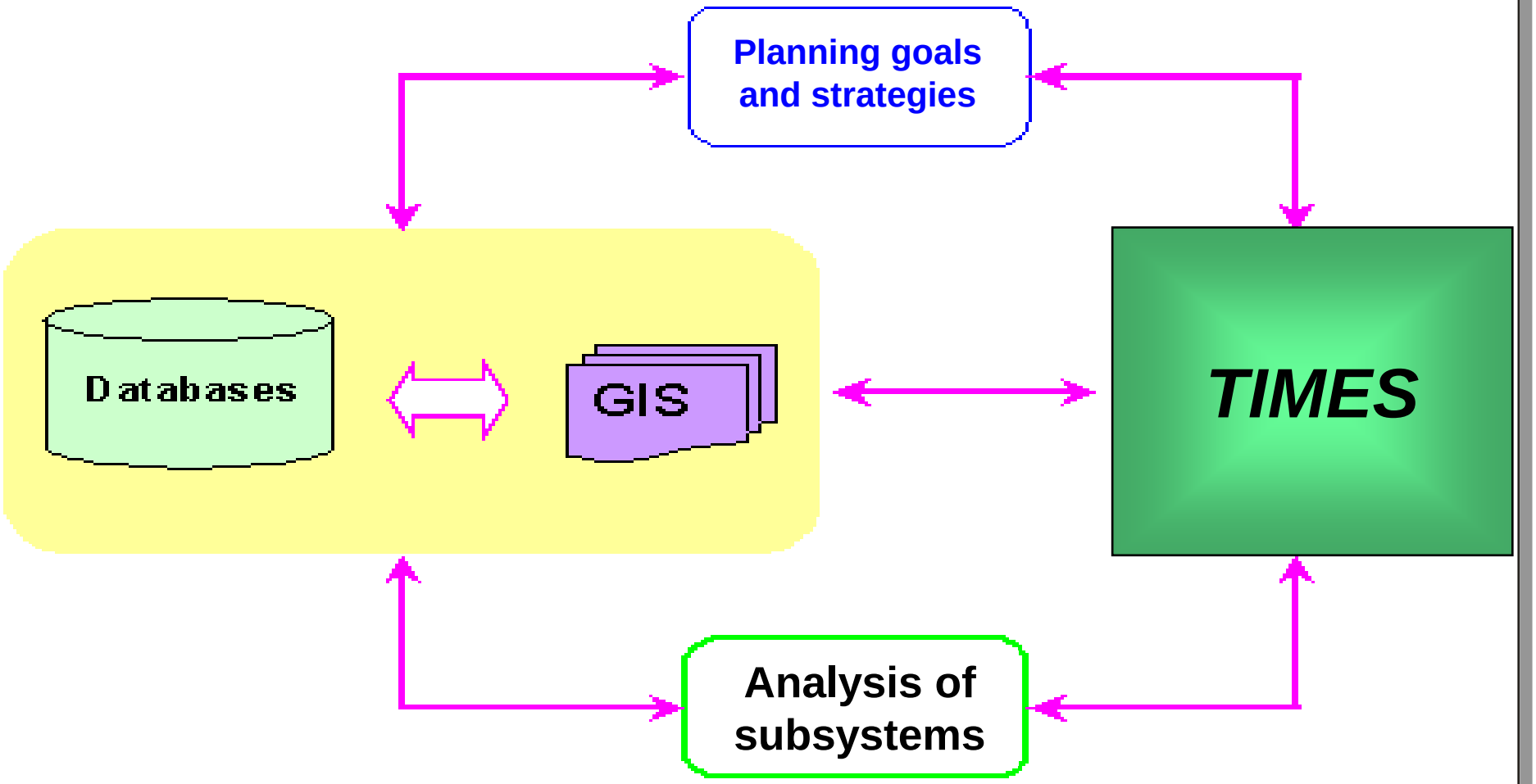
Optimal structure of the system (supply, distribution and demand)

- **by minimizing the total system costs**
- **under consideraton of the energetic framework (biomass / energy supply and demand)**
- **with simultaneous balancing of the environmental impacts**

Comparison of the results with benchmark values or respectively with the situation in other cities in South Africa / Europe

Determining of policies and measures by carrying out scenario analysis and sensitivity analysis.

Combination of bottom-up and top-down approach



Combination of bottom-up and top-down approach