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Canada

ROOFTOP PHOTOVOLTAIC POTENTIAL IN ATLANTIC CANADA

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OUTLINE

- Context
- Photovoltaic technical potential in the Atlantic provinces
- Economic and market potential
- Next steps and open questions

CONTEXT

SOLAR PHOTOVOLTAIC (PV) APPLICATIONS

Bhadla Solar Plant, India – 2 245 MW
Source: T&D World

Net Zero House, Lincoln, Massachusetts, USA
Source: Fine Homebuilding

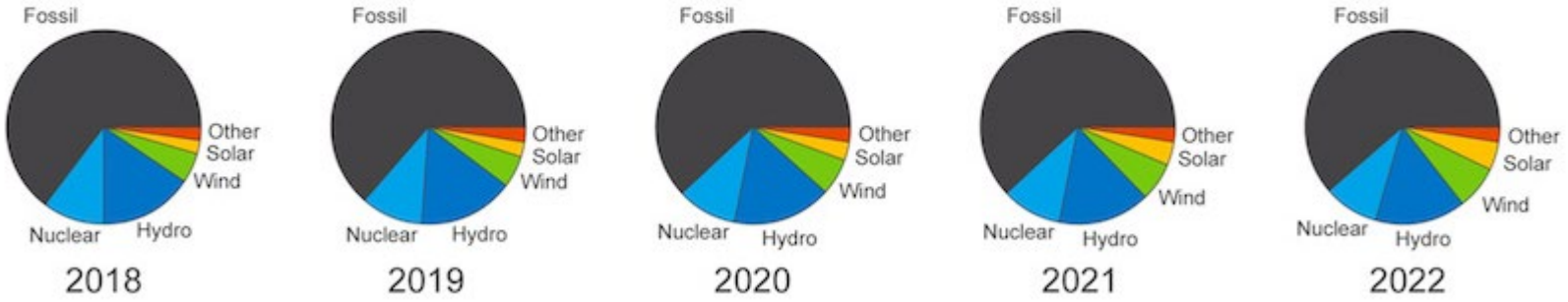
Floating PV, 40 MW, Huainan, China

Agrivoltaic application
Source: Enel Green Power

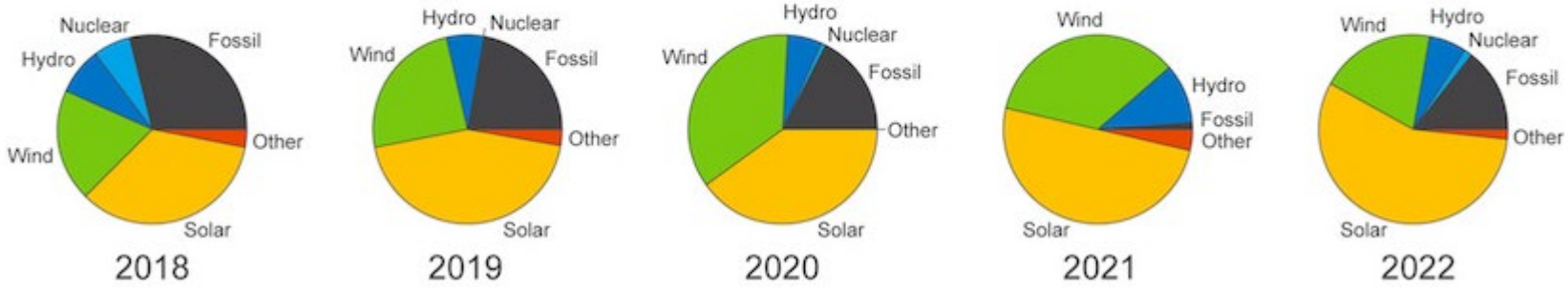
PV-Storage Microgrid, 28 MW, Hawaii
Source: AES Hawai'i

STATUS OF PV WORLDWIDE

Global Electricity Generation

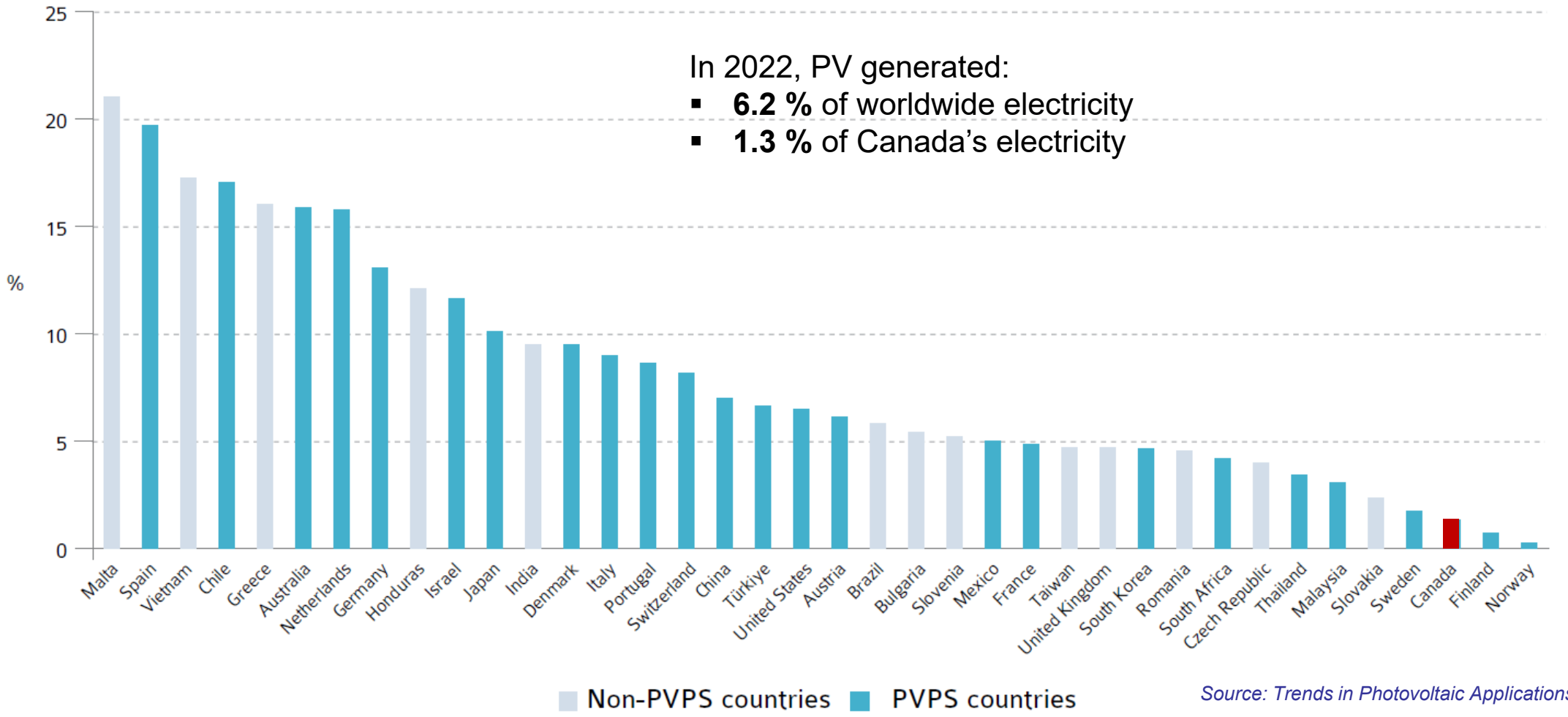


Net Expansions of Global Electricity Capacity



Source: NREL, https://www.nrel.gov/news/program/2023/how-renewable-energy-is-transforming-the-global-electricity-supply.html

GLOBAL SOLAR PV ELECTRICITY PRODUCTION



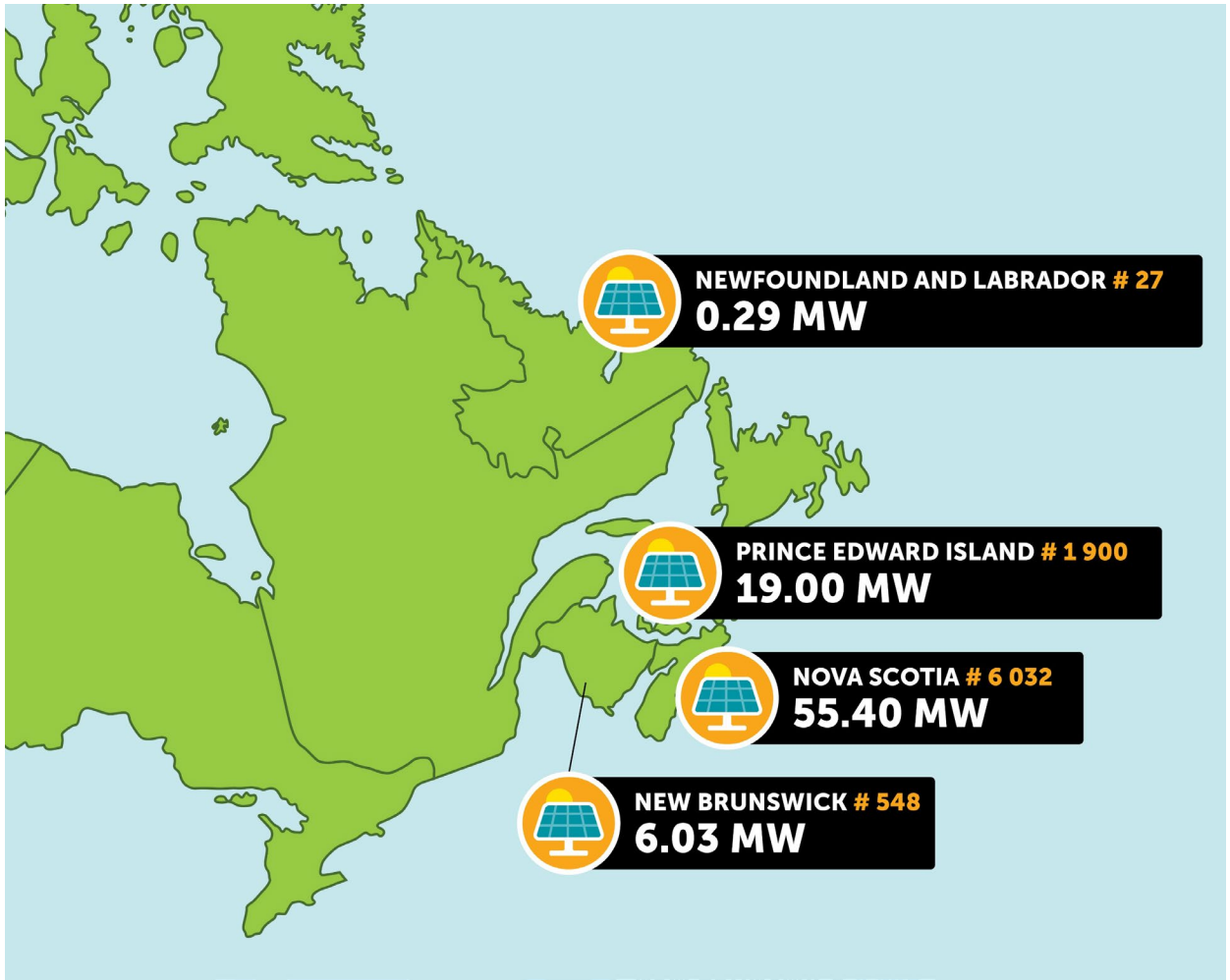
In 2022, PV generated:

- **6.2 %** of worldwide electricity
- **1.3 %** of Canada's electricity

Source: Trends in Photovoltaic Applications 2022 (IEA PVPS)

PV IN THE ATLANTIC PROVINCES

Installed capacity and number of systems per province (December 2022)

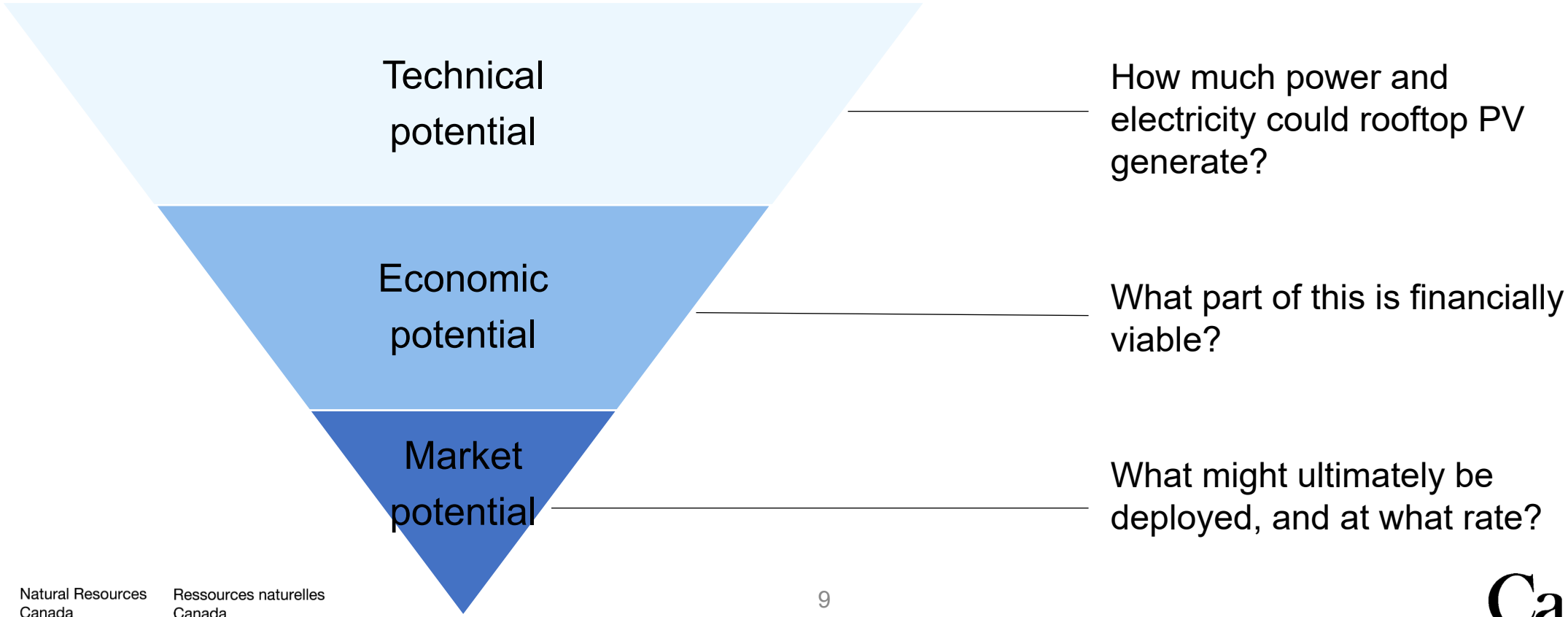


Province	Solar incentives ($/W)	System cost ($/W) and financing options
Newfoundland and Labrador	N/A	3.53 – 4.31 None
Prince Edward Island	1	2.73 – 3.33 Energy loans
Nova Scotia	0.3	2.74 – 3.35 Property Assessed Clean Energy
New Brunswick	0.2	2.65 – 3.24 Energy loan

PV TECHNICAL POTENTIAL IN THE ATLANTIC PROVINCES

ROOFTOP PV POTENTIAL IN THE ATLANTIC PROVINCES KEY QUESTIONS

- Atlantic provinces building stock:
  - ~900,000 residential, commercial and institutional buildings
  - Combined footprint of ~140 km^2 (about the same area as the City of Moncton!)

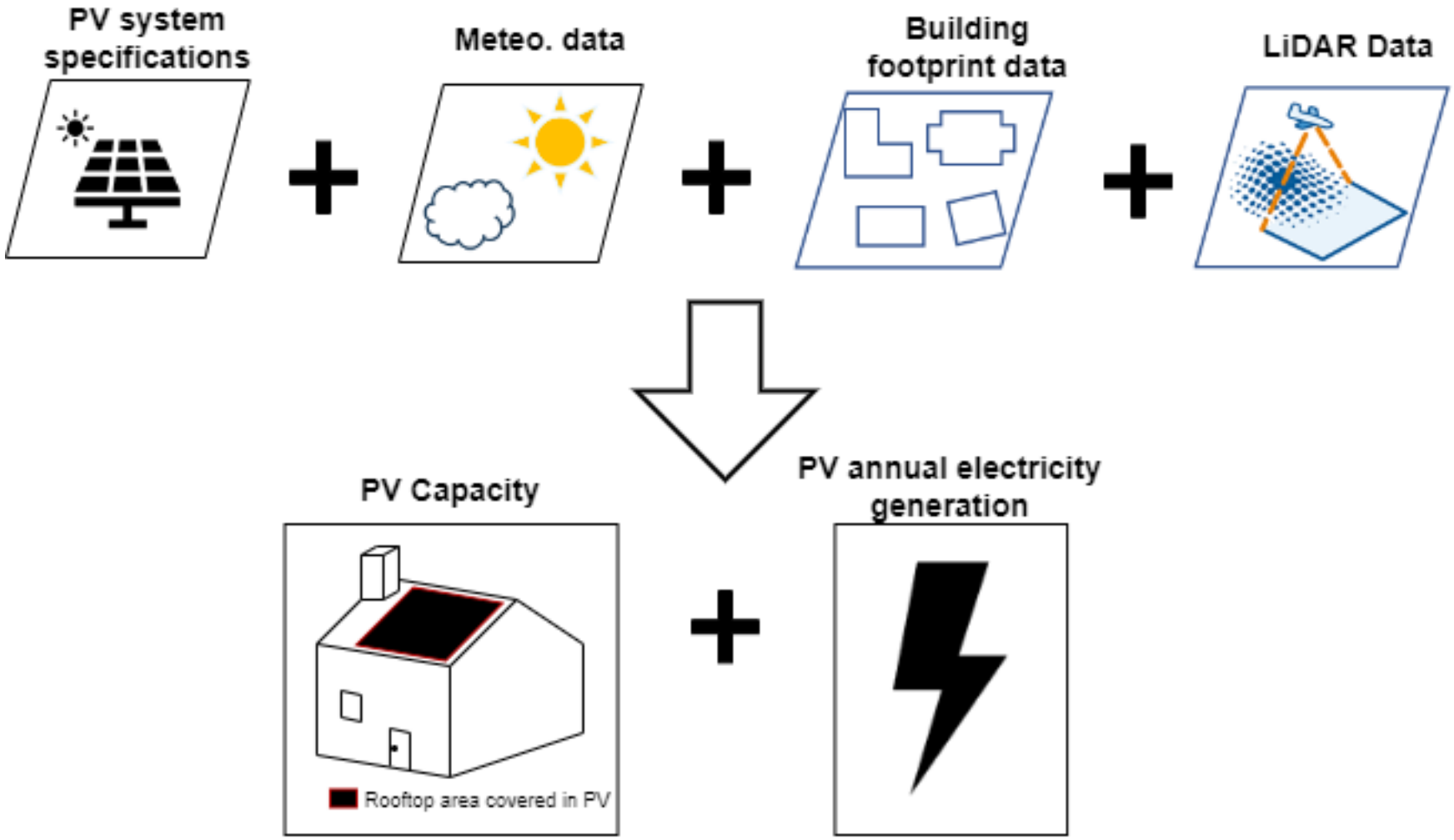


ROOFTOP PV TECHNICAL POTENTIAL: METHODOLOGY

- Step 1: Developed a statistical method based on detailed analysis of 11 municipalities

- Step 2: Used the statistical method to calculate technical potential for each province and territory

STEP 1: PROCESS OVERVIEW

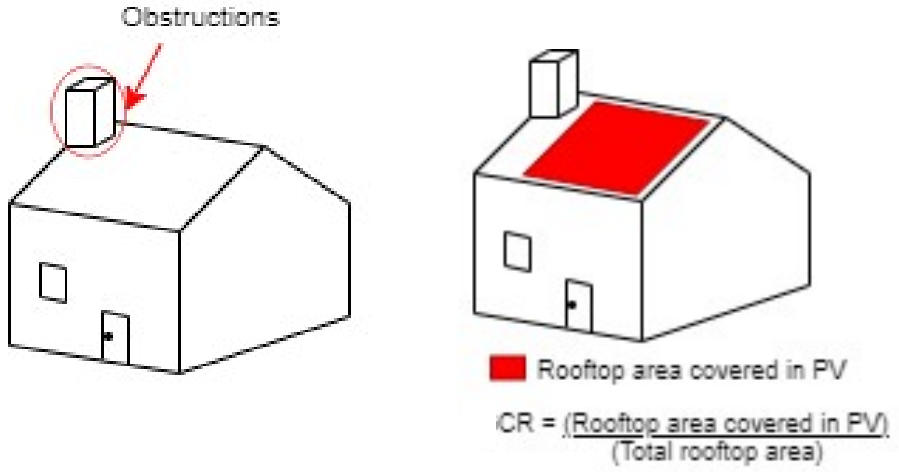


STEP 1: STATISTICAL METHOD

$$P_{rooftops} = A_{ground\ floor} * U_{F2} * \eta_{PV}$$

$$E_{rooftops} = P_{rooftops} * H_{optimal} * PR * Y_r$$

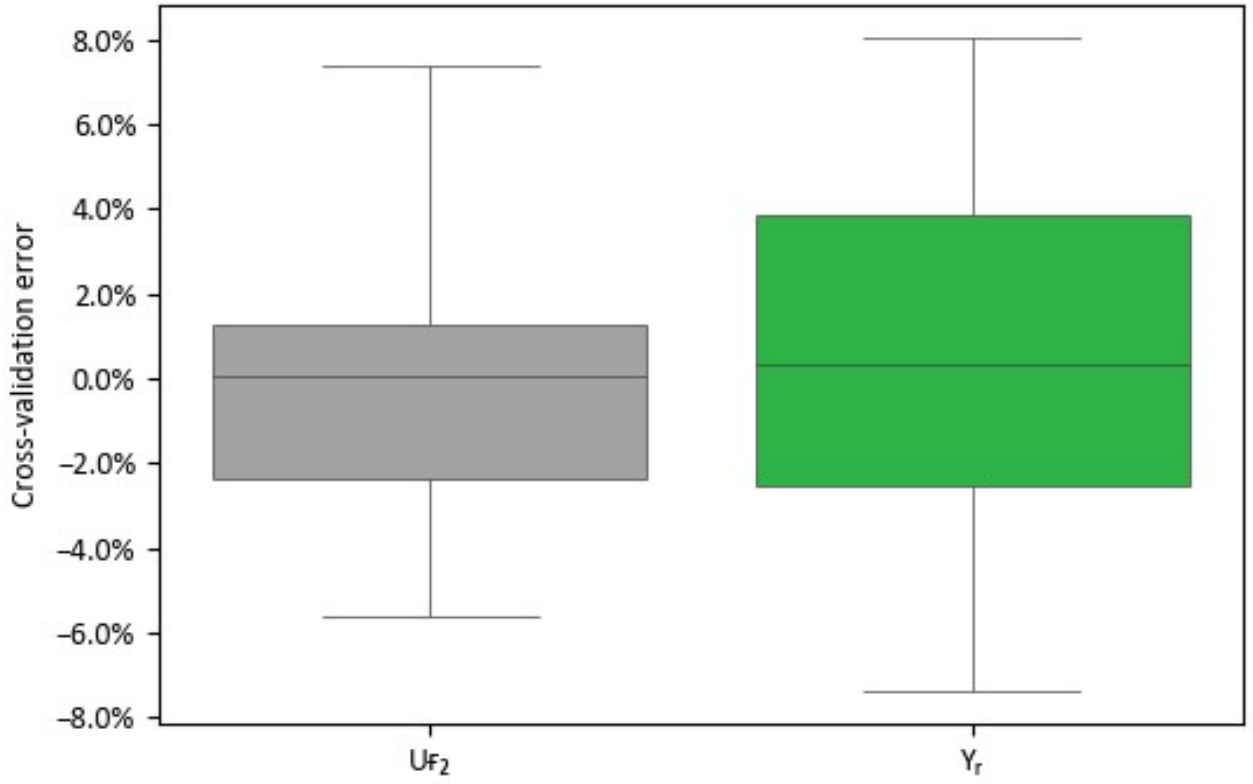
- Two fitted coefficients: U_{F2} and Y_r
- U_{F2} relates to available area:
  - Ground floor to rooftop area conversion
  - Obstructions
  - PV array rooftop coverage (CR)
- Y_r relates to solar resource: impact of shading and rooftop orientation



CROSS-VALIDATION

- Coefficients U_{F2} and Y_r calculated for each municipality and averaged
- Uncertainty of coefficients assessed with cross-validation
  - Averaged coefficients for 10 municipalities
  - Applied calculated coefficients to the remaining municipality
  - Calculated error for each municipality in turn

	Coefficient
U_{F2}	0.81
Y_r	0.70



STEP 2: ESTIMATING ROOFTOP PV POTENTIAL FOR EACH PROVINCE AND TERRITORY

- Estimate the rooftop PV potential across Canada and its provinces and territories using the statistical method

- Input data
  - Building stock data:
    - Comprehensive Energy Use Database (2019)
    - Survey of Commercial and Institutional Energy Use (2019)
    - Survey of Household Energy Use (2019)

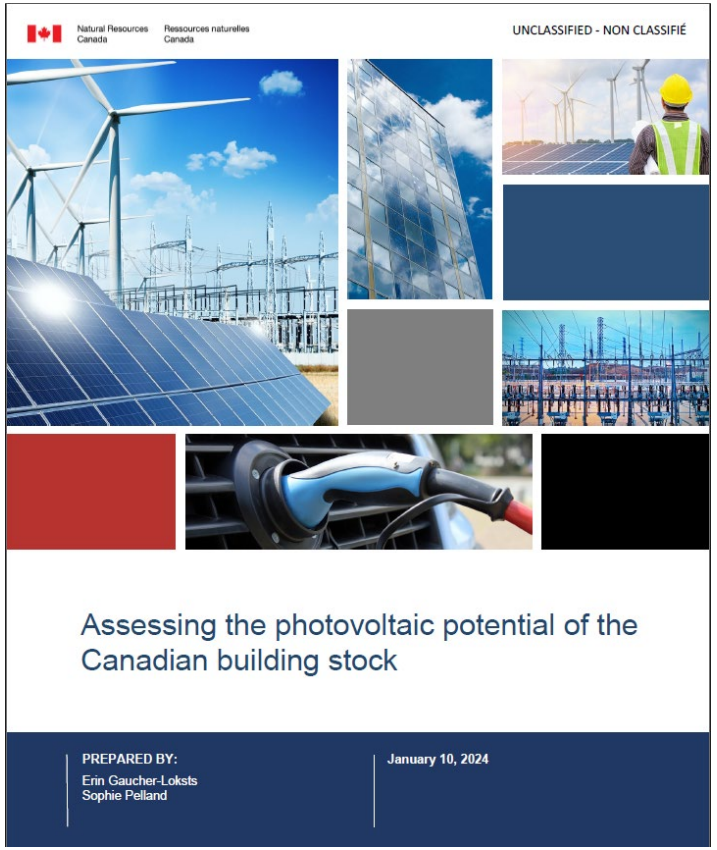
  - Solar resource from NRCan solar and PV potential municipal datasets

- Analysis includes residential, commercial, and institutional buildings

- Estimated standard uncertainty: 25%

RESULTS: ROOFTOP PV TECHNICAL POTENTIAL FOR THE ATLANTIC PROVINCES

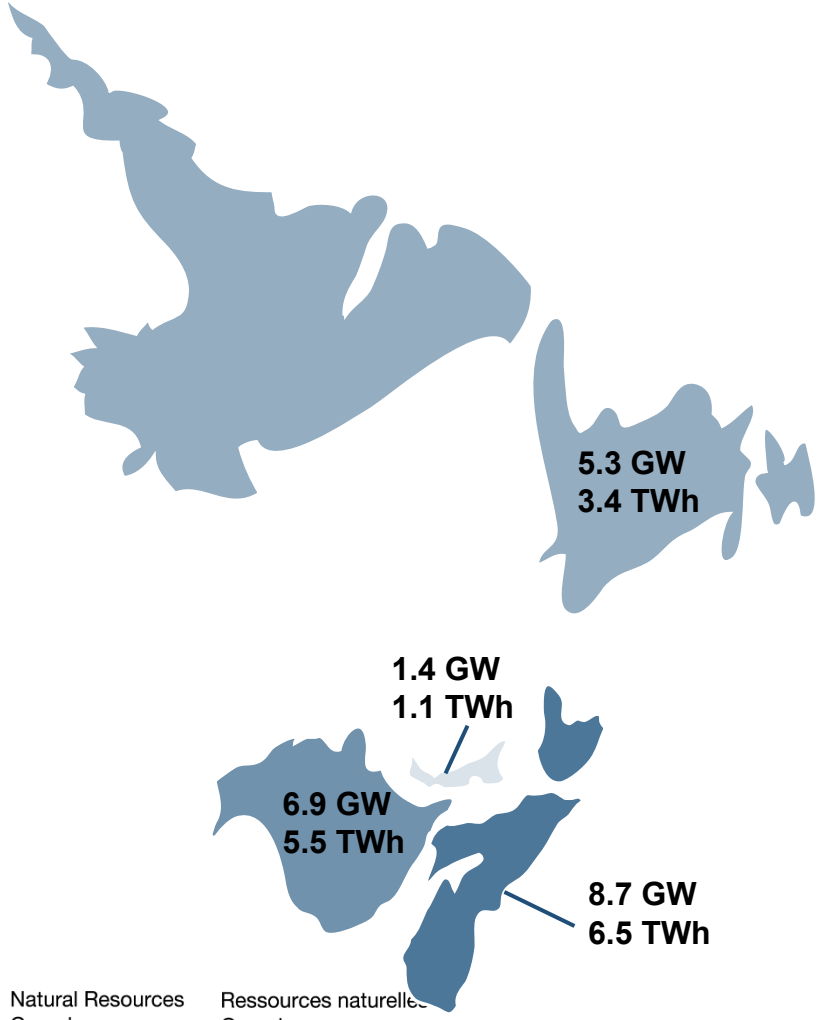
- Rooftop PV potential capacity is **22 GW.** Total generation fleet capacity for the region is 11 GW (CODERS).
- Rooftop PV electricity generation potential is **16.5 TWh per year.** This corresponds to 46 % of total electricity use (36 TWh, CEUD), or 66 % of electricity use in residential, commercial and institutional buildings.
- Electricity generation potential as percent of consumption is greater for residential buildings (110 %) than for commercial and institutional buildings (43 %).



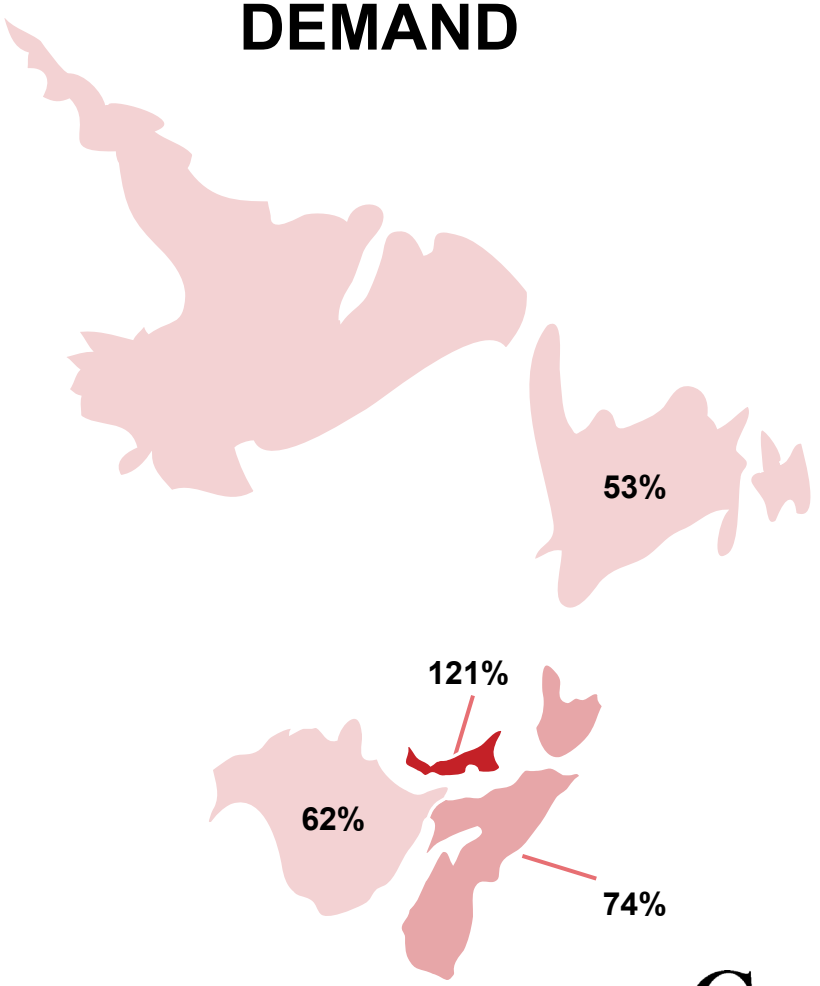
Link to report

RESULTS: ROOFTOP PV TECHNICAL POTENTIAL BREAKDOWN BY PROVINCE

CAPACITY AND ELECTRICITY



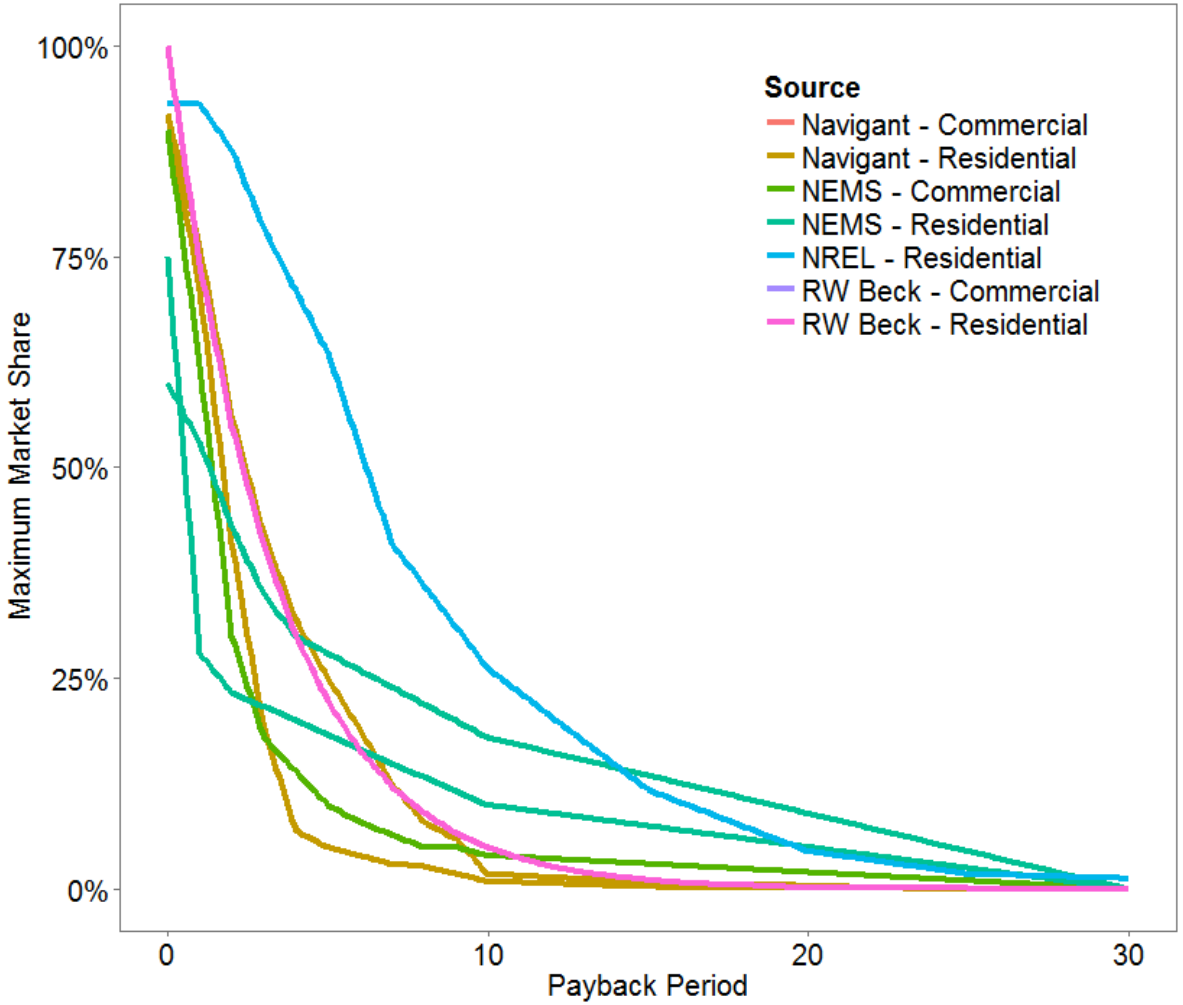
PERCENTAGE OF ANNUAL BUILDING DEMAND



ECONOMIC AND MARKET POTENTIAL

ECONOMIC POTENTIAL: WHAT PART OF THIS IS FINANCIALLY VIABLE?

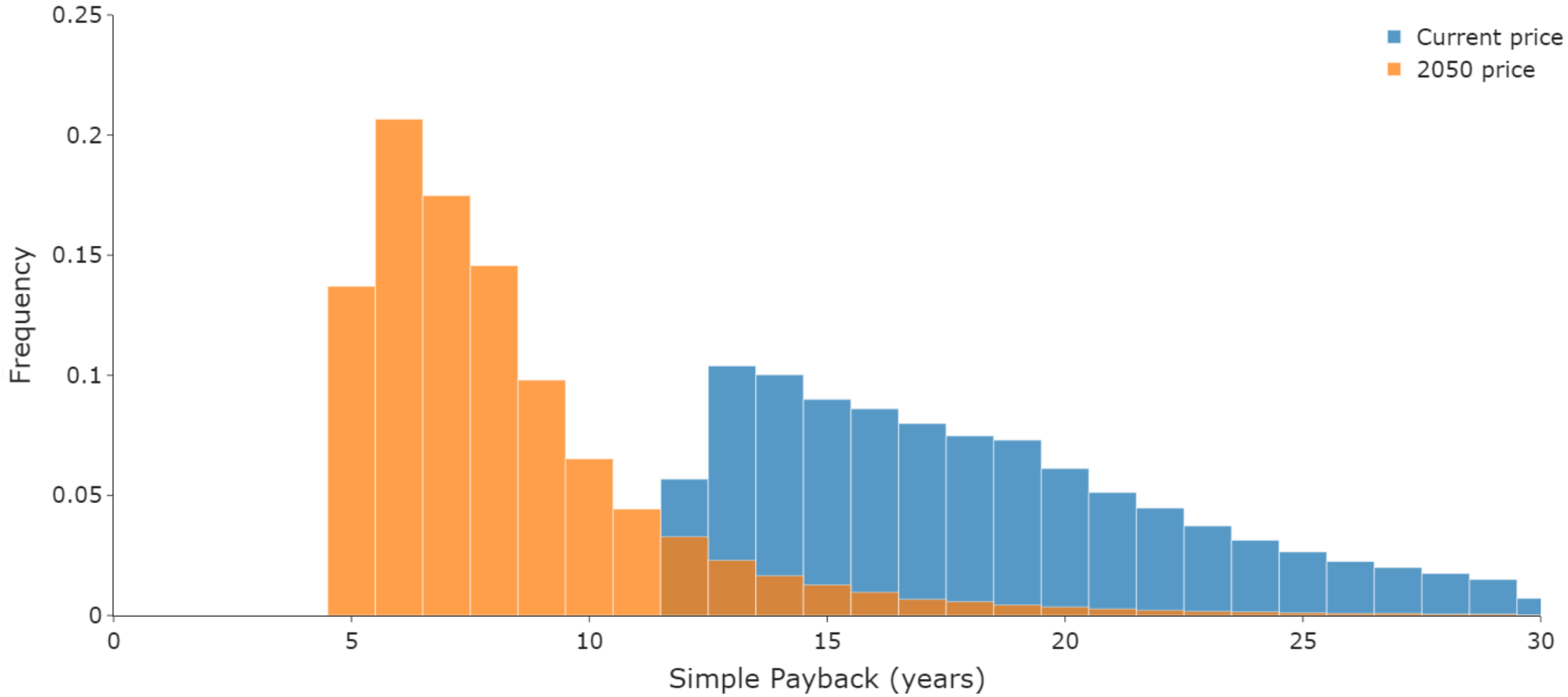
**Subsidies were ignored; NREL ATB moderate cost decline ratios; PV systems with good orientation and low shading; CER annual electricity prices GNZ scenario*



Source: B. Sigrin et al., 2016,The Distributed Generation Market Demand Model (dGen): Documentation

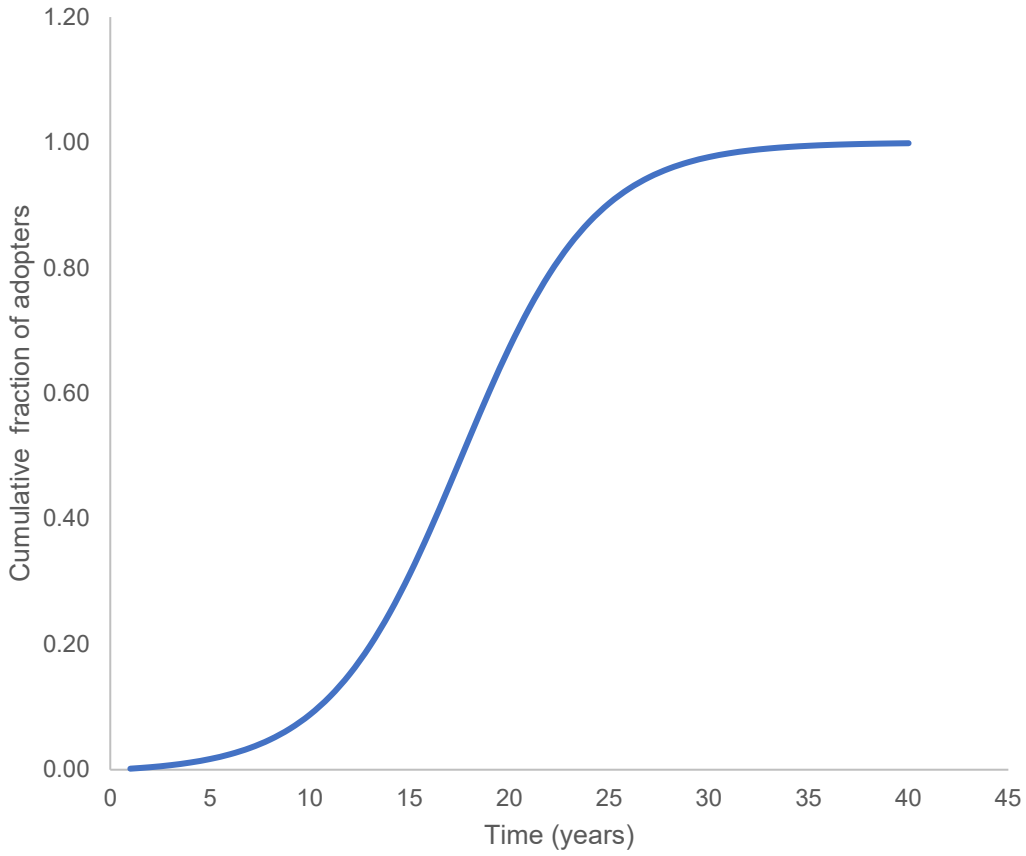
ECONOMIC POTENTIAL: HOW DOES IT VARY ACROSS ROOFTOPS?

Distribution of simple payback for Moncton, now and in 2050



MARKET POTENTIAL: WHAT ARE POSSIBLE DEPLOYMENT SCENARIOS?

- Deployment will be affected by multiple, evolving factors:
  - PV costs
  - Electricity costs
  - Subsidies (if any)
  - Financing schemes
  - Regulatory requirements
  - Electricity grid hosting capacity
  - Growth in building stock
  - Building owner preference



- Currently studying deployment scenarios using the Bass diffusion model

NEXT STEPS AND OPEN QUESTIONS

NEXT STEPS AND OPEN QUESTIONS

- Next steps:
  - Find reasonable parameter ranges for the Bass diffusion model
  - Select scenarios for building stock growth, PV and electricity cost evolution
  - Generate deployment scenarios for each province/territory, based on 11 municipal test cases

- Open questions:
  - How will grid integration considerations and advances in power conversion equipment (e.g. inverters) influence rooftop PV deployment?
  - How will the policy and regulatory environments evolve?
  - How should electricity system planning/operation models account for distributed resources like rooftop PV, demand side management, and storage?

ANY QUESTIONS OR COMMENTS?

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