Advanced Local Energy Planning - ALEP

Integrated Local and Regional Energy Planning using TIMES

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Basel,

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The ALEP Planning Approach

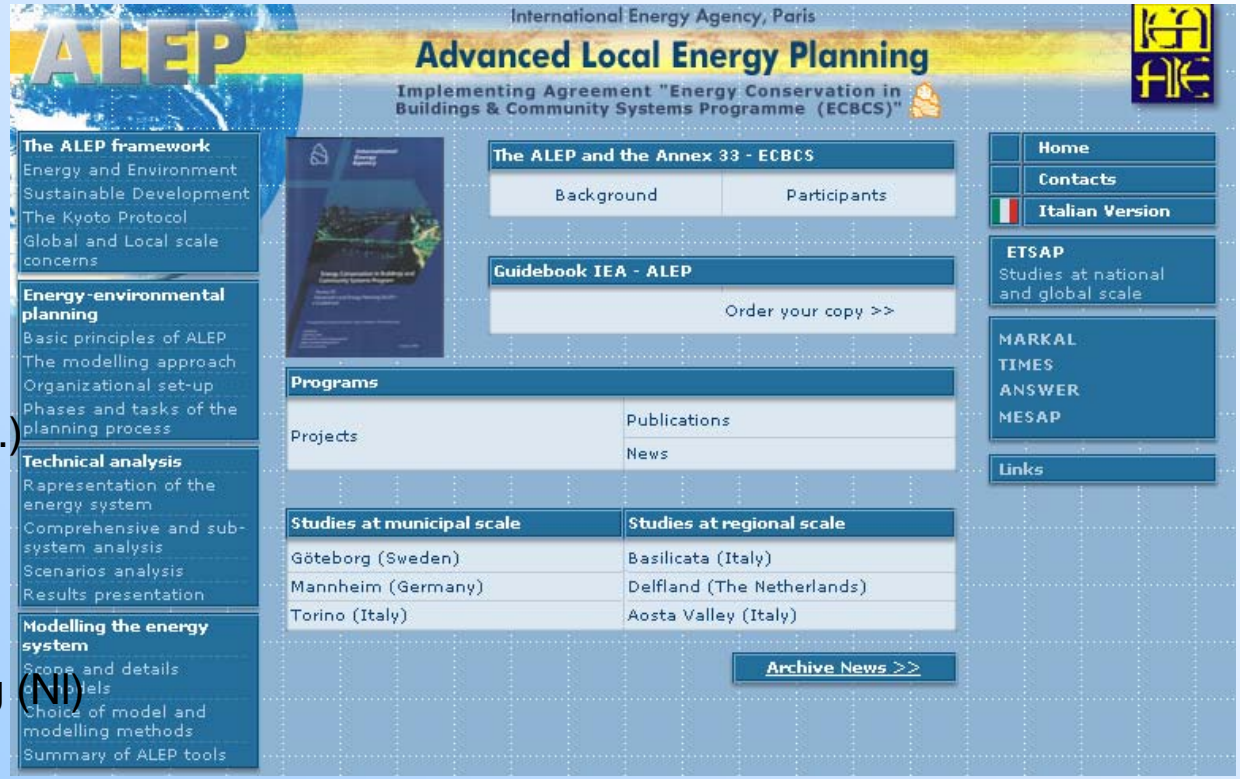
Advanced Local Energy Planning

IEA Implementing agreement

„Energy Conservation for Buildings and Community Systems Programme – ECBCS“

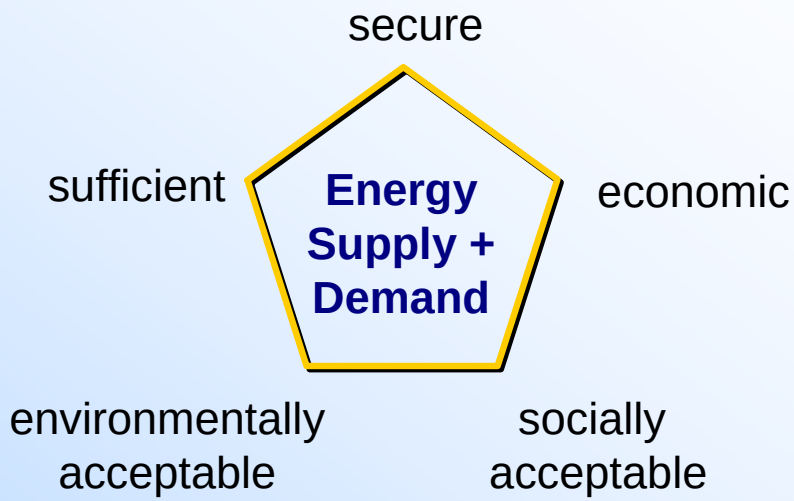
Annex 22: Energy Efficient Communities
Annex 33: Advanced Local Energy Planning

Case Studies:
Basilicata Regional Env. Plan (It.)
Torino LEP (It.)
Aosta Valley (It.)
Göteborg ALEP (Sw.)
Mannheim Energy Plan (G)
Delfland Greenhouse Gardening (Nl)



LEP/ALEP: Integrated Energy Planning - Objectives

- Evaluation of all options
- Selection of an optimal and low risk strategy
- Project selection along priorities
- Projects build upon each other
- Prevent (non-technical) conflicts by pro-active action
- Develop a roadmap / energy plan



➔ **Optimal allocation of available resources (money, people, time, planning capacities)**

Planning Goals

- analyze complex interactions between
  - the energy system
  - the economy
  - the environment

- compare different strategies according to
  - financial criteria
  - ecological criteria
  - social criteria

→ **identify robust strategies under uncertainty conditions and establish a sound policy recommendation**

The 3 Elements of ALEP

Advanced Local Energy Planning

➔ Communication

- ✓ Incorporation of planning in a communication and learning process to prevent conflicts and increase motivation

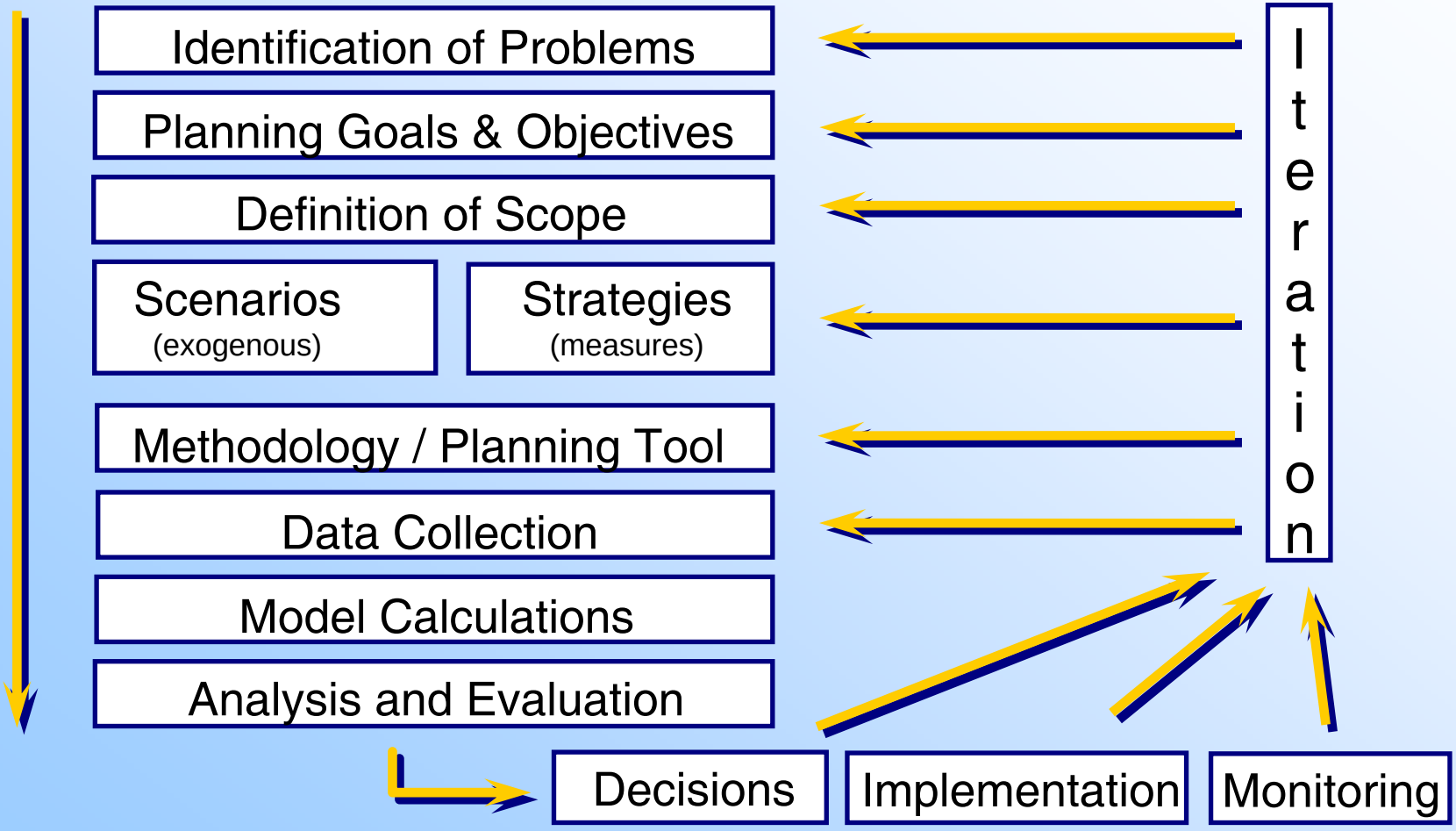
➔ System analysis

- ✓ Analysis of energy supply, demand and the links between e.a.
- ✓ Energy system models for strategical planning (tools/instr.)

➔ Monitoring and Marketing

- ✓ Monitoring of reached aims through project experience
- ✓ continuous improvements of goals and measures
- ✓ Information of the public on measures and results

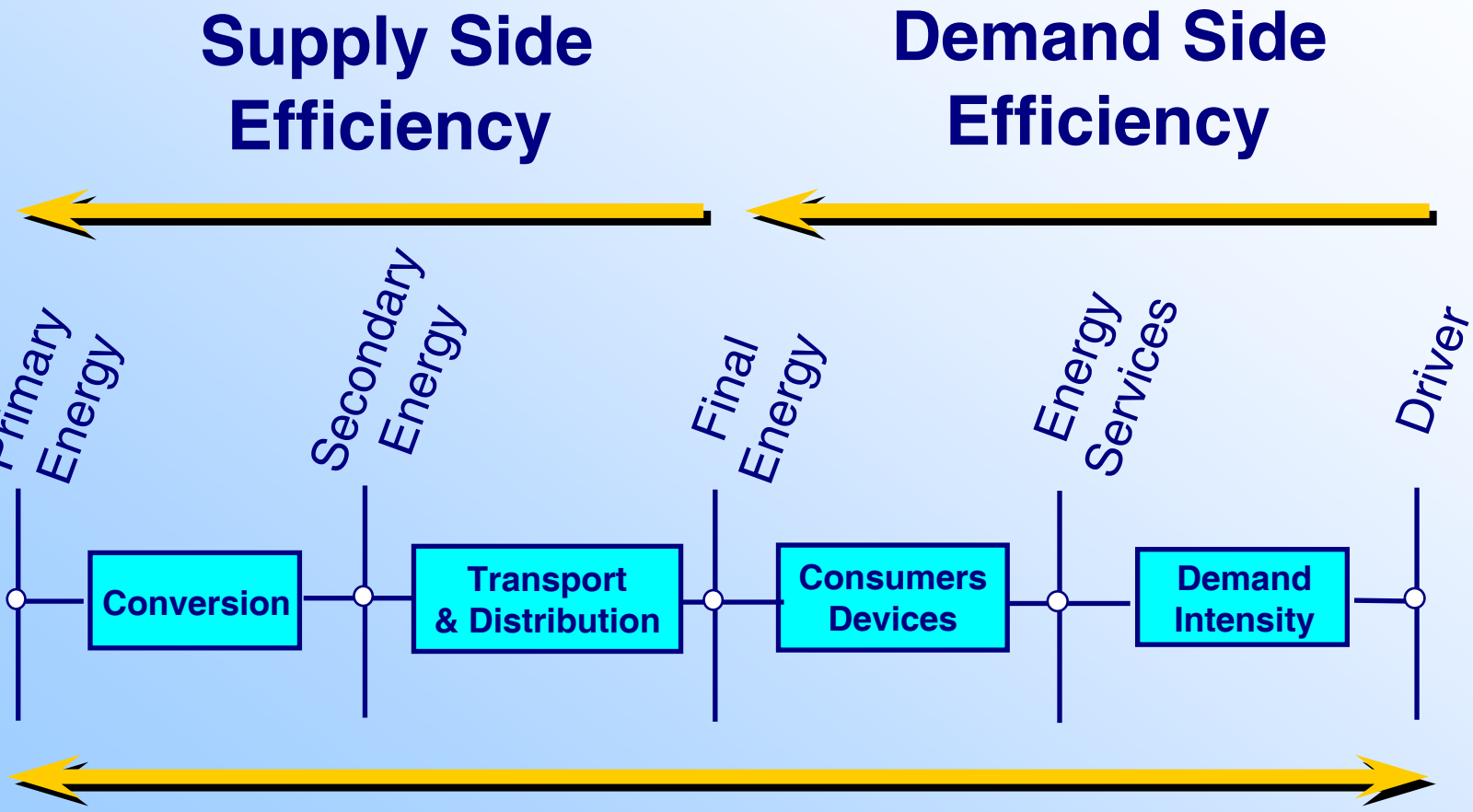
Phases of Structured Energy Planning



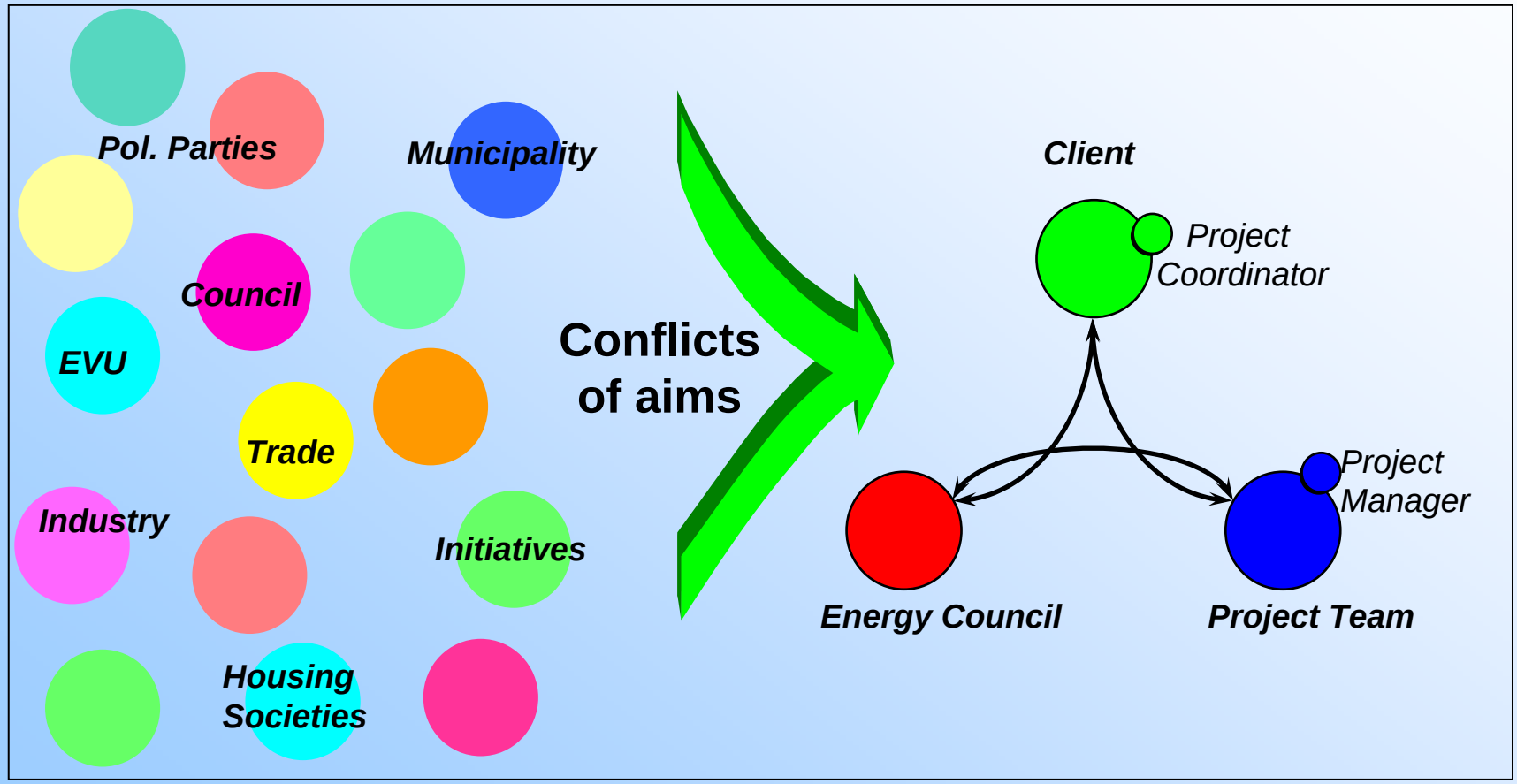
Structured Energy Planning

- **integrates**
  - all economic sectors and all energy forms
  - interregional relations
  - the demand side and the supply side
  - environmental damages
  - economic implications / costs
- **is not a prediction of the future**
  - but a rational basis for decisions for the future with the knowledge of today
- **is not a static master plan**
  - but a continuing planning process
- **is no end in itself**
  - but oriented toward specific activities
- **is not a replacement for decision making**
- **is not an excuse for inaction**

Integrated Energy Planning with RES Approach



ALEP - Project Organisation

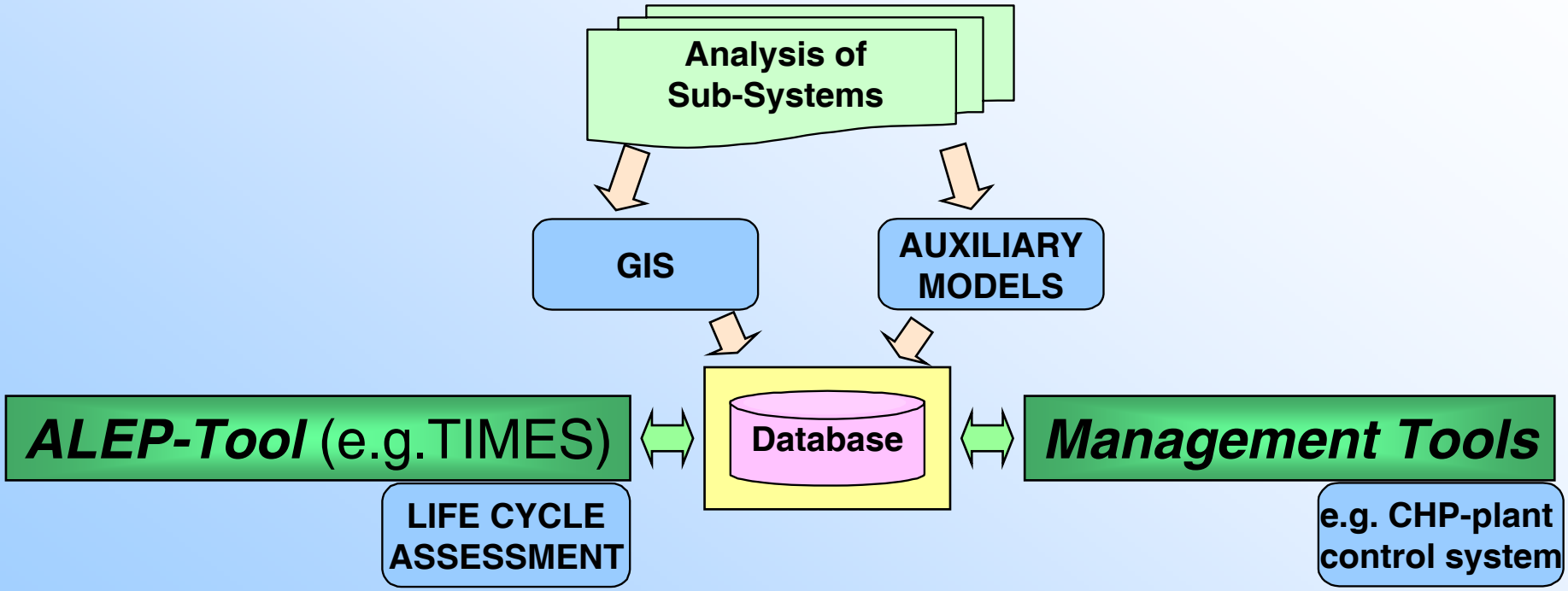


ALEP – Integration of Computer Software/Models

Design Tool	Use within ALEP
„Single purpose“ calc. tools	Optimisation of defined single components of the energy system (e.g. of a heat pump, solar collector, cogeneration plant, etc.) according to given goals
„horizontal“ calc. tools	Considers and optimises the whole chain of energy transformation, or part of it, from boundary to end-use
„vertical“ calc. tools	Considers „intersection“ of two or more energy supply systems (e.g. gas vs. DH optimisation, diff. types of cogeneration heating plants)
„integrated“ calc. tools	Uses comprehensive models for the simultaneous optimisation of supply and demand side measures

Tool	Description
MARKAL	Energy supply and Energy system model (IEA, ETSAP)
TIMES	Advanced Energy supply and Energy system model (IEA, ETSAP)
GEMIS	Life cycle analysis, CO2-emission and energy supply model (Öko-Inst.)
POLES	Energy supply and Energy system model (EU)
PRIMES	Energy-economic model (EU)
SAFIRE	Technology assessment model (EU)
AIDAIR	Information and Decision Support System (IDSS) comp. of EGIS (Energy GIS), TAP (Traffic and Air Pollution) and APPH (Air Pollution and Public Health)
PEGASUS	PC-based design tool for gas networks with GIS-interface
SWEDNET	model for technical-economic planning of the electricity network
LICHEAT TBMENY	Tools for the design of district heating networks and the calculation of costs and heat losses.

Integration of tools for supporting the planning process



Strategic Planning

Operative planning

long term structural optimisation

Short term optimisation management, regulation

Operative vs. Strategic Energy Planning

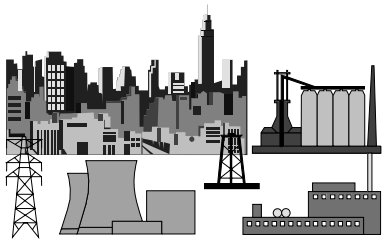
Operative planning

- short-term optimisation from minutes to days
- fixed technical energy system and socio-economic framework
  - requires a large amount of detail within the subsystems (accuracy!!)
  - carried out on a subsystem level with a limited time horizon and little consideration of comprehensive aspects

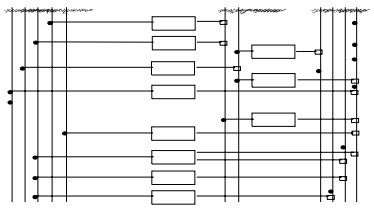
Strategic planning

- is a systematic way of analyzing, evaluating and shaping the future development of the energy system
- consists of setting goals and identifying strategies for achieving the goals
- long-term technological and socio-economic developments
  - less details in subsystems
  - focus on the behaviour of the system at long-term developments

Planning with a Computer Model



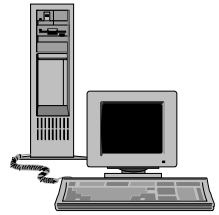
Reality



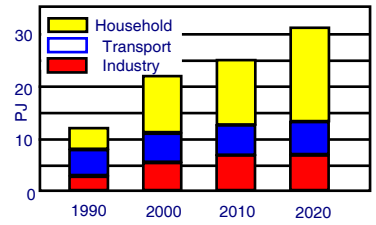
Model Structure

$$P_{BHKW\_S} = \eta_{BHKW} \cdot P_{Coal\_BHKW}$$
$$O_{BHKW\_CO_2} = \varepsilon \cdot P_{Coal\_BHKW}$$
$$Q_{BHKW\_H} = \eta_{2\_BHKW} \cdot P_{Coal\_BHKW}$$

Mathematical Description; Set of Calcul.



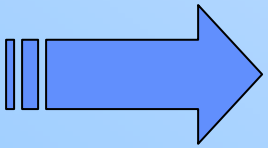
Software Tool



Model Results

Necessity of energy system models

- Foresight of impact of decisions making today (e.g. sustainability).
- Models are designed to find the best way among different alternatives considering exogenous constraints (e.g. emission limis, decistion criteria).
- The energy system model can show the conflict potential of different planning goals and objectives.
- Handling of Operative planning.



In POLYCITY the integrated model approach can be adopted to:

1. **assess the overall energetic, economic and environmental effects and**
2. **results for different municipalities and**
3. **for developing an overall energy and sustainability strategy.**

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ETSAP

IEA (International Energy Agency)

Implementing Agreements

Energy Technology Systems Analysis Programme (ETSAP)

IEA OECD ETSAP

Technology oriented analysis of energy systems:

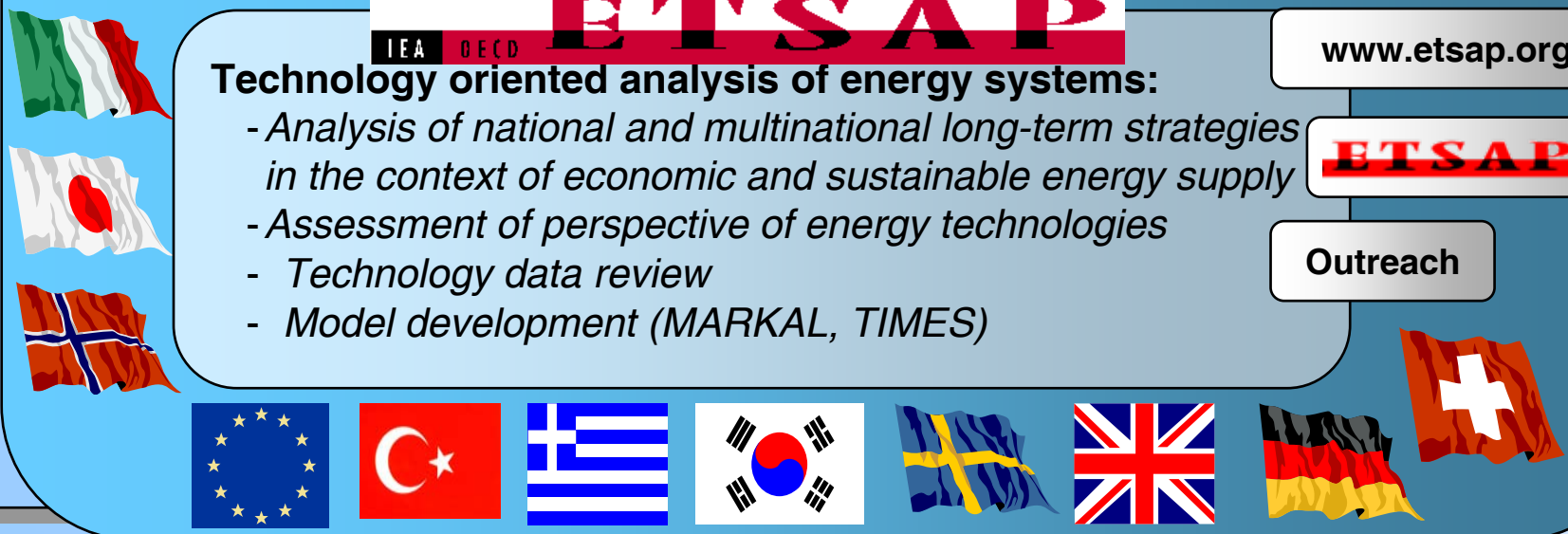
- *Analysis of national and multinational long-term strategies in the context of economic and sustainable energy supply*
- *Assessment of perspective of energy technologies*
- *Technology data review*
- *Model development (MARKAL, TIMES)*

Project Head: GC Tosato

www.etsap.org

ETSAP news

Outreach



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TIMES

TIMES
The Integrated MARKAL EFOM System

Development
- *By* ETSAP
- Implementation in GAMS
- Model generator

Methodology
- Bottom-up Model
- Perfect competition
- Perfect foresight
- Optimisation (LP)

Min / Max Objective function
Equations, User Constraints
Decision Variables < = >
Solution
Input parameters

Applications of the model
- IER:
  - Ostfildern
  - Baden-Württemberg, Bavaria, Saxonia, Hessen
  - Germany
  - European electricity and gas sector
  - World
- Other places:
  - Finland (VTT, Helsinki)
  - Belgium (KUL, Leuven)
  - Italy (Turin)
  - EU-NEEDS project
  - Global model (IPP, Munich; GERAD, Canada)
  - South Africa model, Village model (ERC, Cape Town)

- ***Features***
- Inter-temporal / Long-term
- Flexibility
- Multi-Regions / High spatial resoulution
- Elastic demands
- Vintaging
- Load curve
- Endogeneous (technological) learning
- Macro-economic linkage
- Discrete capacity expansion
- Climate extension

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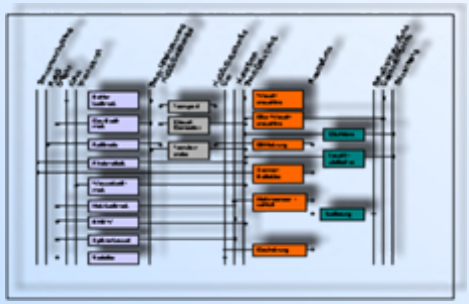
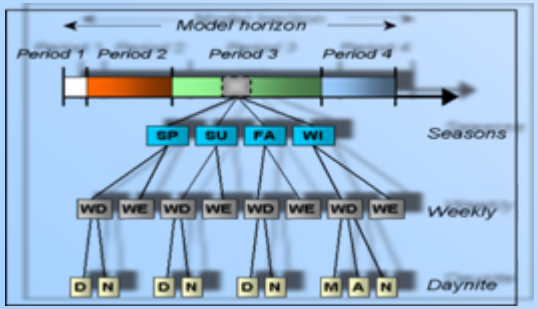
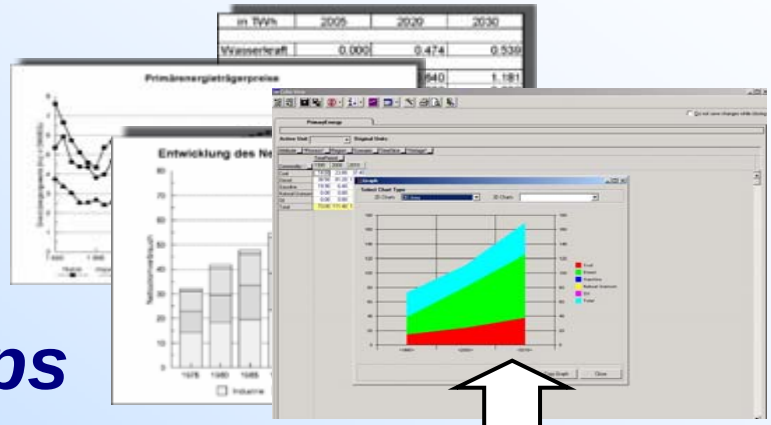
RES



Specification

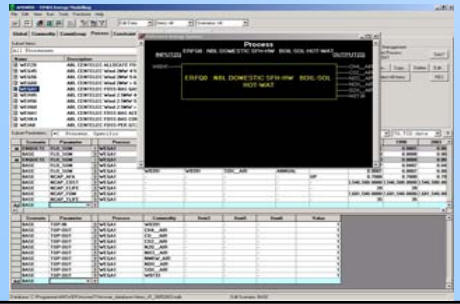


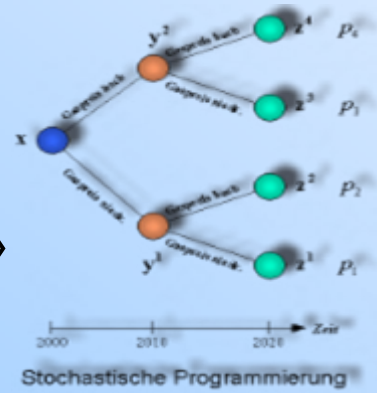
Analysis of results in VEDA (Versatile Data Analyst)



Modeling steps

Model management / data input in ANSWER





Scenarios

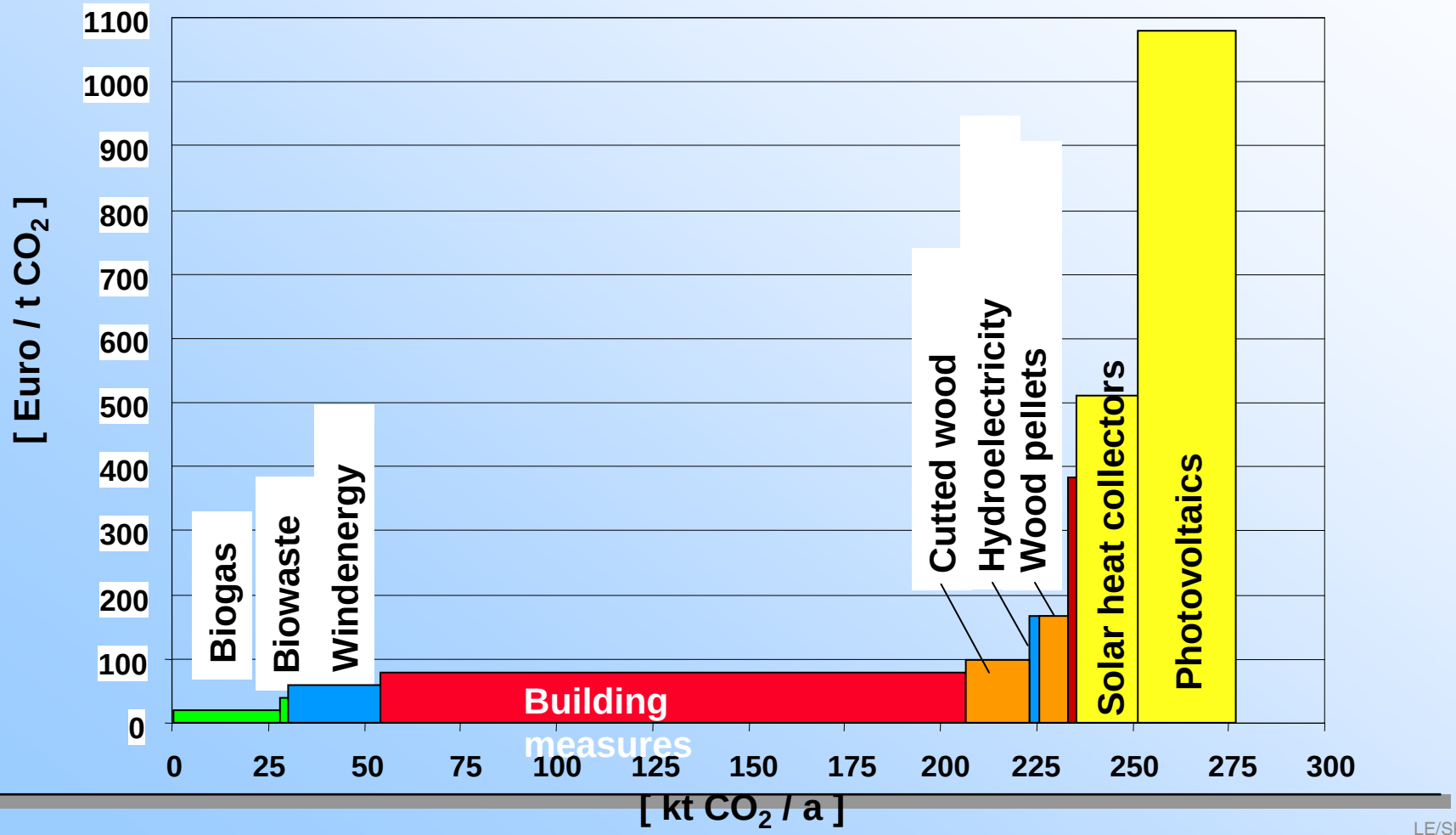
GAMS

Solving (General Algebraic Model Structure and solver)

Results of TIMES

- Optimal structure of the system (supply, distribution and demand)
  - by minimizing the total system costs
  - under consideration of the energetic framework (biomass / energy supply and demand)
  - with simultaneous balancing of the environmental impacts
- Cost/Benefit analysis for heat/cold and electricity generation.
- Comparison of the results with benchmark values and/or with similar situations in other European cities.
- Determining of policies and measures by carrying out scenario analysis and sensitivity analysis.

Cost-Potential-Curve of different measures in an integrated approach



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The TIMES area model

Application (IER)
- Baden-Wuerttemberg
- Citymodel – AGFW
- POLYCITY - Concerto
- EnerKey - Gauteng

Energy prices

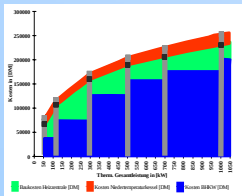
Electricity prices

§

Supply

Existing plants

extension ↕ new



extension

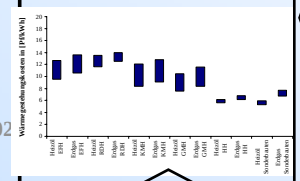
compression

new building

Demand

New

Viability



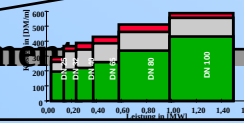
Saving

Industry

Energy prices

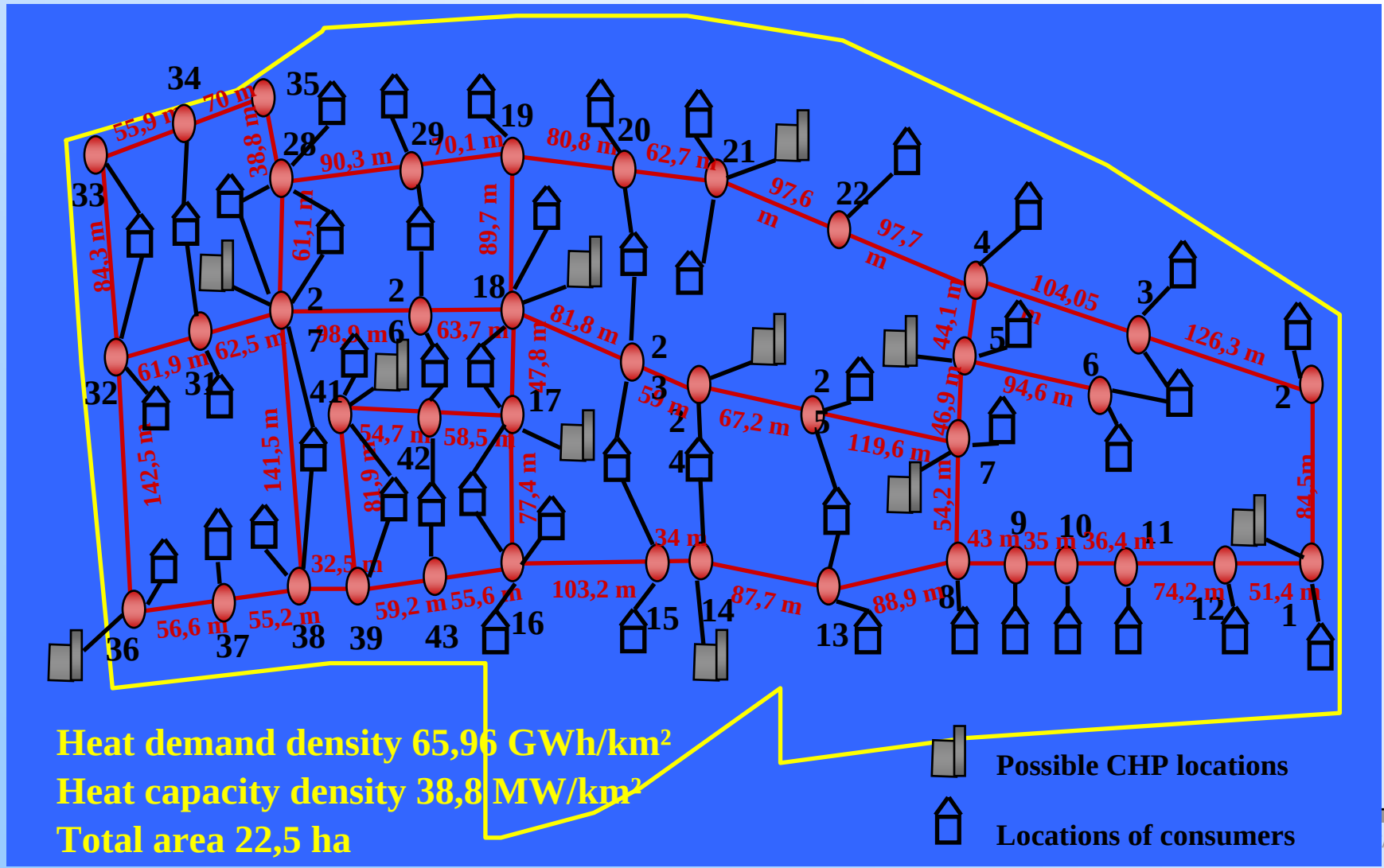
§, Law and Rules

Investment Costs:

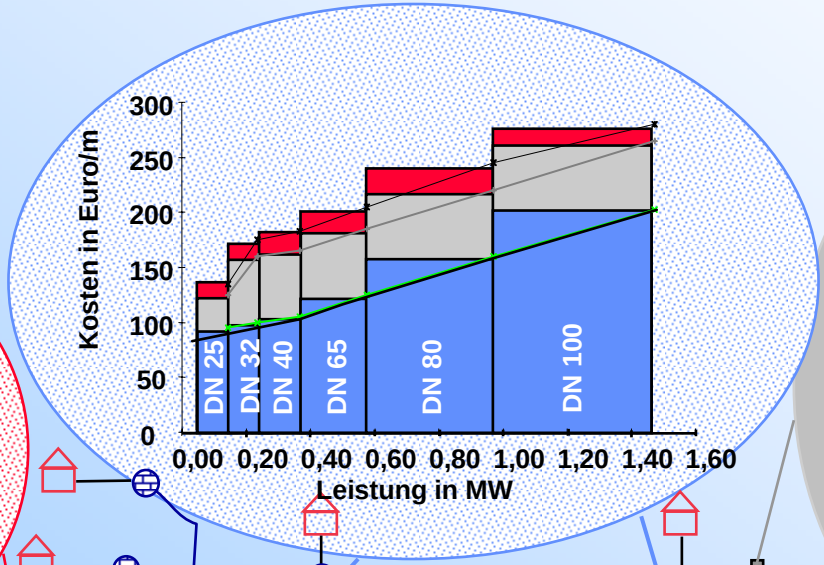


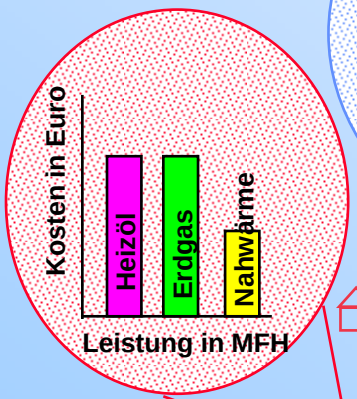
Operating Costs

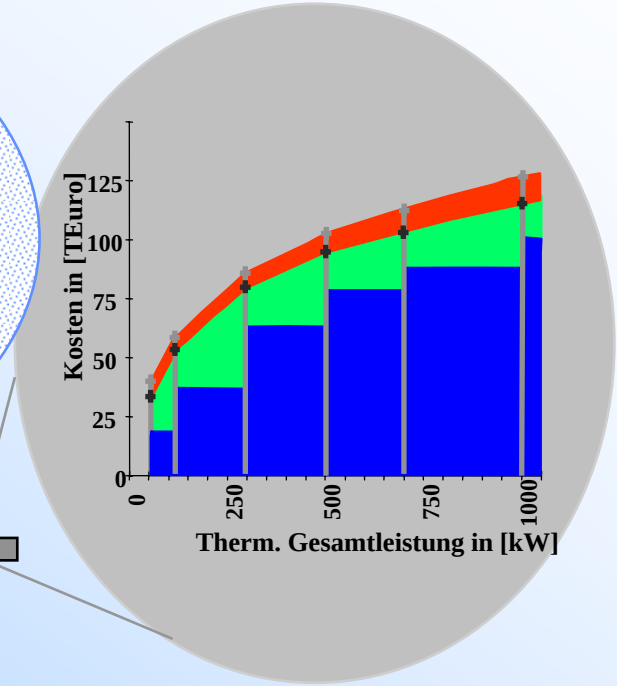
Construction of the model topology – Analysis of aerial photography of the supply area

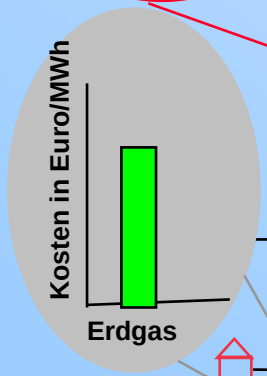


Determination of the heat supply of an area at optimal costs





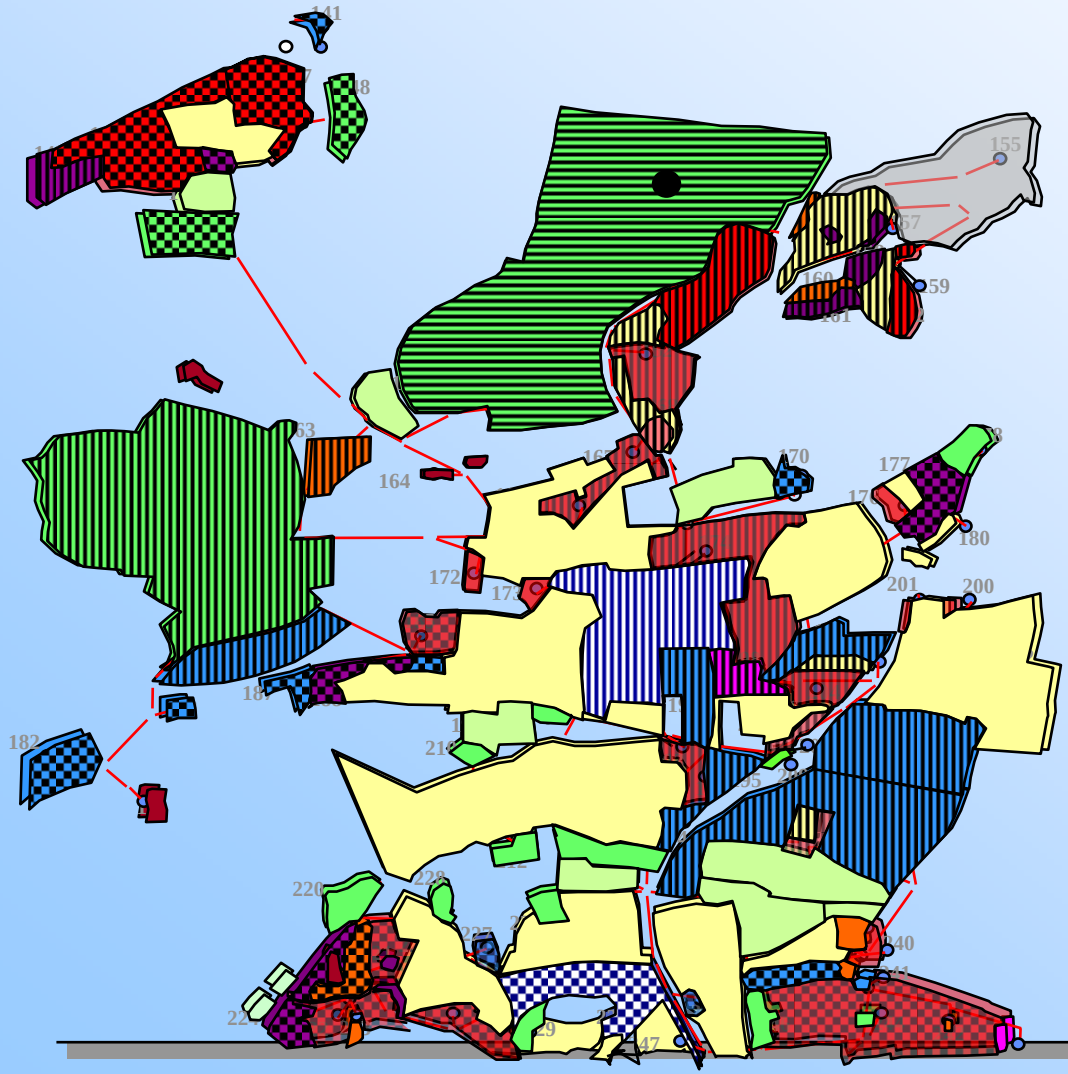




Optimization problem (Separable Mixed Integer Programming)

Total costs = Sum of the costs (Generation + Distribution + consumer devices) = Minimum

Exemplary results of the regionalised area model



district heat (asset)

potential of district heat

potential of local heat

ST0 stand-alone single building

ST1 scattering settlement

ST2 single and double family houses

ST3a urban village core

ST4 terraced houses

ST5a small apartment buildings

ST5b big and small apartment buidlings

ST6 multi-story building

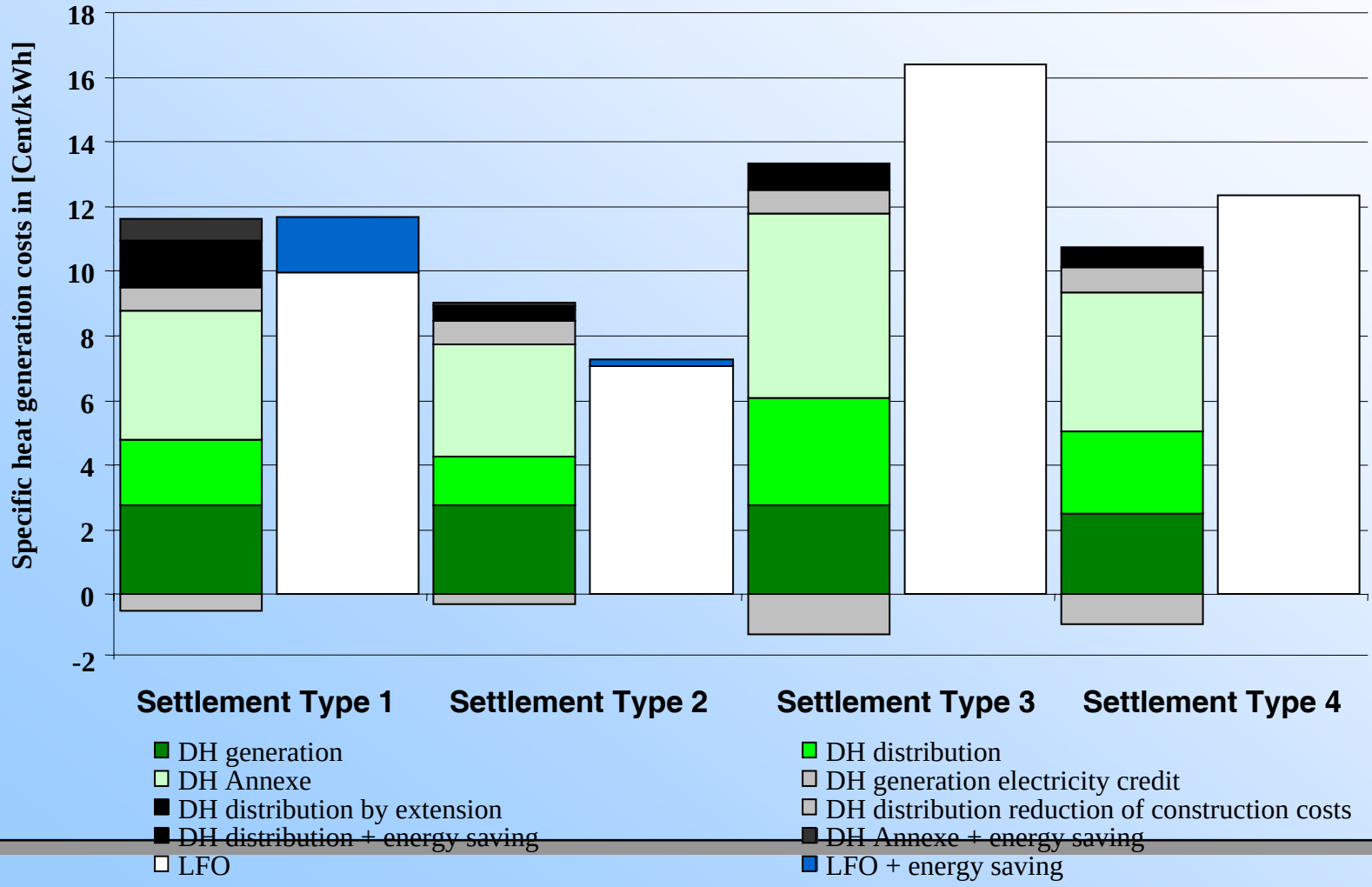
ST8 city housing

ST10b public special buildings

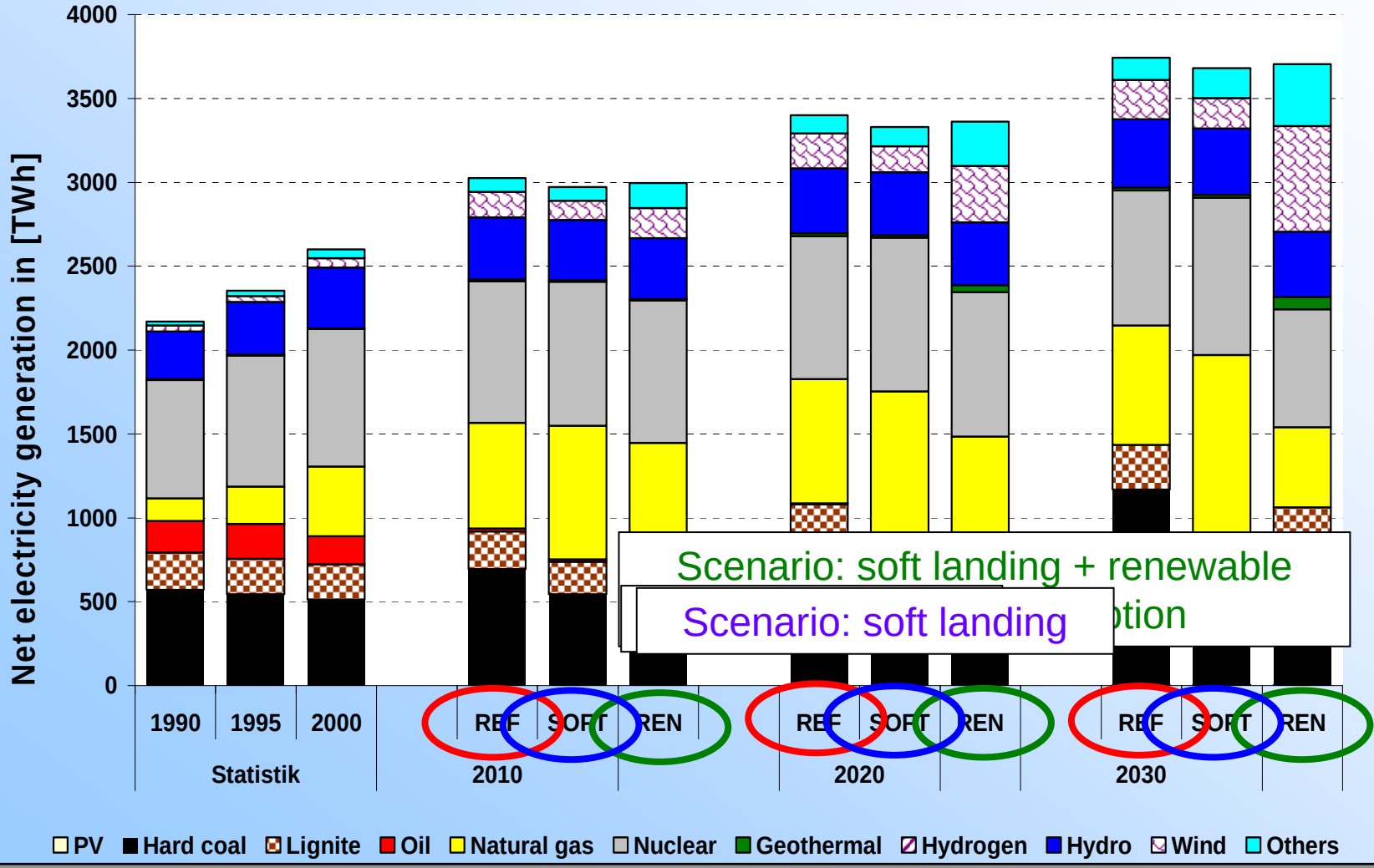
ST11a service buildings

ST12 other supply areas

Comparison of the specific heat generation costs



Scenario analysis of the net electricity generation



Conclusions

For integrated planning the energy model TIMES can play an essential role for the advanced local energy planning to...

- provide a consistent long-term sustainable energy plan that analyses the behaviour of the entire energy system.
- see the implications of current decisions in future.
- find among different alternatives the way which satisfies best to the market allocation of limited resources by considering different exogenous constraints and decision criteria.
- assess the overall energetic, economic and environmental effects and results of the municipality performance.
- show the conflict potential of different goals and objecitves.
- develop an overall energy and systainability strategy.
- analyse with cost benefit.

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Thank you for your attention

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