Glencore RAGLAN Mine Case Study

TUGLIQ's "Lessons Learnt" in Arctic Renewable Energy and Energy Storage

Kivalliq Energy Forum

Rankin Inlet, Siniktarvik Hotel

Tuesday December 3rd, 2019

Why We're Here

- Oil is an important resource, but burning it causes harm to our planet.
- In Canada, the Arctic is one of the world's most fragile ecosystems, and the impacts of global environmental degradation are already visible.
- Working for an energy transition here, will send an important signal within the country and to the world that our planet is our priority and the change is happening *now*.
- Clean, local resources have regional environmental and economic benefit.
- It comes down to creativity, the courage to think beyond what we already know, and consistently building the expertise needed.

TUGLIQ Energy

Our Mission:

- Replace fossil fuels with local resources
- Decrease carbon footprint
  - while increasing regional benefits

Our Values:

- Listening, learning & respecting
  - *Developing with*, not “for”
- Sustainability
- Innovation & performance

TUGLIQ Energy

Who we are:

- A specialist independent power producer (IPP)
- Technology agnostic
- Investors in the North and co-developers

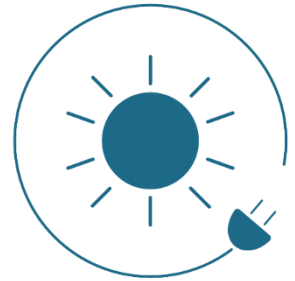
What we do:

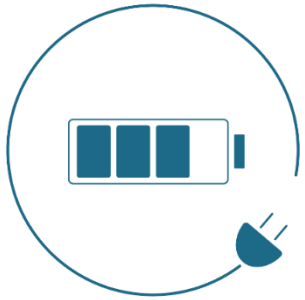
- Bring clean energy to off-grid remote industrials, communities and islands
- Strive for affordable, sustainable solutions
- A-Z project management
- Flexible contractual approaches (ownership and operation)

TUGLIQ Energy

What we do:

- ✓ Wind
- ✓ Solar
- ✓ Storage: Batteries; Flywheels; H2
- ✓ Bio energy & Waste to energy
- ✓ Tidal
- ✓ Transport: Battery powered vehicle; H2 powered vehicle





Integration with existing diesel
High penetration system
Maximum diesel substitution: 93% to date

Where?

Canada: Nunavut, Nunavik, Saskatchewan
International: Mali, Caribbean

Results Highlights
(RAGLAN I&II)

- Over **13M litres** of diesel avoided since 2014
- **4.4 M litres** of annual diesel reduction with 2 wind turbines
- **13 400 tons GHG** avoidance per year, for 20 years
- Successful testing ground for technology adaptation to Arctic conditions
- A solution that can continue to grow:
  EV transport, non-fossil fuel heating, etc.
- A model for future Arctic projects
  - Innovation & problem solving in Arctic construction
  - Cost optimization problem solving (remote logistics, material efficiency)

Arctic Experience

- RAGLAN I&II - **One of only two** industrial sites in the Canadian Arctic
- Wind resource assessments and ESIA (Environmental and Social Impact Assessment) completed in **6 locations**: Nunavik and Nunavut, including Raglan, Iqaluit, Inuvik, Sachs Harbour, TMAC Hope Bay (near Cambridge Bay)
- Innovation & problem solving in **Arctic construction** (ex. permafrost factors)
- **Cost optimization & problem solving**
  (ex. reducing concrete by 90%, a very expensive material in remote locations)
- Maximizing the **resource potential** & choosing the **best fit technology**
  (Arctic suited wind turbine)

Community Case Studies

Community Case Study 1: **Shauvanon, Saskatchewan**

- **Opportunity:**
  - SaskPower Generation Partner Program Solar
  - Self-generate solar power and sell to SaskPower
  - Income activity for commuity-owned land
- **Ownership structure:**
  - 80% Community of Shaunavon
  - 20% TUGLIQ
- **Status:** the community of Shaunavon and TUGLIQ have submitted 2 project proposals to SaskPower that passed the pre-qualification stage in October 2019.

Community Case Study 2:
Kuujjuarapik / Whapmagoostui

- Nimschu-Iskudow Renewable Energy Project
- TUGLIQ contracted for Operations and Maintenance 20-year
- Will train 10 candidate technicians per year for 2 years 2021-2023
  - 5 Inuits
  - 5 Crees
- Onsite classroom, no expatriation
- Hands-on collaboration
- Transferred from TUGLIQ to Ikayu

Community Case Study 3: **Iqaluit**

- TUGLIQ hired to conduct Wind Resource Assessment, Business Case, Bankable reports

Iqaluit Wind Measurement Mast (60m)

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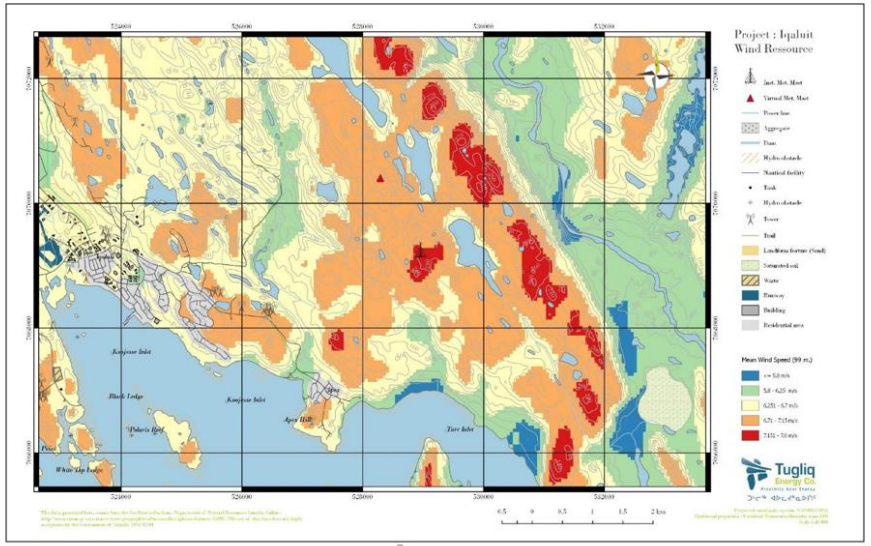
Iqaluit Wind Resource Map Used For Positioning The Meteorological Tower



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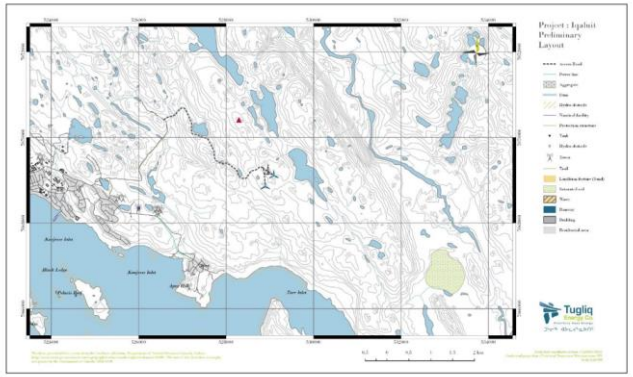
Preliminary Layout With Access Road



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Energy Yield & Diesel Savings

Parameter	Information			
Wind Turbine Scenario	1	2	3	4
Wind Turbine Generator (WTG) Model	E-126	E-103	E-101	E-92
Rated Power (MW)	4.2	2.35	3.5	2.35
Number of Wind Turbines	1	2	1	2
Wind Farm Capacity (MW)	4.2	4.7	3.5	4.7
Rotor Diameter (m)	127	103	101	92
Hub Height (m)	99	98	74	85
Wake Loss (%)	---	1.6	---	0.7
Energy Production Before Additional Losses (GWh/year) (*)	12.6	14.9	8.3	13.7
Capacity Factor Before Additional Losses (%) (*)	34.3	36.1	27.2	33.1
Additional Losses % (**)	16.9			
Energy penetration in the network % (***)	10			
Net Energy Production (P50) (GWh/year)	**9.42**	**11.23**	**6.21**	**10.25**
Net Capacity Factor (%)	25.7	27	20.3	24.8
Diesel Saving (liters/year)	**2,459,543**	**2,908,508**	**1,620,175**	**2,674,266**

(*) Includes wake loss;
(**) Additional losses (typical values for the blade soiling, icing, auxiliary power, etc.);
(***) Energy penetration in the network.

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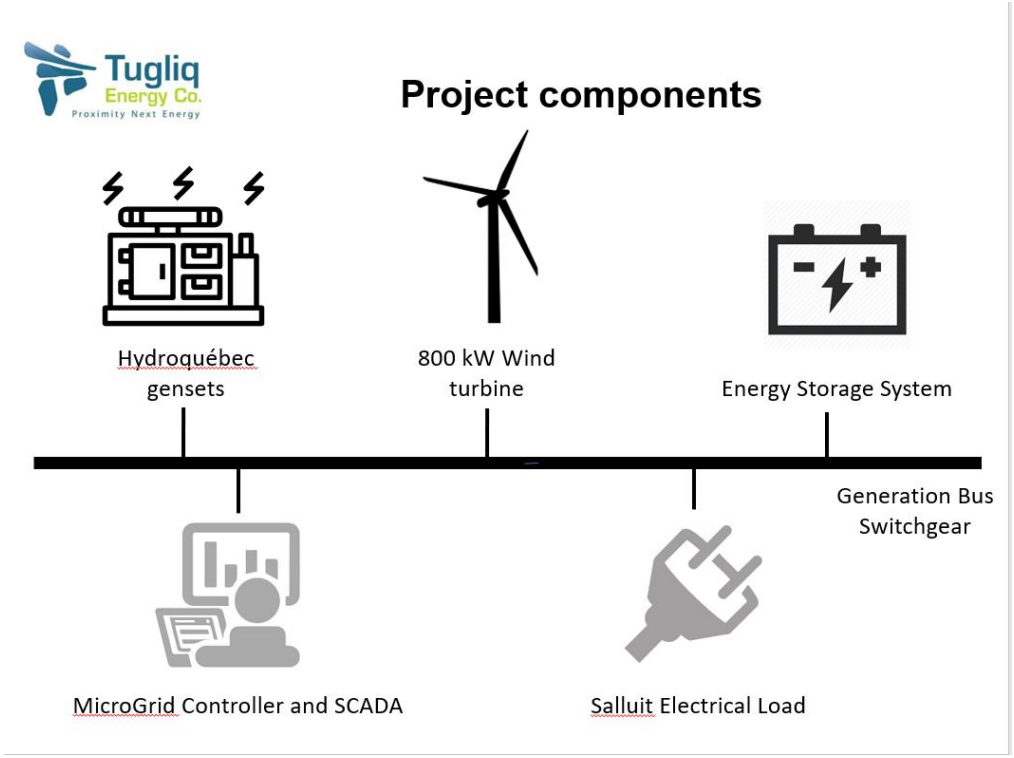
Community Case Study 4: **Salluit**

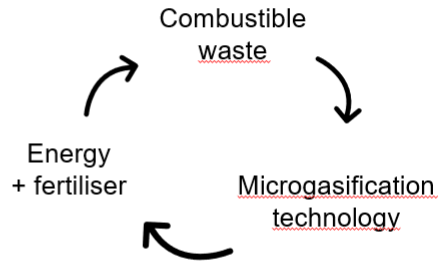


Going one step further:

Waste to Energy

Micro Auto Gasification System (MAGS)

- 60% of waste could be used to produce thermal energy
- Micro gasification system can provide heat for an arena or several household
- Gasification ash can be used as fertiliser



Characteristics	One MAGS
Annual waste treatment	127 Tons per year
Energy recovery	504 MWh/yr
Diesel reduction	139 503 L/yr

Community Case Study 4: **Salluit**

Summer 2019 – Point of discussions

- Site selection for wind turbines according to Salluit residents point of view
  - Visual impact
  - Noise and flickering effect
- Construction
  - Equipment and materials availability
  - Maritime and land logistics constraints
- Local labour
  - During construction
  - Wind operation and maintenance technician
- Interest in waste to energy technology
  - Improvement to current waste treatment
  - Local heat energy production
- Local point of contact for project development

Salluit Wind turbine site selection

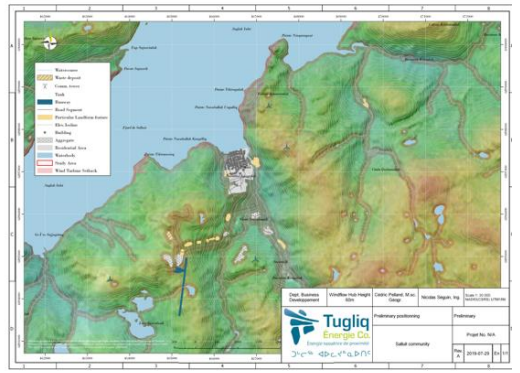
Major constraints*

Environmental
- 7 km from airports
- 500 m residences
- 30 m from riverbanks

Performance
- On the heights (windy area)
- Close to electrical transmission line

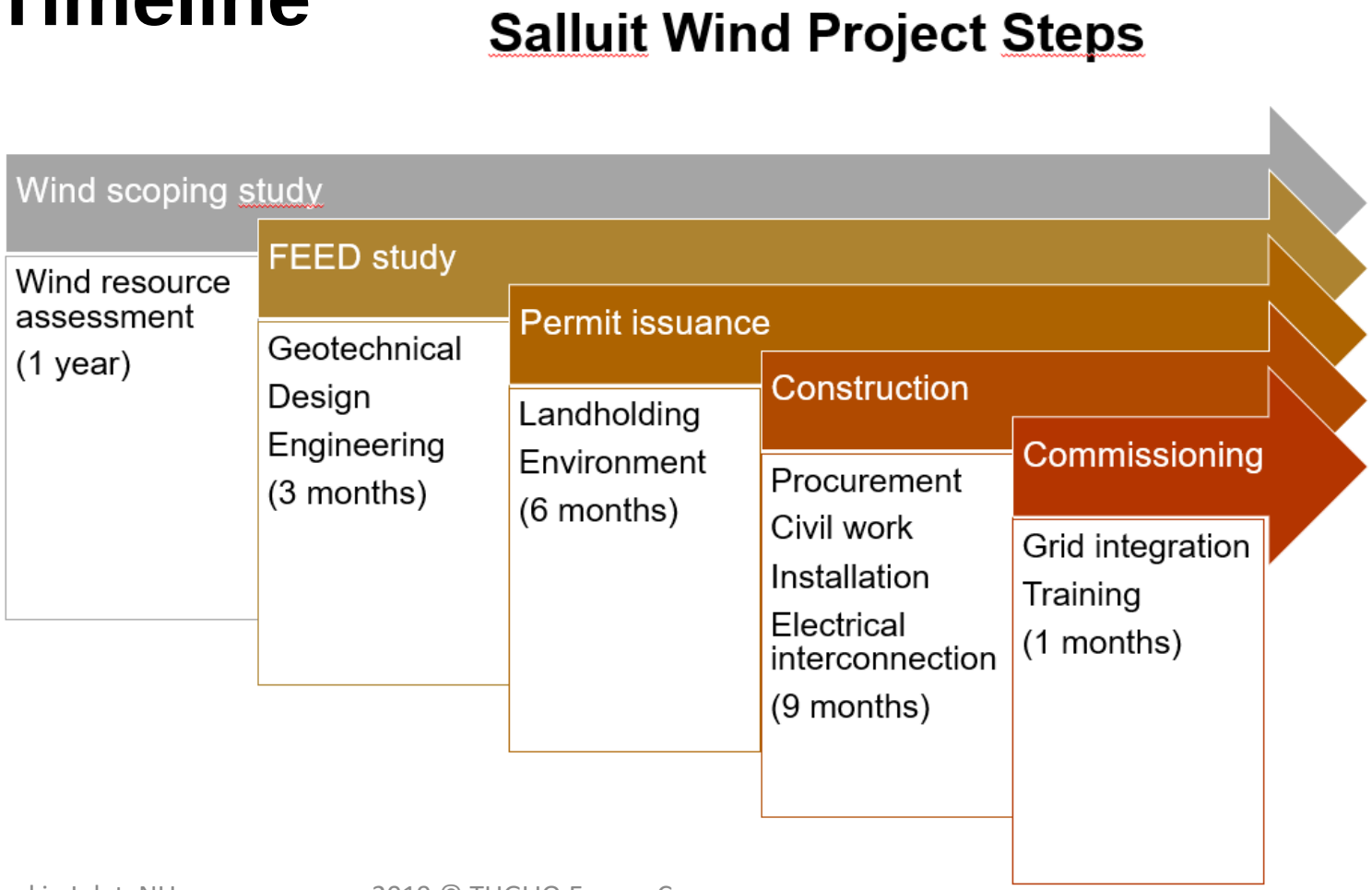
Economical
- Easy access for large parts transportation
- Stable ground

*Non exhaustive list



Community Case Study 4: **Salluit**

Project Timeline



Keys to Success : Flexible Collaboration & Proven Experience

- TUGLIQ collaborates in ways that suit communities' needs and interests.
- TUGLIQ would at the very least, like to provide a project management role because we believe our Arctic experience is mission critical.

Discussion

Thank you

Nakurmiik

Important Takeaways

- Potential
  - Natural resources
  - Experience
- Opportunity
  - Clean Energy
  - Regional Development
  - Youth Training
- Cooperation
  - Building *with*
  - Knowledge and skill sharing

Renewable Energy in the North: A Success Case to Build From

- **RAGLAN I:**
  - Introducing wind power and energy storage to a 100% diesel power grid;
  - Micro grid controller designed to smoothly integrate renewable power;
  - Technological success, with long term fuel cost savings to the mine and reduced carbon footprint

- **RAGLAN II:** a “repeat order”
  - Cost improvements (reduced LCOE);
  - Improved micro grid controller capabilities;
  - Building on lessons learned

Benefits

- Arctic : Excellent wind resource with an air density “bonus”
- Different combinations of resources and technologies are possible
- The RAGLAN projects can be scaled down and modeled to meet community energy needs
- Multiple Community Projects = Multiple Benefits:
  - Cost savings
  - Constant improvements
  - Knowledge-sharing, local employment creation, positioning Inuit youth for the industries of the future

Environnement

Timelines