Grid based Price Calculation Engine – PCE for continuous electrical energy trading

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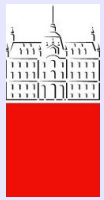

Overview

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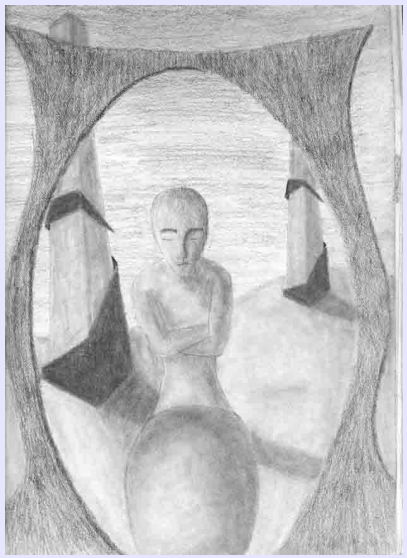

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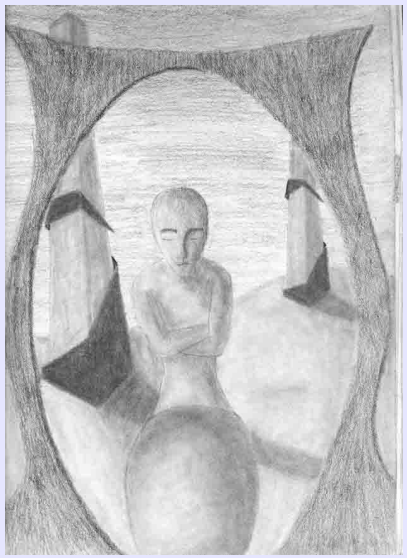

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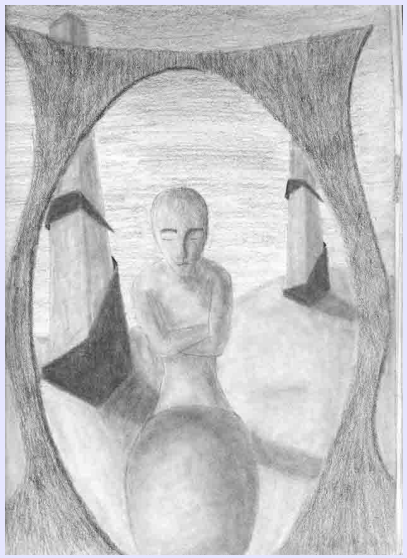

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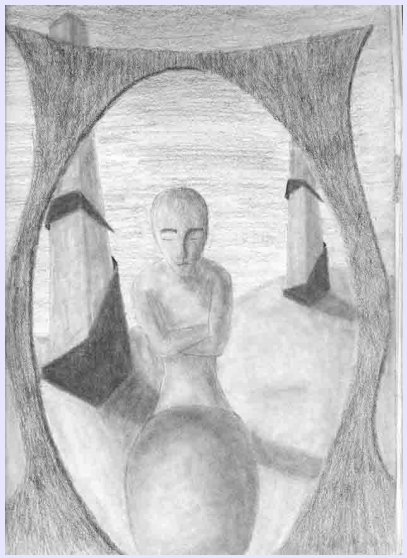

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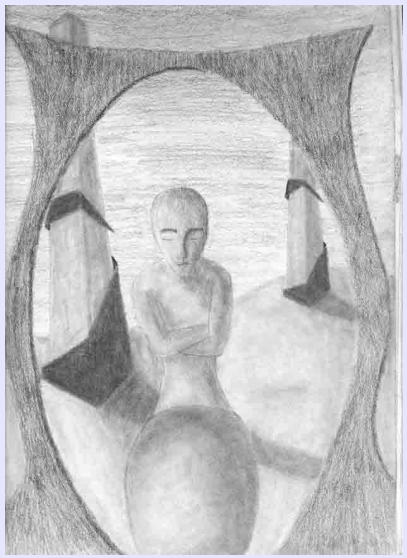

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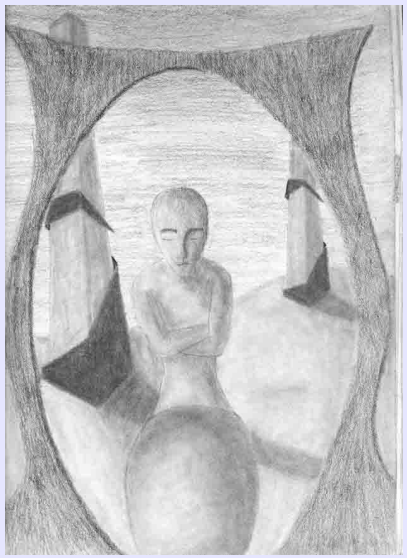

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- Our goal:
  develop a system that offers interactive support for buying electrical energy

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- Each region is connected to other regions with links
- Each region offers a certain amount of electrical energy
- The regions (providers) sell the electricity in products
  The product is defined as
  - start hour
  - end hour
  - minimal and maximal amount
  - price per unit

Description of the problem (II)

Transfer cost

- Transfer of electricity from one region to another loads many links in the el. grid

Source	Destination	I	II	III
EPCG	EPCG	0.0	0.0	0.0
	EPS	12.4	3.7	6.7
	ERS	1.0	0.2	-1.2
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- Current link usage

$$z : E \times \{0 \ldots 23\} \longrightarrow \mathbb{R}$$

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Electrical power grid:

- Transfer matrix - PTDF

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$$p_e \quad : \quad V \longrightarrow 2^{\{0\ldots23\}\times\{0\ldots23\}\times\mathbb{R}\times\mathbb{R}}$$

- Cost of transmission on a link

$$p_t \quad : \quad E \times \{0 \ldots 23\} \times \mathbb{R} \longrightarrow \mathbb{R},$$

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- supply region $\bar{v}$ with exactly $\bar{q}$ units of electrical energy in every hour of the time interval $\{\bar{h}_1 \ldots \bar{h}_2\}$.

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- Minimizing the price

$$\left(\sum_{\langle v, h_1, h_2, q, p \rangle \in \mathcal{S}} p \right) + \left(\sum_{h \in \{h_1 \ldots h_2\}} \sum_{e \in E} p_t \left(e, h, \sum_{\substack{\langle v, h_1, h_2, q, p \rangle \in \mathcal{S} \\ h_1 \leq h \leq h_2}} q \cdot t(v, \bar{v}, e) \right) \right)$$

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- *NP*-hard - reduction from the PARTITION problem
- makes it "impossible" to solve to optimality
- we need a deterministic heuristic

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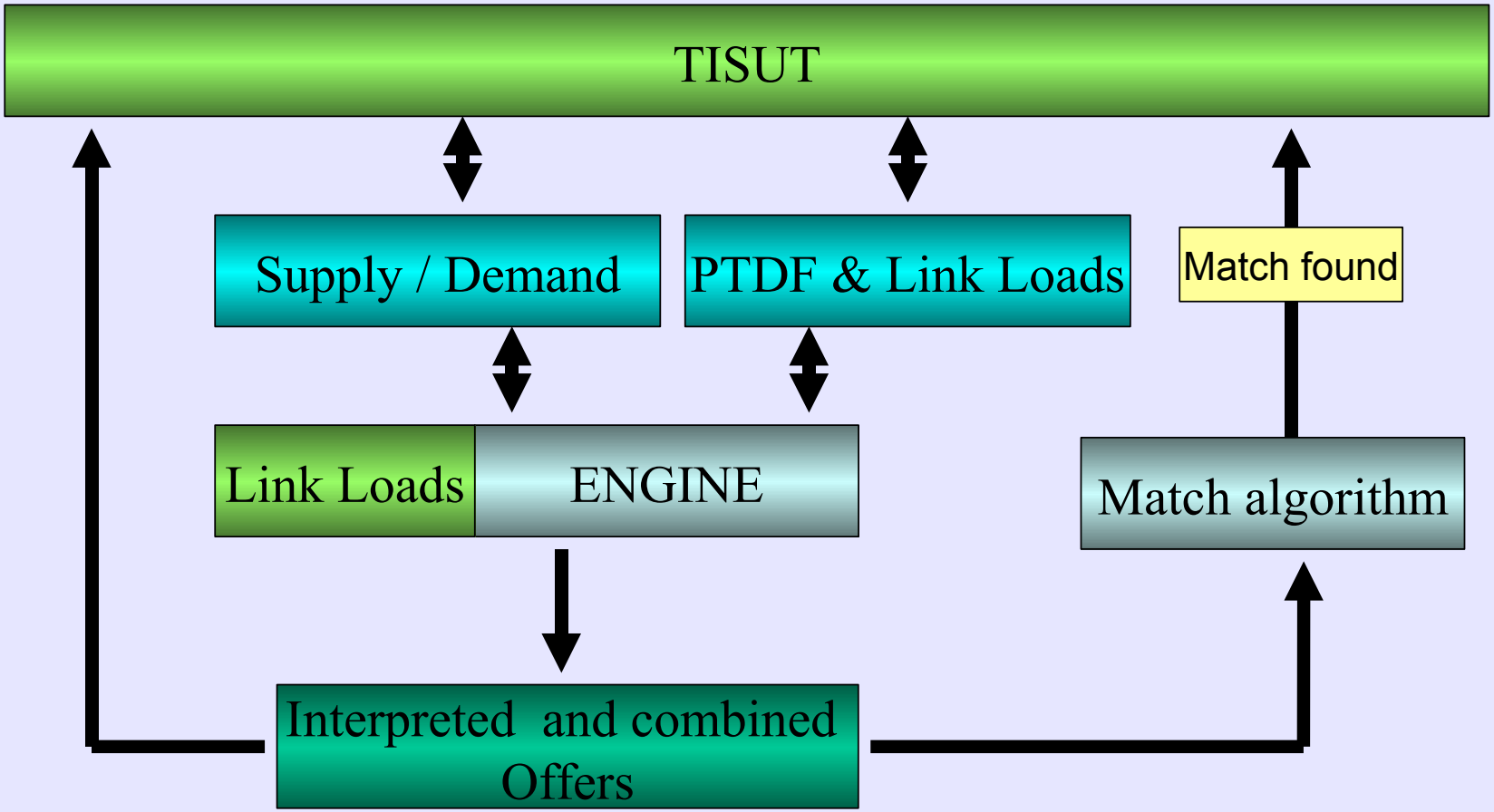
- It does this for all the demands
- If the price of the supply is lower or equal to the price willing to pay, the deal is closed

System outline



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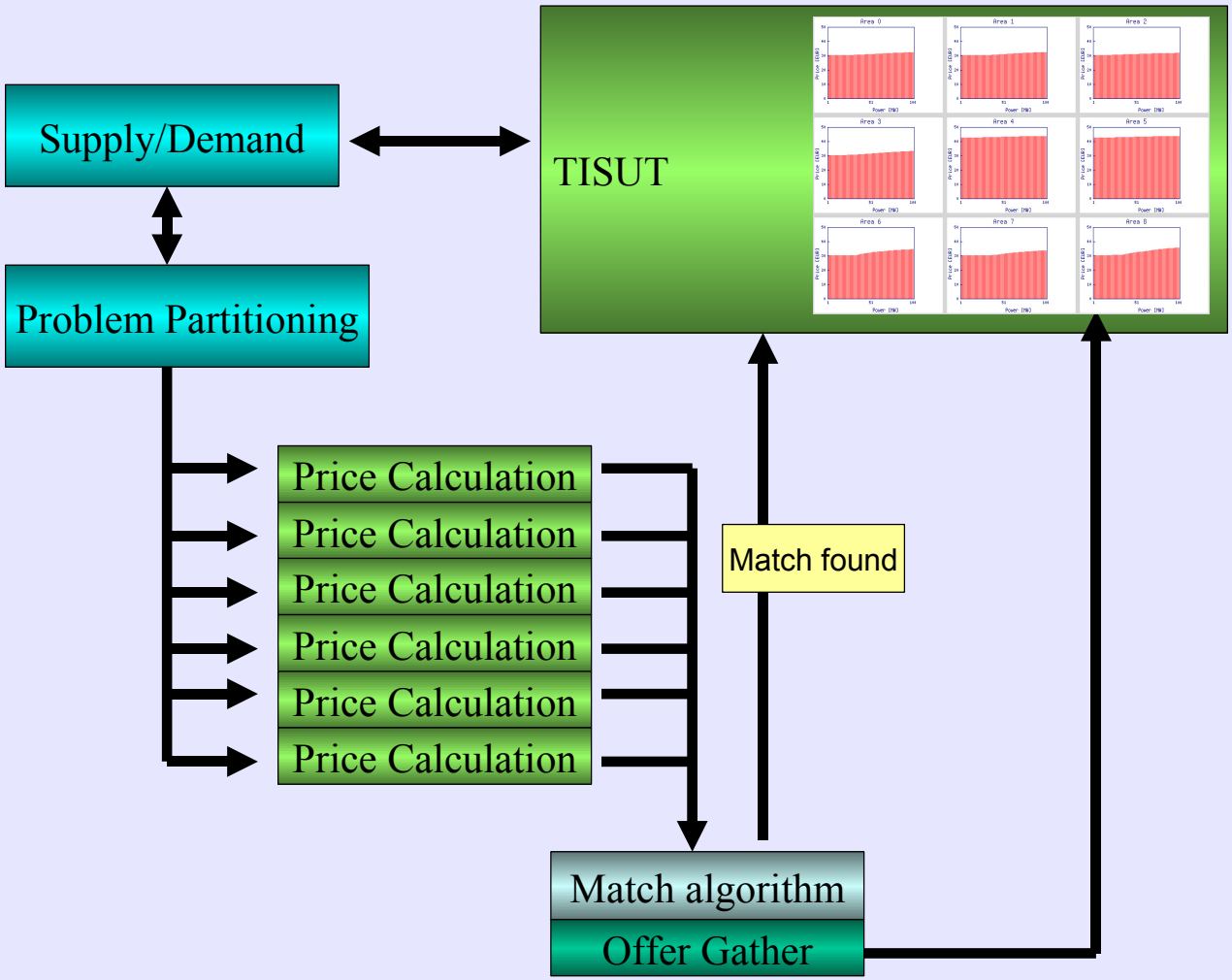
- Future work will focus on more advanced parallelization

Distributed algorithm



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- one iteration finished below 5 seconds

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2. We gave an analysis of the problem
3. We demonstrated a new application suitable for the grid
4. From the math. model new parallelizations can be found

Questions?