  

Comparison between Landfill Gas and Waste Incineration for Power Generation in Astana, Kazakhstan

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Outline

- Astana
- Objective & Scope
- RETScreen
- Waste Characterization
- Landfill Gas
- Waste Incineration
- Results
- Social Impact
- Conclusions
- Outlook

Astana, Kazakhstan

Source: http://www.visahouse.co.uk/kazakhstan-map/

Waste collection in Astana

- Nearly 600-800 t of municipal solid waste are collected daily. i.e., between 53-70% of daily generated waste

Source: http://astana.gov.kz

Source: http://news.nur.kz/

Waste disposal in Astana

- 97% of the generated waste is disposed on landfills.

- Old Landfill (Open Dump)

Now

- Waste Separation Plant
- New Engineered Landfill

There are still

- Open Dump Sites
- Insufficient Waste Collection
- Insufficient Power Capacity

Source: http://tengrinews.kz/

Source: http://www.voxpopuli.kz/

Objective & Scope

Objective

- Assess and compare Landfill Gas (LG) and Waste Incineration (WI)
  - Technical
  - Environmental
  - Economic
  - Social Impact

Scope

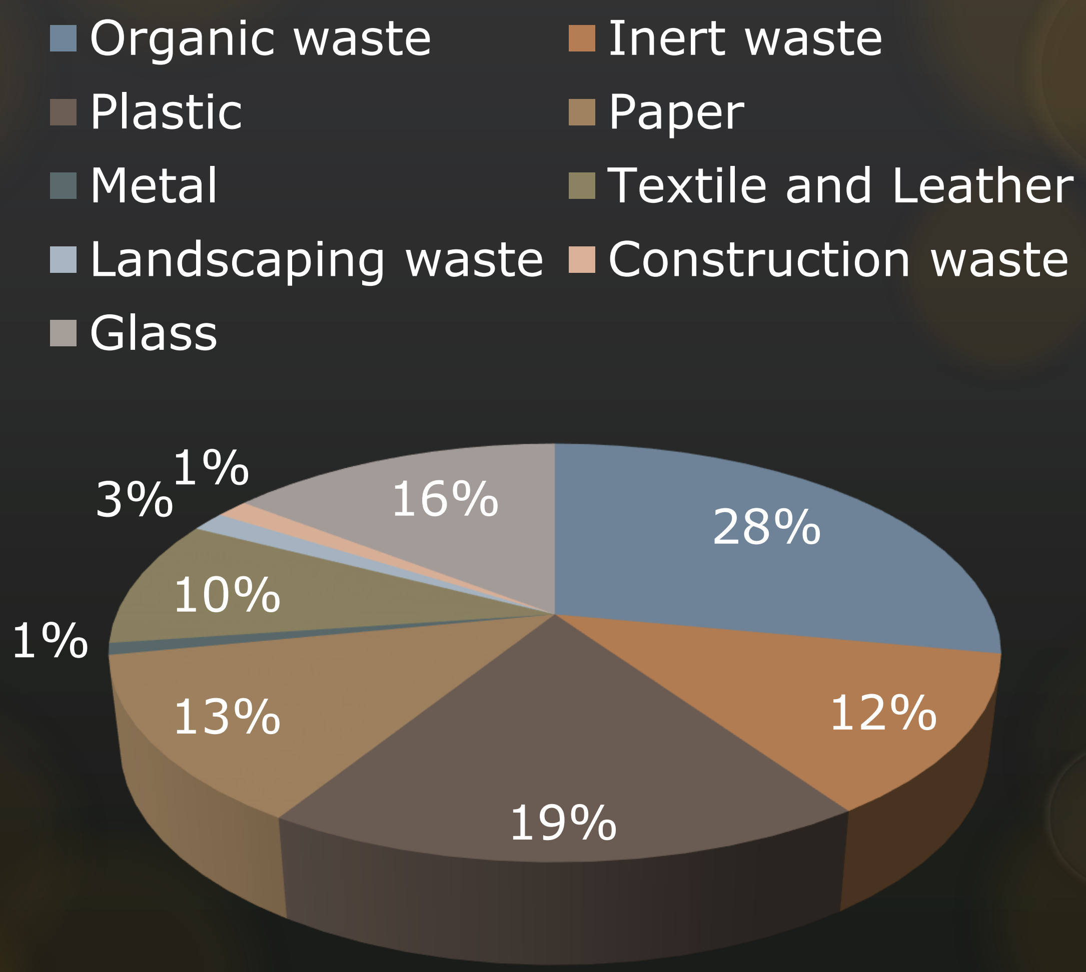
- Total Electricity exported to the grid
- GHG emissions reduction
- Unit cost of produced electricity, NPV, IRR-equity and B-C ratio
- Analysis at pre-feasibility level

RETScreen®

- Free Software
- Clean Energy Project Analysis
- Inexpensive Technical and Financial Feasibility Analysis

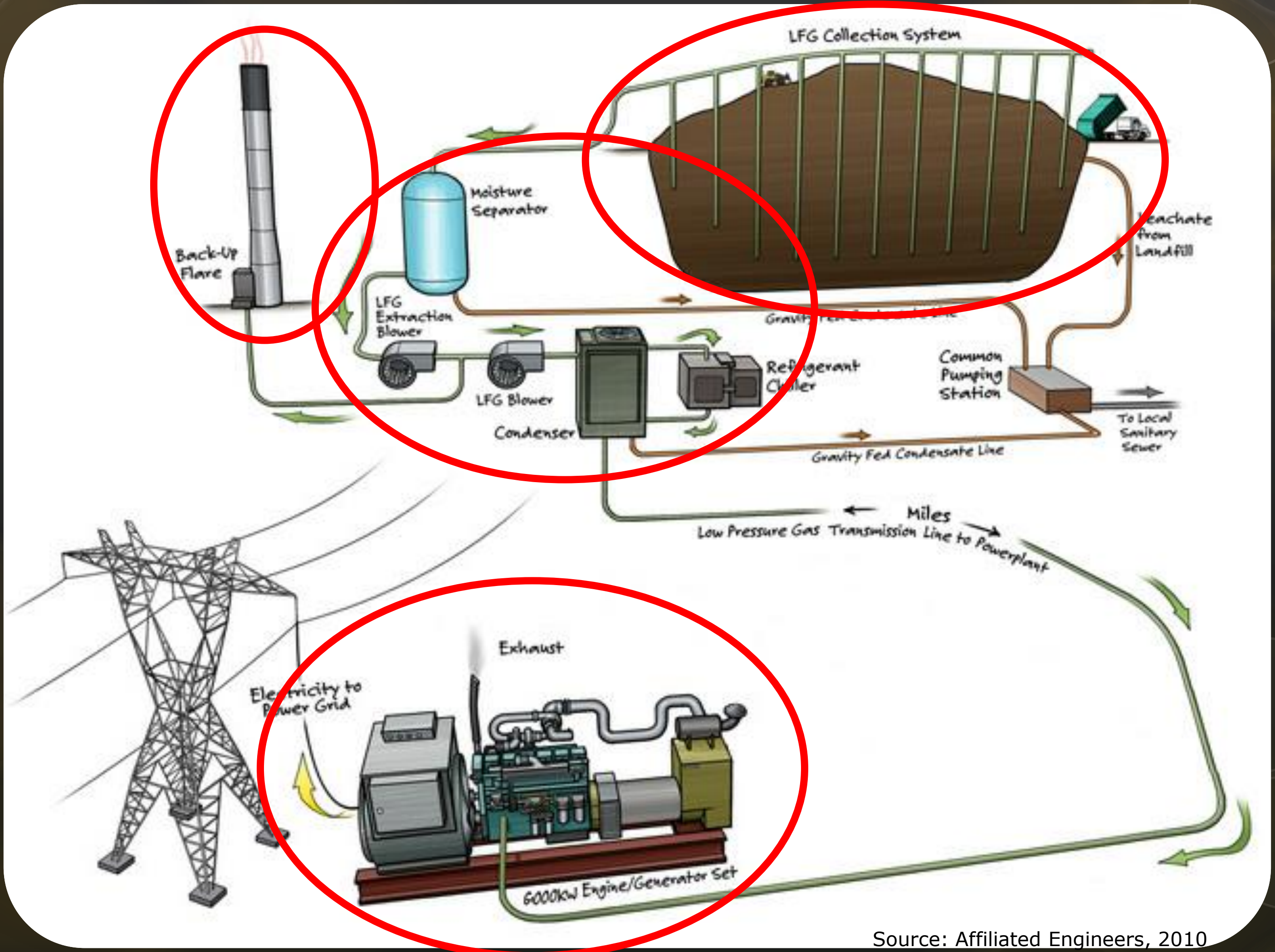
Energy Model → Cost Analysis → GHG Analysis → Financial Summary → Sensitivity & Risk Analysis

Waste Characterization



Source:Ministry of Regional Development, 2012

Landfill Gas (LG) Components



Source: Affiliated Engineers, 2010

Landfill Gas Simulation

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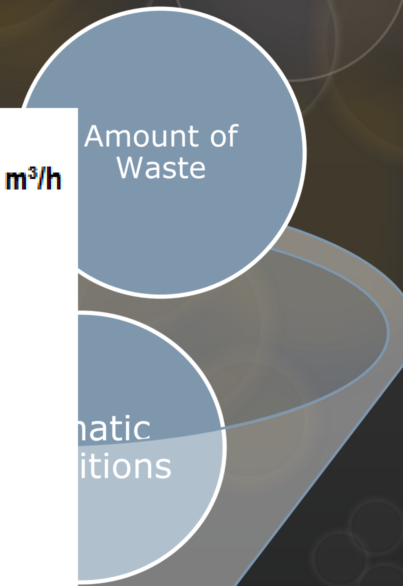

$$\sum^{t} k.L_o.m_i.e^{-k(t-i-lag)}$$

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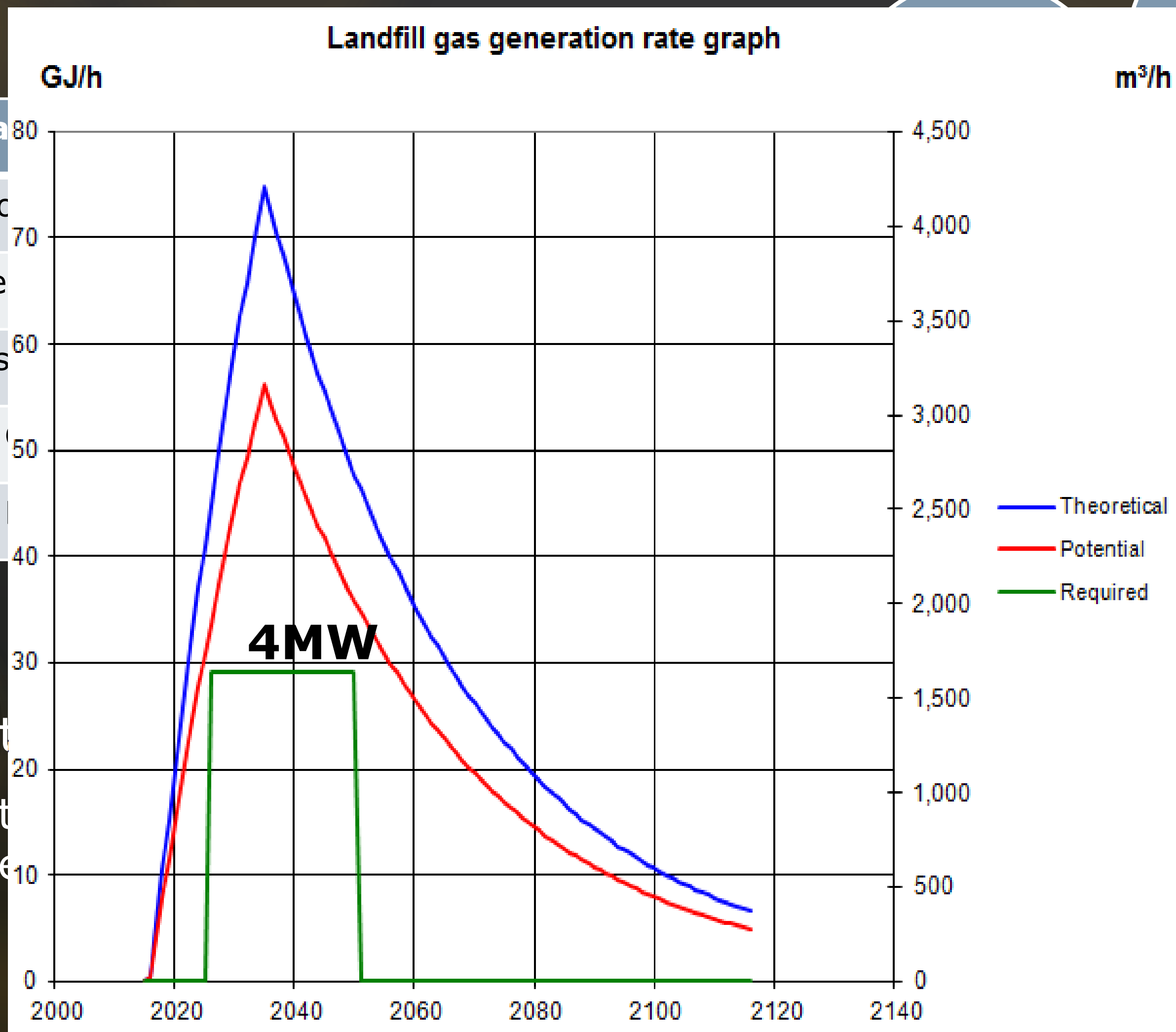
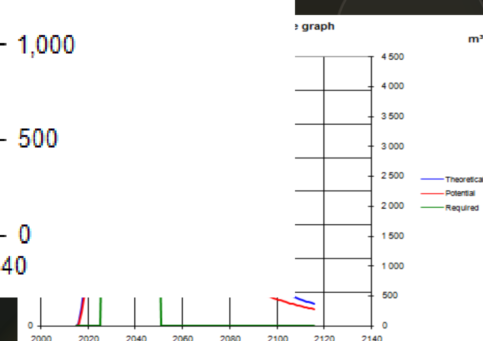
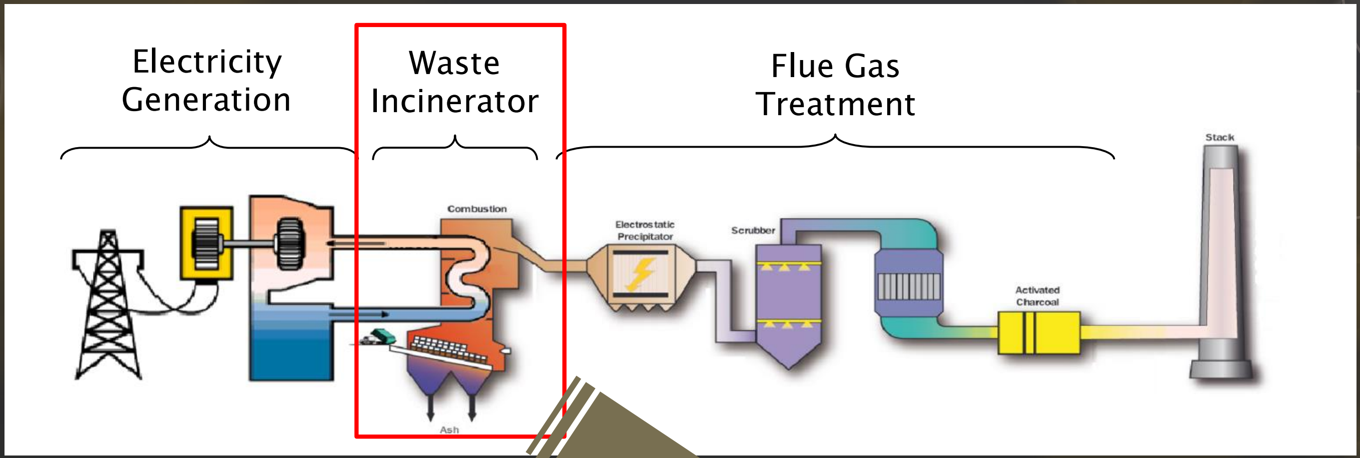




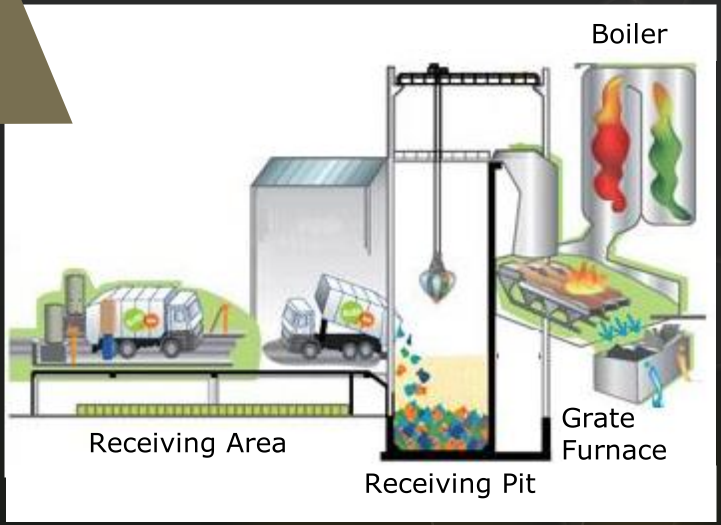
- Assumpt
  - Const Waste
  - 50%
  - 75%

Waste Incineration



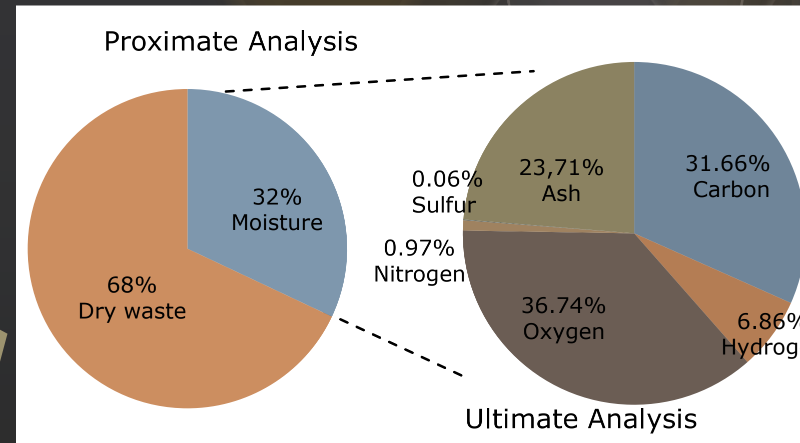
Source: www.sick.com

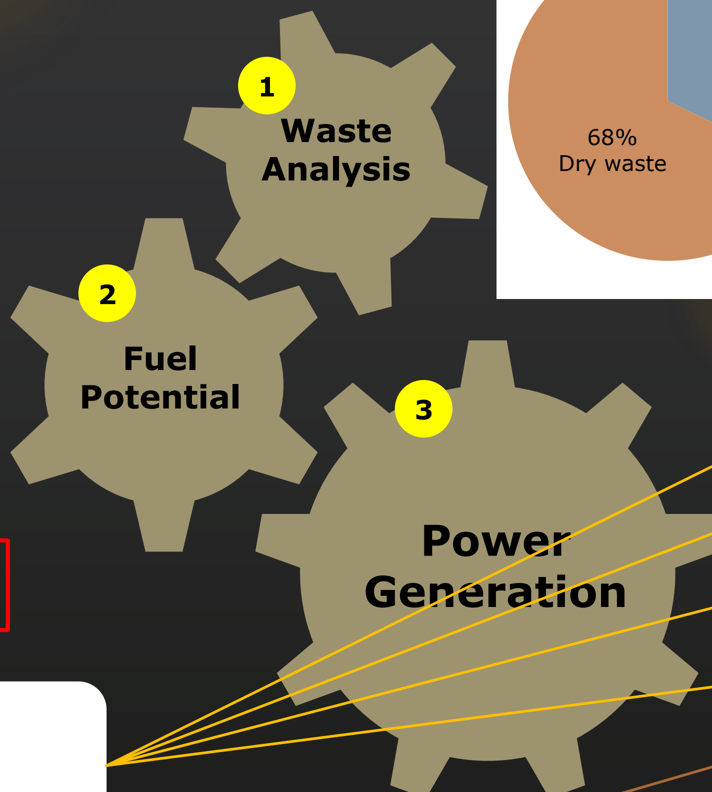
- **Pretreatment** - Drying in the receiving pit.
- **Furnace** - Moving grate furnace is the most robust.
- **Energy Recovery** - Low-pressure steam boiler is convenient when energy recovery is designed for electricity use only (Haukohl, J., Rand, T., & Marxen, R. ,1999)
- **Energy Production** - Rankine cycle with steam turbine, condenser, boiler, and pump for power generation.
- **Flue Gas Treatment** - For 600 ton to 900 ton/day: SNCR, semi-dry scrubber, activated carbon, and a bag house filter are usually used (Kuo, Lin, Chen, Tseng & Wey, 2011).



Source: www.valorena.fr

Waste Incineration Simulation





WASTE INCINERATION		
Waste Feed Rate	270,000	t/yr
Dry Weight of Feed Waste	183,600	t/yr
Feeding Rate	20.96	t/hr
Lower Heating Value	14.245	GJ/t

Fuel Potential 298.56 Gj/hr

Predefined:
- Udomsri, Petrov, Martin & Fransson, 2011
- Suggested values from RETScreen

Simulation:
Energy Model

RETScreen® International
www.retscreen.net
Clean Energy Project Analysis Software

POWER SYSTEM		
Availability	8,401	hours
Back Pressure	50	kPa
Steam Temp.	550	°C
Return Temp.	90	°C
Steam Flow	68,600	kg/hr
Operating Pressure	80	bar
Turbine Efficiency	75	%

Fuel Required 291,4 Gj/hr

Results – Energy and Environment

Source: www.engineeringnews.co.za

Source: www.siemenspowergeneration.com

Technology	Landfill Gas	Waste Incineration
Engine Power Capacity (kW)	4,000	16,447
Electricity Exported to Grid (MWh/yr)	**32,000**	**138,170**

Electricity Export Rate ≈ US$ 70/MWh

Technology	Annual GHG Reduction (tCO_2)
Landfill Gas	**197,005**
Waste Incineration	**201,263**

Energy in Astana: Coal 100%

- Energy Production Cost 50.6(WI) vs. 46.6(LFG) US$/MWh.
- WI energy output > 4.3 times that of LFG.
- Significant GHG reductions are achieved with both technologies.
- LFG GHG reductions ≈ WI GHG reductions.

Results - Financial

Cost Breakdown	Landfill Gas	WI
Initial Cost		
Engineering	Not applicable	Not applicable
Power System	$ 7,743,889	$ 6,232,118
Balance of System	$ 4,036,863	$ 21,126,495
Total Initial Cost	**$ 11,780,752**	**$ 27,358,613**
Annual Cost and Debt Payment		
O&M	$ 1,350,000	$ 8,645,633
Debt Payment (10 yr)	$ 744,419	$ 1,728,775
Total Annual Cost	**$ 2,094,419**	**10,374,408**
Annual Income	**$ 2,240,000**	**$ 9,671,900**

Financial Results	Landfill Gas	WI
IRR on equity	20.6%	19.9%
Payback Period	7.9	9.2
Net Annual Income	$145,181	-$702,508
Net Present Value (NPV)	$63,722,257	$46,386,636
Benefit-Cost Ratio	3.83	4.39

- Inflation Rate – 5.4%
- Discount Rate – 9 %
- Debt Interest Rate – 4.5%
- Electricity-to-Grid Escalation– 8%
- WI rendered slightly better profitability
- Since Kazakhstan is a developing country, affordability is important

Social Impact

- Job Creation
- Improvement of the City’s Image
- Improved Sanitation
- Productivity Increase

Source:http://expertonline.kz

Source: http://bestmaps.ru/

Source: http://www.aksay.kz/

Conclusion & Outlook

- Both technologies are environmentally friendly and economically feasible.
- Any solution would represent a great improvement.
- LFG is preferred in terms of cost of energy production and equity payback period.
- WI is more suitable in case of limited space.
- Risk and sensitivity analysis are recommended.
- Inclusion of carbon credits should be considered.
- Further on-site tests should be carried out.

Thank you.

Any Questions?