REVIEW OF SOUTH AFRICA'S APPLIANCE ENERGY CLASSES AND IDENTIFICATION OF THE NEXT SET OF ELECTRICAL EQUIPMENT FOR INCLUSION IN THE NATIONAL STANDARDS AND LABELLING PROJECT: NEW ELECTRICAL APPLIANCES

Electric Motor Industry Stakeholder Workshops

4 April 2019

Energy Efficient Strategies

KEVIN LANE OXFORD LTD

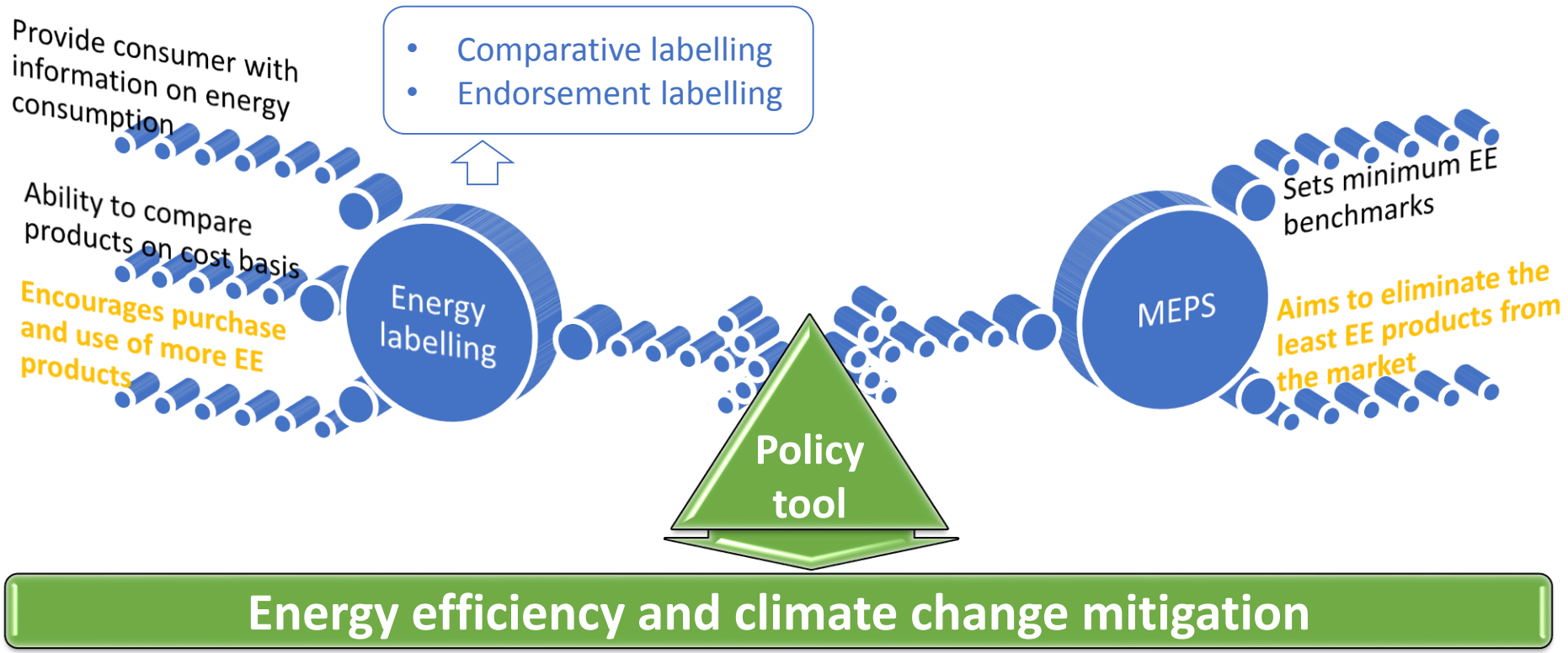
URBAN-ECON Development Economists

Agenda

1. Policy tools considered
2. Scope of work and boundaries
3. Screening process
4. Methodology
5. International MEPS trends
6. SA analysis
7. Recommendations
8. Open discussion

1. Policy tools considered

Energy labelling and MEPS



Policy options to improve energy efficiency

- Two main policy options considered are energy labelling and Minimum Energy Performance Standards (MEPS)
- These are typically enacted through government legislation and regulations
- When is labelling most effective?
  - When consumers purchase products and pay the energy bills
  - When products are on display at purchase and can be compared
  - Where there is a wide range of energy efficiency on the market
- Labelling creates *market pull* to encourage suppliers to offer more efficient products to the market

Policy options to improve energy efficiency

- When is MEPS most effective?
  - When product purchasers do not pay energy bills (can be different parts of a company, landlord and tenant)
  - When products are not on display for sale (purchased on specifications or from catalogues)
  - When there is a significant range of efficiency available (internationally) but this is not always present on the local market
- MEPS is a *market push* to ensure that all products offered for sale meet a minimum efficiency level

2. Scope of work and boundaries

Study objectives (as per TOR)

1. To identify a new set of electrical equipment (residential or commercial) to which compulsory minimum energy efficiency MEPS and/or labelling could be introduced
2. To recommend timelines for implementation of improved and new minimum energy performance levels for the next set of electrical equipment
3. To conduct an impact assessment analysis of the proposed mandatory requirements for each appliance on consumers, retailers, South African manufacturers, and importers
4. To quantify the potential energy and greenhouse gas emission savings that could be achieved through new MEPS and/or labelling over a 10 and 30-year period

Project Scope (UNDP and DOE)

1. **Purpose:**
   - Identify new electrical appliances that could be considered for a Standards & Labelling Programme
2. **Key considerations:**
   - 4-10 products (residential and commercial)
   - Must include distribution transformers
   - Main goal – reduce electricity usage and GHG emissions
3. **Approach:**

3. Screening

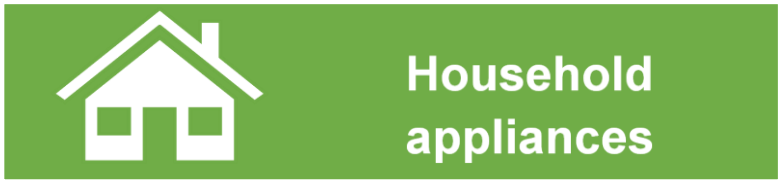
Screening process

All lights, appliances	• **List all lights and appliances products** • MEPS and labelling in 75 countries	**96**
0. Scope	• **Boundaries - Remove products out of scope** • Products covered by MEPS in SA already • Remove any non-electric products	**72**
1. MEPS elsewhere	• **Globally regulated products** • At least two countries/economic blocks • EU MEPS/Ecodesign counted as one	**24**
2. Energy Savings	• **Likley future energy savings from new MEPS** • Efficiency range, sales, usage levels and power • Relative significant future potential energy savings	**9**
3. Ease of adoption	• **Check for adoption, implementation and operation issues** • Relevant test procedures in place, ideally SAN (or IEC, ISO) • MVE issues, especially any verification issues	
4. Other barriers	• **SA appropriate - technical or other barriers** • Technologies, increased purchase costs, rate of market change, local manufacturing impacts	

Shortlisted electric equipment

Heating and cooling equipment

Chiller systems



Household appliances

None

Office equipment and electronics

Computers
Televisions
External Power Supplies

Other equipment (mostly commercial and industrial)

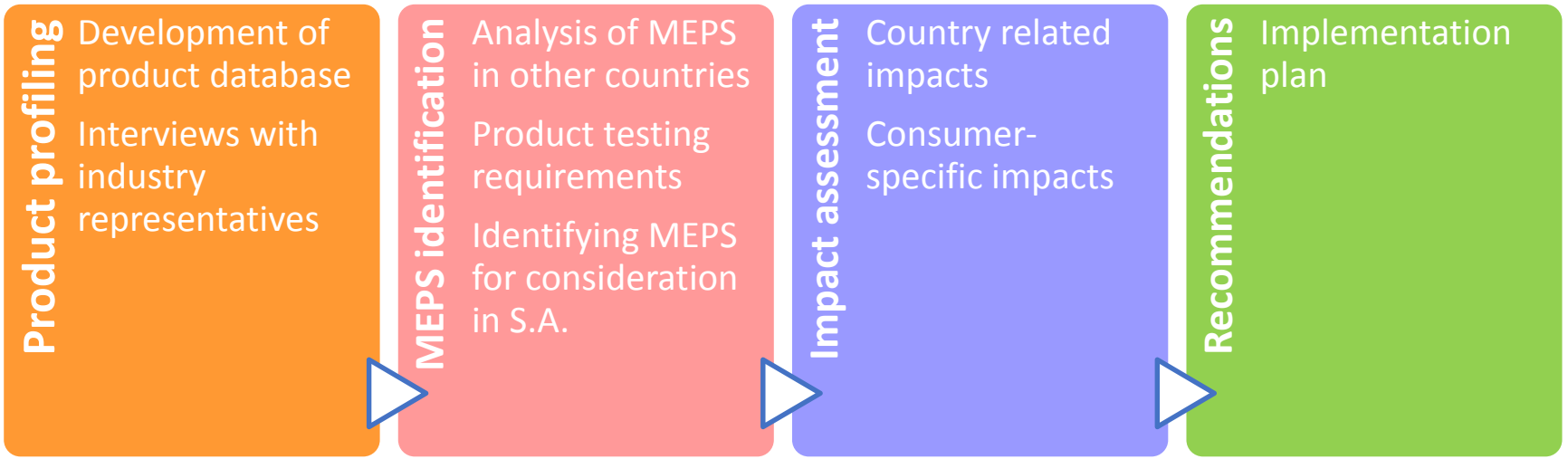
Motors - 3 Phase
Pool Pumps
Refrigerators – Commercial
Distribution Transformers

Note: Large ACs (>7.1kW) to be covered in a separate study

4. Methodology

Methodology

1. Data sources:
   - In-house developed database of electric appliances (web crawling, brochures, etc.)
   - Interviews with the industry representatives
2. Approach:

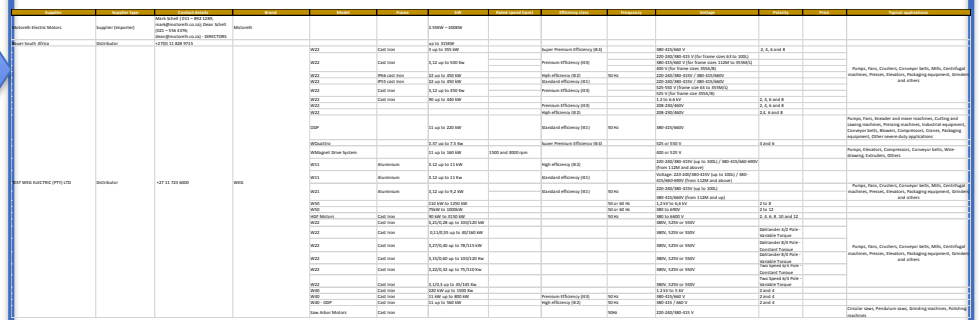


Data sources

- Stakeholder engagements
- Trade info (TradeMap data portal)
- International MEPS programs covered
- Field data collection
  - Online shops
  - Web crawling/catalogues

In-house product database:

- 23 brands and 245 models
- Suppliers, supplier type and contact info
- Frame type, motor size, rated speed
- Efficiency class, frequency, voltage, rated torque
- Motor dimensions, weight, poles
- Price and motor applications



Celebrate Development Diversity

URBAN-ECON Development Economists

5. International MEPS trends

Product overview

- **Major component** of electricity consumption in the **industrial sector**
- Responsible for 45% of global electricity demand
- Significant saving potential:
  - **Long operating hours**
  - Despite small differences in efficiencies

International Review of MEPS for motors

- 42 countries have MEPS
  - Incl 28 European countries
- Most cover three phase 0.75kW to 375kW
- A few cover single phase and small motors (US, Mexico, China)
- IEC60034 is widely used as the test method around the world
- IEC now also defines efficiency levels (IE1- IE4) in IEC60034-30-1 by frequency, poles and size

Minimum Requirements Electric Motors worldwide

Efficiency Levels 3-phase induction motors (Low Voltage < 1000 V)	Efficiency Classes IEC 60034-30-1, 2014 Global classes IE-Code [I]	Testing Standard IEC 60034-2-1, 2014 incl. stray load losses	Performance Standard Mandatory MEPS [III] National Policy Requirement	
Super Premium Efficiency	**IE4**	**Preferred Method [II]**		
Premium Efficiency	**IE3**	**Summation of losses with load test: Additional losses P_{LL} determined from residual loss**	**Canada**	(0.75 - 150 kW)
			Mexico	(0.75 - 375 kW)
			USA	(0.75 - 375 kW)
			USA ***	(0.18 - 2.2 kW)
			South Korea	(0.75 - 375 kW)
			EU 28*	(0.75 - 375 kW)
			Switzerland*	(0.75 - 375 kW)
			Turkey*	(0.75 - 375 kW)
			Japan Toprunner	(0.75 - 375 kW)
			Israel	(7.5 - 375 kW)
			Taiwan	(0.75 - 200 kW)
			Saudi Arabia	(0.75 - 375 kW)
High Efficiency	**IE2**		**Australia**	(0.75 - 185 kW)
			Brazil **	(0.75 - 185 kW)
			Canada	(151 - 375 kW)
			Chile	0.75 - 375 kW
			China	(0.75 - 375 kW)
			Colombia	(7.5 - 373 kW)
			EU 28*	(IE2 + VFD)
			New Zealand	(0.75 - 185 kW)
			Israel	(0.75 - 5.5 kW)
Standard Efficiency	**IE1**		**Costa Rica**	
			Chile	(0.75 - 7.5 kW)
			Vietnam	

28 05 2018
Impact Energy Inc. & TPA advisors

I) Output power: 0.12 kW - 1000 kW, 50 and 60 Hz, line operated 2-, 4-, 6- and 8-poles

II) for 3-phase machines direct online, < 1 kV, rated output power < 1000 kW

III) Minimum Energy Performance Standard

*) European Union, Norway: IE3 or IE2 + VFD; 0.75 - 375 kW

**) IE3 per 30-8-2019; 0.12 - 370 kW

***) Polyphase: eq. to IE3; single phase: IE2 levels or above

5. SA analysis

Market Overview

- Over 23 brands identified
  - All motors are imported
- Different sizes supplied to the market
  - 0.09kW to 1 500kW
  - Majority of the multiphase motors - IEC low voltage categorisation
- Some motors already complying with IEC efficiency codes
  - Among the IE rated:
    - **IE1: 60%**
    - IE2:10%
    - **IE3: 30% (mainly large industrial users; long operating hours)**
- Market size (low voltage industry motors) > 200 000 units p.a.

Usage and supply

Suppliers

- Most popular brands - WEG, ABB, Siemens, and Regal
  - Small companies (5,000 upa)
  - Large companies (50,000 upa)
- All imported
- Distribution:
  - Directly to end-user
  - Wholesalers/dealers

Usage/application

- Mainly industrial sector
- Wide application: pumps, fans, elevators, conveyors, power packs, grinders, pressing machines, compressors, industrial equipment, blowers, extruders, machinery, etc.
- End-users:
  - Small motors with limited usage: highly sensitive to initial costs
  - Medium and large motors with continuous usage: prioritise efficiency

Prices

- Positive correlation between efficiency and price :
  - Better quality lamination
  - More copper
  - Better cooling fan
  - Precise machining of the air gap
- Local prices – at par:
  - China < Brazil & Europe
  - Chinese motors: +20% import duty
  - Brazilian motors: +18% import duty
- Price:
  - IE3 > IE1 by 15%
  - IE3 and IE2 – small difference

Impact analysis – assumptions

- Standard sizes across the full range were selected
- Supplementary data: EMSA and MEPS Reg Impact Assessments in Australia

Electr motor size (kW)	Assumed market share	Assumed Usage (Hrs/yr)	Assumed Loading	Assumed current IEC energy efficiency rating shares			
				IE0	*IE1*	*IE2*	*IE3*
0.75	19%	2500	75%	70%	20%	7%	3%
1.5	15%	2500	75%	70%	20%	7%	3%
3	13%	2500	75%	70%	20%	7%	3%
5.5	12%	3000	75%	70%	20%	7%	3%
11	10%	3500	75%	65%	20%	10%	5%
18.5	9%	4000	75%	60%	20%	10%	10%
45	8%	4500	75%	55%	20%	10%	15%
90	6%	5000	75%	50%	20%	10%	20%
160	5%	5500	75%	45%	20%	10%	25%
300	3%	6000	75%	40%	20%	10%	30%

Impact analysis – assumptions

- Total annual electric motor sales of 200 000 (industry rep estimates)
- Market share by poles: 40% 2 pole, 30% 4 pole and 30% 6 pole
- Average efficiency a composite of various poles
- IE0 efficiency credentials estimated based on known IE1 and IE2 figures

Electric motor size (kW)	Loading impact 50%		Loading impact	Efficiency			
	Full efficiency	50% efficiency		IE0	IE1	IE2	1E3
0.75	0.77	0.67	87.0%	65.3%	71.5%	77.6%	80.7%
1.5	0.8	0.715	89.4%	71.9%	76.6%	81.3%	84.0%
3	0.825	0.75	90.9%	77.4%	81.0%	84.5%	86.8%
5.5	0.86	0.8	93.0%	81.5%	84.2%	86.9%	89.0%
11	0.885	0.835	94.4%	85.2%	87.2%	89.3%	91.0%
18.5	0.9	0.85	94.4%	87.3%	89.1%	90.8%	92.3%
45	0.925	0.89	96.2%	90.3%	91.6%	92.9%	94.0%
90	0.93	0.905	97.3%	91.8%	93.0%	94.1%	95.0%
160	0.93	0.9	96.8%	92.8%	93.8%	94.8%	95.7%
300	0.93	0.9	96.8%	93.0%	94.0%	95.0%	95.9%

Impact analysis – energy savings potential

$$Annual\ total\ energy\ consumption = \left(\frac{kW_{output}}{Efficiency * Loading\ impact}\right) * Year\ hours * Loading$$

Motor Size (kW)	Typical annual energy consumption (kWh/yr)				Annual energy consumption per scenario (kWh/yr)		Annual energy savings (kWh/yr)
	IE0	*IE1*	*IE2*	*IE3*	*BAU*	*MEPS*	
0.75	2 474	2 261	2 082	2 003	2 390	2 003	387
1.5	4 377	4 108	3 871	3 745	4 269	3 745	523
3	7 990	7 643	7 324	7 126	7 848	7 126	722
5.5	16 317	15 796	15 307	14 954	16 101	14 954	1 147
11	35 933	35 080	34 267	33 635	35 481	33 635	1 846
18.5	67 283	65 961	64 690	63 702	66 401	63 702	2 699
45	174 765	172 304	169 911	167 977	172 769	167 977	4 792
90	377 639	373 049	368 569	364 962	373 278	364 962	8 316
160	735 151	727 079	719 182	712 942	726 388	712 942	13 446
300	1 500 484	1 484 043	1 467 957	1 455 247	1 480 372	1 455 247	25 125

Impact analysis – consumer impact

Motor Size (kW)	1E1 Motors			IE3 Motors			Impact: 1E1 to 1E3		
	Energy Consumption (kWh/yr)	*Energy cost (based on R3/kWh tariff)*	*Average motor cost price (2, 4, 6 pole)*	*Energy Consumption (kWh/yr)*	*Energy cost (based on R3/kWh tariff)*	*Average motor cost price (2, 4, 6 pole)*	*Energy Savings (kWh)*	*Energy Savings Value*	*Cost Implications*
0.75	2 261	R6 783	R3 601	2 003	R6 009	R4 141	258	R774	R540
1.5	4 108	R12 324	R4 638	3 745	R11 235	R5 337	363	R1 089	R699
3	7 643	R22 929	R6 750	7 126	R21 378	R7 763	517	R1 551	R1 013
5.5	15 796	R47 388	R9 359	14 954	R44 862	R10 792	842	R2 526	R1 434
11	35 080	R105 240	R12 311	33 635	R100 905	R14 191	1 445	R4 335	R1 880
18.5	65 961	R197 883	R29 640	63 702	R191 106	R34 093	2 259	R6 777	R4 453
45	172 304	R516 912	R72 388	167 977	R503 931	R83 256	4 327	R12 981	R10 868
90	373 049	R111 9147	R124 918	364 962	R1 094 886	R143 679	8 087	R24 261	R18 762
160	727 079	R2 181 237	R197 294	712 942	R2 138 826	R227 062	14 137	R42 411	R29 768
300	1 484 043	R4 452 129	R296 832	1 455 247	R4 365 741	R353 878	28 796	R86 388	R57 047

- Savings based on non-residential tariff of R3/kWh
- For continuous users: higher costs of the unit for the smaller sized motor - offset by operational savings
- For intermittent users: negligible savings

Other considerations

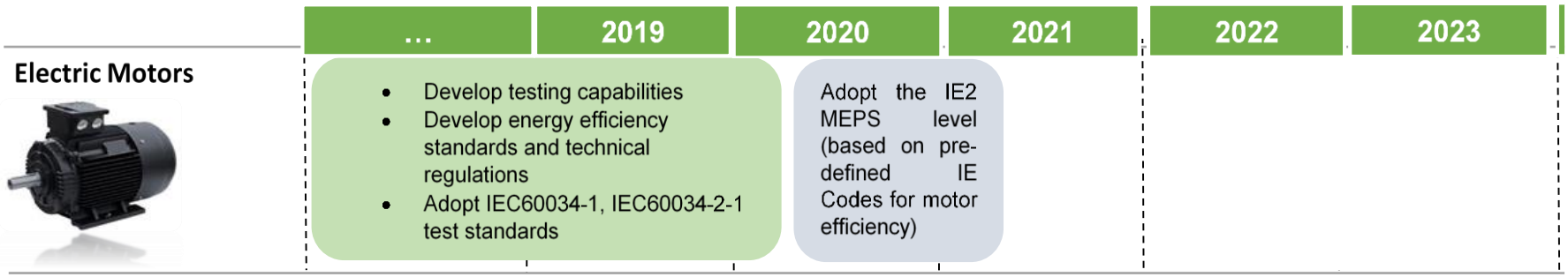
- Local manufacturing industry – non existent

BUT

- Motors - inputs into other products
  - Might be negatively impacted
  - Risk of inflated prices to cover increased costs

7. Recommendations

Recommendations for electric motors



- **Tier 1 = IE2 in 2020** with **Tier 2 = IE3 in 2022**
  - This would bring South Africa into line with major economies in many parts of the world
  - Scope initially three phase 0.75kW to 375kW
  - Scope to cover 2, 4 and 6 pole motors (could consider 8 pole motors as well)
- To align with Europe, allow an IE3 motor or an IE2 motor with a variable speed drive for Tier 2
- **For small motors** 0.18kW to <0.75kW and **single phase motors** ≥0.75kW:
  - Consider only after regulation of three phase
  - Large quantity = difficult to monitor and enforce
  - Will require adoption of US levels (IEC does not cover single phase)

8. Discussion and questions?

Thank you

Elena Broughton
E-mail: elena@urban-econ.com
Tel: +27 12 342 8687
Website: www.urban-econ.com

Celebrate Development Diversity

URBAN-ECON
Development Economists