Vanadium Redox Flow Battery

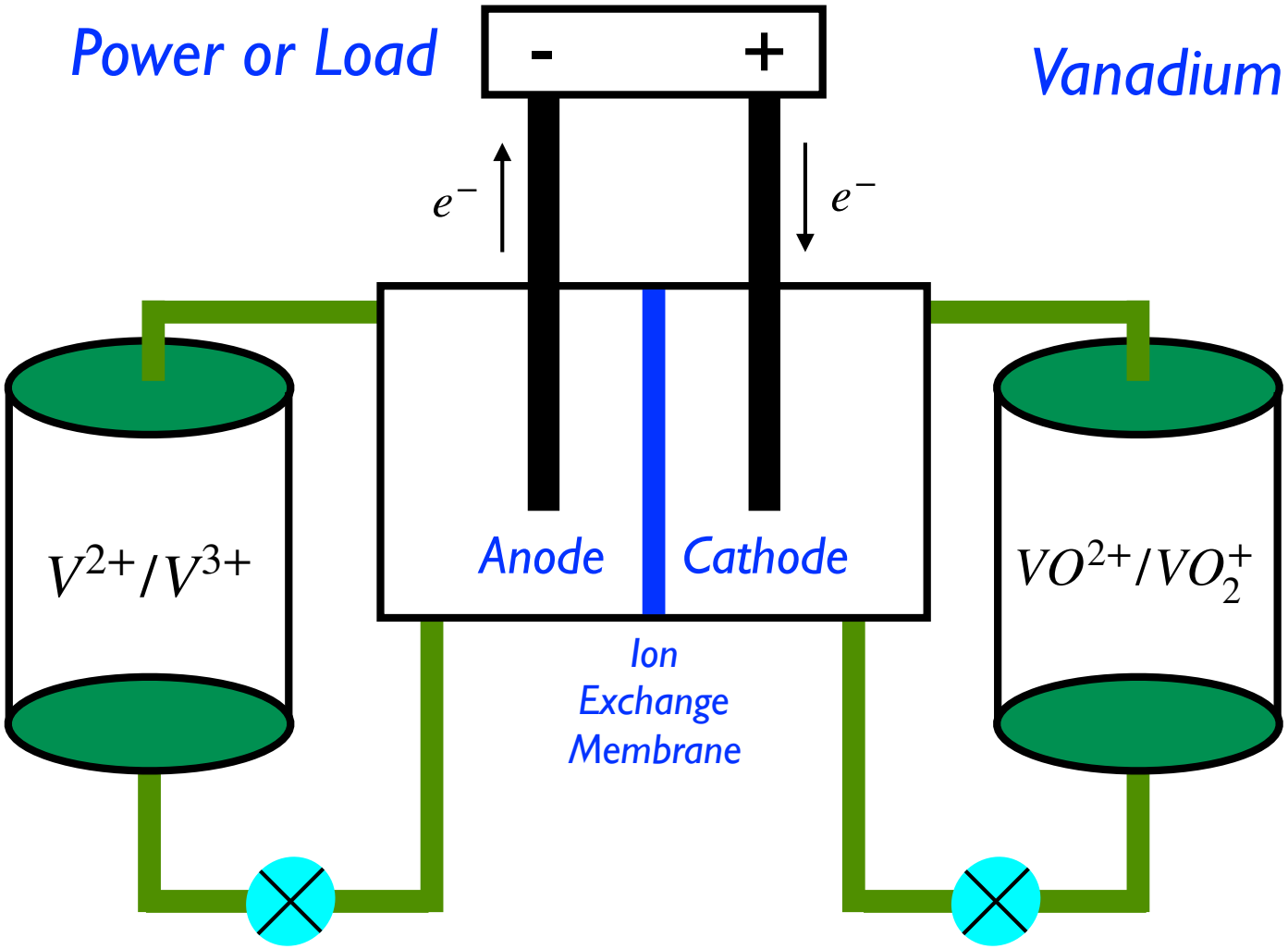
Vanadium Oxidation States

$$V^{2+} \qquad V^{3+} \qquad VO^{2+} \qquad VO_2^{+}$$

World's Largest Battery? 200MW/800MWhr

Chem M3LC

Vanadium Redox Flow Battery



$$V^{2+} \rightleftharpoons V^{3+} + e^-$$

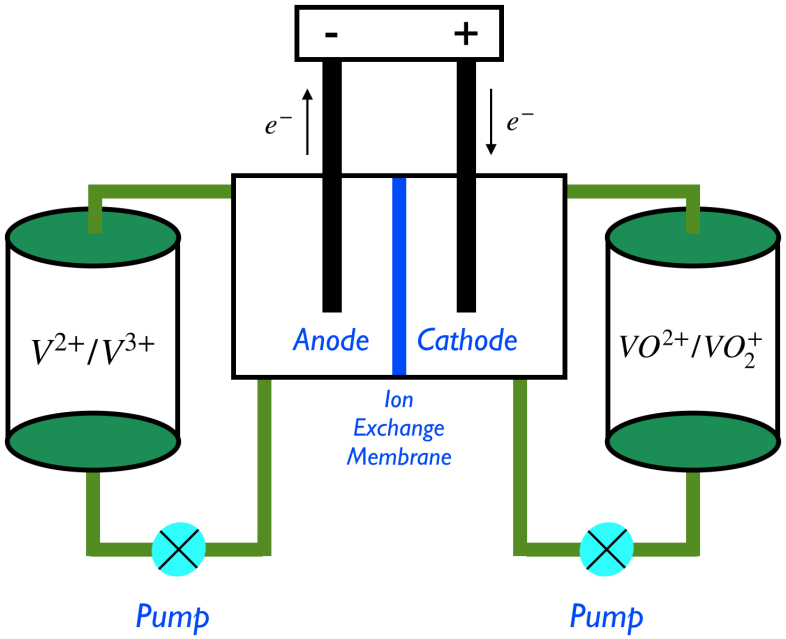
Oxidation

$$VO_2^+ + 2H^+ + e^- \rightarrow VO^{2+} + H_2O$$

Reduction

Chem M3LC

Vanadium Redox Flow Battery



Cathode Half Cell Potential: E^0_{red} = 1.00V

$$VO_2^+ + 2H^+ + e^- \rightarrow VO^{2+} + H_2O$$

Anode Half Cell Potential: E^0_{ox} = -.26V

$$V^{3+} + e^- \rightleftharpoons V^{2+}$$

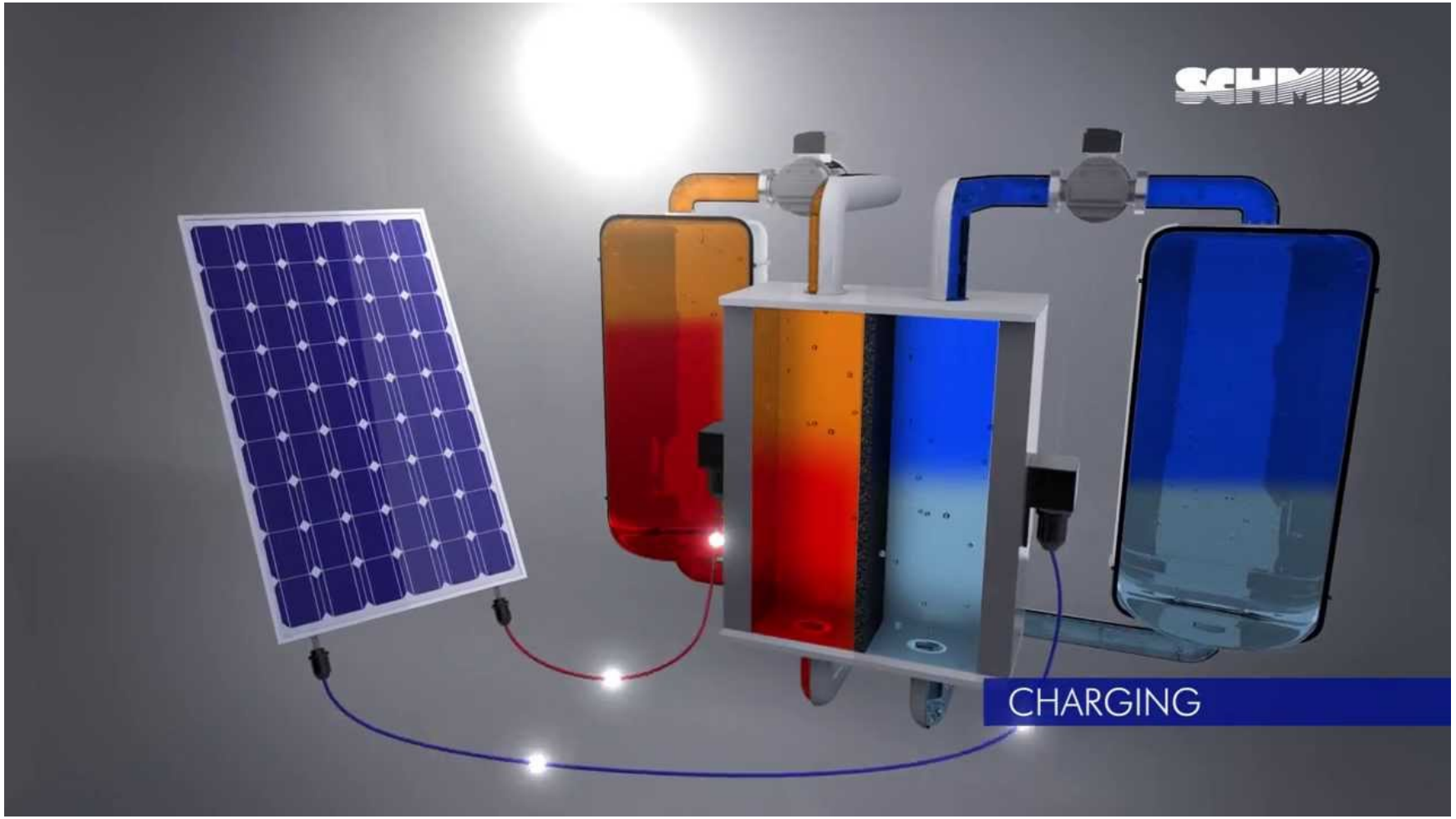
$$E_{cell} = E_{red} - E_{ox}$$

$$E^0_{cell} = 1.00V - (-0.26V) - = +1.26V$$

Spontaneous Discharge Reaction

Chem M3LC

Vanadium Redox Flow Battery



Solar Panel Charging

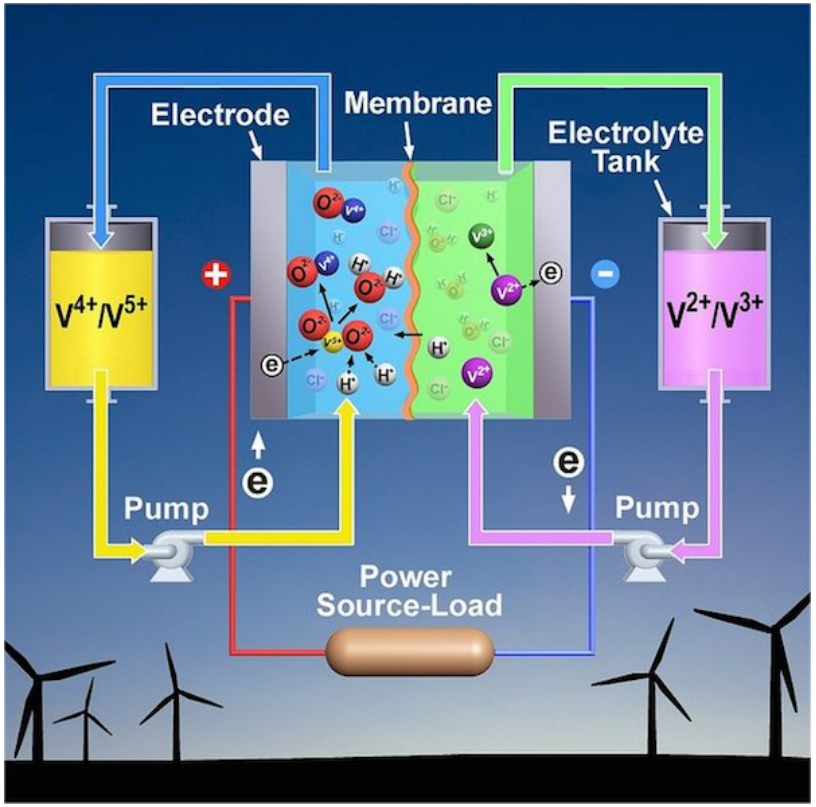
Chem M3LC

Vanadium Redox Flow Battery

Canadian Installation

Chem M3LC

Vanadium Redox Flow Battery



References
[1] X. Li et al., "Ion Exchange Membrane for Vanadium Redox Flow Battery (VRB) Applications," Energy Environ. Sci. 4, 1147 (2011).
[2] M. Skyllas-Kazacos et al., "Progress in Flow Battery Research and Development," J. Electrochem. Soc. 158, R55 (2011).
[3] C. Ponce de Leon et al., "Redox Flow Cell for Energy Conversion," J. Power Sources 160, 716 (2006).
[4] L. Li et al., "A Stable Vanadium Redox-Flow Battery with High Energy Density for Large-Scale Energy Storage," Adv. Energy Mat. 1, 394 (2011).
Excerpted from Xing Xie: http://large.stanford.edu/courses/2011/ph240/xie2/

Picture from https://cleantechnica.com/2015/06/21/flow-battery-vs-tesla-battery-smackdown-looming/