



GEOHERMAL ENERGY:

*A clean and stable
renewable source
for the global energy balance*

***Michele Pipan**
University of Trieste - UGI*



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RATIONALE (3 E)

- *ENERGY priority*
 - *Development of effective alternatives to fossil fuels*
- *ENVIRONMENT priority*
 - *Reduction of gas emissions in atmosphere*
- *ECONOMY priority*
 - *Large and widespread potential of renewable sources for sustainable development*

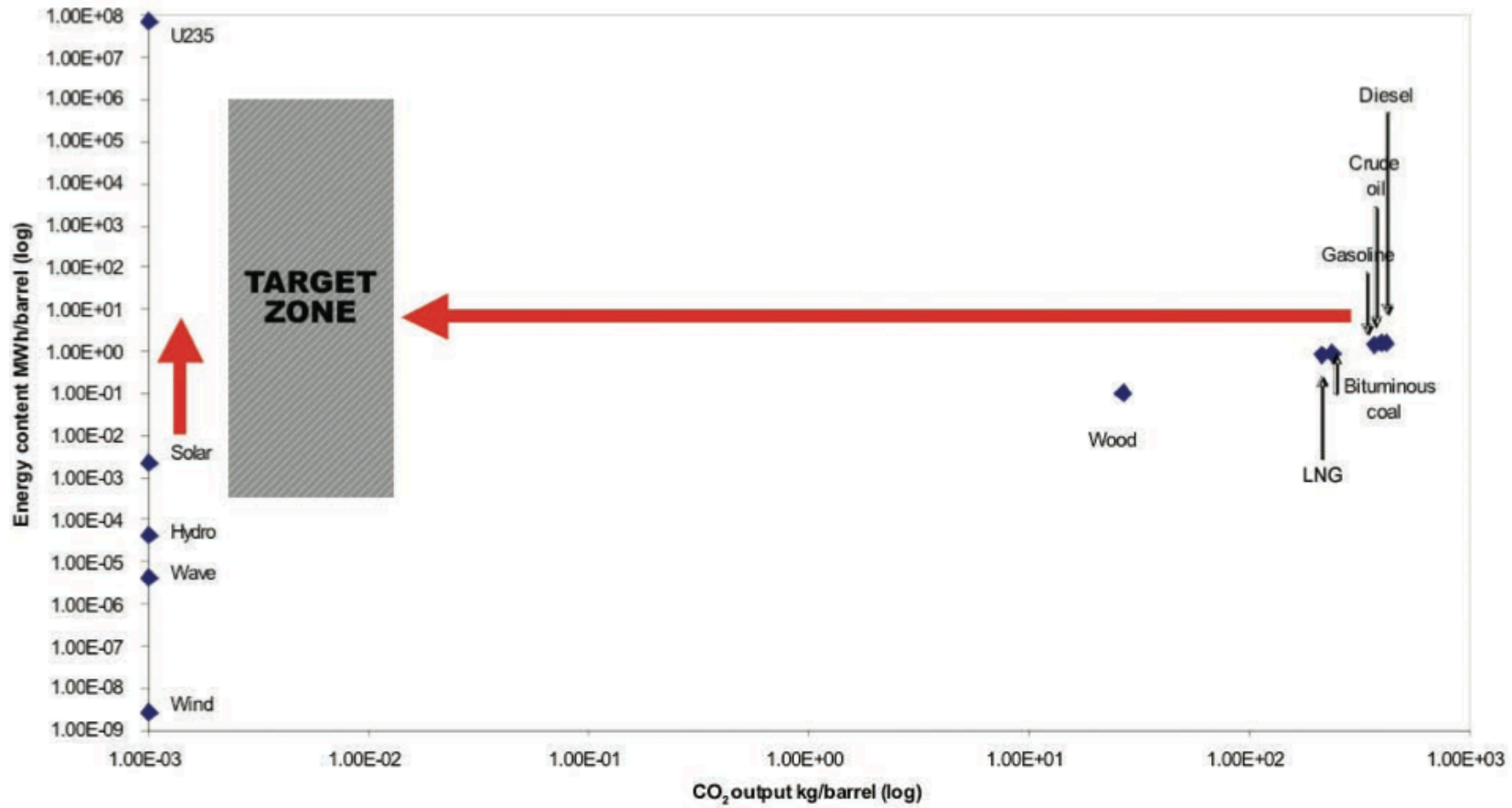


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Energy content vs CO₂ output



(J.Baxter, 2007)



In common with all renewable energy sources, wind is unpredictable and so requires an alternative back-up source of energy storage device to provide renewable and continuous power.

(J.Baxter, 2007)



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Energy and greenhouse gas savings from geothermal energy use (per year) [1]

FUEL OIL (x10⁶ barrels)	CARBON (x10⁶ t)
270	41



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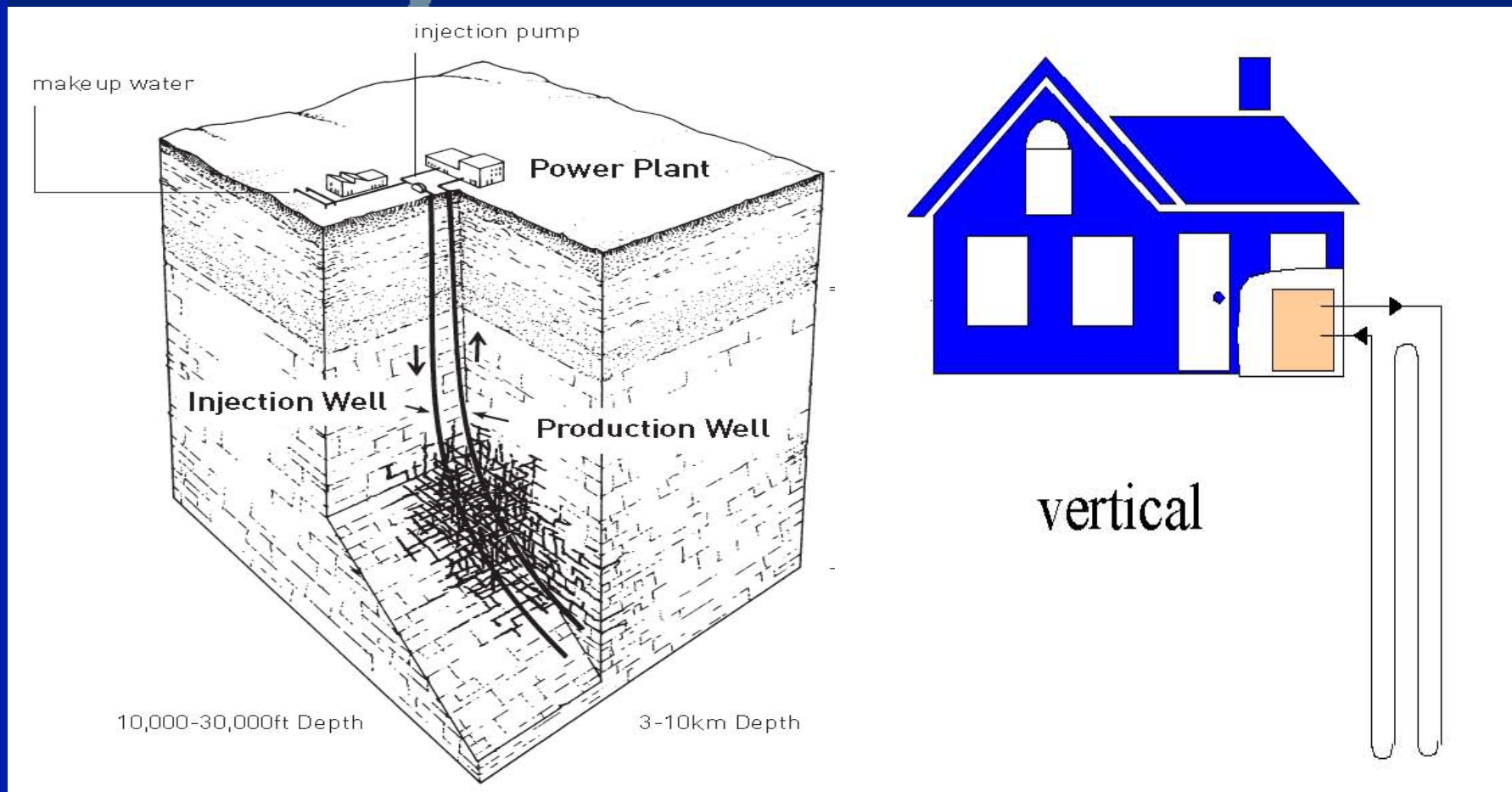


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Energy and greenhouse gas savings from geothermal energy use (per year) [2]

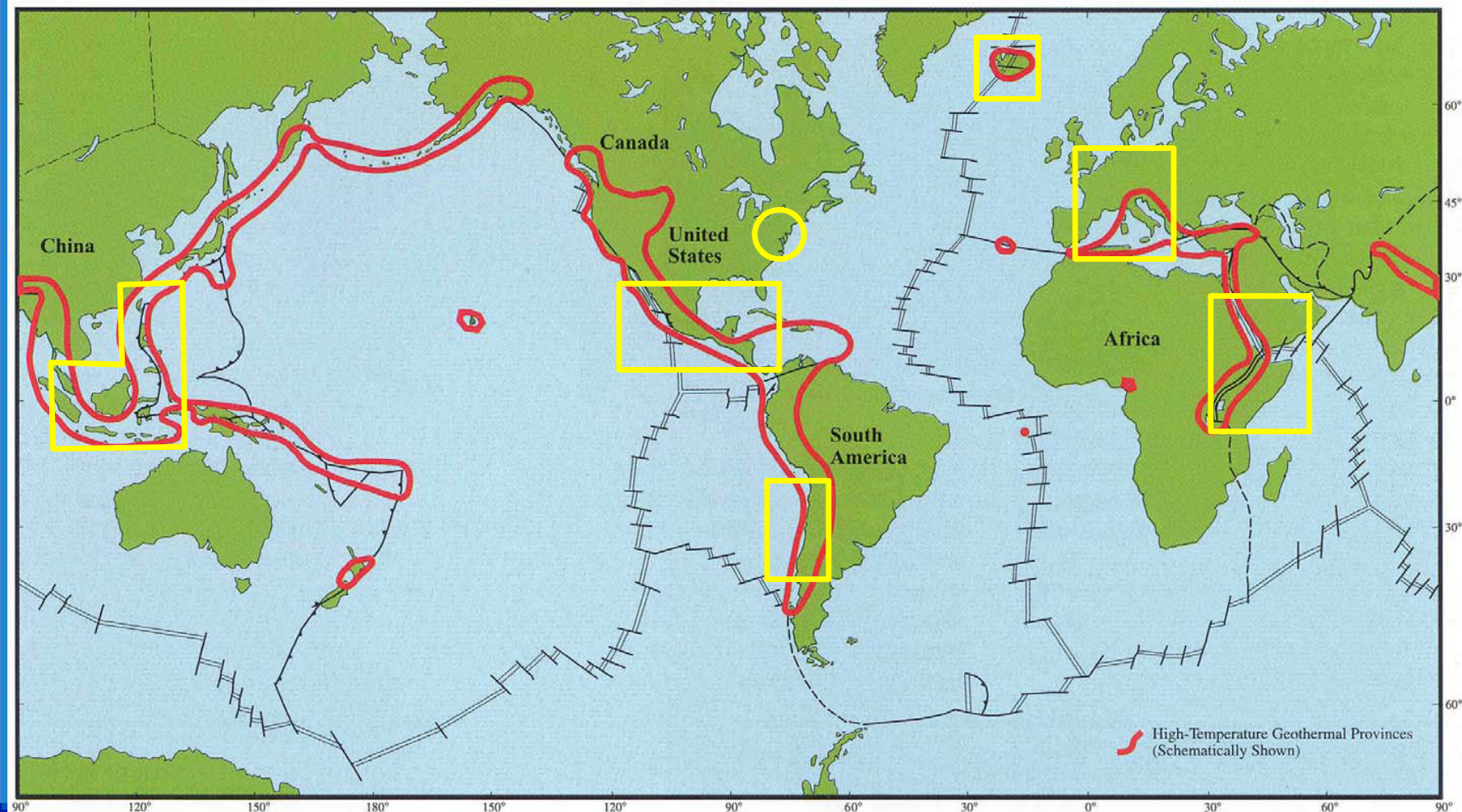
CO ₂ (x10 ⁶ t)			SO _x (x10 ⁶ t)			NO _x (x10 ⁶ t)		
NG	Oil	Coal	NG	Oil	Coal	NG	Oil	Coal
28	118	137	0	0.8	0.8	6.6	22	22

Which are the most promising roads ahead for extended exploitation of geothermal energy?

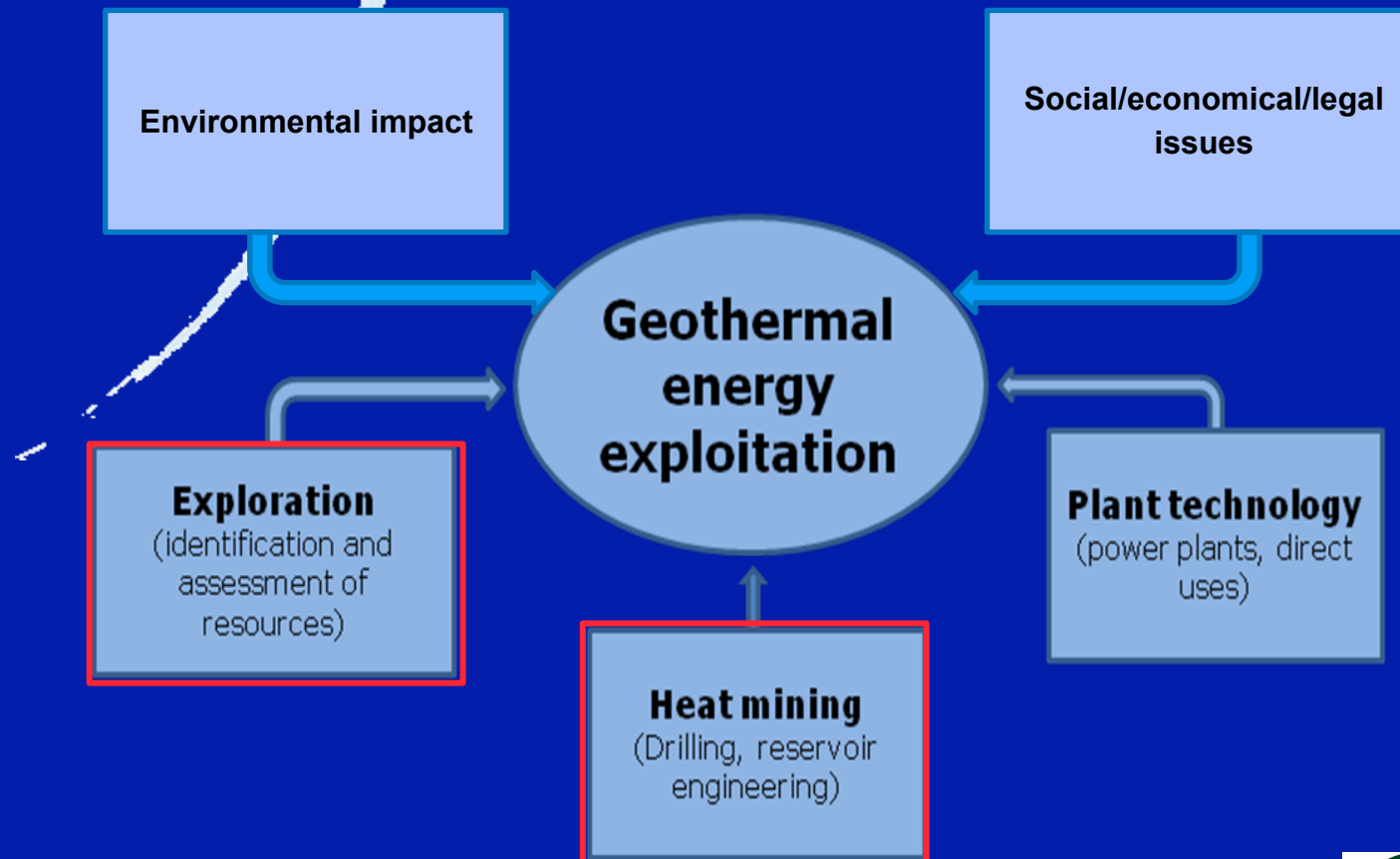




Preparatory activities and contacts of the ICTP Geothermal training program



Key issues in the Geothermal Energy development programme





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KEY ISSUES

- **Resources**
- **Technology**
- **Economics**



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KEY ISSUES (2)

➤ Resources

Development of technology for geothermal resources identification, assessment, exploitation and management with specific focus on Risk Mitigation in the initial phase
[advanced geophysical imaging and characterization at regional and site (plant) scale]



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KEY ISSUES (3)

➤ Technology (1)

Improvement of technology for the effective exploitation of geothermal energy in a large range of subsurface conditions and of target applications. Technology exchange and transfer from hydrocarbon technology [Link between geophysical imaging and reservoir simulation, power generation, heating/cooling, agricultural]



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KEY ISSUES (4)

➤ *Technology (2)*

*Using geothermal energy as a diffuse resource:
the connection between Geothermal Resources
(energy production) and Fuel Cells technology
(energy storage and transfer)*



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KEY ISSUES (5)

➤ Economics

Implementation of guidelines and Decision Support System (DSS) for cost effective geothermal resources and management. Extended support for decision makers in the preliminary assessment, planning and management of geothermal activities.



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...road ahead

Risk mitigation in the initial phases of geothermal energy resources exploitation through enhanced assessment, imaging and characterization of resources (volume, porosity, fluid saturation, $T - \Delta T / \Delta Z$) integrated with reservoir simulation

CONCLUSIONS (1): *GENERAL*

- Increasing trend in the use of geothermal energy for heat and power generation
- Future developments may focus on
 - lower temperature fluids (through combined heat and power plants)
 - Less permeable and less fluid rich rocks (through Enhanced Geothermal Systems [EGS])
 - Agricultural and refrigeration applications (to enhance production and preservation of products)
 - Geothermal heat pumps



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CONCLUSIONS (2): RESOURCES

- **Advanced Geophysical techniques derived from hydrocarbon exploration and exploitation will significantly enhance performances in identification, assessment and management of resources**
- **Future developments in Geophysics for Geothermy will focus on :**
 - **Regional 3-D reconstruction of subsurface structure and evolution for region-wide resources assessment**
 - **Site Ultra-High-Resolution characterization for the enhanced design and implementation of exploitation plants**
 - **Optimization of planning and geothermal energy exploitation activities through enhanced subsurface knowledge**



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CONCLUSIONS (3): *TECHNOLOGY*

- *Integration of High-Resolution Geophysical imaging and characterization with numerical simulation of reservoir conditions for improved assessment, monitoring and management of resources*
- *Nano-technology based in-reservoir measurements*
- *Integration of Geothermal energy production with advanced energy storage and distribution technologies (e.g. fuel cells)*



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CONCLUSIONS (4): *ECONOMICS*

• Providing decision makers with advanced and effective tools for assessment, planning and management. In particular:

➤ Guidelines:

➤ Decision Support System (DSS): computer aided procedure to drive from the initial phase (assessment of resources) through the whole process of planning and exploiting geothermal resources



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! Thanks for your attention !



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