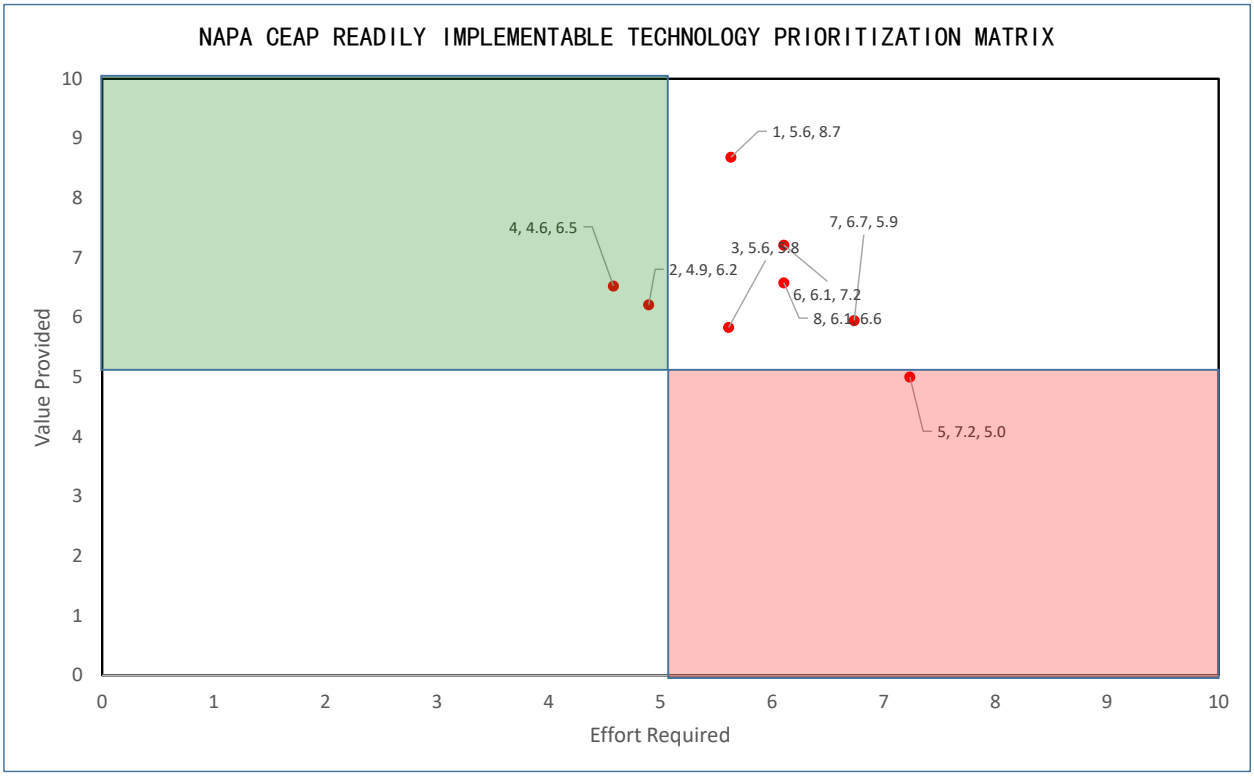
ASPHALT PLANTS:

NAPA CEAP READILY IMPLEMENTABLE TECHNOLOGY TO LOWER CARBON FOOTPRINT MATRIX DEVELOPMENT			
Item	**Matrix ID**	**Effort Required (0 to 10, 10 High)**	**Value Provided (0 to 10, 10 High)**
Stockpile Moisture Mitigation	1	5.6	8.7
Fuel Savings	2	4.9	6.2
Fuel Type	3	5.6	5.8
Reducing Mixture Production Temperatures	4	4.6	6.5
Purchase Renewable Energy	5	7.2	5.0
Plant Upgrades	6	6.1	7.2
HMA Plants at or near Quarry Sites	7	6.7	5.9
Cold and In-place Recycling	8	6.1	6.6



High Value, Lower Effort

4. **Reducing Mixture Production Temperatures**: during WMA production (often not done)

2. **Fuel Savings**
    - Trucking logistics systems/software
    - Equipment Utilization
        - Productivity studies
            - Paths
            - Operation
            - Stockpile and loadout procedures

High Value, Increased Effort

1. **Stockpile moisture** mitigation / Strategies to keep aggregate and RAP stockpiles dry
    - Primary impact: reduced plant drying energy
    - Secondary impact: lower mix variability, better quality, less rework
    - Covering plant feed bins to prevent post rain moisture spikes (more easily/quickly done than sloping/paving storage yard)
    - Sloping Stockpile area
    - Paving Stockpile area
    - Covered Stockpiles
    - Storage site drainage and stockpile layout planning
    - Real time moisture sensors
        - Troxler Moisture Measurement System – MMS Impacts on Reducing Carbon Emissions

Actions

- Mitigation
    - Payback tool – Fast ROI
    - Practical instruction – Procedure
- Challenges:
    - Initial capital investment
    - How do we incentivize?

3. **Fuel Type**
    - Burner
        - Natural Gas (CNG, LNG, RNG)
        - Propane
        - Biodiesel
        - Renewable Diesel
    - Equipment
        - Electric
        - Renewable Diesel
        - Biodiesel

Actions:

- Understanding market and potential gain,
- make sure you are burning efficient
- Fuel / maintenance requirements
- Fuel delivery impacts (pipe, truck, rail, etc)
- Importance of baseline/benchmark
- Opportunities for improvement
- NAPA Tools
    - GHG Calculator / free
    - EPD software / subscription

6. **Plant Upgrades**
    - Variable Frequency Drives
    - Insulation
    - Burner Efficiency
    - Sensors that measure electrical output to troubleshoot which areas that have the most energy use at the plant. It's a Bluetooth technology from my understanding
    - Solar/wind alternative energy production
        - Possibly future exhaust air energy capture – "Design and Experimental Analysis of an Exhaust Air Energy Recovery Wind Turbine Generator"
    - Silo capture system

7. **HMA plants at and/or Near Quarry Sites:** to reduce haul distances

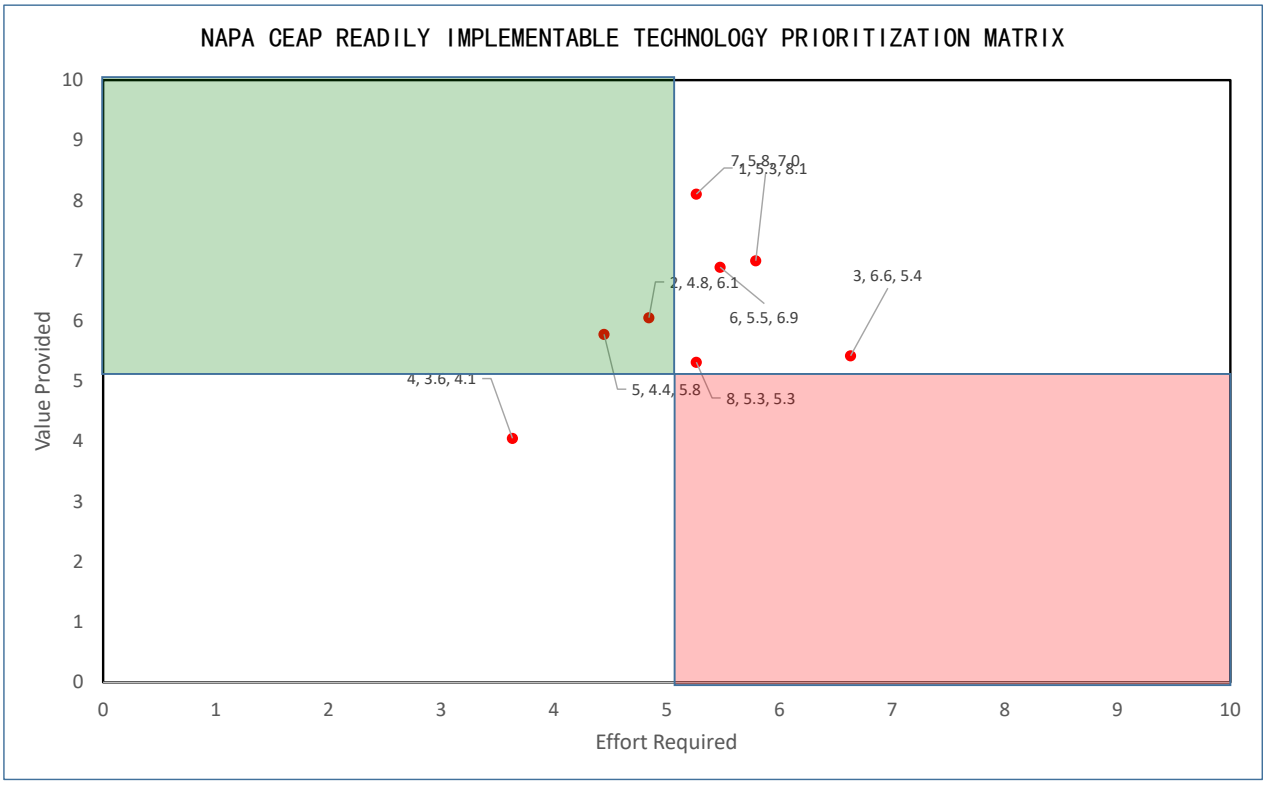
8. **Cold and In-place Recycling**
    - Cold central plant (with 100% ~ 85% to 98% actual? RAP) CCPR
        - Primary impact: more recycle, less plant energy potentially
        - Secondary impact: less virgin aggregate / asphalt consumed (less dependency on crude)
    - Embracing cold recycling as just another type of asphalt pavement
        - Charge dues on tonnage at both national and state levels

Lower Value, Increased Effort

5. **Purchase Renewable Energy:** for HMA plants and recycling operations electricity requirements

PROJECTS/CONSTRUCTION/ DESIGN:

NAPA CEAP READILY IMPLEMENTABLE TECHNOLOGY TO LOWER CARBON FOOTPRINT MATRIX DEVELOPMENT			
Item	**Matrix ID**	**Effort Required (0 to 10, 10 High)**	**Value Provided (0 to 10, 10 High)**
Construction Quality	1	5.3	8.1
Fuel Savings	2	4.8	6.1
Fuel Type	3	6.6	5.4
Paperless Communications	4	3.6	4.1
Pavement Construction: thicker lifts	5	4.4	5.8
Utilize Rubblization and Other In-place Recycling Methods	6	5.5	6.9
Optimized Pavement/Project Design	7	5.8	7.0
Tools to Optimize Equpment Utilization	8	5.3	5.3



High Value, Lower Effort

2. **Fuel Savings**
    a. Trucking logistics/software
    b. Equipment Utilization
    c. Utilize auto engine idle/shutdown features on equipment

5. **Pavement Construction: thicker lifts**
    a. Reduce number of lifts
    b. Increase NMAS/reduce asphalt binder

High Value, Increased Effort

7. **Optimized Pavement/Project Designs:** Address existing conditions with most efficient solution
    a. Starts to fit into discussion for #1 action item

1. **Construction Quality**
    a. Primary impact: longer service life (initial and rehab)
    b. Secondary impact: lower LCC, less raw materials consumed, less traffic delays
    c. Best Management Practices (BMPs)
        i. Increased Density – Increased Durability
        ii. Superpave 5 – Indiana
        iii. Truck tarping
    d. Proper mix type selection
        i. Agency
    e. Pavement design practices
        i. Agency
    f. Technologies
        i. IR thermal scanning
        ii. Dielectric Profiling System
        iii. Intelligent Compaction
        iv. Autonomous machine control
        v. Data management for optimized process control and pavement management systems

Actions:

- Methods for agencies to allow contractors to achieve higher densities with no additional costs
    - Specification modifications
        - Lift thickness
        - Mix/Pavement Design methodologies
    vi. Understanding high density impacts on performance ~98%
    vii. Design procedures for the agency
        1. Perpetual
    viii. Agency personnel education
    ix. Paving Technology training

x. Increased use of the multi-cool tool

6. **Utilize Rubblization and Other In-place Recycling Methods**

8. **Tools to Optimize Equipment Utilization**
    i. Example: Ideal roller suite and settings to achieve density for given mix, production, thickness, weather, etc.

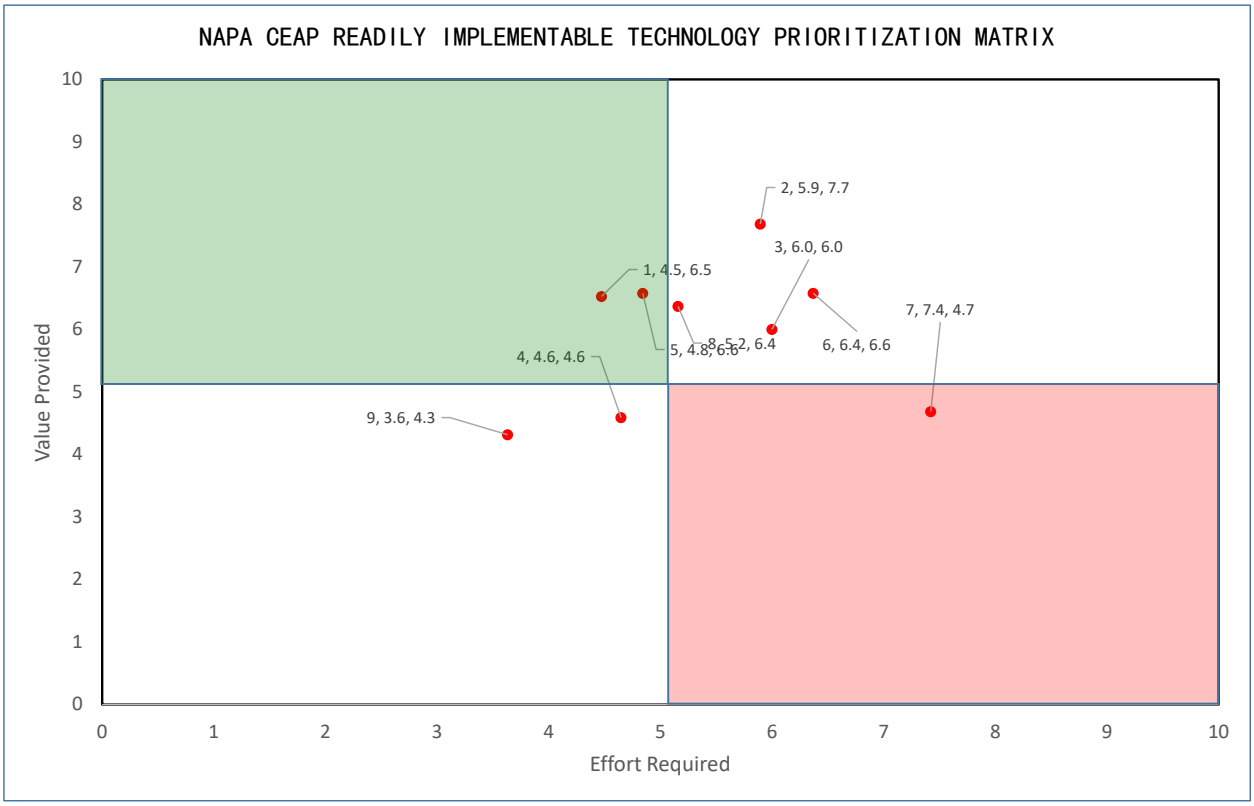
3. **Fuel Type**
    a. Electric
    b. Biodiesel

Lower Value, Lower Effort

4. **Paperless Communication:** faster and more efficient
    a. Tickets
    b. Project document/as-builts/plans/etc.

MIXTURES, MATERIALS, & QUALITY:

NAPA CEAP READILY IMPLEMENTABLE TECHNOLOGY TO LOWER CARBON FOOTPRINT MATRIX DEVELOPMENT			
Item	**Matrix ID**	**Effort Required (0 to 10, 10 High)**	**Value Provided (0 to 10, 10 High)**
Increased Use of WMA Technology	1	4.5	6.5
Balanced Mix Design	2	5.9	7.7
Utilize High-end Mixes	3	6.0	6.0
OGFC - Open Graded Friction Courses	4	4.6	4.6
Simple BMD (SBMD)	5	4.8	6.6
Utilize High Recycle Mixes	6	6.4	6.6
Utilize Other Waste Material Streams in HMA/WMA	7	7.4	4.7
Rejuvenator Use	8	5.2	6.4
Paperless Communication	9	3.6	4.3



High Value, Lower Effort

1. **Increased Use of WMA Technology**
    - Primary impact: reduced plant drying energy
    - Secondar impact: increased recycled opportunity
    - Challenges
        - Cost of additives in low bid system when not required – foaming may not face same challenge
        - Not as plug and play – some applications have challenges

5. **Simple BMD (SBMD)**: for lower volume roads
    a. Tool to increase RAP/RAS while improving performance for counties/cities (e.g., local municipalities)

High Value, Increased Effort

2. **Balanced Mix Design** – Performance Based
    a. Primary impact: increased recycle
    b. Secondary impact: local materials use, less virgin aggregate / asphalt consumed (less dependency on crude)
    c. Allows innovation / Improves mixture quality / extends pavement life
    d. Market competition

    Actions
    - Educate members

6. **Utilize High-Recycle Mixes**

8. **Rejuvenator Use**
    a. Primary Impact: increased recycle
    b. Secondary impact: less virgin aggregate / asphalt consumed (less dependency on crude)

3. **Utilize High-end Mixes** (e.g., Polymer, GTR modified)
    a. Preservation techniques to extend pavement life.

Lower Value, Lower Effort

4. **OGFC Open Graded Friction Courses**
    a. Surface mix performance improvements

9. **Paperless Communication:** faster and more efficient
    a. QC and QA testing results
    b. Database systems with opportunities to increase quality and develop/monitor KPIs real time

Lower Value, Increased Effort

7. **Utilize Other Waste Material Streams in HMA/WMA Mixtures**