



CLIMATE CHANGE SCENARIOS

Yuill Herbert and Professor Ann Dale

October 20th, 2015
(Updated May 30th, 2019)

CLIMATE CHANGE SCENARIOS

Rotmans (1998, p. 158) defines scenarios as “archetypal descriptions of alternative images of the future, created from mental maps or models that reflect different perspectives on past, present and future developments”.

Berkhout et al., (2001, p. 11) describes four assumptions in scenario development:

1. The future cannot be described as a persistence of past trends. It can be shaped by human choice and action.
2. The future cannot be foreseen, but exploring the future can inform the decisions of the present.
3. There is not only one possible future. Uncertainty and ignorance calls for a diverse set of futures (scenarios) mapping a ‘possibility space’.
4. Developing scenarios involves both rational analysis and subjective judgement”.

The following three scenarios consider the implications of contrasting approaches by Canadians to address climate change. The scenarios are guided by characterisations— incremental, reformative and transformative — that emerged from the Meeting the Climate Change Challenge (MC3) research project (Dale et al., forthcoming).

The first step in developing the scenarios involved a comprehensive literature review of journal articles and grey literature on climate scenarios within the fields of climatology, economics, politics and technology. While the focus was on Canada, literature relating to other jurisdictions was also considered. Approximately fifty relevant papers and reports were identified and reviewed in detail (For a partial list, see the bibliography below). Scenarios were then developed compiling the themes or insights from these papers. Of particular influence was Shell’s scenario project, an initiative which has continued for more than forty years and considers a breadth of social, political and economic dimensions, well beyond what one would expect from an oil company. Shell’s approach helped identify which elements were important to consider, for example inspiring the inclusion of categories on ideologies and globalisation (Jacobson et al., 2015).

SCENARIO 1 INCREMENTAL CHANGE	SCENARIO 2 REFORMATIVE CHANGE	SCENARIO 3 TRANSFORMATIVE CHANGE
<i>Increased energy efficiency</i>	<i>Low carbon to carbon neutral economy</i>	<i>Carbon restorative economy</i>

Figure: The three climate scenarios and the associated estimates of global temperature change.

		2050 SCENARIOS		
Scenario components v		SCENARIO 1 INCREMENTAL CHANGE <i>Increased energy efficiency</i>	SCENARIO 2 REFORMATIVE CHANGE <i>Low carbon to carbon neutral economy</i>	SCENARIO 3 TRANSFORMATIVE CHANGE <i>Carbon restorative economy</i>
ROLE OF GOVERNMENTS	Legislation	Minimal new legislation.	Mix of mandatory legislative targets and voluntary programs. Elimination of all oil and gas subsidies.	Mandated targets and timelines for carbon neutrality in all public sector buildings, and private sector by 2030. Immediate moratorium and phased out fossil fuels.
	Regulation	Status quo. Emissions reductions targets are maintained through energy efficiencies or increased. New projects continue to be approved and regulations continue to incentivize fossil fuel development while the regulatory regime is enhanced to account for environmental impacts including impact on fossil fuel use on overall emissions.	Mandatory energy and GHG intensity regulations for buildings, vehicles and appliances. Distributed renewable energy systems and district renewable energy systems (decentralization). Policy of increasing carbon tax is enforced and new projects become unviable as a result. Divestment strategies are in place for 'stranded assets' in the longer term.	Regulatory regime supporting 100% decarbonisation. Mandatory zero waste policies.
	Role of Markets	Continuing liberalisation of markets. Incentives for renewable energy and other mature low carbon technologies. Businesses treat climate as a risk to be managed rather than refocusing their activities.	Little or minimal intervention. Financial incentives for innovation, accelerated research and development. Markets which contribute to reducing emissions are considered 'hot', like the technology sector in early 2000s.	Decentralized locally based energy systems. ² Incentives targeted to community-owned enterprises (co-operatives and municipal corporations).
	Leadership	Maintaining positions of traditional institutional arrangements, power relations and vested interests.	Major governmental reform but still within the existing governmental landscape.	Multi-level governance, shared decision-making, networked government, inverted pyramid of power.
	Taxes	Tax priorities may be adjusted at the margins to account for climate change mitigation and adaptation.	Rapidly increasing carbon tax offsets by reduced income tax rates.	Progressive tax shifting to tax emissions and pollution and reward employment and innovation. Potential carbon household rationing. ³

		INCREMENTAL CHANGE	REFORMATIVE CHANGE	TRANSFORMATIVE CHANGE
ROLE OF GOVERNMENTS	Investments	Ongoing investments in roads and buildings in separate silos and stovepipes, minimal integration between transportation and land-use policies.	Minimal government leadership- private sector drives the transition. Investments in infrastructure also support adaptation to a changing climate.	Major investments in low carbon infrastructure, renewable energy and energy efficiency, particularly focused on transitioning workers from fossil-fuel based economy. ⁴
	Foreign policy	Resource- and climate-based conflicts increase. Migration increases as people are displaced, resulting in increased security and military response. Passively participation in UN negotiations. Under-resourced efforts to address the global effects of climate change are undertaken. Resource-and climate-based conflicts increase. Migration increases as people are displaced, resulting in increased security and military responses. ⁵	Policy priority is to pursue a UN agreement that limits warming to 2 degrees. Proactive international policies are developed to address the geopolitical impacts of climate change. Canada regains international influence. ⁶	Actively pursue a UN agreement while providing funding to Southern countries to adapt and mitigate. Canada regains international influence.
ECONOMY	Household income	Increasing climate shocks cause regional economic impacts on household incomes, increasing economic stress. Major sectors of the economy collapse as fossil fuels are phased out globally at a rapid pace, as stranded investments are forfeited. A boom and bust cycle results in regional disparity and insecurity. Middle class declines. ⁷	Households involved in the fossil fuel industry experience a declining income. Different regions experience ups and downs as a result of climate impacts on specific sectors. ⁸ The need for short term profits amongst publically-traded companies limits the rate of investment in infrastructure required to adapt to climate change. Divestment transition strategies accelerate.	Household incomes decline marginally and stabilise as climate shocks are offset by government investments in a renewable energy-based economy and adaptation and carbon neutral economy. Regions that are less dependent on fossil fuels support the transition of regions that have a more significant reliance on fossil fuels.
	Debt	Household debt is a significant risk as households continue to accumulate debt with the assumption of continuing income growth, increasing the vulnerability to shocks. High risk investments in fossil fuel industries continue, creating an increasing stock of stranded assets. Investments are forfeited when fossil fuel industries are shuttered.	Government establishes safeguards to protect debt against climate shocks. Debt financing mechanisms for low carbon investments by the private sector are incentivised.	Initial investments in transition increase debt load by all actors in society. ⁹

		INCREMENTAL CHANGE	REFORMATIVE CHANGE	TRANSFORMATIVE CHANGE
ECONOMY	Employment	Employment is stable in the short term but declines in the oil and gas sector as global markets and policies shift away from fossil fuels.	New opportunities emerge in renewable energy and other sectors and employment in fossil fuel industries declines. ¹⁰ Regional job losses occur.	There is an employment strategy on retraining or transitioning workers and a managed decline of employment in fossil fuel-based industries.
	Inequality ¹¹	Increasing stratification and wealth concentration. Those with little access to resources suffer the most.	Increasing stratification and wealth concentration.	Inequality declines as government interventions focus on evening out regional differences and transitioning towards a steady state economy. International legal mechanisms compensate for damage to the poorest populations caused by climate change. ¹²
	Prosperity/ Quality of life	Work-life balance continues to decline. Work insecurity increases due to climate shocks. Major social and political disruptions but focus on economic growth is maintained.	Market-based insurance mechanisms are developed (i.e. flood insurance), with unequal accessibility. Focus on economic growth is maintained.	Shift from a growth-based economy to a steady state economy ¹³ with minimal social disruption. ¹⁴
	Finance	Climate risk is a niche consideration. Transition costs escalate rapidly ¹⁵ . There is growth in finance mechanisms and investments in the low or zero carbon economy and an increase in requirements for disclosure of climate risk. ¹⁶	The divestment movement grows rapidly and stigmatises the fossil fuel industry ¹⁷ . New market-based mechanisms to finance low or zero carbon investments emerge. Incentives for corporations and investors to deploy accumulated capital are implemented. Transition costs are minimised.	New state-owned finance mechanisms are established such as green banks. Regulations drive accelerated divestment of fossil fuel-based industries. Transition costs are minimised.
ENERGY TECHNOLOGY	Innovation ¹⁸	Limited innovation in clean technology. Private sector driven innovation.	Private sector innovation with major public incentive frameworks. Stringent intellectual property rights regime.	Open innovation.
	Implementa- tion	Individuals, small companies and innovative municipalities and progressive large companies (niche players) introduce further renewable energy efficiencies.	Key strategic focus for the majority of large multi-national corporations. ¹⁹	Incentives and programs targeted to support community-driven utilities, co-operatives and crown corporations. ²⁰

		INCREMENTAL CHANGE	REFORMATIVE CHANGE	TRANSFORMATIVE CHANGE
ENERGY TECH.	Transport	Ongoing improvement in efficiency of gasoline-powered vehicles, electric vehicles and hybrids. Infrastructure remains status quo.	Major shift toward electric and hydrogen vehicles and sustainable fleets. ²¹ Large urban centres move increasingly towards more sustainable infrastructure.	Shift away from private vehicle ownership to collective sharing fleets. ²² Increase in walking and cycling and major investments in public transit. Full integration of land-use and transportation policies, especially in large urban centres.
	Electricity	Renewable electricity generation increases in fits and starts. Incremental increase in share of renewables in electricity generation.	Large corporate players produce and distribute electricity driven by a majority of renewables. Governments incentivize diversification and decentralization of energy grids and development of national energy security legislation.	Decarbonisation of the electricity grid. ²³ Distributed generation.
ENVIRONMENT	Land-use ²⁴	Development continues in greenfield sites, with a sprawling pattern. Agricultural land is degraded.	Financial incentives favour the development of compact, more dense, mixed-use communities. Increasing prices for food result in agricultural land having an increasing value and conservation.	Financial incentives combined with regulations focus new development on urban centres. Agricultural land is preserved.
	Local pollution	Localised pollution increases as hydraulic fracturing expands. Regulations manage the exposure to air pollution.	Air pollution declines as renewables increase and gasoline-powered vehicles decrease.	Air pollution declines due to renewables and decreased vehicle use.
	Climate/ biodiversity	Continued resource exploitation model of development. A modified resource exploitation model within a precautionary regulatory framework.	Biodiversity strategies are strengthened and market mechanisms use to stimulate habitat protection. Major redevelopment of brownfield sites. A value is assigned to ecosystem services. ²⁵	Proactive legislation and regulatory regimes are in place for habitat protection, protected areas, green spaces, park systems and ecosystem regeneration both in rural and urban areas.
	Adaptation	Society reacts to extreme weather events and climate impacts crisis by crisis. Voluntary mechanisms to advance adaptation are implemented.	Market-based incentives for adaptation are developed ²⁶ and some government leadership.	Society proactively prepares infrastructure and institutions for climate impacts by regulation. Risk management and disaster planning is integrated into planning and sustainability departments.
	HEALTH	Major setbacks in global development gains including spread of disease vectors, food insecurity and under-nutrition, displacement, and mental ill health. ²⁷	Major population health challenges due to extreme weather events, food insecurity and continuing mal-distribution of food stocks.	Overall increases in population health; more active transportation resulting in rapidly reduced obesity morbidity; healthier lifestyles.

	INCREMENTAL CHANGE	REFORMATIVE CHANGE	TRANSFORMATIVE CHANGE
GLOBALIZATION	Global trade; turbulent from climate shocks. Global trade; increasing exogenous shocks from climate change, refugee migrations, escalating, regional conflicts and resource scarcities. ²⁸	Enhanced global trade with investor protections; turbulent from climate shocks.	Locally-diverse economic development complemented by balanced global trade.
IDEOLOGIES ²⁹	Short term gain; continuing dominance of the current capitalist system, ideologically based political partisanship, continuing emphasis on the individual at the expense of the collective.	Government leaders and policies no longer trade-off the collective against the individual, increasing ethical leadership.	Evidence-based decision and policy-making, open policy development, participatory and inclusive.

ENDNOTES

- 1 <http://web.stanford.edu/group/efmh/jacobson/Articles/I/USStatesWWS.pdf>
- 2 The World Bank undertook a major study on the impacts of a 4 degree world: <http://www.worldbank.org/en/topic/climatechange/publication/turn-down-the-heat-climate-extremes-regional-impacts-resilience>
- 3 For a discussion on the role of cooperatives in Scandinavian energy systems see: <http://www.diva-portal.org/smash/get/diva2:820202/FULLTEXT01.pdf>
- 4 For a discussion on personal carbon trading, see <https://www.dovepress.com/personal-carbon-trading-a-review-of-research-evidence-and-real-world-e-peer-reviewed-article-EECT>, http://www.gci.org.uk/Documents/fawcett_2010.pdf and [http://www.geos.ed.ac.uk/~sallen/rachel/Climate%20Policy%20Special%20Issue/Lockwood%20\(2011http://www.unep.org/greeneconomy/0\).%20The%20economics%20of%20personal%20carbon%20trading.pdf](http://www.geos.ed.ac.uk/~sallen/rachel/Climate%20Policy%20Special%20Issue/Lockwood%20(2011http://www.unep.org/greeneconomy/0).%20The%20economics%20of%20personal%20carbon%20trading.pdf)
- 5 See UNEP's work on the green economy:
- 6 See the Pentagon's report on the impacts of climate change: <http://archive.defense.gov/pubs/150724-congressional-report-on-national-implications-of-climate-change.pdf?source=govdelivery>
- 7 See the Climate Action Tracker for scenarios on the current trajectory of GHG emissions reductions: <http://climateactiontracker.org/>
- 8 Climate change is already costing the world more than \$1.2 trillion, wiping 1.6% annually from global GDP: <http://daraint.org/cvm2>
- 9 For a discussion on the uneven impacts of climate change on the economy in the US see: <http://cier.umd.edu/documents/US%20Economic%20Impacts%20of%20Climate%20Change%20and%20the%20Costs%20of%20Inaction.pdf>
- 10 One proposal is to cancel national debts as a mechanism to finance climate change mitigation in less developed countries: <http://www.theguardian.com/sustainable-business/2014/sep/26/cancel-developing-countries-national-debt--climate-change-action>
- 11 For example, see GLOBE's report on current employment from the low carbon economy in BC: http://globe.ca/wp-content/uploads/2012/10/bcge_report_feb_2010.pdf

- 11 Chapter 13 of the IPCC Fifth Assessment Report on Impacts has a discussion on inequality: https://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap13_FINAL.pdf
- 12 The Guardian has a good discussion on the Warsaw Mechanism on Loss and Damage.
- 13 For a discussion on a steady state economy see: Daly, H. E. (Ed.). (1980). *Economics, ecology, ethics: Essays toward a steady-state economy*. San Francisco: WH Freeman.
- 14 See the report on prosperity without growth: <http://www.sd-commission.org.uk/publications.php?id=914>
- 15 Insight on the current impacts of delaying action is available in a new assessment of Canadian climate policy here: <http://rem-main.rem.sfu.ca/papers/jaccard/Jaccard%20Canada%20Climate%20Policy%20Report%20Card%202015.pdf>
- 16 In the US, the Securities and Exchange Commission is requiring disclosure by publically-traded companies: <https://www.sec.gov/news/press/2010/2010-15.htm>
- 17 A discussion on the impact of divestment campaigns can be found here: <http://www.smithschool.ox.ac.uk/research-programmes/stranded-assets/SAP-divestment-report-final.pdf>
- 18 For a discussion on the importance of technology transfer in addressing climate change, please see: <http://www.ids.ac.uk/news/technology-transfer-a-way-forward-for-climate-change-negotiations>
- 19 For example, more commitments along these lines: <http://www.nytimes.com/2015/09/23/science/global-companies-joining-climate-change-efforts.html>
- 20 An example of this type of policy was Nova Scotia's Community Feed-In Tariff program, <http://energy.novascotia.ca/renewables/programs-and-projects/comfit>
- 21 See for example, the plan by the US to have 1 million electric vehicles on the road by 2015: https://www1.eere.energy.gov/vehiclesandfuels/pdfs/1_million_electric_vehicles_rpt.pdf
- 22 This article describes the impact of car-sharing on climate change: http://switchboard.nrdc.org/blogs/mrasey/sharing_is_caring_about_climate_change.html
- 23 For a discussion on the possibility of decarbonising the electricity grid, see: Jacobson, M. Z., & Delucchi, M. A. (2011). Providing all global energy with wind, water, and solar power, Part I: Technologies, energy resources, quantities and areas of infrastructure, and materials. *Energy Policy*, 39(3), 1154-1169.
- 24 Chapter 12 of the IPCC Fifth Assessment Report (Mitigation) on Human Settlements, Infrastructure and Spatial Planning has an extensive discussion on the importance of land-use planning.
- 25 For a discussion on ecosystem services see: De Groot, R. S., Wilson, M. A., & Boumans, R. M. (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological economics*, 41(3), 393-408.
- 26 See: Benfield, A., & Carpenter, G. (2013). Market-based mechanisms for climate change adaptation: Assessing the potential for and limits to insurance and market based mechanisms for encouraging climate change adaptation.
- 27 The Lancet led a major investigation into the relationship between health and climate change.
- 28 See the Pentagon's report on the impacts of climate change: <http://archive.defense.gov/pubs/150724-congressional-report-on-national-implications-of-climate-change.pdf?source=govdelivery>
- 29 For a fascinating analysis, see Yale's report on the Six Americas: <http://environment.yale.edu/climate-communication/files/Six-Americas-September-2012.pdf>

BIBLIOGRAPHY

Bataille, C., Sawyer, D., & Melton, N. (2015). Pathways to deep decarbonisation in Canada- Phase 2 report: Draft final for comment.

Bell, A., Butler, R., Copsey, T., De Meyer, K., Drake, N., & Fletcher, K. (2014). Culture and climate change: narratives. (R. Smith, J., Tyszczyk, R., Butler, Ed.). Cambridge, UK: Shed.

Bent, D., Goodman, J., Hardymont, R., Watt, I., Wassling, K., Preist, C., & Shabajee, P. (2008). Climate Futures responses to climate change in 2030. Forum for the Future.

Berkhout, F., Hertin, J., & Jordan, A. (2001). Socio-economic futures in climate change impact assessment: using scenarios as "learning machines" (No. Working paper 3). Norwich, UK.

Black, R., Adger, W. N., Arnell, N., Dercon, S., Geddes, A., & Thomas, D. S. G. (2011). Migration and global environmental change: Future scenarios. London, UK. Retrieved from <http://centaur.reading.ac.uk/27073/>

Carter, T., La Rovere, E. L. (2001). Developing and applying scenarios. In Climate Change 2001: Impacts, Adaptation, and Vulnerability – Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (pp. 147–190).

Charron, I. (2014). A guidebook on climate scenarios: Using climate information to guide adaptation research and decisions. OURANOS.

Jacobson, M.Z., Delucchi, M.A., Bazouin, G., Bauer, Z.A.F., Heavey, C.C., Fisher, E., Morris, S.B., Piekutowski, D.J.Y., Vencilla, T.A., and Yeskooa, T.W. (2015). 100% clean and renewable wind, water, and sunlight (WWS) all-sector energy roadmaps for the 50 United States. The Royal Society of Chemistry, 2015(8), 2093-2117. doi: 10.1039/c5ee01283j

Kemp, M., & Wexler, J. (2010). Zero carbon Britain 2030. (M. Kemp, Ed.). Machynlleth, Powys: Centre for Alternative Technology.

Leiserowitz, A., Roser-Renouf, C., Howe, P., Maibach, E., & Feinberg, G. (2012). Global warming's six Americas in September 2012. New Haven, CT: Yale Project on Climate Change Communication.

Marshall, G. (2013). Sustainable development narratives for Wales: A framework for communications. Climate Outreach Information Network.

Moore, S. S., Seavy, N. E., & Gerhart, M. (2013). Scenario planning for climate change adaptation: A guidance for resource managers. Point Blue Conservation Science.

Rotmans, J. (1998). Models for IA: The challenges and opportunities ahead. Environmental Modeling and Assessment, 11(3), 155–179. doi:10.1023/A

Shell. (n.d.). Global scenarios 1992-2020. Amsterdam.

Shell. (2013). New lens scenarios. Amsterdam.

Torrie, B. R. D., Bryant, T., Marshall, D., Beer, M., & Anderson, B. (2013). Low-Carbon Energy Futures : A Review of National Scenarios.

Van Notten, P. W. F., Rotmans, J., van Asselt, M. B. a, & Rothman, D. S. (2003). An updated scenario typology. Futures, 35(5), 423–443. doi:10.1016/S0016-3287(02)00090-3