



# Scaling-up:

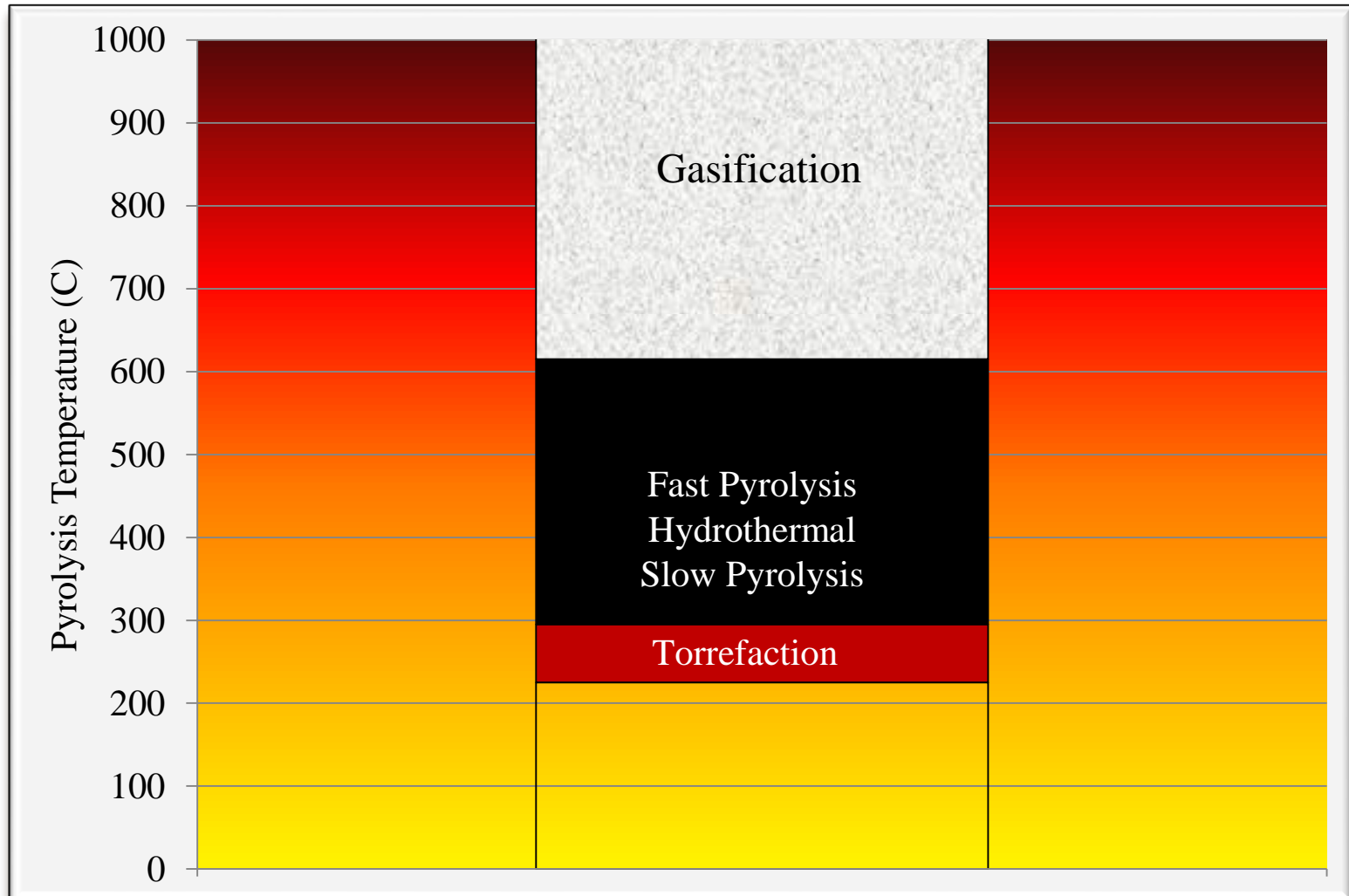
The 4% Dilemma and How to  
Improve the Odds

# Bioenergy Technologies

## Focusing on Pyrolysis

Mechanical	Chemical	Biochemical	Thermochemical
Chipping	Biodiesel	Anaerobic Digestion	Combustion
Grinding	Syngas-FT	Biogas/RNG (biomethane)	Torrefaction (biocoal)
Cubing/ Densification	Cellulosic Ethanol	Cellulosic Ethanol	Slow Pyrolysis (biochar)
Pelletization		Fermentation (ethanol/butanol)	Steam Thermal (black pellets)
			Fast Pyrolysis (pyrolysis oil/biochar)
			Hydrothermal (biocrude/hydrochar)
			Gasification (producer gas/biochar)

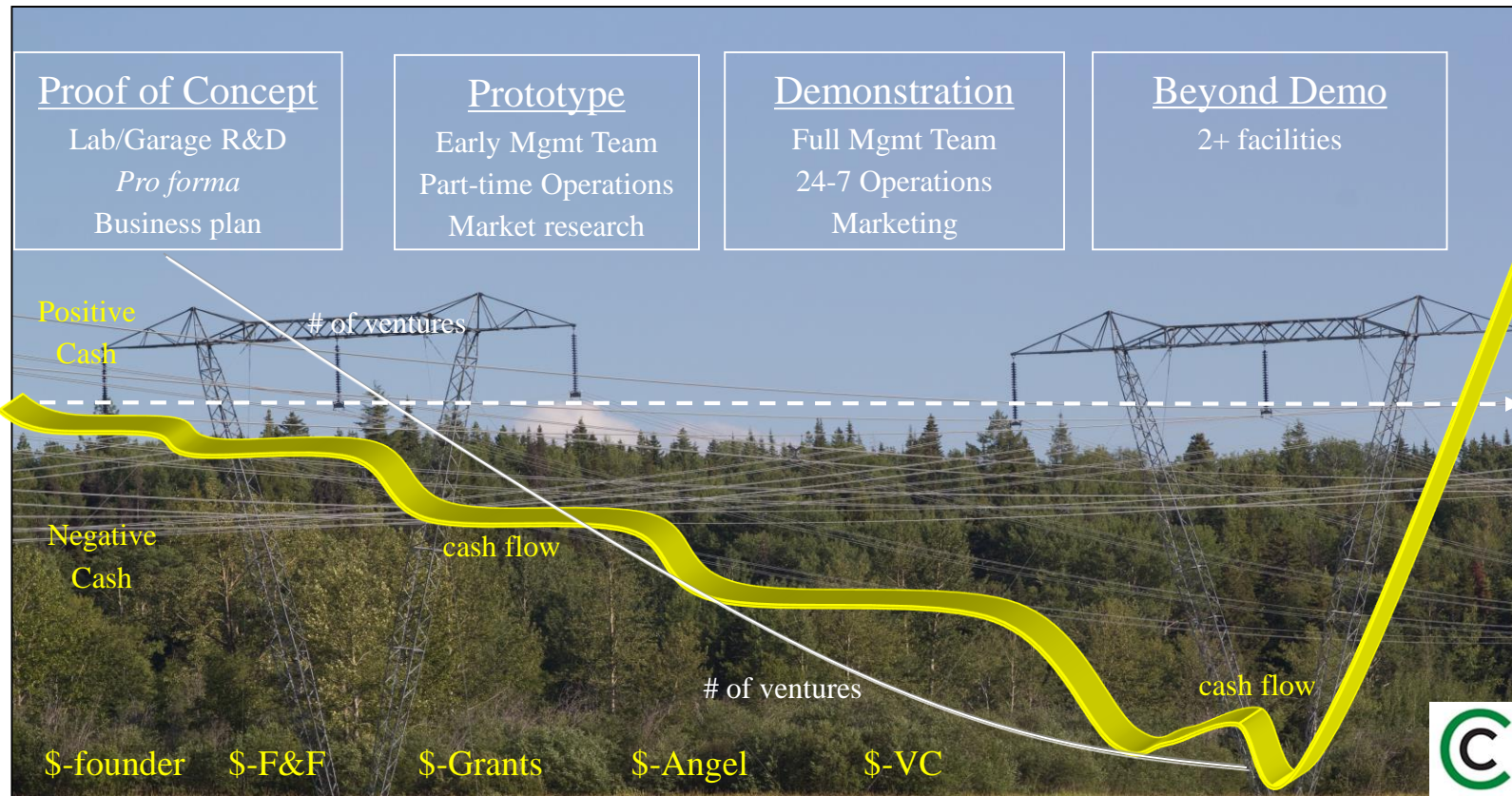
# Pyrolysis Technologies



# Scaling-Up Steps

- ***Proof of Concept***: early stage and bench-scale/garage operations
- ***Prototype***: pilot plants and includes small-scale/mobile units in commercial use
- ***Demonstration***: industrial-scale equipment in continuous operation
- ***Beyond Demo***: more than one industrial scale plant in continuous operation but growth is slow
- ***Commercial***: economics of process have been proven on an industrial scale and are competitive

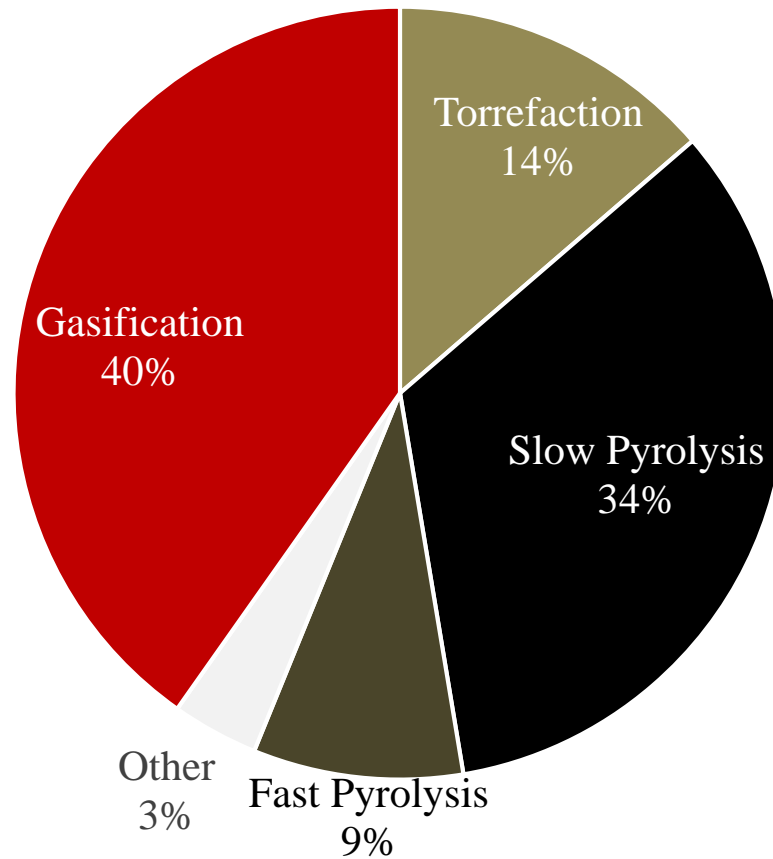
# Scaling-up through the Technology Valley of Death: Cash Flow vs. Time



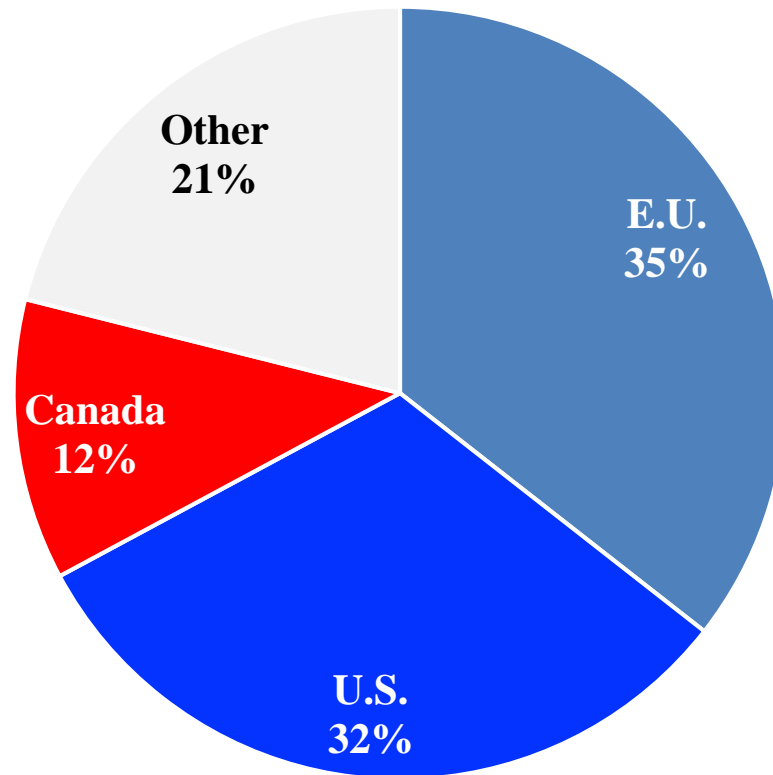
# Pyrolysis Ventures

	EU	US	Can.	Other	Total
Torrefaction	60	53	22	16	151
Steam Thermal	1	2	1	1	5
Pyrolysis-slow	105	107	32	128	372
Pyrolysis-fast	37	29	18	13	97
Hydrothermal Liquefaction	3	6	1	5	15
Hydrothermal Carbonization	15	2	4	0	21
Biomass Gasification	172	150	52	70	444
Total	393	349	130	233	<b>1105</b>

# Pyrolysis Ventures by Technology



# Pyrolysis Ventures by Region





# Scaling-up Challenge – Global

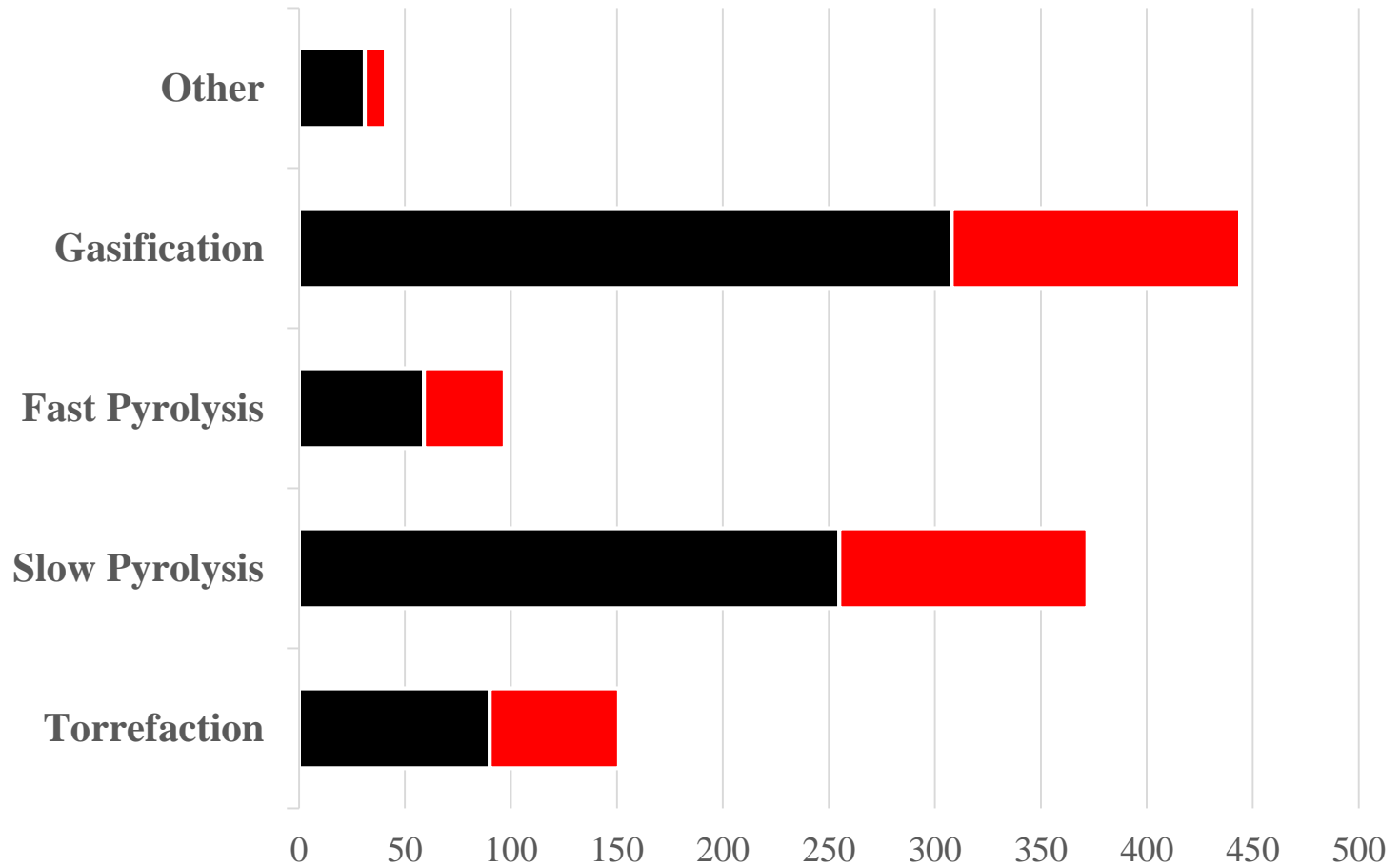
Black – active ventures    Red – inactive ventures

	Torref.	Pyrolysis Slow	Pyrolysis Fast	Gasif. Biomass	Total
Proof of Concept	47/37	99/49	24/16	118/63	300/169
Prototype	35/11	128/49	27/6	139/37	346/109
Demonstration	8/13	23/13	7/16	32/23	70/65
Beyond Demo	0	5/6	1/0	18/13	24/19
Commercial	0	0	0	0	0
Total	90/61	255/117	59/38	308/136	743/362

# Technology – Global

by # of Ventures

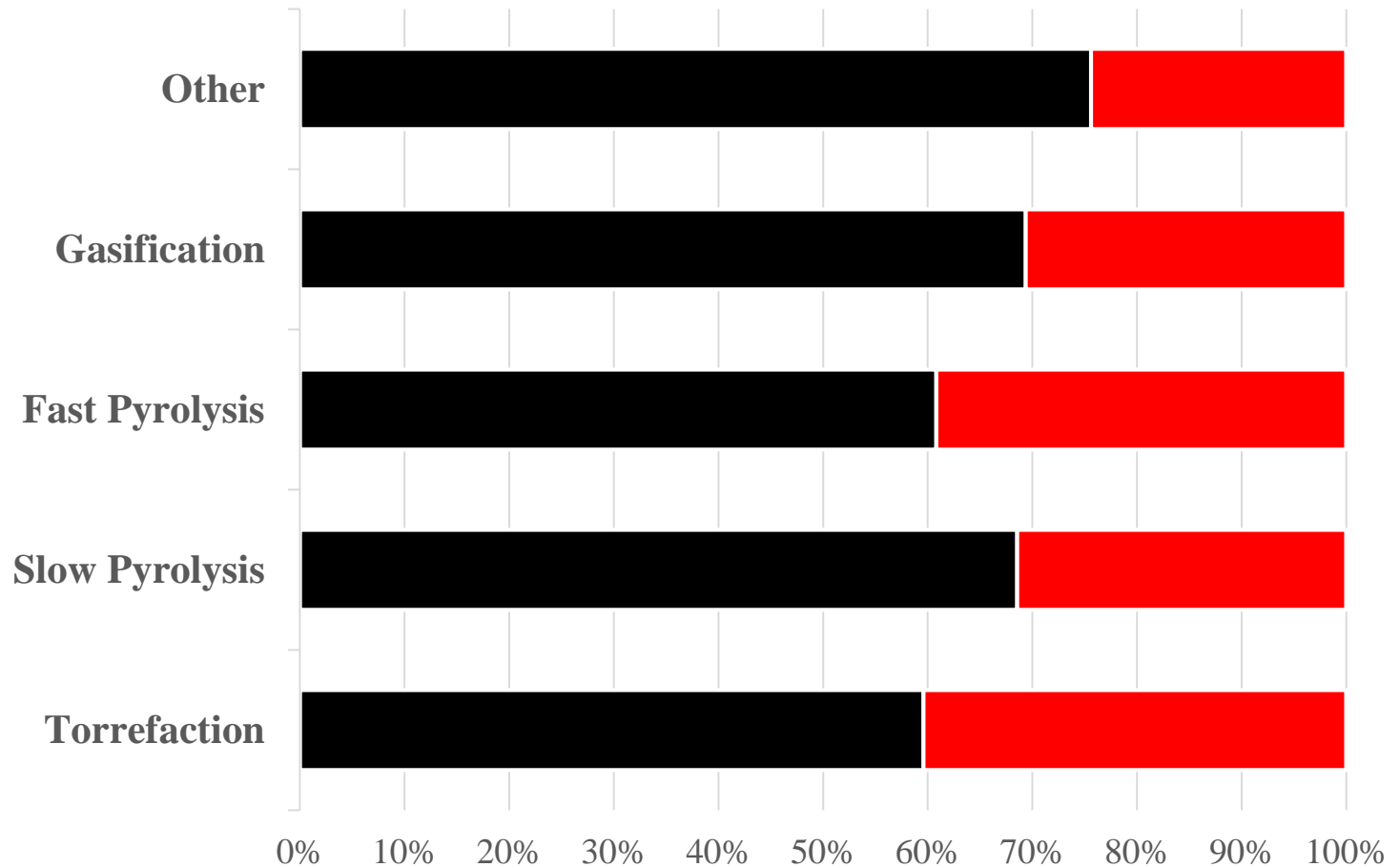
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# Technology – Global

by % of Ventures

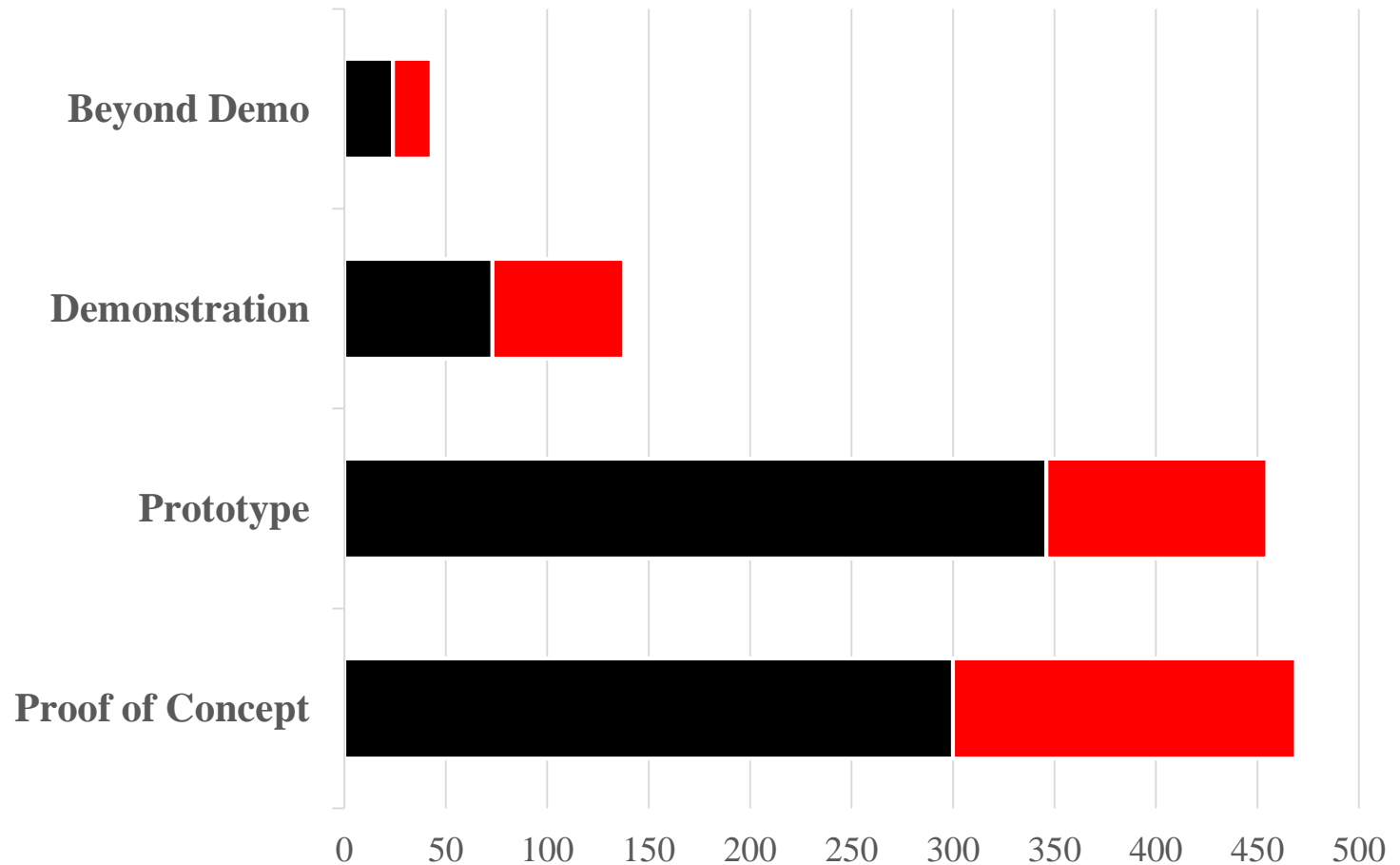
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# Scaling-up – Global

by # of Ventures

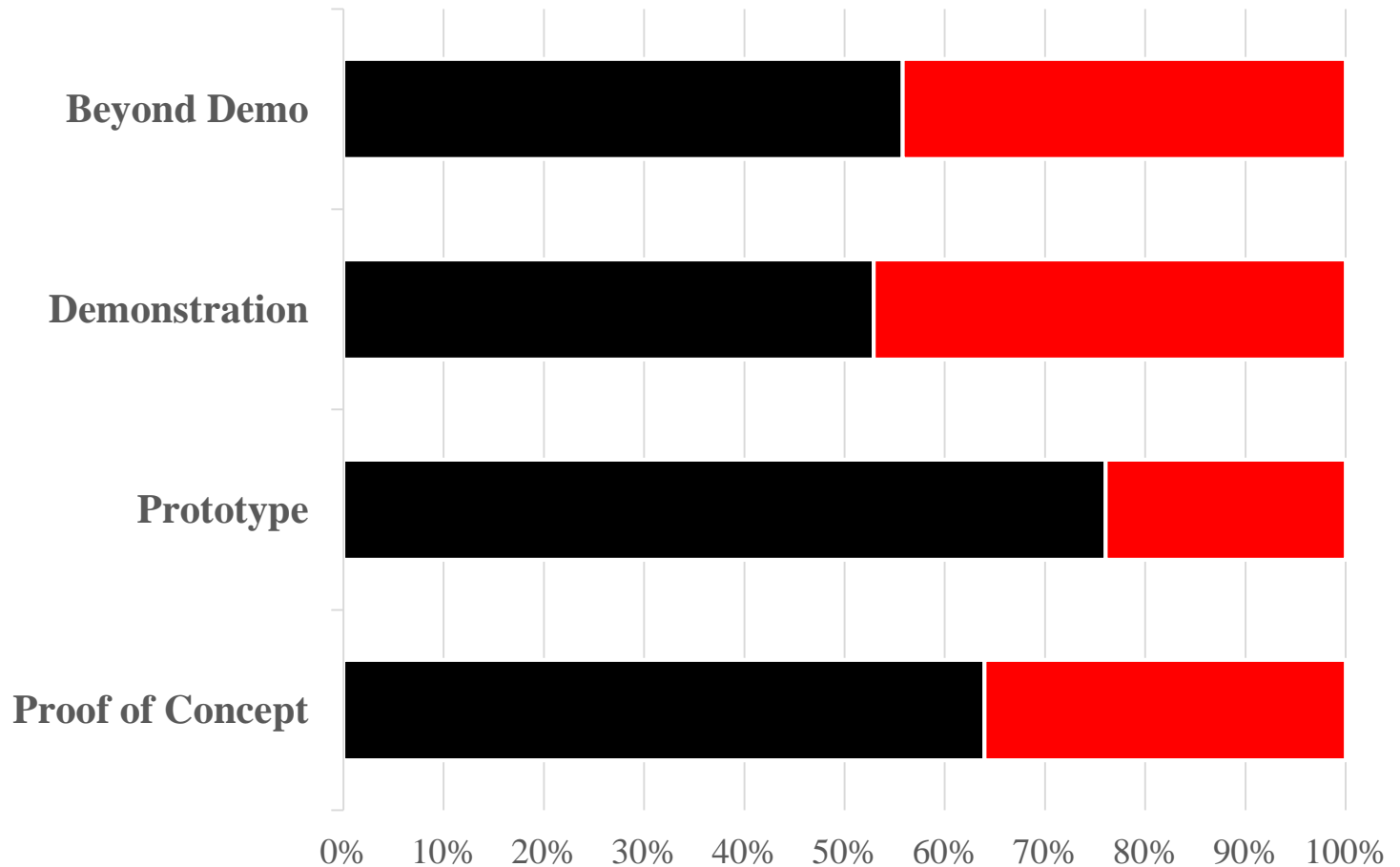
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# Scaling-up – Global

by % of Ventures

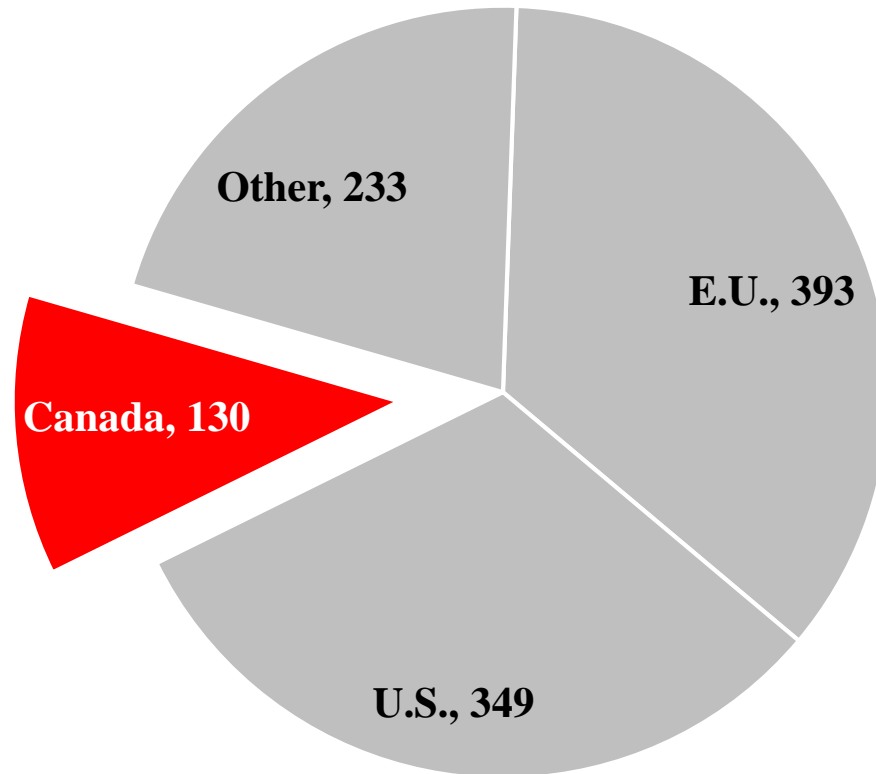
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# Pyrolysis Ventures

Canada

(# of ventures)



# Scaling-up Challenge – Canada

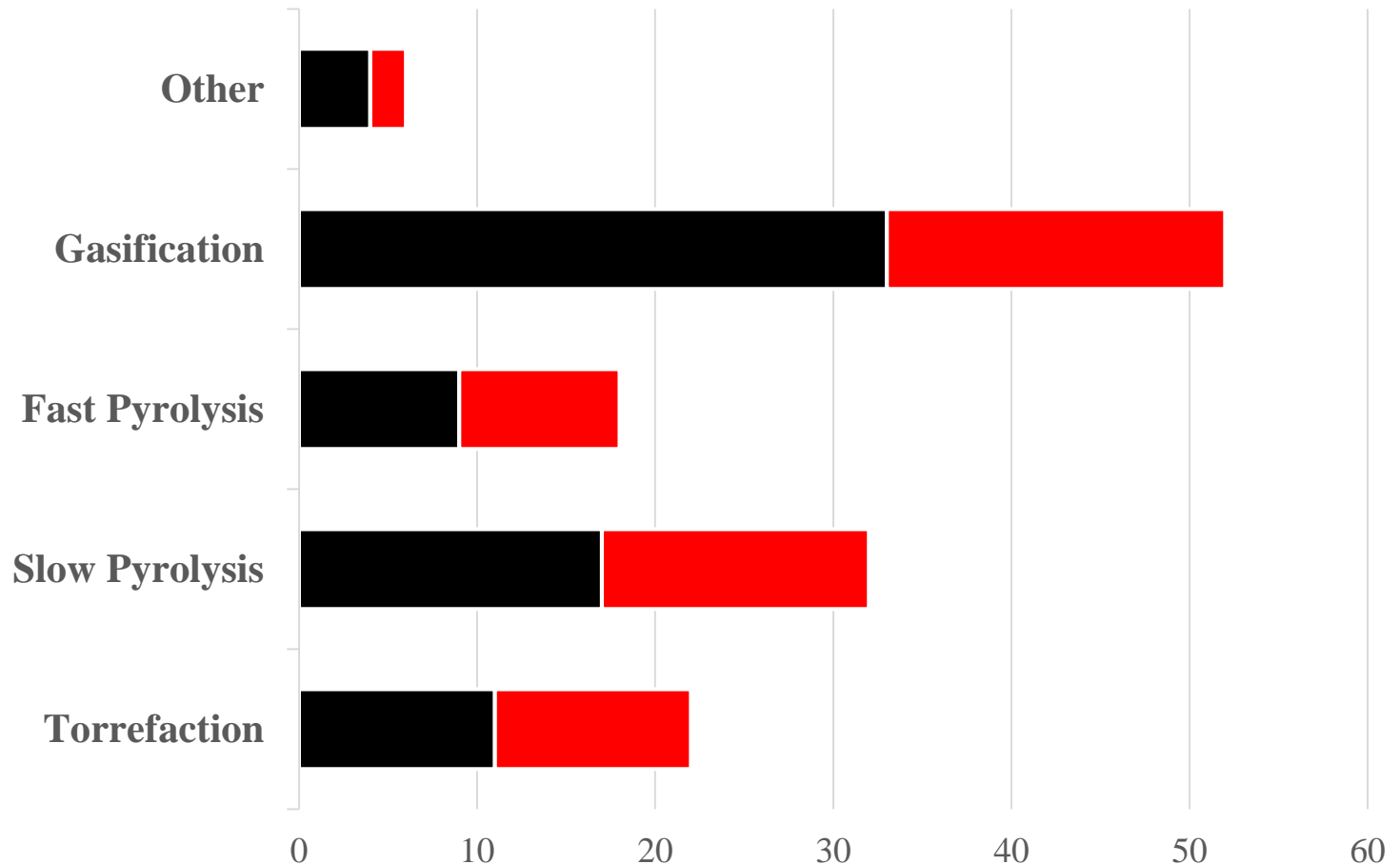
Black – active ventures    Red – inactive ventures

	Torref.	Pyrolysis Slow	Pyrolysis Fast	Gasif. Biomass	Total
Proof of Concept	8/11	8/9	4/3	16/13	38/37
Prototype	2/0	8/5	4/3	12/4	28/13
Demonstration	1/0	1/1	0/3	3/2	5/6
Beyond Demo	0	0	1/0	2/0	3/0
Commercial	0	0	0	0	0
Total	11/11	17/15	9/9	33/19	74/56

# Technology – Canada

by # of Ventures

Black – active ventures    Red – inactive ventures

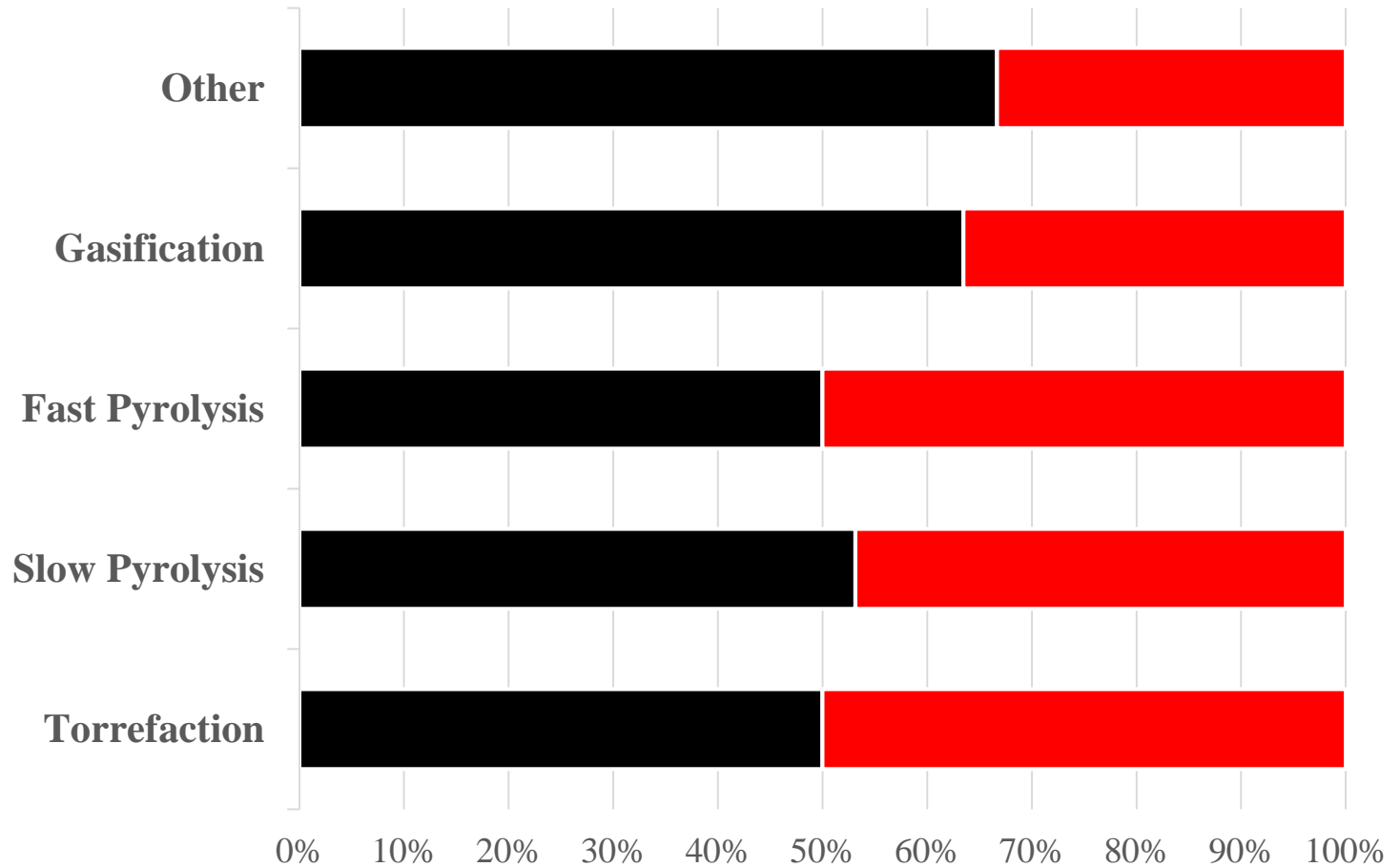




# Technology – Canada

by % of Ventures

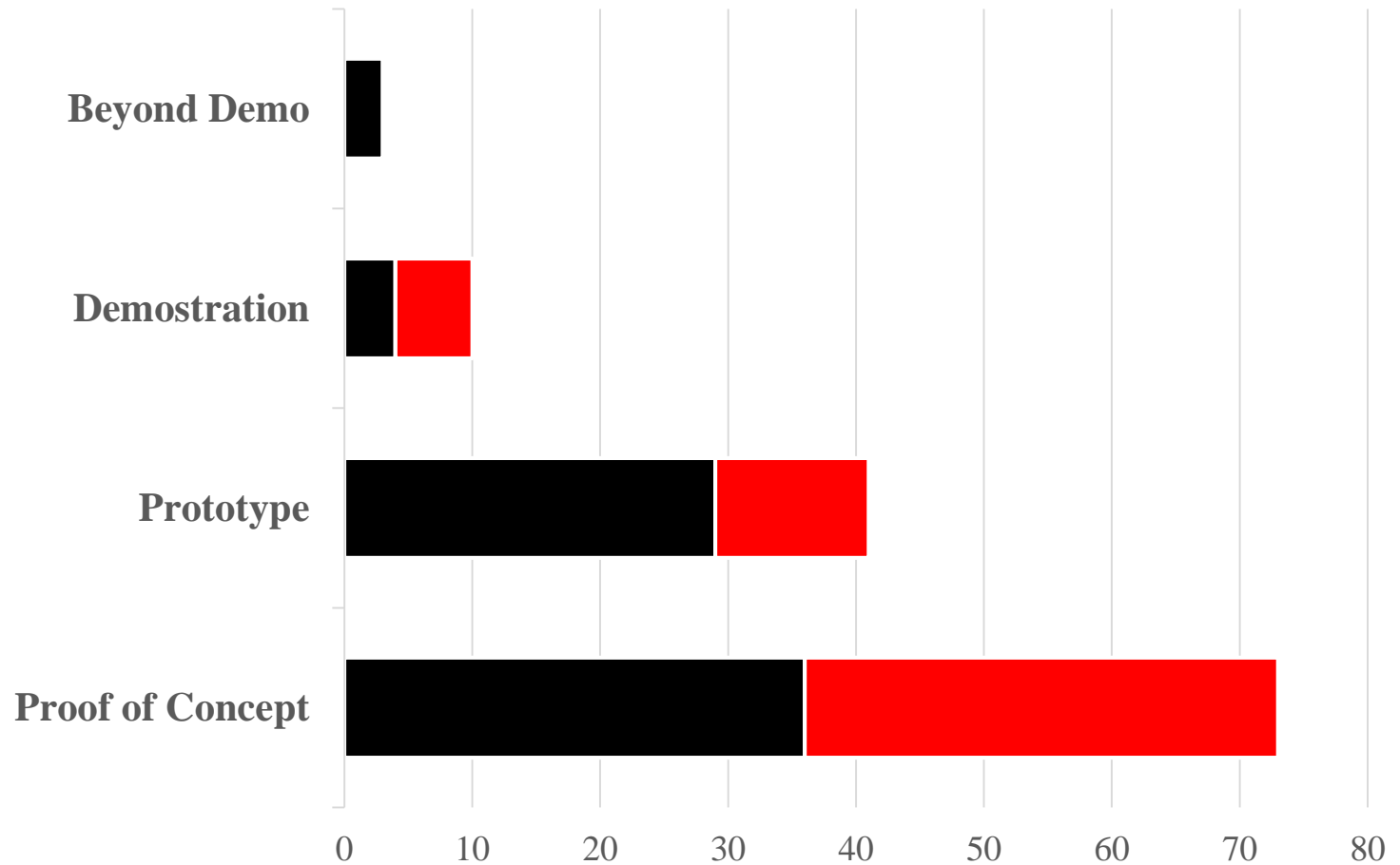
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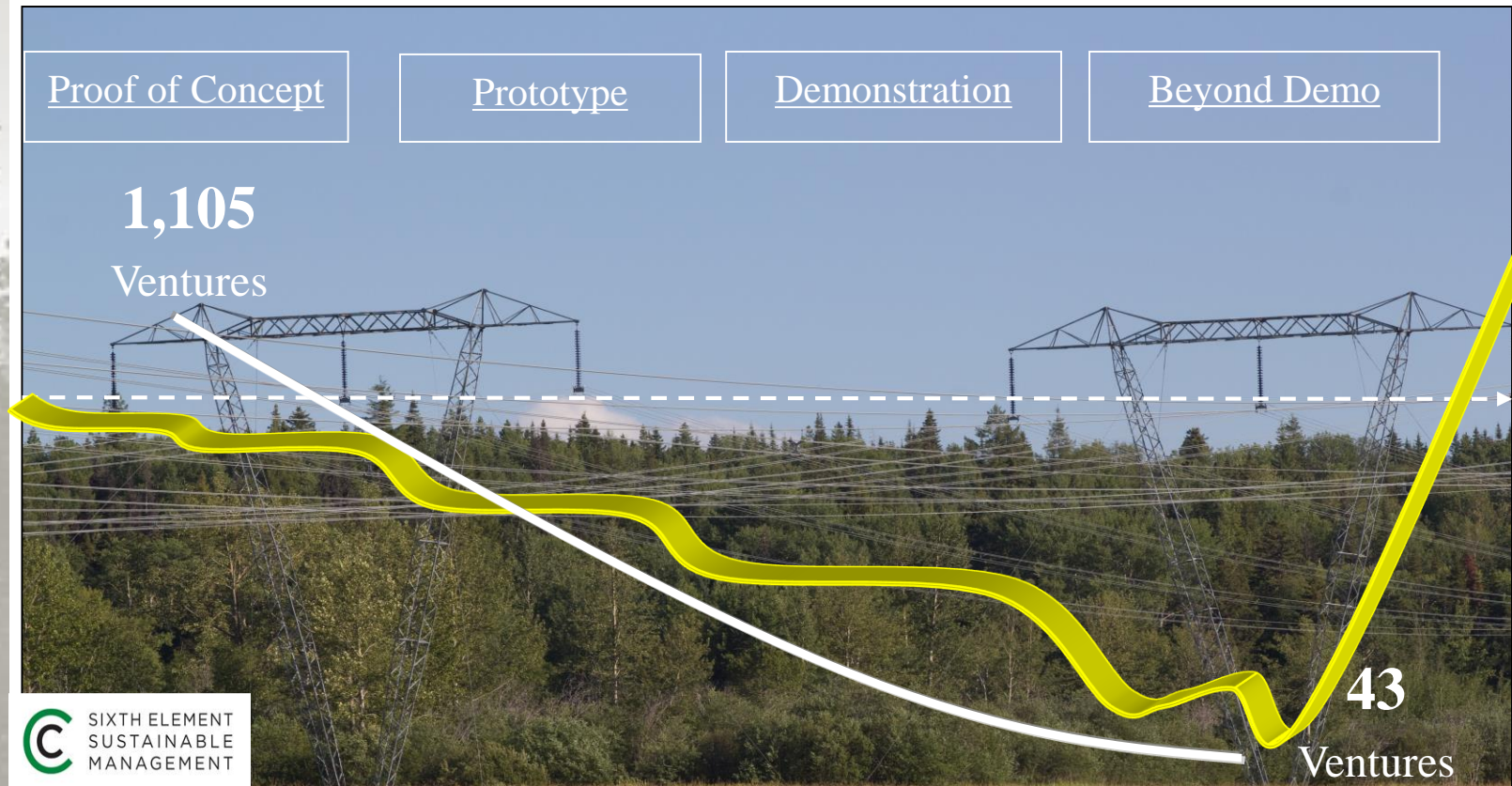
# Scaling-up – Canada

by # of Ventures

Black – active ventures    Red – inactive ventures



# The Scaling-up Challenge: the 4% Dilemma





# The Scaling-up Challenge: Improving the Odds

- I. Thorough & Candid *Pro forma*
- II. Focus, focus, focus
- III. Professional Management Team
- IV. Talk to potential customers
- V. Select path to fastest positive cash flow



# The Scaling-up Challenge: Improving the Odds

- VI. Strategic Industrial Partner
- VII. Patient Financing
- VIII. “Bolt-on” technologies must be tested
- IX. Tested on continuous operation
- X. No short-cuts on scaling-up



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