

OLKARIA III – OPERATIONS & MAINTENANCE

SIX YEARS OF EXPERIENCE

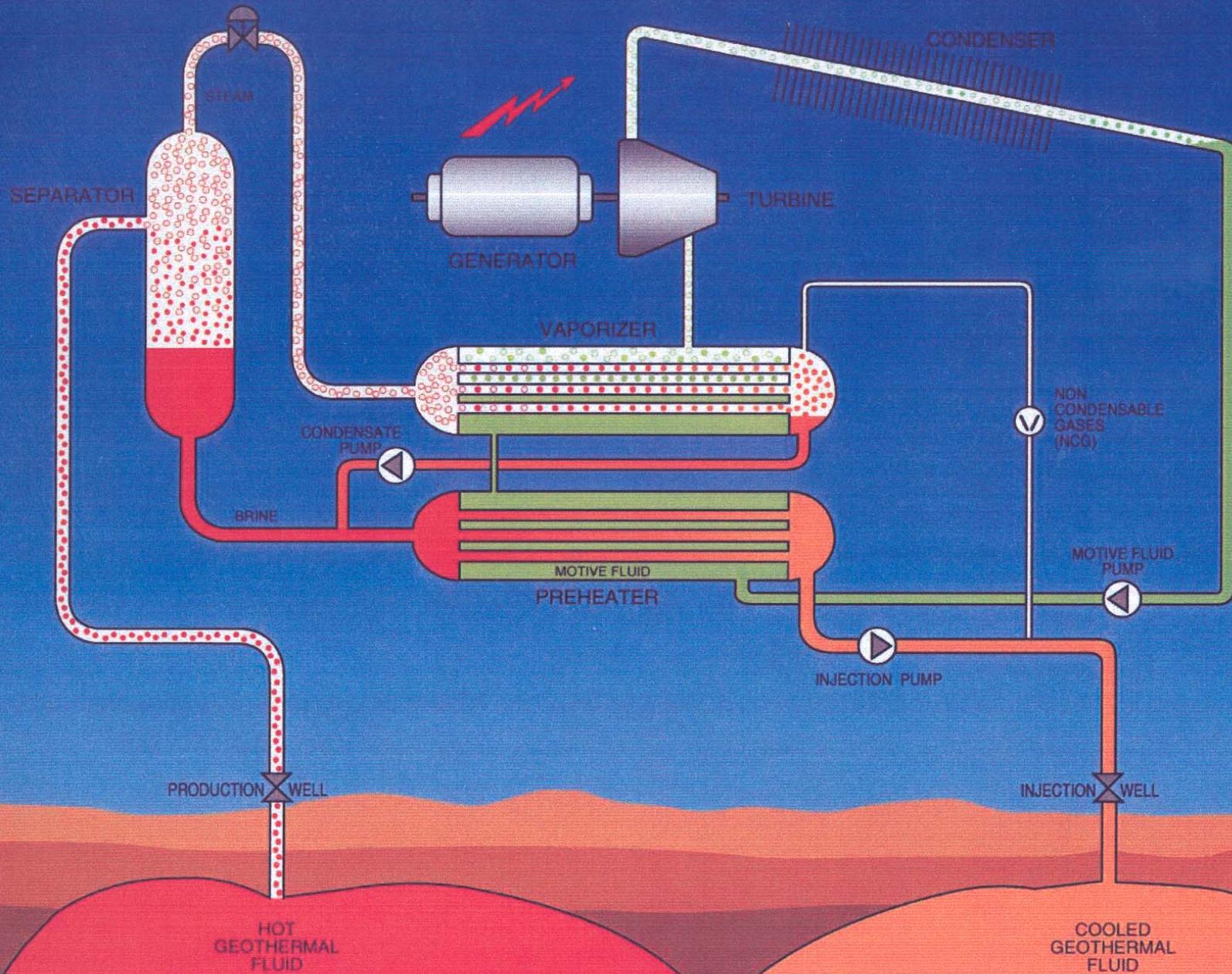
- The development of geothermal power in the Olkaria area is divided into blocks
 - Olkaria I – 3, 15 MW by KenGen 1985
 - Olkaria II – 2, 35 MW by KenGen 2002
- The government opted to develop the Olkaria III field through a World Bank supervised international tender
- ORMAT International was awarded the tender for Olkaria III in 1998

FIELD STUDY & DRILLING

- The study involved a 3-dimensional model of the Olkaria III field through the collaboration of experts from KenGen, GeothermEx, PB Power, Orkustofnun and Ormat engineers
- The study was done in parallel with drilling of new wells
- The data collected was analyzed and integrated into the model enabling continuous calibration of the field
- The result was a decision on the power plant capacity and basis for the obligation to the PPA



ORMAT Two-Phase Binary Geothermal Power Plant

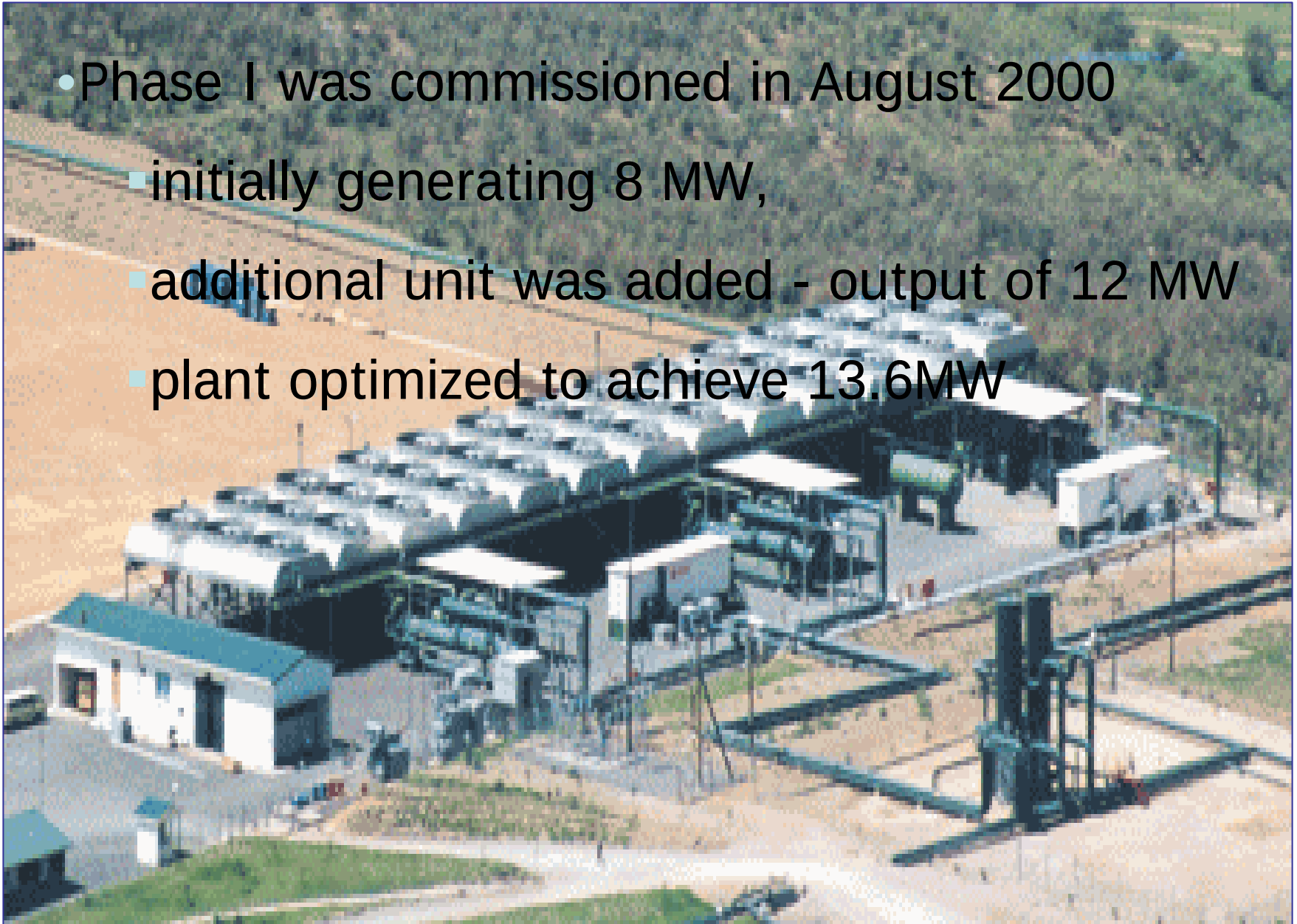


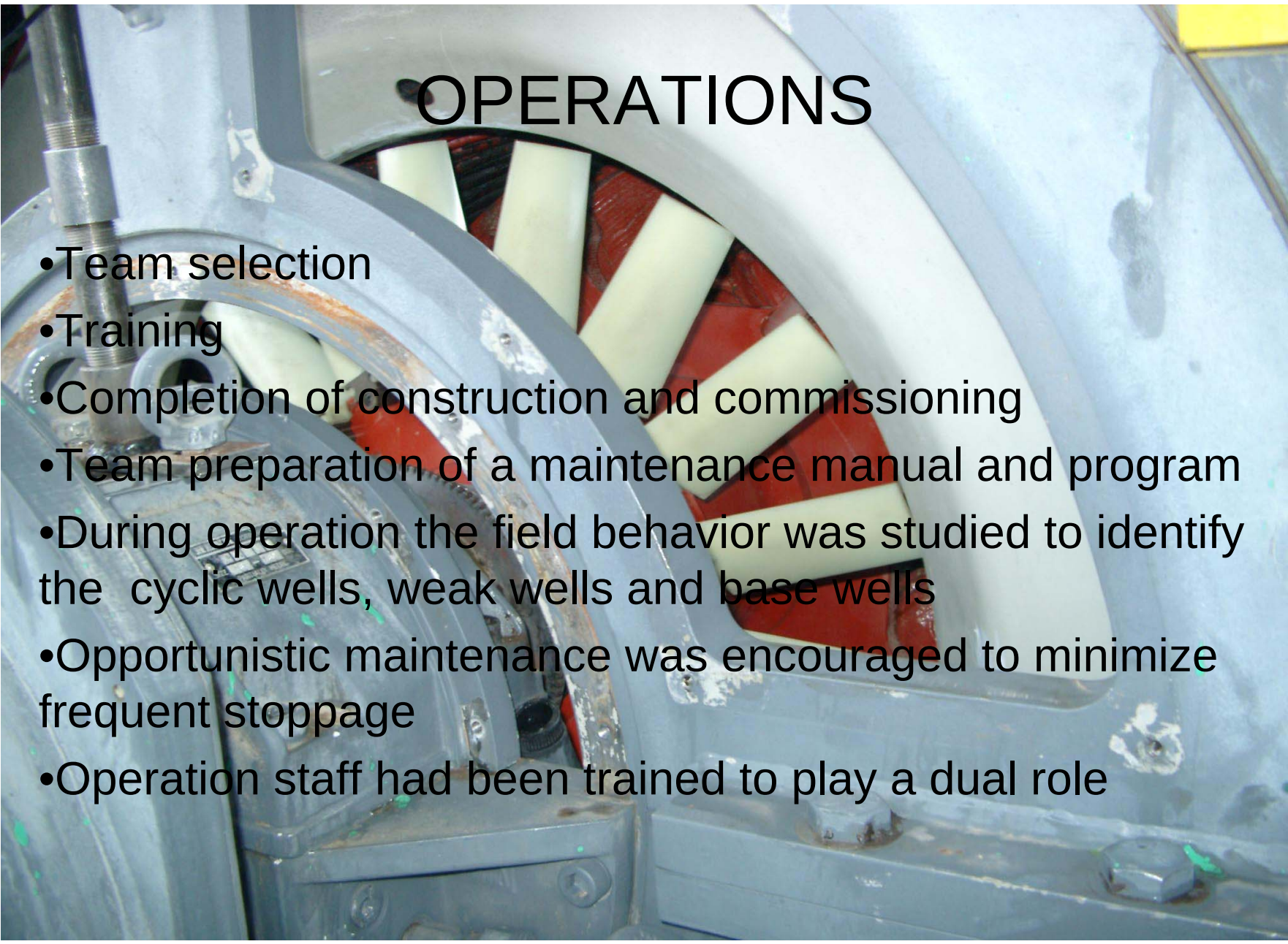
ORMAT BINARY PLANT

- Modular construction – match plant to the field
- Based on the Rankine Cycle
- Heat is transferred from the geothermal fluid to the organic fluid via heat exchangers (vaporizers and pre-heater), where the organic fluid is heated and vaporized.
- The organic fluid is then expanded in the turbine to a lower pressure and temperature at which it condenses in the air cooled condenser
- The organic fluid now in the liquid phase is pumped back to the heat exchangers – either vaporizer or pre-heater.
- The geothermal fluid after the heat has been extracted from it is re-injected to replenish the aquifer and ensure sustainability.
- The turbine drives the generator directly without a gearbox

OLKARIA III PHASE I – 13.6 MW BINARY PLANT

- Phase I was commissioned in August 2000
 - initially generating 8 MW,
 - additional unit was added - output of 12 MW
 - plant optimized to achieve 13.6MW





OPERATIONS

- Team selection
- Training
- Completion of construction and commissioning
- Team preparation of a maintenance manual and program
- During operation the field behavior was studied to identify the cyclic wells, weak wells and base wells
- Opportunistic maintenance was encouraged to minimize frequent stoppage
- Operation staff had been trained to play a dual role

TEAM'S FOCUS

- Established and procured critical spares, equipment and tools
- Established performance parameters
 - Operating temp. relative to saturation
 - Pentane level and consumption per annum
 - Monitored the output in MWh per shift and focused on setting and meeting targets specific for each shift
- Team work, hands on approach and a desire to excel drove performance

MAINTENANCE

- Basic maintenance tools were applied
 - Vibration analysis
 - Temperature monitoring
 - Oil and pentane usage
 - Monitoring of each unit's efficiency
 - Annual inspection and cleaning of pre-heater tubes
 - Annual inspection and cleaning of cyclone separators

MAINTENANCE

- Failures experienced
 - Motor winding failure – feed pump and oil coolers
 - Mechanical seal – resulting in loss of pentane
 - Carbon bearing failure – due to excess vibration
 - Blocked tube in the pre-heater – had to improve cleaning regime
 - Other minor aspects

PLANT PERFORMANCE

- Three basic performance indicators of a geothermal facility
 - Capacity Factor
 - Load Factor
 - Availability Factor
- OLKARIA III PERFORMANCE – 2001 - 2005
 - Availability Factor >98%
 - Load Factor >95%

ENVIRONMENTAL CONSIDERATION

- Olkaria III geothermal project lies partly within Hells Gate National park established in 1984 and Maella-Ng'ati-Kongoni farms
- The park is managed by the Kenya Wildlife Service (KWS) and hence operations of the geothermal plant requires strict compliance with the environmental policies of KWS
- A further project pipes the CO₂ to the neighboring Oserian Development Company, to accelerate the growth of flowers
- Orpower 4 project also works with the local community predominantly the Maasai pastoralists in providing assistance to the community

CONCLUSION

- Successful technology transfer is possible
- Necessary steps applicable to each case need to be developed to achieve the target availability.
 - Training
 - Spares, Tools & Equipment
 - Establish and monitor performance indicators
 - Prepare and manage strict maintenance procedure
 - Good level of automation and monitoring is not prohibitive but useful in managing the facility
 - Create a strong sense of ownership

THANK YOU