Opportunities of

WASTE HEAT RECOVERY

at natural gas transmission systems

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Rastislav Ňukovič, Director of Asset Management

Background and Objectives

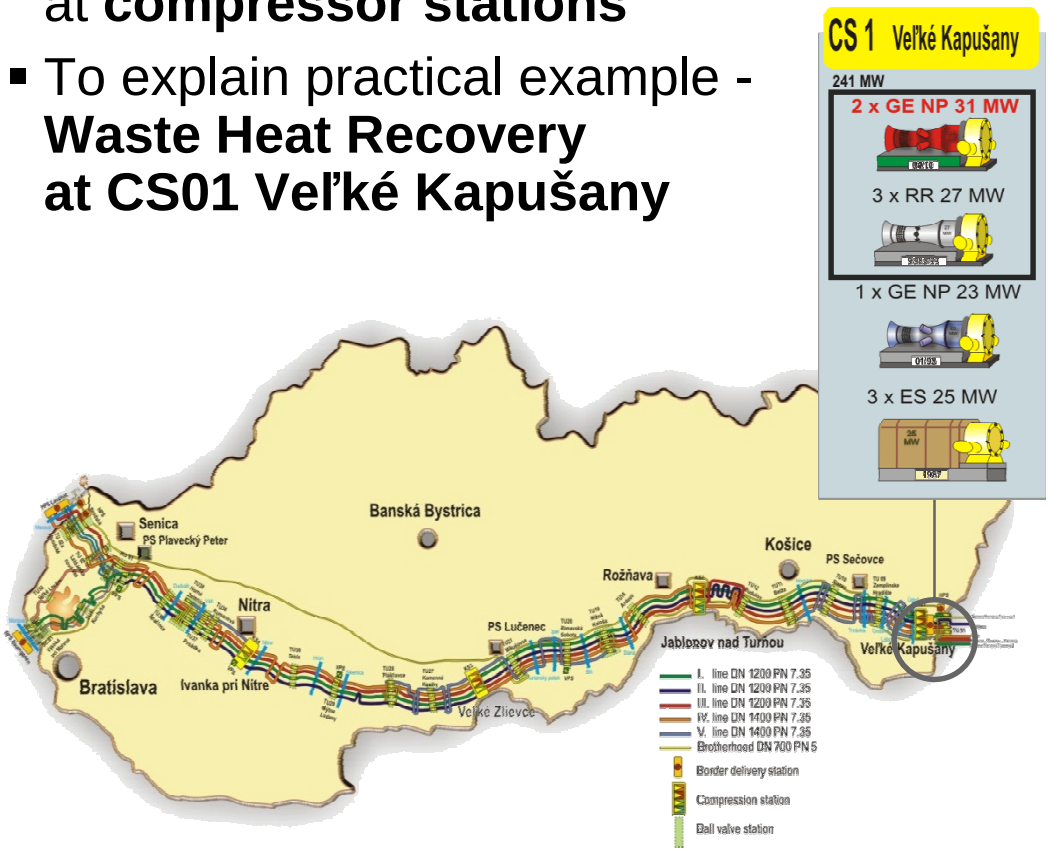
Background

- **Compressor stations** have huge potential for **waste heat recovery, increase efficiency** and **reduction** of overall **environmental footprint**

- Currently only limited number of waste heat recovery systems due to very high volatility of transmission flows

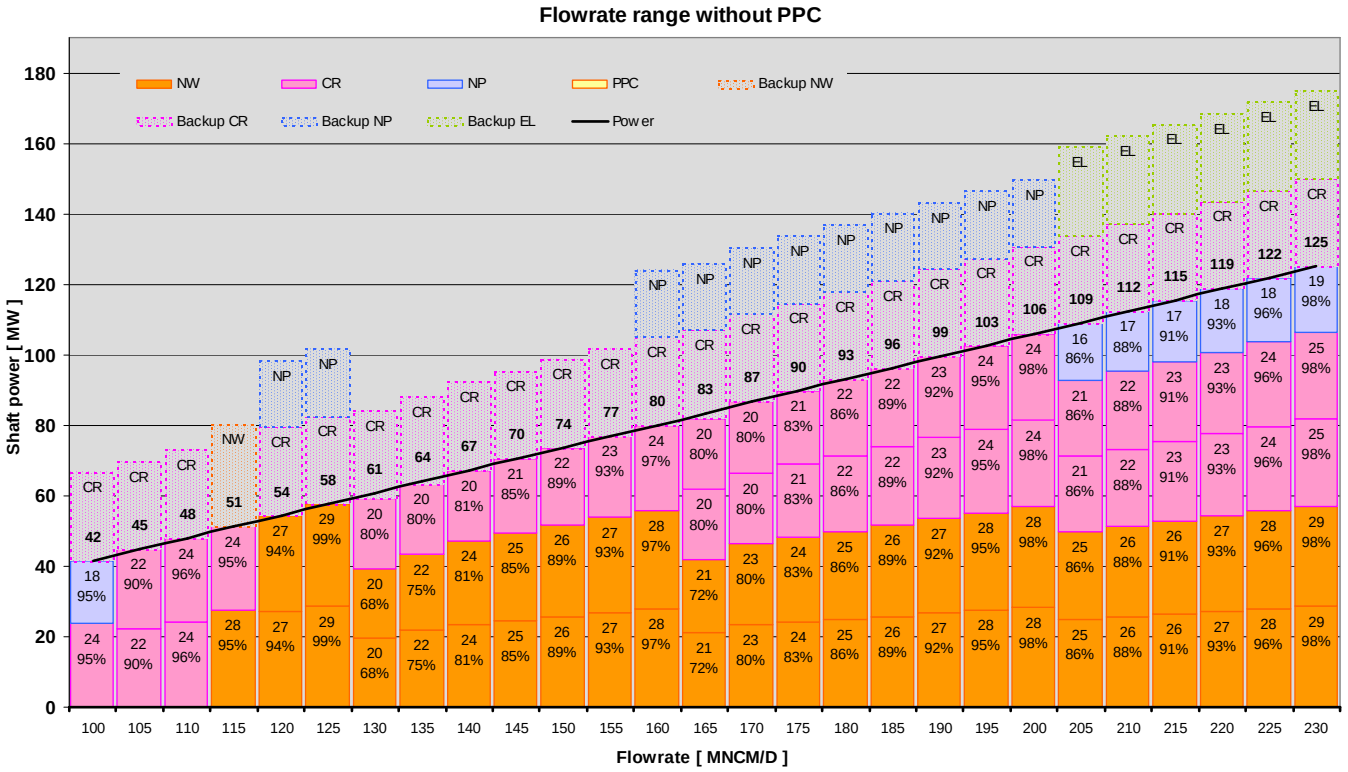
Objectives

- To describe the **philosophy and methodology** how to **utilize waste heat** at **compressor stations**
- To explain practical example - **Waste Heat Recovery at CS01 Veľké Kapušany**



Methodology

- **To identify compressor stations and gas turbines suitable for waste heat recovery**
  - look for a compressor station with very high utilization in a year
  - a compressor station with non-stop operation
  - vicinity of machines is an advantage at designing an engineering solution
- **To identify number of gas turbines to be included in a waste heat recovery project**



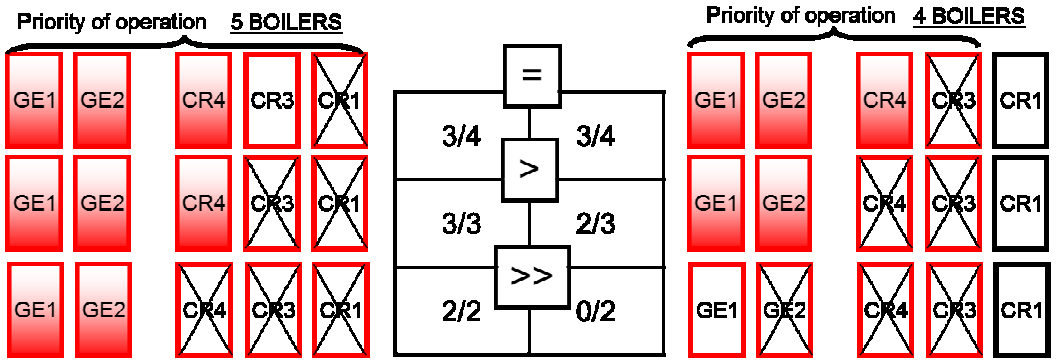
Methodology

- **To identify number of gas turbines to be included in a waste heat recovery project**

VOTL example

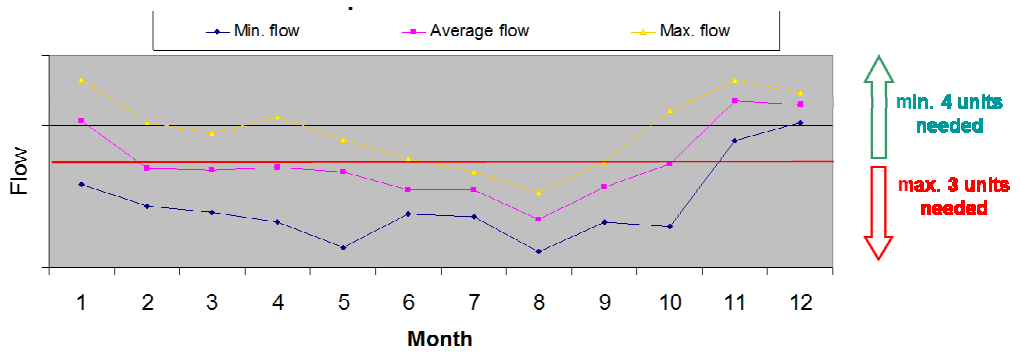
- minimum 2 machines working at 70% of power
- maximum 3 machines

Margins: min/max number of machines in operation and their load



Machines in operation / available machines

Anticipated flow in a year

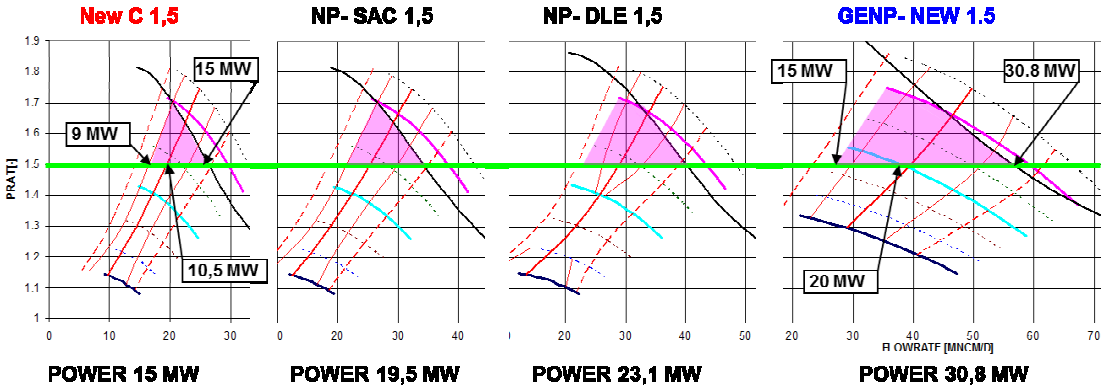


Methodology

- **To propose basic variants for utilizing waste heat**
  - **mechanical work** production to drive gas compressor
  - analysis of impacts to CS operation:
    - change in dispatching system
    - time demand of cool/warm start
    - impact of emergency shutdown
    - parallel operation of existing fleet + steam turbine driven compressor
- **electricity** production
- analysis of requirements for stability of output power

Parallel operation of compressors

gas turbine vs steam turbine driven



VOTF example:

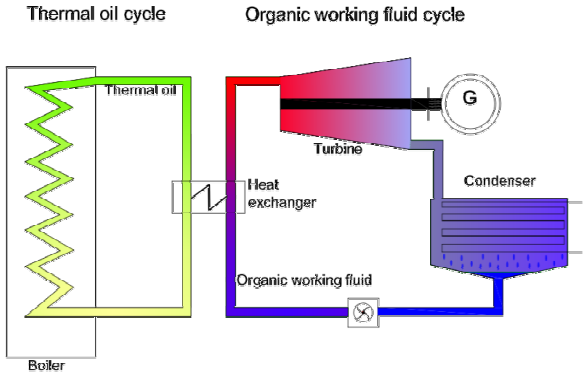
- high risk of domino effect in mechanical work production
- no available suitable compressor (size) for natural gas transmission

Methodology

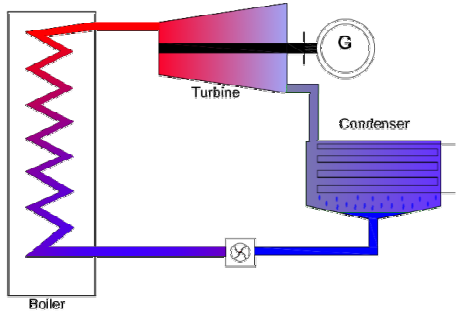
- **To analyze existing infrastructure available**
  - **electricity grid** – voltage level, capacity
  - **water availability** for industrial purposes (steam production, cooling)
  - **sewerage system**, drainage
  - **industrial structure** with high heat consumption (greenhouses, boiler house, factory)

- **To analyze possible technical solutions**

Organic-Rankine Cycle (ORC)



Clausius-Rankine Cycle



VOTE example

- use the Classical Clausius-Rankine Cycle with technology of two pressure steam system, Net electric efficiency - Steam cycle: 21.01%, ORC: 16.04%

Methodology

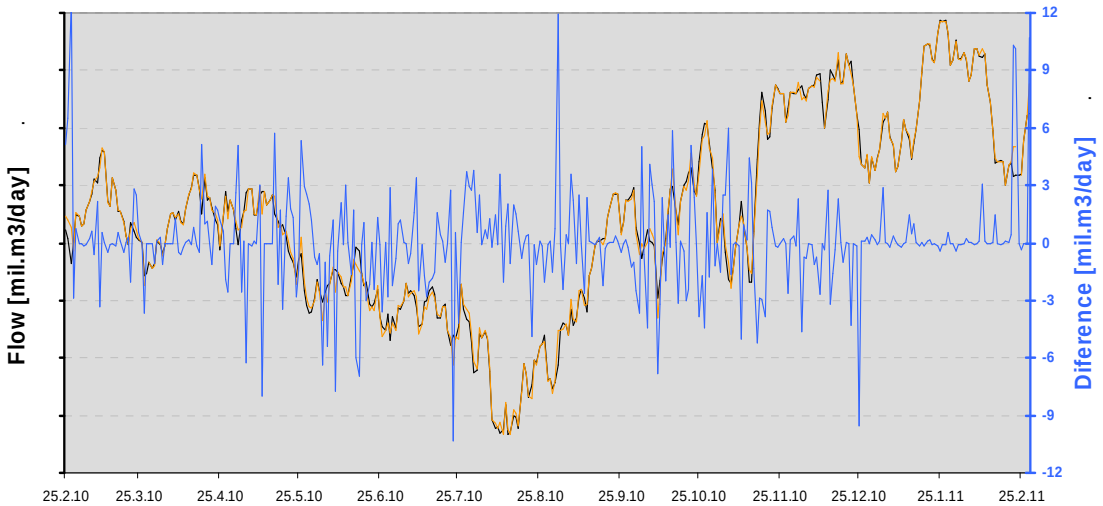
- **To mitigate volatility of flow and thus energy produced**

- **technical measures**

  to limit output power, supplementary heating, ...

- **contractual measures**

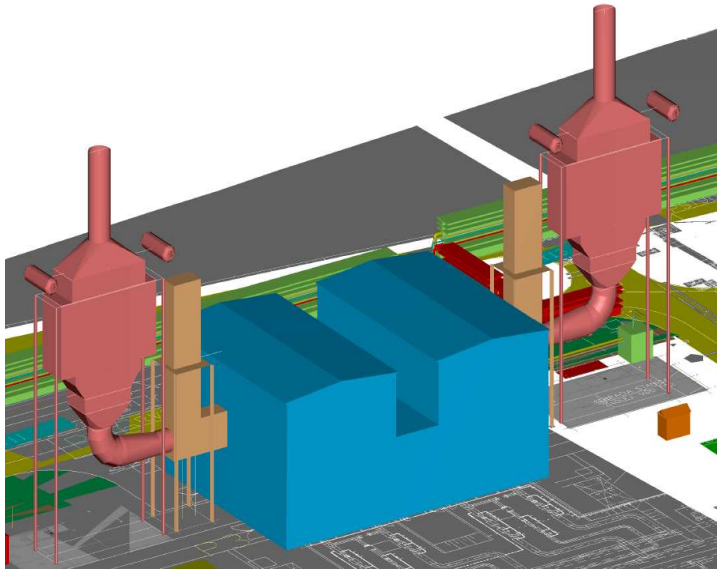
Deviation: nomination assumptions/real flow



VOTE example

- use of supplementary heating (output up to 30% of total G.T. heat power)

Methodology



VOTL example

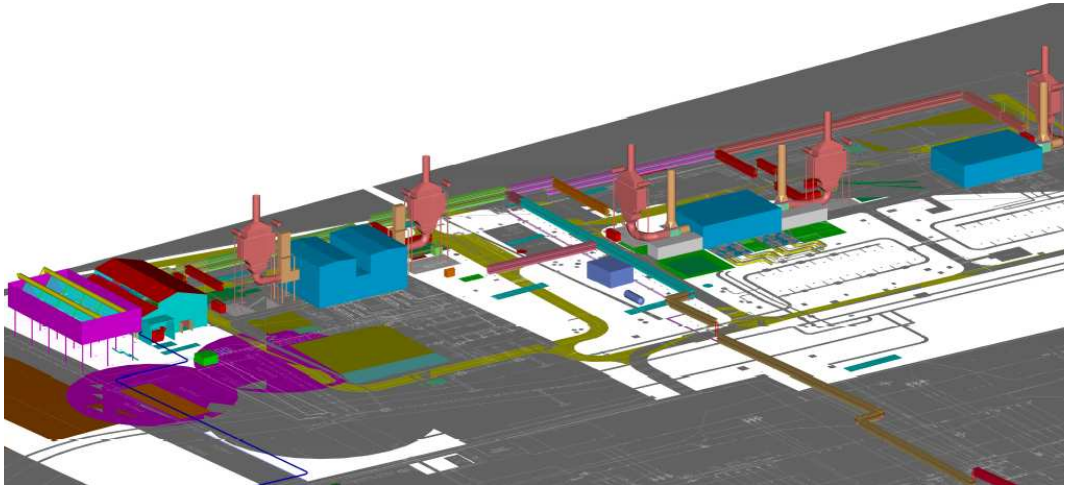
- the result of analysis: production of electricity using steam cycle in 4 boilers for 5 combustion turbines connected - one boiler is of two inputs design

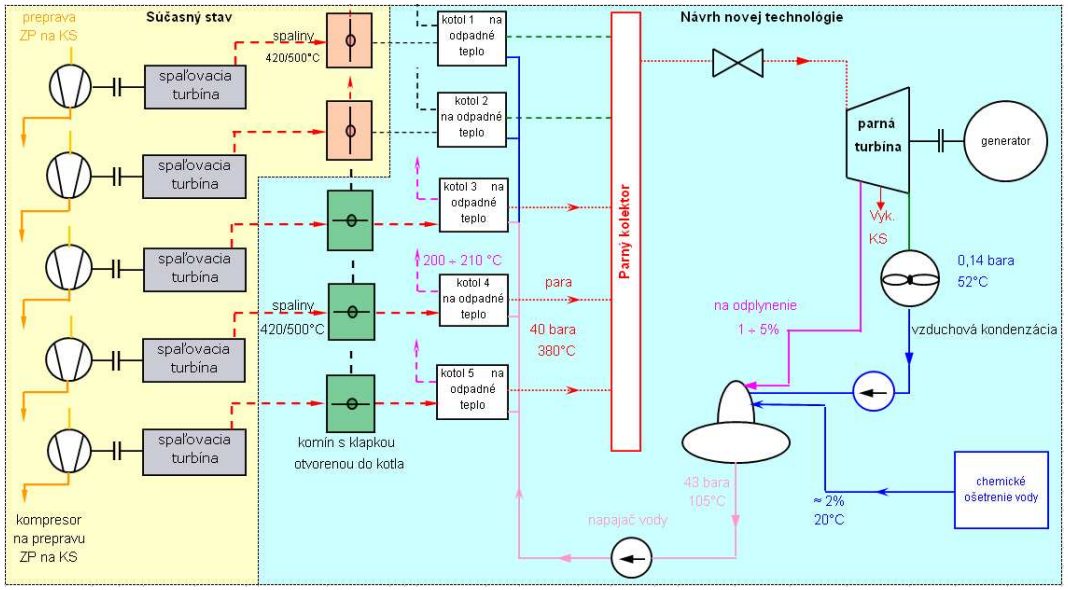
- **To analyze economic and multi-criteria**
- effect on **transport reliability**
  - effect on operation of combustion turbines
  - effect on operation of gas compressors
- internal **Return Rate**
- **safety risks** of installed equipment
  - duct systems
  - use of steam
  - use of thermo-oil
- **availability** of installed equipment
  - boilers
  - expander related equipment
  - duct systems
- capital **costs**
- demand for **new premises**

Conclusions

VOTE project

- 5 gas turbines waste heat utilization
- electrical power output **16 – 30 MWe**
- heating of CS: thermal out up to 8MW
- avg. **efficiency increase 35% - 57%**
- annual production of **200 GWh of electricity, 33 GWh of heat**





Thank you for your attention

Rastislav Ňukovič, Director of Asset Management