Data sources for NetZero Model. All data from Published sources (see Reference list at end)

|  |  |  |  |
| --- | --- | --- | --- |
| **Sector** | **Baseline (2010)** | **Projected net zero condition (2020)** | **Reference** |
| Population  (including 6000 civilians/contractors) | 22,000 | 34,000 | ([Anderson et al. 2011](#_ENREF_1); [McMordie Stoughton et al. 2012a](#_ENREF_45)) |
| Electricity demand | 179,667 MWh | 260,453 MWh | ([Anderson et al. 2011](#_ENREF_1); [Anderson et al. 2012](#_ENREF_2)) |
| Thermal energy demand (natural gas or equivalent) | 971,778 MMBtu | 950,709 MMBtu | ([Anderson et al. 2012](#_ENREF_2); [Anderson et al. 2011](#_ENREF_1)) |
| Total energy demand (electricity + thermal energy) | 1,584,800 MMBtu | 1,839,374 MMBtu | ([Anderson et al. 2011](#_ENREF_1); [Anderson et al. 2012](#_ENREF_2)) |
| Non-tactical fleet fuel | 29,403 MMBtu (2009) | - | ([Anderson et al. 2011](#_ENREF_1)) |
| Electricity generated on site | 3% (2012) | 100% | ([Anderson et al. 2012](#_ENREF_2)) |
| Thermal energy generated on site | 1.5% (2012) | 94% | ([Anderson et al. 2012](#_ENREF_2)) |
| Water demand from utility | 854 Mgal/yr | 424 Mgal/yr (+ estimated 200 Mgal/yr for privatized housing) | ([McMordie Stoughton et al. 2012b](#_ENREF_46); [McMordie Stoughton et al. 2012a](#_ENREF_45)) |
| Volume reclaimed from wastewater | 80 Mgal/yr | 424 Mgal/yr (includes direct potable reuse) | ([McMordie Stoughton et al. 2012b](#_ENREF_46)) |
| Waste generated | 15,920 tons/yr (MSW)  3592 tons/yr (C&D) | - | ([NDCEE 2012](#_ENREF_47)) |
| Waste recycled | 6395 tons/yr (MSW)  3259 tons/yr (C&D) | Goal: 100% diversion | ([NDCEE 2012](#_ENREF_47)) |

\*Electricity, thermal, and total energy demand represent site energy (which does not include primary energy). Total energy demand is calculated by converting electricity demand from MWh to MMBtu, using 1 MWh = 3.412 MMBtu. Baseline (2010) energy demand is interpolated from 2009 and 2011 data.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Potential action or sector** | **Energy impact** | **Water impact** | **Waste impact** | **Reference used to calculate impact** |
|  | **MMBtu/y** | **Mgal/y** | **Tons/y** |  |
| **BASELINE** | **1,584,800** | **854** | **15920** | (MSW not C&D) |
|  |  |  |  |  |
| **ENERGY actions**a | **-67%** | **-15 to -17%** |  |  |
| Energy efficiency, includes WCM's | -18% | -15% |  | ([Anderson et al. 2012](#_ENREF_2)) Table 7 & p. 58 |
| Solar PV, 101MW | -33% | 0% |  | ([Anderson et al. 2012](#_ENREF_2)) Table 8 |
| Wind power, 11MW | -5% | 0% |  | ([Anderson et al. 2012](#_ENREF_2)) Table 8 |
| Concentrating solar power, 20MW | -11% | 0.4-2% |  | ([Anderson et al. 2012](#_ENREF_2)) Table 29 |
| Foodb | 6% |  | 15% | ([NDCEE 2012](#_ENREF_47)) Figure 3, ([Tharion et al. 2005](#_ENREF_65)) |
| Non-tactical vehicle fleet | 2% | 0.7% |  | ([Anderson et al. 2011](#_ENREF_1)) Figure 7 |
| **WATER actions** | **+0.25%** | **-50%** |  |  |
| WWTP expansion | +0.03% | -25.5% |  | ([Anderson et al. 2012](#_ENREF_2)) Table 30 |
| Direct Potable Reuse (DPR) | +0.22% | -25.2% |  |  |
| **WASTE actions** | **-5 to -40%** | **+1.4 to +22%** | **-85%** |  |
| Waste to energy plant, 40MWc | -5 to -40% | +1.4 to +22% | -85% | ([US Army 2012](#_ENREF_72)) p. 18 |
| Biomass plant, 13MWd | -12% | +6.7% | -63% | ([US Army 2012](#_ENREF_72)) p. 20 |
| Waste, MSW onlye | 2% | 0.11% |  | ([Valkenburg et al. 2008](#_ENREF_73)) |
| Waste, MSW+C&D | 3% | 0.14% |  |  |
| Sewagef | 1% | 49.6% |  | ([Heidrich et al. 2011](#_ENREF_32)) |

1. In some cases, site (demand-side) energy units have been converted using 1 MWh = 3.412 MMBtu
2. Food is not part of the reported energy budget; food energy is estimated from literature
3. WTE: 15,920 tons MSW – 40% diversion = 9550 non-recycled MSW on base; (9550 + 300,000 tons from off-base) x 0.6MWh/ton = 185,730 MWh/yr generated, with 1000 gal/MWh water withdrawal (wet recirculating cooling). A low-water scenario uses 30,000 tons MSW from off-base and 500 gal/MWh water withdrawal.
4. Woody biomass, an alternative to WTE: (10,000 tons on base + 13,000 tons off base)/yr x 8.5 MMBtu/ton = 195,500 MMBtu/yr; 1000 gal/MWh water withdrawal = 293 gal/MMBtu (wet recirculating cooling)
5. 15,920 tons/yr MSW generated (19,512 tons/yr including C&D waste) x 0.6 MWh/ton; 69% of commissary (on-post grocery) waste is compostable, so has energy content ([NDCEE 2012](#_ENREF_47))
6. Sewage is not part of the reported energy or waste budgets. Here, total water entering wastewater treatment is considered sewage.

References for Data Sources

Anderson, K., T. Markel, M. Simpson, J. Leahey, C. Rockenbaugh, L. Lisell, K. Burman, and M. Singer. 2011. *Targeting net zero energy at Fort Carson: assessment and recommendations*. National Renewable Energy Laboratory.

Anderson, K., J. Cale, J. Davis, J. Giraldez, R. Hunsberger, L. Lisell, J. Macknick, D. Martin, R. Robichaud, and G. Tomberlin. 2012. *Targeting net zero energy, water, and waste at Fort Carson: assessment and recommendations*. National Renewable Energy Laboratory.

Heidrich, E., T. Curtis, and J. Dolfing. 2011. Determination of the internal chemical energy of wastewater. *Environmental Science and Technology* 45: 827-832.

McMordie Stoughton, K., R. Reilly, B. Boyd, D. Dixon, S. Loper, and E. Giever. 2012a. *Fort Carson Net Zero Water Roadmap*. Pacific Northwest National Laboratory.

McMordie Stoughton, K., E. Giever, J. Williamson, M. De La Rosa, B. Boyd, and S. Loper. 2012b. *Fort Carson Net Zero Water Balance*. Pacific Northwest National Laboratory.

NDCEE. 2012. *Net Zero Waste: Material Flow Analysis Survey Results, Fort Carson*. Johnstown, PA: National Defense Center for Energy and Environment.

U.S. Army. 2012a. *Fort Carson Net Zero waste, water, and energy implementation final environmental assessment and finding of no significant impact*. Fort Carson and US Army Environmental Command.

U.S. Army. 2012b. *Army sustainability report 2012*. Washington, DC: Office of the Assistant Secretary of the Army for Installations, Energy and Environment.

Valkenburg, C., C. Walton, B. Thompson, M. Gerber, S. Jones, and D. Stevens. 2008. *Municipal solid waste (MSW) to liquid fuels synthesis, volume 1: availability of feedstock and technology*. Pacific Northwest National Laboratory.