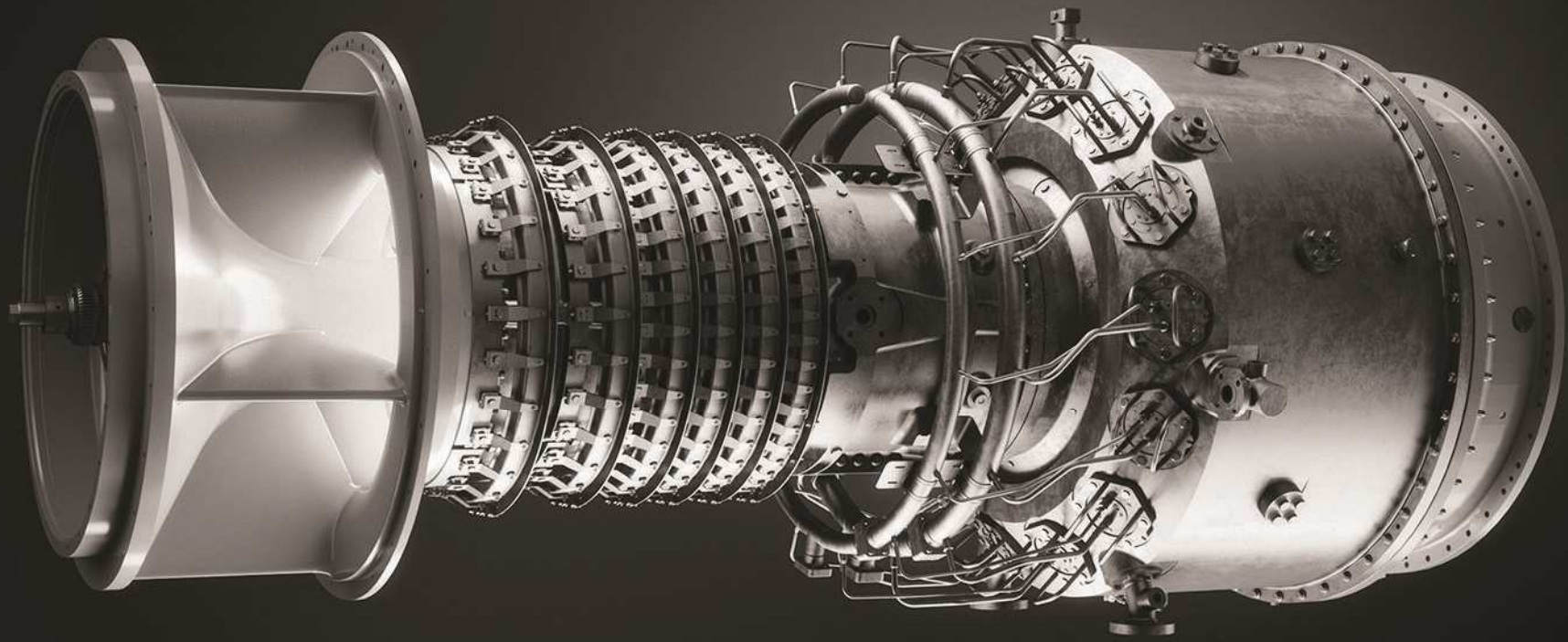
低热值燃料



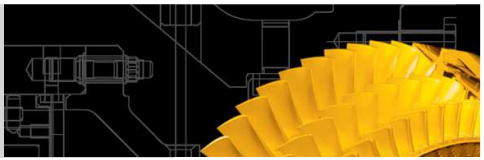
索拉拥有丰富的经验和业绩

A CULTURE OF CUSTOMER CARE

Solar Turbines

A Caterpillar Company

Caterpillar 卡特彼勒集团 – Since 1981



- Global Strength and Presence全球运行优势
- Leading Products and Product Support领先的产品和服务
- Strong Financial Position良好的财务状况

CATERPILLAR®

Construction	Energy & Transportation	Resource

Solar Turbines
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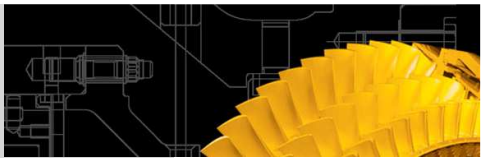
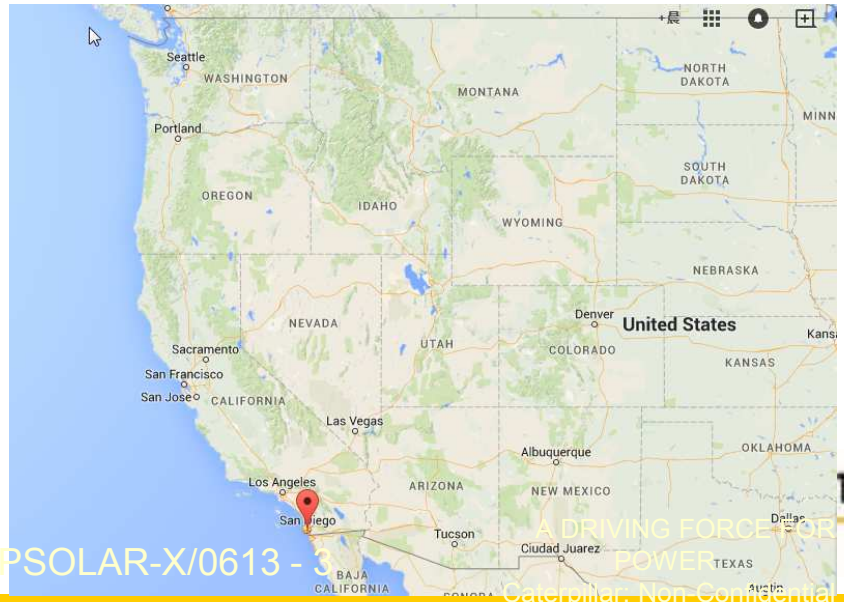


-
- 1927
- 16000
- 24
- (1-23)
- 1981



VPSOLAR-X/0613 - 3
A DRIVING FORCE FOR POWER
Caterpillar: Non-Confidential

索拉的燃气轮机产品系列：

Saturn 20
1590 hp / 1210 kWe

Centaur 40
4700 hp / 3515 kWe

Centaur 50
6130 hp / 4600 kWe

Taurus 60
7700 hp / 5670 kWe

Taurus 70
11,150 hp / 7965 kWe

Mars 90 & 100
13,220 – 15,900 hp
9450 – 11,350 kWe

Titan 130
23,500 hp / 16,529 kWe

Titan 250
31,900 hp / 23,064 kWe

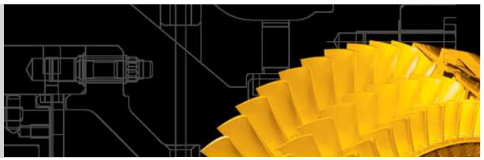
Mercury 50
4600 kWe

Taurus 65
6500 kWe

Over 16,000 Units Sold, Over 100 Countries
Over 2.4 Billion Operating Hours

Caterpillar: Confidential Green

Agenda 议程



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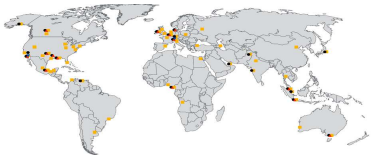

2 索拉的能力

3 索拉的技术

4 索拉的经验

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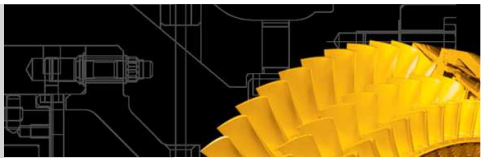
使用可再生，替代燃料的机会



- 焦炉煤气
- 炼厂气
- 垃圾填埋气和沼气
- 煤层气和煤矿瓦斯气
- 生物质气化合成气 - MSW
- Fischer-Tropsch 费托工艺尾气

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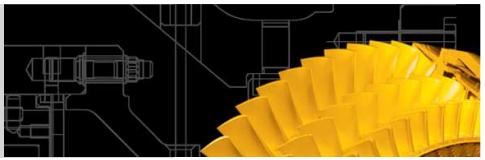
气态燃料来源



行业分类

石油天然气开采

- 粗天然气
- 伴生气
- 管道气
- LNG
- 天然气凝析液
- 液化气LPG

工业副产

- 焦炉煤气
- 炼厂气

生物质

- 垃圾填埋气
- 沼气
- 气化

煤基

- 煤矿甲烷
- 煤层气
- 空气裂解
- 富氧裂解

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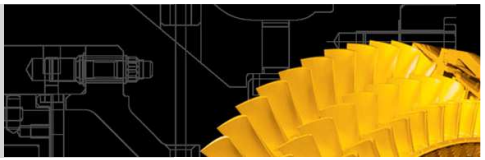
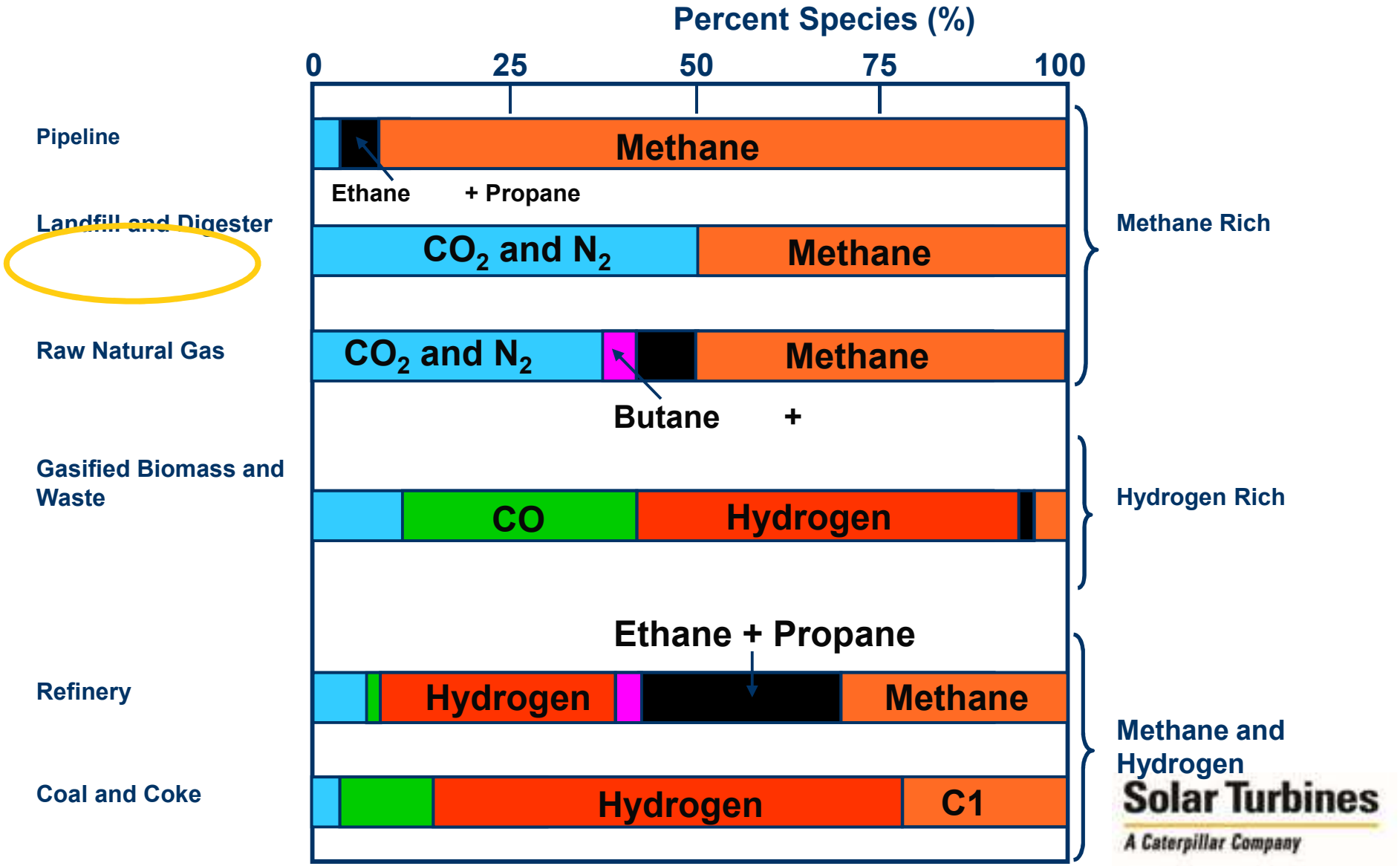
Gas Fuels





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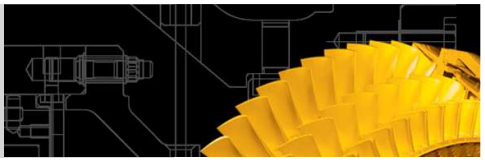
Agenda 议程



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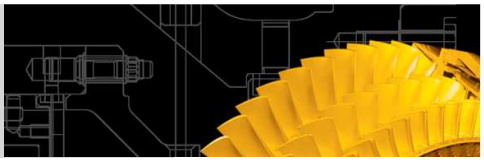

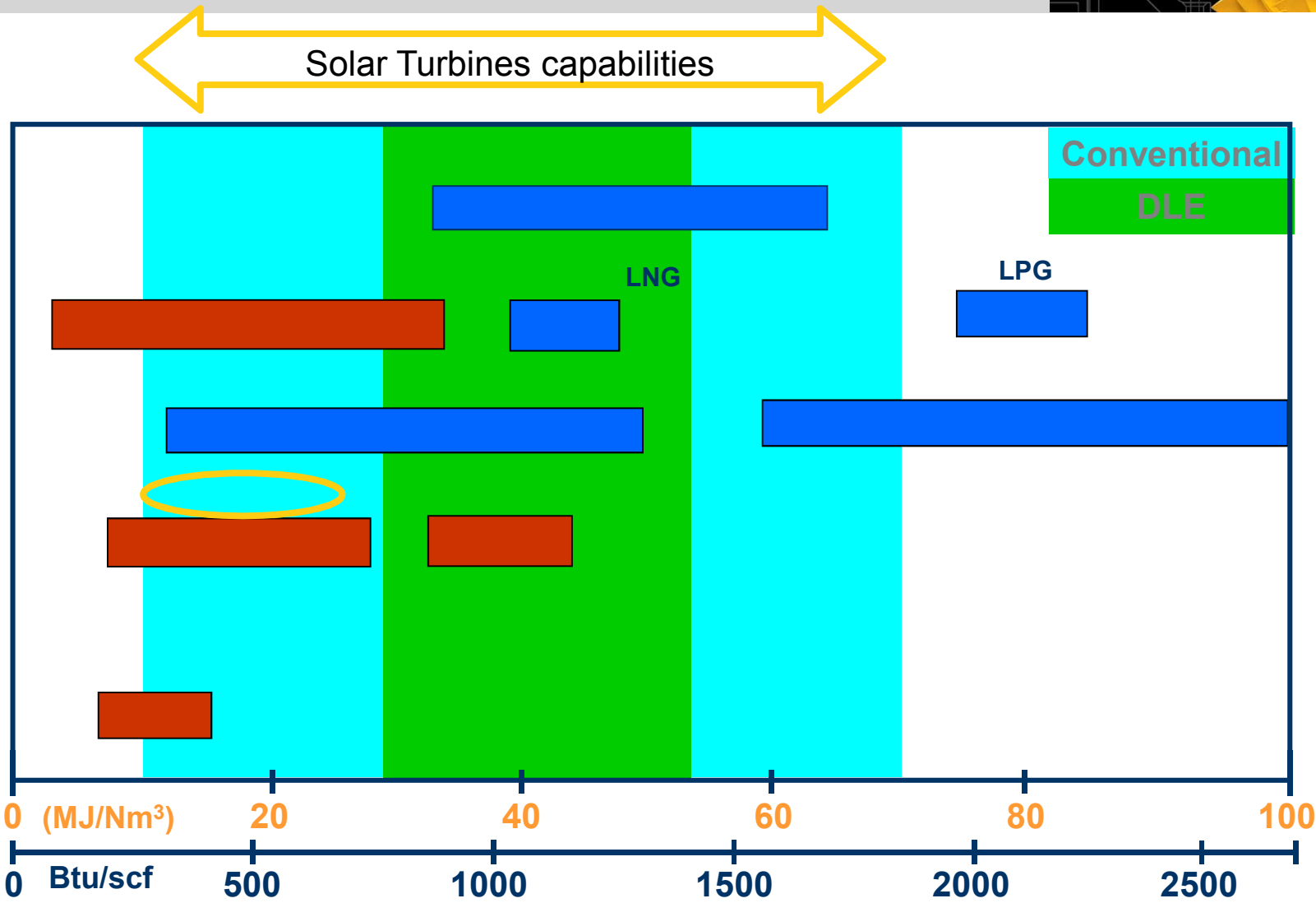

TUBITAK

WOBBE INDEX, $WI = \frac{LHV}{\sqrt{SG}}$

Solar Turbines
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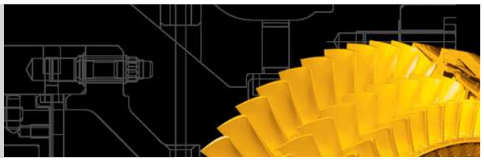
Agenda 议程



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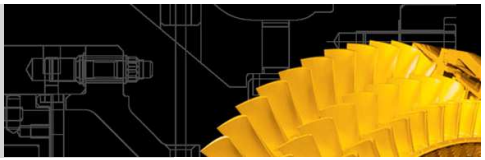
Solar Turbines
A Caterpillar Company

A WELL ESTABLISHED, COMPREHENSIVE PORTFOLIO



SATURN 20
1960

1969
CENTAUR 40

1977
MARS
- Welded Drum Compressor
- Enhanced Turbine Cooling
- 2-Stage Power Turbine
- Single Crystal Material

Scaled Compressor Aerodynamics

Compressor Aerodynamics

1985
CENTAUR 50
- Enhanced Turbine Cooling

Compressor Aerodynamics

1989
TAURUS 60
- 6-Stage Compressor
- 2-Stage Power Turbine

Compressor Aerodynamics

Aerodynamics Materials

高氢燃料

1995
TAURUS 70
- Enhanced Turbine Cooling
- Advanced Materials

Compressor Aerodynamics

1997
TITAN 130

2008
TITAN 250
- Enhanced Turbine Cooling
- Advanced Materials

Compressor Aerodynamics

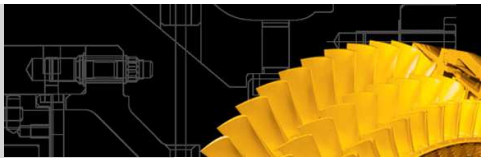
2004
TAURUS 65
- Enhanced Turbine Cooling
- Advanced Materials

Advanced Turbine Aerodynamics

1999
MERCURY 50
- Advanced Aerodynamics
- Recuperator
- Ultra Low Emissions

Turbomach
A Caterpillar Company

A WELL ESTABLISHED, COMPREHENSIVE PORTFOLIO



SATURN 20

1960

1969

CENTAUR 40

Scaled Compressor Aerodynamics

1977

MARS
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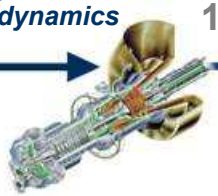
Compressor Aerodynamics

1985

CENTAUR 50
- Enhanced Turbine Cooling

Compressor Aerodynamics

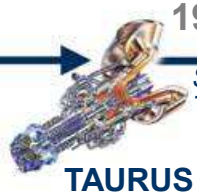
1989



TAURUS 60
- 6-Stage Compressor
- 2-Stage Power Turbine

Aerodynamics Materials

1995

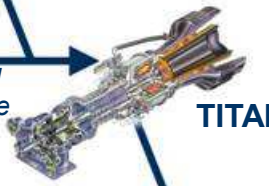


TAURUS 70
- Enhanced Turbine Cooling
- Advanced Materials

Scaled Turbine

Compressor Aerodynamics

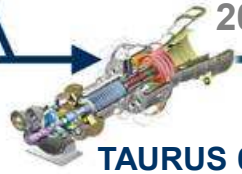
1997



TITAN 130

Compressor Aerodynamics

2004



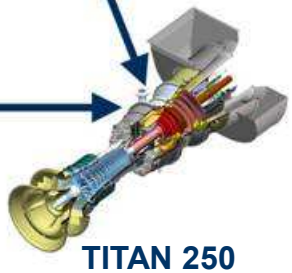
TAURUS 65
- Enhanced Turbine Cooling
- Advanced Materials

Advanced Turbine Aerodynamics

MERCURY 50
- Advanced Aerodynamics
- Recuperator
- Ultra Low Emissions

1999

2008



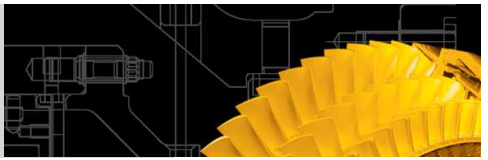
TITAN 250
- Enhanced Turbine Cooling
- Advanced Materials

垃圾填埋气，沼气

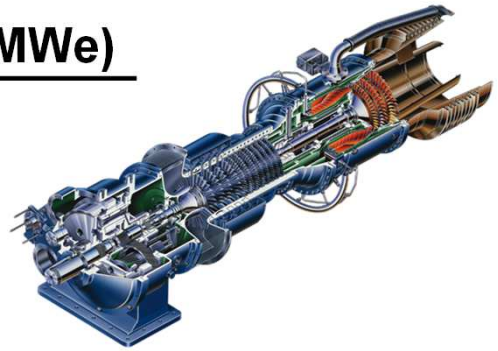
Turbomach

A Caterpillar Company

高氢燃料的主力机型



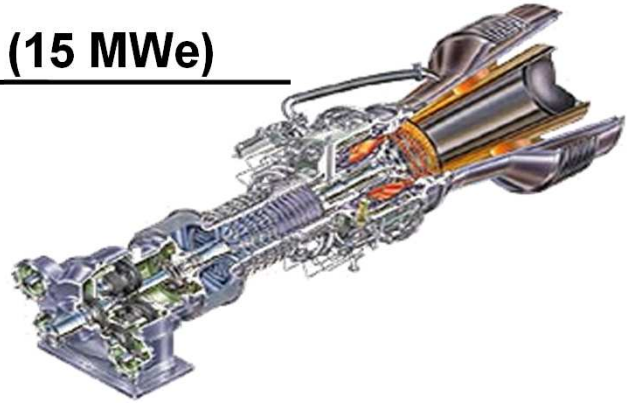
金牛60 (5.67 MWe)



- 1989年开发
- 5.7 MWe, 31.5 % E. E. (ISO)
- 已售出1’780台
- 累计运行超过1.30亿小时

Taurus 60 Experience	Units Sold Population in Units and Hours In Excess of	Est. Hours (000's) Population in Units and Hours In Excess of
Compressor Sets	340	22,700
Mechanical Drives	190	13,600
Generator Sets	1,250	95,600
Total	**1,780**	**131,900**

大力神130 (15 MWe)



- 1997年开发
- 15MWe, 35.2 % E. E. (ISO)
- 已售出610台
- 累计运行超过1300万小时

Titan 130 Experience	Units Sold Population in Units and Hours In Excess of	Est. Hours (000's) Population in Units and Hours In Excess of
Compressor Sets	110	2,300
Mechanical Drives	90	2,200
Generator Sets	410	8,800
Total	**610**	**13,300**

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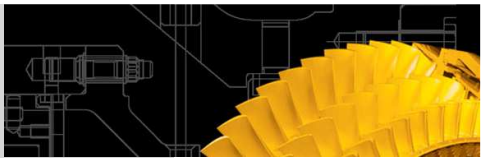
Agenda 议程



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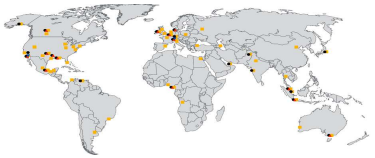


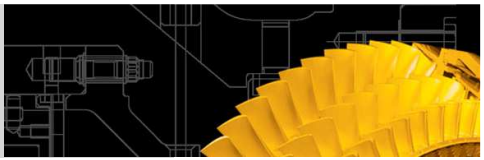
2 索拉的能力

3 索拉的技术

4 索拉的经验

Solar Turbines
A Caterpillar Company

业绩详单



- **沼气装机: 111 台，60个项目**
  - 43 x Centaur 40
  - 3 x Mars 100
  - 19 x Mercury 50
  - 8 x Saturn
  - 38 x Taurus 60

- **高氢燃料装机46台, 16个项目:**
  - 36 x Titan 130
  - 10 x Taurus 60

高氢燃料总运行: 超过100万小时（截至2016年3月）

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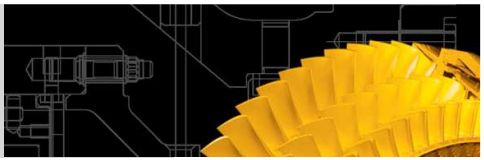
气质要求



- *干净（H2S,硅氧烷Siloxane和颗粒物）*
- *增加燃气压力到所需要的压力*
- *压力要求约2750Kpa以下*
- *干气（加热到水露点20°F以上）*
- *<10 mg Si/Nm3 CH4*
- *<100 ppm H2S*

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允许的运行范围

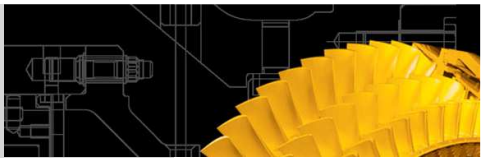

Table 1. Landfill Gas Emissions Estimates @ 15% O_2
(Assumes Wobbe Index Range 300 to 460 Btu/scf LHV)

Turbine Model	ISO NO_x*		CO		UHC		Load Range (%)	Ambient Temp °F (°C)
	ppm	mg/Nm^3	ppm	mg/Nm^3	ppm	mg/Nm^3		
Centaur® 40	42	88	250	318	100	72	80-100	>0 (–18)
Centaur 50	42	88	200	254	100	72	80-100	>0 (–18)
Mercury™ 50	15	25	25	30	25	18	50-100	>0 (–18)
Taurus™ 60	42	88	150	191	75	54	80-100	>0 (–18)
Taurus 70	80	166	100	127	50	36	80-100	>0 (–18)
Mars® 100	72	150	100	127	50	36	80-100	>0 (–18)
Titan™ 130	80	166	100	127	50	36	80-100	>0 (–18)

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焦炉煤气项目

Solar Turbines
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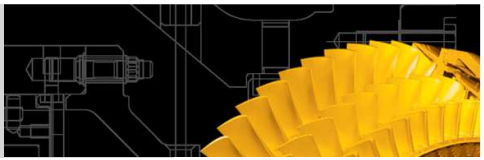
焦炉煤气-燃气轮机分布式能源项目



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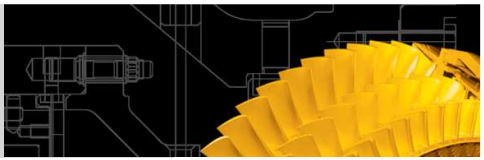
山东金能煤气化



Coke Oven Gas Power Plant Coking Facility

热电冷联产

关键数据:

- **4 x Taurus 60 (5.7 MWe)**
- **4 x Titan 130 (15.0 MWe)**
- **8 x Heat Recovery Boiler**
- **基荷运行**
- **荣获美国环保部颁发的能源之星奖**

关键成功因素:

- **热容量大**
- **占地面积小**
- **运行成本低**
- **可用率高**

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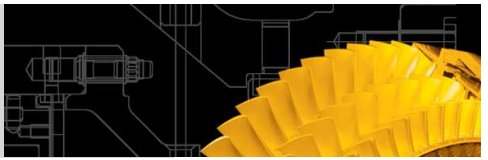
First International EPA Award



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BIOREP – 法国垃圾填埋气1xM100项目

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ISKI 土耳其污水处理场沼气2xC50项目

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美国洛杉矶Calabasas垃圾填埋气3xM50项目

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美国萨克门托BMW垃圾填埋气2xT60项目

美国Toledo沼气，填埋气 2xT60GTCC项目

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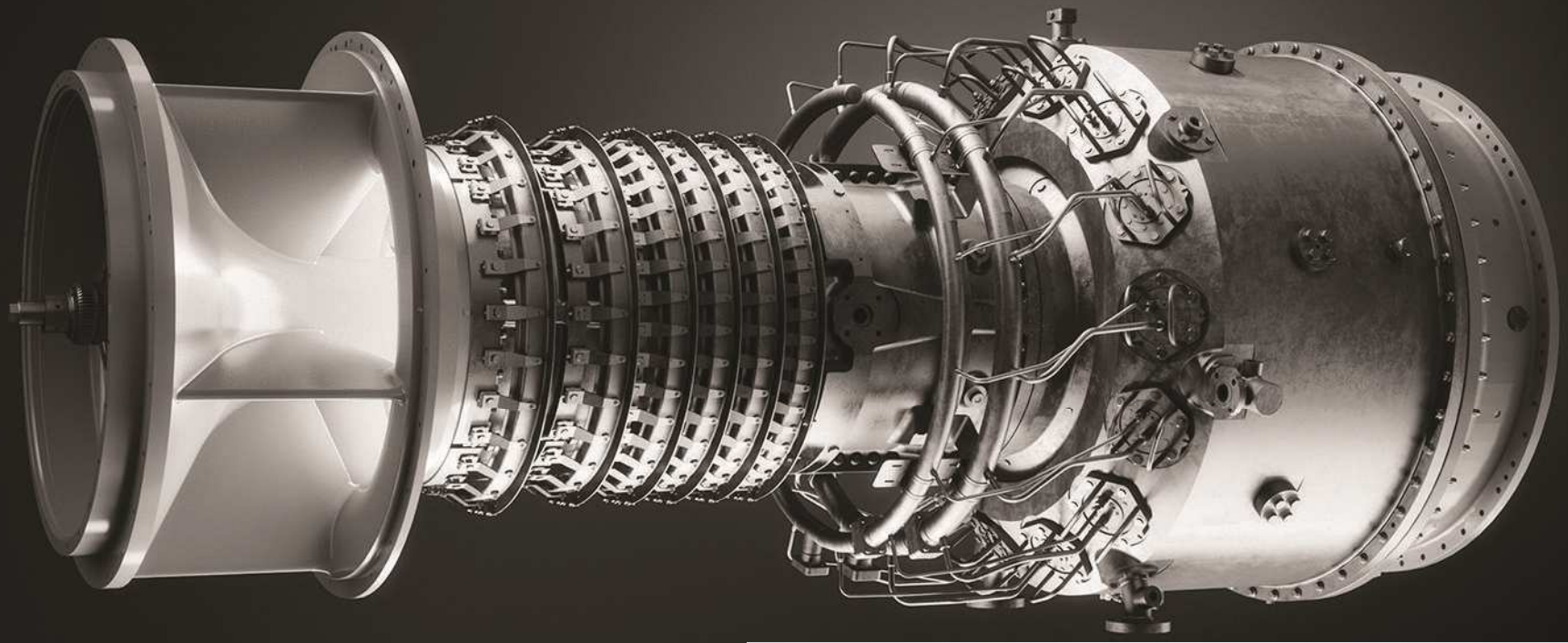
感谢您的聆听



Questions?

Solar Turbines

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