MODELLING RESILIENCE
CALCULATING IMPACT IN SINGLE SYNTHETIC ENVIRONMENTS (SSE)
Highly specialized team includes AI experts, business analysts, civil, environmental and mechanical engineers, data scientists, developers, design talent and human behavior researchers.

National Science and Research Engineering Council of Canada – COVID-19 and Energy Resilience

City Architecture of Tomorrow Challenge (CATCH) Toyota Mobility Foundation and Deloitte Futures – Mobility Futures

Electric Power and Research Institute (EPRI) Incubatenergy Labs Challenge Winners – Dual Disaster

IoT World Expo Silicon Valley KEYNOTE – ITRON IIoT Earthquake Response

National Research Council – Synthetic Energy Grid

Human Movement in Public Spaces – Public Transportation and Arrival Modes, Congestion and Experience

Canada/Singapore Smart Cities Trade Accelerator

Mexico/Canada Smart Cities Trade Accelerator

Alberta Leading Edge Business Award of Distinction

Founded in 2014 – women led, Certified Aboriginal Business.

Revenue funded to-date.

Built on 25 years of AI IP.

Synthetic modelling to address critical risk, optimization, and disruption in energy, utilities, disaster responses, defense, media, manufacturing, digital systems.
1/3 - 3/4 billion
data points

* This is the most conservative estimate
Actually 3/4 billion
but not all strictly relevant to outputs

50 million to 150 million
data points from each run

0.5 million to 1.5 million
records from each run
100 data points each

COVID infection as of July 15
18,000+ households
2,000+ businesses
140+ models

Runs from noon to 7pm on July 15

outage runs 5 hours, from 1pm to 6pm

1pm
6pm
noon
7pm

5 major runs
high covid
high generators
good comms
poor comms
baseline
WHAT IS AN SSE?

A geospatially accurate digital model of your city.

Including physical infrastructure, utilities, business and residences, climate and weather, disasters.

Technologies – existing and anticipated (under consideration or in pilot).

And people – their demographics, psychographics, and their patterns of life.
**EQUATIONS**
Complex mathematical expressions

**STOCHASTICS**
Correlations, nested correlations, Markov chains, probability distributions, Bayesian arrangements

**INFEERENCE ENGINES**
Connection of multiple inputs to multiple outputs via fuzzy rule sets.

**MACHINE LEARNING**
Apply static and time-based surveys to populations from raw and aggregated data

**PROGRAMMED**
Mentioned because the other models above *don’t require programming.* Programmed models are utilized when necessary for complexity or scale.
SINGLE SYNTHETIC ENVIRONMENT (SSE)

Multiple interconnected models
Research, design and review

Test benches, tools to visually check, in-depth review
SYNTHESIZING COVID CONSUMPTION

Businesses and Residences – from the demand side

M1000 - Medical
M2000 - Warehouse
M3000 - Office
M4000 - Retail
M5000 - Education
M6000 - Financial
M7000 - Industrial
M8000 - Restaurants
M9000 - Hotels
M10000 - Nursing homes
M11000 - Automobile service
M12000 - Governmental properties
M13000 - Vacant properties
M14000 - Misc/ uncategorized
Understanding the starting place and the opportunity.
Early on in the project, we found a great study on Willingness to Pay that we thought would be of interest as we look at people’s engagement with their power company and resilience and use this to inform the psychographics of the households on our map.

**Willingness To Pay**

Value Of Reliability (Willingness To Pay To Avoid Outage) Differentiated By Two Selected Customer Characteristics
Synthesize the Population – health, patterns of life, demographics, consumption, consumer segmentation, economics. Based on publicly available data, behavioural research, consumer surveys, and domain experts.
## Synthetic Data

<table>
<thead>
<tr>
<th>Types of businesses</th>
<th>Locations of businesses</th>
<th>Derived income from likely current property value</th>
<th>Location z of income segments</th>
<th>US Census Age from income by narrow income range (5%)</th>
<th>Low income age distribution</th>
<th>High income age distribution</th>
</tr>
</thead>
</table>

**Map Image:** 
A detailed map showing the distribution of synthetic data across various locations, with different colors representing different income segments.

© 2020 Mapbox @ OpenStreetMap
Synthetic Surveys

- Would pay for additional services
- Location of would pay
- EV interest next 12 months
- Location of EV adopters
- Renewables interest
- Location of renewables interest
- Peak rate incentive

Map showing data points with various colors representing different levels of interest:
- d1_income
  - 15000
  - 10000
  - 20000
  - 30000
  - 40000
  - 50000
- electric_vehicle_interest:
  - "Not_interested"
  - "Somewhat_interested"
  - "Very_interested"
Modelling psychographics, discontinuities in customers' preferences and decision-making.
WILLINGNESS TO PAY

Inflecting Willingness to Pay or how people value reliability

Value of Reliability (Willingness To Pay To Avoid Outage) Differentiated By Two Selected Customer Characteristics

**Willingness To Pay To Avoid Outages: Reliability Demand Survey** June 2012 by Kathleen King, PhD, Bates White Economic Consulting, Washington, DC.

Comparisons

<table>
<thead>
<tr>
<th>Trust Improvement</th>
<th>Medical Needs</th>
<th>Medical Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor vs. Good Communication</td>
<td>High Cost</td>
<td>Increase: 1%</td>
</tr>
<tr>
<td>Poor vs. Good Communication</td>
<td>Poor vs. Good Communication</td>
<td>Poor vs. Good Communication</td>
</tr>
</tbody>
</table>

Trust Improvement:
- 4.00
- 10.00

Data:
- 104312700
- Show history
REPAIR PRIORITIES FOR VULNERABLE POPULATIONS
ESTIMATING SOCIETAL COSTS

Incorporating direct and indirect costs — using all types of calculations — incorporating layers of research and localizing.
Consumption and loss

Residential net consumption by income, net, cavi, pre
Business net consumption by type and locations
Consumption curves by business type
Business loss calculations, DOE and other
Losses by survey by type of business
Business losses > $50k by survey by business and location

d2_subtype
- auto
- education
- financial
- hotel
- industrial
- medical
- miscellaneous
- nursing
- office
- restaurant
- retail
- warehouse
MULTIPLE CALCULATIONS
Modelling reactive, responsive changes over time, investment deployment and the changing impacts, electrification and climate change.
Phoenix has a target of reducing GHG emissions by 30% community-wide by 2025. On a community scale, progress was made – as the emissions were 0.5% lower in 2018 than 2012 while the city’s population grew 12%.

Stationary energy – is one of the largest sources of GHG emissions in the community – a 9% reduction from 2012-2019. Stationary energy GHG emissions sources include energy utilized in residential buildings; commercial buildings and facilities; manufacturing industries; agriculture, forestry and fishing energy use; and electricity transmission and distribution energy losses.

Graph source: https://www.phoenix.gov/oep/2018GHG
CHANGING PROFILES, EVOLVING RESPONSES
We found that people were increasingly interested in self-sufficiency to increase their own resilience with the use of renewables and backup power sources.
when we were looking into backup power discussed previously, we also wanted to explore the different fuel types being used and considered.

if engaging with the community to furnish backup power as a part of a community resilience initiative – we thought it might be useful to put some context around the impacts of backup power, both in terms of resilience and GHG emissions.
LIVE INTERFACE
ADAPTABLE, ADDITIVE, ACTIONABLE

Relevant, hyper-localized, geo-spatial, extensible, impact calculations and design lab.
Ability to model and synthesize systems based on publicly available data, domain experts, research, and survey data.

Interconnected Models generate data that is missing or unavailable that is then validated and verified through process, comparison, and consultation.

Does not require extensive, complete, surveillance, regulatory or privacy protected data.
Underway

Disaster Response Preparation

System design and optimization, limitless scenarios including security events, impact and inflections, economics, human condition, behaviour and outcomes

Mobility

System design and economics, traffic modes and models, tech validation, EV and technology adoption, GHG calculations, policy impacts

Future of Electrification and Utilities

Energy efficiency, new tech adoption and validation, grid preparations, optimization systems, ghg emissions, economic impact, policy and incentive response measurement and forecasting
THANK YOU!

December, 2020