

Geothermal Power at Oserian Farms, Naivasha, Kenya

Geothermal Development Associates

ARGeo C2 Conference, Entebbe



Kenya's Use of Geothermal Power

- Most power generated in Kenya from hydro
- Drought is constant risk
- Initially 45 MW installed 1981-85
- Presently 135MW installed, 10% national capacity
- 561MW planned by 2026



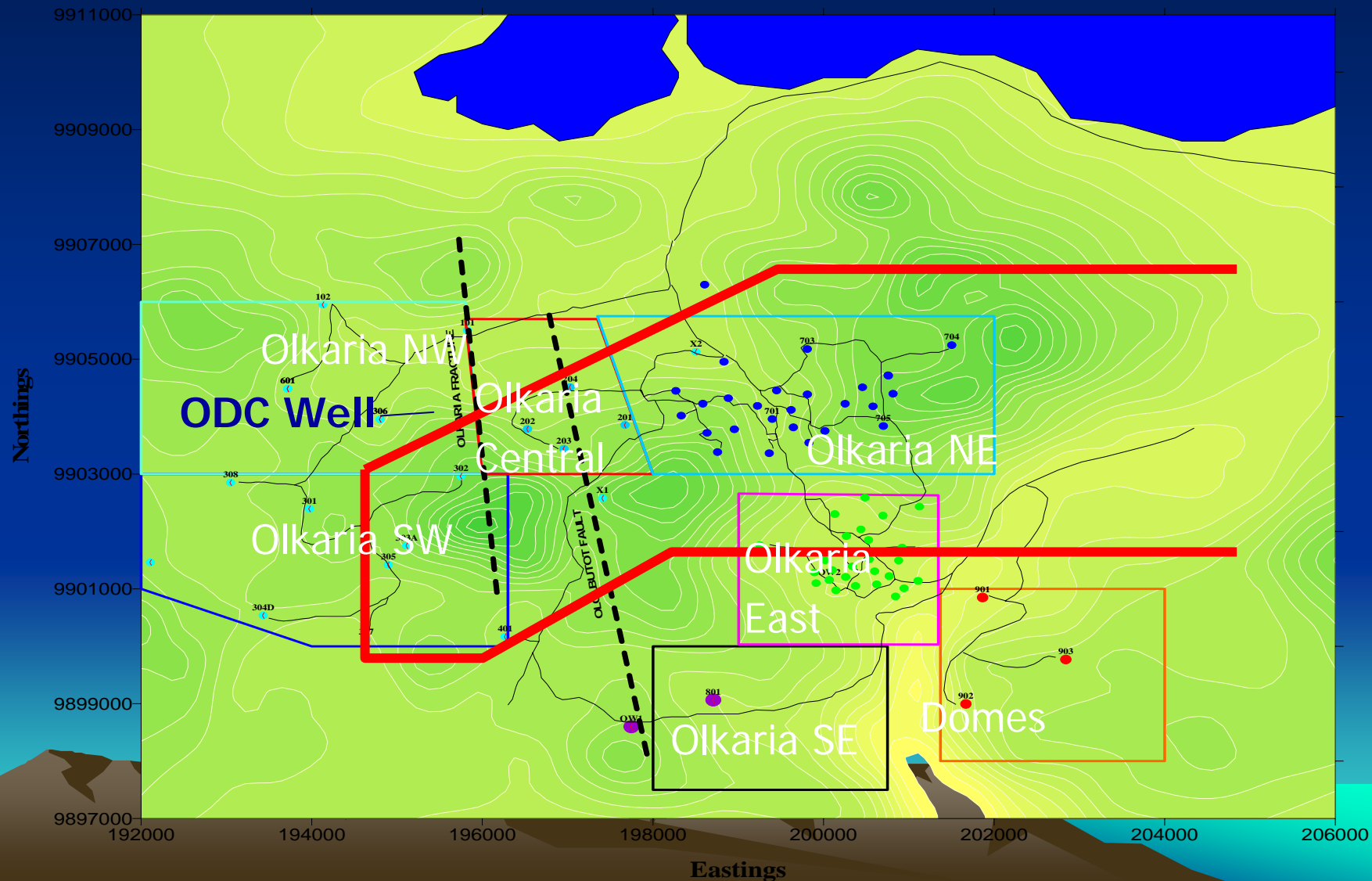
ODC Location



ODC Location



Olkaria Area Geo Wells



History

- Oserian Development Co. Ltd. (ODC) established 1969 as 5 hectare veg farm. Expanded 1982 to include cut flowers
- Using KenGen geothermal exploration well, ODC investigated geothermal use
- Studied Davao City, Philippines experience supplying 60% country's cut flowers using geo plant in national park
- Contracted for 1.8 MW binary plant 2003
- Plant successful, ODC expanded geo use

GDA Supply of Second Geothermal Plant to Oserian

- June 2006 - ODC signed GDA contract to design, manufacture, ship, commission 2 MW nominal geothermal turbine-generator set from Reno, NV to Naivasha, Kenya
- Plant ready for shipment 10 months following contract signature
- Operating since Nov. 2007 in parallel with existing binary plant



Geothermal Plant System Components

- Elliott 4 stage GYR turbine - Jeanette, PA USA
- Kato Engineering 1,750kW, 3 phase synchronous generator - Mankato, MN USA
- Lufkin N12C, double helical gearbox - Lufkin, TX USA
- Oil lubrication system – GDA, Reno, Nevada, USA



ODC's Use of Geothermal Energy Today

- Today 230 hectare greenhouses exporting >400 million stems/year to Europe (30% European cut flower market)
- Largest geothermal greenhouse system in world
- Used for temperature regulation, rose health, power generation for water pumping, lighting, humidity control, computerization



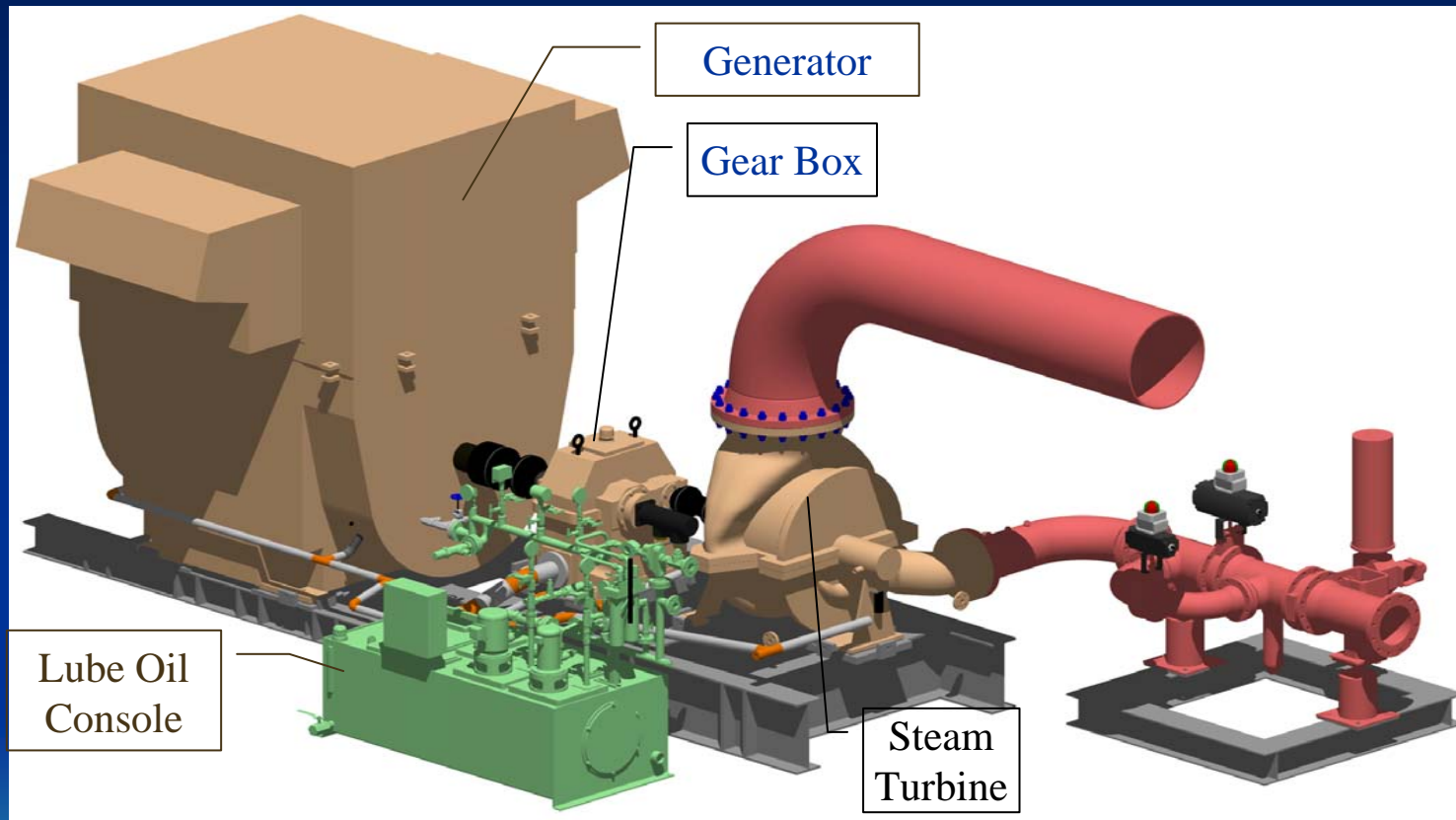
Turbine Rotor in Elliott Factory



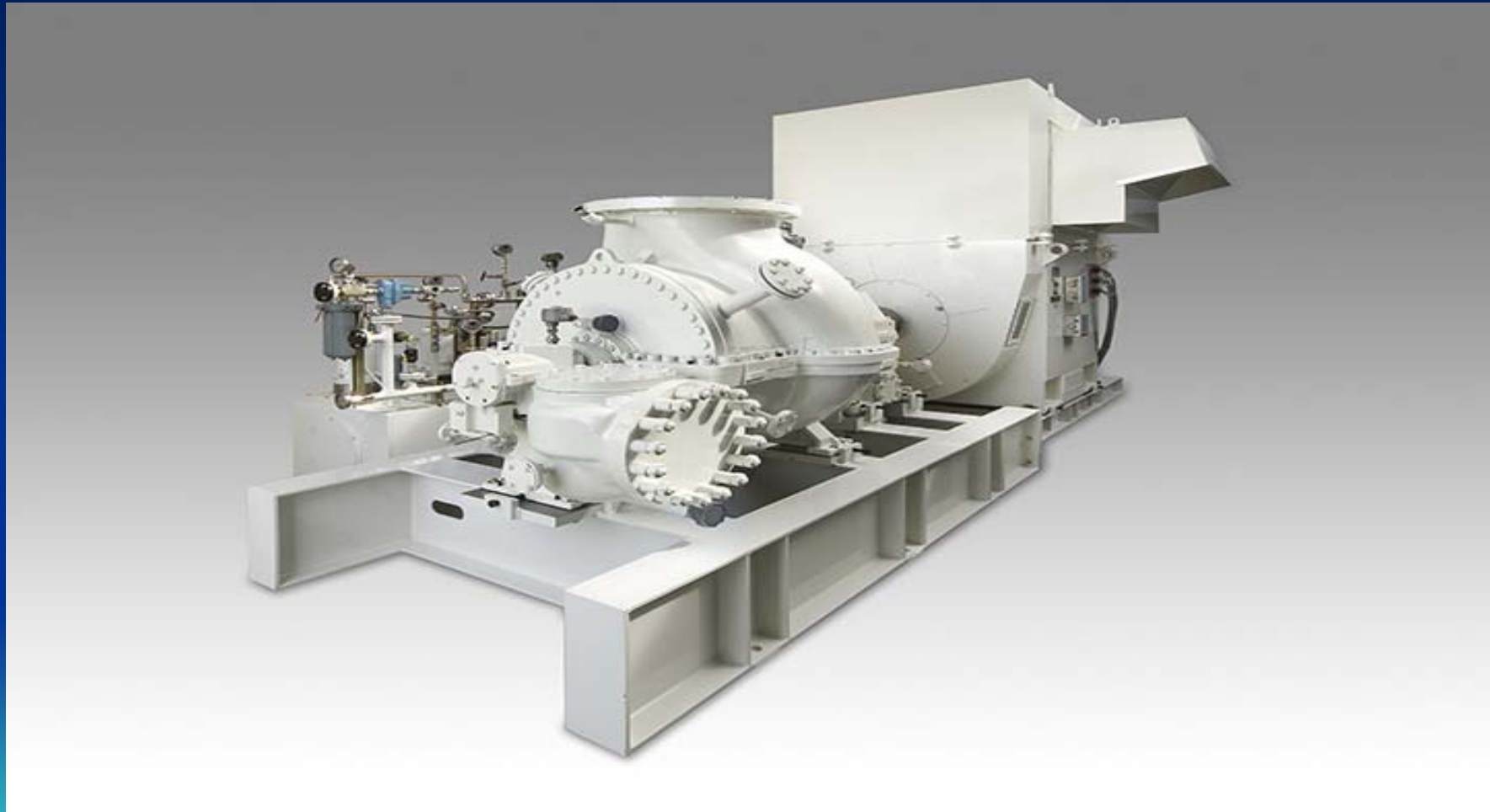
Plant Before Shipment from US



Isometric of Oserian Geo Plant



Plant Assembled in Reno



ODC Workers Preparing Foundation



Steam Line Installation



Connecting Steam Line to Plant



Electrical Connections



System Specifications		
	Non-Condensing	Partial Condensing
Mass Flow	26,100 kg/hr	26,100 kg/hr
NCG	1.1% by weight	1.1% by weight
Turbine Inlet Pressure	470 <u>kPa</u> (abs)	470 <u>kPa</u> (abs)
Turbine Exhaust Pressure	85 <u>kPa</u> (abs)	50 <u>kPa</u> (abs)
Turbine Inlet Temperature	149.5 deg C	149.5 deg C
Gross Generator Output	1,340 kW	1,730 kW
Component descriptions are as follows:		
Steam Turbine	4-stage GYR turbine, Elliott Company, Jeanette, PA, USA	
Generator	1,750 kW, 2,188 kVA, 11 kV, 3 phase, 4 pole synchronous, WPII <u>Kato Engineering</u> , Minnesota, USA	
Gearbox	N12C, double helical, parallel shaft Lufkin Industries, Lufkin, Texas, USA	



Unloading the Plant



Plant Installation





10/17/2007

Housing & Installation



Fully Assembled at ODC



Ready for Commissioning



Wellfield Testing



In Operation



A Job Well-Done



Initial 1.8MW Ormat Plant




Why Small-Scale Geothermal?

- Short manufacturing, shipping, installation times
- Well suited for small island countries, rural electrification
- Allows resource analysis without add'l drilling
- Transportable from site to site
- Facilitates training HC personnel
- Catalyst for political support for larger geo installations



What's Needed to Advance SS Geo Development in E. Africa?

Expertise and financing for:

- Geological, geochemical, geophysical studies, temp gradient drilling
 - Exploration drilling, resource testing
 - Short Term operational assistance for initial plant O&M
 - Training for HC plant operators, wellfield / resource managers
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How GDA Can Help

- Resource identification, assessment, project design, implementation
- Design, engineering, supply of 2-20 MW geo plants
- Possible equity co-ownership/investment
- Training wellfield and plant operators



Thank You

