# Proposals for Non-PGM catalyst target and test protocols

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FCTT (USCAR)

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**Background**

1. Non-PGM ORR catalyst is expected to be an opportunity to enable <u>further cost reduction</u> of fuel cell system beyond an achievement of the low PGM loading ORR catalyst.

2. Therefore, target should be to achieve <u>equivalent performance</u> (power density) of PGM ORR catalyst without using PGM materials rather than equivalent cost (cost neutral).

3. Target and test protocols of PGM ORR catalyst (Table 3 and 5) are applied except metrics with respect to PGM amount.

4. <u>All targets are MEA based</u>. No target is defined for RDE test, but RDE data can be reported for screening purpose.

5. No interim target is defined. Technical progress should be reported toward the target.

**Target for Non-PGM Catalyst**

1. MEA target (Table 3, FCTT Roadmap, June 2013) is equally applicable for the MEA with non-PGM catalyst.

2. In the Table 5, volumetric activity target of non-PGM catalyst ORR activity should be replaced by following ORR activity target (equivalent performance).

| Metrics | Target* | Test Protocols |
|---|---|---|
| ORR activity target | >0.044 A/cm$^2$ at 0.9V$_{iR\text{-corrected}}$ | Roadmap Table 5, footnote f |

*Target is equivalent to advanced PGM catalyst mass activity performance 0.44 A/mg$_{PGM}$ at 0.1 mg$_{PGM}$/cm$^2$.

- No extrapolation
- Report fraction of two electron ORR
- Report the thickness of catalyst layer and Tafel slope

**Durability Metric**

Less than 30 mV loss at 0.8 A/cm$^2$ after 30 K cycles
0.6 V to 1.0 V cycle test protocols (FCTT Roadmap, Table A-1)

## Table 3. Technical Targets for MEAs

| Chatacteristic | Units | 2020 Target | Protocols |
|---|---|---|---|
| Q/ΔTi | kW/°C | 1.45 | *Footnote a** |
| Cost | $/kW | 14 | |
| Durability with cycling | Hours | 5,000 | Footnote d, Table A-6 of Appendix A |
| Performance @0.8V | mA/cm$^2$ | 300 | *Footnote g** |
| | mW/cm$^2$ | 250 | *Footnote g** |
| Performance @rated power | mW/cm$^2$ | 1,000 | *Footnote e** |
| Robustness (cold operation) | | 0.7 | Footnote i |
| Robustness (hot operation) | | 0.7 | Footnote j |
| Robustness (cold transient) | | 0.7 | Footnote k |

\* Footnote a, e and g should be updated.

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**Footnote updates in Table 3**

**Footnote a:**

Q/ΔTi = [Stack power (90 kW) x (1.25 V - voltage at rated power) / (voltage at rated power)] / [stack coolant out temp (°C) - ambient temp (40°C)]. Target assumes 90 kW stack gross power required for 80 kW net power, measured using the protocol for a polarization curve found in Table A-5 of Appendix A, except stack coolant outlet temperature and pressures. Stack coolant outlet temperature is up to maximum operating temperature. Cathode and anode pressures are up to 250 kPa (absolute).

*Footnote g of Table 2 should be updated also.*

**Footnote e:**

~~Need to meet or exceed at temperatures of 80°C up to peak temperature,~~ Measured using the polarization curve protocol found in Table A-5 of Appendix A, except stack coolant outlet temperature and pressures. Stack coolant outlet temperature is up to maximum operating . Cathode and anode pressures are up to 250 kPa (absolute).

**Footnote g:**

Target must be met at 150kPa~~g~~ outlet pressure. …

*Delete "g", pressure unit is absolute, not gauge*

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