

# Energy Conservation Audits for Six Performing Arts Facilities

A Toronto's Green Theatres Project



Anthony Marshall, P.Eng., CEM – January 2012  
For Creative Trust for Arts & Culture

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# Introduction

We are delighted to release this summary report of Energy Conservation Audits conducted for six leading mid size performing arts companies in Toronto between May and October 2011. Prepared for Creative Trust by independent energy auditor Anthony Marshall (P.Eng., CEM) of Carbon Count Energy Consulting, these audits are the first step in what we hope will become a concerted approach to greening performing facilities in Toronto – and a possible model for other communities.

Creative Trust has been working to strengthen the financial capacity and organizational potential of Toronto's performing arts companies since 1998 through collaborative Endowment Fundraising and Working Capital for the Arts: a multi-year capacity building program that has helped music, theatre, dance and opera companies eliminate deficits, build working capital reserves, and develop management, fundraising and audience development skills.

Yet it has always been clear to us that working capital is only one of the urgent capital needs of Toronto's performing arts companies. The other is for affordable, accessible, and well-maintained facilities and performing venues. For the community to thrive, both have to be addressed.

**Creative Trust's Facilities Initiative** was therefore begun in 2009 to tackle the need to repair, renovate or expand performance facilities throughout the city. Many of Toronto's mid size and small performing arts companies are housed in heritage buildings, repurposed as public performing spaces up to 40 years ago. The Facilities Initiative was developed to help more than 20 participating organizations find ways to replace heat-leaking windows, deteriorating roofs, dusty old furnaces and poor insulation, and to deal with the many challenges of maintaining an ageing physical plant while trying to control costs. It has become a network for sharing, learning and raising awareness and funding support to address these issues.

It has also been a place for discussion around issues of greening and energy efficiency. The idea for **Toronto's Green Theatres** was inspired by London's Green Theatre Plan. Its goal is to help Toronto companies meet the highest possible standards for environmental sustainability and energy efficiency in their facilities. Its starting point is to understand what work needs to be done to get there.

With the encouragement and support of the City of Toronto Cultural Services, we contracted Anthony Marshall to undertake energy audits for six Creative Trust companies – Buddies in Bad Times Theatre, Factory Theatre, Tafelmusik, Tarragon Theatre, Theatre Passe Muraille, and Toronto Dance Theatre/STDT. These audits yielded detailed and practical recommendations for energy efficiency upgrades for each company, which will allow them to integrate greening into their facility upkeep and long-term repair and renovation plans. They will also make it possible for the participating organizations to access a range of energy efficiency support and incentive programs, including through Toronto’s Energy Efficiency Office.

There is no doubt that measures taken to green Toronto theatres will result in energy savings and improved working environments. We also plan to use the results of these audits as part of an overall strategy that can be rolled out to performing venues throughout the City, and which may include examining opportunities for collaborative work and group sourcing and purchasing; encouraging leadership around environmental issues; inspiring Creative Trust members and the wider theatre community to build energy efficiency into each new build or renovation project; and sharing our experience with other arts and nonprofit organizations perhaps serving as an inspiring example of ‘green leadership.’

Toronto’s Green Theatres is the first arts sector initiative of its kind in Canada. Like all Creative Trust’s work, it was developed collaboratively and will rely on our collective muscle for its success. We thank both Toronto’s Cultural Services and Energy Efficiency Offices, which have been wonderfully supportive of our plans to work across our sector to reduce theatres’ carbon footprints. We hope that our results will act as a catalyst for changing awareness and behavior around one of the most compelling issues of our day.

Jini Stolk  
Executive Director, Creative Trust

# Performing Arts Companies/Facilities Included in Energy Audit Process

Energy Audits for Companies/Facilities in Toronto (May – October 2011):

- Toronto Dance Theatre and The School of Toronto Dance Theatre – 17,361 ft<sup>2</sup>
- Factory Theatre – 17,033 ft<sup>2</sup>
- Tarragon Theatre – 19,000 ft<sup>2</sup>
- Theatre Passe Muraille – 14,000 ft<sup>2</sup>
- Tafelmusik – 44,400 ft<sup>2</sup>
- Buddies in Bad Times Theatre – 11,000 ft<sup>2</sup>

# Building Energy Performance Index (BEPI)

## Building Energy Performance Index (BEPI) – Performing Arts Facilities

### Buddies in Bad Times Theatre - 2010/2011 (11,000 ft<sup>2</sup>)

Utility Type	Usage	Cost \$	Energy index [ekWh/ft <sup>2</sup> /year]	Cost index \$/ft <sup>2</sup>
Electricity - kWh	194,480	\$ 23,323	17.7	\$ 2.12
Natural gas - m <sup>3</sup>	33,864	\$ 11,202	32.2	\$ 1.02
Water - m <sup>3</sup>	2,319	\$ 7,109		\$ 0.65
Total		\$ 41,635	49.9	\$ 3.78

### Toronto Dance Theatre 2010 - (17,361 ft<sup>2</sup>)

Utility Type	Usage	Cost \$	Energy index [ekWh/ft <sup>2</sup> /year]	Cost index \$/ft <sup>2</sup>
Electricity - kWh	187,432	\$ 32,456	10.8	\$ 1.87
Natural gas - m <sup>3</sup>	32,847	\$ 8,934	19.8	\$ 0.51
Water - m <sup>3</sup>	1,714	\$ 3,457		\$ 0.20
Total		\$ 44,847	30.6	\$ 2.58

# Building Energy Performance Index (BEPI)

## Building Energy Performance Index (BEPI) – Performing Arts Facilities

### Factory Theatre - 2010 (17,033 ft<sup>2</sup>)

Utility Type	Usage	Cost \$	Energy index [ekWh/ft <sup>2</sup> /year]	Cost index \$/ft <sup>2</sup>
Electricity - kWh	127,535	\$ 15,341	7.5	\$ 0.90
Natural gas - m <sup>3</sup>	28,320	\$ 12,128	17.4	\$ 0.71
Water - m <sup>3</sup>	1,484	\$ 3,349		\$ 0.20
Total		\$ 30,818	24.9	\$ 1.81

Tarragon Theatre - 2010 (19,000 ft <sup>2</sup> )				
Utility Type	Usage	Cost \$	Energy index [ekWh/ft <sup>2</sup> /year]	Cost index \$/ft <sup>2</sup>
Electricity - kWh	177,097	\$ 19,946	9.3	\$ 1.05
Natural gas - m <sup>3</sup>	23,677	\$ 7,411	6.9	\$ 0.39
Water - m <sup>3</sup>	1,278	\$ 2,623		\$ 0.14
Total		\$ 29,980	16.3	\$ 1.58

# Building Energy Performance Index (BEPI)

## Building Energy Performance Index (BEPI) – Performing Arts Facilities

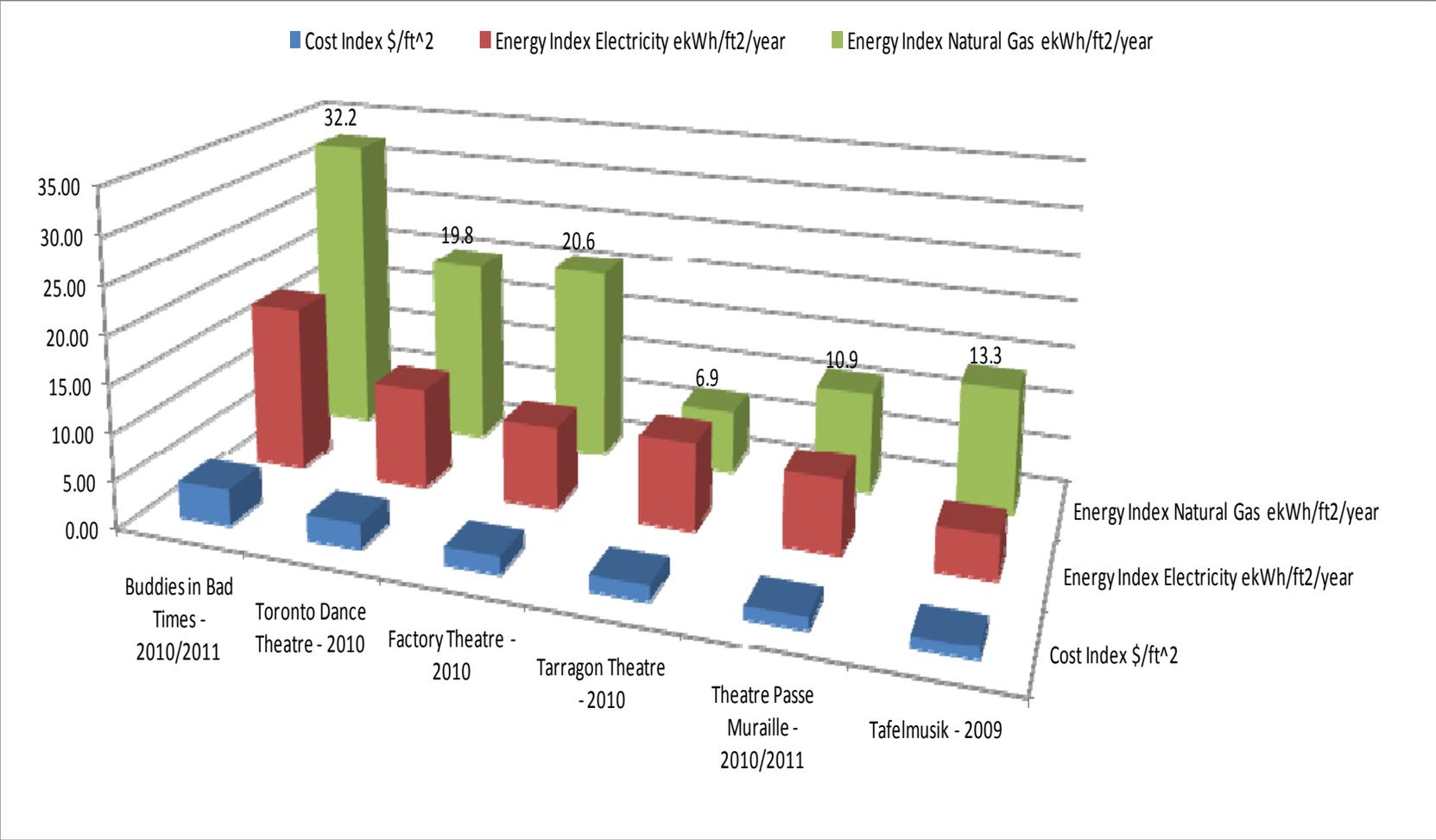
### Theatre Passe Muraille - 2010/2011 (14,000 ft<sup>3</sup>)

Utility Type	Usage	Cost \$	Energy index [ekWh/ft <sup>2</sup> /year]	Cost index \$/ft <sup>2</sup>
Electricity - kWh	107,858	\$ 13,287	7.7	\$ 0.95
Natural gas - m <sup>3</sup>	14,574	\$ 4,099	10.9	\$ 0.29
Water - m <sup>3</sup>	147	\$ 322		\$ 0.02
Total		\$ 17,708	18.6	\$ 1.26

### Tafelmusik - 2009 (44,400 ft<sup>2</sup>)

Utility Type	Usage	Cost \$	Energy index [ekWh/ft <sup>2</sup> /year]	Cost index \$/ft <sup>2</sup>
Electricity - kWh	198,472	\$ 21,062	4.5	\$ 0.48
Natural gas - m <sup>3</sup>	55,991	\$ 30,487	13.3	\$ 0.69
Water - m <sup>3</sup>	749	\$ 1,432		\$ 0.03
Total		\$ 52,981	17.8	\$ 1.20

# Energy Use Index Comparison By Facility



# Variables and Systems Affecting Energy Use

## Variables Affecting Facility Energy Use and Energy Intensity:

- It was determined that there is no standard energy intensity value for these facilities (each facility design and operation is unique.)
- Many variables at each site prevent one from concluding that there is a 'standard energy intensity index', such as:
  - Highly variable operating hours, # of performances, # of staff, performance lighting requirements and equipment use.
  - Variation in ventilation rates – Some facilities have minimal mechanical ventilation equipment. Some facilities use mechanical cooling systems, others do not.
  - Equipment condition and design efficiencies varies widely – Boilers, transformers, cooling systems, windows, doors, weather-stripping, insulation levels.
  - Use of electric duct heating systems and/or electrically heated domestic hot water systems in some facilities increases electric demand.
  - Some facilities use programmable thermostats and radiator zone controls, others do not. Some facilities use building automation, others do not have BAS systems.

# Energy Conservation Measures Common to Several Facilities – Lighting

Lighting Retrofit Measures common to most facilities were determined to be:

- **Lighting System Retrofits:**
- T12 to T8 (28 Watt). Magnetic ballasts replaced with electronic ballasts.
- T8 (32 Watt to 28 Watt).
- Exit Sign incandescent to LED conversion.
- Incandescent to compact fluorescent conversion.
- MR16 halogen to dimmable LED's.
- Incandescent 'globe' to dimmable compact fluorescent cold cathode lamps (change rooms and make-up rooms).
- High Wattage incandescent to LED or compact fluorescent (cfls') conversion.
- Lighting System Controls – Passive Infrared (PIR) controllers for randomly occupied areas such as offices, mechanical rooms, closets, dance theatres, outdoor lighting systems, meeting rooms and washrooms.

# Energy Conservation Measures Common to Several Facilities cont'd – Building Envelope

- **Insulation, Door, Windows, Weather-Stripping, Air-Curtains (door entrances):**
- Some second floor offices with peaked roofs had minimal ceiling insulation.
- Several flat roofs had water damage, minimal insulation and/or failed mechanical seals around ventilation equipment.
- Many heritage (and newer) doors had poor seals along the floor and between the doors themselves. They require weather-stripping, door sweeps and frame cleaning/painting.
- Many heritage (and replacement) windows require repair (and weather-stripping) to the sliders and glazing. Caulking is required in some instances.
- Most entrance doors will benefit from the use of air curtains to reduce infiltration of air during the heating and cooling seasons.
- Some second floor peak and flat roofs require insulation or repair to mechanical seals surrounding ventilation equipment installations.
- Domestic hot water and steam boiler piping and domestic hot water piping will benefit from the installation of pipe insulation to reduce radiant heat losses.
- Heritage building envelope specialists can prepare detailed costs for each building where required.

# Energy Conservation Measures Common to Several Facilities cont'd – Controls

- **Installation of Building Automation Controls:**
- Electric perimeter floor heaters, cabinet heaters and office duct heaters will benefit from the use of Programmable Thermostat Controllers during unoccupied times.
- Various heating systems are used, including gas-fired hot-water and low-pressure steam boilers. These systems will benefit from the installation of Outdoor Temperature Reset Controllers and Radiator Zone Thermostats.
- Air Curtains (with occupancy sensors) and Thermostat Controls can be used to reduce infiltration of outdoor air, reducing heating and cooling costs.
- Scheduling of Rooftop Ventilation units is suggested during evenings and other unoccupied times. Thermostat occupancy controllers and Building Automation Systems can provide this control.
- Carbon Dioxide (CO<sub>2</sub>) level outdoor air controllers can be used with some rooftop ventilation units to minimize ventilation cooling/heating loads.
- Building Automation Systems are suggested for facilities with rooftop units and boilers to integrate their control to prevent simultaneous operation (heating and cooling).
- Hot water/steam radiators should have thermostatic control valves installed to regulate space temperature better than current operations.

# Energy Conservation Measures Common to Several Facilities cont'd – Boilers, Transformers

- **Installation of New, High Efficiency Equipment (Capital Upgrade):**
- Equipment such as steam and hot water boilers within two facilities were low-efficiency, 'natural draft' combustion designs.
- It is recommended to replace the existing 'natural draft' gas-fired hot-water and low-pressure steam boilers with mid-efficiency, power vented boilers. These systems will provide higher combustion efficiency and lower 'standby losses'. In some cases, chimney repair is required and also possibly new liner installation is needed.
- Some electrical transformers are low-efficiency designs. They generate more heat losses than currently available High Efficiency Transformer designs. These can be replaced to improve long term operating efficiencies for electrical systems. They also will reduce heat gain in the building during the summer.
- Rooftop ventilation unit replacement for Toronto Dance Theatre, Tarragon Theatre, Theatre Passe Muraille and Buddies in Bad Times Theatre is suggested. R11 and R22 refrigerants are not environmentally friendly. Unit efficiencies (SEER) are low and the ability to maintain refrigerant levels will be limited in the near future.

# Energy Conservation Measures Common to Several Facilities cont'd – Fuel Switching

- **Fuel Switching from Electric to Natural Gas Equipment:**
- Equipment such as electric domestic hot water heaters, in some instances, can be replaced with mid to high efficiency power vented natural gas water heaters.
- These units substitute higher cost electricity with cleaner, lower cost (per unit of energy) natural gas.
- The gas-fired domestic hot water (DHW) boilers may provide significant electrical demand reduction which in some instances reduces electric charges.
- Some electric heaters can be replaced with forced air, hot water or steam heated radiator systems. This is a costly capital installation, though the cost of operating with natural gas is lower and more environmentally friendly in the long term.
- Some small solar thermal heating systems can be installed as demonstration systems. The payback period for this type of project is longer than typical installations as hot water usage is low at most of these facilities. Solar systems operate best during the summer, however, most Theatres are not operating during this period so the economics are weak in favour of building these systems.

# Energy Conservation Measures – Heat Reflectors (Steam and Hot Water)

- **Heat Reflector Panels (Facilities Using Heating Radiators):**
- Facilities using Steam or Hot Water heated radiators lose significant heat directly through adjacent brick, block or drywall materials during operation.
- The installation of Aluminized Heat Reflectors on walls, reduces heat loss through walls.
- More heat is reflected directly to ambient air, reducing space heating load.
- Heat Reflector Panel installation is a low-cost, easy to install, fast payback energy conserving measure for Hot Water and Steam heated radiator facilities.
- Piping insulation is also a relatively low cost measure to provide energy savings on presently un-insulated heating pipes located in the boiler room.

# Energy Conservation Measures – High Efficiency Appliances

- **High Efficiency Appliances:**
- Several facilities identified in the energy audit reports have requirements for new high-efficiency appliances such as washing machines, dishwashers, refrigerators, window air conditioning systems etc.
- There is a wide variety of available equipment that will provide energy savings on the market today. There are several incentives and rebates available to help finance replacing existing equipment. These should be considered as long-term capital upgrades for the facility.
- Low cost power bars can be used to reduce evening power consumption from computers and miscellaneous equipment.

# Energy Conservation Measures – Solar Photo-Voltaic Panels

- **Solar Photo-Voltaic Panels:**

- Several facilities having flat roofs with unobstructed Southerly exposure have the potential for Solar Photo Voltaic (Solar PV) panel installation.
- The installation of Solar PV panels provides an additional income stream for the facility. The installation is cost effective, with typical payback periods between 9 and 15 years.
- Roof replacements and/or repairs are suggested for several sites. This can be coordinated with the installation of new Solar PV Rooftop Panel installations.
- Some slate tile roofs may also be retrofitted with Solar PV Panels designed to match this style of roofing material. These are more costly to purchase, though are very durable and can be used to supplement income for the facility owner.

# Water Conservation Measures

- **Water Conservation Measures:**
- Most facilities identified in the energy audit reports have minimal water use.
- The use of low-volume toilets can be considered as both capital upgrades and as a water conserving measure.
- Auto-flush sensors for urinals is recommended in all facilities. Some tank-flush designs are presently used (or none).
- Automated water faucets throughout the facilities is more of a convenience than water conserving measure.
- Upgrades to the facility water faucets and shower-heads using low-flow faucets is a low cost and easy method of conserving resources. Many devices are available from Enbridge at low or no cost.
- Conservation of water also indirectly reduces greenhouse gas emissions and energy use and should be considered with any energy retrofit project.

# Ideas to Consider For Energy Retrofit Planning

- **Lighting Retrofit Measures:**
  - Each facility can review lighting measures to decide on which are practical (budget and operationally) to pursue. Lighting suppliers can coordinate product support and testing at each facility as required to determine most suitable products. Excellent product support is essential, not simply retrofitting equipment.
- **Control Systems Measures:**
  - A review of control measures should be prepared for each site. Quotations and specifications should be obtained for review by facility owners. Possibly one or two suppliers could be used to complete all retrofits. A discount as well as good product support may be obtained by using a single supplier. This should be investigated.
- **Boilers and Heating System Upgrades:**
  - Decisions need to be made regarding boiler system capital upgrades. There is potential for failure of some equipment. Leasing or equipment could be a consideration. Suppliers, pricing and technologies require investigating and close review.

# Ideas to Consider For Energy Retrofit Planning cont'd

- **Rooftop Ventilation Equipment:**

- The rooftop ventilation equipment identified in the energy audit reports requires replacement in the near future (3-6 years) to ensure reliability. In the longer term, they require replacement to ensure energy performance for the facility and to ensure refrigerant availability in the longer term. Several manufacturers can provide equipment specifications and pricing. One or two contractors may give volume pricing and better long term service support which is valuable to the operator.
- A mechanical design consultant may be required if additional, new ventilation equipment is to be considered for some facilities.

- **Roofing Equipment:**

- A review of the facility budgets is required to determine if replacement or repair is most feasible for the sites. In addition, consideration is required of the need to add or replace existing rooftop equipment. New roofing materials need to be integrated into the design for solar PV rooftop installations.

# Ideas to Consider For Energy Retrofit Planning cont'd

- **Building Envelope Retrofits:**

- All of the facilities involved in the energy audit procedure were found to require some form of repair and/or upgrade to the building envelope. It is suggested to obtain support from a heritage facility building envelope specialist. Pricing for repairs that are of greatest concern could be obtained and reviewed. Discounts for volume work should be possible from the supplier.
- Systems such as air curtains can be seen at existing installations and tested to determine if they are feasible for use at the performing arts centres. This can be arranged easily with the supplier.

- **Solar PV Array Installation/Energy Contracts:**

- Solar PV array proposals can be obtained from several suppliers, including turn-key equipment operators. The applications for the Ontario Power Authority contracts need to then be completed and reviewed. Facility operators need to determine whether these systems are of benefit to the owner. Similarly, solar thermal 'demonstration' system proposals can be obtained and reviewed for each site as required.

# Energy Project Incentives and Project/Incentive Support to Facility Operators/Owners

- **Energy Incentives:**
  - There are energy retrofit incentives available from programs such as saveONenergy administered through the City of Toronto on behalf of the Ontario Power Authority.
  - Additional incentives may be available from Enbridge with respect to the installation of new boilers, air curtains, piping insulation and electric water heater replacement.
  - Incentive applications should be submitted before work is started on the energy retrofit/upgrade projects to ensure eligibility.
- **Energy Retrofit Project Application and Equipment Selection Support:**
  - There will be need for continuing work with the facility owners/operators to provide support with submitting energy retrofit incentives applications and applications for solar PV system installation as required. There will be also be need for support with equipment selection or providing direction in finding equipment suppliers when required.

# Project Partners

**Anthony Marshall, P.Eng., CEM**, Energy Engineer and Certified Energy Manager, is the founder of **Carbon Count**, an Energy Conservation engineering company that provides facility energy audit information to clients. Energy audit reports stating the facility energy or 'carbon' footprints are prepared for clients. Advice and recommendations on how to improve the facility operation using energy conservation measures, renewable energy systems and demand management techniques as well as new energy efficient technologies is provided in reports to clients.

For more information about Carbon Count and their services visit [www.carboncount.ca](http://www.carboncount.ca). Anthony Marshall can be reached at [anthony@carbon.count.ca](mailto:anthony@carbon.count.ca).

**Creative Trust** is a collaborative capacity building organization that helps Toronto's mid-size and small performing arts companies develop skills and achieve financial health and balance. Its aim is to build vibrant, sustainable music, theatre and dance organizations that will continue to inspire, move and challenge audiences for years to come.

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