UNIVERSITY of Prince Edward ISLAND

SCHOOL OF SUSTAINABLE DESIGN ENGINEERING

PEI's Unique Energy Situation and Opportunities for its Capital City

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PEI's Energy System is *Unique*

- 98% of electricity *generated* on PEI comes from wind turbines
- 40% of electricity *consumed* on PEI comes from Island wind*
- PEI's emissions are mostly from transportation, buildings, and agriculture

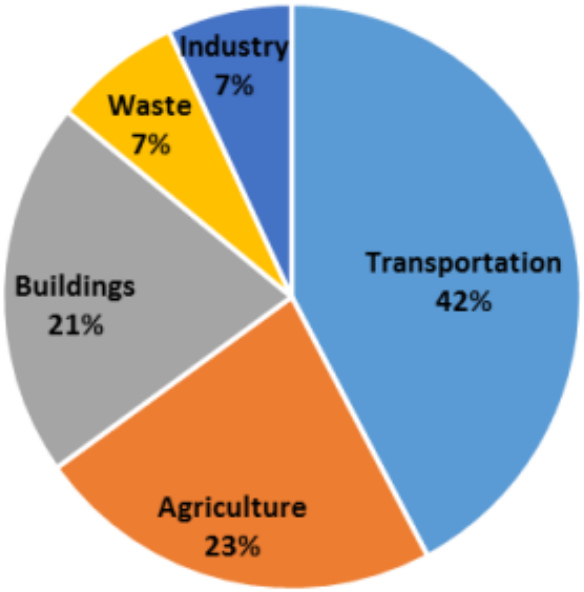
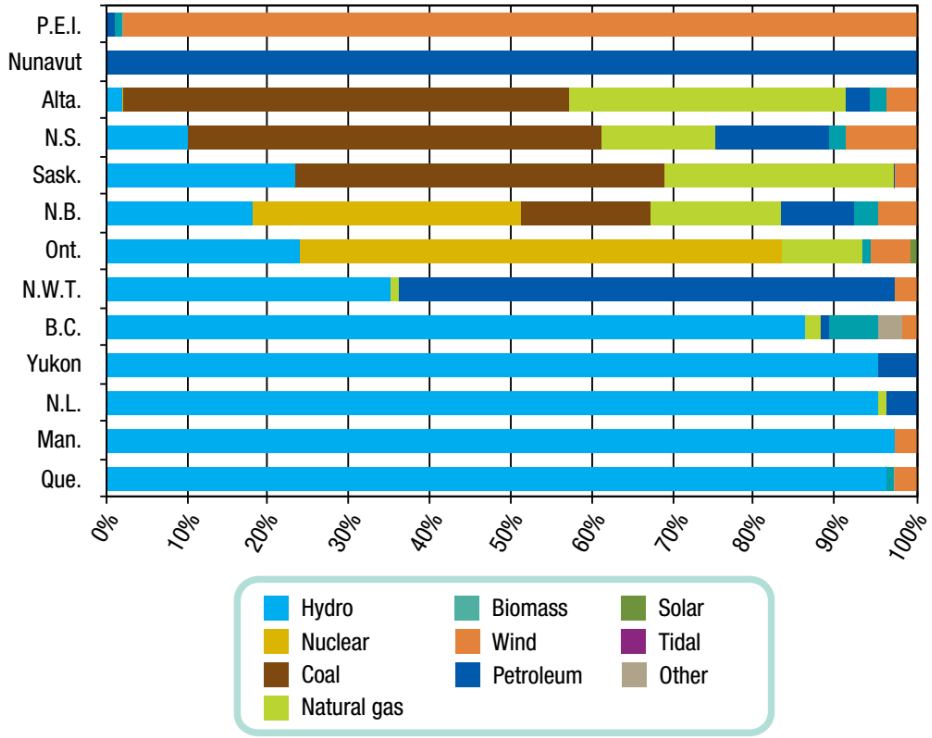


Image: 2016/2017 Provincial Energy Strategy: www.peiec.ca

PEI's Primary Electricity Source: Wind



Energy Fact Book 2016-2017, Natural Resources Canada

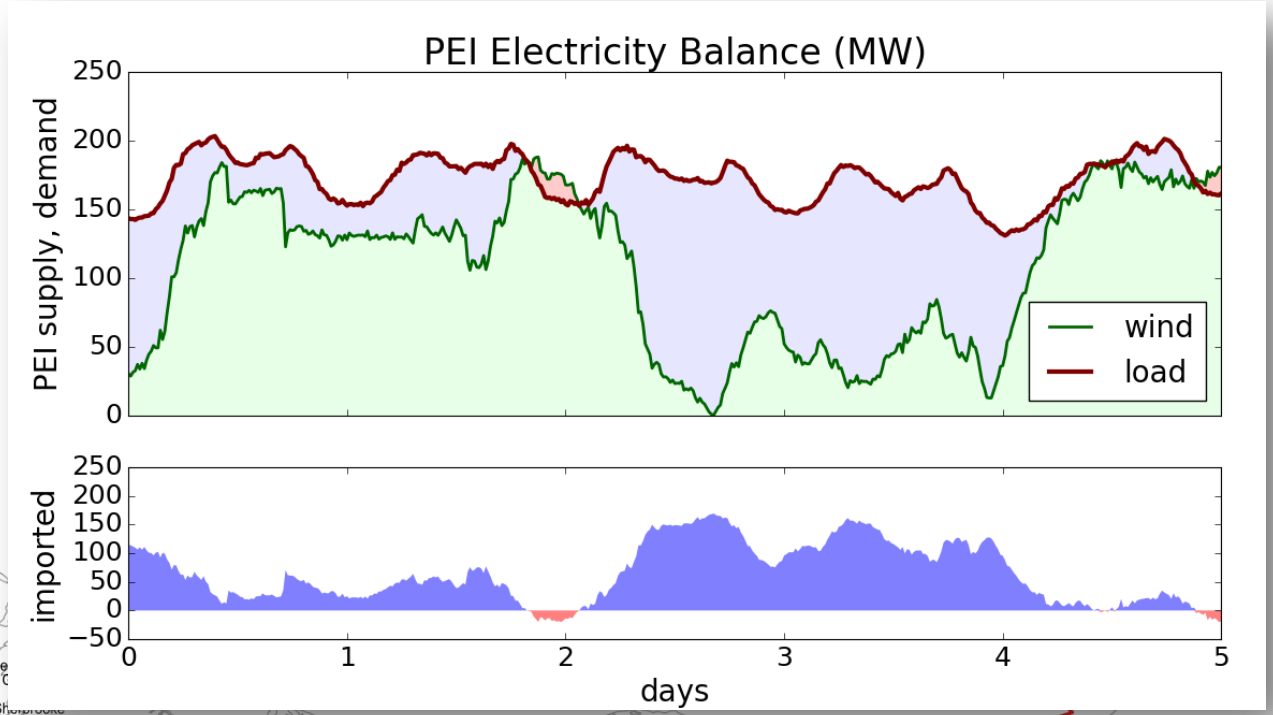
We Have Great Sustainable Energy Examples

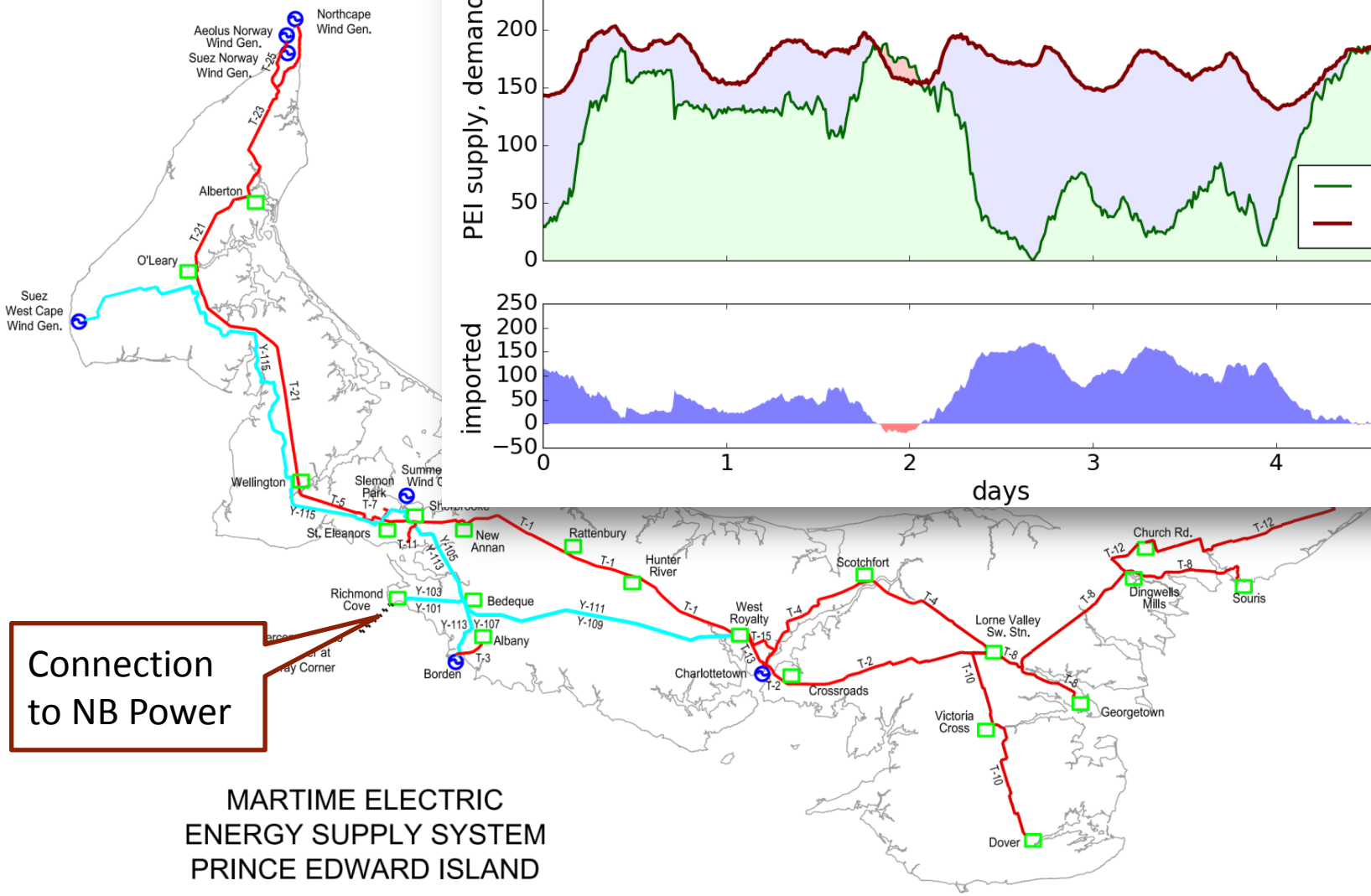
- The Island uses its strong wind resource
  - 204 MW of wind turbines
  - highest wind energy ratio of any province

- Summerside is a leader in clean energy
  - own electrical utility
  - 12 MW wind farm, new solar array
  - smart grid and household thermal storage
  - electric vehicle charging stations

- New opportunities are emerging
  - batteries and solar panels becoming competitive
  - ongoing electrification of heating (heat pumps)
  - impending electrification of transportation (Evs)

Problem: Supply and Demand Must Balance



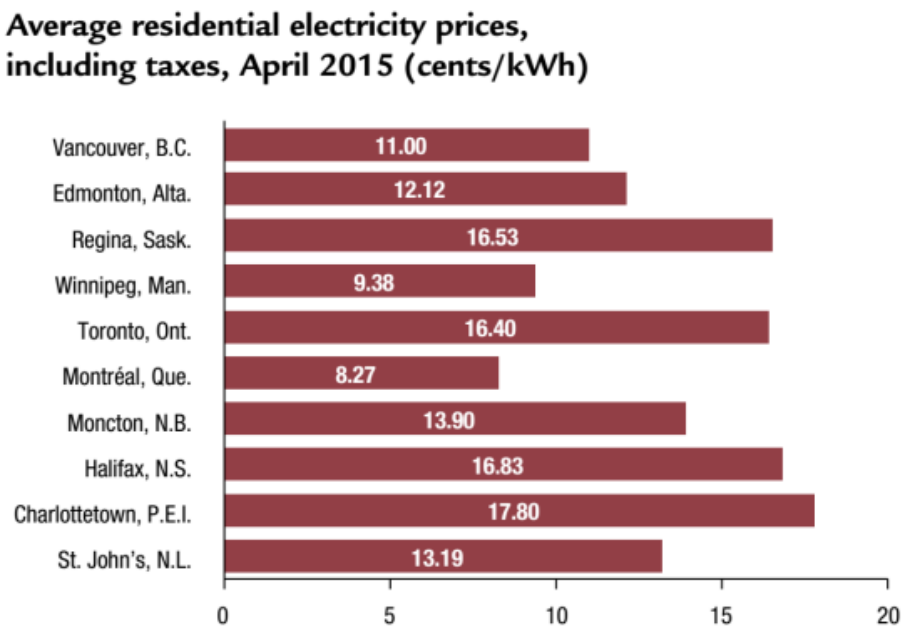


Connection to NB Power

MARTIME ELECTRIC
ENERGY SUPPLY SYSTEM
PRINCE EDWARD ISLAND

Reliance on New Brunswick

- Reliance on NB Power for electricity imports and supply-demand balancing is a cost and a source of price uncertainty
- How can we reduce greenhouse gas emissions, costs, and uncertainty?



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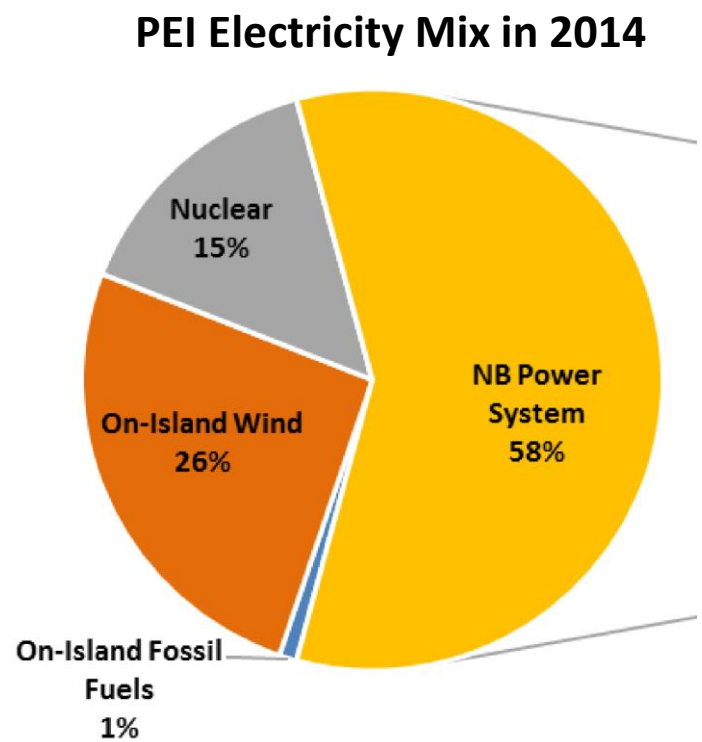
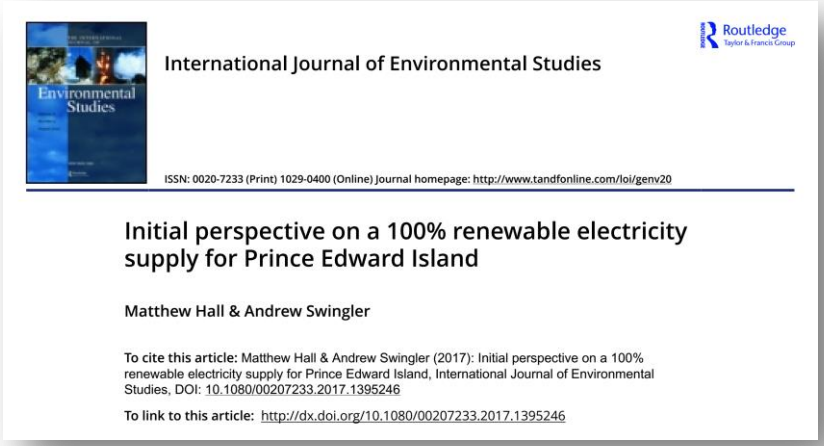


PEI Provincial Energy Strategy 2016-2017

What if we cut the cable?

- What would it take for PEI's electricity use to be 100% from on-Island wind and solar?
- Scenarios using a year's worth of data for demand, wind power, and solar power



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Initial perspective on a 100% renewable electricity supply for Prince Edward Island

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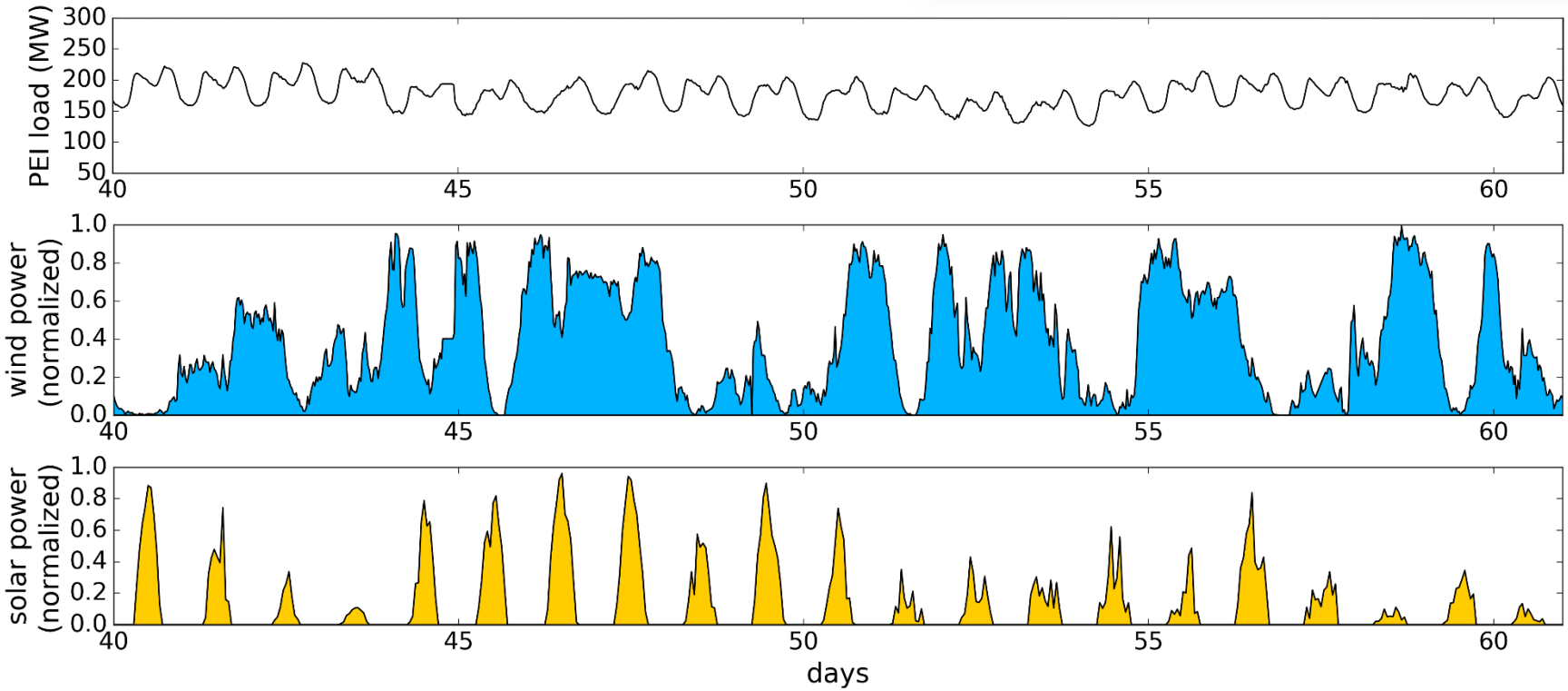
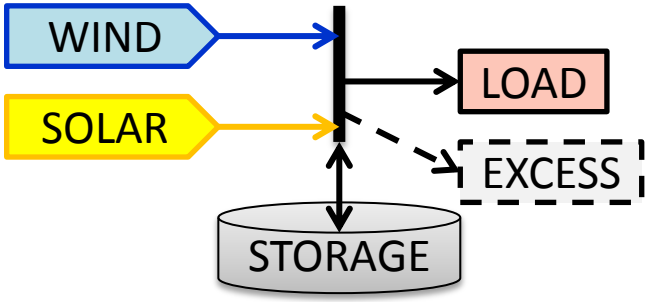


Simulating Different Wind-Solar Scenarios

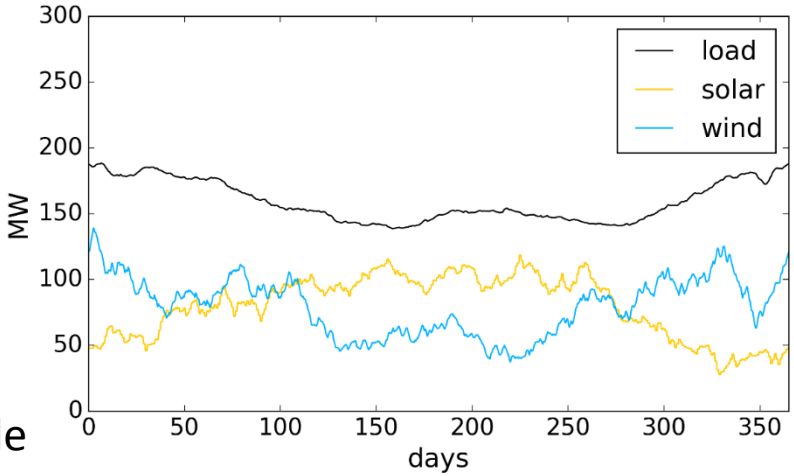
- Analyze electricity generation, demand, and storage on a 30 minute basis for one year

at every moment,
SUPPLY = DEMAND



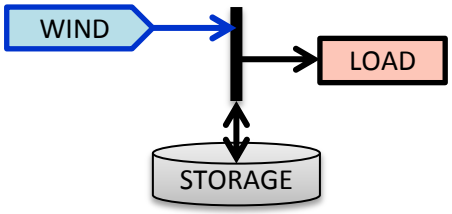
- Try different amounts of wind, solar, and battery storage to meet demand at all times
  - energy storage (in case of no wind/sun)
  - curtailment of excess wind/solar

- Take advantage of seasonal trends →

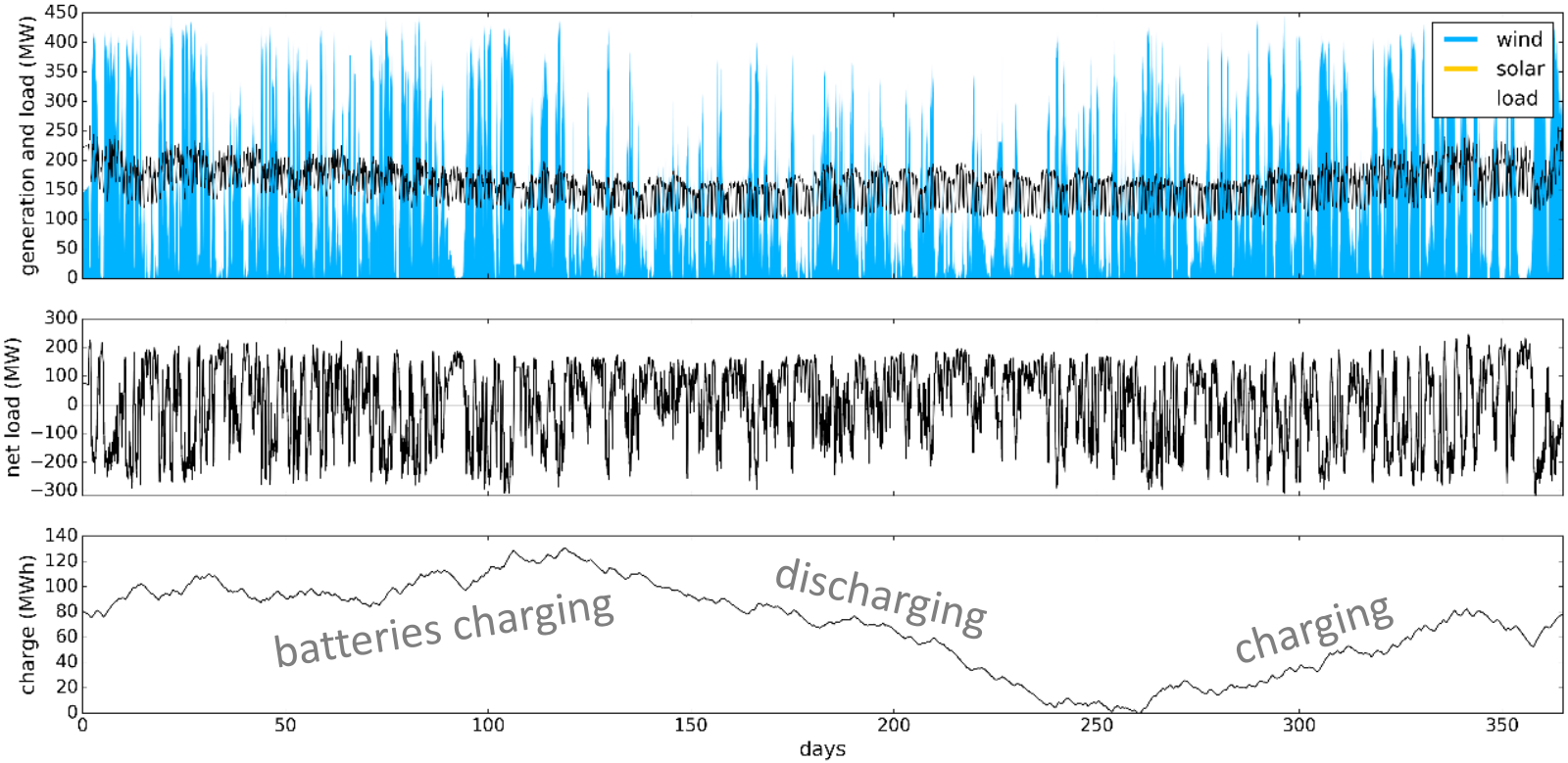


- Estimate costs
  - wind: $2/W plus O&M, 20 year lifetime
  - solar: $2/W plus O&M, 30 year lifetime
  - battery storage: $500/kWh capacity, variable lifetime

Scenario 1: 100% Wind Power

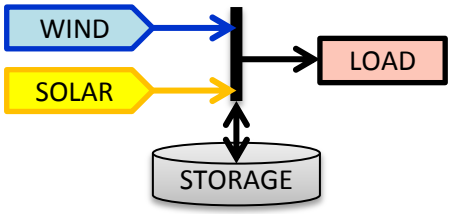


- 450 MW of wind turbines, 132 GWh of energy storage

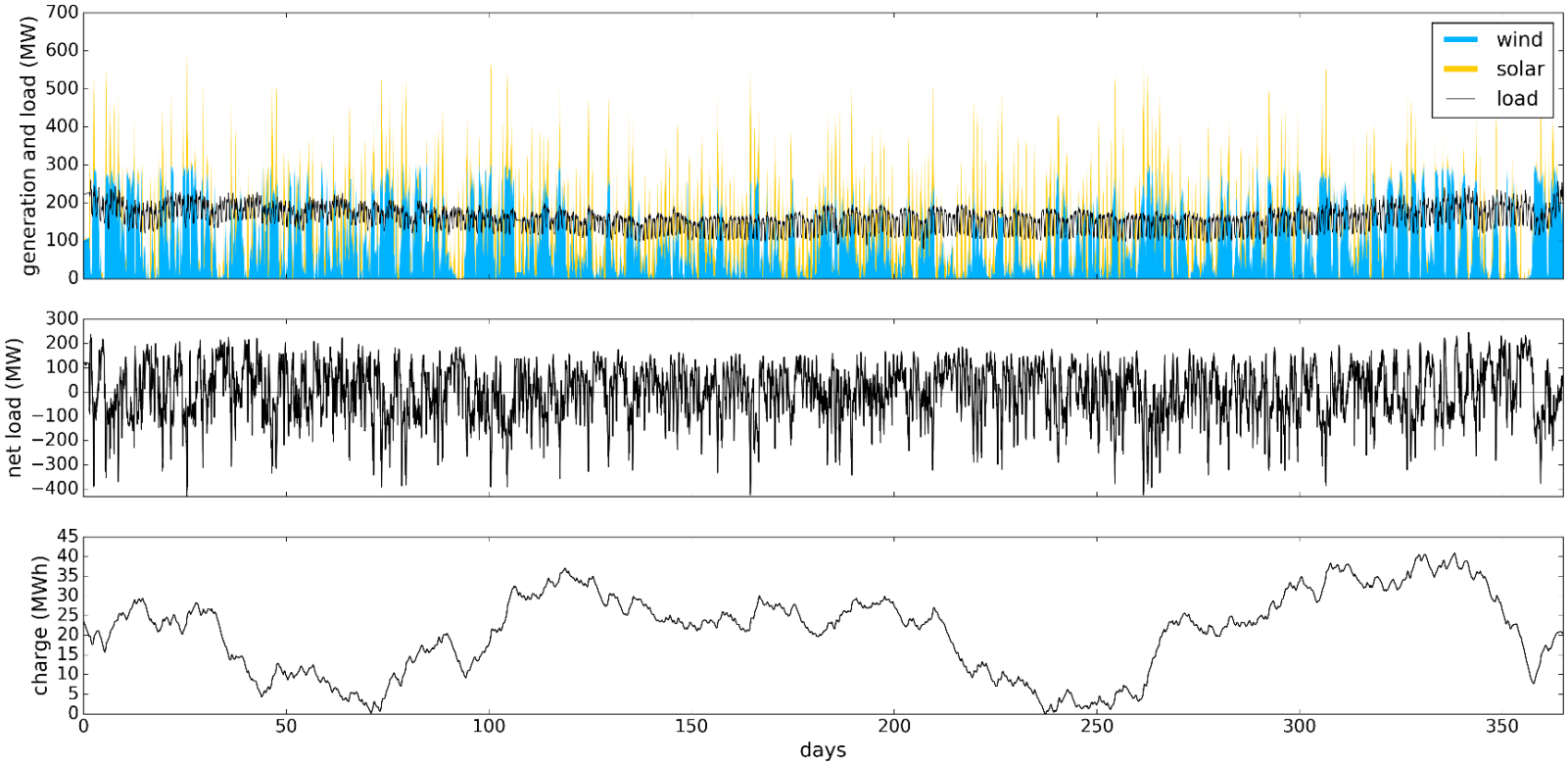


- More wind in winter means a year's worth of storage is required
- Cost of energy: **$2.9/kWh**

Scenario 2: Mix of Wind and Solar

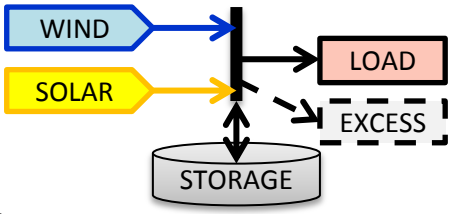


- 313 MW of wind, 350 MW of solar, 41 GWh of storage

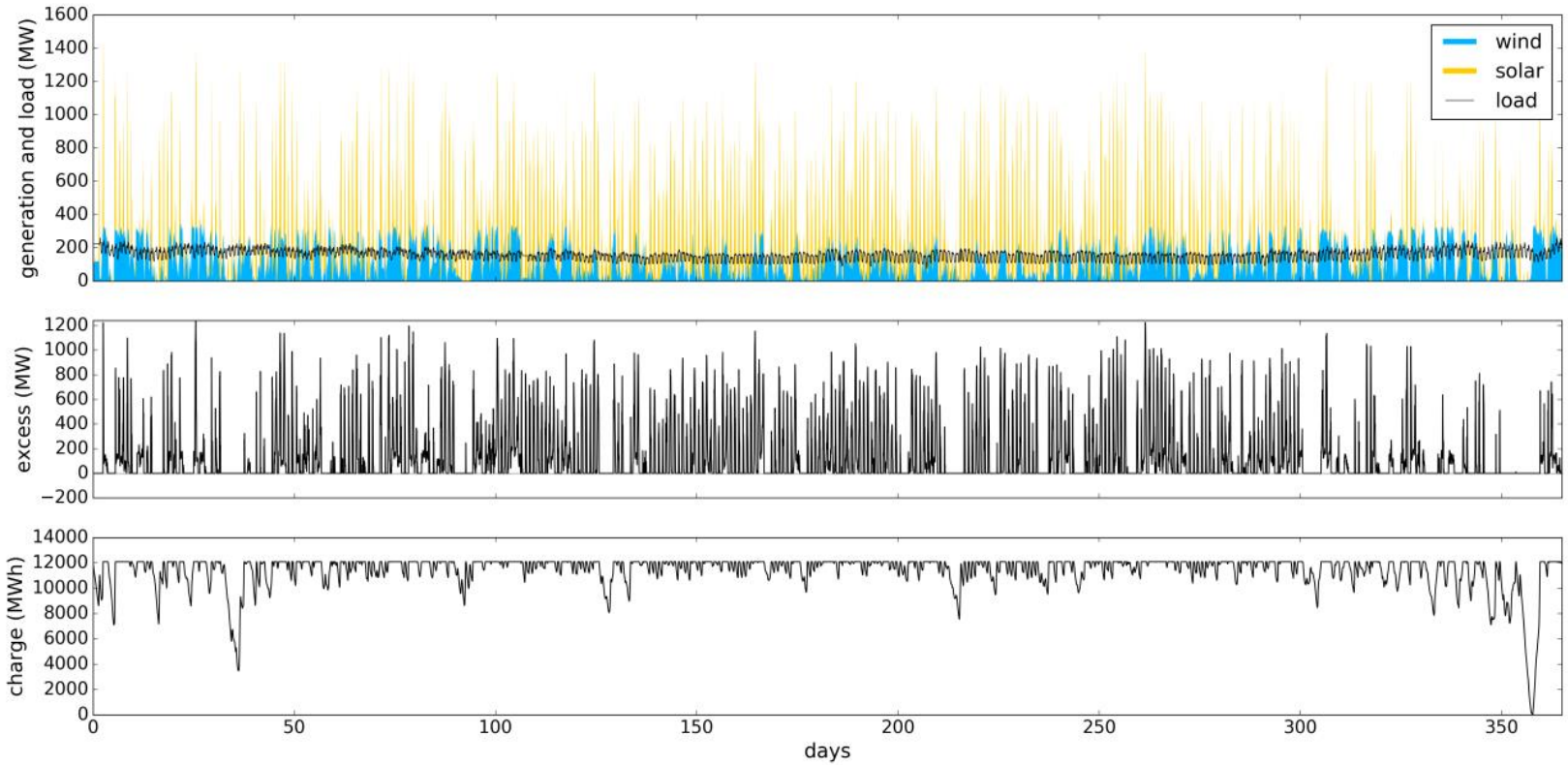


- Storage requirement is reduced from 132 GWh to 41 GWh
- Cost of energy: **$1.0/kWh**

Scenario 3: Curtailment of Excess

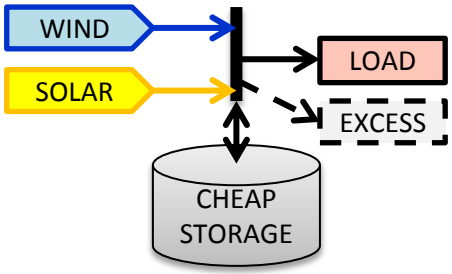


- 351 MW of wind, 1220 MW of solar, 12 GWh of storage

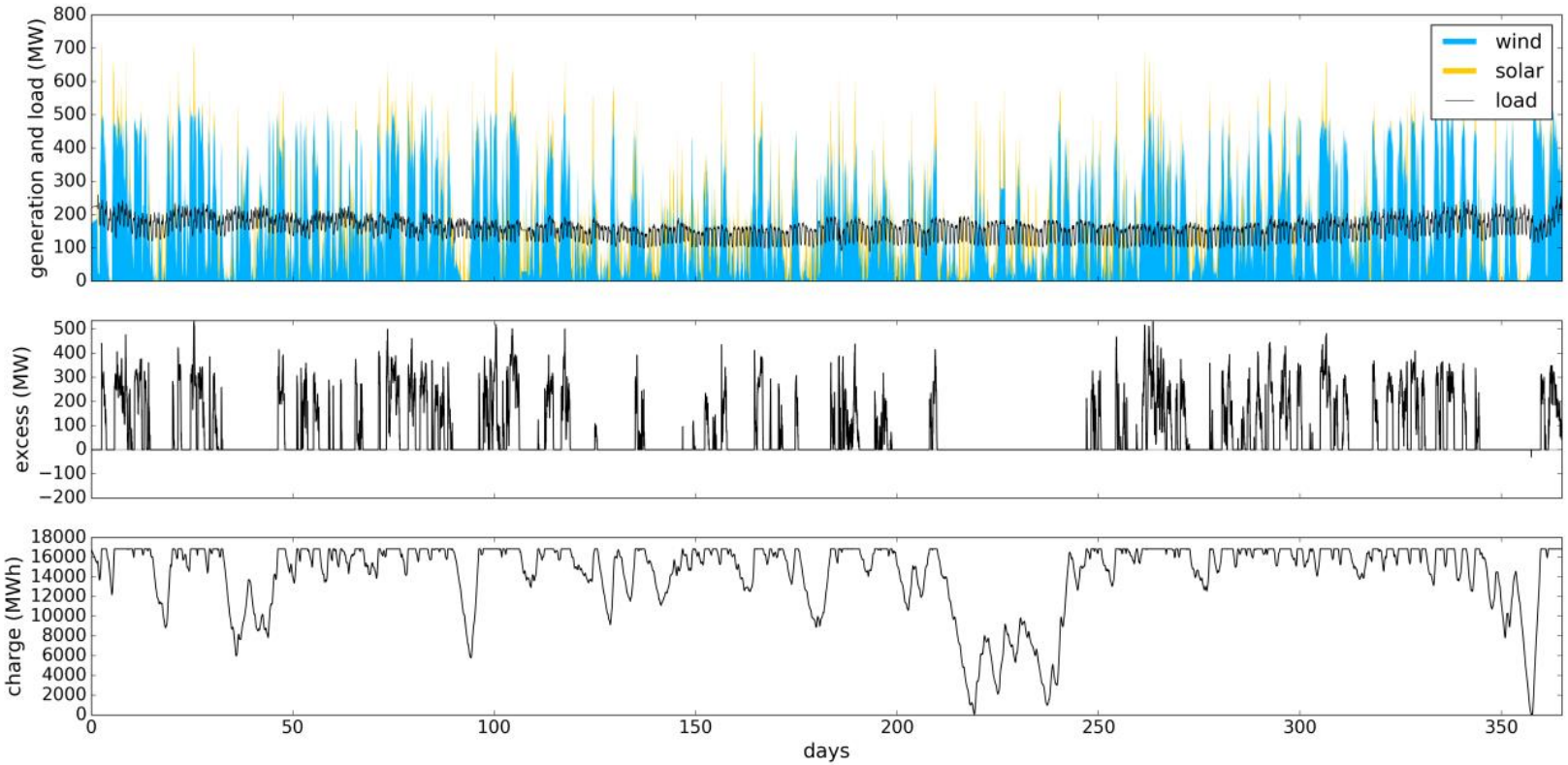


- Oversizing generation reduces storage from 41 GWh to 12 GWh
- Cost of energy: **$0.46/kWh**

Scenario 4: Low Cost Storage



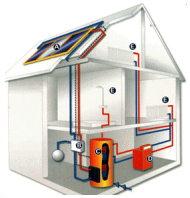
- 537 MW of wind, 246 MW of solar, 17 GWh of storage



- Cheap storage makes costs plausible
- Cost of energy: **$0.15/kWh**

What this tells us

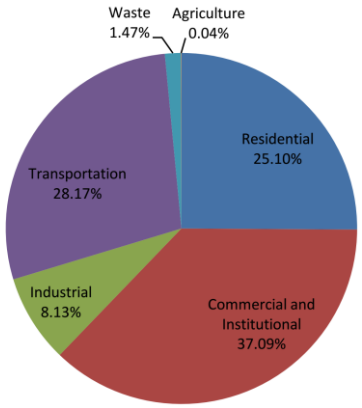
- Moving towards electricity independence and 100% renewable sources…
  - is technically feasible
  - is aided by the addition of solar power
  - is aided by allowing curtailment of excess renewable energy
  - is prohibitively expensive at current battery costs
  - is affordable *if energy storage costs fall dramatically*



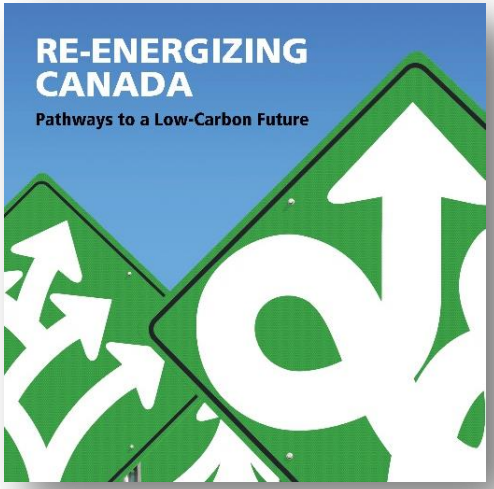
What is the Role of Cities?

- Energy and emissions are about *how people live*
- 25% of PEI's population is in Charlottetown
  1. transportation is over ¼ of emissions
  2. heating is maybe ½ of emissions
  - *both are increasingly being electrified*

Charlottetown Emissions

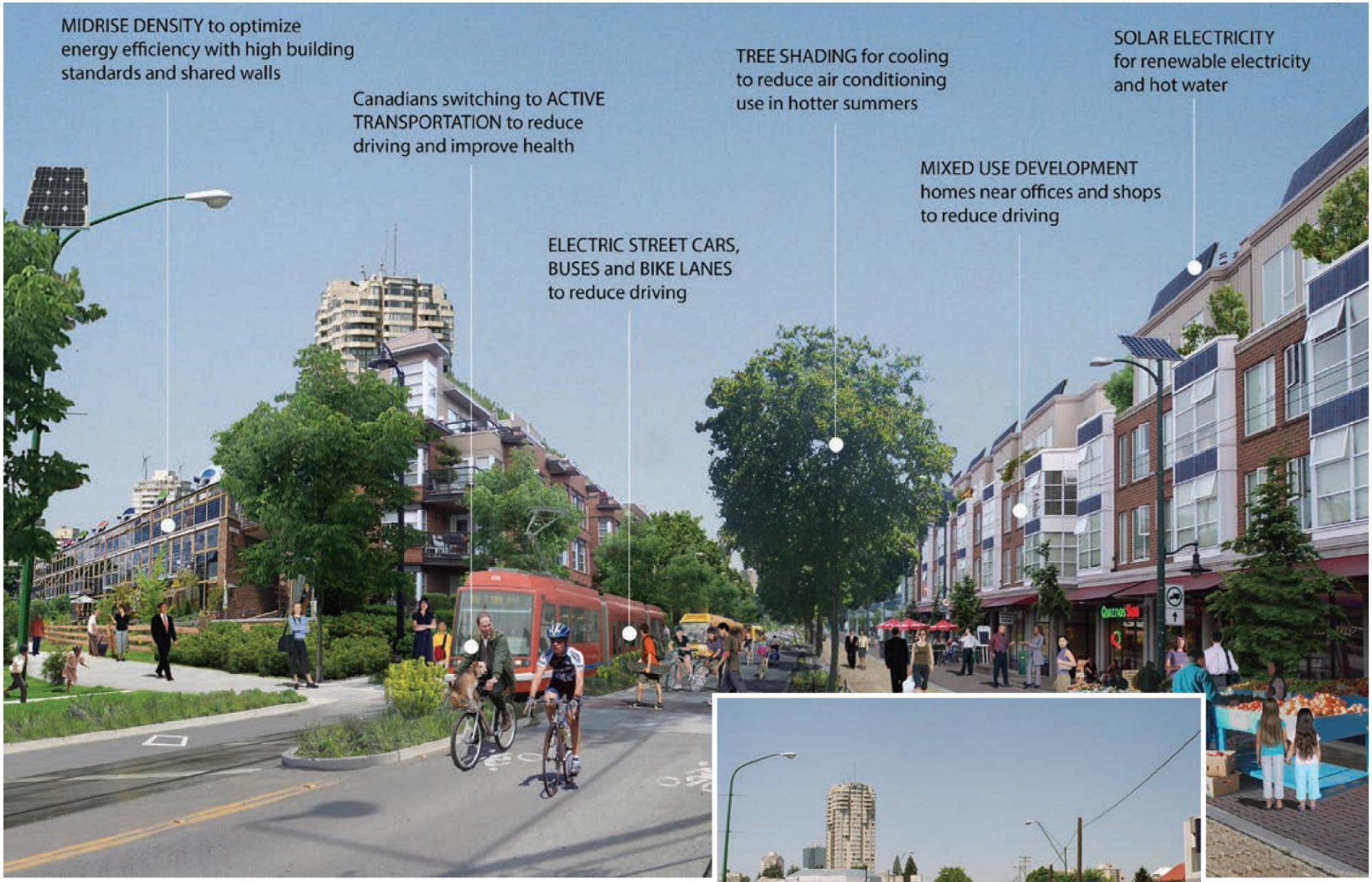


Sustainable Canada Dialogues

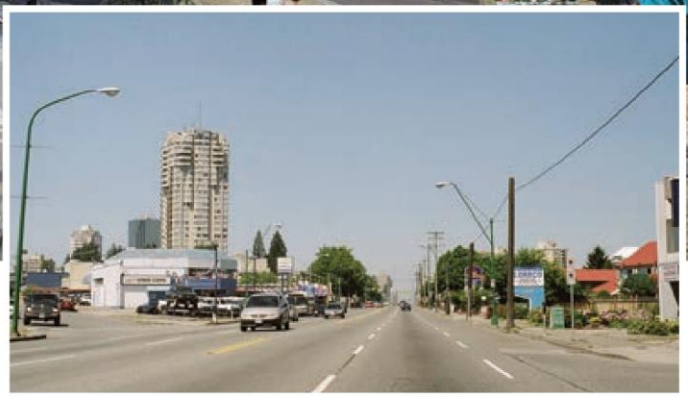


- *Re-Energizing Canada* report from 72 scholars commissioned by Natural Resources Canada
  - first two fields of action:
  1. Re-imagining transportation
  2. Cities as sustainability laboratories

www.sustainablecanadadialogues.ca/en/scd/energy



AFTER



BEFORE

Sustainable Canada Dialogues

Re-Energizing Canada, Sustainable Canada Dialogues, 2017

In a city, energy sustainability comes with *comfort and convenience*

- A greener and smarter grid with renewable energy and demand response programs
  - *know where your energy comes from, be paid to change use*
- Community-scale aggregation of energy producers and consumers
  - *be able to invest in local renewable generation, reduce costs*
- Energy efficiency initiatives (especially for buildings)
  - *more comfort at home and work in the winter*
- Widespread public transport, good bus shelters
- Bike paths/lanes for commuters, bike sharing programs
  - *convenient and safe active transportation options city-wide*
- Electric vehicle and car sharing infrastructure
  - *Be able to own (or hire on short notice) an electric car*

Conclusion

Reduce emissions, save money, improve quality of life

- Energy innovations have many benefits:
  - Connected community energy systems
  - Walking, biking, public transit, car sharing
  - Electric vehicles
  - Heat pumps and better building insulation

Low-cost storage

(demand response)

(battery storage)

(thermal storage)

- In a city, energy sustainability is about reducing emissions, reducing costs, and *improving quality of life*
- PEI is unique; if our energy sustainability actions are smart, we can play a big role in PEI's supply-demand challenge and enable a greener and more self-sufficient island.

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